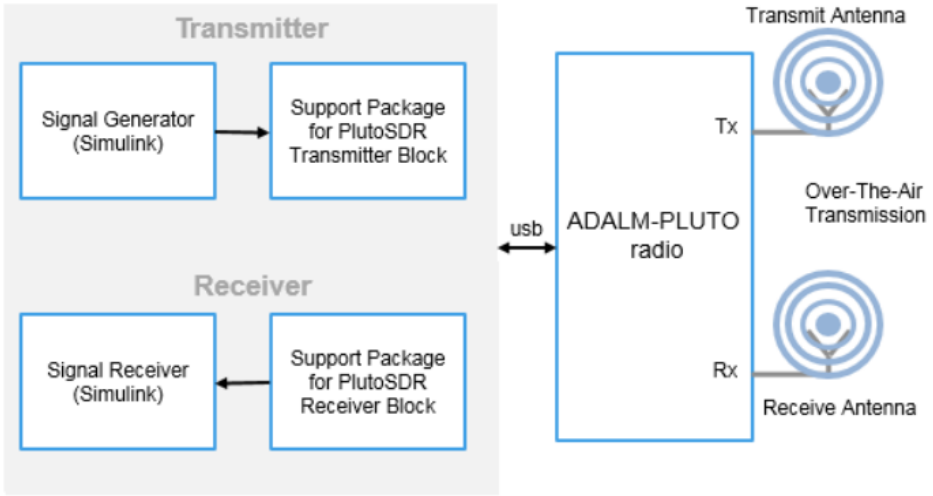
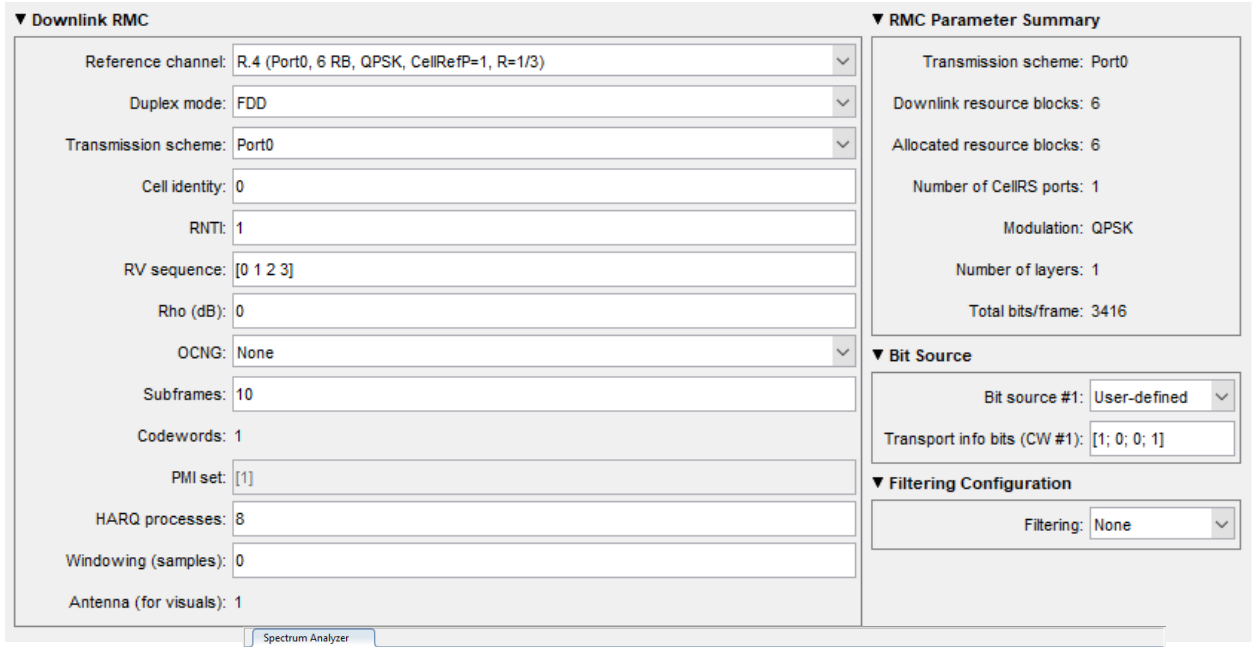
Verification Framework

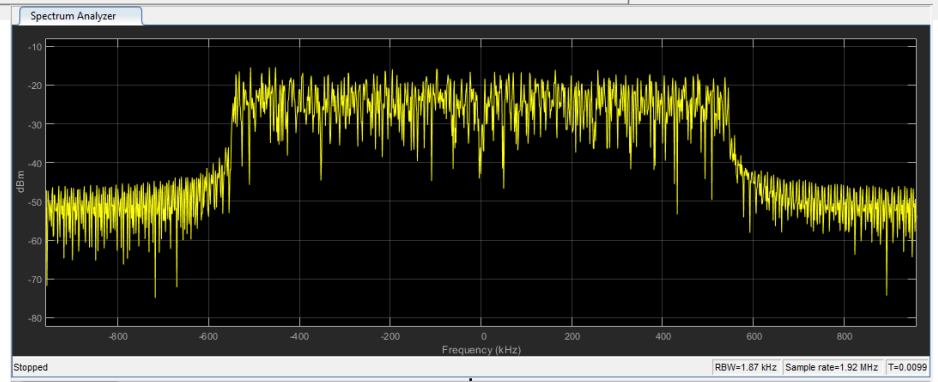
Test bench development and its validation

