New Capabilities for Comms, Radar, & EW with an SDR-based Research Platform

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Evolution of the Wireless World

Transforming All Industries

Software-Defined Solutions

High-Performance Requirements

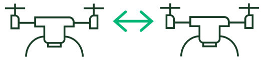
Higher Frequency

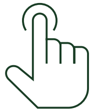
Wideband

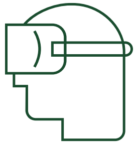
Multi-Channel

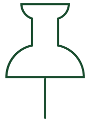
Evolving Application Requirements of 5G and Beyond

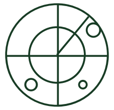
Applications


WIRELESS COGNITION


WIRELESS SENSING


IMMERSIVE XR

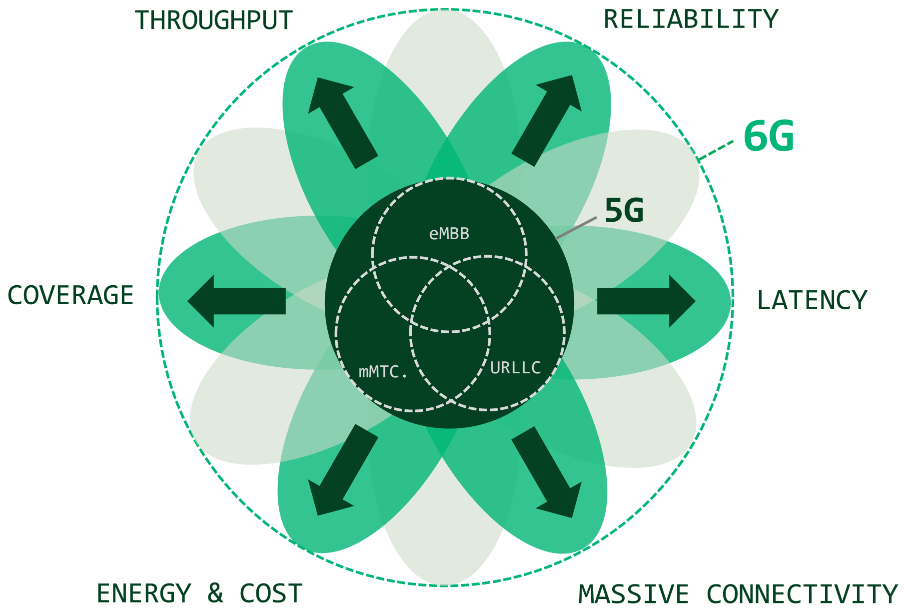

DEVICE LOCATION


IMAGING & RADAR


MOBILE HOLOGRAM

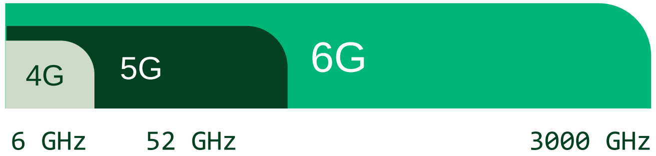
AND MORE

Requirements



Enabling Technologies

Terahertz Frequencies



Extreme MIMO
More Antennas and Distributed Radios

Joint Communication & Sensing

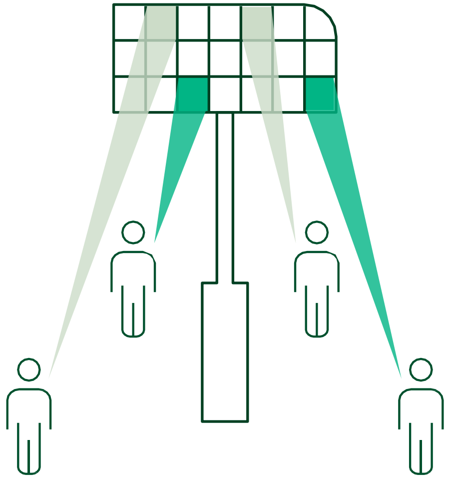
Spectrum Efficiency & Sharing

AI and Machine Learning

Enabling Technologies That Could Drive 6G

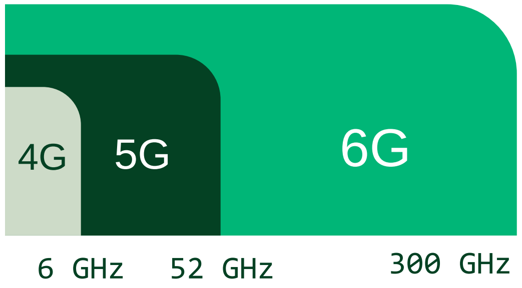
Evolution of MIMO

Build on multi-antenna techniques from 5G with more elements and distributed architecture.



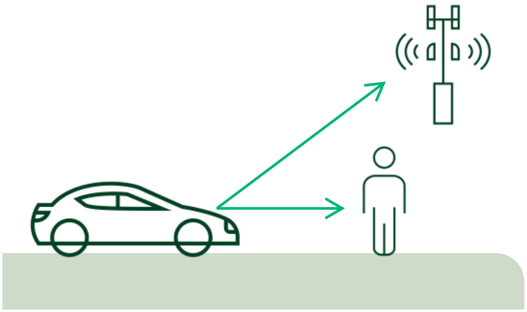
Sub-Terahertz

Utilize extremely wide bandwidths at frequencies once thought impractical for commercial wireless.



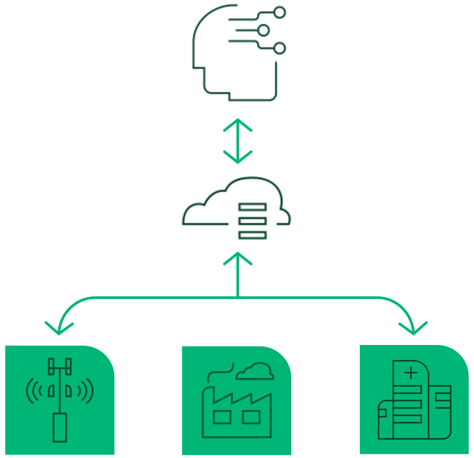
Joint Communications and Sensing

Improve spectral usage by combining sensing and radar functions with communications channels.



Machine Learning and Artificial Intelligence

Leverage new techniques across all 6G – from the signal chain to the network topology.



