Before the
Federal Communications Commission
Washington, D.C. 20554

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In the Matter of	)	
	)	
Amendment of the Commission's Rules to	)	ET Docket No. 96-102
Provide for Unlicensed NII/SUPERNet	)	RM-8648
Operations in the 5 GHz Frequency Range	)	RM-8653
	)	

August 13, 1996

REPLY COMMENTS OF CHANDOS A. RYPINSKI
President, LACE Inc.

Summary

The Commission is encouraged to give large weight to the original comments and particularly to the conclusions in the WINForum Reply Comments. The content of the WINForum Reply Comments are known because of my participation in their preparation.

These comments are reinforcing, and as in the initial comments, deal with more detailed matters that must be addressed in the regulations finally drafted. The chosen areas of discussion are largely technical on the following topics:

1. **Interference to LEOS systems** where it is concluded that effects are grossly overstated. Some of the differences between assumptions made and the probable facts are described. It is seen that the interference potential metric is energy/MHz rather than EIRP or transmitter connector power.

2. **Channel dimensions** where support and detail is added for specifying at least minimum channel widths. Some discussion is provided on allowing narrow channel bandwidths on the band edge where there is more sensitivity to out-of-band radiation for other services.

3. **Modulation restrictions** where further support is presented for avoiding bits/Hz type of restrictions, and for utilization metrics with a capacity/MHz/unit area proportionality.

4. **Outdoor system constraints** where the benefits of allowing and encouraging high directivity on balance outweigh interference considerations. The matter of how to implement longer (but not long) reach links is further considered.

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These reply comments are discussion on the specific points listed in the summary above and include specific responses to some points raised in the preceding comments. It is assumed that these reply comments will be considered together with the comments filed 30 days ago in this matter.

Interference to LEOS systems

It is concluded that interference effects are grossly overstated. To proceed in a more effective way, it is necessary to identify the differences between assumptions made in other comments and the probable working conditions. If the interference power metric is energy/MHz rather than EIRP or transmitter connector power, then there are particular regulatory actions which will be necessary to be sure that there is minimal interaction with the satellite services.

Up or Down Link at 5.15-5.25 GHz

There is an initial discrepancy concerning the use of this band. The statement of the Joint Commenters is clear. The band is an uplink. Accordingly, my comments will respond to that assumption. There is also a Qualcomm/Loral link budget at hand which identifies the same band for down link use. There would be a different problems set for this case.

The possibility of interchanging the use of the band to the latter assumption exists. Even though this would greatly ease some of problems now described, it is not now posed as a recommended solution.

The case considered is the amount of interference visible to each satellite considering the useful coverage that is obtained from an altitude of about 750 nautical miles.

Satellite Antenna Coverage

The geometrical horizon (disregarding bending in the atmosphere) is about 2600 statue miles from satellite altitude. The grazing path has much higher attenuation due to obstacles and increased atmospheric losses. At the receiving point, the feeder station will need some angular clearance above the horizon, and 10 degrees or more would materially reduce losses, particularly for an entity that is sensitive to rather small increases in noise energy at the satellite receiver.

The L/Q Licensee describes an Iso-flux antenna producing uniform signal level at the earth surface independent of angle from the down vertical up to some limit. The useful coverage range for this type of pattern (where gain increases at increasing slant angles) is necessarily much less than horizon to horizon. Given that the footprint is as wide as the 48 states, there will be something less than both coasts visible except when the satellite is at midcontinent.

The presumption that the area viewed at one time by each satellite is the entire 48 states for the entire transit seems much more than the will actually be experienced.

Feeder Station Transmitter Power and Satellite Receiver Noise Temperature

The LQ Licensee appears to ask for an aggregate noise level 30 db below thermal noise at the satellite receiver (.004 dB noise degradation). This is unreasonable and unnecessary.

Whatever noise degradation may occur can be offset by an increase in earth station transmitter power. If the NII service could under some peak condition cause noise to reach a level of 10 dB below thermal noise (as considered by the ITU), the degradation could be overcome by a 0.4 dB increase in feeder station transmitter power.

A 10% power increase is probably within the tolerance margin that is provided in the transmitter, and it is within the range of what could be accomplished simply if it is necessary or useful. It is not proposed that this be done, but rather it indicates how easily the non-existent problem could be addressed if it were to occur.

