Introduction to Software Defined Radios

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Agenda

- Why Software Defined Radios?
- What is a Software Defined Radio?
- Block Diagrams
- Technical Challenges
- Amateur Contributions
- How to Build A SDR
  - The DSP-10 As a SDR
- Supporting Documentation
- Conclusion
Why Software Defined Radios?

Comments of ARRL:

“ARRL is most interested in this proceeding, not only because of the utility of the Amateur Radio Service as a testing ground for different configurations of SDRs, but also because of the potential long-term opportunities for SDRs to effect substantial changes, even conceptual changes, in traditional frequency assignment and spectrum allocations decision making in all services.”

ARRL comments to the Notice of Inquiry Regarding Software Defined Radios dated June 14, 2000 (ET Docket No. 00-47 released March 21, 2000).

http://www.fcc.gov/searchtools.html
Why Software Defined Radios?

Dale Hatfield, WØIFO,
Chief, Office of Engineering and Technology,
Federal Communications Commission

“This could stimulate a whole new generation of amateur innovation that not only includes the more spectrally efficient systems I mentioned earlier, but also radios that could adapt to their environment as well.”

Speech to AMRAD’s 25th Anniversary Dinner June 17, 2000
http://www.fcc.gov/Speeches/misc/dnh061700.html
What Is a Software Defined Radio?

Software Defined Radio (SDR)

Performs the majority of signal processing in the digital domain using programmable DSPs and hardware support, but some signal processing is still done in the analog domain, such as in the RF and IF circuits.
What Is a Software Defined Radio?

Software Radio (SW)

The ultimate device, where the antenna is connected directly to an A-D/D-A converter and all signal processing is done digitally using fully programmable high speed DSPs. All functions, modes, applications, etc. can be reconfigured by software.
Benefits of SDR

- Flexible
- Reduced Obsolescence
- Enhances Experimentation
- Brings Analog and Digital World Together
New Breed of Radio

- Reprogrammable
- Multiband/Multimode
- Networkable
- Simultaneous voice, data, and video
- Full convergence of digital networks and radio science.
Block Diagram
Software Defined Radio

Antenna

RF
Variable Frequency Oscillator

IF
Local Oscillator (fixed)

Bandpass Filter

Baseband
ADC/DAC DSP
Block Diagram
Software Defined Radio

- Antenna
- RF
- Local Oscillator (fixed)
- ADC/DAC
- IF
- DSP
- Baseband
Block Diagram
Software Radio

Antenna

RF

ADC/DAC

IF

Baseband

DSP
Smart Radios

The positive control over the transmitter’s use of the spectrum has traditionally been the purview of the radio operators, who were guided and trained to follow the rules of engagement carefully crafted during the course of decades to prevent harmful interference to other users.

The control of radio functions by software algorithms embedded into the future “smart” communications device will directly affect the manner in which that device uses the spectrum.
Smart Radio

- When combined with the software radio’s ability to monitor the RF environment and precisely sense its location, the software radio opens the possibility of sharing spectrum among vastly different users.
What Is a Software Defined Radio?

Cognitive Radio

As radios embed increasingly complex and realistic models of their environments, users, and networks, they begin to approach what an outside observer might call rational, or common-sense behavior.
Technical Challenges

- Dynamic Radio
- ADC/DAC Speed
- Smart Radio Algorithms
Amateur Contributions
How to Build a SDR

- **DSP-10** by Bob Larkin, W7PUA
  - *QST - Sep, Oct, Nov 1999*
  - [http://www.arrl.org/tis/info/vhfproj.html](http://www.arrl.org/tis/info/vhfproj.html)

- **R2-DSP** by Rob Frohne, KL7NA
  - *QST - Apr 1998*
  - [http://www.wwc.edu/~frohro/R2_DSP/R2-DSP.html](http://www.wwc.edu/~frohro/R2_DSP/R2-DSP.html)

- **A Panoramic Transceiving System for PSK31**
  - by Skip Teller, KH6TY and Dave Benson, NN1G
  - *QST - Jun 2000*
  - [http://www.arrl.org/tis/info/psk31.html](http://www.arrl.org/tis/info/psk31.html)
The DSP-10 As a SDR
DSP-10

Constructed by
Ernie Manly, W7LHL
Supporting Documentation

- **Signals, Samples and Stuff: A DSP Tutorial**
  by Doug Smith, KE6DX
  
  *QEX - Mar, May, Jul, Sep 1998*
  
  [http://www.arrl.org/tis/info/dsp.html](http://www.arrl.org/tis/info/dsp.html)

- **Basics of Digital Receiver Design**
  by Brad Brannon, N4RGI
  
  *QEX – Sep/Oct 1999*

- **A DSP-Based Audio Signal Processor**
  by Johan Forrer, KC7WW
  
  *QEX – Sep 1996*
  
Conclusion