"Configurable and Robust Wireless Communications Nodes"

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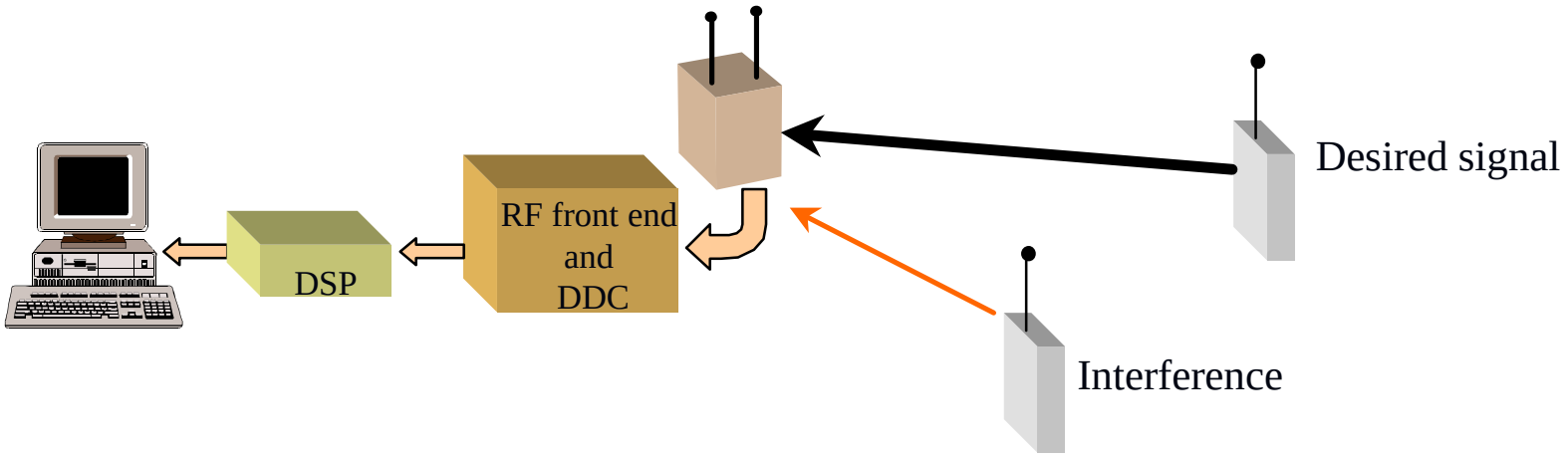
Objective

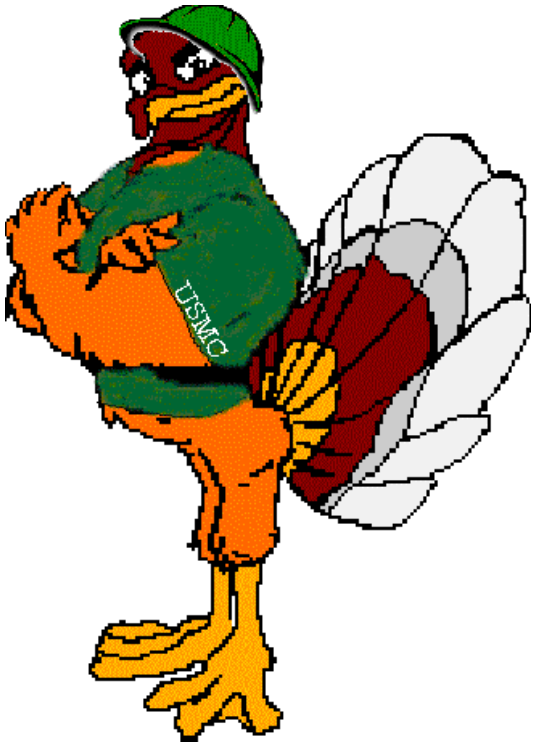
- To create a new software radio based on reconfigurable computing with the flexibility and advanced features to serve the varying needs of the GloMo community

