Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of THE ESTABLISHMENT OF POLICIES AND SERVICE RULES FOR THE BROADCASTING SATELLITE SERVICE AT THE 17.3-17.7 GHZ FREQUENCY BAND AND AT THE 17.7-17.8 GHZ FREQUENCY BAND INTERNATIONALLY, AND AT THE 24.75-25.25 GHZ FREQUENCY BAND FOR FIXED SATELLITE SERVICES PROVIDING FEEDER LINKS TO THE BROADCASTING-SATELLITE SERVICE AND FOR THE BROADCASTING SATELLITE SERVICE OPERATING BI-DIRECTIONALLY IN THE 17.3-17.7 GHZ FREQUENCY BAND	IB Docket No. 06-123

COMMENTS OF DIRECTV, INC.

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SUMMARY

DIRECTV, Inc. ("DIRECTV"), the nation's leading Direct Broadcast Satellite ("DBS") service provider, welcomes the opportunity to comment on proposed service and licensing rules for the Broadcasting Satellite Service ("BSS") in the 17.3-17.8 GHz and 24.75-25.25 GHz bands ("17/24 GHz BSS"). As the *BSS NPRM* suggests, developing appropriate operational rules involves the balancing of competing interests and assessing trade-offs to find the optimal blend of operating parameters such as power levels, antenna size, and orbital spacing. DIRECTV believes that the Commission can best foster development of this band by adopting basic technical baselines that establish a predictable and stable interference environment yet leave sufficient flexibility to accommodate a variety of operational scenarios.

As discussed in greater detail in these comments, DIRECTV submits that the 17/24 GHz BSS rules should include the following basic characteristics:

- Orbital spacing of 4°, centered on slots currently used for Fixed-Satellite Service ("FSS") operations, for the CONUS portion of the geostationary arc;
- Protection criteria based on use of 60 cm receive antennas that conform to the ITU reference standard (though operators would be free to use smaller and/or non-conforming antennas);
- Graduated coordination triggers on downlink power levels tailored to the requirements for reliable service in different parts of the country;
- Standardized parameters for earth stations that allow routine individual licensing of feeder link antennas and establish a baseline of protection for subscriber terminals;
- First come, first served processing of applications;
- Availability of 17.7-17.8 GHz for service outside the United States, and even within the United States on a non-protected basis; and
- Public interest requirements similar to those imposed on DBS operators.

Systems that meet the Commission's technical requirements would qualify for routine processing and be deemed coordinated with one another. Applicants would, of course, be free to propose operations with non-conforming technical characteristics, but would have to coordinate with conforming systems, demonstrate the proposed operations are compatible with conforming systems' operations, and accept excess interference, as appropriate, from conforming systems.

The 17/24 GHz BSS band presents a golden opportunity to make even more intensive use of valuable spectrum/orbital resources and thereby enhance the ability of satellite systems to provide robust multichannel video services. DIRECTV believes that adoption of the flexible yet streamlined approach outlined in these comments would best serve the public interest by encouraging and accelerating deployment of 17/24 GHz BSS systems.

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<u>COMMENTS OF DIRECTV, INC.</u>

DIRECTV, Inc. ("DIRECTV"), the nation's leading Direct Broadcast Satellite ("DBS") service provider, welcomes the opportunity to comment on proposed service and licensing rules for the Broadcasting Satellite Service ("BSS") in the 17.3-17.8 GHz and 24.75-25.25 GHz bands ("17/24 GHz BSS").[1] As the Commission is aware, DIRECTV was the first to propose such service over nine years ago, and has had space station applications pending since that time.[2] While much has changed in the interim, realizing the potential for 17/24 GHz BSS operations to supply additional capacity and thereby support greater competition in the multichannel video programming distribution ("MVPD") market remains an important public interest goal.

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[1] *See Establishment of Policies and Service Rules for the Broadcasting Satellite Service at the 17.3-17.7 GHz Frequency Band and at the 17.7-17.8 GHz Frequency Band Internationally, and at the 24.75-25.25 GHz Frequency Band for Fixed Satellite Services Providing Feeder Links to the Broadcasting-Satellite Service and for the Broadcasting Satellite Service Operating Bi-directionally in the 17.3-17.7 GHz Frequency Band*, 21 FCC Rcd. 7426 (2006) ("*BSS NPRM*").

[2] *See Public Notice*, Report No. 2208 (rel. July 1, 1997) (DIRECTV Petition for Rulemaking); FCC File Nos. SAT-LOA-19970605-00049, -00050, and -00051 (DIRECTV space station applications).

As the *BSS NPRM* suggests, developing appropriate service rules involves the balancing of competing interests and assessing trade-offs to find the optimal blend of operating parameters such as power levels, antenna size, and orbital spacing. Fortunately, unlike the established DBS band, the 17/24 GHz BSS band offers a largely blank slate upon which to write these rules, without the constraint of having to address protection of an installed base of tens of millions of consumers whose service depends upon a long-standing regulatory regime.[3]

DIRECTV believes that the Commission can best foster development of this band by adopting basic technical baselines that establish a predictable and stable interference environment yet leave sufficient flexibility to accommodate a variety of operational scenarios. As demonstrated by the two-degree spacing policy adopted by the Commission for FSS frequency bands, such a regime provides many advantages. It allows satellite operators to design innovative systems with confidence that they will perform satisfactorily in a defined environment. It also assures consumers of satellite services that their intended use of the spectrum will not be undermined in the future. And neither operators nor the Commission need engage in the time-consuming process of coordinating with compliant systems operating in accordance with established rules at adjacent slots.

DIRECTV submits that the Commission should adopt an orbital spacing policy for the 17/24 GHz BSS modeled in many ways after the approach it took for Ka-band FSS – a band currently being developed, in part, for DTH services. Under this approach,

3 Thus, the assumptions underlying DIRECTV's comments on proposed rules for a new BSS service are radically different from those that would be appropriate in assessing a change in the well-established DBS regulatory regime.

systems that meet the Commission's technical requirements qualify for routine processing and are deemed coordinated with one another. Applicants would, of course, be free to propose operations with non-conforming technical characteristics if they coordinate with conforming systems, demonstrate the proposed operations are compatible with conforming systems' operations, and accept excess interference, as appropriate, from conforming systems. For a variety of reasons, DIRECTV has concluded that the optimal orbital separation for the 17/24 GHz BSS service would be four degrees, positioned to coincide with existing FSS orbital locations. Moreover, these rules would be applicable to orbital locations best suited to serve the entire contiguous United States (*i.e.,* from 83° W.L. to 123° W.L.), with variations allowed outside that arc so long as they did not adversely affect conforming systems within it.

I. 17/24 GHz BSS Slots in the Domestic Arc Should Presumptively Have Four Degrees of Orbital Separation, Centered on Existing FSS Locations

DIRECTV's original proposal. When it filed its 17/24 GHz BSS applications in 1997, DIRECTV anticipated that it would want to collocate these satellites at slots already used for DBS operations, and that other DBS operators would want to do the same. This suggested 17/24 GHz BSS slots at 101º W.L., 110º W.L., and 119º W.L., which would constrain the choices for additional slots over a significant portion of the full-CONUS arc. DIRECTV – and other applicants that followed – therefore gravitated toward 4.5º spacing, essentially halving the distance between the presumptive slots.

As discussed below, DIRECTV has more recently concluded that such collocation would present certain challenges in terms of both co-frequency uplink and downlink interference. In addition, collocation would exacerbate the already problematic level of orbital congestion at existing DBS slots.[4] Accordingly, DIRECTV no longer believes that basing 17/24 GHz BSS orbital spacing on the existing DBS locations established under the ITU Region 2 Plan should be the starting point for this service's orbital plan. It now believes that the Commission should instead assign 17/24 GHz BSS orbital locations with four-degree spacing such that they coincide with existing FSS – not DBS – slots.

Optimal orbital spacing and receive antenna size. DIRECTV believes that operating with slightly less orbital spacing (*i.e.*, 4° rather than 4.5°) can better achieve important public interest goals. Determining optimal orbital spacing is driven largely by the size of the receive antenna to be protected. In order to evaluate the options, set forth in Table 1 are the aggregate carrier to interference ("C/I") ratios for several orbital spacing/receive antenna size combinations.

	Orbital Spacing (degrees)					
Receive Antenna Size (cm)	**2.0**	**3.0**	**4.0**	**4.5**	**5.0**	**6.0**
35	1.0	6.3	13.1	16.7	18.9	21.1
45	3.4	11.1	18.6	20.2	21.4	23.3
50	4.7	13.7	19.8	21.1	22.3	24.2
60	7.3	17.7	21.3	22.7	23.9	25.8
65	8.5	18.6	22.0	23.4	24.6	26.5
70	9.8	19.3	22.7	24.0	25.2	27.2

Table 1. Aggregate C/I versus orbital spacing and receive antenna size, dB

These values were calculated using the following assumptions:

- two interfering 17/24 GHz BSS satellites on each side (first and second adjacent slots to the East and West);
- 0.05° East-West satellite station-keeping;
- 0 dB difference in EIRP between the victim satellite and each interferer;

[4] For example, there are six satellites currently operating at the nominal 101° W.L. location, with two more authorized to go there.

- receive antenna mis-pointing of 0.5°[5] (mis-pointing towards interferers to the East means receive antenna is mis-pointed away from interferers to the West, and vice versa); and
- consumer earth station antennas comply with the Recommendation ITU-R BO.1213 reference pattern[6] at 17.5 GHz, for both co-polarized and cross-polarized signals.

Although Table 1 shows that it would also be possible to achieve roughly comparable results by pairing greater orbital separation and smaller antennas or less orbital separation and larger antennas, DIRECTV submits that there are several reasons to favor four degree spacing and presumptive use of 60 cm antennas. First, 17/24 GHz BSS locations could be aligned with locations used by existing Ku- and Ka-band FSS satellites operating every two degrees across the geostationary arc. This would enable the licensee(s) at each location to capture the financial and operational efficiencies of combining multiple payloads on a single space station. As the Commission pointed out in the *BSS NPRM*, it is particularly likely that such hybrids would be used where existing satellites are already used to provide direct-to-home services in order to capitalize on the possibility of marketing a single antenna with dual-band receivers.[7]

The Commission has historically favored the use of such hybrid satellites due to their patent efficiency advantages.

> Operating a state-of-the-art hybrid satellite at a particular orbital location may be more efficient than operating two single-band satellites at that location. Construction, launch and insurance costs for one, albeit larger, satellite will be lower than for two satellites. Moreover, advances over the

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5 A 0.5° mis-pointing value is used since the receive terminals in this band will be new installs, and presumably will be aligned with greater care than was required for DBS terminals with the benefit of nine-degree satellite spacing.

6 *See* Recommendation ITU-R BO.1213, "Reference receiving earth station antenna patterns for planning purposes to be used in the revision of the WARC BS-77 Broadcasting-Satellite Service Plans for Regions 1 and 3".

7 *See BSS NPRM* at ¶ 41.

past several years have made it possible to construct hybrid satellites that have technical capabilities equivalent to single-band satellites. Thus, hybrid satellites can provide cost savings to operators and customers with no decrease in technical performance.[8]

The ability to use a hybrid satellite will enable operators to capture these efficiencies and significantly reduce the costs of providing service in all authorized bands. The uniform power spectral density characteristics of all-digital video transmissions would be especially well suited to combining with digital transmissions in other bands.

Second, at present, DBS operators in the United States offer most of their DBS customers multiple-feed antennas with effective diameters of 60-65 cm, and this size antenna is also the standard in other regions of the world. Clearly, this size antenna has become accepted in the marketplace. When used with existing DBS satellites, those antennas typically provide consumers a C/I value on the order of 21 dB or more.[9] As demonstrated in the table above, the use of 60 cm receive antennas with 17/24 GHz BSS satellites separated by four degrees would result in aggregate interference levels, and resulting service availabilities, comparable to current DBS operations, offering consumers a similar experience from either type of satellite.[10]

Moreover, given the capacity available to other MVPDs with terrestrial fiber and coaxial plant, satellite operators have had to provide service from multiple orbital

[8] *Hughes Communications Galaxy, Inc*., 5 FCC Rcd. 3423 (Com. Car. Bur. 1990). *See also EchoStar Satellite Corp*., 18 FCC Rcd. 15875, 15878 (Int'l Bur. 2003) ("the Commission has recognized the cost efficiencies inherent in hybrid satellites and has attempted to accommodate hybrid satellites where possible"); *Hughes Communications Galaxy, Inc.*, 7 FCC Rcd. 7119, 7120 (Com. Car. Bur. 1992) (recognizing cost and other efficiencies).

