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January 13, 1997

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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF SECRETARY

By Hand

Mr. William F. Caton
Acting Secretary
Federal Communications Commission
1919 M Street, N.W.
Room 222
Washington, D.C. 20544

Re: GN Dkt. 96-228/Wireless Communications Services

Dear Mr. Caton:

On January 9, 1997, a conference call was held between several members of the Office of Engineering and Technology and several RF engineers at Lucent Technologies. The subject matter of the conference call was Lucent Technologies' January 8 Technical Statement.

Since that time, we have had discussions with the technical consultants for Primosphere Limited Partnership. Based on those discussions, Lucent Technologies has supplemented its January 8 Technical Statement as enclosed.

Please call me should there be any questions.

Very truly yours,

David B. Jeppsen

Enclosure

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List ABCDE

copy by hand:

Richard Smith, OET
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copy by facsimile:
Leslie Taylor, Counsel to Primosphere
Robert Ungar, Counsel to Primosphere

* January 8, 1997 Technical Statement of Lucent Technologies is also enclosed

Lucent Technologies
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Supplemental Technical Statement of Lucent Technologies Inc.

Amendment of the Commission's Rules to Establish Part 27, the Wireless Communications Service ("WCS") GN Docket No. 96-228

January 13 1997

The following is a supplement to the January 8, 1997 Technical Statement of Lucent Technologies Inc.

Band Plan/Pairing

After technical discussions with Primosphere Limited Partnership, we agree that the WCS spectrum with SDARs in the middle of the band is unique to spectrum management and represents some extraordinary technical challenges. A reasonable solution to the threat of harmful interference to SDARs in the middle band is to allow only fixed services in the WCS spectrum.

Lucent recommends that the WCS spectrum be divided into six (6) 5 MHz bands, A,B,C,D,E,F as shown below:

2.3 GHz Band Plan

A	B	C	2320-2345	D	E	F
2305-2310	2310-2315	2315-2320	SDARs	2345-2350	2350-2355	2355-2360
Fixed Wireless Loop Paired w/ E	Fixed/Data Paired w/ F	Fixed Voice/Data unpaired		Fixed Voice/Data unpaired	Fixed/Data Paired w/ A	Fixed Wireless Loop Paired w/ B

As Lucent has stated in its comments filed in this proceeding, it is important that the Commission allocate the band to a specific set of services in order to give the industry the certainty it needs to move the auction forward. Thus, Lucent recommends that the band be allocated for the services indicated above.

By limiting the blocks to fixed services only, the Commission can help alleviate the threat of harmful interference to SDARs in the middle band. The Commission should clarify, that to the extent possible, operators in the bands should work with SDARs operators, either directly or through industry associations, to coordinate implementation and resolve disputes about any interference into the SDARs spectrum.

Emission Limits

Lucent's January 8 Technical Statement explains that the 70 + 10 log (P) emission limit being proposed for fixed systems is overly restrictive and that the 43 + 10 log (P) emission limit for fixed systems should be adequate. To the extent that there is harmful interference from fixed WCS systems to adjacent SDARS systems, the licensees should be required to implement, where appropriate, certain interference mitigating techniques. As an alternative, Lucent suggested that the Commission could impose a slightly more restrictive limit (60 + 10 log (P)) on the forward link of fixed systems.

Subsequently, Lucent and Primosphere Engineers have discussed their differences. Based on additional information provided by Primosphere, Lucent has modified a couple of assumptions. The resulting analysis indicates that for fixed applications, the 70 + 10 log (P) requirement is sufficient for forward link operation. On the reverse link, the commission could reduce the specification by at least 10 dB.

In order to ensure adequate protection on the forward link, the commission could require that the WCS services operating in the C and D blocks utilize opposite circular polarization for their transmissions on the forward link. This approach has been suggested by Primosphere. However, we do not believe this to be necessary for the reverse links.

Finally, Lucent has seen the filing of Primosphere proposing that Section 27.54 of the rules be ammended to impose a 100W EIRP limit to fixed stations. Lucent Technologies does not believe that this limit is required, given the emissions limits already being proposed by the Commission.

The results of Lucent's interference analysis with SDARs systems are attached as Table 1.

Table 1

INTRODUCTION

The following is an interference analysis of a potential fixed wireless application at 2305-2320 MHz and 2345-2360 MHz into the Satellite Digital Audio Radio System.

APPROACH

The interference analysis is based on an approach similar to that used by Primosphere Limited Partnership. However, we feel that some of the assumptions made by Primosphere are overly conservative, and therefore have proposed different assumptions based on our experience.