USRP Product Portfolio Overview





	Ettus Research USRP B2XX	Ettus Research USRP N310 / N32X	Ettus Research USRP X310	Ettus Research USRP E320	NI Ettus USRP X410
Frequency	70 MHz – 6 GHz	3 MHz-6 GHz (N32X) 10 MHz-6 GHz (N310)	*10MHz – 6 GHz	70 MHz – 6 GHz	**1 MHz – 8 GHz**
Bandwidth	56 MHz	200 MHz (N32X) 100 MHz (N310)	*160 MHz	56 MHz	**400 MHz**
Channels	2 Tx, 2 Rx	2 Tx, 2 Rx (N32X) 4 Tx, 4 Rx (N310)	2 Tx, 2 Rx *4 Rx (TwinRx)	2 Tx, 2 Rx	**4 Rx, 4 Tx**
RF Performance	Good	Best	Best	Good	**Better**
Architecture	Integrated	Integrated	*Configurable w/ Daughterboards	Integrated	**Integrated**
Communication	USB	10 GbE or PCIe	10 GbE or PCIe	10 GbE	**100/10/1 GbE or PCIe**
Synchronization	2x2 MIMO	Up to 128x128 (N32X) Full Phase Synchronization	*2x2 MIMO	2x2 MIMO	**4x4 MIMO**
SW Support	GNU Radio, C++, Python, MatLab, LabVIEW	GNU Radio, C++, Python, MatLab, RFNoC	GNU Radio, C++, Python, MatLab, RFNoC, LabVIEW, LabVIEW FPGA	GNU Radio, C++, Python, MatLab, RFNoC	**GNU Radio, C++, Python, RFNoC, *LabVIEW *Q4 2021***
Key Features	Low SWAP-C, Highly portable	Stand Alone, Wide bandwidth, Multi-Channel Sync Ready (N32X)	*Configurable RF Front End, Programable FPGA	Low SWAP, Embedded Deployable, Standalone	**RFSOC Based, 5G Ready, Wide Band, Multi-Channel**

RELEASED

NI Ettus USRP X410 Product Overview

RF Capabilities

Frequency Range:	1 MHz - 8 GHz
Signal Bandwidth:	400 MHz
Receive Channels:	4X
Transmit Channels:	4X
Max TX Power:	up to 22 dBm[1]
Max RX Power:	0 dBm

[1] see specification for details

Digital Capabilities

Xilinx Zynq Ultrascale+ RFSOC
- Built-in quad core ARM processor

Onboard IP: SD-FEC, DDC, DUC

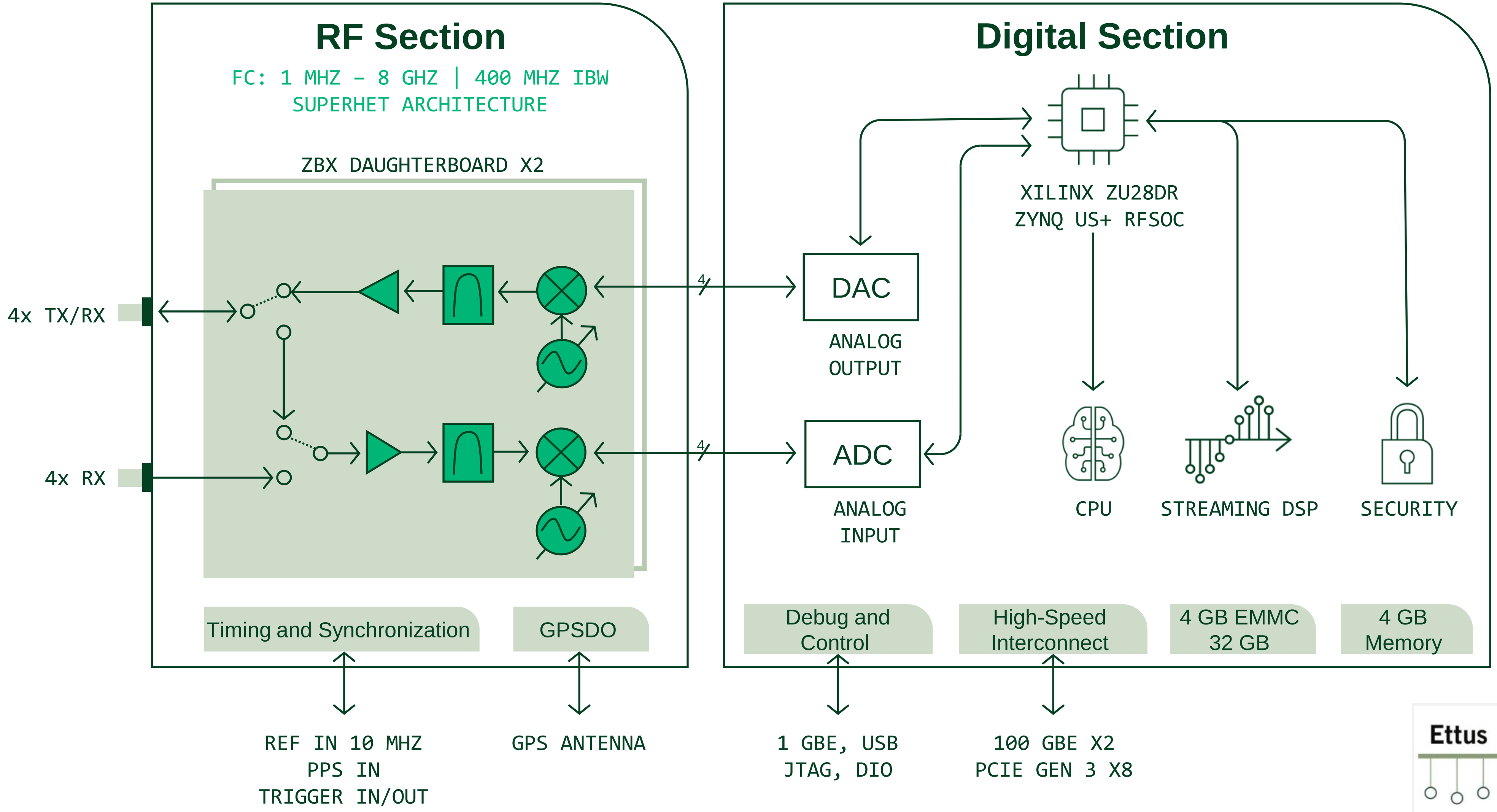
Interface options: dual QSFP28, PCIe Gen 3 x8[2]

