



# From 4.4 to 440

Another year of USRP and UHD Updates

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Chief Engineer

# USRP X440

Game Changing  
Bandwidth and Channel  
Density in Software  
Defined Radio



# NI Ettus USRP X440 Product Overview

## IF Capabilities

Front-End Conn:	Balun coupled, MMPX
IF Range:	30 MHz – 4 GHz*
Bandwidth:	Up to 1.6 GHz* / channel, 3.2 GHz / total
Direct Sampling:	Flexible, up to 4 GSps
Number Channels:	8 (TX/RX or TRX)
Phase Coherency:	Yes (sample based)
TX output level:	< 0 dBm full scale
RX input level:	10 dBm full scale

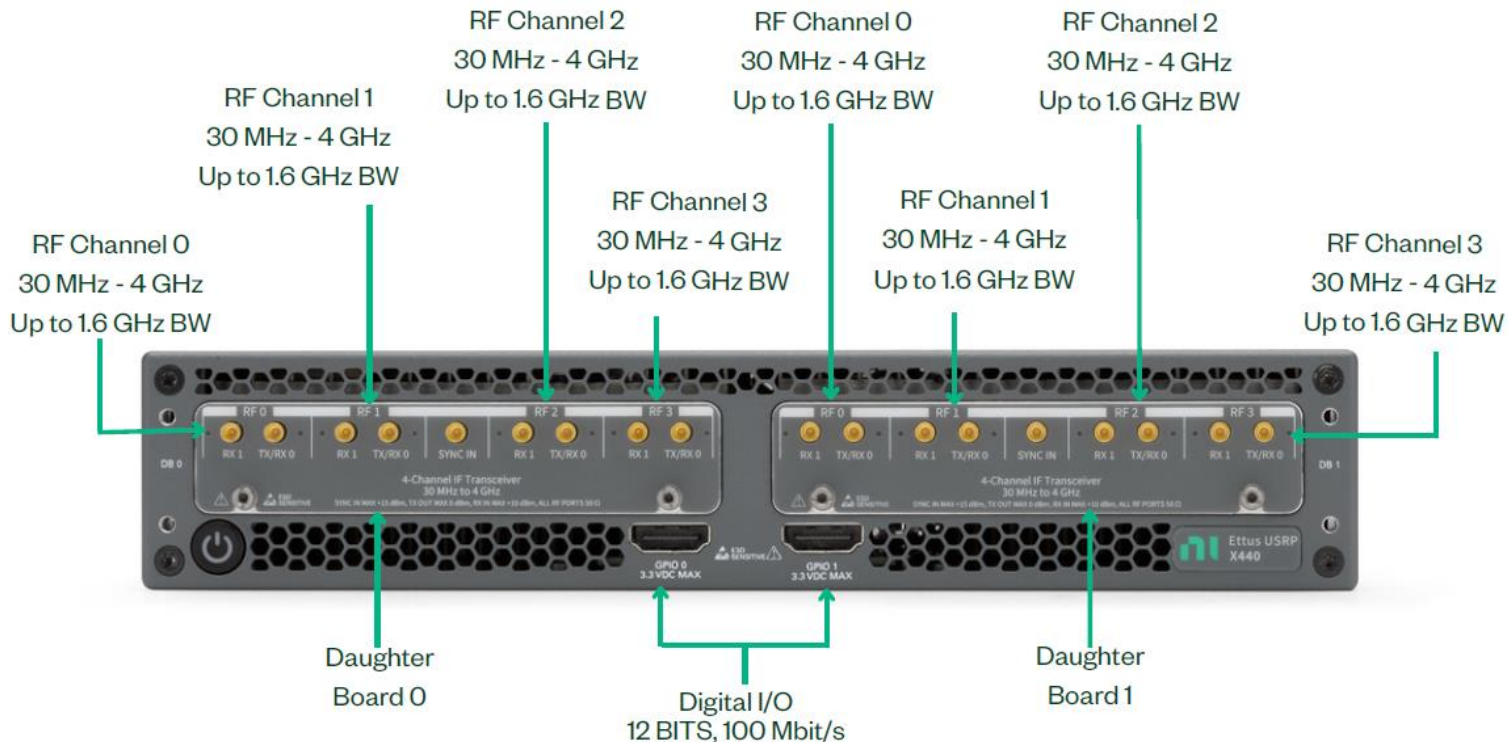
\* IF-Bandwidth combination limitations apply due to Nyquist zones and gaps