The SDARS receiver system noise energy is first computed based on a reasonably good receiver design. Allowing for 1 -2 dB of noise fluctuation, an allowable interference noise energy is established. Based on the EIRP of a typical Fixed Wireless System (FWS), the path loss stemming from the distance between the SDARS antenna and the FWS antenna, and the FWS antenna pattern gain roll-off, the link budget is computed. Thus the isolation required is determined and compared to the FCC proposed isolation requirement.

INTERFERENCE ANALYSIS

Primosphere indicates that the SDARS system receive Noise Energy is on the order of 200-300°K. We believe this to be difficult to achieve for typical subscriber units, when antenna noise temperature is included. However, we use a number of 250°K for a worst-case analysis. This translates to 24dBK.

Thus, the SDARS system Noise Energy = -228.6 dBW/K+dBHz +24 dBK
or -144.6 dBW/MHz.
or 3.467 E-15 W/MHz.

Lucent also believes that a 1-2 dB allowable noise rise is reasonable for the SDARS noise floor from a WCS interferer. For a 1.5 dB noise rise, the allowable interferer level would be -148.4 dBW/MHz.

FWS Forward Link

Consider the Forward Link of a typical Fixed Wireless System. The EIRP from the Base Station (BS) is typically 16 dBW/MHz. Based on the directional antenna pattern look angles and distances, 3 cases are examined here.

Case 1, Assume that the SDARS antenna is approximately 100 ft from the base of the BS antenna tower where the BS antenna is mounted 100 ft above ground. The distance D_s used for path loss calculation is

D_s = 141.4 ft, assuming SDARS antenna is on the ground.

Assuming free space, the path loss, $L_s = 10 \log (4 \pi D_s / \lambda)^2$,

where λ = 0.4203 ft, the wavelength at 2340 MHz,

L_s = -72.5 dB.

Even if the BS antenna is tilted down as much as 5 degrees towards the ground and, at such a close distance, the SDARS antenna is at a directional angle outside of the first sidelobe region. Based on the BS antenna pattern, the gain at such look angle is more than 20 dB below that of the main beam peak. The Fixed Wireless system interference to SDARS is determined as follows:

BS EIRP		16 dBW/MHz
Minimum path loss		-72.5 dB
Minimum BS antenna pattern roll-off		-20.0 dB
SDARS antenna gain	+	3.0 dB
Interfering energy from FWS at SDARS receiver		-73.5 dBW/MHz
Interference Noise Energy Allowed		-148.4 dBW/MHz-148.4
Required Out-of-band Isolation		-74.9 dB

Thus, this rather conservative approach falls in the ballpark of the -70dB Out-of-band Emission proposed by FCC. In addition, we do not include such effects as possible cable loss and antenna polarization loss etc.

Case 2, let's double the distance between the SDARS antenna and the base of the BS antenna tower. D_s = 223.6 ft, and thus L_s = -76.5 dB. The directional angle is such that the SDARS appears outside of the BS antenna main lobe region where the energy received will be at least 18 dB below that from the BS antenna main beam peak. The gain reduction could be even greater at the region between the main lobe and the first sidelobe. Similarly, the Fixed Wireless system interference to SDARS is determined as follows:

BS EIRP		16 dBW/MHz
Minimum path loss		-76.5 dB
Minimum BS antenna pattern roll-off		-18.0 dB
SDARS antenna gain	+	3.0 dB
Interfering energy from FWS at SDARS receiver		-75.5 dBW/MHz
Interference Noise Energy Allowed		-148.4 dBW/MHz
Required Out-of-band Isolation		-72.9 dB

Again, this number is comparable to the 70 dB isolation proposed by FCC, and still assumes there are not additional mitigating effects such as cable loss and antenna polarization loss etc.

Case 3, Assume that the BS antenna is not down tilted. In order for the SDARS antenna to be seen at the FWS BS antenna near main beam region, the distance would be at least 1370 ft. That is when the SDARS antenna is in the direction with pattern roll-off of 2dB below BS antenna main beam peak. Thus, D_s = 1373ft, and thus L_s = -92.3 dB. Again, the Fixed Wireless system interference to SDARS is determined as follows:

BS EIRP		16 dBW/MHz
Minimum path loss		-92.3 dB
BS antenna pattern roll-off		-2.0 dB
BS antenna pattern roll-off		-2.0 dB
SDARS antenna gain	+	3.0 dB
Interfering energy from FWS at SDARS receiver		-73.5 dBW/MHz
Interference Noise Energy Allowed		-148.4 dBW/MHz
Required Out-of-band Isolation		-74.9 dB

Again, the result is comparable to the -70 dB isolation proposed by FCC.