[9] As the Commission noted, applying the rules for routine licensing of Ku-band earth stations translates to off-axis discrimination value of 20.5 dB for the downlink transmissions. *See BSS NPRM* at n. 116.

[10] As the Commission observed, because off-axis discrimination performance for a given size antenna improves at shorter received-signal wavelengths (*i.e.*, higher frequencies), 17/24 GHz BSS antennas should be able to deliver quality of service comparable to 12/17 GHz DBS systems while operating with satellites at more closely spaced orbital locations. *See BSS NPRM* at ¶ 44.

locations in order to provide a competitive service offering. It is reasonable to expect that 17/24 GHz BSS capacity will be used either in conjunction with those existing services or in combination with other, as-yet untapped satellite spectrum. In either case, a multi-feed antenna capable of receiving signals from multiple slots will be desirable – and such an antenna will almost certainly need to be larger than the 45 cm antennas originally offered by DBS service providers when their nascent operations were limited to a single orbital location. In addition, as shown in Table 1 above, it would be difficult to provide sufficient protection to smaller antennas without increasing orbital spacing beyond four degrees or assigning differential power level maximums to neighboring systems.

Third, although the Commission could predicate spacing on the use of smaller antennas, doing so would decrease the number of slots available and therefore result in less intensive use of this valuable spectrum. For example, in order to achieve a similar service level using a 45 cm antenna, 17/24 GHz BSS satellites would have to operate with at least five degrees of separation. Over the portion of the arc affording optimal coverage of the entire contiguous United States (approximately 83° W.L. to 123° W.L.), the larger spacing required to accommodate these smaller antennas would translate into nine slots for 17/24 GHz BSS operations – as compared to the eleven slots that would be accommodated using a four-degree regime (*i.e.,* the smaller antennas would reduce the number of slots by over 20%). Furthermore, such five-degree slots would coincide with the two-degree FSS slots only every ten degrees, resulting in very limited opportunities for realizing the benefits of hybrid FSS/BSS satellites.

In sum, DIRECTV agrees with the Commission's conclusion that "adoption of a 17/24 GHz BSS orbital separation that is some multiple of two degrees might best facilitate our goals of maximizing orbital capacity and operator flexibility while providing sufficient protection for small-diameter subscriber antennas."[11] DIRECTV supports the use of four-degree spacing as providing the best combination of orbital/spectrum efficiency for operators and quality of service for consumers.

II. The Commission Should Protect 60 cm Receive Antennas That Conform to the ITU Reference Standard

As indicated above, DIRECTV believes that 60 cm is an appropriate minimum size consumer receive antenna to accommodate when considering a GSO orbital spacing policy. Although millions of DBS subscribers have smaller antennas, 60 cm dishes have become more prevalent over the last few years, and they have been a consumer standard in Europe and elsewhere for even longer. Moreover, given the likelihood that 17/24 GHz BSS operators will want or need to combine capacity from multiple orbital locations in order to compete effectively with terrestrial MVPD alternatives, the required multi-feed receive antennas would almost necessarily have an effective diameter of 60 cm or more.

As mentioned in the *BSS NPRM*, the Commission historically has opted not to regulate the diameter or other technical characteristics of receive-only antennas explicitly, preferring instead to establish limits on other system characteristics that shape the interference environment.[12] The Commission has asked whether it should take a different approach here by adopting reference antenna performance standards as it has done in implementing its two-degree spacing policy with respect to FSS.[13] DIRECTV believes that establishing such standards would create a more stable and predictable

[11] *Id.* at ¶ 41.

[12] *Id.* at ¶ 47.

[13] *Id.*

interference environment, which could be of particular importance in the 17/24 GHz BSS band given its reverse-band relationship with existing DBS operations.

If the Commission is to adopt such standards, it must be sure that they are not overly conservative and are representative of real-world antennas used by DTH systems. At present, there is very little measurement data on relatively small receive antennas operating in the 17 GHz band. However, DIRECTV and others have recently generated data on antennas in the nearby Ka-band (18.3-20.2 GHz) in connection with DIRECTV's ongoing deployment of HDTV services via satellite. This data, for the most part, conforms to the reference pattern given in Recommendation ITU-R B.O.1213 for 60 cm antennas. Accordingly, DIRECTV believes that this ITU standard would be an appropriate reference pattern to use as a baseline for protection in routine licensing of 17/24 GHz BSS systems under the Commission's rules.

While DIRECTV favors protection for antennas with a minimum diameter of 60 cm designed to conform to the ITU standard, we believe that the Commission should continue its policy of leaving operators discretion to determine the technical characteristics of their equipment. Accordingly, operators should remain free to deploy smaller and/or non-conforming antennas – so long as they recognize that they must accept any resulting increase in interference from other systems that operate within permitted levels. This would enable each operator to choose the interference safe harbor of the ITU standard, or to deploy antennas with different characteristics if its technical and business analysis justified doing so.

III. The Commission Should Establish Graduated PFD Limits for 17/24 GHz BSS Downlink Transmissions

The Commission has frequently adopted presumptive downlink power limits for space station transmissions in order to facilitate both inter-service and intra-service sharing.[14] By imposing these limits, the Commission has effectively established a relatively homogeneous operating environment while obviating the need for time-consuming coordination among systems. It has also ensured that receiving antennas can be deployed without fear that they will later be subjected to much higher levels of satellite interference as newer generations of satellites are brought into use. On the other hand, such limits can restrict future innovations that require greater satellite power levels. DIRECTV submits that the Commission can devise an appropriate limitation on downlink power levels in the 17/24 GHz BSS band that balances these competing considerations, and should therefore adopt such limits as it has done in other bands.

If the DBS band is any indication, 17/24 GHz BSS operators will employ both CONUS beams and more localized spot beams. Conventional DBS CONUS patterns are to some degree comparable, placing more power in the Eastern United States in order to help counteract the higher rain attenuation typical in that part of the country. DBS spot beams, however, typically have higher EIRPs than DBS CONUS beams at any given point because the coverage area is much smaller and hence the antenna gain is much higher. While DBS CONUS patterns from adjacent satellites thus allow fairly straightforward prediction of interference, EIRP differences of as much as 10 dB or more

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[14] As described in the *BSS NPRM*, for example, the Commission's rules define power flux density ("PFD") limits for C- and Ka-band operations in Section 25.208, and impose additional PFD requirements for blanket licensing of Ka-band earth stations in Section 25.138. *See id.* at ¶ 54.

can result between DBS spot and DBS CONUS beams from neighboring orbital locations.

In the DBS environment, which is characterized by nine-degree spacing of orbital locations, the impact of spot beam usage normally is not severe on overall C/I because the off-axis discrimination of the consumer receive antenna is sufficient to overcome the EIRP imbalance. In a regime using less orbital spacing, this imbalance can be expected to have a much more significant impact on C/I and resulting quality of service to consumers. To illustrate this point, consider what the entries in Table 1 would look like if reduced by 10 dB. The result would be an aggregate C/I of only 11.3 dB for 60 cm antennas with satellites spaced four degrees apart, and no entries with C/I greater than 17.2 dB, even with six-degree satellite spacing and 70 cm consumer antennas.

A number of different strategies could be used to minimize this problem. For example, the Commission could address potential EIRP imbalances between neighboring systems by segmenting the 17/24 GHz BSS frequency band so that a certain portion of spectrum is allocated for spot beam use and the remainder for CONUS beams. Similarly, the Commission could segment the geostationary arc so that a certain portion is allocated to use for spot beam satellites and another portion is allocated for CONUS beam use.[15] In either case, this segmentation approach would ensure that inter-system interference would involve spot-to-spot and CONUS-to-CONUS scenarios, avoiding the significant power differentials that would most likely arise in a spot-to-CONUS situation. However, such segmentation would require the Commission to make an *a priori* judgment as to the

15 The Commission briefly experimented with such an arc segmentation approach for Ku-band FSS satellites, but abandoned it after only eight years. *See Assignment of Orbital Locations to Space Stations in the Domestic Fixed-Satellite Service*, 11 FCC Rcd. 13788, 13790-91 (Int'l Bur. 1996).

comparative need for CONUS and spot beam capacity – an approach that entails all of the disadvantages normally cited when central planning replaces market forces.[16]

If it were to conclude that smaller receive antennas are necessary to the success of certain BSS services, the Commission could instead adopt another form of segmentation in which the allowable downlink power levels alternate between high and medium power limits for adjacent orbital locations. Under a four-degree spacing regime, each high-power slot would be eight degrees away from the next high-power slot, with medium-power satellites at four degrees of separation between and on either side of the high-power satellites. The differential in maximum power levels need not be large – only on the order of 3 dB. Assuming such a segmentation approach, high-power slots could be used to provide service to receive antennas of approximately 45 cm diameter, while medium-power slots could provide service to 80 cm antennas, while still achieving 21 dB C/I. This approach would accommodate BSS services that place a premium on using smaller antennas. Yet even the medium-power operations would use antennas small enough to qualify for the protections of the Commission's Over-the-Air Reception Devices ("OTARD") rules throughout CONUS,[17] and may be quite acceptable for other BSS services.

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16 *See, e.g.*, Spectrum Policy Task Force Report, ET Docket No. 02-135, at 41 (rel. Nov. 7, 2002) ("The command-and-control model should be applied only in situations where prescribing spectrum use is necessary to accomplish important public interest objectives or to conform to treaty obligations"); G. Rosston and J. Steinberg, "Using Market-Based Spectrum Policy to Promote the Public Interest," OPP Staff White Paper (rel. Jan. 21, 1997) ("In recognition of these shortcomings of central planning, we believe the Commission should, whenever possible, rely on market forces to ensure economically efficient use of spectrum").

17 *See* 47 C.F.R. § 1.4000 (protecting antennas less than one meter in diameter). Because of the low look angle and high atmospheric attenuation, receive antennas in Hawaii operating with such medium-power systems would have to be somewhat larger, and likely would fall outside the OTARD protections.

But DIRECTV believes that the best option would be for the Commission to adopt a set of graduated PFD triggers, such that systems operating below specified levels would qualify for routine processing while those proposing to operate above them would be subject to greater scrutiny, including requirements of coordinating with neighboring satellites and providing a more complete interference analysis. Based on rain rates across the U.S., PFD limits would generally need to be higher in the East than in the West, with the highest PFD required in the Southeast. One example of a simple graduated PFD scheme is the following, as illustrated in the Figure 1 below:

- -115 dBW/m^2/MHz east of 100° W.L. and south of 38° N.L.,
- -118 dBW/m^2/MHz east of 100° W.L. and north of 38° N.L.,
- -121 dBW/m^2/MHz west of 100° W.L

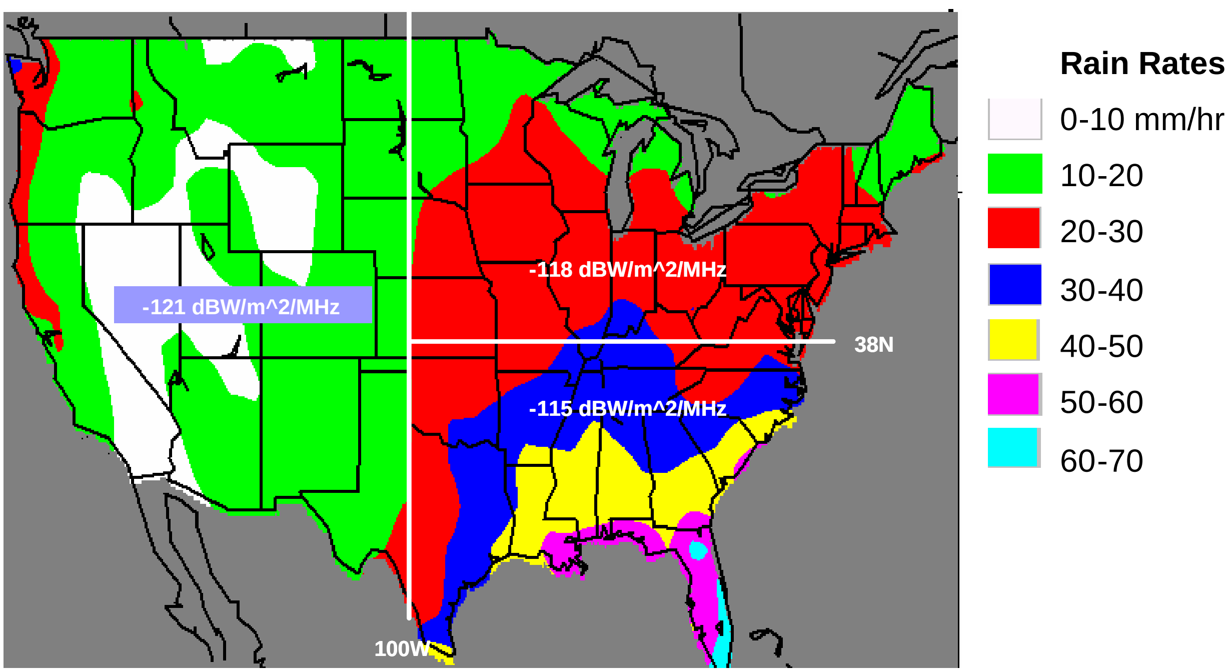

Figure 1. Rain Rates for 99.9% Availability

This is but one of many possible downlink limitation regimes, and further refinement could be made to more closely equate the PFD limitations with rain rates and other factors. Unlike the approaches discussed above, this PFD strategy does not require the Commission to pre-judge the relative proportion of spot and CONUS beam usage or high- and medium-power satellites in the band. If the Commission were to adopt some form of graduated PFD limits along the lines discussed above, DIRECTV would advocate a fairly simple regime as the easiest for operators to implement and for the Commission to enforce.

