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

In the Matter of	)	
	)	
Spectrum Policy Task Force Report	)	ET Docket N0. 02-135
	)	
	)	

REPLY COMMENTS

Summary

Shared Spectrum favors adoption of the Spectrum Policy Task Force ("SPTF's") recommendations. (ET Docket No. 02-135, November 2002). Our spectrum occupancy measurements indicate that spectrum utilization is low. The real problem is not a spectrum shortage, but developing reliable spectrum access methods that enable new systems to co-exist with non-cooperative existing Primary users.

Shared Spectrum is developing an adaptive spectrum access approach based on the SPFT's concept of Interference Temperature. Analysis and simulations indicate that the method is effective in allowing secondary spectrum usage with minimal interference. We suggest adoption of statistical methods to specify Interference Temperature. It is not necessary to defer setting different threshold levels for each band, geographic region, or service until a noise survey is complete.

1 Introduction

Shared Spectrum is a newly formed company developing broadband wireless equipment optimized for secondary spectrum markets applications. As noted by the Commission[1], there is no equipment on the market now with the flexibility and capability to facilitate the use of available spectrum for a broad range of services. Our goal is to offer technology and equipment to fully realize the potential of the secondary spectrum

[1] *Promoting Efficient Use of Spectrum Through Elimination of Barriers to the Development of Secondary Markets*, FCC 00-402, Para. 4.

market as rapidly as possible. The technology to accomplish this could be fielded in a few years, but regulatory issues (technical and spectrum availability) now limit its development.

In the following sections, we discuss some of the comments submitted to the Spectrum Policy Task Force ET Docket No. 02-135, filed January 27, 2003. A summary of our reply comments is:

- We disagree that additional noise survey measurements are necessary before some initial noise temperature limits can be set by the Commission. We believe that:
- The noise temperature limit needs to be defined at the primary receiver's input port except for bands with uni-directional links (i.e. TV broadcast) where a geographic field strength level should be used.
- The noise temperature limit should continue to be the aggregative interference limit and that as a condition of approval that the secondary system needs to have a method to account for cumulative effects.[2]
- Motorola's proposal to use carrier-to-interference ratios instead of the interference temperature method is unworkable.
- Interference temperature-based, adaptive spectrum access systems transmitting power above a certain value should be part of an external network and should employ a "dead-man" type switch to enable interference control and traceablility. Adaptive systems transmitting below this certain value don't need the "dead-man" switch and could be operated in isolation.
- Comments that interference temperature based, adaptive spectrum access systems are "too hard" and the Commission should withhold support are ill informed.

2 Need More Studies to Set Interference Temperature Levels

There were comments suggesting that the Commission needs to conduct noise survey studies to establishing some initial interference temperature guidelines. [3] We

[2] Several methods to accomplish this are discussed below.

[3] Comments of AT&T Wireless Services, Inc., page 13, ET Docket No. 02-135, January 27, 2003.

believe that initial interference temperature limit values should be the noise figure of typical primary receivers. This is a conservative value that could be increased after noise surveys are completed.

We believe that spectrum utilization in most bands is very low and that significant spectrum access opportunities exist in the regions between licensed transmitters. Figure 1 shows a scenario with two licensed transmitters spaced some distance apart. In between these transmitters is a region where a secondary transmitter could operate and not cause significant interference to either licensed transmitter. As the secondary transmitter location approaches the licensed transmitter, the interference level increases until the interference power equals the power of thermal noise. As the secondary transmitter moves closer to the licensed transmitter, the interference power equals the power caused by man-made noise. In this scenario with high man-made noise, the secondary operation region determined by the man-made noise level is larger that the region determined by thermal noise.