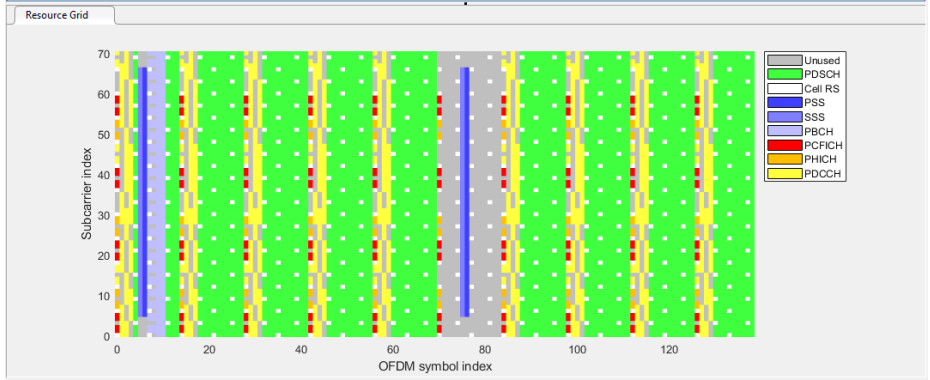
LTE Test Signal

- Generate the LTE Downlink RMC waveform from LTE Waveform Generator in Matlab and export the waveform to Matlab and convert it IQ waveforms
- RF coverage from 325 MHz to 3.8 GHz, with up to 20 MHz of instantaneous bandwidth
- One transmitter and one receiver, half or full duplex





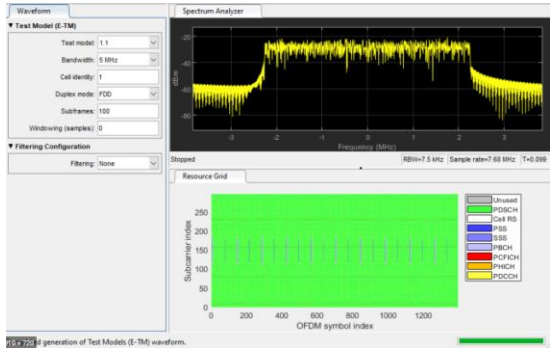




Reference Links:

- https://github.com/analogdevicesinc/TransceiverToolbox/tree/pluto_lte_app/trx_examples/streaming/LTE_PA_App
- https://plutosdr.org/lte-enb-transmitter-conformance-tests-using-adalm-pluto/
- https://www.mathworks.com/help/supportpkg/plutoradio/ref/plutoreceiver.html

