Evolution of Software Defined Radio; Breakthroughs by Leveraging COTS Technology

References, DEMO BUILD INSTRUCTIONS on Page 15, 16, 17:
USB SDR Tuner: http://www.nooelec.com/store/sdr/nesdr-mini2-rtl2832u-r820t2.html

Joe Jesson
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Evolution of Software Defined Radios (SDR);
Breakthroughs by Leveraging COTS Technology

Evolution of Software Defined Radios:

- **1st Generation**
  Government and Military SDR Architecture (WJ, Condor Systems)

- **2nd Generation**
  Commercial and Educational Market (RFSpace SDR-14)

- **3rd Generation**
  Amateur Radio Market (Flex, Elecraft, Peaberry)

- **4th Generation and Future Direction**
  Hobbyist and Spectrum Hackers (GNURadio, Ettrus, HackerRF)

- Demo of GQRX RTL-SDR on a LIVE Distribution
Cold War CEI/Watkins-Johnson Surveillance Receivers

CEI RS-111 (Mfg 1968):
Architecture:
- Surveillance Receiver used in WATERGATE bugging
- 30 MHz – 1,000 MHz Continuous Coverage
- <=1uV Sensitivity, 20kHz AM
- 21.4 MHz IF Frequency
- Panoramic Spectrum Display Built-in
- Transistor + Tube Design

Mfg: US 1968
Cost New: $6,250
**Cold War CEI/Watkins-Johnson Surveillance Receivers**

**Panoramic Display - RF Band-limited - Spectrum Monitor Replacement:**

Initial Entry Point - Substitute Swept-Spectrum Display with a Fast Fourier Transform (FFT) Spectrum Display

Second DSP Entry Point is the Bandpass Filter and Demodulator.
The **RFspace SDR-14** is a 14-bit software defined radio receiver. It offers a broad range of spectrum analyzer and demodulation capabilities. The hardware samples the whole 0-30 MHz band using a sampling rate of 66.667 MHz. The digital data from the ADC is processed into I and Q format using a direct digital converter (DDC). The I and Q data is then sent to the PC for processing using a USB interface. All of the demod and spectral functions are done on the PC side.
Direct Conversion

FLEX-5000

192kHz

ADC

DSP

192ksp

DET

DET

PAN

Distortion

FlexRadio Systems
Software Defined Radios
Softrock Low-Cost SDR (Partial SDR)

Softrock board includes Simple RF Filter (single band) and Direct Conversion Tayloe Mixer but Requires PC for A/D Converter (Audio), FFT and Demodulator Application. PC Audio is typically limited to 48Kb sampling rate.
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USB Tuner, 25MHz – 1750 MHz

“Say hello to the newest member of NooElec's popular NESDR SDR-range, the **NESDR Mini 2**. The Mini 2 uses a brand-new tuner IC, the **R820T2** made by Rafael Micro, to provide **increased sensitivity and improved SNR**.

A greatly-**improved telescopic metal antenna** is also included with your SDR set at no extra charge. If you liked the NESDR Mini, you will love the NESDR Mini 2!

The perfect device for learning software defined radio, on the cheap. Amateur radio, ADS-B, police & fire scanning, trunking, satellite images--you name it, this little guy can probably do it. Outperforms many devices 10x its cost!

This custom NooElec SDR is a modified DVB-T USB dongle tuned for SDR usage, including upgraded crystal, capacitors and inductors compared to generic devices. Full compatibility with a large array of software packages, such as MATLAB®, HDSDR, SDR Touch, SDR#, Planeplotter--too many to list.”

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Low-Cost DVB TV Tuner Architecture

ASIC Digital TV Tuner Chip TV USB (~$12.00) Block Diagram Showing I/Q Demodulator. This follows a Fast 8/11-bit A/D Converter
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SDR# (Windows/Linux with Mono) (Free)

SDR# (pronounced “SDR Sharp”) is the most popular free RTL-SDR compatible software in use at the moment. It is relatively simple to use compared to other SDR software and has a simple set up procedure. We have a full overview of the installation procedure on our Quick Start Page. Reference: http://www.rtl-sdr.com/big-list-rtl-sdr-supported-software/
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HDSDR (Windows) (Free)

HDSDR is based on the old WinRAD SDR program. HDSDR supports the RTL-SDR through use of an ExtIO.dll module. To install HDSDR, download the program from the link on the main HDSDR page, then to use the RTL-SDR you will need to download the ExtIO_RTL2832.dll file and place it into the HDSDR folder. When opening HDSDR, select the newly copied ExtIO_RTL2832.dll. The other dlls that come with HDSDR will not work with the RTL-SDR, even though they have RTL-SDR in their filename. The official installation instructions can be found here:

http://www.rtl-sdr.com/big-list-rtl-sdr-supported-software

I like the S-Meter in this Excellent SDR Application.