## Digital Capabilities

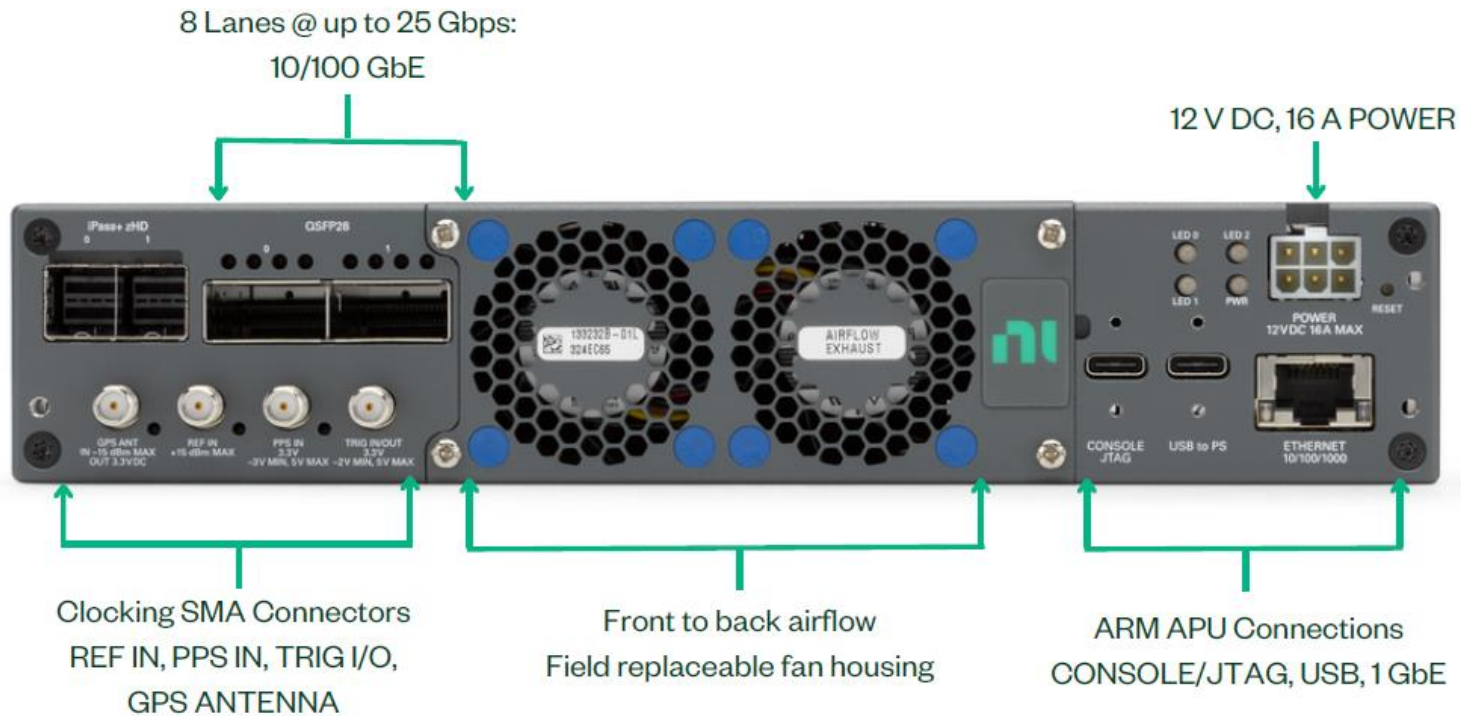
Xilinx Zynq UltraScale+ RFSOC ZU28DR-2  
Built-in quad core ARM processor  
Streaming Interface: Dual 100GEth via QSFP28  
Synchronization: 10 MHz / PPS, GPSDO, IF  
Software: Open source (GNU Radio, RFNoC, UHD)  
GPIO for Front-End control via UHD API or FPGA  
2x 12 lanes via HDMI with SPI protocol support



