Filing on NOI 02-381 Pertaining to Rural use of Spectrum

## Credentials

I am David Hughes, owner of Old Colorado City Communications, Colorado Springs, Colorado an Internet telecommunications ISP, who has intensely used and pioneered the use of unlicensed spread spectrum and UNII radios in all the bands covered by FCC Part 15 Regulations, since 1994.

I have also been, since 1995, the Principal Investigator for a series of 5 National Science Foundation (NSF) grant projects totaling $2 million, to investigate and model the uses of broadband Wireless for (1) Rural Education 1995-1997 (2) Mongolian Connectivity 1995-1996 (3) Environmental and Biological Field Sciences in the US from Puerto Rica to Alaska. 1998 – 2002.

Additionally I have been a principal advisor to the National Assembly of Wales for their £100 million deployment of wireless to bring broadband to all parts, and especially rural parts, of Wales unserved by any other technology or services. Presently I am technical advisor to the Sargamatha Pollution Control Commission of Nepal, for the reliable installation and operation of a broadband network using US build Part 15 radios at 18,000 feet on the Khumba Glacier base camp at the foot of Mount Everest, Nepal, to serve the connectivity needs of hundreds of trekkers and climbers.

I am associated, as part of several Industry Organizations and online technical forums, with hundred of Wireless ISPs who operate, largely in rural and fringe-urban areas across the United States. Through daily online contact I am very familiar with their successes and failures, and their frustrations with the 'one-size-fits-all' limitations of Part 15 Rules which apply whether radio devices are used in urban centers, rural small town, or extremely remote rural areas.

## Your NOI Questions

"H.. Unlicensed Spectrum

29. We also seek comment on the extent to which spectrum is being used to provide wireless services to rural communities. We ask commenters to identify the service providers that are utilizing unlicensed spectrum and the types of service they are offering. Further, we seek comment regarding actions the Commission could take to encourage or facilitate the use of unlicensed spectrum. For example, unlicensed operation is generally limited to very low power levels in order to help ensure that the operation does not interfere with licensed services. However the interference potential of unlicensed devices may be low or negligible in rural communities. Should unlicensed devices be permitted to use higher output levels in such environments? "

My answers are contained in the Rationale, and then specific observations, and recommendations, below.

## Public Policy Rationale for Unlicensed Wireless
## My Opinion

In all cases, I have tried to use, and encourage the use, of unlicensed digital radios under the existing FCC Part 15 rules for an ever widening variety of rural, and remote area, community, educational, business, governmental, and scientific purposes. The overridingly important reason I have done this, is because ONLY unlicensed rural digital radio networks are the only cost-effective means to bring broadband to the 25% of the US population which lives in rural areas – 97% of the US land area, (US Census figures) with population densities far too small to be profitable to traditional providers of Internet connectivity, whether by wired or licensed wireless means.

These rural area are also INVARIABLY the ones with the LEAST amount of RF transmissions/reception per square mile, and with the LEAST problem of interference between licensed and unlicensed devices.

So not only have I strongly believed – and demonstrated – that the use of Unlicensed spread spectrum and UNII band radios is the MOST cost effective way to deliver broadband the last 10-15-25 miles (not last mile as in big urban centers) I have strongly noted this practice BETTER implements a MAJOR goal of the 1996 Telecommunications Act which was to give ALL Americans access to Advanced Telecommunications capabilities, than ANYTHING provided by Rural Telephone Companies, or Cable or High Cost per Mile dedicated broadband connections.

I extract here the following from the Telecommunications Act of 1996, Pub. LA. No. 104-104, 110 Stat. 56 (1996) to remind you of what YOU, the FCC was charged with.

"SEC. 706. ADVANCED TELECOMMUNICATIONS INCENTIVES.

