The Evolving Radio-Frequency Environment for the Long Wavelength Array (LWA)

Patrick C. Crane
23 June 2009

When the Low Frequency Array (LOFAR) radio-telescope project started about ten years ago, one of the first tasks was to identify possible locations for it. Three sites were quickly identified for various political and/or technical reasons: The Netherlands, New Mexico, and Western Australia. The next step was to survey the three sites for radio-frequency interference (RFI); the best site was Western Australia and the worst was The Netherlands; New Mexico was intermediate. Since then, participants in the project have gone three separate ways: the Murchison Widefield Array (MWA) in Western Australia, LOFAR in Europe, and the Long Wavelength Array (LWA) in New Mexico.

The "Sturm und Drang" over the transition to digital television (DTV) in the United States finally came to an end on 12 June 2009. This transition was expected to have significant effects on the frequency range of the LWA, 10-88 MHz, which includes the VHF television channels 2-6 (54-72 MHz and 76-88 MHz). Unlike analog television which has empty space between and outside the video and audio carriers, digital television uniformly uses the full bandwidth of 6 MHz. Potentially, channels 2-6 could have been filled with full-power digital television stations, which would have wiped out radio astronomy at those frequencies. That did not happen!

Nor do other, new users appear likely to impact significantly the use of those frequencies by the LWA. The radio-frequency environment in New Mexico for the LWA is very good:

1. After the DTV transition there are no full-power television stations operating on VHF channels 2-6 (54-72 MHz and 76-88 MHz) in New Mexico. The nearest such stations are located in Las Vegas, NV; Grand Junction, CO; Ensign, KS; Fredericksburg, TX; and possibly Flagstaff, AZ (which has petitioned to remain on channel 22). There is a small number of class A, low-power, and translator stations operating on these channels in New Mexico but we hope to work with them as they also go digital. Nationally, there are approximately 40 full-power stations using channels 2-6.

2. Strong adjacent band interference from FM stations (88-108 MHz) is a significant factor affecting the LWA. However, FM radio is undergoing a slow transition from analog transmission to HD Radio. This transition is largely transparent to the public because, unlike DTV, FM stations can broadcast simultaneously in both analog and digital formats. When the transition to digital transmission is complete and analog transmissions are turned off, under the current standards for HD Radio, the digital transmissions have only one percent of the transmitter power of the analog transmissions and achieve similar coverage. Some broadcasters have petitioned the FCC to raise the limit to ten percent, which would still be a significant improvement from our perspective.

3. One possible problem at low frequencies is broadband over power lines (BPL) which uses the frequency range 2-81 MHz. However, most of rural New Mexico is served by 19 electric

cooperatives who apparently think that BPL “doesn't make economic or technical sense in a (true) rural service area like central New Mexico.” According to an article in the New York Times (http://bits.blogs.nytimes.com/2009/02/19/ibm-delivers-rural-broadband-over-power-lines/), BPL is only "cost-effective in areas that have 5 to 15 customers near each mile of line." Furthermore, if necessary, we can seek protection for the LWA in the low-frequency radio-astronomical allocations similar to that already provided to the VLA at 74 MHz.

4. Another possible problem is the effort by several high-technology companies (e.g., Google, Microsoft, Cisco, Motorola, etc.) to use empty television channels (“TV White Space”) to provide unlicensed, low-power, broadband wireless networking. In its final rulemaking, the FCC limited TVBDs (“TV band devices”) to using only channels 2, 5, and 6 of VHF channels 2-6 and only for “fixed TVBDs that communicate only with other fixed TVBDs.” Furthermore, we can seek protection from TVDBs as a radio astronomy facility as has been provided to the ATA, Arecibo, GBT, VLA, and VLBA in Section 15.712(h) by the FCC.

5. A final concern is radio-frequency interference produced by corona discharge from extra-high-voltage electric transmission lines. We are working with agencies of the State of New Mexico to determine and enforce suitable minimum separation distances. To assist in this effort, we have implemented the BPA model for radio-frequency interference from extra-high-voltage transmission lines.

6. The frequency range 20-54 MHz is generally free of radio-frequency interference with only occasional occurrences of narrowband interference. Interference below 20 MHz is quite common but the strength is variable with ionospheric conditions; such interference is essentially the same world-wide.

7. Radio astronomy has five allocations in the band 10-88 MHz summarized in the table which, in terms of the above discussion, may be used very productively by the LWA.

Low-Frequency Allocations for Radio Astronomy

Frequency Range	Description (U.S.)
13360-13410 kHz	Primary
25550-25670 kHz	Primary
37.5-38.0 MHz	Secondary, Land Mobile Primary
38.0-38.25 MHz	Primary, Shared with Fixed and Mobile
73.0-74.6 MHz	Primary