Examining an Inexpensive Wideband Software Defined Radio Receiver

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Define "inexpensive…"

How does $20 sound for hardware?

- *(Not counting the price of the computer, of course…)*

For that price, you get:

- DVB-T USB dongle

- Stub magnetic-mount antenna with suitable connector

- Remote control (intended for the dongle's original use as a DVB receiver, useless for our purposes)

Pro tip: prowl eBay. I found the device I use for $8.

What's needed?

1. A computer (which you probably already have)
   1. The software is CPU-intensive, so newer machines do a better job
   2. The software is 32-bit, which means 64-bit machines aren't required, but will have plenty of CPU horsepower
   3. The examples I'm showing today are Windows applications, but there are Mac and Linux packages as well
2. Some free software
3. The receiver hardware itself: any DVB-T USB device with a RTL2832U ADC chip (I use the NooElec R820T)
4. A suitable antenna (a basic magnetic-mount stub comes with most receivers, but an antenna like a Discone® will greatly improve sensitivity and range)
5. A bit of time to learn how to make it all work together

How does it work?

Simple enough, from the user's perspective:

1. A signal is received through the antenna and processed through the ADC circuit in the USB device.

2. Output from the device is sent to the computer via the USB interface and used as input for the receiver software.

3. The software handles all filtering, demodulation, and audio processing, and outputs the result to the computer speakers.

Setting it up

Before beginning the installation process, READ THE DOCUMENTATION - TWICE.

A good and easy-to-follow description of the installation and setup process can be found at http://rtlsdr.org/softwarewindows.

- The website itself is a wealth of information on using RTL2832U-equipped DVB-T receivers as SDR devices – I recommend perusing the site.
- The only error in their instructions is that the *install.bat* file must be executed with administrator privileges (Windows Vista or later).

I suggest starting with the SDR# receiver software, available from http://www.sdrsharp.com – good documentation and easy to use

Another good Windows package is HDSDR, available from http://www.hdsdr.de.

- This package requires a bit more work to set up, but allows for somewhat finer-grained control of the receiver.

What do you get?

Out of the box, the R820T dongle will receive from around 25MHz to around 1850MHz.

Both software packages I've tested:

- allow for reception of AM, SSB, both wideband and narrowband FM, CW, and multiplex FM.

- have a means of saving frequencies, bandwidth settings, filters, etc. in a "favorites" database.

- allow for recording of received data, either as RF across the bandpass or as AF.

NOTE: recording raw RF data requires a great deal of storage…a ten-minute recording of a 1.5MHz bandpass data feed can consume over 500MB.

Now for a few value-added items…

By adding an upconverter (either homebrew or purchased), the incoming signal can be heterodyned and passed to the ADC

- Typical cost between $20 and $50, plus the cost of either a purchased patch cable to run between the upconverter and the USB device or the parts to make one)

Bringing the upconverter into the signal path provides reception capability from DC to the upper frequency limit of the ADC

Adding a software-based "virtual audio cable", the output of the SDR tuner software can be used as input to such applications as FLDigi

- Most common virtual audio cable program runs $25, there may be free software available as well

Adding a second USB device and additional software will allow SDR# to receive and track trunked systems (but won't decrypt secure transmissions on those systems – that's illegal!)

- There aren't any public-safety services in the area using trunked systems…yet…so I haven't tested this capability.

