



Wireless Campus Networking Working Group

Position Paper on WLAN Radio Frequency Interference Issues

Executive Summary

The purpose of this position paper is to inform campus decision makers about a critical issue associated with operating IEEE 802.11b wireless networks (WLANs). It is not intended to encourage nor discourage deployment of wireless networks but rather to educate interested parties on the issue of radio frequency (RF) congestion and interference problems when operating spread spectrum wireless systems.

A recent Federal Communications Commission (FCC) enforcement action serves to highlight the criticality of RF interference. Specifically, the FCC is within their regulatory power to bring an enforcement action against any RF transmitter that causes harmful interference with the operation of licensed devices. If the source of interference cannot be remedied within a specified time, the FCC can require the offending device to cease operation. Moreover, FCC Part 15 devices like wireless access points, must accept all interference that may be caused by the operation of an authorized radio station, by another intentional or unintentional sources, by equipment operating in the 2.4 GHz Industrial, Scientific and Medical (ISM) equipment band, or by other incidental sources.

In laymen's terms, one could find himself on the losing end of a FCC enforcement action that requires the campus to shutdown portions of its campus 802.11b wireless network simply because it causes harmful interference with a licensed device such as those operated by the Amateur Radio Service. Moreover, there is little redress under FCC regulations when other devices interfere with the operation of the 802.11b wireless network.

The Wireless Working Group is recommending that campuses in the early stages of deploying wireless networks do so with the eventual goal of deploying IEEE 802.11a networks which operate in the higher 5 GHz U-NII bands; a 300 MHz wide slice of spectrum established by the FCC in 1997 for public and community use and free of competing sources of congestion¹.

¹ Free from congestion in two of the three U-NII working domains. See body of paper for full details.

Background and Impetus for Concern

Many campuses are now aggressively moving forward in the deployment of wireless networks, especially those built upon IEEE 802.11b technology available from a variety of vendors. To support this activity, EDUCAUSE has created the Campus Wireless Working Group under the Net@EDU umbrella to provide a robust forum for campus leaders to address technical and policy issues.

Recently at the annual Net@EDU meeting in Tempe, AZ, an FCC official presented an overview of the Commission's regulatory procedures to conference attendees. Of specific interest to the Wireless Working Group is the FCC's increasing concern with spectral congestion and the resulting interference in the 2.4 GHz ISM equipment band. The FCC licenses 802.11b wireless access points to operate under Class B, §15.247 of the FCC regulations in the 2.4 GHz ISM band. The regulations state that any device licensed to operate under Part 15 may not interfere with or otherwise disrupt the operation of licensed devices co-existing in the same spectrum. In other words, unlicensed Part 15 devices are the lowest priority, after the Federal government, FCC licensed services, and Part 18 devices (ISM transmit-only devices) when it comes to sharing the 2.4 GHz band.

To reinforce the urgency of this issue, we can point to anecdotes that have been appearing in the recent press. An April 27, 2000 article in the New York Times entitled "Preparing for a Collision of Wireless Services" reads: "If wireless networks proliferate as fast as many researchers predict, is it possible for the airwaves to become overloaded? Cell phones and some handheld organizers transmit and receive scores of messages a day. With laptop computers and other devices added to the mix, will there eventually be one big wireless traffic jam?"

Two more examples come from the amateur radio world. ARS, short for Amateur Radio Service (FCC Part 97) has allocations in all of the Part 15 bands. ARS is a licensed service and has higher priority access than Part 15 devices. In some cases, ARS has primary access to parts of the bands and can use power levels up to 1.5 kW for most emission modes and up to 100 W for spread spectrum with an automatic power control to force power minimization. There is very little use of spread spectrum today, but rules were changed in October 2000, to allow more liberal use of spread spectrum. The most used modes are FM repeaters and TV. A repeater in the SF Bay area, operating since 1996, has seen a continuously rising noise floor over the last several years. This year the level has finally affected the base station operation; a problem mostly caused by outside high EIRP² Part 15 operations, showing that things are definitely changing for the worse.