NII Station Duty Cycle

It is well known that the duty cycle of communication systems (particularly telephone) is highest when the supply of station access equipment is small vs. need. As the number of NII stations increases, the per-station use will decrease. Initially, units will be bought be individuals and entities that need them, and they will be used. As time goes on, larger proportions of units will be used simply to have access and availability rather than to increase overall usage and capacity.

While 1% duty cycle is reasonable for the first million stations, tens of millions will not increase traffic proportionally. This assumption is overly conservative when applied to large numbers of users (like 20% of the population), though it might be reasonable for numbers corresponding to 0.5% of the population.

It is easily possible to support the duty cycle assertion from experience with LAN systems, where the high transfer rates are more needed for low delay than for aggregate capacity.

Mitigation of Interference at the Source

There are many things which can be done, and which could be recognized in regulations. The essential step is recognizing the problem before units are designed. The total affect of all of the points below could be an order of magnitude.

Power Limit Specified in Spectral Density

Assuming that absolute transmitter power is capped for a bandwidth of 50 MHz, all modulations of lesser bandwidth should be limited to proportionally lower values. While there is considerable inducement to do this for level playing field sharing, it would mean also that all stations are alike in their share of the interference to the mobile satellite system.

It is also true that this would end the range advantage of narrow band systems obtained by concentrating their power. Those with range motivated needs will discover that the range loss can be more than recovered by suitable channel coding (spectrum spreading) accompanied by a lesser need for fade and error margin. They will be better off as a result.

Transmitter ON Time Limits

Limiting the aggregate interference is a further reason to use defined ON time and duty cycle limits suggested in my preceding comments in this matter. 256 octets of payload and a frame length of 288 octets would result in transmitter ON time of 230 μseconds at 10 Mbps transfer rate and proportionally more or less at other speeds. The aggregate spectrum usage would be better off with an absolute limit of 1 millisecond single burst maximum ON time, even before considering the benefits to the aggregate power computation.

In this frequency band, the narrow band services must use the short burst because telephone connections are limited by allowable transfer delay as describe in my preceding filing, and because of fairness considerations in channel sharing.

Station Antenna Directivity

Station antennas are naturally vertical monopoles. Up to 10 dB of gain in the vertical pattern is not only possible but desirable. This amount of gain would increase the length about 10 X but the starting point is less than 0.75" ($\lambda/4$). Every effort should be made to encourage this type of antenna. By allowing 3 dB of increase of EIRP for each 6 db of increase in antenna gain, those suppliers who believe the increase in range is worthwhile would be motivated.

An effort should be made to keep antennas somewhere near vertical. While this is impossible to enforce, it is possible to design antennas that have a statistical probability of being near vertical on table-sitting portable computers and on access-points.

Moderate azimuth directivity should be allowed and encouraged. On the average, it does not change interference much, particularly from the view point of a satellite receiver near the horizon. Since for the most part directional antennas will be randomly pointed, the average of all is not going to be much different than if they were all omni-directional. The interference risk area would have a different shape for individual stations.

Universal use of near vertical antennas with a vertical beamwidth of under 30° could greatly reduce the total interference from stations to satellites within 45° of the nadir. From the point of view of one satellite, this would reduce the noise contribution of the half of the continent immediately under the satellite to 10% of what it would be without the antenna directivity.

Relay Link Antenna Directivity

It should be understood that relay links with less than 2 km range may have great usefulness in networking access points. Such links can stay within the same constraints as end links in part because of an absolute assumption of unobstructed radio paths. Given that relaxation of EIRP power limits is necessary some of the time, overall interference will be less with directive antennas. Because of random orientation and high atmospheric absorbtion at low angles, the number of such stations actually affecting a satellite may be a tiny fraction of those which are installed.

Out-of-band Noise Rejection

The argument might be raised that out-of-band energy from a few user station might interfere with feeder earth station receivers. Since in the Joint Commenters paper, a maximum number of 50 such stations nationally is estimated, this is probably a non-problem. It is now pointed out that if it were necessary to have another 20 dB of noise rejection to protect the 6.3 GHz band, it would be possible at very little cost provided that the need is known before designs are started.