- Demonstrate the utility of smart antennas at the handset



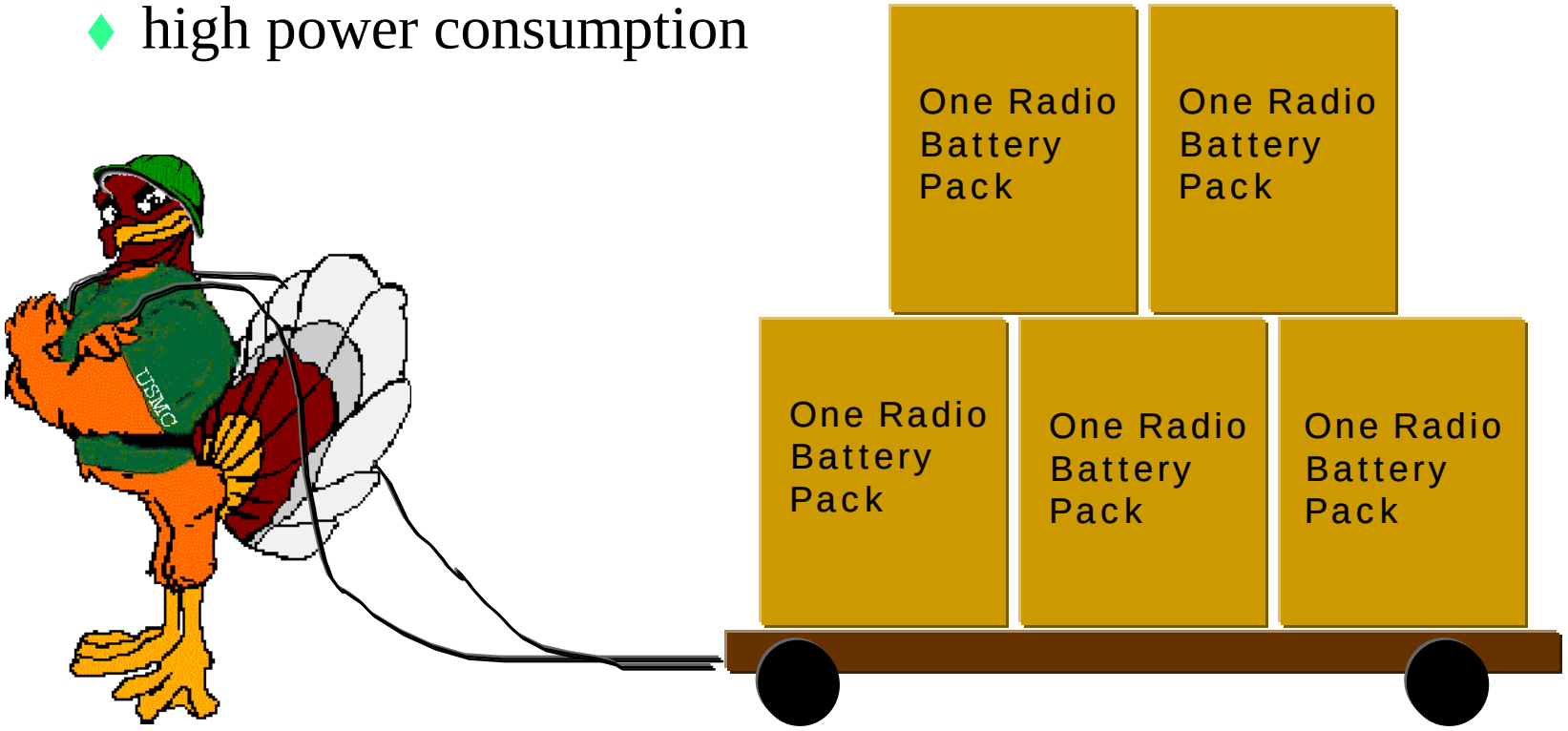
Impact on DoD

- **Efficient and Adaptable Battlefield Communications**
  - flexible, high performance radio platform that operates robustly under rapidly changing conditions
  - adaptation to provide fault tolerance, jam resistance, bandwidth efficiency, and legacy system compatibility
  - long field life and survivability



Challenges/Problem

- **Major drawbacks of contemporary radios**
  - large computational complexity
  - high power consumption

