Use It or Lose It, SHF Edition

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There's been a lot of action in the past few years on the amateur 13 cm band (2300-2310 and 2390-2450 MHz) using gear that was originally made for Part 15 unlicensed service (802.11b/g). It's possible to build point-to-point or broadcast links to carry serious bandwidth for very little money, but there is so much non-amateur activity in much of the country that it's practical only in fairly remote areas or for short distances.

Companies are putting a lot of pressure on the FCC to allow unlicensed operations over a wider frequency range (some money-making operations like PCS cell phones are actually Part 15 unlicensed transmitters). There is much more amateur spectrum to lose if we don't use it more actively. All sorts of point-to-point and point-to-multipoint networks can be constructed in these bands if there is interest. There are two other frequency bands, much less crowded than 2.4 GHz, where hams can build systems using modified Part 15 gear.

Part of our 5 cm band is shared with Part 15 users, like it is on 13 cm. The main overlap is with the high power ISM band, 5725-5850 MHz, where anyone can operate point-to-point links under Part 15 with 1 watt of transmitter output, and antennas with any amount of gain. This leaves 5650-5725, in which low power unlicensed operation is permitted, and 5850-5925 which is quiet but for some military users. The FCC has only in the past year begun approving Part 15 radios in the lower band (5470-5725) because it took them a long time to work out the details of the Dynamic Frequency Selection (DFS) process needed to avoid military radar.

The other band of interest is 9 cm, 3300-3500 MHz. In other countries, most of this band is a commercial, licensed allocation used to deliver broadband Internet and TV to the home. Many manufacturers make gear for this frequency but can't sell it in the US – except to hams. The Ubiquiti SR3 radio covers this range by using an on-board heterodyne converter and a standard Atheros 2.4 GHz chip set. Similar converters are available as standalone units from Teletronics and Hyperlinktech.

The 9 cm band is particularly critical to defend, because it's adjacent to licensed spectrum and used as a commercial band in much of the rest of the world (making it a much more attractive target for companies who would like to make it part of their business plan). At this writing, there are two radio cards in production in this band, one from Wavesat and one from Ubiquiti. Those concerned with the security of Wifi type links on 2.4 or 5.8 GHz should look into this band. All of the boards and software packages described later in this article also function with at least the Ubiquiti 9 cm card.

There are a couple of techniques to QSY existing Part 15 equipment from is factory-programmed unlicensed frequencies to Part 97 frequencies. One is to change the master clock oscillator crystal, and this approach works well to open up the 2390-2400 MHz range in commercial units. The other is to enable the chip sets' inherent ability (if it's

made by Atheros, one of the more common suppliers) to operate over a wider frequency range. The remainder of this article concerns the operation of 802.11a type gear on amateur frequencies in the Part 97 5 cm band.

8021.11a is not spread spectrum, but rather Orthogonal Frequency Division Multiplex (OFDM) consisting of 52 subcarriers or "tones" (48 for data and 4 pilot) spaced 312.5 kHz apart. Each tone carries symbols 4 microseconds long with 0.8 microseconds between symbols, and the symbols may be encoded using BPSK, QPSK, 16QAM or 64QAM modulation. Higher modulation modes result in more bandwidth capacity in the same 20 MHz cluster of carriers, at the expense of higher signal-to-noise requirements. Some modern chip sets also allow the transmission of the number of data subcarriers, to allow the same total power to be concentrated among fewer carriers, making the entire transmission 5 or 10 MHz wide instead of 20.

One of the common "physical layer" chip sets in 802.11a wireless LAN equipment today is the Atheros, and current versions cover around 2300-2700 and either 4900-5850 or 4900-6100 MHz. Companies using Atheros chip sets have to sign very restrictive agreements about the use of Atheros firmware, since much of the chip set's functionality is provided by an external processor through a "hardware abstraction layer" or HAL. Atheros licenses a specific version of HAL to each manufacturer, which generally prevents its use outside the Part 15 bands.

Some companies (http://www.ascom.ch is one) have licensed a more permissive version of the HAL, which permits them to provide drivers to other companies in which the full range of the Atheros chip set can be used. These other companies in turn (and others, who get their drivers from who knows where) offer a whole driver package that allows a mini-PCI wireless radio card based on the Atheros chip set to be used over its whole range.

At least three companies, Mikrotik in Latvia (http://www.mikrotik.com), Valemount in Canada (http://www.star-os.com) and Antcor in Greece (http://www.antcor.com), sell router software packages based on Linux that use Atheros-based wireless cards which can be operated over their whole frequency range including Part 97-only frequencies. We have been using Mikrotik for several years in a public safety (Part 15 compliant) system with very good results. This software isn't free or open source, but it's not expensive, particularly when bundled with the hardware that each of these companies sells.

A package of a 22 dBi flat panel antenna, processor board and radio operating from 5.2 to 5.8 GHz is under $300 from Mikrotik. Other packages of board, software and radio can be as little as $150. Most of these packages will also support 900 MHz, 2.4 GHz and 3.4 GHz radio cards. Comparing the features and claims of the three companies mentioned, and running their demo versions, will give

you a good education on how this whole router/HAL/radio package works. At the end of the day, you can build point-to-point and point-to-multipoint systems on Part 97 frequencies and construct your own wireless area network.

One of the most appealing features of high capacity point-to-point systems is their ability to bring Internet connectivity from a region where it's functional to an area where it's not, due to isolation or disaster. The public safety system mentioned above provides connectivity, surveillance, VoIP telephones, telemetry and equipment control over three hops on 5.8 GHz spanning more than 50 miles in total, and it's been in reliable operation for more than a year now. It would be simple to outfit a go-kit with a couple of hops of this gear on amateur frequencies and be able to span similar distances on short notice.

The legal issue of operating 802.11-type systems connected to the Internet under Part 97 generates a lot of discussion, and many assertions have been made about what an FCC judge would determine to be the intent of the Rules. ARRL and FCC seem to have reached an understanding that it's not "encryption" if you use publicly-described codes such as WEP, and publish your password. The issue of handling third-party Internet traffic over a Part 97 link is a little more complex, but that's for another time.

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