Synchronization: 10 MHz / PPS, GPS DO option

Software:
- Open source (GNU Radio, RFNoC, UHD)
- NI-USRP[2], LabVIEW FPGA[2]

[2] available in September 2021

The NI Ettus USRP X410 | Hardware Features



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The NI Ettus USRP X410 | Software Features

System Model

C/C++, MATLAB, SimuLink

python™

LabVIEW™

CPU Design

Embedded Coder®
MATLAB

python™

GNURadio
THE FREE & OPEN SOFTWARE RADIO ECOSYSTEM

LabVIEW™

FPGA Design

RFNoC via GRC
Xilinx Vivado,
HDL Coder®

LabVIEW FPGA

Deploy

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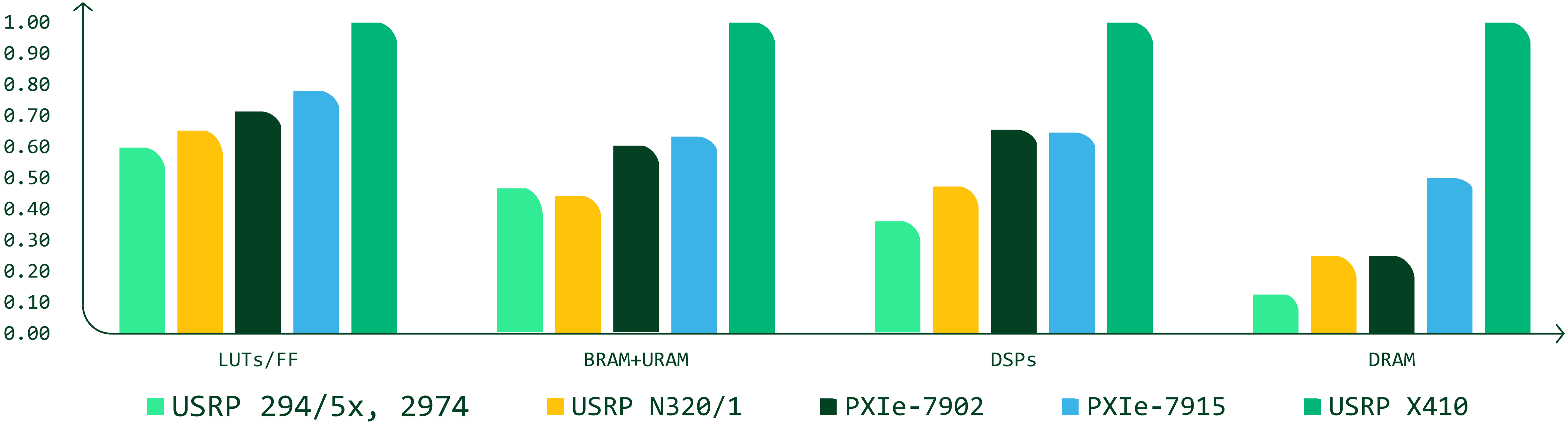
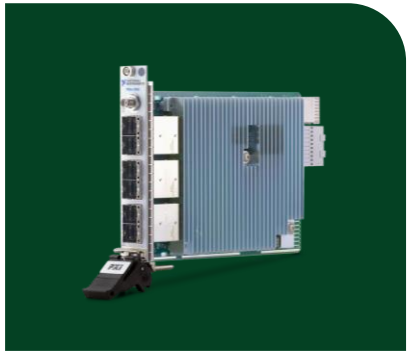
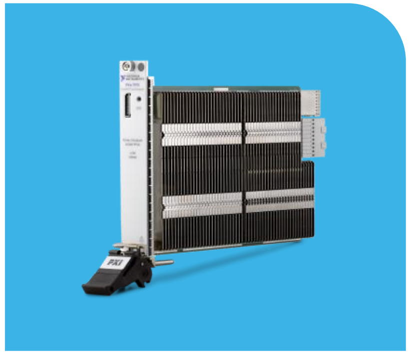
USRP/FlexRIO FPGA Resource Comparison






USRP X410 Overview – Front Panel

RF Channel 0
1 MHz – 7.2 GHz
Up to 400 MHz BW

RF Channel 1
1 MHz – 7.2 GHz
Up to 400 MHz BW

RF Channel 2
1 MHz – 7.2 GHz
Up to 400 MHz BW

RF Channel 3
1 MHz – 7.2 GHz
Up to 400 MHz BW

Daughter board 0

Daughter board 1

Digital I/O
12 bits
100 Mbit/s

Digital I/O
12 bits
100 Mbit/s

USRP X410 Overview – Rear Panel

PCIe
Gen3 x8
~7 GB/s

8 Lanes @
up to 25 Gbps:
10/100 GbE, Aurora

12V Power

Clocking SMA Connectors
REF IN, PPS IN, TRIG I/O,
GPS Antenna

Front to back airflow
Field replaceable fan housing

ARM APU Connections
Console/JTAG, USB, 1 GbE

Introducing the Most Powerful USRP Yet !

The NI Ettus USRP X410

Ettus Research™
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OPEN AIR INTERFACE 5G Testbeds

3dB LABS

Advanced Signals Intelligence

GNURadio Ready
THE FREE & OPEN SOFTWARE RADIO ECOSYSTEM

RFNoC Ready

See more at
www.ni.com/sdr
www.Ettus.com

See the demo in the NI / Ettus Research Booth
(Virtual and In Person)