# USRP X440 Front Panel



# USRP X440 Back Panel

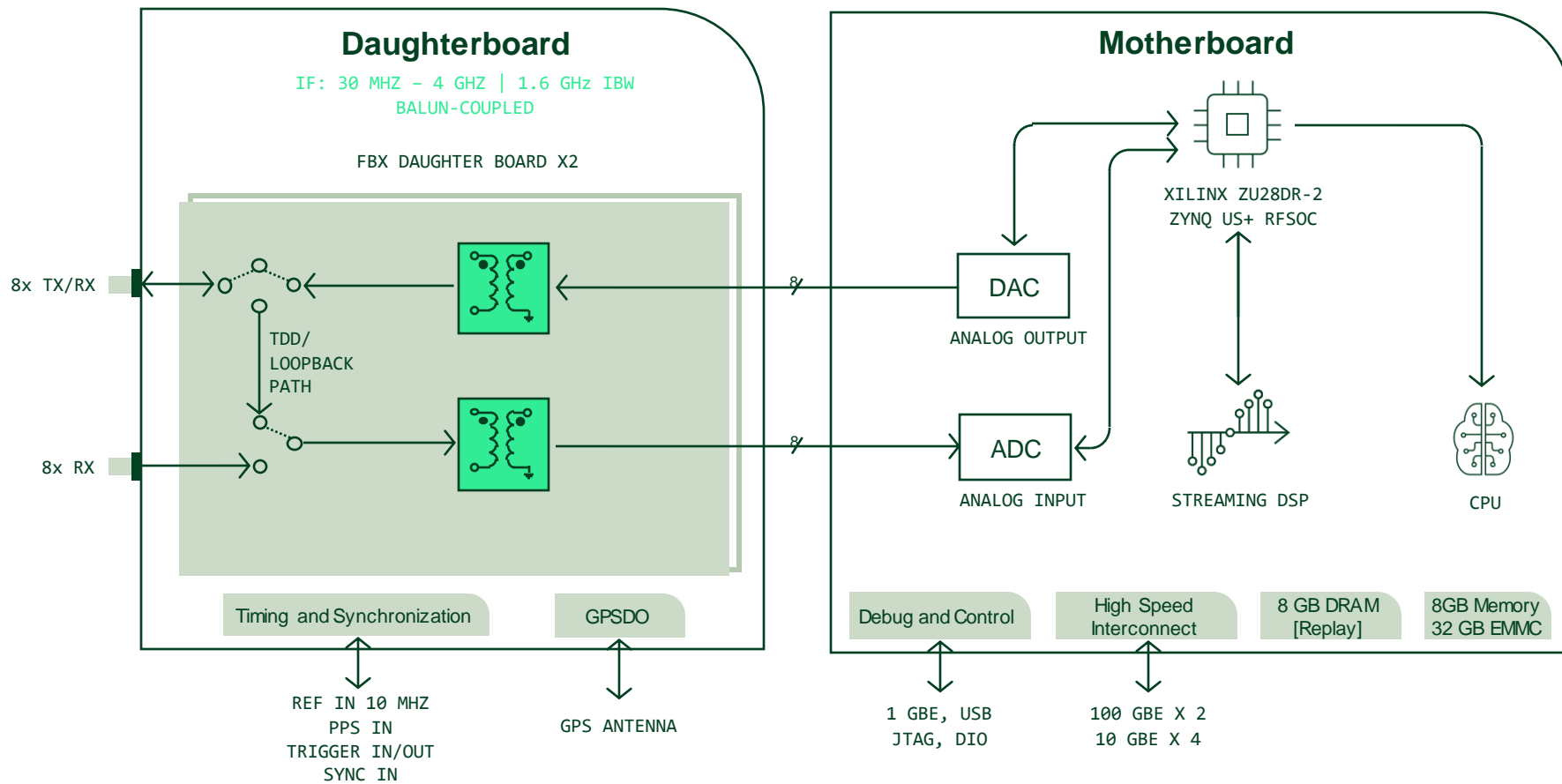


# USRP X440 Comparison to X410



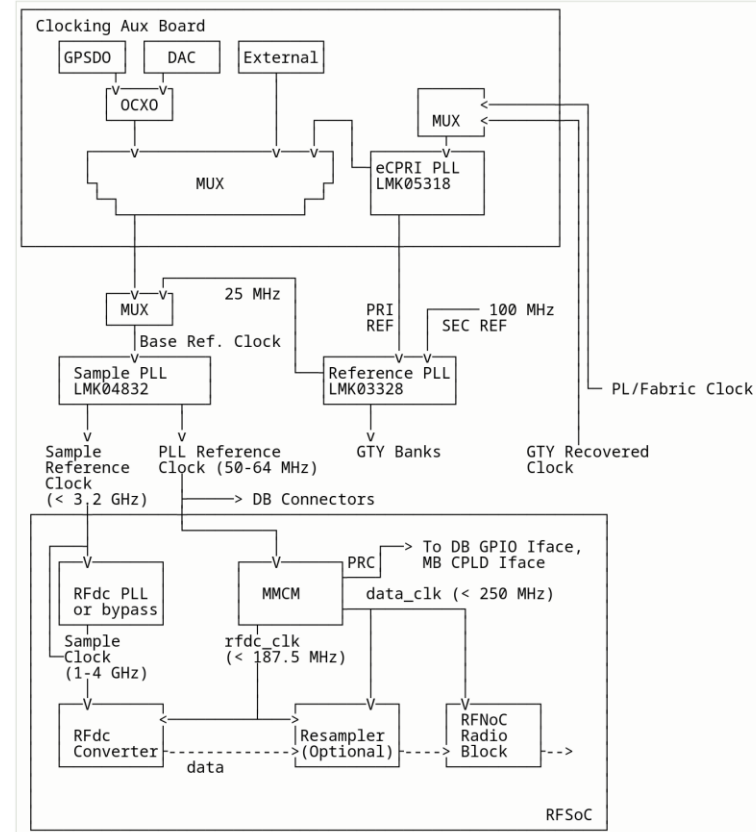
	NI Ettus USRP X410	NI Ettus USRP X440
Frequency	1 MHz – 7.2 GHz	30 MHz – 4 GHz
Bandwidth	400 MHz	Up to 1.6 GHz
Channels	4 Tx, 4 Rx	8 Tx, 8 Rx
I/O Type	RF	IF
DRAM / Replay Support	Yes	Yes
Communication	100/10/1 GbE or PCIe	Dual 100 GbE, 10/1 GbE
Synchronization	10 MHz, PPS, GPSDO	10 MHz, PPS, GPSDO, IF
Software Support	GNU Radio, C++, Python, RFNoC, LabVIEW, LabVIEW FPGA	GNU Radio, C++, Python, RFNoC
Key Applications	Communications, 5G, Wireless Research	Radar, Electronic Warfare, Direction Finding, SIGINT. SATCOM Ground Stations, mmWave

# NI Ettus USRP X440 High Level Block Diagram



# Flexible sampling rates & synchronization

- > 100 different sampling rates available (125 Msps -> 2048 Msps, "even" rates, 5G rates...)
- Phase coherent (same device, device-to-device)
- UHD abstracts away most clocking decisions (with some advanced options available)

