

Vatsal Patel

Gregory Durgin

Wireless Communication Transceiver

Software Defined Radio Technical Review

Introduction

Software defined radio, also known as SDR, is a digital communication system implemented by software instead of hardware components. A typical software defined radio is attached on an antenna. Then, the software transforms the stream of data to a format the application requires. This software run receiver allows the user to change the function of the receiver by changing a few parameters of the software, instead of rewiring and adding components to the hardware [2]. There are several components that go into a complete Software defined radio.

Current applications

Software Defined radio greatly reduces the costs of transmitters and receivers. It also enables the radio to be upgrades and modified with little to no cost. Many FM radio stations are transmitted using software defined radio now. That enables the radio to easily change the broadcast channel by simply changing a few parameters. Police radios run on multiple short length channels. Software defined receiver allows the control center to see the incoming channels on a computer and easily change between different channels by a click of a mouse. There are a few software defined radios in the market currently. One of the newer low cost one is the bladeRF by Nuand. BladeRF has USB 3.0 for communication, for high speed data transfer. It is capable of capturing 40MHz 12-bit full duplex quadrature samples in real-time. It has a working range between 300 MHz to 3.8 GHz [5]. BladeRF is the cheapest option, starting at about \$400. Other competitions include HackRF. HackRF is even cheaper than bladeRF and its radio spectrum is from 30 Mhz – 6Ghz. However, the sample size and rate is slower than bladeRF.

USRP is another product that is on the higher price spectrum, but it offers more options and power for more professional needs. The higher end version offers a range between 50 MHz to 6 GHz and 150,000 FPGA logic elements [6].

The Underlying Technology

The object of the SDR is to convert a modulated radio-frequency signal from the frequency domain to time domain for software processing [2]. In the frequency domain, the amplitude is measured against frequency and in the time domain it is measured against time. The RF signal is read in by the antenna, then A to D conversion takes place, where the signal is converted from analog format to digital format. After the signal is digitalized, the signal goes through channelization and sample rate conversion [4]. Finally, using various hardware and software processing techniques the signal is processed to the final desired state [4].

Building Blocks

Implementing a software defined radio requires both hardware and software components. On the software side there are various algorithms that are used to process the data. Other software like middleware and COBRA are also used [3]. On the hardware side FPGA, DSP and ASIC is used for data processing [3]. Software controlled radio is a very broad term, the customization can vary greatly from product to product. A SDR can be made using an old TV antenna and tuner for free [1]. It can also be made professionally for a few thousand dollars.

Sources

- [1] S. Cass, "A \$40 Software-Defined Radio," *IEEE Spectrum*, June 25, 2013. [Online], Available: <http://spectrum.ieee.org>. [Accessed October 28, 2013].
- [2] E. Grayver, *Implementing Software Defined Radio*. Manhattan Beach, CA: Springer Science, 2013.
- [3] D. Gupta, "Software-defined radio," U.S. Patent 8483626, 9 July, 2013.
- [4] Z.C. Alex, S. R, and S. K. Vasudevan, "Software Defined Radio Implementation," *International Journal of Computer Applications*, no. 8, art 5, 2010. [Abstract]. Available: *IJCA Journal*, <http://www.ijcaonline.org>. [Accessed: October 28, 2013].
- [5] Nuand, "bladeRF – the USB 3.0 Superspeed Software Defined Radio." Available: <http://nuand.com/>
- [6] USRP, "USRP B210." Available: <https://www.ettus.com/product/details/UB210-KIT>