Radar/EW Research Platform for SDR

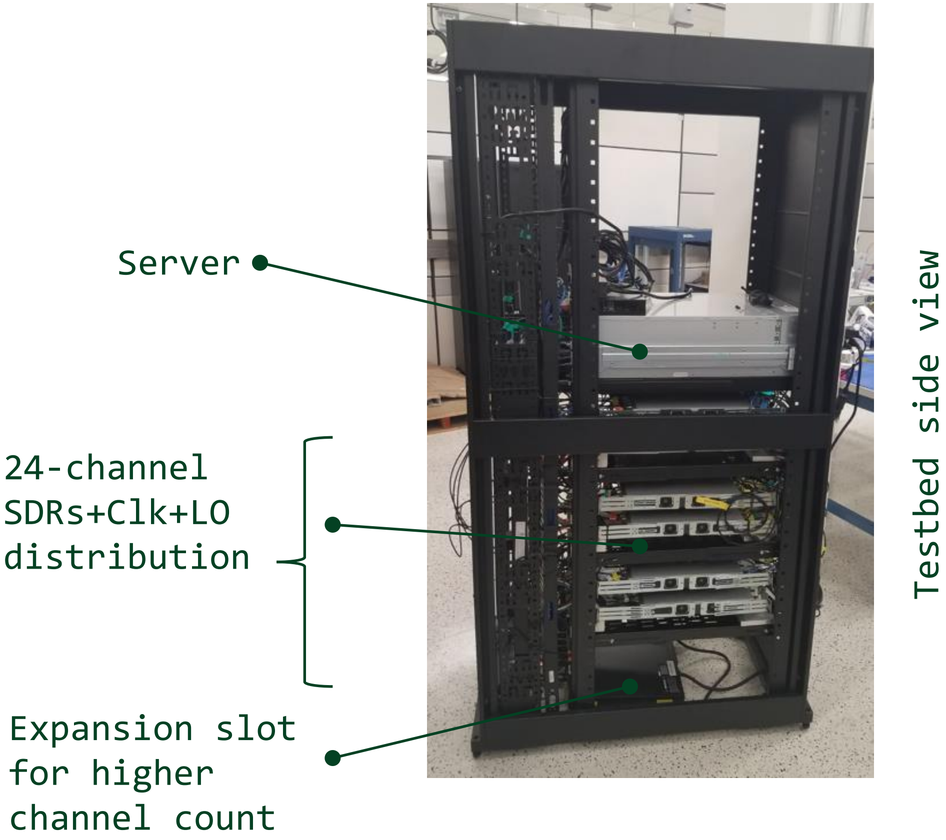
Radar/EW Research Platform for SDR

Abhay Samant – Chief Software Engineer Aerospace and Defense Systems R&D

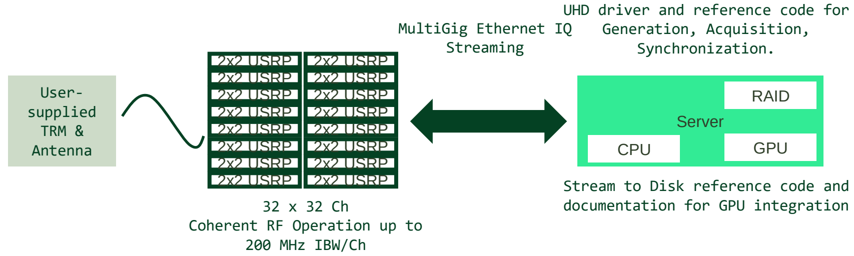
Radar/EW Research Platform Reference Architecture

H2 2021

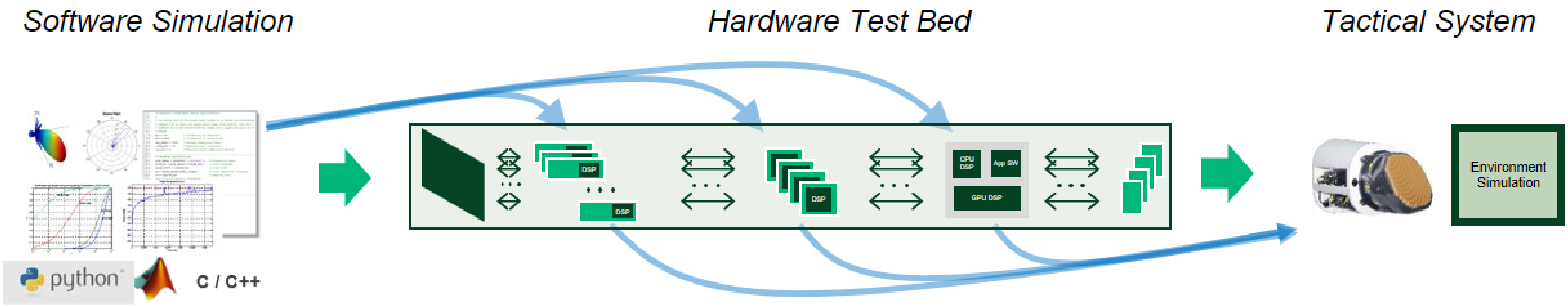
- Enables radar/EW researchers struggling to rapidly prototype new concepts to move quickly from software simulation to hardware demonstration, ultimately turning novel concepts into fielded capability faster
- Key Features
  - Direct Conversion RF Sampling (200 MHz IBW) with **NI USRP** (L, S, C band)
  - Coherent operation through duration of experiments w/ LO, RefClk, and PPS sharing
  - 32 Channel TxTx,RxRx,TxRx Synchronization and Streaming (Ref C++ code, System Configuration)
  - Waveform Generation from File (C++) using RFNoC Replay blocks
- Multiple open-source software programming options, including C++ and Python
- System specification datasheet for array synchronization and waveform generation/acquisition example code for USRP
  - Repeatability better than 10deg, Stability better than 1deg
  - Target: Full rate streaming 8 channels, reduced rate streaming at higher channel count
- Documentation for integrating GPU-based DSP and MATLAB Host programming
- NI-Supported Code available for open-source access on GitHub
- NI Technical Consulting Services for project acceleration and risk mitigation



NI USRP-based CogRF Test Bed



Getting from the Whiteboard to Proven Concept



Develop and simulate algorithms and system in software

Develop hardware test bed, iterate with offline processing, migrate processing to hardware

Validate algorithms against simulator and real-world scenarios, iterating as necessary

Migrate validated algorithms to mission hardware, perform integration testing/validation

USRP N320 / N321

Common:

3 MHz – 6 GHz range

200-MHz BW per channel

2X2 MIMO

200/245.76/250-MHz sample rates

Preselection filters

Dual SFP+ ports (1 GbE, 10 GbE, Aurora)

QSFP+, RJ45

GPSDO

Ethernet-based sync (White Rabbit)

