Design and Implementation of a Portable Software Radio

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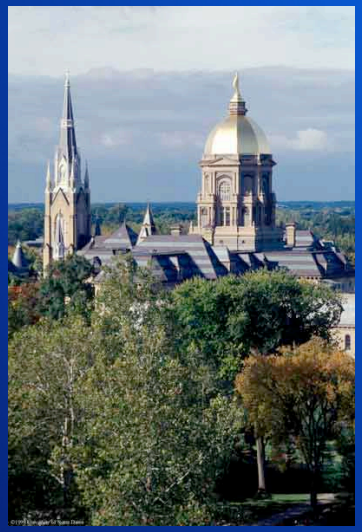
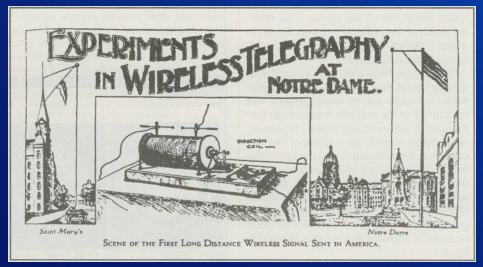
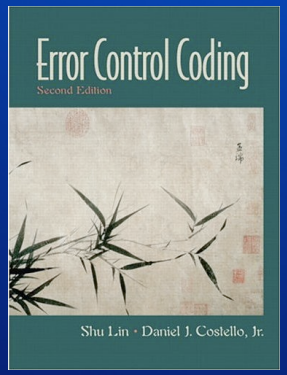
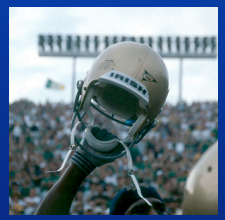
EE @ ND









- University
  - Founded 1842
  - South Bend, IN
  - Catholic, Research I
  - US News Top 25
- Department
  - 25 Faculty
  - 115 Graduate Students
  - $5-6M/year in Research (2003-2007)

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Today's Talk

- Software Defined Radio
- Portable Software Radio Prototype
- Start-up company: RFware
- Notre Dame Wireless Institute

Sponsors

National Institute of Justice (NIJ)

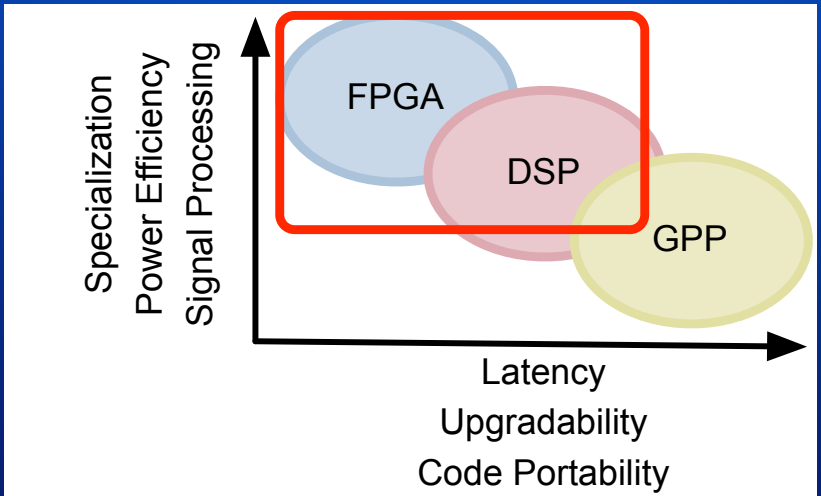
National Science Foundation (NSF)

“Software Defined Radio”

- Software Defined Radio (SDR) broad concept
- “SDR has been around for 15 years”
  - → TRUE
- “SDR ‘Holy Grail’ of wireless and yet to come”
  - → TRUE
- Many opportunities not yet realized