Although the Commission could take any one of the approaches discussed above, DIRECTV believes that a regime based on graduated PFD limits, appropriately calibrated to the propagation characteristics of various parts of the country, would provide the best opportunity for flexibility within an established interference environment.[18] Accordingly, DIRECTV encourages the Commission to implement such an approach.

IV. The Commission Should Adopt an Off-Axis EIRP Mask for 17/24 GHz BSS Uplink Transmissions

The Commission has not adopted limits on uplink power levels used by DBS feeder link earth stations, although the Region 2 BSS Plan assumes a value of 87.4 dBW per carrier for DBS feeder links. To some extent, operating at such a high power level is a luxury available in the nine-degree spacing environment that has characterized DBS service to date. In other bands with closer orbital spacing, stricter limitations on uplink

[18] One approach that DIRECTV opposes is the introduction of non-geostationary orbit ("NGSO") systems in this band. None of the pending applications anticipates use of an NGSO architecture. Moreover, given that NGSO systems have access to abundant spectrum resources that they have not yet even begun to tap, there is no justification for making yet more spectrum available to them. *See, e.g., Amendment of Parts 2 and 25 of the Commission's Rules to Permit Operation of NGSO FSS Systems Co-Frequency with GSO and Terrestrial Systems in the Ku- Band Frequency Range*, 16 FCC Rcd. 4096 (2000) (creating primary allocation for NGSO systems in the 12.2-12.7 GHz band); *Redesignation of the 17.7-19.7 GHz Frequency Band, Blanket Licensing of Satellite Earth Stations in the 17.7-20.2 GHz and 27.5-30.0 GHz Frequency Bands, and the Allocation of Additional Spectrum in the 17.3-17.8 GHz and 24.75-25.25 GHz Frequency Bands for Broadcast-Satellite Service Use*, 15 FCC Rcd. 13430 (2000) (allocating 18.8-19.3 GHz band solely to NGSO/FSS systems).

operating parameters have been the rule. DIRECTV believes that such limits should be applied to the 17/24 GHz BSS band as well.

Generally speaking, DIRECTV believes that the uplink regime established in Section 25.138 for Ka-band satellite systems provides an appropriate model for rules in this band. Under that regime, in order to qualify for routine processing, transmitting earth stations must meet a specified off-axis EIRP mask regardless of their on-axis absolute EIRP or their actual antenna performance. Considering the types of earth station antennas used today for feeder links in the DBS bands and the expected maximum EIRP required of 17/24 GHz BSS feeder link antennas, DIRECTV believes that off-axis EIRP limits of the same magnitude as that currently specified in Section 25.138 (appropriately scaled to a 1 MHz resolution rather than 40 kHz) such as the following would be appropriate:

$32.5 - 25*\log(\theta)$	dBW/MHz	for $2^{\circ} \leq \theta \leq 7^{\circ}$
11.4	dBW/MHz	for $7^{\circ} \leq \theta \leq 9.2^{\circ}$
$35.5 - 25*\log(\theta)$	dBW/MHz	for $9.2^{\circ} \leq \theta \leq 48^{\circ}$
3.5	dBW/MHz	for $48^{\circ} < \theta \leq 180^{\circ}$

Such limits would address concerns with off-axis interference and thereby be more conducive to four-degree spacing[19] and facilitate coordination with other services in the band.

DIRECTV also supports the imposition of an adaptive uplink power control provision modeled after Section 25.138(a)(5), such that earth stations may operate at

19 It is worth noting that these limits have been used successfully with Ka-band systems in a two-degree spacing environment, and therefore should be more than adequate with four-degree spacing.

higher power levels where necessary to compensate for atmospheric attenuation (*i.e.,* rain fade).

As in the Ka- and other bands, an application that demonstrates compliance with these rules should be eligible for routine licensing. However, an applicant should remain free to seek authority to operate at levels above those specified in the rules, so long as it submits an appropriate technical showing, as well as evidence that all potentially affected parties (*i.e.,* all 17/24 GHz BSS networks within ±8° of any point of communication, as well as all terrestrial systems in the earth station coordination area) acknowledge and do not object to the higher power density levels.

V. Licensing and Processing Framework

DIRECTV believes that applications for 17/24 GHz BSS authorizations are best handled under the general framework established in the Commission's *Space Station Reform Order*.[20] Unlike the DBS service, which involves special rules developed as part of an internationally planned band, the 17/24 GHz BSS band is unplanned, similar to virtually all other FSS bands. Thus, the Commission is free to determine its own technical rules for 17/24 GHz BSS operations as it deems appropriate to further the public interest. As discussed at length in these comments, DIRECTV believes that the Commission should adopt the kinds of rules it has adopted in other FSS bands to promote a stable, well-defined interference environment and streamlined processing of applications. In light of these considerations, DIRECTV submits that 17/24 GHz BSS applications should generally be processed in a manner similar to geostationary orbit ("GSO") FSS applications.

[20] *See Amendment of the Commission's Space Station Licensing Rules and Policies*, 18 FCC Rcd. 10760 (2003) ("*Space Station Reform Order*").

Accordingly, DIRECTV supports use of the Commission's "first-come, first-served" licensing approach for GSO-like applications as a methodology for processing 17/24 GHz BSS applications, including those currently pending. Using this approach will enable the Commission to process applications in the most expeditious manner possible – an important consideration given that the spectrum becomes available for use next year. DIRECTV also supports applying the same safeguards against speculation (such as performance bonds and milestones) to this new service that apply to other GSO-like services.[21] However, DIRECTV sees no reason why 17/24 GHz BSS systems should be treated unlike other GSO-like systems by limiting their license terms to only 10 years instead of the 15-year standard applicable to all other non-broadcast systems covered by the *Space Station Reform Order* framework.[22]

DIRECTV also believes that, consistent with past practice, existing applicants should be allowed to amend their pending applications to conform to the rules adopted in this proceeding without losing their place in the processing queue. "Whenever the Commission develops satellite service rules concurrently with consideration of pending applications for that service . . . [it] always allow[s] applicants an opportunity to amend their pending applications to bring them into conformance with the rules that [it] adopt[s] for the particular service."[23] In this particular case, applicants have made varying

[21] Absent evidence that these safeguards have not worked in the past, DIRECTV sees no reason to impose stricter measures on the 17/24 GHz BSS service than apply to GSO-like systems generally.

[22] *See BSS NPRM* at ¶ 13. Consistent with treating 17/24 GHz BSS systems like other GSO systems, DIRECTV also supports using the application fees associated with geostationary space stations and fixed satellite transmit/receive earth stations for this service, *see id.* at ¶ 8, and adopting a grant-stamp procedure for replacement satellites, *id.* at ¶ 14.

[23] *Final Analysis Communications Services, Inc.*, 16 FCC Rcd. 21463, 21468 (2001) ("*Final Analysis*"). *See also Establishment of Rules and Policies for the Digital Audio Radio Satellite Service in the 2310-2360 MHz Frequency Band*, 12 FCC Rcd. 5754, 5783 (1997) ("in any satellite service rulemaking

assumptions about any number of operational parameters – including such critical parameters as orbital spacing and power levels – that may not comply with the rules ultimately adopted for this service. In that case, existing applicants should be allowed to amend their applications as necessary to bring them into compliance, including amendments to designate different orbital locations if required, while maintaining their relative priority for processing.[24]

Non-U.S. licensed 17/24 GHz BSS systems seeking to serve the United States must be subject to the same technical and regulatory requirements – including orbital spacing parameters – that the Commission imposes on domestic licensees.[25] In addition, all 17/24 GHz BSS systems serving the United States, whether licensed by the Commission or another administration, should be subject to the public interest obligations of Section 25.701.[26]

Similarly, all 17/24 GHz BSS systems must provide service to Alaska and Hawaii if technically feasible from their assigned orbital location, and such service must be reasonably comparable to the service provided to CONUS subscribers.[27] However, to the extent an operator provides service from more than one orbital location, compliance with this condition should be determined on a fleet-wide basis, rather than on a satellite-by-

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proceeding, we always give pending applicants the opportunity to amend their applications to conform to the final rules").

[24] "[T]he Commission has always limited conforming amendments to changes made necessary by the newly adopted service rules," *Final Analysis*, 16 FCC Rcd. at 21468, and DIRECTV would expect the same principle to hold true here. Thus, amendments that transfer control of an applicant or result in an increased potential for interference not mandated by the new rules would cause the application to lose its place in the processing queue.

[25] *See BSS NPRM* at ¶ 18.

[26] *Id.* at ¶ 20.

[27] *See id.* at ¶¶ 23-24.

satellite basis. This gives needed flexibility without compromising the underlying goal of ensuring comparable service nationwide. For example, to the extent this spectrum is used for local-into-local service, the Commission would not want to force each satellite to include spot beams to retransmit local stations in Alaska and Hawaii if the same programming could be retransmitted more efficiently from a single satellite in the fleet (*e.g.,* one located in the western portion of the arc).

VI. Potential Interference Between DBS and 17/24 GHz BSS Operations

A. Ground Path Interference

Ground path interference concerns potential disruption to 17/24 GHz BSS receive antennas by DBS uplink transmissions. Table 2 below illustrates two cases of such interference. Both cases reflect the same underlying assumptions except for the path loss between the BSS receive antenna and the DBS feeder-link transmit antenna. Case 1 assumes no shielding of the receive terminal from the feeder-link transmitter, and the off-axis gain is taken directly from Recommendation ITU-R BO.1213. Case 2 provides additional path loss of 15 dB, comparable to what might result from a similar antenna being mounted on the side of a house shielded from the feeder-link site.

Parameter	Units	Case 1	Case 2
Delta T/T Required	%	6.0	6.0
I/N Required	dB	-12.2	-12.2
Frequency	GHz	17.5	17.5
Isotropic area	dB-m^2	-46.3	-46.3
FL Ant. Gain	dBi	65.0	65.0
FL TX power	dBW	13.0	13.0
FL EIRP	dBW	78.0	78.0
FL xpndr BW	MHz	24	24
FL angle to horizon	Deg.	28.0	28.0
25.209 off-axis gain	dBi	-4.2	-4.2
FL EIRP density toward horizon	dBW/Hz	-65.0	-65.0
Receive e/s angle to horizon	Deg.	40.0	40.0
E/S off-axis gain toward horizon	dBi	-5.0	-5.0
Additional loss due to shielding	dB	0.0	15.0
E/S sys. Temp	K	175.0	175.0
E/S noise power density	dBW/Hz	-206.2	-206.2
Io max from FL	dBW/Hz	-218.4	-218.4
Required spreading loss	dB	-102.1	-87.1
Required distance from FL to e/s	**km**	**35.9**	**6.4**
Reverse band satellite EIRP	dBW	55.0	55.0
Xpndr BW	MHz	36.0	36.0
E/S antenna gain	dBi	36.5	36.5
Spreading loss	dB	-162.5	-162.5
E/S wanted receive power	dBW	-117.3	-117.3
BW advantage	dB	1.1	1.1
C/I	**dB**	**26.6**	**26.6**

Table 2. DBS Feeder-link Interference into 17/24 GHz BSS Receive Antennas

As illustrated by Table 2, the separation distance from a DBS feeder link required for satisfactory reception of 17/24 GHz BSS service can be quite large, especially in the absence of additional shielding. Accordingly, care must be taken when installing 17/24 GHz BSS receive antennas near DBS feeder link earth stations.

