IEEE DySPAN 2008 Demonstration Proposal Attachment

Title: A Heterogeneous Cognitive Radio Network Enabling Dissimilar Cooperative Spectrum Sensing, Dynamic Spectrum Access, and Interoperability

Team members: Feng Ge, Alex Young, Ying Wang, Qinqin Chen, Al Fayez, Mark D. Silvius, Sujit Nair, Terry Brisebois, Gladstone Marballie, Charles W. Bostian

Contact Information

Primary Contact Name		Feng Ge
Organization		Center for Wireless Telecommunications, Wireless@Virginia Tech, Virginia Tech
Address		436 Whittemore Hall Blacksburg, VA 24061-0111
Phone Number		1-540-231-2558
Email Address		gef@vt.edu

Description

The demo system diagram containing real devices are shown in Figure 1.

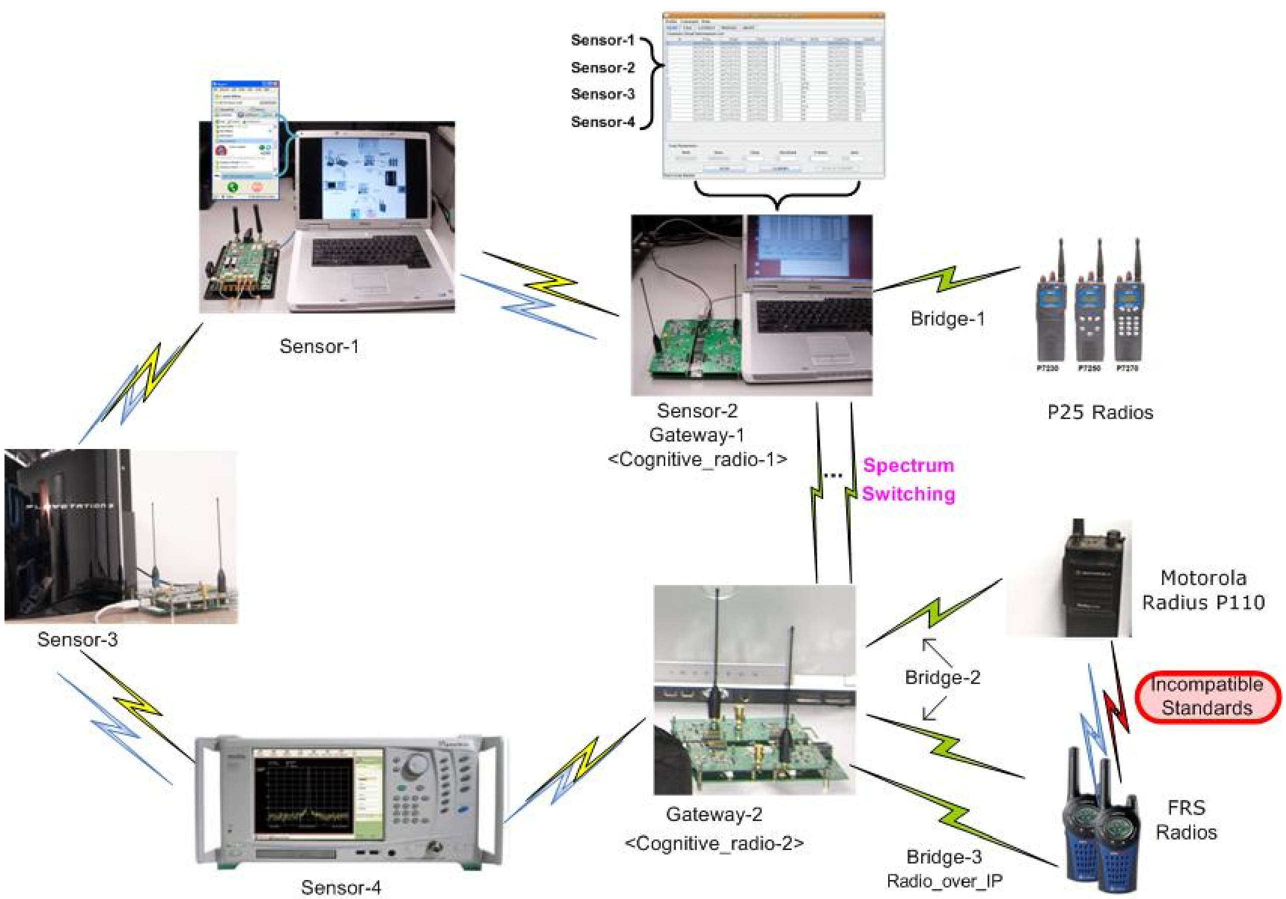

Figure 1 – The CWT's Heterogeneous Cognitive Radio Network Enabling Dissimilar

Cooperative Spectrum Sensing, Dynamic Spectrum Access, and Interoperability.

The purpose of this demonstration is to showcase the capabilities of a heterogeneous cognitive radio network. This network enables two applications: DSA applications based on cooperative spectrum sensing, as well as interoperability among different legacy radios and a Wi-Fi network.

As shown in Figure 1, four sensors are used for cooperative spectrum sensing: (1) Sensor-1 is based on a Lyrtech board and uses a laptop to display sensing results and to bridge the Lyrtech board to the Wi-Fi network. It has an RF front end with an antenna covering 450 MHz to 490 MHz. It runs signal detection and classification algorithms on a DaVinci DSP and Virtex-4 FPGA. (2) Sensor-2 uses two RFX400 USRP daughter boards which cover a frequency range of 400MHz - 500MHz configured through GNU Radio. It uses energy detection followed by a k-nearest neighbour algorithm (K-NN) to group signal features. (3) Sensor-3 uses the same USRP daughter boards as sensor-2 while GNU Radio runs on PS3 powered by a Cell BE. It implements cyclostationary feature based signal detection. (4) Sensor-4 uses an Anritsu receiver with an antenna covering the 400MHz - 500MHz range. It has Windows XP installed with Matlab which supports sensor algorithms.

