# HAM FRIENDLY DIGITAL SIGNAL PROCESSING

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# Agenda

- Discuss relationship of DSP and SDRs

- Introduce GNU Radio: open source, graphical programming

- Demonstrate a selection of DSP operations: FM radio, Panadapter, filter, wave form generator, audio output

- How to get started with GNU Radio – resources, nuts and bolts

# SDR and DSP Fundamentals

- <u>All</u> radio receivers process signals and output to 'baseband':
  IF, filters, detectors, audio output

- SDR receiver digitizes radio signals to baseband:
  direct conversion and direct sampling

- DSP software processes the baseband data to complete the radio

- The software is the DSP, the DSP is the software, DSP is the radio

# Key Takeaways

- DSP uses same signal flows as traditional analog radio

- DSP uses same processes – mixers, filters, amplifiers, etc.

- DSP is much simplified in comparison- no concern about impedance matching, signal leakage, and filtering

- DSP offers higher performance due to unmatched digital precision

# SDR Terminology

- Direct Conversion: converts RF to digital baseband with no IF stage

- Direct Sampling: A/D and D/A converters have huge baseband and can operate at RF.  No need for direct conversion

- FPGA: a logic block for initial DSP located on the SDR hardware

- Data Interface: can be USB 2.0, 3.0, or Ethernet to computer

# Realities of Homebrew SDR

- Modern SDR hardware miniaturized - components require automated assembly

- SDR hardware can be paired with multiple different software applications:  e.g. SDR#, HRD, SDR Console, and others

- DSP software is where the ham can homebrew SDRs.  GNU Radio is the soldering iron equivalent for modern SDR building projects. DSP is the radio.

# GNU Radio

- Open source: no cost, 'rolling' development always an adventure

- Linux Ubuntu OS preferred.  Windows and Mac OS problematic

- GNU Radio optimized for 'real time' signal processing as different from simulation or modeling

- Graphical programing – connect DSP 'blocks': ideal for hams more interested in their radio than their computers

# GNU Radio Demonstration

1) FM Radio using inexpensive RTL SDR

2) Panadapter display

3) Digital Filter with variable bandwidth

4) Waveform generator

5) Audio output

# How to Get Connected with GNU Radio

## Primary Information Sources

- GNU Radio Primary Portal:http://www.gnuradio.com

- GNU Radio Ham Radio Wiki URL: http://www.http://gnuradio.org/redmine/projects/gnuradio/wiki/Ham Radio

- GNU Radio for Beginners:  http://www.w7fu.com  everything you need to know to get started.

# How to Get Started with GNU Radio

- GRC 'get started' Wiki with instructions:
http://www.http://gnuradio.org/redmine/projects/gnuradio/wiki/InstallingGR

- Live GNU Radio: Simple "boot and go". Bootable USB memory stick or CD with Linux Ubuntu and GNU Radio pre-installed. Make it yourself or purchase. No changes to your hard drive or native OS.

- Dual boot installation of Linux Ubuntu and GNU Radio. Best method for serious work. "Virtual' machines only for simulation.

# In Conclusion

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# FAQ's

Q: Does GNU Radio function with a Windows OS?

A: "Sorta", hard work with significant limitations.
   They are working on it.  The GNU Radio
   developers are primarily oriented to Linux OS.


Q: What type of computer is required?

A:  Two cores @ 2500 MHz: i3 is minimum, I5 or i7 recommended
    by the developers

# FAQ's (continued)

Q: If I have questions or am lost can I reach you?

A: Absolutely, I'll do what I can to help.

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# Additional Questions ?

Hardware ?

Software ?

Other related topics ?