As the Commission recognizes, there are relatively few existing DBS feeder link earth stations,[28] most of which are located in fairly remote areas of the country. Although DBS operators have more recently sought authorization for additional feeder link earth stations to uplink local broadcast signals from regional collection sites, the number of such sites is still very small. DIRECTV, for example, operates DBS feeder links from only four sites across the country, and has no plans for additional regional sites. Clearly, licensed and operating DBS uplink facilities must be grandfathered under any rules adopted in this proceeding so that they may continue to operate in the manner in which they were designed in reliance on the rules then in effect. Accordingly, DIRECTV does not support the imposition of off-axis EIRP density or other transmitting power limits for existing DBS feeder link antennas, or a requirement that such be shielded.[29] Nonetheless, for the reasons stated above, preserving the status of a very limited number of sites is unlikely to have a material impact on the availability of 17/24 GHz BSS service to consumers.

Going forward, however, if DBS operators seek to build new feeder link facilities after 17/24 GHz BSS systems have deployed, the calculus becomes changes dramatically. At that point, it is the consumer's (not the DBS operator's) reasonable expectations that must be protected. In such a case, proposed DBS feeder link operations should be coordinated with existing 17/24 GHz BSS users. This process would be greatly facilitated to the extent new DBS uplink facilities were required to operate within a strict PFD limitation toward the horizon and/or to deploy shielding at their earth station sites.

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[28] *Id.* at ¶ 58.

[29] *See id.* at ¶¶ 65-66.

Whatever methodology the Commission chooses for coordination, the parameters used for analysis must assume that 17/24 GHz BSS receive antennas meet the Commission's performance standards. Any non-conforming consumer antennas should not be protected beyond the level required to protect a conforming one.

The other ground path scenario involves potential interference from DBS feeder link earth stations into 17/24 GHz BSS telemetry earth stations. DIRECTV believes that, with careful planning, it is possible to coordinate the operations of these two services, even to the point where the facilities can be collocated. Accordingly, DIRECTV does not believe that the Commission should limit operator flexibility by precluding such collocation or by requiring some minimum separation distance. Rather, DIRECTV supports the Commission's proposal that operators seeking to collocate such facilities should be required to make a technical showing demonstrating their ability to maintain sufficient margin in their telemetry links in the presence of the interfering DBS signal.[30] This will enable those operators who want to capture the efficiencies of collocation (*i.e.*, shared personnel, facilities, power, etc.) to do so, provided they can prove to the Commission that receipt of critical 17/24 GHz BSS telemetry data will not be subject to disruption.

B. Space Path Interference

In this case, the concern is that 17/24 GHz BSS space stations transmitting in the 17 GHz band will cause interference to DBS space stations receiving in this band. Generally speaking, DIRECTV believes that such interference presents a significant problem to the extent that DBS and 17/24 GHz BSS satellites are located in close

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[30] *Id*.. at ¶ 68.

proximity. In fact, difficulties in accommodating such operations were an important factor in DIRECTV's conclusion that an orbital spacing plan for 17/24 GHz BSS should not start from a premise of collocation with existing U.S. DBS slots.

Accordingly, DIRECTV believes that the Commission should allow such collocation only in those instances where an applicant controls both DBS and 17/24 GHz BSS satellites at a particular location. Even in such a case, the applicant should be required to show (1) that it has the consent of any other DBS licensee at the same nominal location, and (2) its ability to maintain sufficient margin in DBS command links in the presence of the interfering 17/24 GHz BSS signal.[31]

To illustrate this point, the minimum separation distance required between transmitting and receiving satellites in the 17 GHz band under certain baseline assumptions likely to apply in the DBS and 17/24 GHz BSS services has been assessed. While many parameters affect this separation distance, two of the most important are the gains toward the GSO arc of the transmitting and receiving satellite antennas and the desired level of protection for the receiving DBS satellite antenna.

Because collocation of satellites transmitting and receiving in the same band has not previously been an issue, DBS antenna gain at an angle 90 degrees off-axis has not typically been measured. Thus, some educated assumptions must be made about the likely characteristics of such antennas. Figures 2 and 3 below show predicted 17 GHz receive antenna patterns in the equatorial (orbital) plane for a 1.2-meter Gregorian antenna and a 2.8-meter offset antenna, respectively.[32]

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[31] *Id.* at ¶ 78.

[32] These patterns are for CONUS beams, and therefore the beam peaks (not seen in the plots) are approximately 6.5 degrees above the equatorial plane.

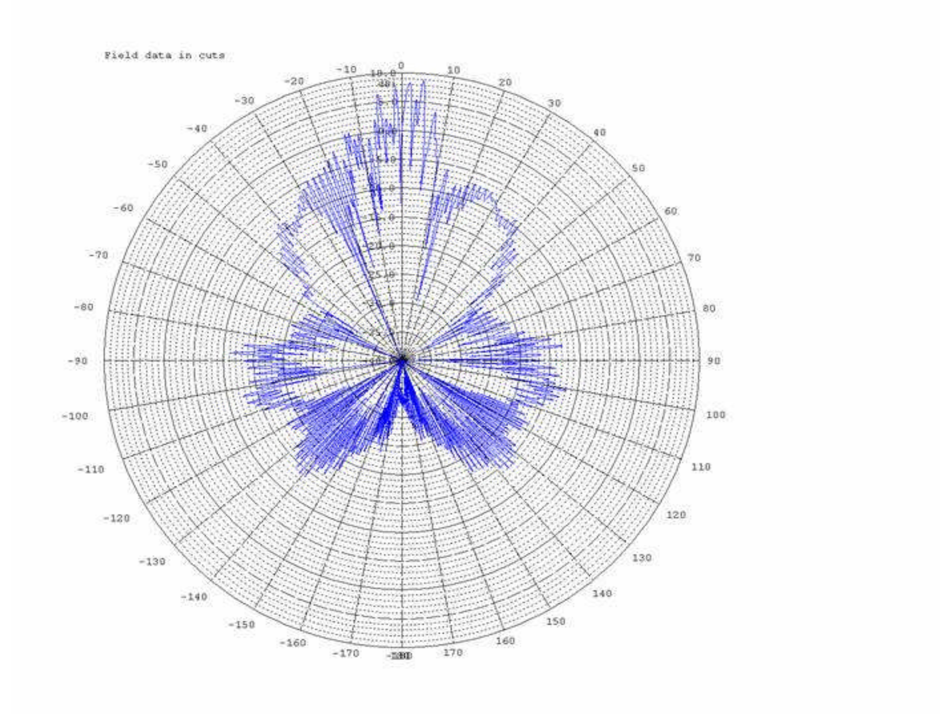

Figure 2. Typical Gregorian 1.2m Satellite Receive Antenna Plot in Orbital Plane, dBi

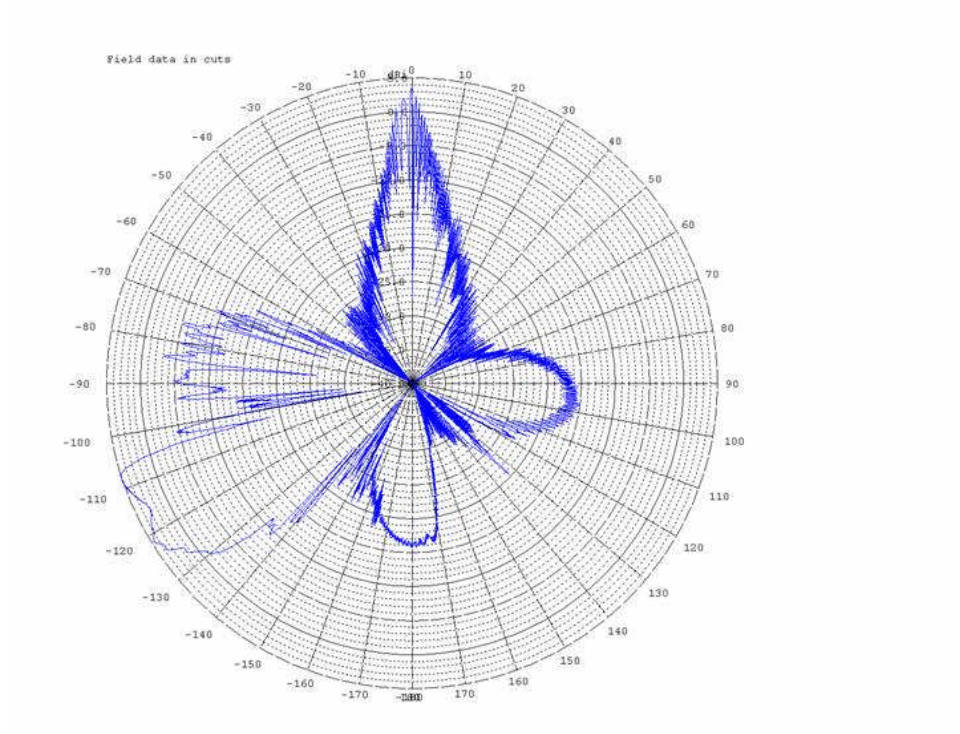

Figure 3. Typical Single Offset 2.8m Satellite Receive Antenna Plot in Orbital Plane, dBi

As shown in these figures, the Gregorian antenna has a ± 90° off-axis gain of about -10 dBi, and the offset antenna has a worst case ± 90°-120° off-axis gain of 5 dBi. These values are used in the parametric analyses in Table 3.

Parameter	**Units**	**Case 1**	**Case 2**
Delta T/T Required	%	6.0	6.0
Io/No Required	dB	-12.2	-12.2
17 GHz Rcv. System Noise Temp	dBK	29.5	29.5
Boltzmann's Constant	dBW/K/Hz	-228.6	-228.6
Noise Power Density (No)	dBW/Hz	-199.1	-199.1
Frequency	GHz	17.5	17.5
Io Max from Transmitting Satellite	dBW/Hz	-211.3	-211.3
17 GHz Satellite TX Power in BW	dBW	26.0	26.0
Sat. TX antenna gain 90 deg. off-axis	dBi	-10.0	-10.0
Sat. RX antenna gain 90 deg. off-axis	dBi	-10.0	5.0
17 GHz rcv. xpndr BW	MHz	24.0	24.0
Isotropic Area	dB-m^2	-46.31	-46.31
Required Spreading Loss	dB/m^2	-97.2	-112.2
Minimum Separation Distance	km	20.35	114.42
Minimum Separation Distance	**Orbital Deg.**	**0.04**	**0.24**
Wanted PFD at satellite	dBW/m^2/BW	-86.0	-86.0
Wanted PFD density	dBW/m^2/Hz	-159.8	-159.8
Sat. RX ant. Gain	dBi	35.0	35.0
Wanted receive power density	dBW/Hz	-171.1	-171.1
C/I	dB	40.2	40.2

Table 3. Required Orbital Separation based on Satellite-to-Satellite Interference

Table 3 above presents two cases illustrative of satellite-to-satellite interference in the 17 GHz band. Case 1 presents the case in which the off-axis gain of both the transmit and receive antennas is -10 dBi. Case 2 presents the case in which the transmit antenna off-axis gain is -10 dBi, but the receive antenna off-axis gain is 5 dBi. The remaining parameters are the same for both cases, including the use of a conservative protection criterion ($\Delta T/T$ = 6%, based on a system temperature of 900K) and an interfering transmit power for the 17/24 GHz BSS satellite of 400 Watts after associated output losses.