FWS Reverse Link

Let's now consider the Reverse Link of a typical Fixed Wireless System. The EIRP from the Subscriber Station (SS) is nominally 4 dBW/MHz. Due to the highly directive nature of the SS antenna, the back lobe is well below 25 dB with respect to the main beam peak. Assuming the SDARS antenna is about 100 ft from the SS antenna, the path loss is computed to be -69.5 dB. The Fixed Wireless system interference to SDARS is determined as follows:

SS EIRP		4 dBW/MHz
Path loss		-69.5 dB
Pattern roll-off		-25.0 dB
SDARS antenna gain	+	3.0 dB
Interfering energy from FWS at SDARS receiver		-87.5dBW/MHz
Interference Noise Energy Allowed		-148.4 dBW/MHz
Required Out-of-band Isolation		-60.9 dB

Comparing this number to the 70 dB isolation proposed by FCC, this meets the proposed FCC specification with almost 10 dB to spare without even accounting for other additional losses. Thus, the commission could relax the reverse link specification without affecting SDARS operation.

The results of Lucent's interference analysis with SDARs systems are attached as Table 1.

Table 1

INTRODUCTION

The following is an interference analysis of a potential fixed wireless application at 2305-2320 MHz and 2345-2360 MHz into the Satellite Digital Audio Radio System.

APPROACH

The interference analysis is based on an approach similar to that used by Primosphere Limited Partnership. However, we feel that several of the assumptions made by Primosphere are overly conservative, and therefore have proposed different assumption based on our experience.

The SDARS receiver system noise energy is first computed based on a reasonably good receiver design. Allowing for a couple of dB of fluctuation, an allowable interference noise energy is established. Further, based on the EIRP of a typical Fixed Wireless System (FWS), the path loss stemmed from the distance between the SDARS antenna and the FWS antenna, and the FWS antenna pattern gain roll-off, the link budget is computed. Thus the isolation required is determined and compared to the FCC proposed isolation requirement.

INTERFERENCE ANALYSIS

Without an expensive sophisticated cooling mechanism, the Noise Temperature for any receiver RF front end must exceed the ambient Thermal Noise Temperature of 290 °K. Assuming the SDARS receiver has a reasonably good LNA and with the Receiver RF front end Noise Figure accounted for, it is rather realistic to assume a 2,000. °K of SDARS Noise Temperature, which translates to 33 dBK.

Thus, the SDARS system Noise Energy = -228.6 dBW/K-Hz +33 dBK
or -135.6 dBW/MHz.
or -2.754 E-14 W/MHz.

In order to allow for a 2 dB increase on the Interference Noise Energy budget for an average SDARS receiving system, -133.6 dBW/MHz (or 4.365 E-14 W/MHz) is allowed. This results in a delta of 1.611E-14 W/MHz or -137.9 dBW/MHz Allowed Interference Noise Energy.

FWS Forward Link

Consider the Forward Link of a typical Fixed Wireless System. The EIRP from the Base Station (BS) is typically 16 dBW/MHz. Based on the directional antenna pattern look angles and distances, 3 cases are examined here.

Case 1, Assume that the SDARS antenna is approximately 100 ft from the base of the BS antenna tower where the BS antenna is mounted 100 ft above ground. The distance D_s used for path loss calculation is

D_s = 141.4 ft, assuming SDARS antenna is on the ground.

Assuming free space, the path loss, $L_s = 10 \log (4 \pi D_s / \lambda)^2$,

where λ = 0.4203 ft, the wavelength at 2340 MHz,

L_s = -72.5 dB.

Even if the BS antenna is tilted down as much as 5 degrees towards the ground and, at such a close distance, the SDARS antenna is at a directional angle outside of the first sidelobe region. Based on the BS antenna pattern, the gain at such look angle is more than 20 dB below that of the main beam peak. The Fixed Wireless system interference to SDARS is determined as follows:

BS EIRP		16 dBW/MHz
Minimum path loss		-72.5 dB
Minimum BS antenna pattern roll-off		-20.0 dB
SDARS antenna gain	+	3.0 dB
Interfering energy from FWS at SDARS receiver		-73.5 dBW/MHz
Interference Noise Energy Allowed		-137.9 dBW/MHz
Required Out-of-band Isolation		-63.4 dB

Comparing this number to the -70 dB Out-of-band Emission proposed by FCC, this worst-case analysis meets the proposed FCC specification with at least 6.6 dB to spare. This is a rather conservative number considering there are other additional losses such as cable loss and antenna polarization loss etc. which would amount to additional 4 dB of additional margin and thus relax the out-of band emission requirement to 60+10log(p).