Positioning Long Reach Outdoor Links above 5.25 GHz

If they are allowed at all, higher power density and longer range links could be positioned at the top edge of the band—5.336-5.350 GHz as described in my preceding comments. This would avoid contribution to interference at the satellite receivers.

Channel Bandwidths

There is clearly wide support for channelization of the preponderance of the band at about 25 MHz. There is less consensus on the positioning of such channels within the band. There has been no service described, particularly those with lower capacity transfer requirements, which would not be well served by using a wide channel a lesser amount of time.

My opinion is that the channel width should be double with use of the halves permitted. This is slightly different and more restrictive than permitting use of two contiguous 25's to get one 50. It is possible to live with either.

It is interesting, that no comment appeared to call for the exact frequency plan used by HIPERLAN though most desired a loose plan which would allow its use. Since HIPERLAN I is a distributed control peer-to-peer, it remains preferable to have at least one channel where that type of operation is allowed exclusively.

There is incentive to place narrower band channels at the edges of the allocation. Such channels are easier to limit out-of-band radiation in adjacent allocations.

Having considered these points, the plan offered in my preceding comments should satisfy most of the expressed need among those who believe that a channel plan is necessary. Those who don't believe a regulatory channel plan necessary, probably consider the need for some level of coordination between different users unimportant.

Modulation Restrictions

Avoidance of bits/Hz type of restrictions is highly recommended.

Interference limited system design is essential to full utilization of the spectrum. Modulations which are most resistant to like-signal interference also yield more capacity when compared with distributed-control, peer-to-peer narrow band and adaptively equalized systems. To enable design under these criteria, it is essential to leave raw bit/Hz open.

In particular, this band needs spread spectrum modulation. The benefits of fade and interference resistance and of avoiding the need for diversity antennas are swing factors. This is sure to be proved with channels wide enough to use beneficially such modulations. 50 MHz is barely enough.

What the regulatory environment should allow is different suppliers to tradeoff these factors in their products. My estimate on this tradeoff is shown in Figure 1 attached.

Outdoor System Constraints

There are different concepts of outdoor services one of which is "community networks." Another uses point-to-point links as a relay system as might be needed on a campus between buildings.

Another kind of network envisions a wide area distribution system with long reach point-to-multipoint end links. A much greater range is possible for multiple fixed location stations using highly directive antennas. The interference potential of such stations again averages to be little different than if they were omni-directional.

A long reach channel with a low information rate resembles the capability of a leased line, and with a high information rate might be alternatively supplied by an expensive leased line.

Such systems must be considered for their interference potential not only to the satellite services, but to each other and to the premises area systems. All of these considerations are minimized if such links adhere to the same duty cycle, radiated power density and ON time limits as the interior systems. In this case a 1:1 power reduction required for use of very high gain antennas is a disincentive to narrow beams. If the user could get half of the benefit of antenna gain by diminished power reduction, there would be motivation. All users and the satellites will benefit from limiting radiation in directions where it is not useful but still can cause interference.

To minimize satellite interference, it would be desirable for fixed high gain antennas to be prohibited from pointing at any vertical angle other than zero degrees. Moreover, there should be automatic power control on high EIRPs such that the link operating power is a small margin

above the necessary power. It is also important to require the same limits on burst transmitter ON time and duty cycle as would be imposed on premises area systems.

However painful the politics, these frequencies and these links should not be allowed to use "nailed-up" continuous connection technology. That does not preclude transmitting a 64 Kbps voice channel as it would be done over a LAN or ATM network.

Video connections are simply more bursts per second on a high bandwidth medium.

What is good for satellite interference is equally good for co-use of the same frequencies by premises area and by outdoor systems.

Conclusion

The above points go beyond the normal comments because the "devil is in the details." To launch this new service it is vital to understand the services performed and then regulate the playing field as required for sharing and the greatest possible reuse of the frequencies in geographically separable environments.

The following are important regulatory points:

- Limiting transmitter ON time to 1 millisecond or less
- Limiting user station duty cycle to less than 10% after one millisecond
- Uniformly limiting radiated power density to a consistent level
- Limiting both station and fixed installation radiation at angles above horizontal
- Maximize incentives to use directional antennas covering only necessary areas.
- Prohibit continuous connection type of channel use.