SDR# screenshot (receiving a broadcast FM station)
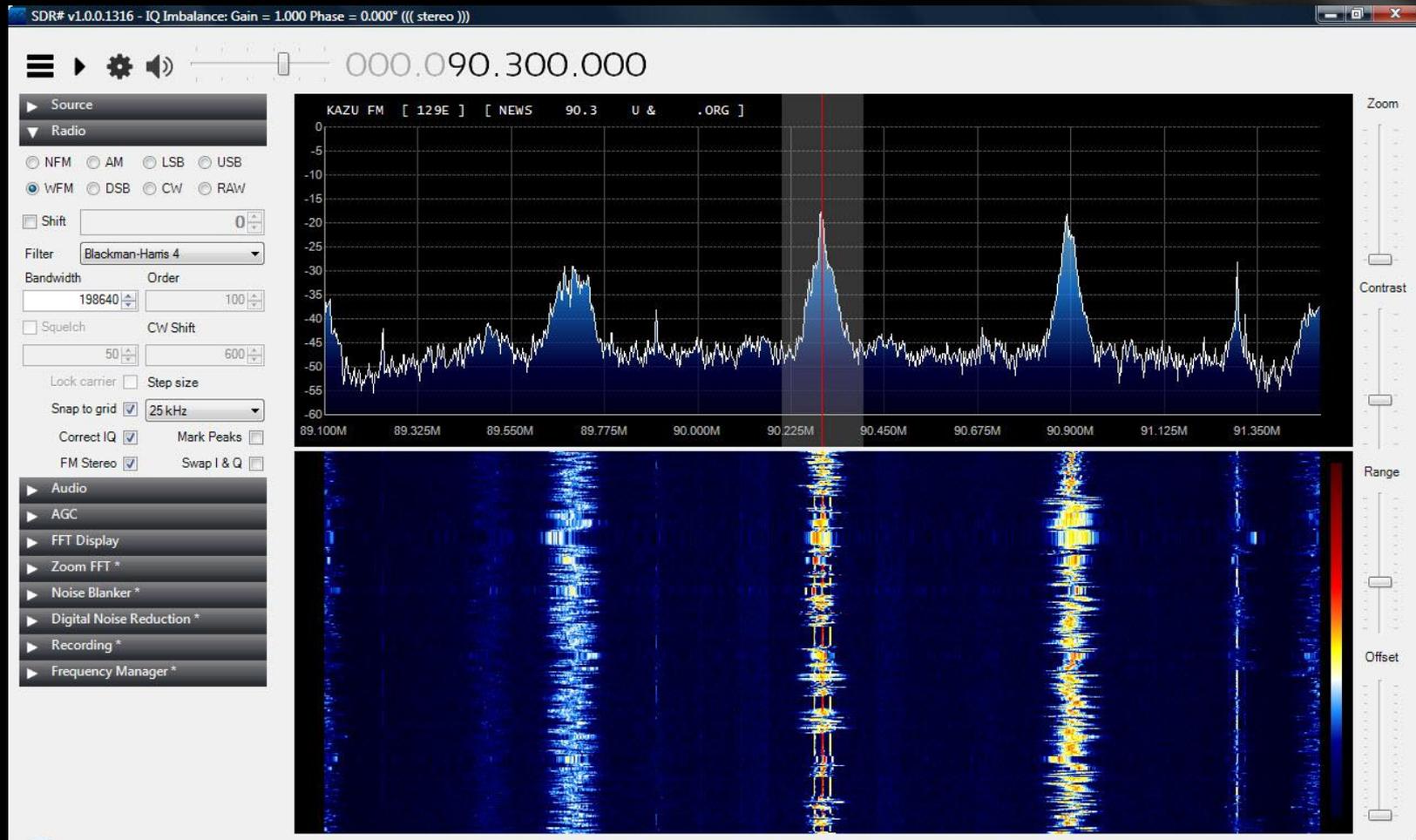
HDSDR screenshot (receiving narrowband FM public safety signal)
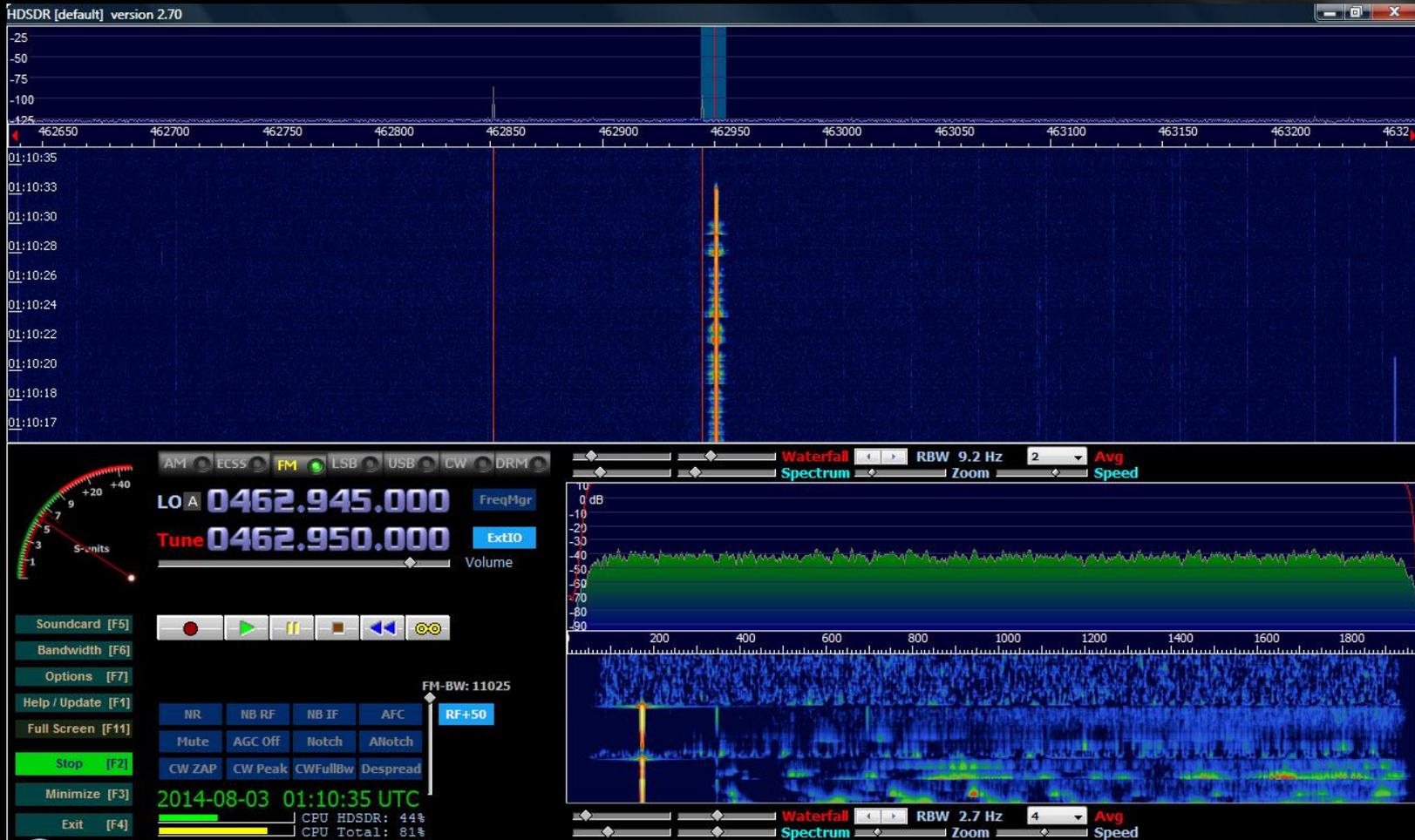
What would we use this for?