Based on this illustrative analysis, it appears that it may be possible to locate a 17/24 GHz BSS satellite within a few tenths of a degree of a DBS satellite, especially if proper care is taken in the design of the 17/24 GHz BSS transmit antennas. However, it is important to note that this analysis illustrates just two cases of satellite-to-satellite interference in the 17 GHz band based on a strict interference limit of 6% $\Delta T/T$. Assuming a different value for this limit, along with various off-axis gains of the transmit and receive antennas, can produce a wide range of required orbital separations. DIRECTV submits that, given the uncertainties involved, the best option is to allow only those operators that control satellites in both bands at a given slot – who can "self-coordinate" their transmissions – to operate DBS and 17/24 GHz BSS satellites in close proximity. Moreover, in order to mitigate potential interference from satellites that have yet to be designed, the Commission may wish to consider adopting a strict off-axis gain specification for 17/24 GHz BSS satellite transmit antennas intended to be located within a certain distance of a DBS satellite.

VII. Spectrum Issues

A. International Coordination

The Commission requests comment on the interplay between the service rules adopted in this proceeding – including any orbital spacing requirement – and the process for international coordination of space station operations.[33] As the Commission is well aware, ITU filings are a poor indicator of the true intent to launch a satellite in a specific

[33] *See BSS NPRM* at ¶ 37.

frequency band to a specific orbital location. In some cases, a change in a company's business plans or in the general economic environment leads to abandonment of an earlier proposal. Unfortunately, there are also a large number of ITU filings made purely for the purpose of regulatory arbitrage with no serious intent to develop the slots for which filings are made. For example, Luxembourg recently submitted 85 APIs spanning the entire GSO arc around the globe that laid claim to virtually all satellite bands from 235 MHz to 120 GHz. These APIs duplicated a similar tranche filed by Luxembourg in February 2005, which will expire early next year. There is no basis to expect that all of these filings will actually be brought into use through the launch of a space station operating in the target bands. Accordingly, there is no reason to preclude the Commission from issuing a license to operate at an orbital location simply because it is covered by an ITU filing from another administration.

As discussed above, DIRECTV favors both four-degree orbital spacing and a first-come, first-served processing regime. To the extent an operator is the first to file an application for a slot consistent with the four-degree spacing regime – or revises an existing application to achieve such consistency – the Commission would be in a position to grant that application, assuming that the applicant is otherwise qualified. If the operator seeks a license from the Commission at a location where the United States has ITU priority, or if the operator seeks market entry from a location that is available (*i.e.*, for which there is no existing U.S. licensee or application pending at the Commission) and for which it has been licensed by another administration that enjoys ITU priority, the case is easy. Yet, perhaps in recognition that most ITU filings will not be brought into use, the Commission has adopted a policy of granting authorizations subject to international coordination even in cases where the applicant does not have ITU priority, so long as the applicant meets the Commission's licensing requirements.[34] DIRECTV sees no reason why that policy should not be used in this context as well.

It is worth bearing in mind that, under DIRECTV's approach, only those orbital locations between 83° W.L. and 123° W.L. would be subject to the presumption of four-degree spacing. An operator seeking to use any location outside that forty degrees of the geostationary arc would be free to propose something different, so long as it did not affect compliant systems operating within the restricted portion of the arc.

B. Domestic Coordination

As noted in the *BSS NPRM*, a number of domestic spectrum users also present potential coordination issues. First, the 17/24 GHz BSS uplink band is shared on a co-primary basis with the terrestrial 24 GHz Fixed Service ("24GFS") in the 25.05-25.25 GHz portion of the band. Second, U.S. government radiolocation systems operate on a primary basis in the 15.7-17.3 GHz band, which is adjacent to the 17/24 GHz BSS uplink band. Third, U.S. government radionavigation systems are co-primary in the 24.75-25.05 GHz band under the domestic allocation (though secondary under the Region 2 allocation). Fourth, U.S. government radiolocation systems operate on a secondary basis in the 17.3-17.7 GHz band at specific geographic locations within the United States. The *BSS NPRM* requests comment on sharing of these bands among the assigned services.

<u>Sharing with co-primary terrestrial 24GFS</u>. 17/24 GHz BSS feeder link earth stations share a co-primary allocation in the 25.05-25.25 GHz band with 24GFS systems,

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34 *See, e.g., Telesat Canada*, 15 FCC Rcd. 24828, 24834 (Int'l Bur. 2000) ("As an initial matter, we agree with Telesat that it is not necessary to complete international coordination before a satellite system can be authorized to provide service in the United States," when domestic coordination has been completed).

which consist of a fixed main (nodal) station and one or more fixed user terminals and provide fixed point-to-point, point-to-multipoint, or multipoint-to-multipoint communications.[35] 24GFS systems are authorized on a geographic license basis under which the country is divided into 176 Economic Areas ("EAs"). There are also licenses in this band that resulted from the relocation of the Digital Electronic Message Service ("DEMS") from the 18 GHz band, which are assigned to the much smaller Standard Metropolitan Statistical Areas ("SMSAs"). As the *BSS NPRM* notes, this geographic licensing creates the prospect that additional nodal stations and user terminals will be deployed within the licensed areas in the future.[36]

In order to gauge the potential for coordination issues, DIRECTV has examined the Commission's Universal Licensing System database to identify the licensed areas of current DEMS and 24GFS licensees. The results of this examination are shown in Figure 4 below, which outlines in blue any EA in which a DEMS or 24GFS system is licensed.[37] As is plainly evident from this analysis, there are large portions of the country where none of these systems are licensed to operate. Because only a limited number of BSS feeder link earth stations will be deployed in the band, it should be possible to locate them in areas outside of these licensed areas, or at a minimum to avoid urban areas with high density 24GFS/DEMS deployment.

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35 *See* 47 C.F.R. § 101.3.

36 *See BSS NPRM* at ¶ 91.

37 For purposes of this analysis, we have made the simplifying assumption that a DEMS SMSA license covers the entire EA in which it is located. However, only seven EA licenses were actually issued as a result of the 24GFS auction in 2004, so the vast majority of these EAs are only partially encumbered with terrestrial licenses.

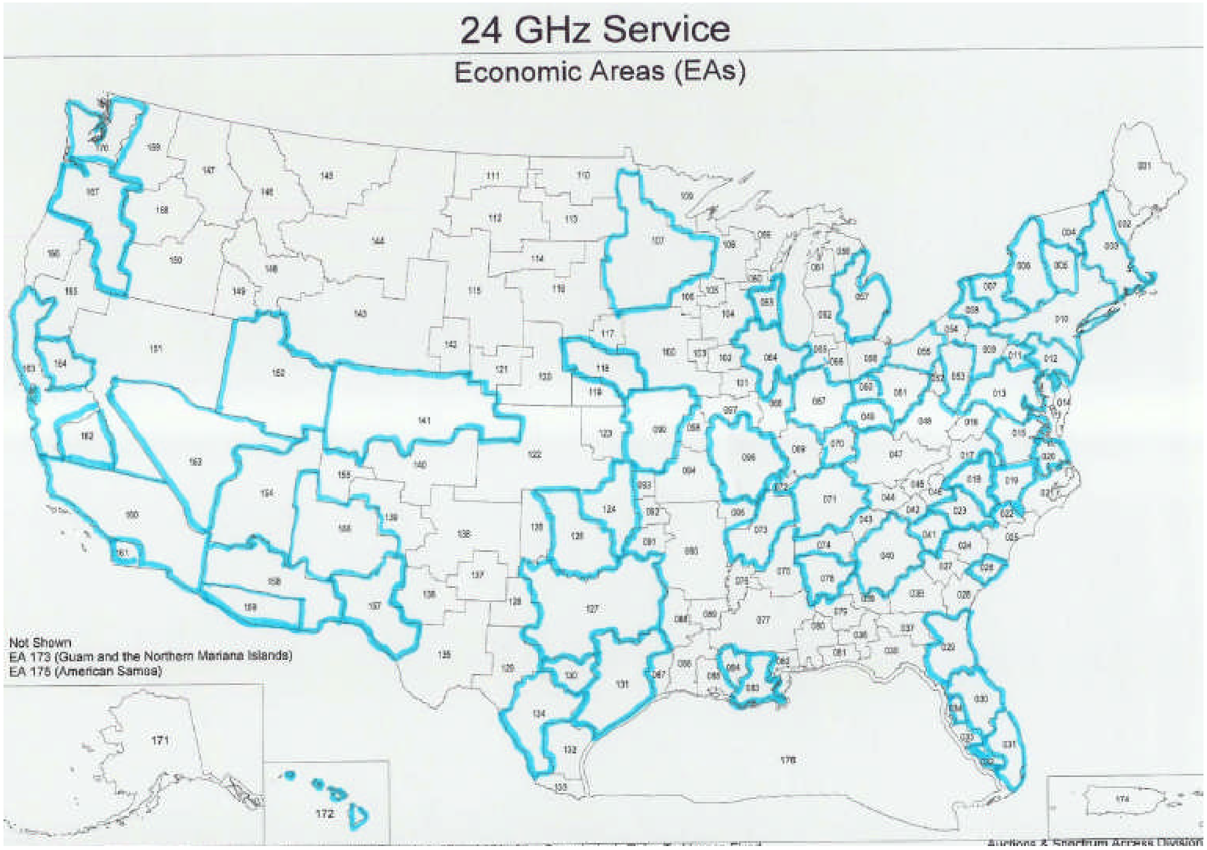

Figure 4. 24 GHz Fixed Service and DEMS Licensed Areas

As noted in the *BSS NPRM*, the Commission has well-developed procedures for coordination between satellite earth stations and terrestrial fixed operations that share equal rights to spectrum.[38] Combined with the power limits and antenna pattern requirements imposed on FSS earth stations operating in this band,[39] these procedures should provide sufficient protection to 24GFS and DEMS systems, just as they have done in other bands for years. However, DIRECTV submits that in this particular case, an additional presumption would be appropriate. Specifically, Section 101.509 includes the Commission's recommendation that coordination between terrestrial systems in this band

[38] *See* 47 C.F.R. § 25.203.

[39] *See id.* at §§ 25.204, 25.209.

licensed to operate in adjacent service areas is not necessary if the PFD at the boundary of the relevant adjacent area is lower than -114 dBW/m^2 in any one MHz.[40] DIRECTV proposes that the Commission adopt this same PFD as a coordination threshold such that 24GFS/DEMS sites located outside the -114 dBW/m^2 contour around a 17/24 GHz BSS feeder link earth station would be deemed to be not affected. Sites located within this contour would only be considered to be affected if a more detailed study that more accurately reflects the interference geometry indicates that the -114 dBW/m^2 PFD level is actually exceeded with respect to such site.[41]

Sharing with adjacent band government radiolocation systems. The *BSS NPRM* notes the potential for interference to 17/24 GHz BSS consumer receive antennas from high-power government airborne radar systems operating just below 17.3 GHz, and asks for an analysis of this interference and potential mitigation strategies.[42] Based on the information currently available, DIRECTV has prepared an analysis of this potential interference, which is set forth in the Appendix attached to these comments. As shown in that analysis, these radar systems can cause significant interference to 17/24 GHz BSS consumer antennas under certain conditions, but those conditions appear unlikely to exist for the vast majority of the time in most areas. Nonetheless, DIRECTV encourages the Commission to initiate and facilitate discussions between industry and NTIA to get further information on these radar systems in order to develop both a better appreciation for their interference potential and optimal strategies for addressing those concerns.

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40 *See id.* at § 101.509(e).

41 The Commission's rules reflect its expectation that "[l]icensees should be able to deploy with a PFD up to -94 dBW/m^2 in any 1 MHz at the boundary of the relevant adjacent areas without negatively affecting the successful operations of the adjacent area licensee." *Id.*

42 *See BSS NPRM* at ¶¶ 94-98.

Sharing with co-primary in-band radionavigation systems. Although 17/24 GHz BSS is the lone service in the 24.75-25.25 GHz band with a primary allocation internationally, the domestic table of allocations affords co-primary status to the radionavigation service. The Commission indicates that there are no government radionavigation systems currently operating in the 24 GHz band. It is not possible for DIRECTV to assess and comment on the levels of interference that would be caused to undefined future radionavigation systems by 17/24 GHz BSS feeder link transmissions. However, we would note that such feeder link earth stations are likely to be relatively few in number, isolated in location, and limited in off-axis gain (due to the large size of the antennas). Accordingly, for the reasons discussed in the Appendix, the risk of interference into government radionavigation operations should be fairly limited in scope. Moreover, because information on 17/24 GHz BSS earth stations will be publicly available (unlike information on government radar systems), government operators should be able to take them into account in determining operational strategies.