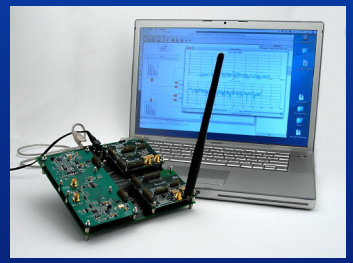
Commercial SDR Today

- FPGA & DSP heavy
- Moderate upgradeability, fairly classic communication architectures
- Suitable for portable form-factor devices



GPP-based Software Radio

- Use general purpose processor (GPP), not DSPs & FPGAs for signal processing
- Develop protocols in high level language *reliably*
- Leverage existing data-transport mechanisms
- Advanced upgradeability, novel architectures
- Not currently seen in portable form-factors



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Wireless Development Comparison

Prove novel algorithm in Python or MATLAB then…

- DSP / FPGA SDR
  - Design hardware from scratch, algorithm in mind
  - Write Verilog and re-prove algorithm, or use DSP
  - Test, debug, iterate
- GPP-based Software Radio
  - Download to existing multi-purpose hardware
  - Communicate!

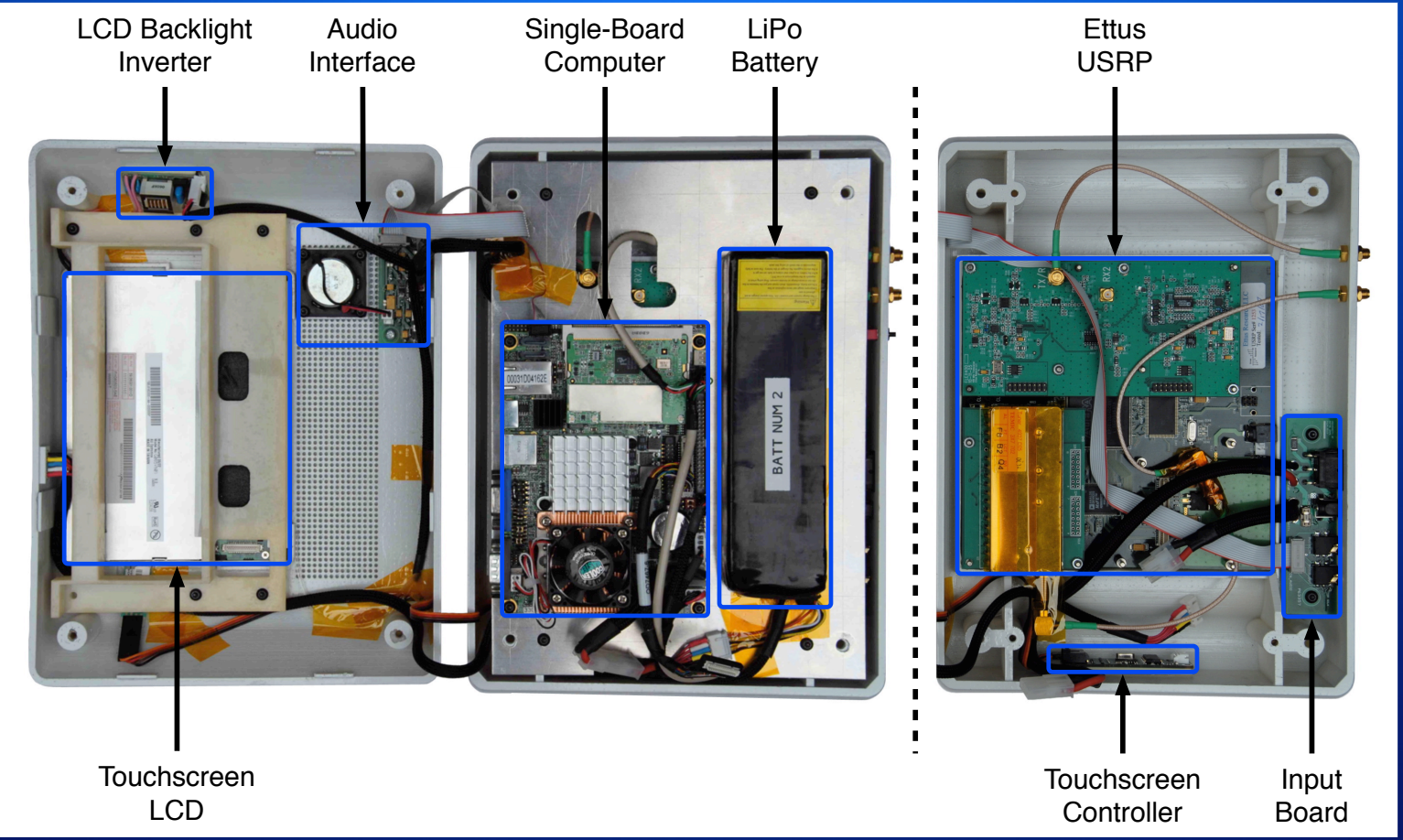
Portable Software Radio Prototype

- Open-source software
  - GNU Radio
  - Application-Programming Framework (APF)
- Off-the-shelf hardware
  - Single-board computer
  - Ettus Research USRP
  - Touchscreen LCD
  - LiPo rechargeable battery

Prototype | Software

- GNU Radio
  - Open-source Software Radio framework
  - Desktop computer with Linux, OS X, Windows
  - C++ signal processing blocks, Python ‘flow graph’
  - Great for academic research and experimentation
  - Not quite suitable for commercial applications
- Augmented with Application-Programming Interface (APF)
- Need Unix background, else steep learning curve

Prototype | Hardware



Numbers

