Implementing a Base Station Using the SDR Platform for Coexistence of Heterogeneous Wireless Systems

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Outline

- Introduction
- Spectrum Access Scheduling
- System Specification

Problem: Spectrum Scarcity

- The radio spectrum is a precious and limited resource.
- Fixed allocation.
  - Most of the usable part of the spectrum has been divided among various radio services.
- Continuous and fast emergence of wireless standards.
- Running out of the radio spectrum?
- Actually, the currently allocated spectrum is not fully utilized.

Proposed Solution: Spectrum Access Scheduling (SAS)

- Reason: the conflict between the spectrum scarcity and underutilization.

- Proposed approach: Spectrum Access Scheduling
  - To improve the spectrum utilization efficiency.
  - The underutilized spectrum is shared among heterogeneous systems.

Cognitive Radio V.S. SAS

- Related work: Cognitive Radio
  - Primary users and Secondary users
  - Secondary users apply a opportunistic method to access spectrum holes.
- Our solution: Spectrum Access Scheduling
  - All wireless users are considered as first-class citizens of the spectrum domain.
  - Users apply a deterministic method to access the common bands.

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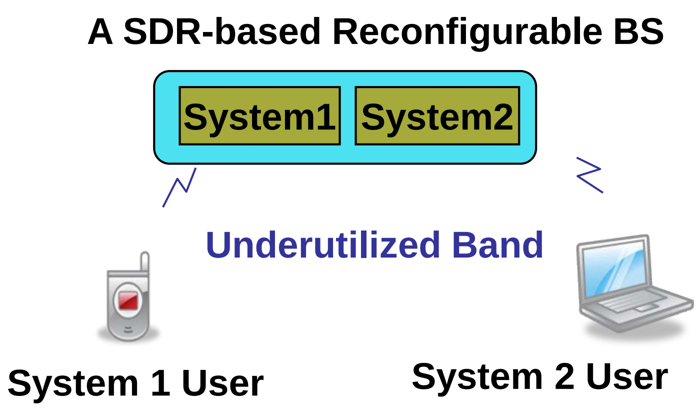
SAS System

- A centralized system.
  - Mostly affecting the base station of the overall system architecture.
    - The protocols are aware of each other at the base station, so that the spectrum is shared with minimum disruptions.
  - A cost-effective SDR-based base station.

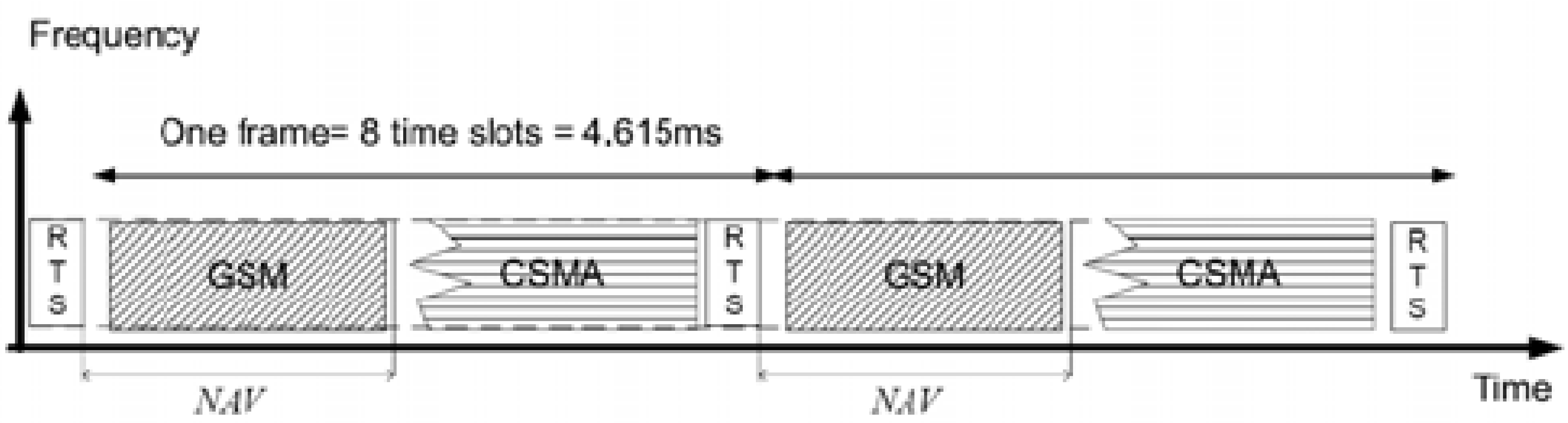
SAS System (cond’t)

- The underutilized spectrum is time-shared between heterogeneous systems.
  - Channels can be shifted to the same band through frequency up/down converters.



Example: GSM and Carrier Sensing Multiple Access (CSMA)

- GSM and CSMA time share the GSM-900 band.
  - The base station sends RTS (Request To Send) control frames to reserve the channel time periods for GSM.
  - Every CSMA node receiving the RTS frame has to set its NAV (Network Allocation Vector) in accordance with the duration field of the RTS frame.