It is urged that we move toward allocating use of this frequency under regulations considering the points raised above. It also urged that the more general recommendations of WINForum be strongly considered in further rulemaking.

Respectfully submitted,

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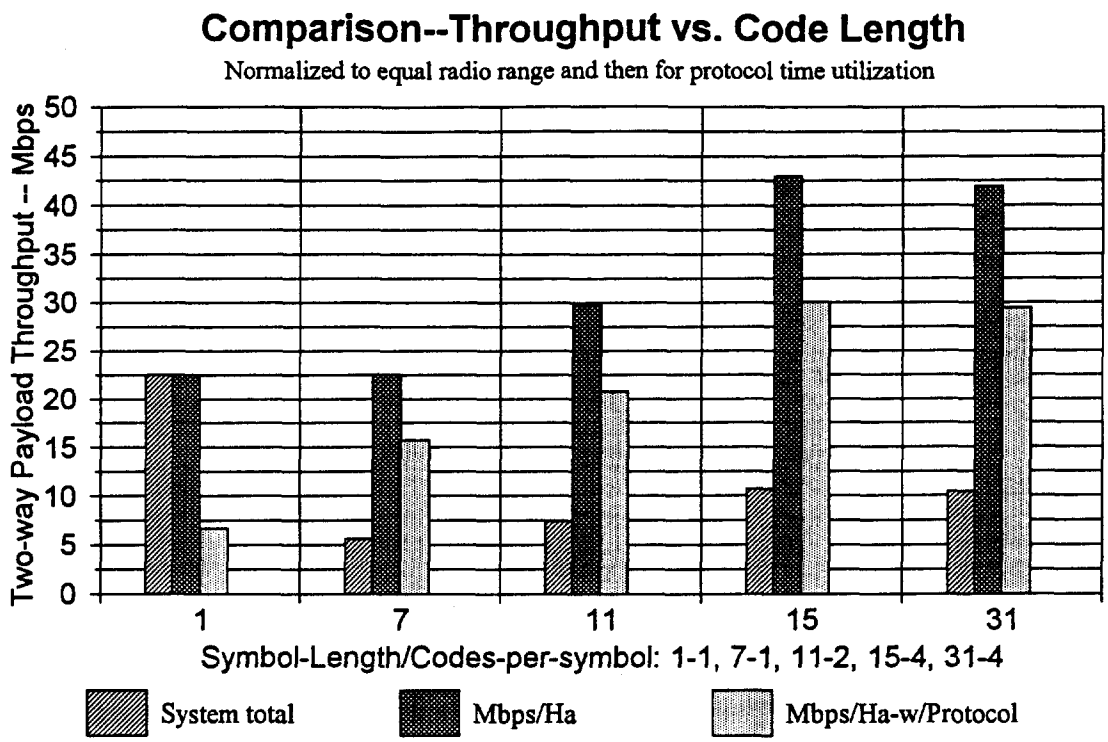

Figure 2--Throughput Capacity for Various Channel Codes in a 50 MHz Bandwidth

Using a particular set of assumptions and calculations, the general conclusion is that there is much more throughput capacity available from better spread spectrum modulations than from a single adaptively equalized channel of the type used in HIPERLAN. The spread modulations will be less degraded by like-signal cochannel interference and will be at least as resistant to propagation induced intersymbol interference. The raw transfer rate for all systems is 70 Mbps/Mcps for all modulations. Overhead is based entirely on 48 octet payload ATM cells in a longer frame. The capacity available in one coverage is that shown divided by the reuse factor of 16 (1), 4 (7 & 11) or 1 (15 & 31).

The **left bar** is the capacity for one reuse group. The per coverage capacity of the single channel system with reuse factor = 16 is 1/16th of the transfer rate. The reuse factor for the spread spectrum plans is 4 by time division for the two shorter symbols and by code division for the two longer symbols. Each coverage has equal radio range, but not equal area coverage.

The **center bar** is after conversion to Mbps/hectare with equal radio coverage range.

The **right bar** takes into account 30% use of channel time for an LBT system and 70% for a centrally managed channel access system. This diminishes capacity relative to the center bar.

The order of magnitude of increase for the longer code symbols is 4:1 better for the SS systems than for the adaptively equalized unspread channel.

This figure is taken from a private paper by C. A. Rypinski.