Stand-alone operation

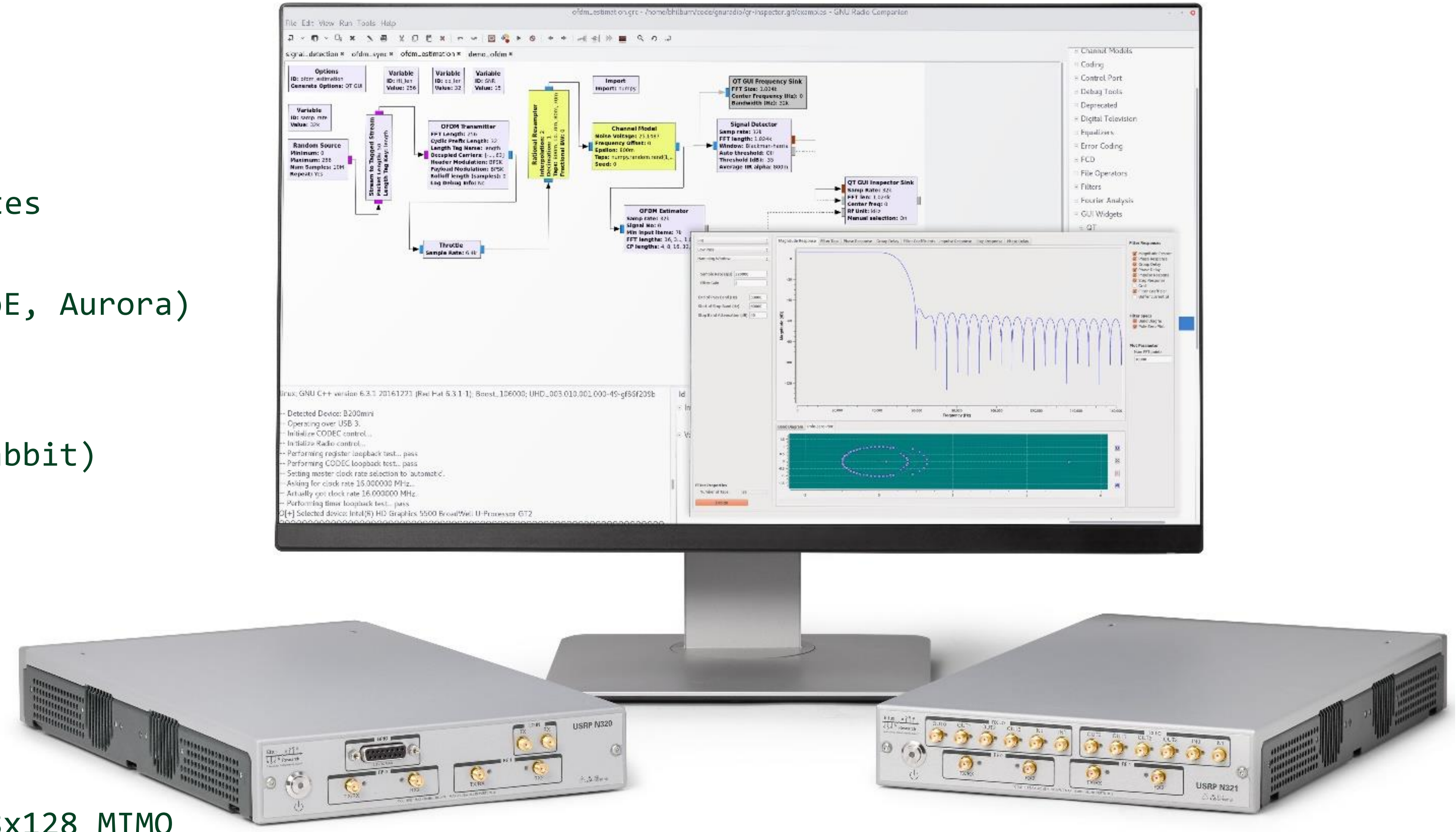
N320:

Zynq XC7Z100-2FFG900I

External LO input ports

N321:

LO Distribution for up to 128x128 MIMO



GNU Radio

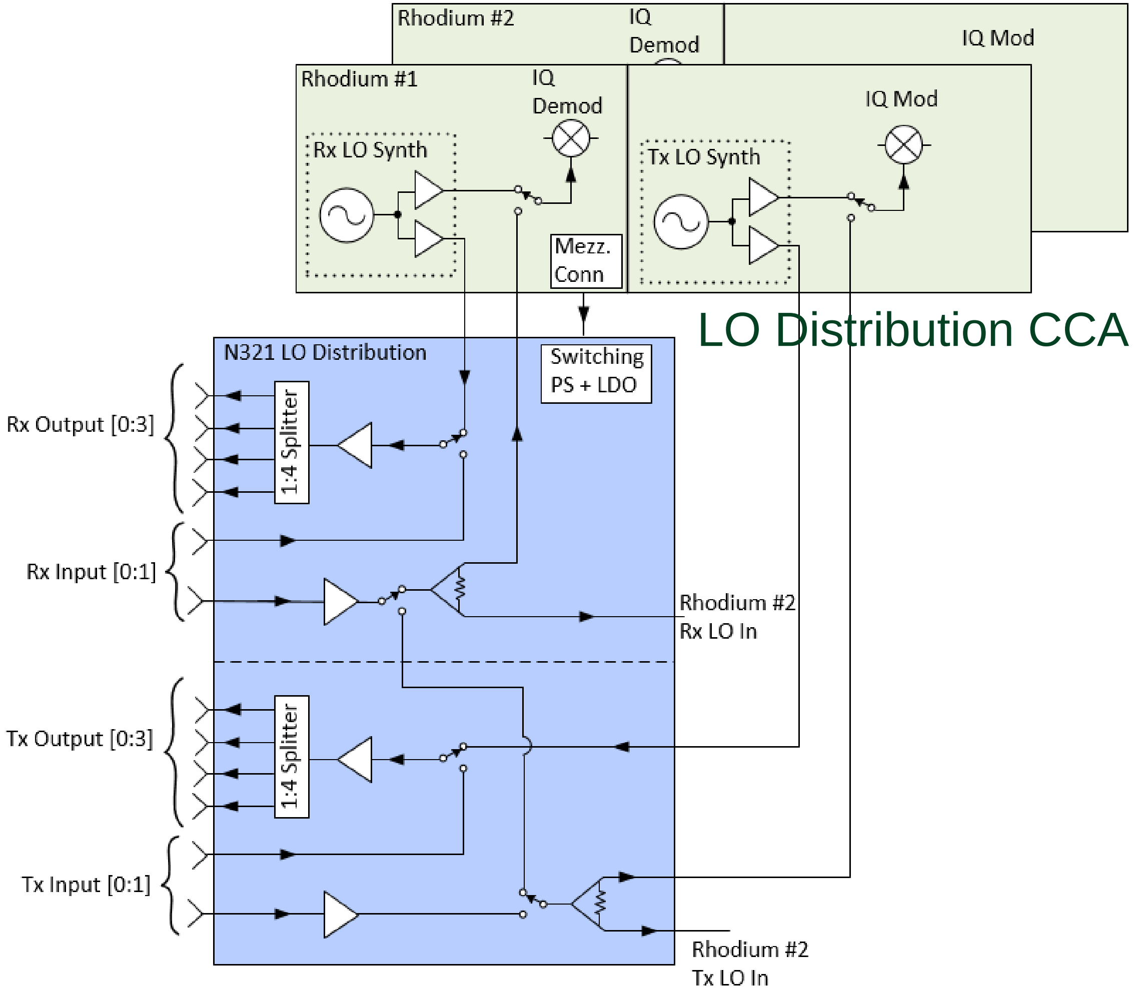
THE FREE & OPEN SOFTWARE RADIO ECOSYSTEM