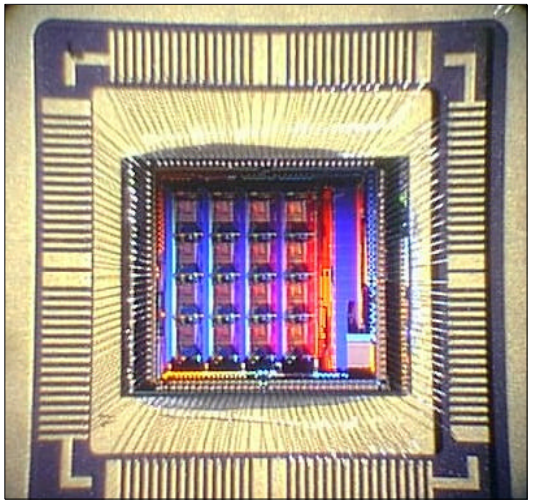


Technical Approach

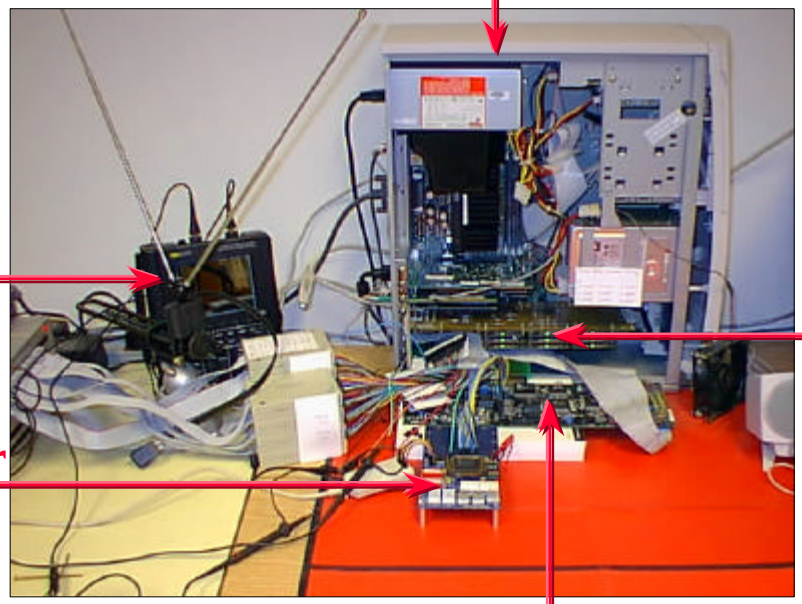
- **Run-Time Reconfigurable Computing (RC) Platform**
  - Based on FPGA or FPGA-like devices
  - Much more efficient than traditional computing architectures
- **Prototype RC Software Radios**
- **RC Hardware Signal Processing Modules**
  - Adaptive Interference Rejection Module
  - Adaptive Turbo Coding Module
  - Hand-Held Antenna Module
  - Adaptive Equalizer Module
  - More to come . . .
- **Apply Software Radio to Virtual Network Simulation Testbed**
- **Application Development Tools**
  - Tools for Rapid Prototyping onto the RC Platform
  - Radio Applications Development Tools

Accomplishments

- **Software Radio Based on Configurable Computing**
  - Colt Chip configurable processor (GloMo1)
  - Multiuser receiver
  - High-level design for a generic soft radio
  - Design of the Stallion processor



Colt Chip
(Stallion is the next generation)



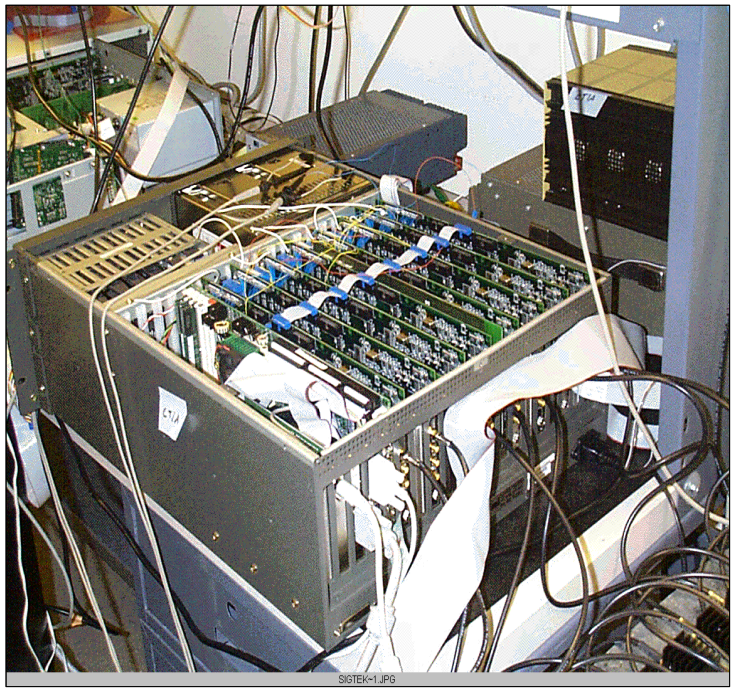
Multiuser Receiver

Accomplishments

- **Smart Antennas at the Handset**
  - Created and built 2 measurement systems to measure propagation characteristics as seen by the handset
  - Initial data collection shows an improvement of up to 17 dB in the link budget with adaptive combining and 7dB with diversity combining