(a) IN GENERAL- The Commission and each State commission with regulatory jurisdiction over telecommunications services shall encourage the deployment on a reasonable and timely basis of advanced telecommunications capability to all Americans (including, in particular, elementary and secondary schools and classrooms) by utilizing, in a manner consistent with the public interest, convenience, and necessity, price cap regulation, regulatory forbearance, measures that promote competition in the local telecommunications market, or other regulating methods that remove barriers to infrastructure investment.

(c) DEFINITIONS- For purposes of this subsection:

(1) ADVANCED TELECOMMUNICATIONS CAPABILITY- The term `advanced telecommunications capability' is defined, without regard to any transmission media or technology, as high-speed, switched, broadband telecommunications capability that enables users to originate and receive high-quality voice, data, graphics, and video telecommunications using any technology."

Of course it is well known by now that the largest companies – the Regional Bell Operating Companies, have failed to carry out the mandate for ubiquitous broadband – for all Americans – laid down by the US Congress. Instead and in spite of all the purported incentives for doing so.

So What is the Problem?

The biggest obstacle to using Part 15 spread spectrum or UNII radios in the 902-915Mhz, or 2.4-2.483Ghz, or 5.2-5.8Ghz bands is the FCC LIMITATIONS ON EFFECTIVE ISOTROPICALLY RADIATED POWER – EIRP.

Currently Unlicensed Radios operating in these bands are limited to 4 Watts EIRP, or a maximum of 36dB. I contend that Part 15 rule was made entirely with DENSE URBAN AREAS in mind, where 'interference' with other unlicensed radios is most possible, but ranges, in miles for WANs is the least. But in SPARSELY POPULATED RURAL AREAS, the greater problem is RANGE in miles to a Wireless ISP Customer, not INTERFERENCE! I have NEVER encountered Interference between Part 15 Radios in rural areas, either across open space, or across typical smaller rural towns as a problem! And given the ever greater configurability of radios such as 802.11b – permitting 11 separate channels, three non-overlapping – it is trivial to select other frequencies within the band, to avoid what interference from similar radios might already occur.

Even in a rural town which would have 3 competing Wireless ISPs (a VERY rare occurrence) all using WI-Fi 2.4ghz 802.11b radios, all three can coexist without interference by simply selecting the three non-overlapping channels.

BUT those same three wireless ISPs will be severely limited in providing their service to customers up to a mile away, Line of Sight through almost ANY trees, and anything but the flimsiest walls. Because the EIRP limit is so low – 36db. Or effectively 4 watts.

I contend that 25 watts, or 44dB as a MINIMUM should be permitted in rural areas.

With a 100mw 802.11b radio (such as a Cisco 350) and a 24dBi gain antenna, a Wireless ISP can deliver 2mbps (effectively a T-1) 25 miles, with an acceptable Operating Margin of 15dB. AND at shorter ranges, such as in towns, be able to reach client omni or plate antennas either inside or just outside a window AND pass through light screens of trees typical of inhabited areas.

In the Rules first published in 1985 for Spread Spectrum Unlicensed Radios, the approach was ONE SIZE FITS ALL. It has NOT changed in 22 years even after the 1996 Telecom Act, mandating broadband for all, came out. Yet only if more power is permitted, given the limitations inherent in the permitted frequencies – especially in the 2.4 and 5.5ghz areas of being blocked by the thinnest stand of trees, and stopped by ordinary walls and roofs.

So permitted EIRP POWER is the first issue to be addressed.

## Who Operates as WISPs Rural?

The NOI asks who is operating Rural Unlicensed and what services do they offer.

The best estimates, from a number of sources, and from the many Wireless ISP Maillists, range from 2,500 to 7,000 Wireless ISPs are

operating in the US. 75% of them serve Rural customers – defined as those customers in rural areas, or out at the very edges of larger cities where no DSL or Cable Modems reach. (few WISPs will set up in a dense urban area where not only can cable and DSL reach them, but with distances less than 3-5 miles, wired T-1s can be affordable.)