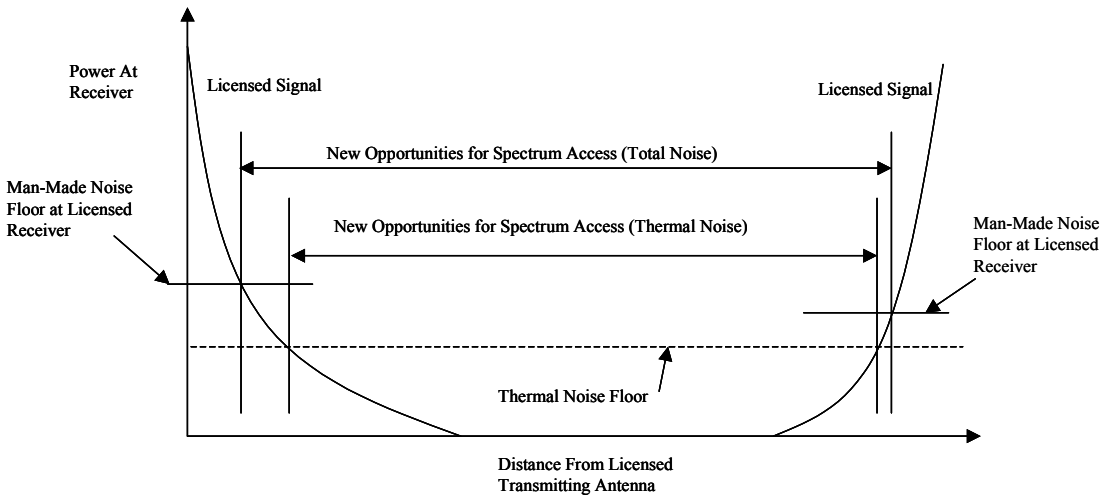

Figure 1 Significant spectrum access opportunities exist in the gaps (as determined by the thermal noise level) between licensed transmitters.

Our measurements indicate that spectrum occupancy is low. Some bands are not used over large regions in the U.S. at any time, and that some bands are used in a

few locations only a small fraction of the time. An interference temperature based on thermal noise levels would allow access to these bands with no significant detriment to the present users.

As studies of man-made noise levels are completed, these results can be used to increase the interference temperature limits at select locations and in certain bands. This would allow more spectrum to be utilized in the future.

We urge the Commission to adopt initial interference temperature limits based on typical receiver thermal noise levels. This is a conservative and prudent first-step.

3 Definition of Interference Temperature

Several comments suggested clarification in the definition of interference temperature. Motorola's comments[4] highlight the question of whether the definition should be a spatial requirement or a requirement based on interference at the primary receiver's location. Motorola correctly points out that very close to the secondary transmitter significant interference would be generated but this is of no consequence if there was no primary receiver in this region. We agree with Motorola's conclusion that the interference temperature should be defined at the primary receiver locations and not at all locations within a region.

Motorola also describes the difficulty that a receive-only secondary system would have in sensing the presence of receivers in bands with unidirectional links (i.e. broadcast television)[5]. We believe that in these bands, interference temperature should be defined using geographic boundaries and field strength limits (dBuV/m) similar to what is done in the TV bands now.

Motorola suggests that instead of temperature, that Carrier-to-Interference (C/I) ratio should be used as the interference measure.[6] We believe that this is counter to how spectrum should be described by the government and it is would be an impractical metric for spectrum sharing because it greatly increases the amount of information

[4] "Comments of Motorola, Inc", Page A-1, ET Docket No. 02-135, January 27, 2003

[5] "Comments of Motorola, Inc", Page A-3, ET Docket No. 02-135, January 27, 2003

[6] "Comments of Motorola, Inc", Page A-1, ET Docket No. 02-135, January 27, 2003

needed by the secondary system. One of the government's goals is to develop a clear and exhaustive definition of spectrum rights and responsibilities.[7] Part of this goal is to define an interference protection parameter, i.e. the maximum level of noise/interference that the spectrum user must accept from other RF sources. The use of C/I as an interference metric defeats this goal because it provides no information on the interference level. The received carrier power will depend on the primary system's use of power control, the user's locations, and the methods to handoff users between base stations. All of these factors are complex and many are under the control of the primary user.

We envision that enforcement of interference temperature limits will be accomplished by occasional monitoring by the FCC or another group using a power splitter at a primary receiver. Interpreting the measured carrier levels would involve investigation of the above factors in detail to insure that they were "typical" values and not some anomalous values created to "slant" the results. This added complication would make enforcement impractical. Likewise, it is impractical for the government to auction spectrum based on parameters that are unknown at the time of auction or are at the control of the primary user.

Furthermore, C/I should not be used as an interference metric because it greatly complicates spectrum sharing. As described in our previous comments, it is feasible for a secondary system to estimate the level of interference it causes to a primary system using a receive-only method.[8] Having the secondary system estimate the carrier strength remotely is much more difficult (and probably not feasible) because but the primary transmitter-to-primary receiver propagation path loss is unknown to the secondary system. In contrast, the interference temperature involves the primary transceiver-to-secondary receiver propagation path loss, which can be estimated by the secondary system.