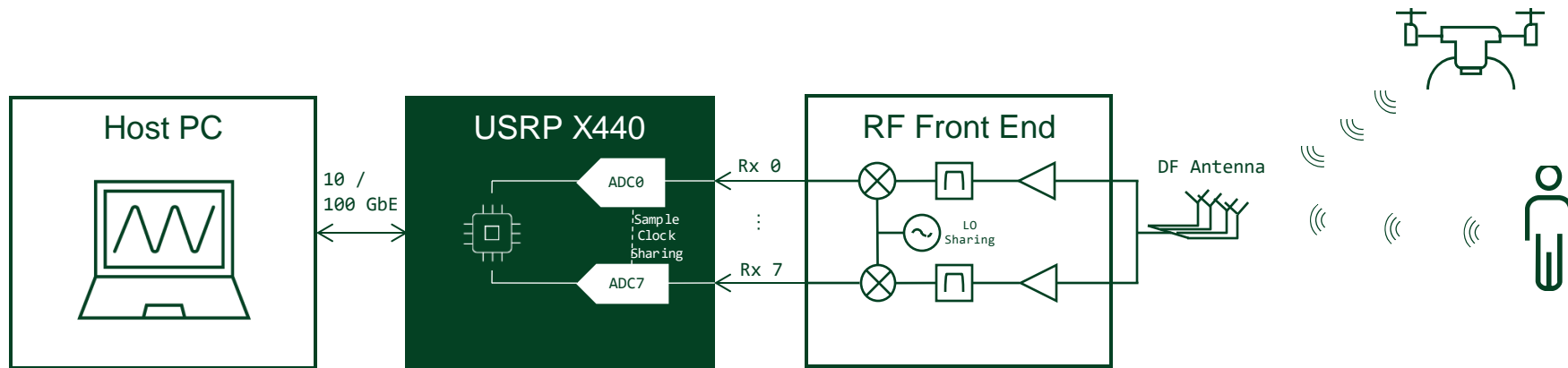




# Applications for USRP X440



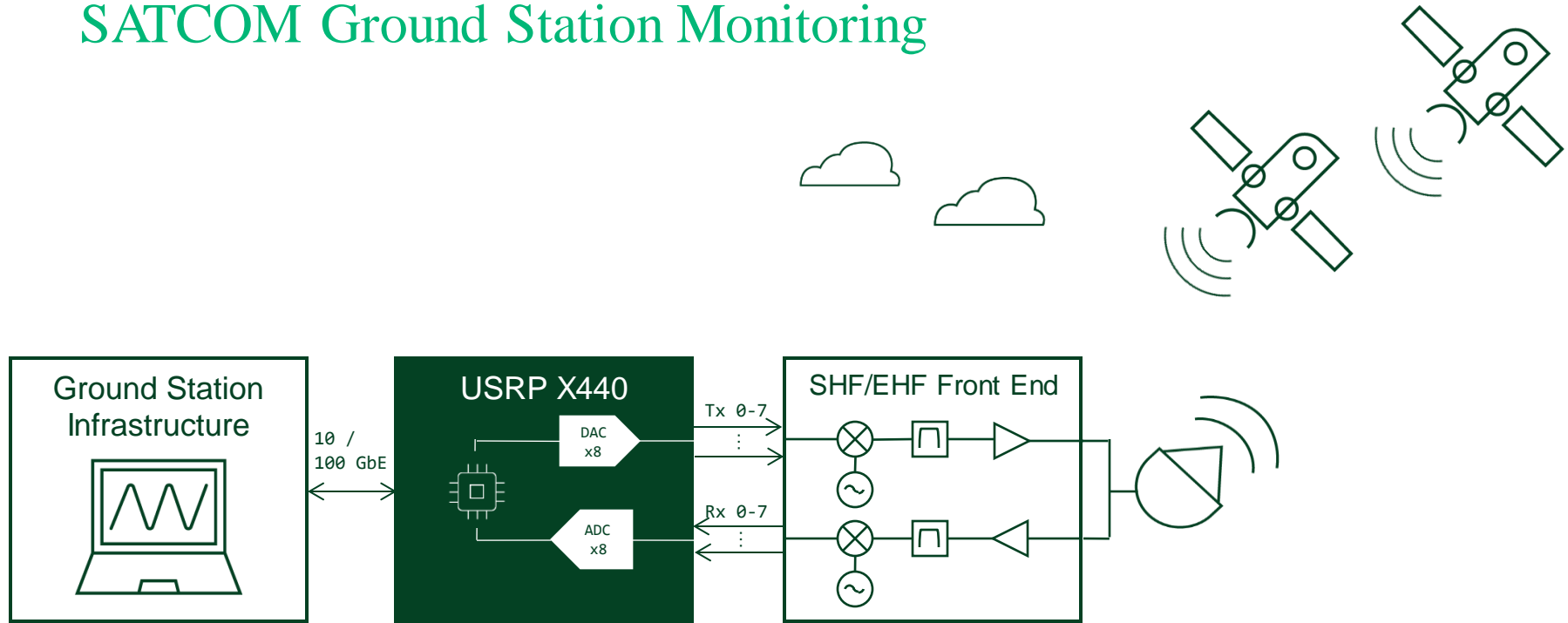
# Direction Finding



Phase coherent sampling for Angle of Arrival estimation

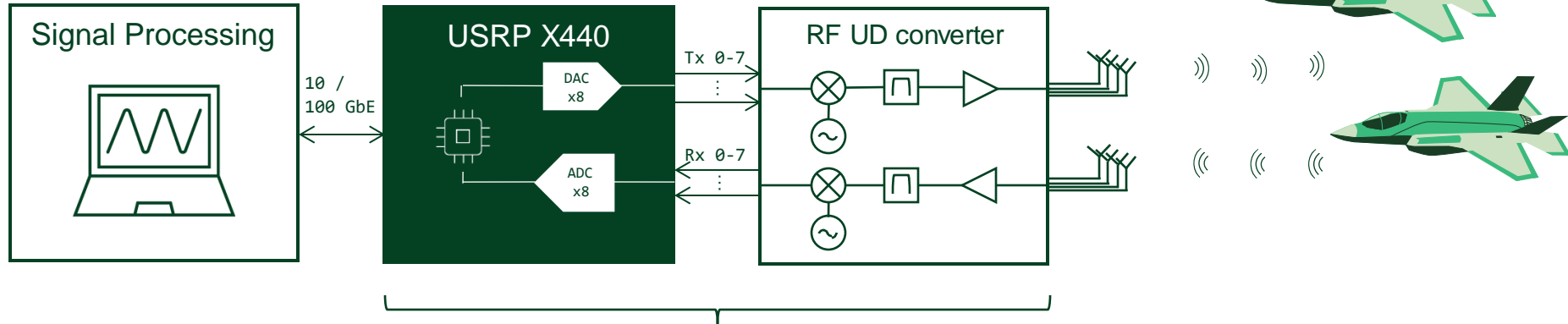


# SATCOM Ground Station Monitoring



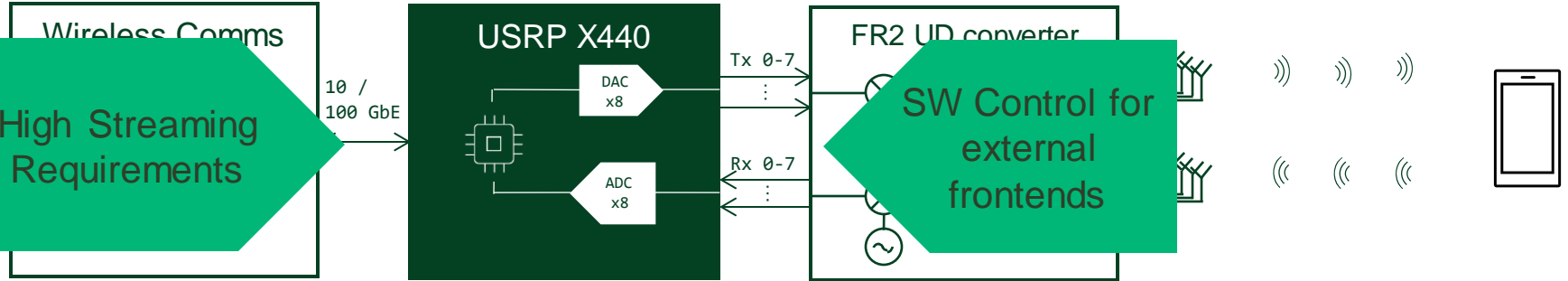
Raw, unimpaired wideband IF signal for clean up- and downconversion

# Radar Prototyping



X440's channel density and wide Bandwidth makes it an ideal platform for Radar Prototyping. 100GbE data links and onboard FPGA provides streaming and data compression capabilities provides an ideal mix of centralized versus edge compute for effective prototyping techniques