Sharing with secondary in-band government radiolocation systems. The domestic table of frequency allocations affords secondary status to government radiolocation systems operating in the 17.3-17.7 GHz band. According to the *BSS NPRM*, numerous types of radiolocation stations have been operated in this band, including ship, ground and airborne equipment, and there may be future systems in this band as well.[43] In addition, NTIA has stated that "it anticipates continued operation of Federal radiolocation systems in certain portions of the 17.3-17.7 GHz band, in a limited number of geographic areas after April 1, 2007," and the *BSS NPRM* indicates that such continued operations

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43 *Id.* at ¶ 99.

may have to be accommodated.[44] However, unlike the airborne radiolocation systems operating below 17.3 GHz, there is no information on the characteristics of these systems, other than the fact that historically they have operated over limited geographic areas.

Given this lack of information, it is not possible for DIRECTV to assess and comment on the levels of interference that would be caused by current (and undefined future) radiolocation systems to 17/24 GHz BSS consumer receive antennas. However, for the reasons discussed in the Appendix, we would expect that these radar systems can cause significant interference to 17/24 GHz BSS consumer antennas under certain conditions, but that those conditions would be unlikely to exist for the vast majority of the time in most areas. To the extent NTIA or other government agencies could provide any information on these systems, further evaluation of such data would be appropriate.

C. 17.7-17.8 GHz Usage

The Commission has made two proposals in the *BSS NPRM* that would give operators more flexibility in their use of spectrum. First, only 400 MHz of the 500 MHz allocated internationally for BSS service in this band has been allocated to 17/24 GHz BSS for use in the United States. DIRECTV supports the Commission's proposal to permit operators to use the international BSS allocation in the 17.7-17.8 GHz band for international services.[45] Other countries may not have allocated this spectrum to other services, or may have assigned them different priority or coordination status.[46] In

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[44] *Id.* at ¶ 100.

[45] *Id.* at ¶ 31.

[46] For example, this spectrum is protected for use by BSS systems in Mexico. *See* Cuadro Nacional de Atribución de Frecuencias Mexico 1999, footnote MEX181 (available at www.cft.gob.mx/cofetel/html/agitec/cuadro/nacionalghz.html).

countries where this spectrum is available for BSS use, there is no reason to preclude a U.S.-licensed satellite from providing it (subject to local licensing requirements).

In addition, DIRECTV submits that operators should be able to use the 17.7-17.8 GHz band for domestic BSS services on a non-protected, non-interference basis. There is very little chance that downlink transmissions from a 17/24 GHz BSS satellite would cause interference to the much stronger transmissions of the terrestrial services operating in this portion of the band, particularly if the satellite downlink transmissions meet the PFD limits already established in Article 21 of the ITU Radio Regulations for FSS systems operating in the 17.7-19.7 GHz band.[47] And in areas where an operator determines there is little terrestrial use of this spectrum, there is no reason to require that this spectrum remain fallow by precluding its use for the provision of video programming to consumers. Given the capacity constraints faced by existing direct-to-home satellite services, the unavailability of 100 MHz of this band could unnecessarily handicap an operator's ability to provide a robust and competitive video service.[48]

Second, at present, the Commission's rules limit use of the 24.75-25.25 GHz band to feeder links for BSS satellites operating in the 17.3-17.7 GHz band.[49] The Commission proposes to make this spectrum available for use by feeder links operating

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47 *See* ITU Radio Regulations, Table 21-4.

48 Although the Commission six years ago declined to create a secondary allocation for 17/24 GHz BSS system in this portion of the band, it also stated that it would "re-examine this issue in the future when the needs of operators are clearer." *Redesignation of the 17.7-19.7 GHz Frequency Band, Blanket Licensing of Satellite Earth Stations in the 17.7-20.2 GHz and 27.5-30.0 GHz Frequency Bands, and the Allocation of Additional Spectrum in the 17.3-17.8 GHz and 24.75-25.25 GHz Frequency Bands for Broadcast-Satellite Service Use*, 16 FCC Rcd. 19808, 19823 (2001).

49 *See* 47 C.F.R. § 2.106, footnote NG 167.

with BSS satellites in other bands, such as DBS.[50] The flexibility to use this alternative uplink spectrum could be useful in avoiding ground path interference problems associated with reverse band operations in the DBS uplink band (17.3-17.8 GHz). For example, a DBS operator might be able to use the 24.75-25.25 GHz band for its uplink transmissions from a site where the density of 17/24 GHz BSS subscribers would preclude the use of the traditional DBS uplink band.

However, as discussed above, feeder link earth stations operating in this band face the challenges of sharing spectrum with co-primary commercial and government systems. It is also worth noting that 17/24 GHz BSS operators will likely require more uplink locations than has been necessary for traditional DBS operators. Because of the greater atmospheric attenuation at this higher frequency, it will likely be necessary to deploy diversity sites for each feeder link, just as DIRECTV has done in the nearby Ka-band. This effectively doubles the number of feeder link earth stations compared to the number used for DBS, and thus could significantly increase the potential burden on system sharing the band. Accordingly, while access to this spectrum could ameliorate coordination difficulties in appropriate cases, the Commission should carefully weigh the offsetting disadvantages of increased interference in this band.

VII. Other Technical Requirements

A. TT&C

As in the early days of DBS, there are at present no ground facilities to support 17/24 GHz BSS operations either in the U.S. or elsewhere around the world. Although it is reasonable to anticipate that such facilities will begin to be deployed in ITU Region 2

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50 *See BSS NPRM* at ¶ 69.

after the BSS spectrum allocation becomes effective in April 2007, it is safe to say that a reliable network of earth stations will likely not be available over a widespread area for quite some time. In similar circumstances involving the nascent DBS and Ka-band services, the Commission has recognized that strict adherence to the requirement of Section 25.202(g) that TT&C functions be conducted at either or both edges of the licensed band would not serve the public interest. Thus, operators have been granted waivers on a case-by-case basis such that they are authorized to conduct TT&C in more established bands.[51] DIRECTV believes that a similar approach should be used for the 17/24 GHz BSS service, such that applicants must demonstrate the need for using other frequency bands and that such operations have been coordinated with any other operator licensed to use that frequency band at the relevant orbital location.[52] Assuming such a showing, the restrictions of Section 25.202(g) should be waived routinely.

However, because the 17.3-17.7 GHz band has not been allocated for use by BSS satellites outside of Region 2, there is no reason to expect that earth station facilities capable of receiving 17/24 GHz BSS satellite telemetry will be deployed in any other region of the world. This is particularly of concern during (1) the initial phases of launch and transfer orbit, when the satellite is transiting through a large portion of the sky, and (2) on-station emergencies, when the satellite has lost earth lock and is searching for a signal. During these critical, short-term mission phases, it is imperative that the satellite be able to establish contact with as many diverse earth station sites as possible. The

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51 *See, e.g., Astrolink Int'l LLC*, 15 FCC Rcd. 23738, 23741 (Int'l Bur. 2000) (authorizing extended C-band TT&C on Ka-band satellite); *Directsat Corp.*, 11 FCC Rcd. 22375 (Int'l Bur. and OET 1996) (authorizing C-band TT&C on DBS satellite).

52 Use of the guard band used by DBS operators for TT&C should only be permitted where the same entity controls both the DBS and 17/24 GHz BSS spacecraft at the orbital location. *See BSS NPRM* at ¶ 84.

Commission has recognized that, as opposed to on-station TT&C, the use of more established satellite bands solely for these purposes is a "relatively short-term" function, and consequently has been amenable to evaluating requests to use FSS frequencies for these purposes for other nascent bands.[53] Accordingly, DIRECTV submits that, for the foreseeable future, all 17/24 GHz BSS space stations should presumptively be allowed to use other, more established frequency bands for TT&C for these purposes so long as they are able to coordinate such use with potentially affected operators.

B. Channelization and Polarization

For the most part, there is no need to impose a standardized convention for polarization, bandwidth, or center frequency for 17/24 GHz BSS operations.[54] However, consistent with the preferences expressed in the pending applications, DIRECTV supports a requirement that all downlink transmissions from any particular orbital location have the same type of polarization – *i.e.,* either all circular or all linear. DIRECTV also supports a full frequency re-use requirement.[55] Valuable orbital and spectrum resources should be put to intensive use, and this requirement helps ensure that they can be.

The Commission seeks comment on the need for a cross-polarization requirement for the 17/24 GHz BSS service, recognizing that in order to achieve full frequency re-use, some degree of polarization isolation is necessary.[56] Cross-polarization interference can

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53 *See, e.g., EchoStar Satellite L.L.C.*, 20 FCC Rcd. 4281 at ¶ 8 (Int'l Bur. 2005) (granting authority to use Ku-band frequencies for TT&C on Ka-band satellite); Public Notice, Rep. No. SAT-00287, 20 FCC Rcd. 8173, 8175 (Int'l Bur. 2005) (grant stamp of similar request by EchoStar).

54 *See BSS NPRM* at ¶ 88.

55 *See id.* at ¶ 89.

56 *Id.* at ¶ 90.

result from either ground terminal or spacecraft polarization imperfections, or from atmospheric effects such as rain. Cross-polarization interference is almost entirely an intra-system design issue and generally does not affect inter-system coordination.

The Commission requires that all FSS and DBS space stations be designed to provide a minimum 30 dB cross-polarization isolation in the primary coverage area.[57] However, in both its DBS and Ka-band operations, DIRECTV has found that this level is higher than really necessary given recent advances in digital transmission technology. For example, use of digital modulation with forward error correction coding on both polarization senses reduces the system sensitivity to cross-polarization interference. Typically, DIRECTV optimizes polarization isolation, directivity and antenna implementation losses to yield the best overall performance. The expected level of cross-polarization isolation and resulting cross-polarization interference accounts for a small fraction of the overall total link noise. When all of these factors have been considered, DIRECTV has found that a minimum isolation of 27 dB is more than sufficient to avoid excessive levels of intra-system interference.

The Commission has often waived the cross-polarization requirement to allow systems to operate with 27 dB isolation, or even less.[58] There is no need to impose an

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57 *See* 47 C.F.R. §§ 25.210(i), 25.215.

58 *See, e.g., Hughes Communications, Inc.*, Stamp Grant, File No. SAT-MOD-20050523-00106, at condition 9 (granted Jun. 30, 2006) (waiving the cross-polarization isolation requirement when antennas were designed to meet a cross-polarization isolation requirement of 23 dB); *DIRECTV Enterprises, LLC*, Stamp Grant, File No. SAT-LOA-20041122-00210, at condition 3 (granted Mar. 18, 2005) (waiving requirement for Ka-band satellite designed to meet minimum requirement of 27 dB); *New Skies Satellites N.V.*, 17 FCC Rcd. 10369 (Int'l Bur. 2002) at ¶ 19 (waiving cross-polarization isolation requirement where deviation was limited to a portion of the coverage area and isolation was 25-30 dB, with typical isolation better than 27 dB).

exacting standard here, when doing so clearly is not necessary to providing quality BSS service to consumers.

IX. SHVA Statutory Copyright License

Because 17/24 GHz BSS operators will provide a service very similar to DBS, one would expect that such service will include the provision of local and distant broadcast signals just as current DBS operators offer. However, it is not entirely clear that the statutory copyright licenses under which such signals are currently retransmitted would cover such retransmission by 17/24 GHz BSS operators.

Sections 119 and 122 of the Copyright Act make available a statutory license for secondary transmissions of distant and local broadcast signals, respectively, by a "satellite carrier."[59] The term "satellite carrier" is defined for both provisions in Section 119(d) of the Copyright Act as an entity that uses the facilities of a satellite or satellite service licensed by the Commission and operates in the FSS or DBS to provide point-to-multipoint distribution of television station signals, and that owns or leases a capacity or service on a satellite in order so provide such distribution.[60] The 17/24 GHz BSS service clearly is not what the Commission has traditionally referred to as "DBS," which operates in a different downlink band.[61]

However, while the downlink for 17/24 GHz BSS falls under a BSS allocation, the uplink is actually under an FSS allocation. Accordingly, the statutory license could be construed to cover 17/24 GHz BSS because it "operates" in the FSS as part of the

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59 *See* 17 U.S.C. §§ 119, 122.

