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Sharing tv spectrum may require cognitive radio technology

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In the early days of broadcast TV, the world was analog and spectrum was plentiful. Spectrum sharing was unnecessary and, indeed, hadn't even been invented. Dedicated spectrum was allocated to each TV channel and later, 202 wireless microphones were permitted to operate in unused channels (FCC part 74).

Conventional TV stations use 6-MHz channels, numbered 2 to 69 in the VHF and UHF spectrum (54 to 72 MHz, 76 to 88 MHz, 174 to 216 MHz and 470 to 806 MHz). The 2009 transition from analog to digital TV, expected to free up channels 52 through 69 due to DTV's higher spectral efficiency, has prompted the FCC to update its regulations, allowing more efficient use of the spectrum, now possible with modern technology.

A hidden-node example signal from a TV station reaches WSD through a building or other obstructions and may be undetectable due to propagation losses. A TV antenna on the roof receives the same signal at a power level sufficient for viewing. WSD, not having detected the signal, may transmit and cause interference at the TV tuner.

The new regulations (FCC Dockets 04-186, 02-380) may allow unused portions of the TV spectrum to support wireless broadband services. They require the use of cognitive radios able to determine whether a channel is available prior to transmitting.

Two types of services are targeting the use of TV spectrum: fixed services in the form of wireless rural-area networks, being standardized by IEEE 802.22, and mobile services -- namely, white spaces -- being advocated by the Wireless Innovation Alliance.

The WIA is working with the FCC to open access to the TV spectrum without promoting any particular standard. IEEE 802.22 is developing a standard, originally based on the 802.16d protocol for fixed WiMAX and now also incorporating cognitive-radio techniques.

The IEEE 802.22 and FCC drafts specify three methods for detecting licensed transmissions:

» An internal GPS could be used in conjunction with a database to determine whether the unlicensed device is located far enough away from licensed stations.

» The unlicensed device could receive information from a broadcast station indicating which channels are available.

» The unlicensed device could incorporate sensing capabilities to detect whether licensed transmitters are in its range. If no signals are detected, the device could transmit. If signals were detected, the device would have to search for another channel.

The FCC is working with the sensing thresholds specified in the IEEE P802.22 Draft v1.0: -116 dBm for Advanced Television Systems Committee (digital TV); -94 dBm for National Television System Committee (analog TV); and -107 dBm for wireless microphones.

This level of sensitivity is needed to address the "hidden node" issue -- a condition when a TV signal is undetectable at the white-spaces device (WSD), but strong enough to be received through a TV antenna.

Analysis and field testing done by ITU-R, FCC and other organizations demonstrate that even when a WSD is deep inside a building, the signal reaching it is likely to be at most 30 dB lower than the signal at a rooftop antenna. The 802.22 draft sets the detection threshold 30 dB below a tuner's lowest receive level and states that an unlicensed device must detect a broadcast within 2 seconds and with probability of >90 percent.

Hidden node is a well understood issue, addressed today by protocols such as RTS/CTS in 802.11. From a technology perspective, hidden nodes can be effectively managed by the proposed FCC measures to ensure peaceful coexistence of TV broadcasting and unlicensed wireless services.

--Fanny Mlinarsky