On February 8, 2001, the FCC asked a national wireless Internet Service Provider (WISP) to eliminate interference to Amateur Radio operations in the Dallas, Texas area. The FCC wrote Darwin Networks Inc. (www.darwin.net) regarding complaints of harmful interference to a licensed amateur TV station operating at 2.4 GHz; interference that is said to be a result of the company's deployment of 802.11b wireless access points at the Post Townlake Village property in Dallas (see <http://www2.arrl.org/news/stories/2001/02/15/2/?nc=1> for full story).

² Effective Isotropic Radiated Power – The arithmetic product of the power supplied to an antenna and its gain.

"Darwin Networks is obligated under Commission rules to locate the source of interference caused by its equipment and make necessary corrections within a reasonable time," FCC Special Counsel for Amateur Radio Enforcement Riley Hollingsworth noted. If Darwin Networks cannot eliminate the interference to the licensed operator, then they will be required to shut down their operations at the apartment complex (see §15.5.c of FCC regulations).

Setting aside for the moment interference issues associated with ARS and WISPs, over 400 regional and local ISP's are currently using Part 15 devices for last mile bypass. Moreover, many colleges and universities are looking at point-to-point and point-to-multipoint wireless solutions to replace expensive local loops or to gain access to remote campus buildings where previously it was cost prohibitive.

And finally, the Holy Grail that we all have been waiting for, there may be 1 billion "Bluetooth" devices operating in the 2.4 GHz ISM band by 2005.

While more devices are being deployed in the 2.4 GHz ISM than anyone likely imagined, the wireless industry seems to be in denial about the overall problem of spectral congestion. There is some belief that several of the current uses of Part 15 devices were unanticipated and unintended. Moreover, there seems to be both disagreement inside the FCC as to exact role of Part 15 devices and consumer/manufacture confusion about how Part 15 devices should be used.

Impact

While the Darwin Networks incident may seem like an isolated event, Dewayne Hendricks, CEO of the Dandin Group and a member of the FCC Technological Advisory Council, thinks that conflicts in the 2.4GHz ISM spectrum will increase dramatically as more 802.11b access points are deployed.

In practical terms, the deployment of access points internal to a building's structure normally radiates an insignificant spectral signature outside of the building. This coupled with the unlikely probability that a campus will have a person operating a licensed device (working in the official capacity of their job) within their campus perimeter greatly minimizes the risk of unintended interference. However, if a campus plans on irradiating outside common areas or deploying wireless LANs in off-campus locations, including those in which students reside, the chance of interference greatly increases.

This is only one side of the equation, however. A potentially more devastating effect may be a FCC licensed service or Part 18 ISM devices interfering with the operation of your wireless network. §15.5.b of the Regulatory Code states "...interference must be accepted [by Part 15 devices] that may be caused by the operation of an authorized radio station, by another intentional or unintentional radiator, by industrial, scientific and medical (ISM) equipment, or by an incidental radiator." Thus, operators of Part 15 devices like 802.11b wireless LANs, have little or no redress under FCC regulatory guidelines when it comes to other sources interfering with them.

The rapidly emerging 802.11a wireless standard which operates in the higher frequency 5 GHz range seems to offer a solution for this predicament, particularly for higher education. In 1997, the FCC specifically set aside 300 MHz of spectrum divided into three bands for “public and community use,” entitled the Unlicensed National Information Infrastructure Band (U-NII). Each U-NII band, or working domain as they are sometime called, is 100 MHz wide: the low band runs from 5.15-5.25 GHz, mid from 5.25-5.35 GHz, and the high band from 5.725-5.825 GHz. While the high band has licensed devices and ISM devices sharing the same spectrum, the low and mid-range band are allocated specifically for public/community use and, except in one instance³, will not be shared with any licensed or ISM devices which could cause interference or congestion. While there is potential for interference at the high band from higher priority licensed services and other Part 15 devices, its primary application is for outdoors point-to-point and point to multipoint wireless links using directional antennas where the risk of interference is controllable.