60 *See id.* at § 119(d)(6) (incorporated by reference in 17 U.S.C. § 122(j)(3)).

61 *See* 47 C.F.R. §§ 25.201, 25.202(a)(7) (defining DBS service as operating in the 12.2-12.7 GHz band Space-to-Earth).

overall provision of service to subscribers. This is a permissible reading of the statute, and makes the most sense from a policy perspective in that it gives similar rights to similar services, furthering the apparent legislative intent. In order to avoid any confusion, the Commission should provide an authoritative construction of the statute to clarify this point so that all operators can proceed without fear of potential copyright violation. Alternatively, the Commission could amend its definition of "DBS" to include the use of the 17/24 GHz BSS downlink band.

Assuming that the statutory license of Section 122 is applicable, certain other requirements for carriage of broadcast stations must also be observed. For example, each satellite carrier that retransmits broadcast signals pursuant to Section 122 is subject to the "carry one, carry all" requirements of the Communications Act, and the Commission does not have the authority to waive this statutory mandate.[62] Similarly, each satellite carrier with more than five million subscribers has certain obligations for retransmitting broadcast signals in Alaska and Hawaii.[63] Any 17/24 GHz BSS operator that accepts the advantages of the statutory copyright license must also accept the responsibilities that come along with it.

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[62] *See* 47 U.S.C. § 338(a)(1).

[63] *See id.* at § 338(a)(4); *see also Implementation of Section 210 of the Satellite Home Viewer Extension and Reauthorization Act of 2004 to Amend Section 338 of the Communications Act*, 20 FCC Rcd. 14242 (2005).

CONCLUSION

The 17/24 GHz BSS band presents a golden opportunity to make even more intensive use of valuable spectrum/orbital resources and thereby enhance the ability of satellite systems to provide robust multichannel video programming services. DIRECTV believes that adoption of the flexible yet streamlined approach outlined in these comments would best serve the public interest by encouraging and accelerating deployment of 17/24 GHz BSS systems.

Respectfully submitted,

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October 16, 2006

APPENDIX

As noted in the *BSS NPRM*, the Radiolocation Service is allocated on a primary basis in the 15.7-17.3 GHz band in the domestic table of allocations. Military services are reportedly the largest users of this band, having made a considerable investment in a large number of radar systems, including numerous high-powered synthetic aperture radars ("SARs") that operate near the band edge adjacent to the lower edge of the 17/24 GHz BSS band. The *BSS NPRM* requests comment on potential interference concerns arising from these operations.[1]

Generalized, Worst-Case Analysis

In order to assess the potential extent of such interference, we begin by making an initial estimate of the worst-case scenario, using the technical details for these SAR systems provided in Appendix C of the NPRM. For this purpose, we assume a simplified interference geometry, with an aircraft flying at a nominal altitude of 4500m[2] and transmitting pulses at the maximum peak power levels indicated in Appendix C. We further assume a peak BSS satellite per carrier EIRP of 60 dBW, which is representative of what could be expected for such systems.

As shown in Figure 1, this peak SAR power, when added to the nominal antenna gain, results in peak EIRP levels of 44.6 dBW and 73.1 dBW for the low- and high-power radar systems, respectively. It is relatively straightforward to compute the worst case C/I_{peak} for this adjacent band interference scenario, which in this case is on the order of -61 dB and -89 dB for the low-power and high-power radar cases, respectively. This

1 *See BSS NPRM* at ¶¶ 96-97.

2 *See* Letter from Frederick R. Wentland to Edmond J. Thomas, Enclosure at 6 (Apr. 8, 2005) ("April 8 NTIA Letter").

represents the case of an airborne radionavigation system illuminating the area containing a subscriber terminal as it flies through the main beam of the subscriber receive terminal. As is shown in the Figure 1, the subscriber terminal would need to have an elevation angle of approximately 50º, but this is not unusual for subscriber antennas in the southern parts of the United States.

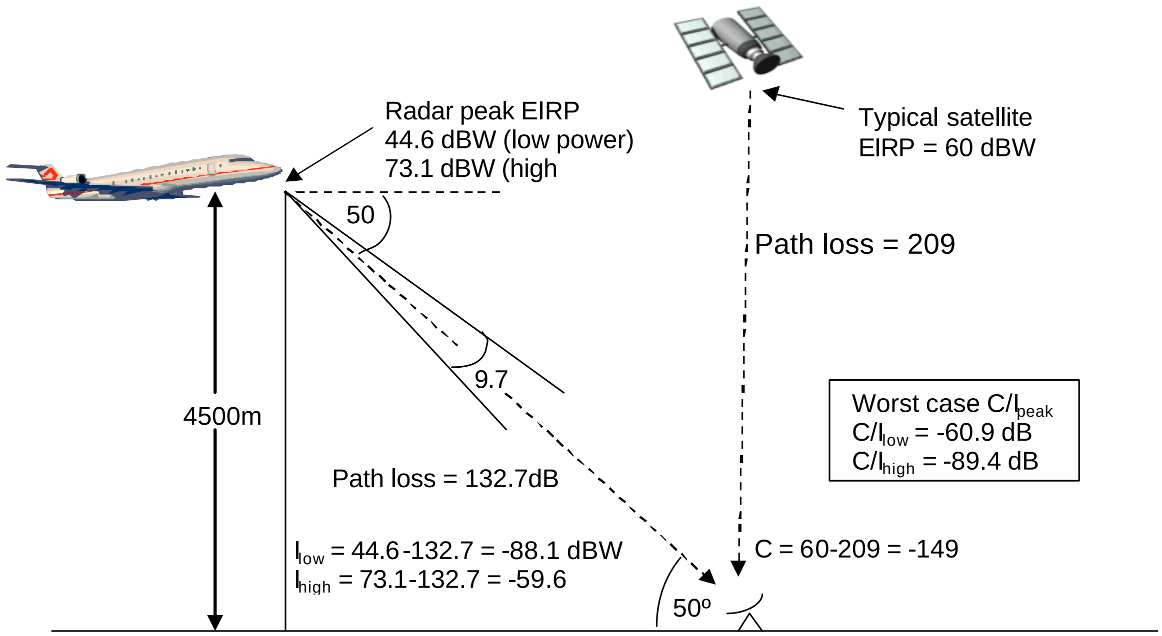

Figure 1. Worst Case Airborne Radar Interference Scenario

It is clear from this simplified, static worst case analysis that such high levels of adjacent band interference would have the potential to overload the front end of the subscriber terminal. While incorporating a front end receive filter into the design of the subscriber outdoor unit ("ODU"), as suggested by NTIA in the NPRM, could help to improve this situation, the magnitude of the improvement and the impact such a filter would have on the overall performance of the receiver requires further investigation. It may also be possible to incorporate a peak limiter into the design of the initial stages of amplification of the ODU to prevent front end damage, albeit at the expense of further degrading the receiver performance. Again, this is an area that would require further study.

Detailed Analysis

Having looked at a simplified worst case situation, we now turn to a more detailed analysis of the potential interference issues. For this purpose, we focus on the high-power airborne radar case (which presents the upper bound of the problem), though obviously a similar analysis could be conducted for the low power radar as well. The analysis covers the four potential interference paradigms: (1) airborne radar-to-subscriber terminal main beam-to-main beam coupling (M-M); (2) airborne radar main beam-to-subscriber terminal sidelobe coupling (M-S); (3) airborne terminal sidelobe-to-subscriber terminal main beam coupling (M-S); and (4) airborne terminal sidelobe-to-subscriber terminal sidelobe coupling (S-S).

In order to perform this more detailed analysis, we have adopted the following assumptions, which we believe likely to be representative of operations in this band:

- ODU antenna 3-dB beam width: 2º (representative of 60 cm receive dish)
- ODU antenna main beam gain: 39 dBi (representative of 60 cm receive dish)
- Sidelobe level of ODU antenna: -30 dB from main beam
- Radar antenna 3-dB beam width: EL=2.5º, AZ=2.2º (System 2 from Appendix C of *BSS NPRM*)
- Radar antenna gain: 38 dBi main beam
- Radar antenna scanning angles:

  Horizontal: ±30º
  Vertical: 0° to 90º about aircraft broadside, left or right side looking

- Aircraft altitude: 4500 m = 14,764 ft

- Nominal 1-D width covered by the 3-dB beam of the radar antenna:

  14,764 ft * ($\cot 48.75^0 - \cot 51.25^0$) = 1,098 ft; this is assumed both along and across the path of flight due to a circular-like antenna pattern

- Sidelobe level of aircraft antenna: - 30 dB from main beam

- 17/24 GHz BSS transponder frequencies start at just above 17.3 GHz, with a center-to-center frequency spacing of 40 MHz

- Satellite transmission symbol rate of 30 Mbaud

These assumptions create two sectors of 60º by 90º each on both sides of the aircraft that are relevant for analysis, as shown in Figure 2. We also assume that the pointing angle of subscriber antennas within these sectors is equally likely in all directions.

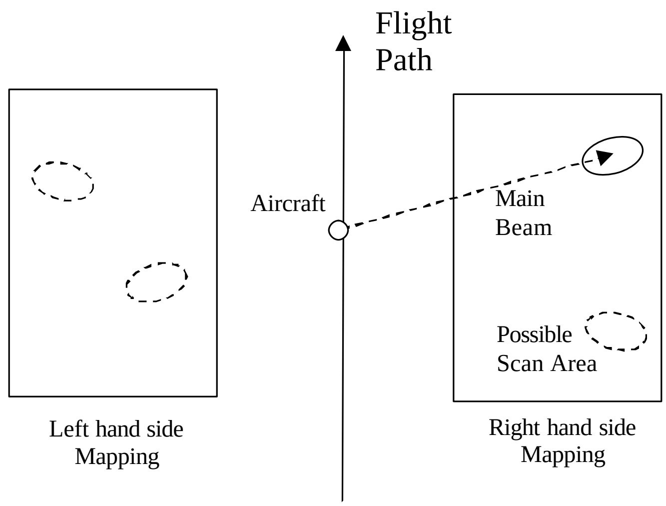

Figure 2. Airborne Radar Antenna Coverage

Figure 3 depicts a more detailed example interference geometry, where the mapping radar is the emitter and the subscriber terminal is the victim receiver. The subscriber terminal always points to the satellite and the airborne radar illuminates the subscriber terminal in this example. The figure assumes a vertical plane that contains the satellite, the ODU and the aircraft. This assumption is convenient for interference calculations; the actual plane would be slanted due to the fact that the radar antenna is side-looking and the subscriber terminal generally has an independent azimuth look angle to the satellite. However, the simplified geometry allows quick calculations with results accurate to within one order of magnitude for simplicity.

As calculated above, the 3 dB radar footprint is approximately 1,098 ft along the direction of flight. The distance between Points A and B in Figure 3 in the aircraft flight path can be similarly calculated to be about 878 ft, assuming that the ODU elevation angle to the satellite is 50°.

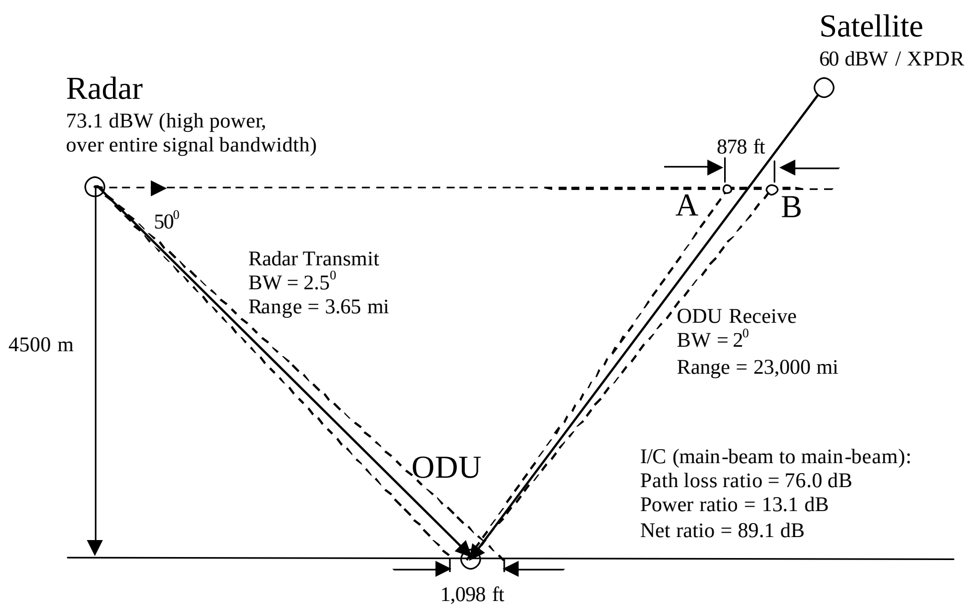

Figure 3. Detailed Example Interference Geometry

The horizon range of the radar in nautical miles can be calculated as $R_{NM} = 1.23\sqrt{h}$, where h is the altitude of the radar in feet. This works out to about 149 nautical miles (or 172 miles) from an aircraft altitude of 4500 m (2.8 mi). The $1/R^2$ factor attenuates the signal at 172 miles by about 36 dB more than that at the nearest range of 2.8 miles.