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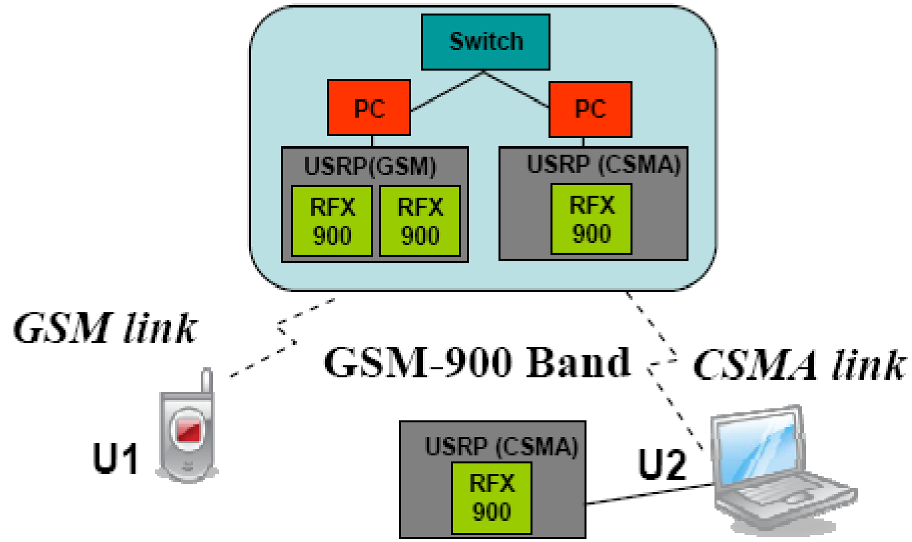
SAS Base Station

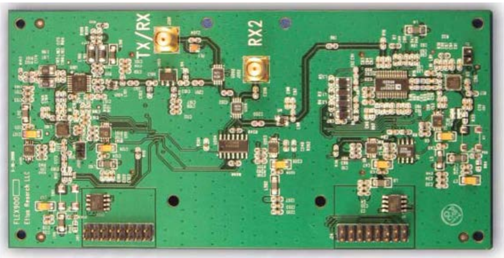
- Configuration
  - General purpose computer
  - USRP (Universal Software Radio Peripheral)
  - RFX 900 daughterboard

- For simplicity, we use two sets of computing hardware systems to virtually simulate a single base station .
  - A virtual base station eliminates the complexity of the OS kernel programming, and allows us to focus on protocol engineering issues for coexistence.
  - The two computers are synchronized by the PTP daemon (PTPd).
    - PTPd implements the Precision Time protocol (PTP) as defined by the IEEE 1588 standard.



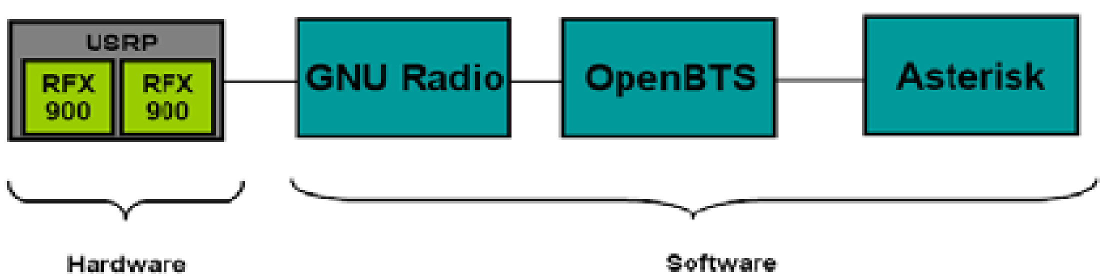
USRP (Universal Software Radio Peripheral)

- USRP motherboard
  - ADC and DAC
  - FPGA
    - The FPGA implements the control logics to reduce the samples.
- RFX900 daughterboard
  - Frequency Range: 750 to 1050 MHz
  - Transmit Power: 200mW (23dBm)
  - Daughterboards turn a USRP into a complete RF transceiver system.