Secondary receiver for additional repeater monitoring, situational awareness

Receiving FLDigi signals without having to tie up the transceiver (additional software required for this application)

Equipment testing

- The ADC is NOT laboratory-grade, so I wouldn't use it for calibration, but it's good for a "best guess" check of parameters such as tuning, PL tones, etc.

Panadapter – look for signals in a given segment of spectrum, find either unused frequencies that can be put to use or active frequencies for monitoring and communication

Equipment suppliers

USB DVB-T device: I use the NooElec R820T (found on eBay for $8, available on Amazon for around $17 plus shipping and tax) – there are other USB devices that do as well, just make sure it has the RTL2832U ADC chip (the specific tuner chip doesn't matter)

Upconverter: I don't have one yet, but I'm looking at the NooElec "Ham It Up" v1.2, price $45 direct from NooElec, can be found sometimes on eBay for around $20. It's a bare board, but NooElec does offer aluminum cases.

- Don't forget the cabling between the upconverter and the USB device. Power comes from a separate USB connection either to the computer or to a "wall wart".
- Plenty of sources online for schematics to build your own upconverter, as well as YouTube videos on how to get it all working

For the lazy or impatient, NooElec does sell a full bundle including DVB-T dongle, upconverter, aluminum case for the upconverter, and necessary cables & adapters – still needs a USB power supply cable for the upconverter, check the specs for which specific connector is needed)

Direct ordering: http://www.nooelec.com

Software sources (all Windows, sorry)

SDR# - http://www.sdrsharp.com

HDSDR – http://www.hdsdr.de

LibUSB (Windows driver for the USB device) - http://zadig.akeo.ie/
- Windows 8 or 8.1 users will need to DISABLE "driver signature enforcement"
- Windows XP users will need a separate download

Virtual Audio Cable - http://software.muzychenko.net/eng/vac.htm
- Free trial, then $25-50 registration (see website for details on pricing and support)

GNU Radio – for the tinkerers, programmers, etc. http://www.gnuradio.org
- Some information is out of date, but overall a good picture of how SDR development looks in the free/open-source software arena
- Covers other hardware, such as the FunCube, SoftRock transceiver, etc.

RTL-SDR wiki at http://rtlsdr.org provides a great deal of OS-agnostic information, but some is out of date – caveat emptor.

Any questions?