The primary customers are SMALL BUSINESSES in Rural Area. Who are willing to buy or lease a Client 802.11b radio and antenna, and pay from $60 to $200 a month for IP services from 128kbps to 512kbps. Web access, email on the ISPs servers, sometimes small Web Servers.

Rural ISPs, most of whom offer more than Wireless Services (dial up in some cases), dedicated T-1 or above short distance, in town, wired IP, sales, installation and servicing computers, and wireless. One robust Access Point can handle 40-50 customers, who, without the wireless open would have NOTHING. 2-3 Access Points serving different sectors, handling 125 wireless customers can justify the cost of a T-1 wireline running 20-30 miles to a larger town. BUT, the most savvy WISPs use UNII 5.2ghz unlicensed radios as a VERY low cost Backhaul between their location and the next larger city – bypassing the need for a telco local loop at 'monopoly' prices of from $1,500 to $3,00 a month.

In my own case (Old Colorado City Communications), my use of a 5.8ghz unlicensed UNII 8mbps backhaul permitted me to as an ISP to AVOID $1,200 a month Qwest T-1 costs, permitting me to both lower my costs to my customers and buy more bandwidth from my upstream ISP (NOT Qwest!)

BUT, I was only covering less that 5 miles in fringe (outside of DSL and Cable) city. I could NOT do that in a town such as Calhan, Colorado, 20 miles from Colorado Springs, because the permitted POWER (EIRP) would not permit me or anyone else to span that distance between two $5,000 UNII band radios. So Calhan has NO broadband today.

## Scientific Uses

Who else uses Unlicensed Wireless in Rural Areas? Increasingly, scientists, both academic and government researchers. When the National Science Foundation (NSF) learned of my expertise in extending wireless to small towns and especially their K-12 schools who have LONG been deprived – for reasons of cost – of Broadband, they asked me to Model Wireless for Environmental and Biological Research. And funded me for 3 years at over $1 million to do that modeling.

I quickly learned there are over 1,200 Environmental and Biological Scientists, right now, organized around 24 Long Term Ecological Research projects associated with Universities and Federal Agencies, funded to the level of over $100 million a year by the NSF. Their study areas almost exclusively are in remote (not just rural REMOTE areas, from the bleak steppes of Northern Alaska to the rain forests of Puerto Rico, and from the lake country of Northern US – Wisconsin, Minnesota, Michigan, and offshore on BOTH coasts. There are ALSO over 200 field stations organized under the Organization of Biological Field Station OBFS, which ALSO work in rural and remote areas.

In almost all these cases the researchers are attempting to collect long term data from free standing 'Data Loggers' costing from 2 to $10,000 per local site location. Some are weather stations, others record soil chemistry, light, growth patterns, radiation, and a host of other environmental AND biological data. UNTIL affordable Unlicensed Wireless solutions became available in the last 10 years, incredibly enough the Researchers have had to depend on MANUAL retrieval, sometimes several times a week, of the data. A costly labor intensive operation. (example – a woman technician has been employed for 7 years by the University of Alaska, to launch a boat twice a week on the Tanana River at Fairbanks, Alaska, go 16 miles downriver, land it, walk in up to a half mile, swap out manually a data module, come back up the river, and dump the data into a computer and the University network. Resorting to dog sleds and snowmobiles in the winter as the ice hardens. Only now, pushing 915Mhz Freewave frequency-hopping radios to their range and power limits, can this now be done wirelessly. BUT the 4 watts EIRP limitation has made the operation cost far more (multiple relay site radios) than it would with radios at 10-20 watts of power.

The Scientists love the idea of using Unlicensed Wireless which they can afford to do far more extensive gathering of data. And they want stop motion and full motion video, AND the capture of environmental sounds wirelessly, from the field location back to the Field Research Station, or in extreme cases, to a low cost satellite link to the Internet. But the MAJOR Finding of my 3 year's field research has been that the power limitations on the radios, COUPLED with the higher frequencies that cause signals to be blocked by the simplest forested areas, or deciduous tree leafs, makes what SHOULD be a great leap into the future of field science, a frustrating search for relay points, field power sources – all to 'get around' the power limitations in areas where there are NO interfering unlicensed OR licensed devices. Interference? I have yet to meet a polar bear carrying a digital radio or even cell phone which would be interfered with.