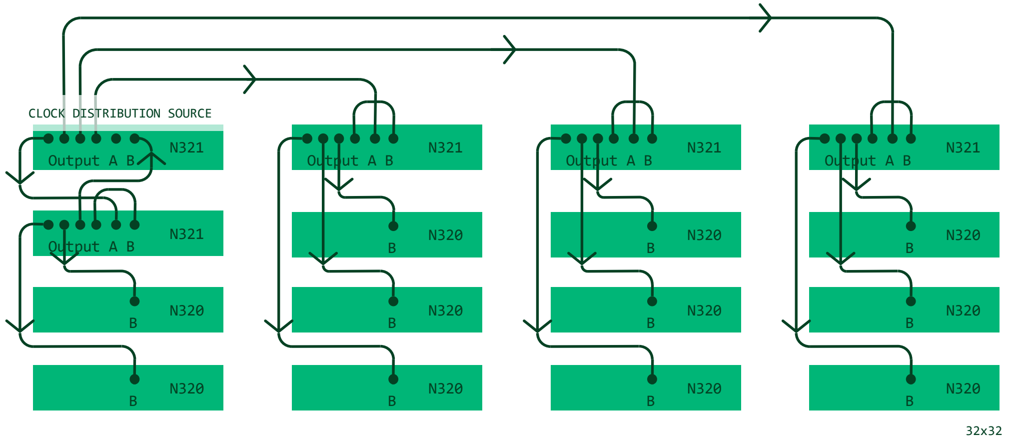
Ettus Research™

LO Distribution CCA Inside The N321

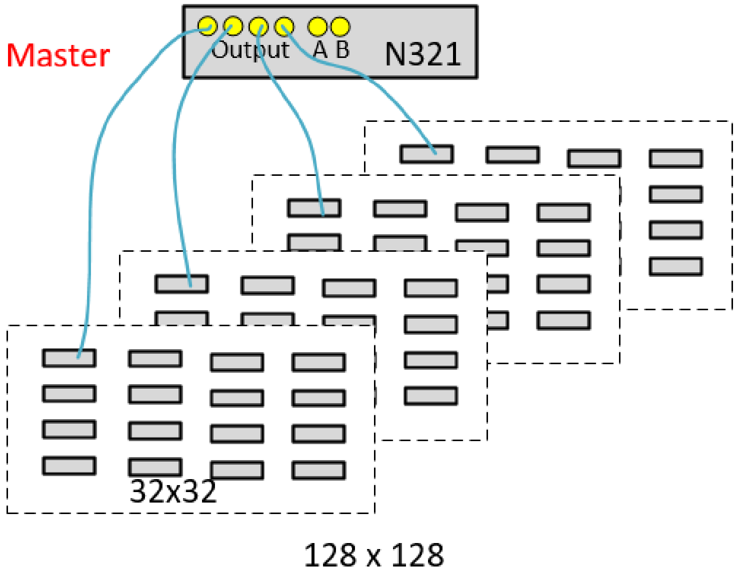
Star LO Distribution

Support up to 128x128 MIMO

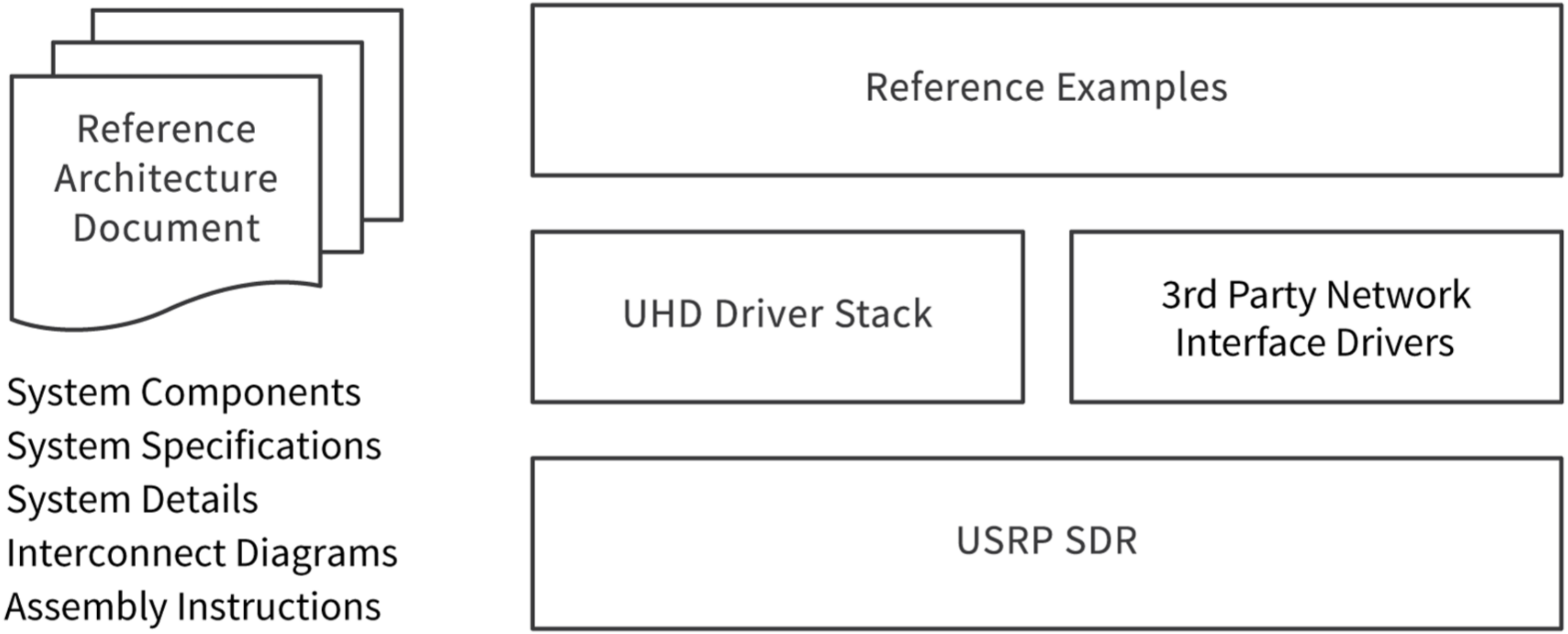