OpenBTS

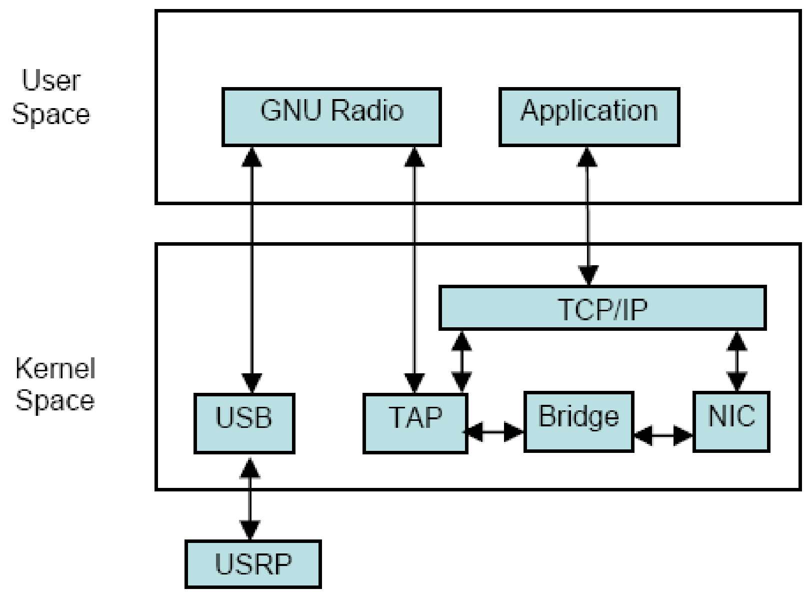
- OpenBTS is an open-source project.
- OpenBTS uses the USRP to present a GSM air interface ("Um") to standard GSM handsets.
- OpenBTS interfaces with libusrp libraries to use USRP.
- OpenBTS uses the Asterisk PBX (Private Branch Exchange) software to control and manage calls between GSM handsets and VoIP endpoints.
- OpenBTS supports GSM functions without supporting functions provided by traditional GSM components – the Base Station Controllers (BSCs), Mobile Switching Centers (MSCs) or Visitors Location Registers (VLRs).



CSMA

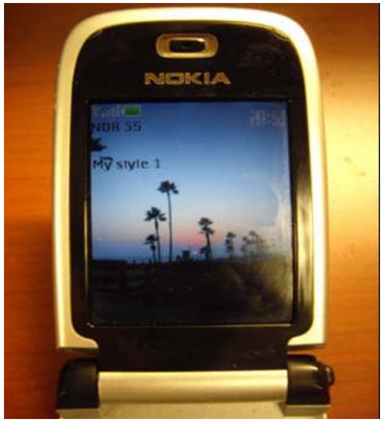
- A TAP (a virtual Ethernet network device) is generated in the kernel, so Ethernet frames can be sent and received through the TAP.

- A virtual bridge is generated to connect the TAP and the physical network interface card (NIC) that connects to the Internet.



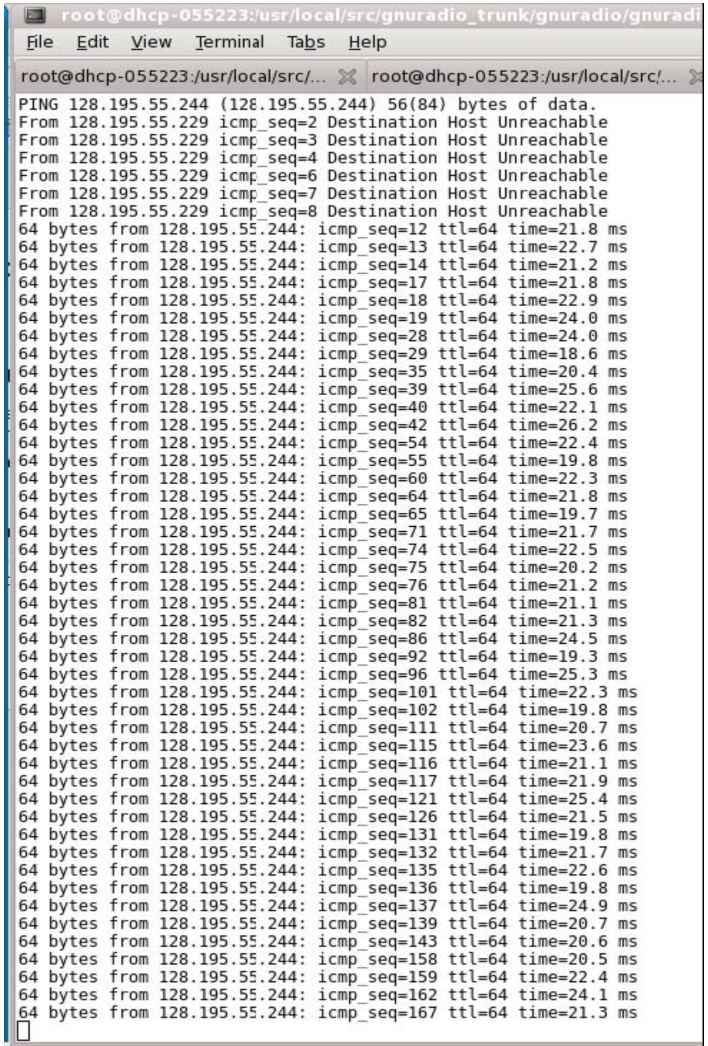
Coexistence of GSM and CSMA

- Carrying out two communication sessions simultaneously.
  - GSM
  - CSMA



a commodity cell phone

running the ping function



Conclusions

- Spectrum access scheduling (SAS) for spectrum reuse purpose.
- Cognitive Radio V.S. SAS
  - CR
    - Primary users and Secondary users
    - Opportunistic
  - SAS
    - Equal spectrum share holders
    - Deterministic

Questions?

Thank you !