Example. I was compelled to build, for $7,000 a 120 foot tower to put the antenna of a 915Mhz radio, operating at the full 4 watts EIRP in order to fetch data from a raft on a Wisconsin lake, at only 9,600 baud, only 2 miles away. At ground level without the tower the radio at that frequency and power ONLY penetrates one half mile of pine trees. It SHOULD be able to penetrate at LEAST one mile. Can't under existing FCC rules. Using Wi-Fi 802.11b 2.4ghz radios are useless for that kind of task. Their range in the same forest is less than one quarter of a mile. Ridiculous and unnecessary. Who will they interfere with in the virgin forest? The Principal Investigator for that Trout Lake research station (University of Wisconsin) which has been doing Limnology Studies there since 1924, CANNOT use off the shelf radios under FCC rules to reach his 7 primary lakes in a 10 mile circle, even with the 120 foot tower (40 feet above the trees).

Example. The University of Virginia does studies on the seaward islands off the Chesapeake Bay peninsula. A typical one is Hog Island 15 miles off shore, near Oyster, where the forward research station of the UofV is, with a wired T-1 internet coming to it. Only with the utmost difficulty, flirting with the upper permitted limits of antenna gain, and placing antennas in high and almost inaccessible places was it possible to span that 15 miles across water through one screen of

very light trees in which directional antennas are in totally isolated coastal areas! The antenna aimed at the island sends it signal out to sea, and the antenna on the island would have to go another 10 miles 'behind' the research station, after the first 15 to the research station, before it reaches any other habitation. If the permitted EIRP was 15 watts EVERYTHING would be easier, cheaper, and more reliable. As it is it's a marginal connection.

The President has approved a doubling – from $4 billion to $8 billion in NSF Funding. Environmental and biological science is going to vastly increase as the US struggles to understand the earth, creatures on it, global warming. DATA GATHERING lies at the heart of the science. Increase the permitted power of Unlicensed Radios to support, in the public interest, American field science across the vast rural and remote spaces out there. Quit thinking about Downtown Washington DC every time you think 'interference.'

## Education

While most of the K-12 schools in the US follow the pattern of population density, the fact is 25% of the 84,000 schools and 16,000 school districts, with 55,000,000 students, 3 million school teachers, and the 15,000 public libraries are in RURAL places.

The greatest Digital Divide in America has been getting the Internet to these schools. Now the e-rate program of the Universal Service Fund was supposed to solve all that – at a cost to Rate-Payers of $2.5 Billion a year. But the REQUESTS for funds last year exceeded $5 Billion. And a very bad and extraordinarily shortsighted decision by the FCC 4 years ago when the E-rate FCC rules were promulgated PRECLUDED these 16,000 School Districts from expending e-rate funds for the purchase, and use BY the schools, of Unlicensed Wireless Devices. Instead it literally forced the schools to request the funds to pay for, annually TELEPHONE CONNECTIVITY SERVICES. So in rural areas rather than permit the schools to extend T-1 level Internet connectivity BETWEEN their various, cross town/city schools at Zero local loop costs, or even upstream to the nearest ISP, instead the E-rate funds have gone back into the pockets of the Telephone Companies while providing data links which COULD be zero cost Wireless. That's really stupid, and no FCC staffer has ever been able to explain to me why this rule was adopted. Leaving me to assume it came from the lobbying clout of greedy telcos who have NO incentive to provide connectivity any other way.