Test Bench Demo



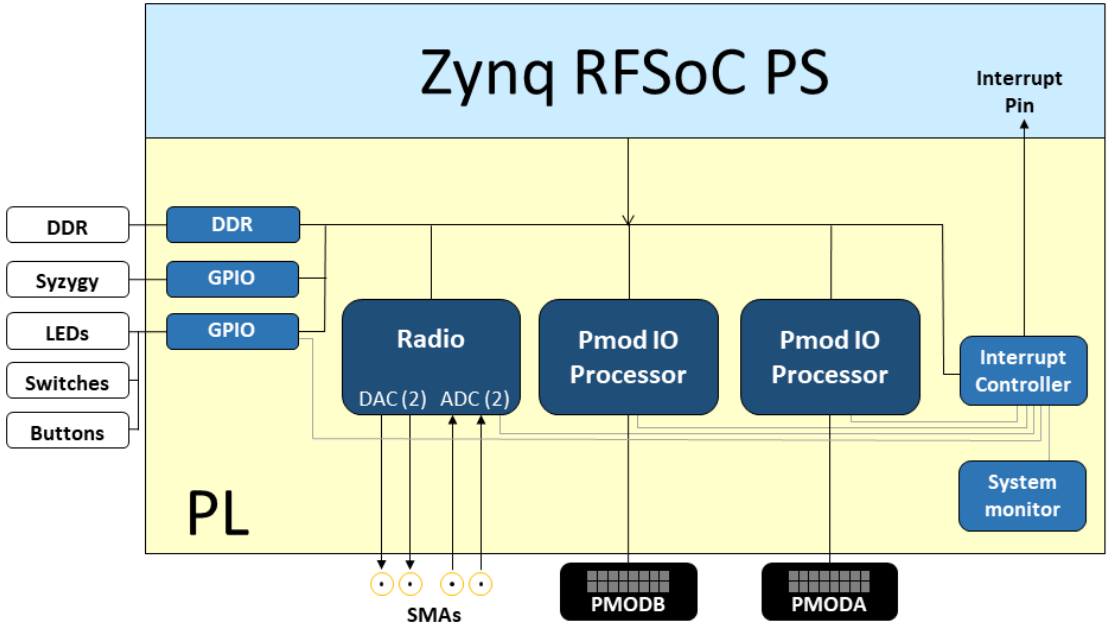
RTL Digitizer

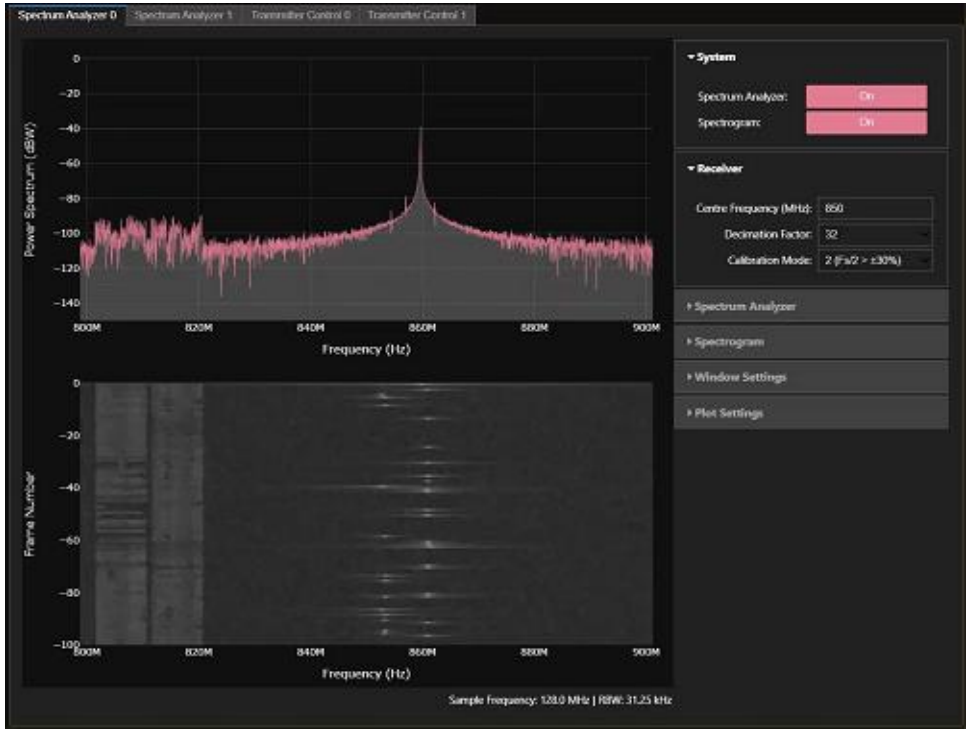
- LTE Cell scanner open-source software from GitHub
- First verified with NAR bands – 900MHz, able to detect different MIB's from different Cells
- Picked non-NAR region band – 860MHz to generate LTE Test signal
- Generated LTE Test signal using Matlab– 5MHz, 25 RB, 64QAM, Cell ID: 11 with PSS, SSS, PBCH.
- Exported this signal to MatLab to play from Pluto SDR
- Play LTE test signal continuously from Pluto SDR and run cell search algorithm in PYNQ to capture the transmitted LTE test signal

```
root@maheshv_pynq:/home/xilinx/jupyter_notebooks/Capstone/LTECellScanner# CellSearch --correction 0.999960 --ppm 10 --freq-start 860000000
LTE CellSearch v1.0.0 (release) beginning
  Search frequency: 860 MHz
  PPM: 10
  correction: 0.99995999999999996
Found Rafael Micro R820T/2 tuner
Exact sample rate is: 1919923.098783 Hz
Examining center frequency 860 MHz ...
Allocating 15 zero-copy buffers
  Detected a cell!
    cell ID: 11
    RX power level: -28.5491 dB
    residual frequency offset: 806.824 Hz
Detected the following cells:
A: #antenna ports C: CP type ; P: PHICH duration ; PR: PHICH resource type
CID A      fc    foff RXPWR C nRB P  PR CrystalCorrectionFactor
 11 1    860M    807h -28.5 N  25 N 1/6 0.99996093813038011699
```

Spectrum Analyzer

- RFSoC 2x2 overlays
  - The base overlay is included in the PYNQ image for the RFSoC 2x2 board
  - The base design includes a bitstream with IP which allows to use the RF ADCs and DACs on the board
  - Up to 2 GHz bandwidth for inspection
  - Inspect range 0 - 4.096 GHz
  - Adaptive bandwidth control and center frequency selection
  - Reprogrammable windowing
  - Hardware accelerated processing (time domain → frequency domain → power spectrum [dB])
  - PYNQ abstracted allowing Python to interface with the hardware
  - Plotly visualization of spectrum and spectrogram (waterfall)
  - Simple dashboard for more convenient control/visualization





•Reference Links:

•https://www.rfsoc-pynq.io/overlays.html
•https://www.rfsoc-pynq.io/base_overlay.html
•git clone https://github.com/Xilinx/RFSoC2x2-PYNQ.git
•https://github.com/strath-sdr/rfsoc_sam
•https://github.com/strath-sdr/rfsoc_ofdm