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[7] Spectrum Policy Task Force Report, Page 17, November 2002.

[8] "Comments of Shared Spectrum Company", Page 3, ET Docket No. 02-135, January 27, 2003

Several comments mention that the aggregation or cumulative issue.[9] [10] The interference temperature limit as described by the Spectrum Policy Task Force is the aggregated value at the primary receiver, and thus, the maximum secondary transmit power will vary with the number of active secondary users in the region.

We believe that there are multiple methods to account for aggregation such as using large transmit power margins, using local measurements to estimate the number of active secondary users in a region, using network wide derived estimates of the number of active secondary users in a region, or measurement based-feedback methods. The best method will depend on the secondary device's connectivity to external networks; it's link range, and other factors that vary with application and frequency band.

4 Traceability and Control

Several groups pointed out the need for the ability to trace and control secondary systems to locate and stop malfunctioning or "bad actor" devices.[11,12,13] We agree that secondary transceivers with transmit power levels above a certain level should be part of a network that is connected to a controlling authority. This authority could be a commercial secondary operator that is known to the primary spectrum users. Only secondary transceivers in constant connection with the controlling authority would be able to access certain primary bands. A cryptographic protected "dead-man" feature would be used so that if connection to the authority were lost, the secondary transceiver would be limited to "safe" frequencies until connection was reestablished. In the event of an unintended interference event, the controlling authority could selectively disable or reduce the transmit power of the secondary transmitters until the "bad actor" is identified.

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[9] "Comments of Motorola, Inc", Page A-2, ET Docket No. 02-135, January 27, 2003

[10] "Joint Comments of the Association for Maximum Service Television, Inc. and the National association of Broadcasters", Page 8, ET Docket No. 02-135, January 27, 2003.

[11] "Comments of AT&T Wireless Services, Inc", Page 17, ET Docket No. 02-135, January 27, 2003.

[12] "Comments of Motorola, Inc", Page 28, ET Docket No. 02-135, January 27, 2003.

[13] Comments of "Joint Comments of the Association for Maximum Service Television, Inc. and the National association of Broadcasters", Page 10, 16, and 19, ET Docket No. 02-135, January 27, 2003.

The use of a controlling authority for secondary transceivers below a certain maximum transmit power level would not be required. These devices would be unable to cause significant interference.

5 Secondary Operation is Too Hard

Several parties commented that the interference temperature method is not practical, infeasible, futuristic, merely a theoretical concept, may work in theory, and not enforceable.[14,15,16] We believe that these comments are incorrect because systems using similar concepts are in wide use, and that these comments are based on extreme applications.

The Automatic Link Establishment (ALE) System[17] operates in the HF band and uses dynamic frequency assign algorithms that monitor existing traffic and selects open frequencies. This is an adaptive spectrum access system similar to what is being developed by Shared Spectrum Company. The ALE System is used by the Air Force's HF Global Communications Systems Air/Ground Network, Shares (an amateur radio network), the U.S. Federal Emergency Management Agency's FEMA National Radio System, and other groups for many years. Motorola[18] and other companies sell ALE equipment.

The likely applications for adaptive spectrum access systems are not in densely used spectrum, but to exploit spectrum opportunities that last for hours to years in time and extend over large geographic regions (10 km to 1000 km in size). Comments such as "fleeting moments of time" and "microsecond basis"[19] are not representative of spectrum use in most bands. For example, a fixed secondary system operating in the TX Auxiliary band could use the band hours or days at a time because the primary transmitter duty cycle when observed at the specific secondary system location is low.

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[14] "Comments of Motorola, Inc", Page 27, ET Docket No. 02-135, January 27, 2003

[15] "Joint Comments of the Association for Maximum Service Television, Inc. and the National association of Broadcasters", Page 12, ET Docket No. 02-135, January 27, 2003.

[16] "Comments of AT&T Wireless Services, Inc", Page 12, ET Docket No. 02-135, January 27, 2003.

[17] http://www.armymars.net/ALE/ALE-Handbook

[18] http://www.mobat.com/

[19] "Comments of AT&T Wireless Services, Inc", Page 19, ET Docket No. 02-135, January 27, 2003.

Respectfully submitted,

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