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Good Enough for the Pentagon

THE FEASIBILITY OF "SMART RADIO" TECHNOLOGY IN THE TV WHITE SPACES

*By Benjamin Lennett**

October 2008

An important fact that has been lost in the debate about opening unused television channels (TV white spaces) to white space devices is *that the Pentagon has already approved the unlicensed sharing of military spectrum in the 5 GHz band* for devices utilizing similar spectrum sensing technology proposed for white space devices in the TV band. In the upper part of the 5 GHz band, wireless devices are required to dynamically scan the airwaves and avoid operation on spectrum utilized by radar systems. The experience of the 5 GHz band clearly demonstrates the ability of the FCC, device manufacturers, and primary users to develop technological standards and requirements that allow spectrum to be shared on an unlicensed basis *without causing interference* to critical uses such as military radar.

Unlicensed Access in U.S. Military Radar Spectrum (5 GHz Band)

When considering opening the upper part of the 5 GHz band (5470 – 5725) for use by wireless network devices, it was imperative to the National Telecommunication Information Administration (NTIA) and the Pentagon that products entering the new band would protect both fixed and mobile U.S. military radar systems.

▪ ***Importance of Preventing Interference.*** Radar is highly susceptible to interference even from a wireless device operating at very low power. A radar system transmits a powerful set of pulses into an environment. When these pulses strike an object, their energy is scattered and a small amount of that energy is bounced back towards the transmitting station. The radar's receiver then measures the time difference and the frequency shift information to calculate distance and other information about the object it struck. A wireless device operating on the same frequency as the radar or nearby to a radar antenna would show up on the radar's display, with the device's wireless signal producing streaks and other irregularities that severely inhibit the ability of the military user to accurately assess the environment.

▪ ***Developing Technical Standards.*** In 2003, the FCC opened a proceeding to allow unlicensed wireless local area network (WLAN) devices to operate in the military radar band (5470 – 5725). Given the increased security threats after the 9-11 attacks, the Pentagon required devices to protect sensitive radar systems that could pick up small boats or planes (typically smaller and less reflective targets) out of background clutter as well as detect stealth aircraft that can hide from most conventional radar systems. Over the next three years, working together with the Pentagon, NTIA and the wireless networking industry, the FCC developed an extended set of technical requirements that would ensure wireless equipment protect radar systems operating in the band. In June 2006, the FCC released the final set of technical standards required for device certification.

Benjamin Lennett serves as the Senior Program Associate for the Wireless Future Program at the New America Foundation. Shawn Chang of Free Press also contributed to this publication.

▪ ***"Listen before Talk", Dynamic Frequency Selection (DFS).*** The FCC's technical standards require a device operating in the military radar band to utilize dynamic frequency selection (DFS) to detect radar systems and avoid utilizing the radar's operating frequency. Wireless devices operating at a power level of 200 mW (twice the proposed power level of 100 mW for mobile white space devices in the TV band) must be able to detect radar signals of -62 dBm and higher power devices must be able to detect radar signals at -64 dBm. If a device senses a radar signal it must leave the frequency it has detected the signal on. Within 10 seconds, the device must cease all transmissions on that frequency.

Additional Unlicensed Access in Military Spectrum: The DARPA/XG Program

Since 2006, the next Generation Communications (XG) program funded by the Defense Advanced Research Projects Agency (DARPA) and managed by the Air Force Research Laboratory (AFRL) has successfully developed, tested, and deployed smart radio "listen before talk" sensing technology that allows "smart" radios to share the 225-400 MHz band with other military radios. DARPA contracted with Shared Spectrum Company (SSC) to develop technology that would allow mobile sensing devices to operate in the same spectrum as fixed, instrumented military and commercial legacy radios.

The technology has already been successfully tested and demonstrated. SSC tested six mobile XG radios in September 2006 and found that the devices caused no harm to existing military radios in compliance with regulatory rules, that XG can operate in the presence of high strength electromagnetic environments, and that XG allows for more efficient utilization of the spectrum. On the basis of XG's success, the Army is in the process of procuring 100,000 field radios that utilize dynamic frequency selection technology.

Implications for the TV White Spaces

The opening up of military radar spectrum in the 5 GHz band and the DARPA XG Program clearly demonstrate the feasibility of opening up the television white spaces to unlicensed devices. If smart radio, "listen before talk" sensing technology is able to co-exist with military radar and military radios, then the same technology should be capable of co-existing with commercial broadcasters in the television band. In fact, by comparison, the TV white space environment is a much less challenging environment since the waveforms are well known, are fixed location, documented openly, 6 MHz wide, and have precise timing and frequency stability. Despite this, the FCC has taken considerable steps to scrutinize the feasibility of white space devices and will likely impose stricter requirements on devices than in other shared bands.

▪ ***More rigorous testing completed.*** The FCC has completed extensive laboratory and field testing of "concept devices" to determine the feasibility of white space devices. This testing has gone far above and beyond the FCC's previous effort in examining the feasibility of smart radio devices in the military radar band. Even so, the results of the testing have demonstrated that "listen before talk" technology will work in the TV band and that even first-generation

"concept devices" were capable of reliably detecting DTV signals. Beyond this testing, the FCC will have to certify any white space device before it can be sold to the public.

▪ ***Higher sensing thresholds.*** "Concept devices" submitted to FCC testing, were able to detect DTV signals at threshold level below -114 dBm, nearly 1000 times weaker than a the -84 dBm signal required to show a digital picture. The sensitivity threshold for wireless devices in the military radar bands are -62 dBm for 200 mW power and -64 dBm for higher power devices or nearly 100,000 times less sensitive than what will likely be required for white space devices.

The results from the OET report, clearly demonstrate the feasibility of smart radio technology. An FCC approval of white spaces devices in the TV band is only a first step; any white space device will still need to go through an additional FCC certification process. In addition, the wireless networking industry since the creation of the IEEE 802.11 and the Wi-Fi standard has maintained strict technical requirements for devices to receive industry approval. This has continued in the opening of the 5 GHz band with associations such as the Wi-Fi alliance (which includes white space proponents Microsoft, Philips, and Motorola) developing best practices guidelines for devices. The continued success of spectrum sharing is dependent upon secondary devices not interfering with the primary user. Thus, device manufacturers have a powerful incentive to enforce strict technological standards and ensure devices operating in shared bands do not cause interference to primary users. If sharing spectrum with smart radio devices is good enough for the Pentagon, it should be good enough for broadcasters.

Resources

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