SDR – A Technology Well Suited Research in Next Generation Wireless Technologies

Malay Duggar
Vision For The Future Of Wireless Research

**Applications**
- Wireless Cognition
- Wireless Sensing
- Immersive XR
- Device Location
- Imaging & Radar
- Mobile Hologram
- And more

**Requirements**
- Throughput
- Reliability
- Coverage
- Energy & Cost
- Latency
- Massive Connectivity
- 5G
- 6G

**Enabling Technologies**
- Sub-Terahertz Frequencies
- Integrated Sensing & Comms
- Extreme MIMO
- AI and Machine Learning
Overview of 6G

Enabling Technologies that Could Drive 6G

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

- 7-24 GHz FR3
- Sub-THz FR4

**New Applications**
Global communications coverage and detailed radio-sensing with multi-purpose radar/comms channels.

- Non-Terrestrial Networks
- Integrated Comms & Sensing

**Spectral Optimization**
Native application of AI to improve techniques across all 6G — from the signal chain to the network topology.

- Evolved MIMO
- Machine Learning and AI

New Spectrum

- 4G
- 6G
- 5G
- 6G

New Applications

- 6
- 24
- 95
- 300 GHz
OAI Reference Architecture for 5G System Prototyping with NI USRP

Bridging the gap between theoretical and practical issues around 5G system deployment and implementation for enabling engineers and researchers to rapidly develop and test novel use-cases.
# NI Ettus USRP X440 Product Overview

## IF Capabilities

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Front-End Conn.</td>
<td>Balun coupled, MMPX</td>
</tr>
<tr>
<td>IF Range:</td>
<td>30MHz – 4GHz (direct sampling)</td>
</tr>
<tr>
<td>Bandwidth:</td>
<td>1GHz / channel, 4GHz / total</td>
</tr>
<tr>
<td>Direct Sampling:</td>
<td>Up to 4GSps</td>
</tr>
<tr>
<td></td>
<td>~1.8 GHz (1st Nyquist)</td>
</tr>
<tr>
<td></td>
<td>~3.6 GHz (2nd Nyquist)</td>
</tr>
<tr>
<td>Number Channels:</td>
<td>8 (TX/RX or TRX)</td>
</tr>
<tr>
<td>Phase Coherency:</td>
<td>Yes (sample based)</td>
</tr>
<tr>
<td>TX output level:</td>
<td>&lt; 0dBm full scale</td>
</tr>
<tr>
<td>RX input level:</td>
<td>10dBm full scale</td>
</tr>
</tbody>
</table>

Integration with Custom Front-Ends for Radar and Comms/EW research and prototyping

## Digital Capabilities

- Xilinx Zynq Ultrascale+ RFSOC ZU28DR-2
  - Built-in quad core ARM processor
- Streaming Interface: Dual 100GEth
- 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

Subject to change
## UHD Update Cycles

### UHD 4.1.* Cycle
- X410 GPIO API
- X410 250 Msps MCR
- Support more hardware revisions
- B200 sync improvements, N320 IQ-balance/DC-offset improvements, ...

### UHD 4.2.* Cycle
- X410 Full 4x4 100 GbE streaming
- X410 DRAM Record/Replay Support
- X410 Full GPIO Support incl. timed commands

### UHD 4.3.* Cycle
- Raw UDP streaming API
- Extension API
- Vivado 2021.1 Upgrade

- Countless cleanups, Boost compatibility patches, Fedora/Windows/Ubuntu compatibility patches, bugfixes, CMake patches, documentation improvements, stale code cleanup, RFNoC improvements, ...