# mmWave Comms Research

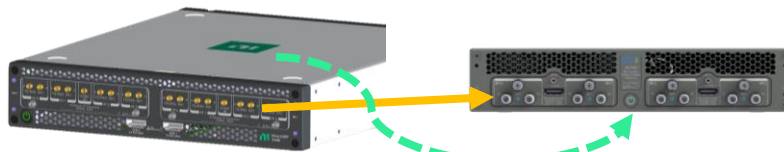
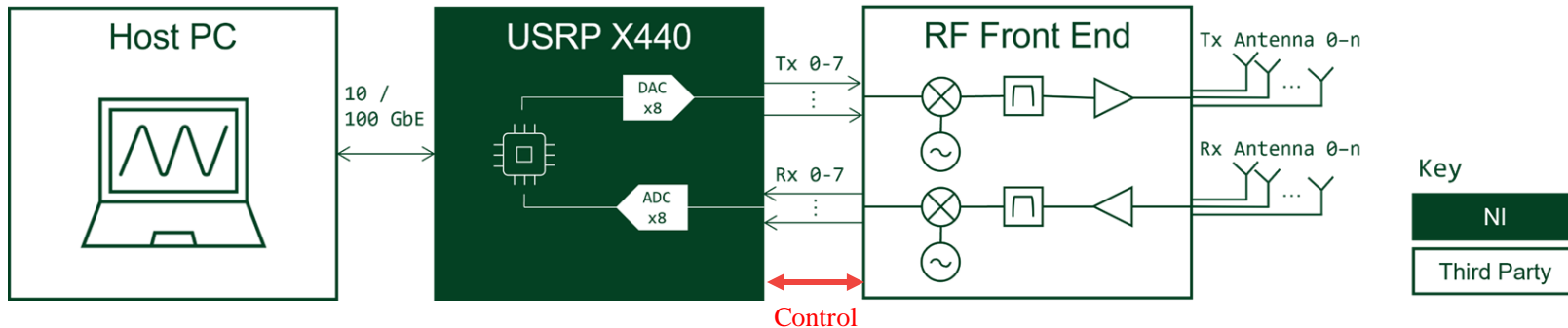


For example, running a wireless communications stack like OpenAirInterface in FR2 mode

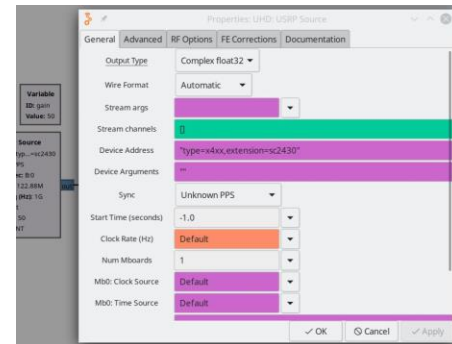
For example, 5G NR FR2 Up/downconverters and/or antenna arrays like the TMYTEK UD Box.

The X440 is NOT a successor or replacement of the X410. Depending on the requirements the X410 might still be the more suitable solution for FR1 research as it combines the digitizer and RF Front End for that Frequency Range in a single device.

