Title
SDRCADE: Software Defined Radio for Efficient Channel Access, Flexible Sensor Network Gateways, and a Rapid Develeopment Enviornment (SYS 16)

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SDRCADE

SOFTWARE DEFINED RADIO FOR EFFICIENT CHANNEL ACCESS, FLEXIBLE SENSOR NETWORK GATEWAYS, AND A RAPID DEVELOPMENT ENVIRONMENT

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Introduction: Software Defined Radios

Software Defined Radios

- **Software defined radios (SDRs) present an opportunity for unprecedented flexibility and adaptability**
- **Trade performance of hardware for flexibility of software**

  By performing communication processing in software applications, we can quickly ***design*** systems, easily ***modify*** them, and support a vast range of ***communication modes*** with a single device.

Cognitive Radios

- **Bringing intelligence down to the physical layer**
  - Physical layer ***learns*** from and ***adapts*** to its current environment to optimize performance
  - Software radio makes the high degree of complexity manageable
  - Nodes can opportunistically share spectrum with licensed users, while avoiding harmful interference

Efficient Channel Access: Exploiting physical layer information to increase efficiency

- **Spatiotemporal channel information map**
- Initial and ideal idea is ***creating a Database*** of <src_id, dst_id, src_xyz, dst_xyz, *channel_information*> pairs and make this centralized ***global map*** available to all nodes at zero cost. A more practical approach is keeping a local imperfect copy of the map at the nodes.

- **Best candidates for Link layer knobs**
  - ***Antenna direction***
  - ***Frequency band*** selection
  - Channel equalizer coefficients
  - Transmit power

  Optimal choices are a function of obstacles, primary users, co-channel interferers, location, frequency, and antenna orientation of the peer node.

Sensor Network Gateways: Flexible, multi-mode, multi-channel gateways

- **Decode multiple channels at once**

  The wideband nature of the USRP makes it feasible for a single SDR base station to simultaneously communicate on ***multiple independent channels***, and provide network bridging across incompatible radio standards

- **Possibilities for GNU Radio as a gateway:**
  - Multiplex between incompatible radio standards (FSK → OQPSK)
  - ***Radio channel debugger*** which allows inspection of the radio channel in a sensor network

Rapid Development Environment: Graphical system design and simulation

- **Hierarchical graphical modeling in Ptolemy**

  Allow systems engineer to design configurable block diagrams, with efficient target system ***synthesis***, which hides low-level implementation details and accelerates design time.

- **Rapid design flow**
  - Construct systems from a ***rich library*** of processing blocks
  - Simulate with Ptolemy and automatically generate efficient ***target implementations*** using GNU Radio and the Click modular router

Proposed Solution: Implementations for channel access, gateways, and design environment

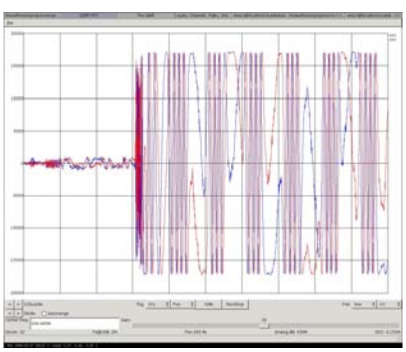

Figure 1: Mica2 FSK signal as seen from the GNU Radio Oscilloscope

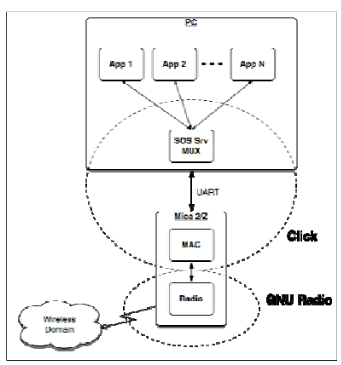

Figure 2: Click and GNU Radio emulate Mica2/Z base-stations

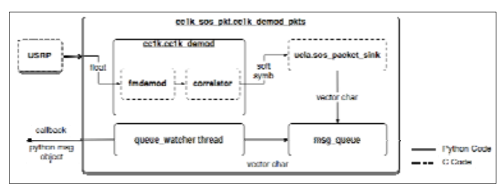

Figure 3: Mica2 FSK decoding block.

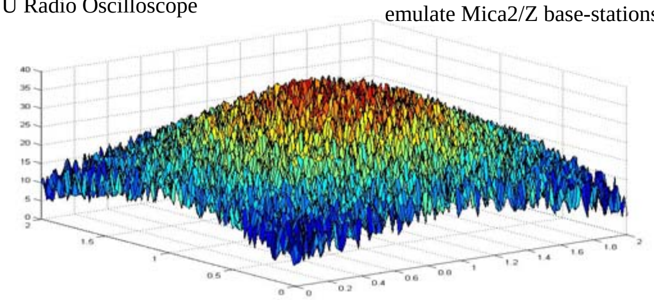

Figure 4: SNR map when omni-directional antenna is placed in the center an SNR ranging from 0 to 30 db

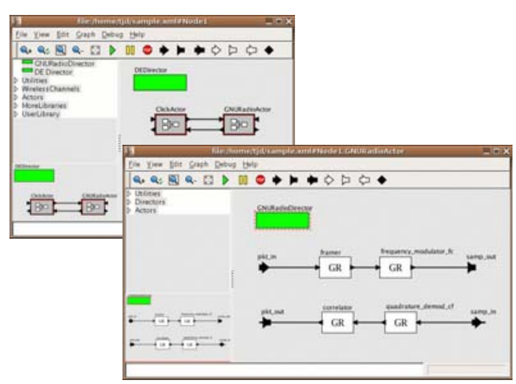

Figure 5: Hierarchical SDR model in Ptolemy-based design environment