Reference:
http://www.rtl-sdr.com/big-list-rtl-sdr-supported-software
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SDR-RADIO.COM V2 (Windows) (Free)

SDR-RADIO
Windows SDR Application
This one has the most number of built-in features but requires a fast processor.

Reference:
http://www rtl-sdr.com/big-list rtl-sdr-supported-software/

SDR-RADIO.COM V2 is a popular SDR program with many advanced features. As such is it a fair amount more difficult to learn and use compared to SDR# and HDSDR. Be sure you install version 2 and not V1.5 as only V2 has RTL-SDR support.

http://www rtl-sdr.com/big-list rtl-sdr-supported-software/
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New Software Definable Radio on Live Distro

Pre-Installed GNU Radio Applications

There are many 3rd-party applications, demos, drivers, and block libraries produced by the GNU Radio community. Below is a list of pre-installed packages that highlight some of the diverse capabilities of GNU Radio:

- `gr-osmosdr` *(46bb1ad1) (updated)*, a set of blocks supporting various hardware SDRs and applications, and related dependencies
- `gqrx` *(v2.3.2) (updated)*, a narrowband SDR receiver application by Alexandru Csete
- `GNSS-SDR` *(g9b95919ed) (updated)*, a fully software-based GPS, Galileo, and GLONASS real time receiver
- `gr-air-modes` *(g9891907e)*, a Mode-S/ADSB aircraft telemetry receiver
- `gr-dvbs2` *(g50075c64)*, a software defined DVB-S2 digital television transmitter
- `gr-dvbt` *(g434494c1)*, a software defined DVB-T digital television transceiver
- `gr-ieee-80211` *(g7805bae2) (updated)*, an IEEE 802.11a/g/p transceiver
- `gr-ldpc` *(g63ca16b)*, an implementation of generic LDPC codecs
- `gr-lte` *(g9d7f9351) (updated)*, an implementation of a 3GPP LTE receiver
- `gr-radar` *(g0e8lf1c9)*, the GNU Radio Radar Toolbox
- `gr-rds` *(gffca151) (updated)*, an implementation of broadcast FM radio RDS reception
- `gr-specest` *(g5113c1f4)*, an implementation of several spectral estimation algorithms
- `OpenLTE` *(g76945c80) (updated)*, an open source 3GPP LTE implementation

New with this release is `gr-fosphor`, a GPU-accelerated real-time spectrum analyzer display component. However, due to distribution restrictions, the GNU Radio Live SDR Environment only comes pre-installed with the Intel CPU Open CL driver, and gr-fosphor is not able to take advantage of any graphics chipsets in the PC that boots it. It is possible, after converting the ISO image to a USB drive, to further download, install, and configure additional Open CL support for gr-fosphor.
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GQRX (Mac/Linux) (Free)

GQRX is pre-installed on several Linux Live Distributions, e.g. GNURadio.

Instruction Steps Follow – see Next Two Slides

GQRX is a free simple to use SDR receiver which runs on Linux and Mac systems. It is similar to SDR# in terms of features and simplicity of use. GQRX comes with a standard FFT spectrum and waterfall display and a number of common filter settings.

http://www.rtl-sdr.com/big-list-rtl-sdr-supported-software
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Preparing the Bootable Live UBUNTU/GQRX USB Drive

STEPS:
1). Download LIVE UBUNTU Linux (with GQRX Pre-Installed)

2). Create USB bootable Image, point to the ISO file just downloaded

GQRX LAUNCH STEPS:
1). Insert the bootable USB in the powered-off PC
2). Press Power ON switch, immediately tap F12
3). Select and Press Enter to Boot from USB stick
4). Approximately 1-2 minutes, you will be in UBUNTU Linux
5). Insert TV Tuner SDR USB Stick
6). Select TERMINAL (>___) window and type gqrx (enter)

HOW TO SOLVE BOOTABLE USB PROBLEM in WIN8
See: https://help.ubuntu.com/community/UEFI
Evolution of Software Defined Radio; Build Your Own SDR for Fun!

GNURadio
Design your own Radio and Transmitter using GNURadio Flowgraphs

http://www.stargazing.net/david/GNUradio/RTLFMstations.html
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GNURadio FM Radio Example
Execute your custom-designed FM radio monitor you just designed

http://www.stargazing.net/david/GNUradio/RTLFMstations.html