# X4xx Extension Framework



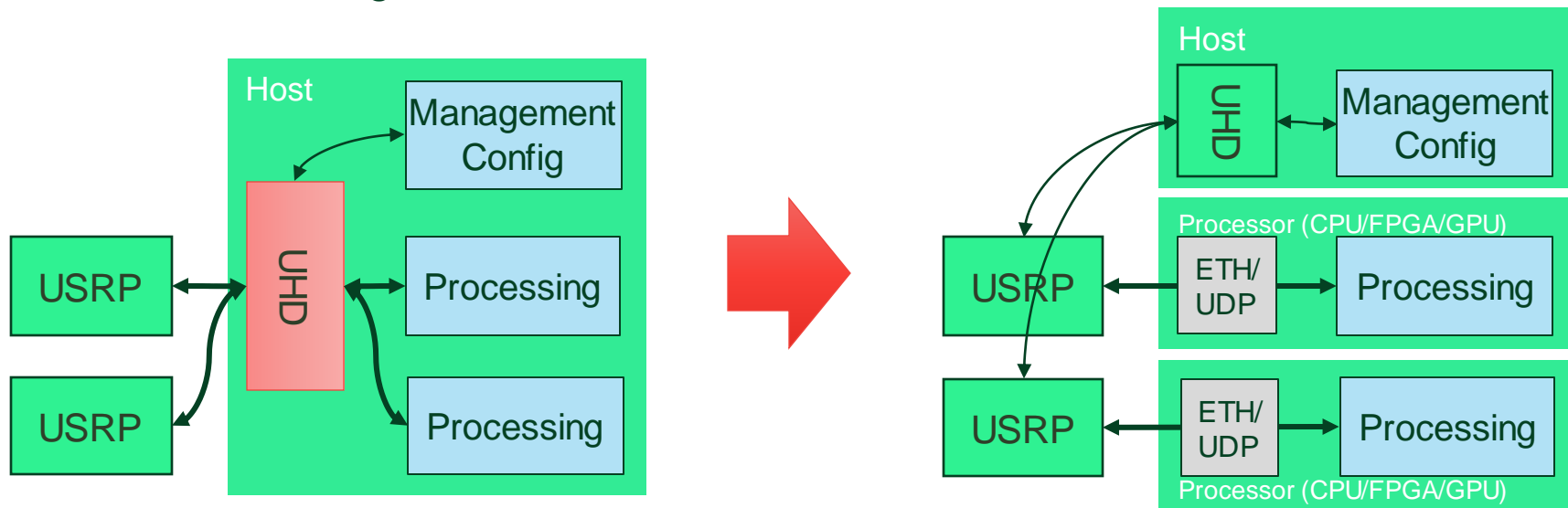
**Extension API**



## Raw UDP Traffic to Remote Destination

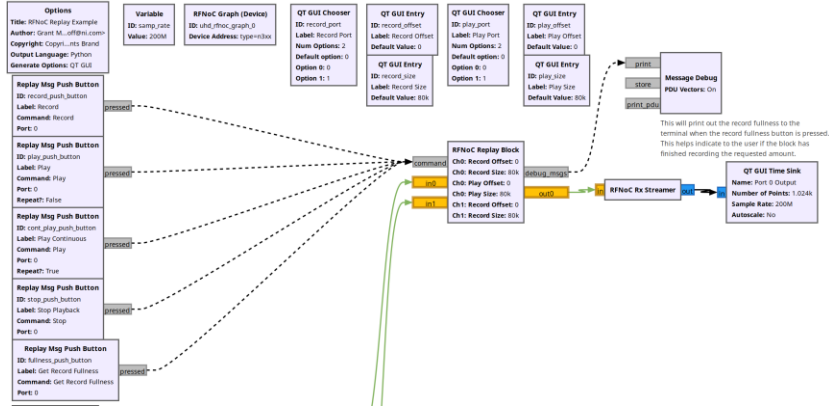
### More **streaming flexibility**:

- RX Stream to any network destination working, TX in preparation
- Stream data with or without CHDR metadata, prepared for VITA49 framing
- Seamless integration into RFNoC



# RFNoC Support: Now merged into main

- For a long time, RFNoC support in GNU Radio relied on separate OOT (gr-ettus)
- Current main branch includes everything we ever had in gr-ettus, and more
- Includes examples for almost all of our standard blocks
- Thanks to Jeff for helping with merging!

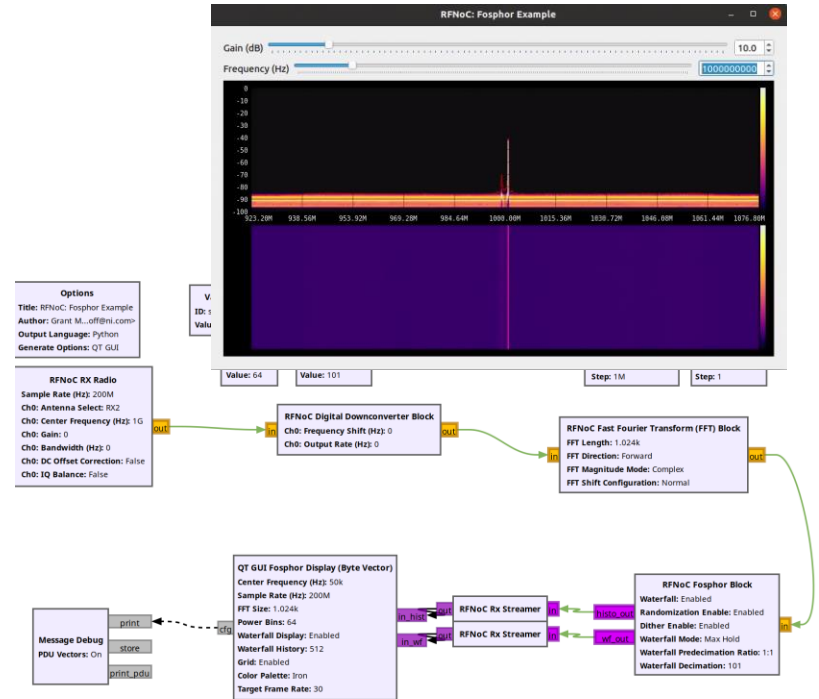
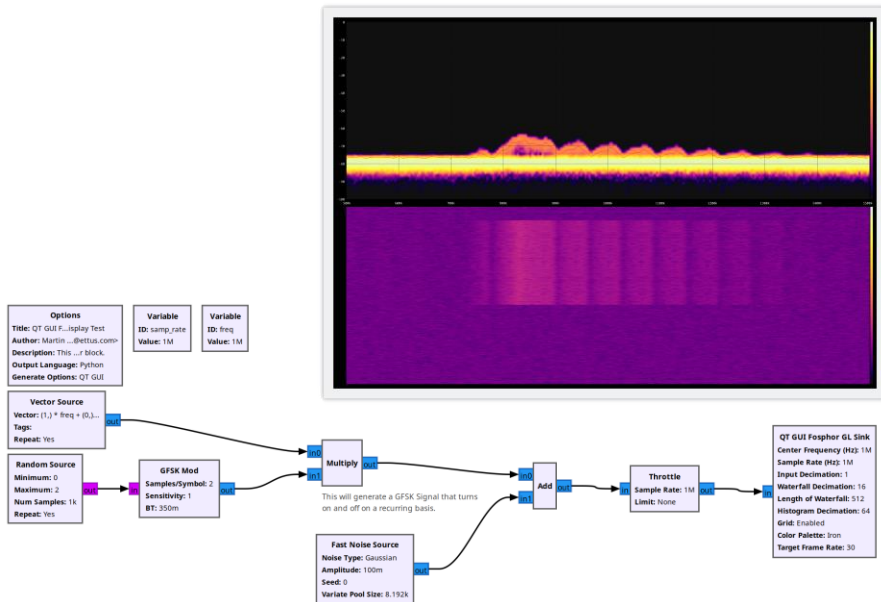