Case 2, let's double the distance between the SDARS antenna and the base of the BS antenna tower. D_s = 223.6 ft, and thus L_s = -76.5 dB. The directional angle is such that the SDARS appears outside of the BS antenna main lobe region where the energy received will be at least 18 dB below that from the BS antenna main beam peak. The gain reduction could be even greater at the region between the main lobe and the first sidelobe. Similarly, the Fixed Wireless system interference to SDARS is determined as follows:

BS EIRP		16 dBW/MHz
Minimum path loss		-76.5 dB
Minimum BS antenna pattern roll-off		-18.0 dB
SDARS antenna gain	+	3.0 dB
Interfering energy from FWS at SDARS receiver		-75.5 dBW/MHz
Interference Noise Energy Allowed		-137.9 dBW/MHz
Required Out-of-band Isolation		-62.4 dB

Comparing this number to the 70 dB isolation proposed by FCC, this worst-case analysis meets the proposed FCC specification with more than 7.6 dB to spare. Similarly, by adding the possible cable loss and antenna polarization loss etc., additional 4 dB of margin is realized and thus the out-of band emission requirement of 60+10log(p) is more than adequate here.

Case 3, Assume that the BS antenna is not down tilted. In order for the SDARS antenna to be seen at the FWS BS antenna near main beam region, the distance would be at least 1370 ft. That is when the SDARS antenna is in the direction with pattern roll-off of 2dB below BS antenna main beam peak. Thus, D_s = 1373ft, and thus L_s = -92.3 dB. Again, the Fixed Wireless system interference to SDARS is determined as follows:

BS EIRP		16 dBW/MHz
Minimum path loss		-92.3 dB
BS antenna pattern roll-off		-2.0 dB
BS antenna pattern roll-off		-2.0 dB
SDARS antenna gain	+	3.0 dB
Interfering energy from FWS at SDARS receiver		-73.5 dBW/MHz
Interference Noise Energy Allowed		-137.9 dBW/MHz
Required Out-of-band Isolation		-64.4 dB

Comparing this number to the -70 dB isolation proposed by FCC, there is a 5.6 dB of margin in case. However, with additional cable loss and antenna polarization loss accounted for, the isolation required is well within the 60dB region. Again, one should be convinced that 60+10log(p) is sufficient.

FWS Reverse Link

Let's now consider the Reverse Link of a typical Fixed Wireless System. The EIRP from the Subscriber Station (SS) is nominally 8dBW/2.5MHz, or 4 dBW/MHz. Due to the highly directive nature of the SS antenna, the back lobe is well below 25 dB with respect to the main beam peak. Assuming the SDARS antenna is about 100 ft from the SS antenna, the path loss is computed to be -69.5 dB. The Fixed Wireless system interference to SDARS is determined as follows:

SS EIRP		4 dBW/MHz
Path loss		-69.5 dB
Pattern roll-off		-25.0 dB
SDARS antenna gain	+	3.0 dB
Interfering energy from FWS at SDARS receiver		-87.5dBW/MHz
Interference Noise Energy Allowed		-137.9 dBW/MHz
Required Out-of-band Isolation		-50.4 dB

Comparing this number to the 70 dB isolation proposed by FCC, this meets the proposed FCC specification with almost 20 dB to spare without even accounting for other additional losses. Similar to the above analysis for the forward link, by adding the possible cable loss and antenna polarization loss etc., additional 4 dB of margin is realized and thus the out-of band emission requirement of 50+10log(p) is more than adequate here.

Comparison to Primosphere Interference Analysis

According to the response letter from Primosphere to FCC, the SDARS receiver Noise Temperature was assumed to be 200.0 °K. This resulted in a system Noise Energy of -145.6 dBW/MHz, which yielded a good 10 dB more conservative number than that of a practical receiving system.

The allowable 0.2 dB increase in Noise Energy is almost un-measurable because an average spectrum analyzer has resolution of 0.1dB. We believe a more reasonable assumption would be 2 dB, and have used that in the above computation.

Primosphere assumed a 10 dBW/MHz of FWS EIRP, without accounting for any pattern roll-off due to a high directivity antenna typically used for the Fixed Wireless systems and/or other mis-match VSWR gain drop or antenna polarization gain drop. The link budget is summarized below:

FWS EIRP		10 dBW/MHz
Path loss at 100ft		-69.2 dB
BS antenna pattern roll-off		0.0 dB
SDARS antenna gain	+	3.0 dB
Interfering energy from FWS at SDARS receiver		-56.2 dBW/MHz
Interference Noise Energy Allowed		-158.6 dBW/MHz
Required Out-of-band Isolation		-102.4 dB

Comparing this number to the 70 dB isolation proposed by FCC, Primosphere suggested that an additional isolation of 32.4 dB should be required. Based on their assumptions, a -89.4dB (or approximately -90 dB) Out-of-band emission is proposed by Primosphere. Lucent Technologies believes this is too conservative as expressed above.