Antenna Unit

Vector Channel Measurement System



Status

- **General Project Accomplishments**
  - ✓ most of the planning and literature search
  - ✓ seven papers published
- **The Receiver**
  - ✓ modification of the digital downconverter board
  - ✓ high-level radio design and block diagram completed
  - ✓ preliminary division of DSP and FPGA module tasks
  - ✓ preliminary measurements to model propagation for hand-held diversity
- **Configurable Computing**
  - ✓ final improvements over first generation Colt chip
  - ✓ multi-user transmitter module for the rapid radio prototype
  - ✓ radio interface to the rapid radio prototype
  - ✓ board to connect the DDC board to the prototyping platform

Status

- **Networking**
  - ✓ baseline architecture for deploying TCP/IP over the circuit-switched service of the VT radio
  - ✓ transmitter emulator design
  - ✓ implementation strategy
  - ✓ interface design

- **Turbo Coding**
  - ✓ research fundamentals of turbo coding and error control coding
  - ✓ literature search and on-line bibliography
    http://www.ee.vt.edu/valenti/reference.html

Status

- **Smart Antenna**
  - ✓ create vector measurement systems and analysis software
  - ✓ select analog to digital conversion and data logging system
  - ✓ identify hardware and software for reading recorded data
  - ✓ document experiments and hardware and software needed

Plans for Future Development

- **Architecture Characterization & Design 4Q97 - 4Q99**
  - System Definition 4Q97 - 1Q99
  - Tool Development 1Q98 - 4Q99
- **Computing Platform Organization & Design 4Q97 - 3Q00**
  - Test Stallion Reconfigurable Processor 4Q97 - 2Q99
  - Create Prototyping Board Using Reconfigurable Processor to Verify Algorithm Porting 1Q98 - 2Q99
  - Create Special Reconfigurable Processor Bands for the Software Radio 1Q98 - 2Q99
  - Create Rapid Radio Prototyping Tools for Porting SP Algorithms 4Q97 - 3Q00

Plans for Future Development

- **Software Radio Algorithm Modeling and Implementation 4Q97 - 1Q01**
  - Algorithm Development 4Q97 - 3Q00
  - Hardware Development 4Q97 - 1Q01
  - Evaluation 3Q98 - 2Q00
- **Virtual Testbed for Simulating Performance 4Q97 - 4Q99**
  - Design 4Q97 - 2Q99
  - Implementation 2Q98 - 4Q99
  - Evaluation 3Q98 - 2Q00

Plans for Future Development

- **Demonstrations 3Q98 - 4Q00**
  - ✓ Multiuser CDMA Receiver with Interference Mitigation on the Rapid Radio Prototype 3Q98
  - ♦ Handset Diversity Gain using the Hand-Held Smart Antenna Testbed 4Q98
  - ♦ Reconfigurable Receiver for CDMA Interference Mitigation 4Q98
  - ♦ Turbo Code Encoder/Decoder Implemented using Reconfigurable Hardware 1Q99
  - ♦ Radio Application Program Interface (API) 4Q99
  - ♦ Run-Time Reconfigurable Implementation of Receiver Management Functions 4Q99
  - ♦ Handset Diversity Gain using the Software Radio and Displaying Performance Improvement 1Q00
  - ♦ Turbo Code Hardware Integrated with Reconfigurable CHARIOT Software Radio 4Q00
  - ♦ Multi-Mode Capacity for the Reconfigurable Radio 4Q00
  - ♦ Network Use of Software Radio as part of System Demonstrations 4Q00

Technology Transition

- **Applications to Military and Commercial**
  - Smart Antennas for mobile applications
  - Turbo Coding for commercial CDMA equipment manufacturers (Qualcomm, Lucent, Motorola, Nokia, Nortel)
  - Multi-mode radio structure
- **Actual transitions (completed, planned, or underway**
  - MPRG Affiliates Program - over 25 companies with advance access to publications and research information
  - Licensing negotiations with FPGA company
  - Projects underway with commercial wireless firms to transition technology for third generation
  - Publications in journals and conferences, theses and dissertations

Key Resources

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- **http://www.mprg.ee.vt.edu/research/glomo/index.html**

- **Technical papers available at booth (Cavalier Room)**