UHD	
RFNoC	Blocks
	Replay Msg Push Button
	RFNoC Digital Downconverter Block
	RFNoC Digital Upconverter Block
	RFNoC Fast Add-Subtract Block
	RFNoC Fast Fourier Transform (FFT) Block
	RFNoC FIR Filter Block
	RFNoC Fospor Block
	RFNoC Keep One in N Block
	RFNoC Log-Power Block
	RFNoC Moving Average Block
	RFNoC Replay Block
	RFNoC RX Radio
	RFNoC Rx Streamer
	RFNoC SigGen Block
	RFNoC Split Stream Block
	RFNoC Switchboard Block
	RFNoC TX Radio
	RFNoC Tx Streamer
	RFNoC Vector IIR Block
	RFNoC Window Block
	Device Control



# RFNoC Support: Including rfnoc-fosphor, of course

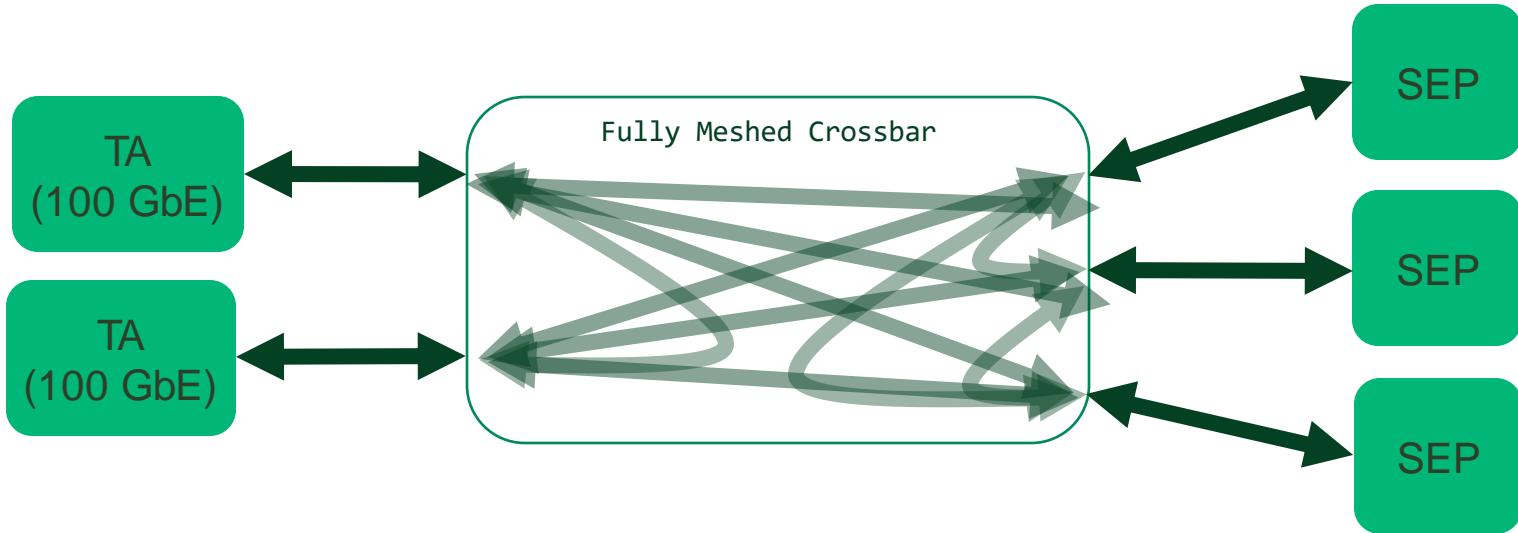
- Work with GR maintainers... and good things will happen