An ad hoc network is built from Wi-Fi adapters. It serves as the control channel to collect sensor results and notify the two cognitive radio (CR) nodes, CR node 1 and node 2. As a master node, CR node 1 fuses all sensor results into a single spectral map of the entire radio environment which is accessible to CR node 2 through Wi-Fi. Built from GNU Radio and USRPs, both cognitive radios are able to reconfigure themselves on different frequencies and modes for communication. This ability also enables them to quickly switch from a channel should a primary signal returns. Based on DSA protocols and the overall sensing results, CR node 1 dynamically communicates with CR node 2 through any detected vacant channels. Dynamic spectrum access is demonstrated between two CR nodes within frequency ranges of FRS frequency range (462.5625MHz - 467.7125MHz). Primary signals may come either from our own radios or from other teams' communication devices.

We achieve interoperability through three gateway functions. Here the Wi-Fi network serves as a network backhaul and all connected sensors with operating systems become network nodes.

CR node 1 serves as gateway-1 which bridges a P25 radio to the Wi-Fi network. CR node 1 receives P25 digital radio signal through our modified USRP RFX400 controlled by GNU Radio, down-converts it to baseband signal, decodes and demodulates the P25 signal into baseband digital audio, and sends it to other network nodes. Other network nodes can receive and play back the audio content through their speakers.

CR node 2 serves as gateway-2, which has two bridge functions. Bridge-3 is similar to Bridge-1, but uses analog instead of digital radio signal. Bridge-2 differs from the others because it works as a repeater to make two incompatible radios talk to each other, rather than going to the Wi-Fi network. Bridge-2 uses two modified USRP RFX400 daughter boards; one to cover the 100MHz - 200MHz range, and the other to cover 400MHz - 500MHz. FRS radio signal is received by one of the RFX400 boards and demodulated to baseband signal. CR node 2 then modulates the baseband signal according to the police radio standard, and transmits the modulated signal through the other RFX400 board.

References [1-7]

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