- Dual 12 bit I/Q analog-to-digital at 64 MS/s
- Dual 14 bit I/Q digital-to-analog at 128 MS/s
- Useful bandwidth
  - Total signal bandwidth over USB 2.0 ~ 6 MHz
  - Access to ~30 MHz spectrum in FPGA
- 50 MHz – 2.9 GHz TX/RX

~$3700 Bill of Materials for one-off prototype device

Current Applications

- Public safety communications
  - Intelligent multi-channel reception
  - Advanced communication bridge
  - P25 radio at NTIA in 3 weeks
- Dynamic spectrum access
- Cooperative diversity

Anything from GNU Radio with USRP

Future Applications

- Cognitive Radio
- Multi-protocol handsets with single hardware transceiver
- Multi-user Detection (MUD) example
- Real-time physical layer (PHY) adaptation

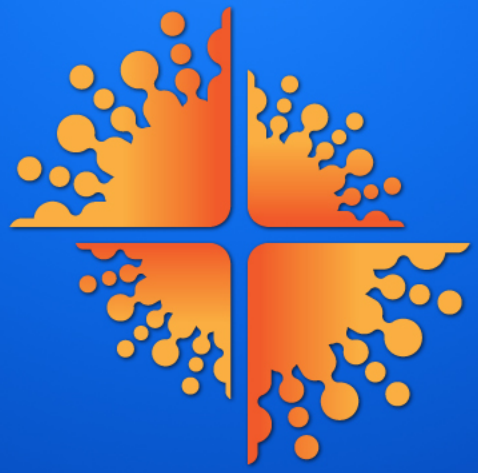
GPP-based Software Radio will enable entirely new wireless applications

Start-up Company: RFware

- Grand prize winner 2008 Notre Dame McCloskey Business Plan Competition
- Commercialize GPP-based portable software radio
  - *Affordable* wireless experimentation
  - Public Safety Communications
  - Government Communications
- What could you do with this?

RFWARE

info@rfware.com



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Coming soon…

UNIVERSITY OF NOTRE DAME

Closing

- Today's SDR vs GPP-based Software Radio
- Constructed Portable Software Radio
  - general-purpose processor (GPP) for signal processing
  - open-source software
  - off-the-shelf hardware
- Communications Magazine Article, August 2008
- Start-up company to commercialize: RFware
- Notre Dame Wireless Institute

Inflection point in wireless communications