# Improved FPGA usage options

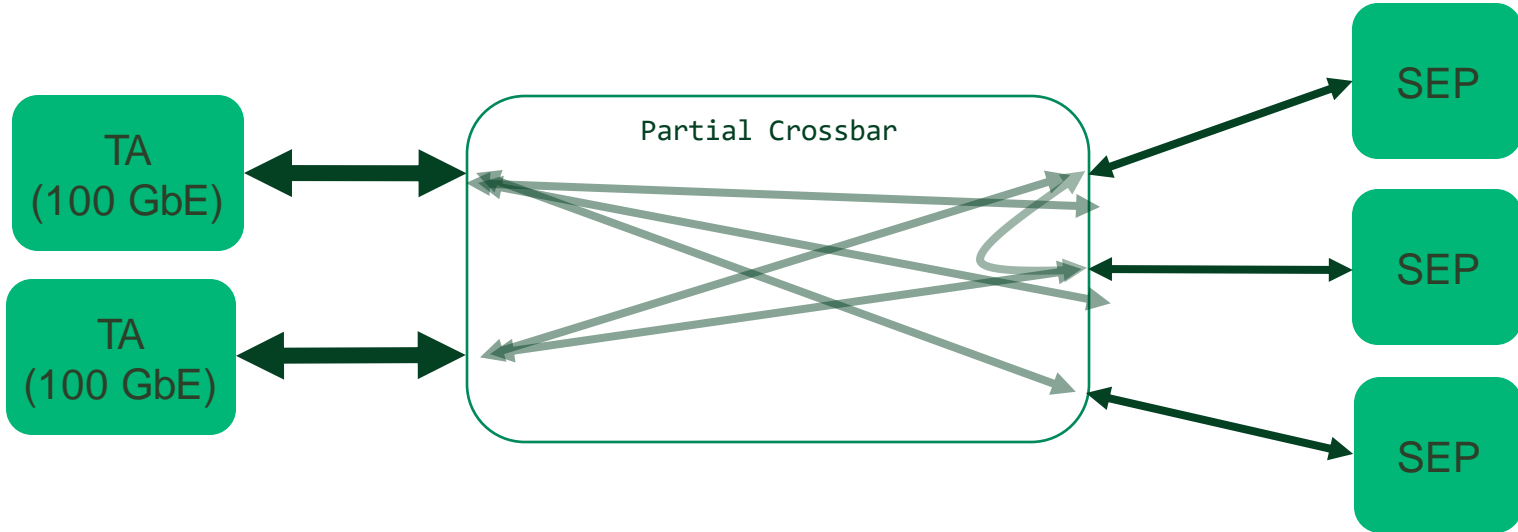


Many more options available to customize FPGA usage!



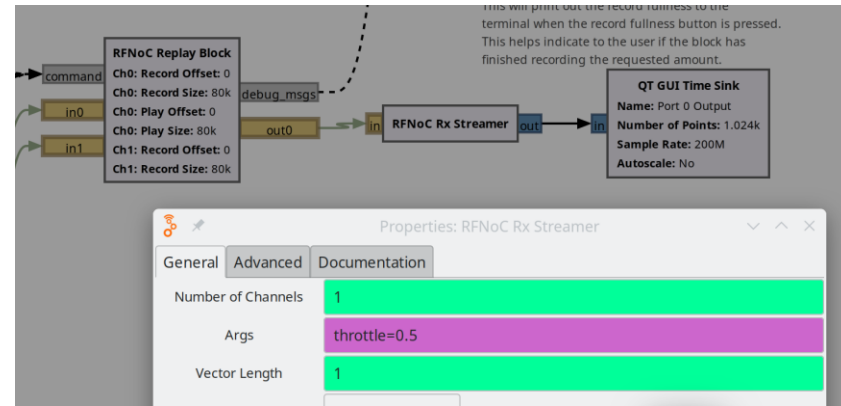
# Improved FPGA usage options

Many more options available to customize FPGA usage!



# Other FPGA build improvements

- Improved support for parallel builds (faster build times)
- Improved scripting for meeting timing
- Improved DRAM performance on X3xx and E320 USRPs
- New image flavors for X4xx series (e.g., X410\_UC\_200)
- Stream endpoint throttling (e.g., for DRAM downloads)



# UHD 4.5

- Driver team is preparing a release
- ...almost released!
- Includes X440 support
- ...and many bugfixes

```
commit 9fb9d79d85aac9260c77cf8e706308c5f7e9d826
Author: Aki Tomita <aki.tomita@ni.com>
Date:   Mon Aug 28 09:27:03 2023 -0500
```

Prepare for 4.5.0.0 release

- Updated version string
- Updated CHANGELOG
- Updated Debian-related files
- Updated manifest

The screenshot shows a GitHub release page for the tag `v4.5.0.0-rc1`. The page includes a 'Releases' tab and a 'Tags' tab. The release is titled `v4.5.0.0-rc1` and was tagged by `atomita-ni` 4 days ago. The release description is 'Tagging UHD-4.5.0.0 release candidate 1.' Below the description, there is an 'Assets' section with two assets: 'Source code (zip)' and 'Source code (tar.gz)', both uploaded 4 days ago. A 'Show all 2 assets' link is provided at the bottom of the assets list.

Releases Tags

v4.5.0.0-rc1  
9fb9d79

Compare

**v4.5.0.0-rc1**

atomita-ni tagged this 4 days ago

Tagging UHD-4.5.0.0 release candidate 1.

**Assets** 2

- Source code (zip) 4 days ago
- Source code (tar.gz) 4 days ago

Show all 2 assets

# Find out more!

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13:00

**USRP FPGA  
Processing Using the  
RFNoC Framework**  
*Neel  
Pandeya*

14:00

15:00

*Cochise, ASU Memorial  
Union 2nd Floor  
13:00 - 15:30*



Thank you!