Recommended Actions

There is no denying the likely impact that wireless communications will continue to have on college and university campuses. Nor is it likely that campus decision makers can wait for technology to provide them with an eloquent solution.

Therefore, the working group recommends the following:

- Include in your cost-benefit/risk analysis the exposure your campus or installation may be subjected to by licensed FCC devices in your area. Each campus’s environment will be unique. Urban or metropolitan campuses may (or may not) have greater risks than rural campuses. Installations in medical clinics, hospitals, or scientific labs may have larger risks of interference by Part 18 ISM devices.

Current FCC licensee information can be found online at www.fcc.gov and there are companies that specialize in GIS representation of FCC licensee data. However, it should be noted that Part 15 installations are not grand fathered. Thus a FCC licensed device that begins operation well after your wireless network has been deployed is afforded the same protection under FCC regulations as those devices that exist before deployment.

Moreover §15.5.b of the regulations states that all Part 15 devices must accept interference from intentional, unintentional, and/or incidental sources. Thus no redress is available should a Part 18 industrial, scientific, or medical device interfere with your wireless LAN (prior or post-operational).

- Those individuals charged with the design and deployment of wireless LANs need to completely understand the propagation characteristics of radio waves at both the 2.4 GHz and 5 GHz frequencies and the subsequent effect that antennae selection has on those

³ The U-NII low band is shared with the Mobile Satellite Service (the only license service sharing the U-NII low band) and therefore low-band devices are limited by regulation to indoor use only in order to minimize interference. The risk of interference between the two applications is insignificant when deployed properly.

characteristics. The use of outside consultants for campuses that do not have the RF design expertise in house is strongly recommended.

- Campuses should view their initial investments in 802.11b as short-term. Furthermore, campuses should undertake their initial RF site survey with an eventual eye towards 802.11a deployment. Since a majority of your deployment cost will be in design and installation, to pull the extra circuits necessary for 802.11a coverage is not ill advised. Under such a scenario, you may utilize only a third to a half of your newly pulled circuits for your initial 802.11b deployment, but the necessary infrastructure will be readily available when the time comes for 802.11a deployment.
- Finally, campuses are encouraged to contact the major wireless vendors and encourage them to accelerate development and delivery of 802.11a technologies. Most vendors are targeting Q4 2001 to Q2 2002 to bring out 802.11a equipment.

Conclusion

Depending on the environment, the chance of interference between a campus' 802.11b wireless network and other licensed or unlicensed devices in the 2.4 GHz ISM band may run from remote to probable. The FCC had the foresight to recognize this potential conflict some four years ago and designated the 5 GHz U-NII band specifically for public and community use. The emerging 802.11a specification is designed to operate in the U-NII low and mid bands free from interference with devices set to arrive late 2001 to early 2002.

The 802.11a wireless networking standard is not without its own complications. While supporting data rates up to 54 Mbps compared with 802.11b that only supports data rates up to 11Mbps, the effective coverage area is much smaller and the signal loss due to multipath reflections is more pronounced. Depending on the environment, 1.5 to 3 times as many 802.11a access points as 802.11b are needed to get the same effective coverage, albeit at higher throughputs. This coupled with anticipated higher initial selling costs might make it more attractive to first deploy 802.11b and take your chances. However, the Wireless Working Group recommends performing the initial RF site survey with 802.11a in mind and then pulling the necessary extra circuits. While 802.11b network deployment will require only a fraction of the total circuits pulled, the infrastructure will be in place to deploy 802.11a when costs drop or conflicts arise.

The Net@EDU Campus Wireless Working Group

The Wireless Working Group works with all forms of wireless communications, both licensed (LMDS, ITFS, 3G/4G cellular) and unlicensed (802.11a, 802.11b). The goal of the working group is to enable those individuals responsible for wireless decision-making and deployment to collectively identify, document, and solve as many issues as possible. Proceedings of the working group can be found at www.educause.edu/wireless and a constituent listserv is available at wireless-lan@listserv.educause.edu. Interested parties engaged in wireless design and policy issues are encouraged to join the constituent listserv.