Example: In the San Luis Valley of Colorado, a small school (800) in a small town in one of the poorest counties in America, is 40 road miles from Alamosa, where the Internet from Denver terminates. I demonstrated to the school in 1997, that they could be connected FREE 30 cross valley miles, using a pair of Unlicensed Wireless radios. I could ONLY demonstrate 115kbps because of the FCC power limitations. But I DID demonstrate that. Today with a pair of Cisco 350 802.11b Wireless Bridge $1,000 radios with -91dB receiver sensitivity, their standard 100mw of radio power (20db) AND with a pair of 24dbi gain directional antennas that 30 miles across the flat valley would deliver a MIMINUM of E1, 2Mbps to and from that school for NO monthly cost. Only the cost of the Internet services in Alamosa, roughly $500, would be incurred. INSTEAD of $2,500 per month, E-rate, with Qwest providing

wired local loop for $2,000 a month. Difference? $6,000 a year versus $30,000!

And all that would take would be 24dbi permitted above the radio's 20db, to make the link legal, and REALLY cost effective. But (1) the E-rate rules won't permit that small poor school to spend its money that way (my estimate is that the one time cost would be less than $5,000) and (2) the restrictive rules of EIRP prevents it from technically happening. (the radios could only reach about 18 of the 30 miles)

Interference? There is NOTHING but some cattle, about 5 visible farm houses across that arid southern Colorado desert valley.

That story can be repeated all across Rural America.

IF the power were raised to 25 watts, or 44dbi as I recommend, those rural schools ALSO could start implementing the FUTURE of education - distance learning - by making it possible for schools to mount omni antennas with perhaps 12dbi gain on the roofs of their schools, or relay through radios on local towers, and REACH the homes, nights and weekend of ALL the students in their district, giving them Broadband To and From their school AND out to the net through their school for students whose parents do NOT have slow dialup AOL accounts - which is ALL they have in rural America, IF they are inside the local dialing area of an ISP.

But based upon my studies for the NSF 'Wireless for Education' in 1995-1996 the mean distance across Rural School DISTRICTS is 10 miles. To reach that from the center of schools, with a robust signal, the radio plus an inline amplifier plus a 12db gain omni (for 360 degree coverage of district homes) would require at least 10 watts, or 40dbi permitted. Right now, under current rules no more than homes inside of a radius of from 2 to 3 miles could be served.

Implementation of My Recommendations for 25 Watts EIRP
For Unlicensed Wireless in Rural Areas.

The last question asked in Paragraph H 29 of the NOI was

"If so what criteria would have to be met in order to qualify to use the higher power levels?"

The question IMPLIES, getting special permission on a case by case or group basis for using the higher power. Right now - though I know of no WISP who has successfully done it - it is possible to Request a Wavier for 'Experimentations' under Part 5 FCC Rules. While this is theoretically possible, the reality is that while the FCC Part 5 staff might clear such a request within a week, it would be mandatory to send that request to the IRAC, for approval. THAT COULD TAKE MONTHS. And I am very skeptical of case by case reviews of requests.

So how can 'rules' be made that have a highly probability of being followed that permits higher Unlicensed Radio power in Rural areas than in Urban.

I suggest that the FCC start really using Technology, which incorporates Power rules, into radios!

It is technically possible right now, to INCORPORATE GPS location data INTO Unlicensed Radios. Which then could be linked BOTH to the FCC Data Base that contains the data about Licensed services, including exact geographical coordinates of licensed radios, AND to a data base which can be contained on-a-chip inside Radios, that 'defines' Rural. Using the Census Bureau definitions, and geographical boundaries of tracts.

Then, by requiring radios which users want to buy and use higher power limits, to contain the GPS location, data base, and software controls OVER the power, to enforce more by technology, than rules, the permitted power limits for individual radio locations.

## Conclusion

It is in the Public Interest, and a proper implementation of the 1996 Telecommunications Act, to permit Wireless Radios operating under Part 15 rules to be permitted to operate up to 25 watts of EIRP in rural areas. That is my fixed opinion after a decade of deploying as many Part 15 spread spectrum and UNII radios in rural areas for Education, Business, Community, Public Safety, and Science as anyone in the US.

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