LO Distribution CCA Inside The N321

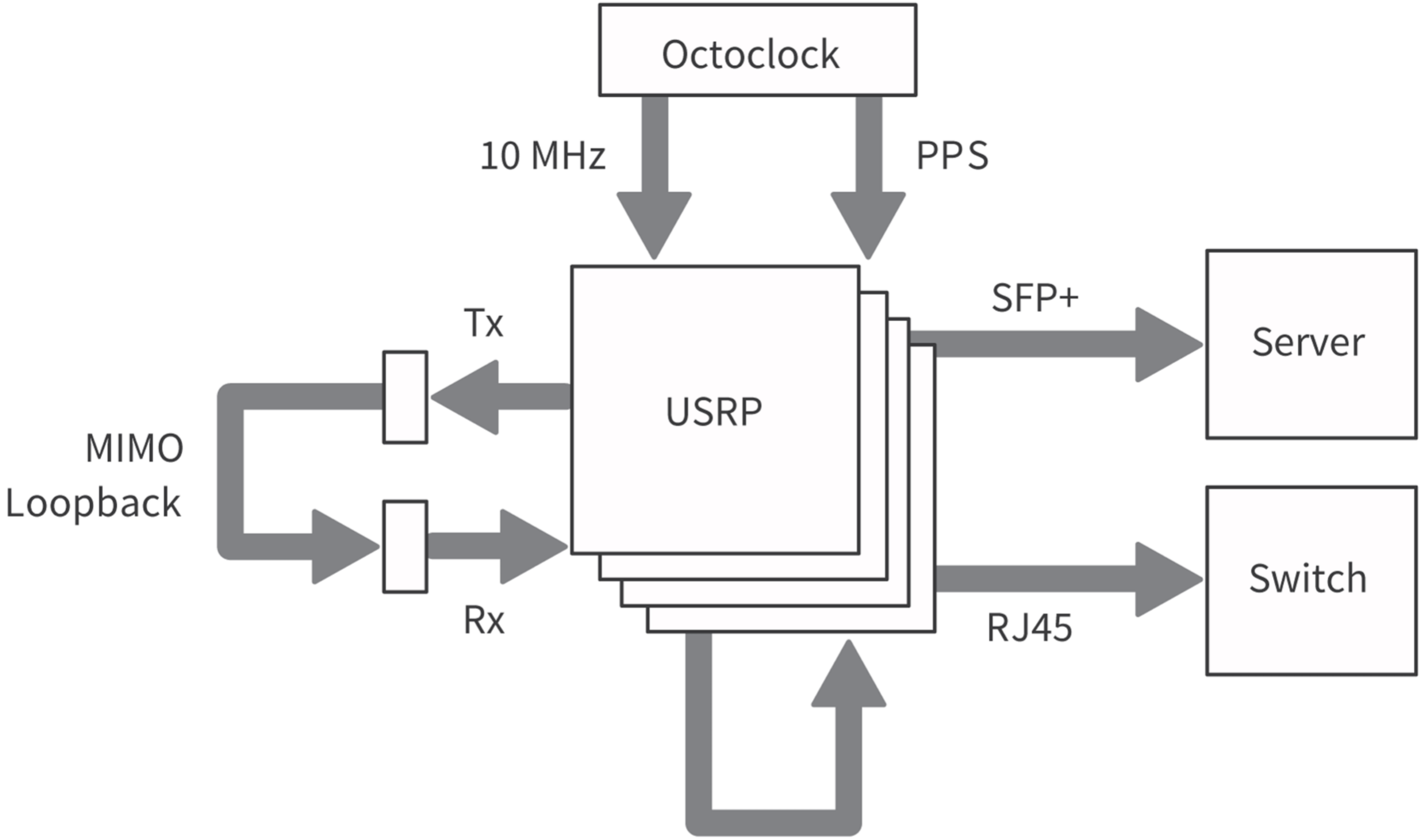


Software Architecture of Reference Architecture

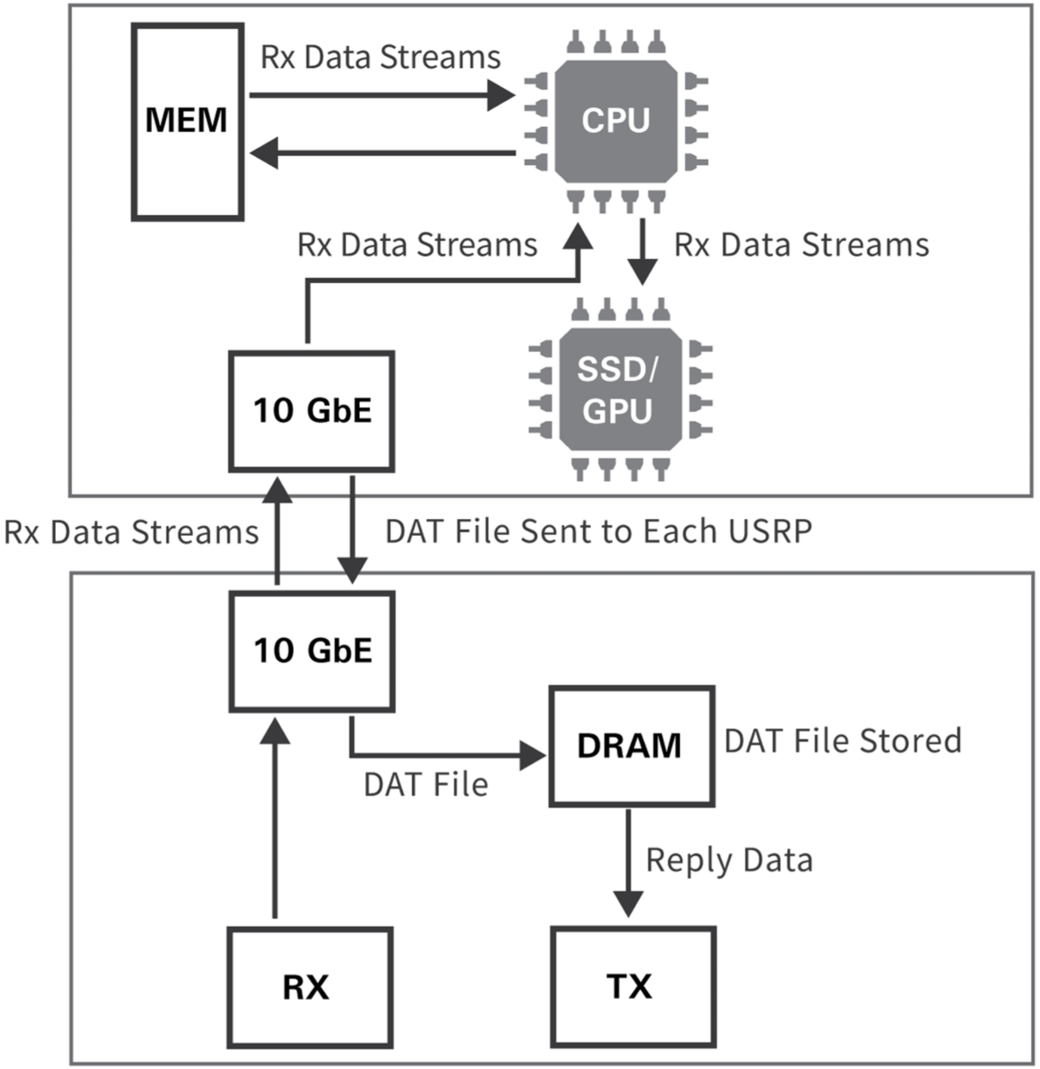


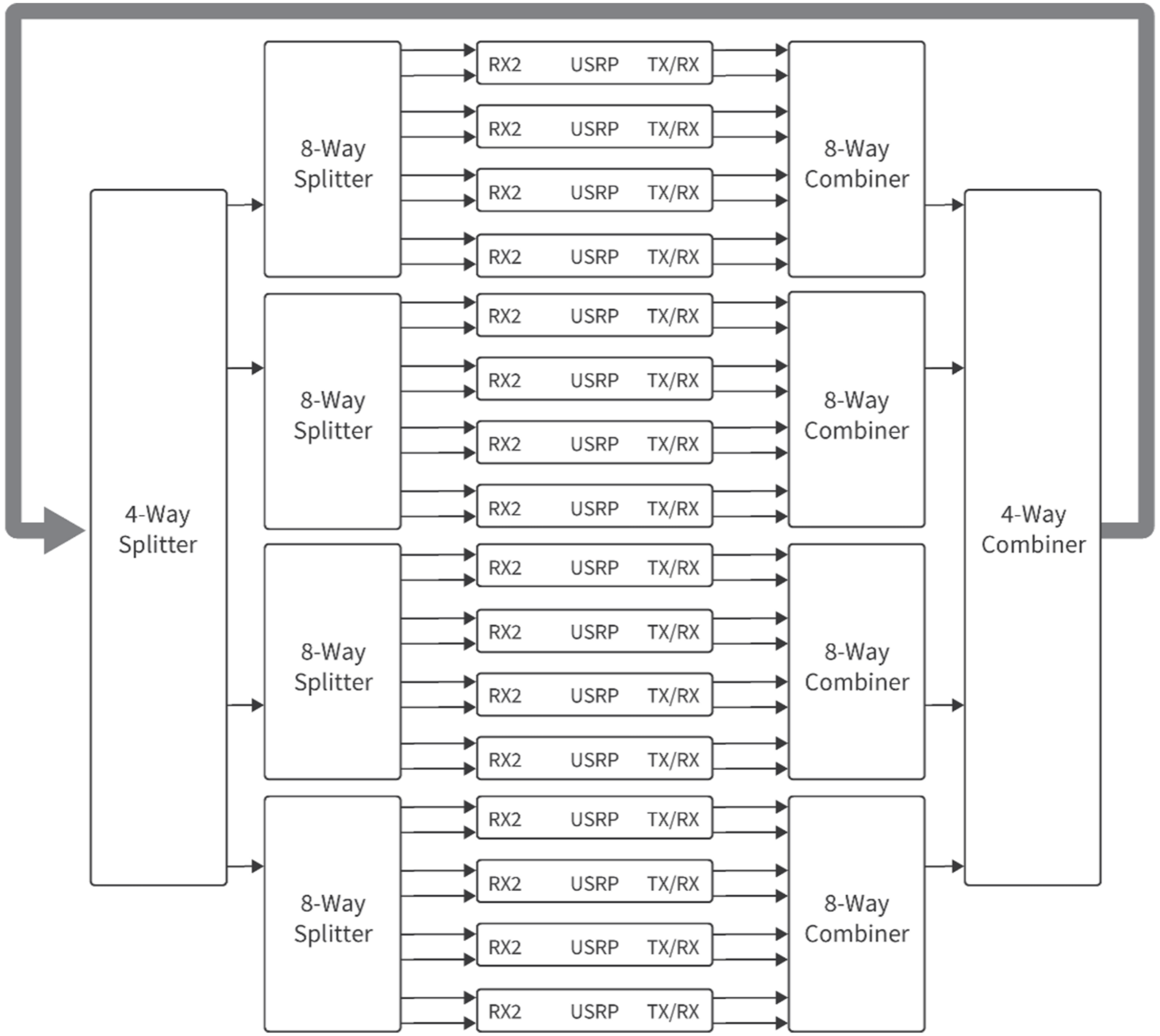
- System Components
- System Specifications
- System Details
- Interconnect Diagrams
- Assembly Instructions

Hardware Architecture of Reference Architecture



Data Movement and Synchronization





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