In order to determine the probabilities of the four interference scenarios, we make the simplifying assumptions that the direction of the ODU main beam is equally likely in the hemisphere above the ODU, and that the direction of the radar beam is equally likely in the hemisphere below the aircraft. The antenna pointing is independent between ODU and radar. With these assumptions, and assuming that an airborne radar is flying in the vicinity of the subscriber terminals being considered, the probability that the airborne radar is illuminating a subscriber terminal, or that the airborne radar is within the main beam of the subscriber terminal, is $p = \frac{q_{AZ} q_{EL}}{8}$, where q_{AZ} and q_{EL} are the azimuth and elevation beam widths of the antenna in radians.[3] For the subscriber terminal, $q_{AZ} = q_{EL} = 2^0 = 0.035\, rad$, and $p_{ODU} = 1.5 \times 10^{-4}$. For the radar, $q_{AZ} = 2.2^0 = 0.038\, rad$, $q_{EL} = 2.5^0 = 0.044\, rad$, and $p_{RAD} = 2.1 \times 10^{-4}$.

With these assumptions and preliminary analyses in mind, we proceed to evaluate each of the four interference scenarios in turn.

Scenario 1: Airborne Terminal Main Beam-to-Subscriber Terminal Main Beam Interference (M-M)

In this scenario, the satellite, airborne radar, and subscriber terminal are collinear and the airborne radar antenna main beam illuminates the subscriber terminal, as shown in Figure 4. (The thick arrow represents the radar main beam.) This also corresponds in Figure 3 to the case in which the airborne radar is between points A and B within the main beam of the subscriber terminal.

[3] This is because the antenna beam covers a solid angle of $\frac{p q_{AZ} q_{EL}}{4}$ steradians, and a hemisphere covers a solid angle of 2π steradians.

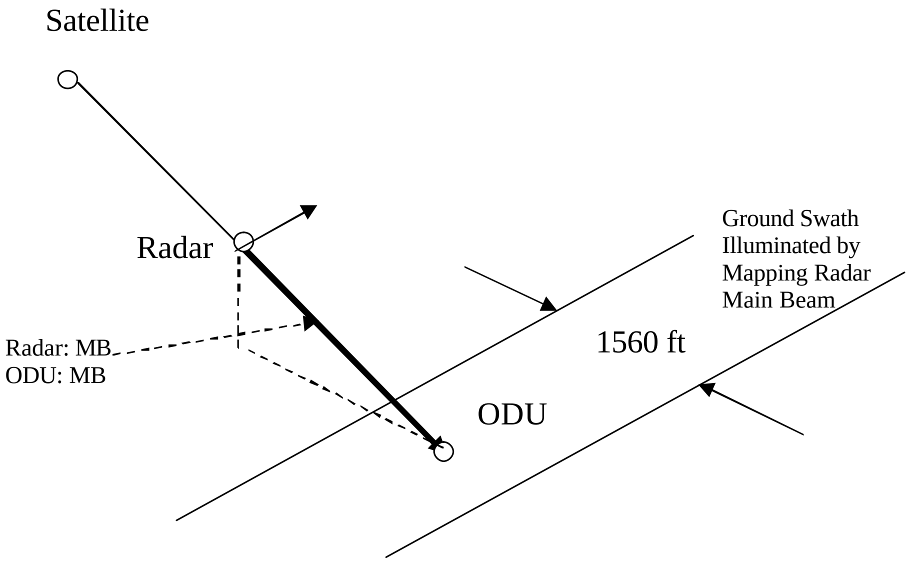

Figure 4. Main Beam-to-Main Beam Interference

The probability of this scenario occurring can be estimated as the joint probability that the aircraft is within the main beam of the subscriber terminal AND the aircraft is illuminating the subscriber terminal. This is simply $p_{ODU}*p_{RAD}= 3.18x10^{-8}$. It is clear that this worst case alignment, while possible, is highly unlikely. When this worst case does occur (and assuming an aircraft speed of 500 feet per second), the airborne radar will stay in the main beam of the subscriber terminal for 878/500 or 1.76 seconds, and the subscriber terminal will stay in the main beam of the airborne radar for 1,098/500 or 2.2 seconds.

Calculations in Figure 1 show that in the M-M interference scenario, the interference to carrier ratio ("I/C") could be as high as 89.1 dB. The airborne radar out-of-band spectral characteristics contained in Appendix C of the *BSS NPRM* dictate a power profile of the interference over frequency, providing a minimum of 20 dB of reduction in power at the edge of the band (*i.e.*, 17.3 GHz). This represents the worst-case co-frequency I/C ratio. Thus, I/C starts at a high of 89.1 dB – 20 dB = 69.1 dB at 17.3 GHz for the first transponder, continues to taper off over the next transponder, and then stays flat at an I/C of 29 dB for the rest of the transponders, as shown in Figure 5. A similar impact applies to the cross-polarized transponders.

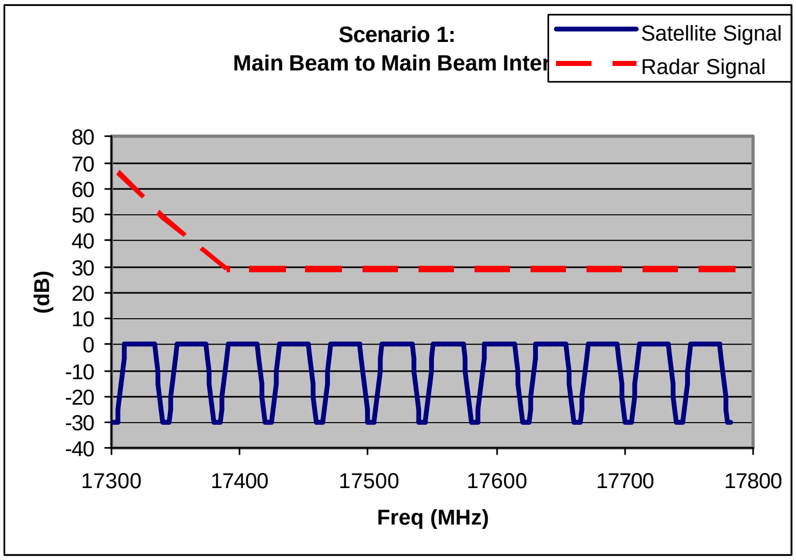

Figure 5. I/C Versus Frequency for Interference Scenario 1

Scenario 2: Airborne Terminal Main Beam-to-Subscriber Terminal Sidelobe Interference (M-S)

Moving away from the absolute worst case analysis of Scenario 1, in this interference scenario the radar antenna points to the ODU, but is off the line of sight of the ODU to the satellite, as shown in Figure 6.

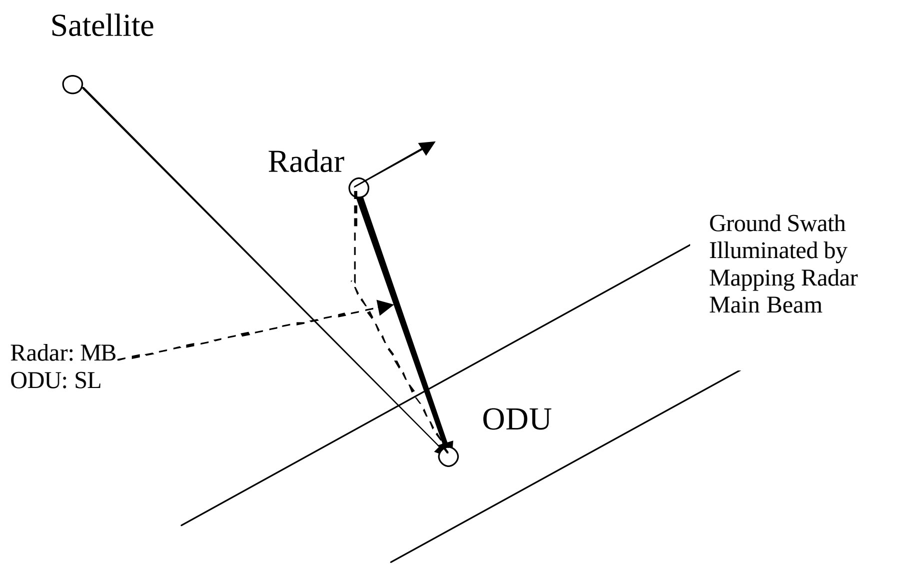

Figure 6. Main Beam-to-Sidelobe Interference

The probability of this case occurring is simply the probability that the subscriber terminal is within the main beam of the airborne radar, or p_{RAD}, which was shown earlier to be $2.1x10^{-4}$. Again, this assumes that an aircraft is within the radio horizon of the subscriber terminal. When this interference situation occurs, the subscriber terminal would remain in the main beam of the radar antenna for 2.2 seconds, assuming an aircraft speed of 500 fps.

Compared with Scenario 1, the worst case I/C in Scenario 2 is reduced by 30 dB (due to the reduced sidelobe gain of the ODU). In particular, I/C at the lower edge of the first transponder would be reduced from 69 dB to 39 dB. The radar interference power would then taper off to an I/C level of -1 dB at the third transponder, and the rest of the 12 transponders would experience an I/C of -1 dB (*i.e.*, interference power is below transponder power), as shown in Figure 7.

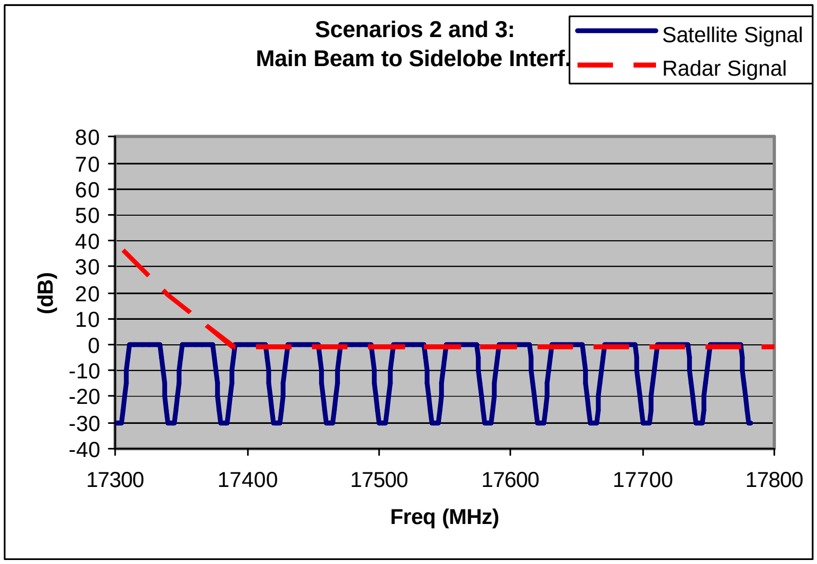

Figure 7. I/C Versus Frequency for Interference Scenarios 2 and 3

Scenario 3: Airborne Terminal Sidelobe-to-Subscriber Terminal Main Beam Interference (S-M)

In this interference scenario, the airborne radar antenna points away from the subscriber terminal, but the radar antenna is in the main beam of the subscriber terminal. This creates a sidelobe-to-main beam interference situation as depicted in Figure 8.

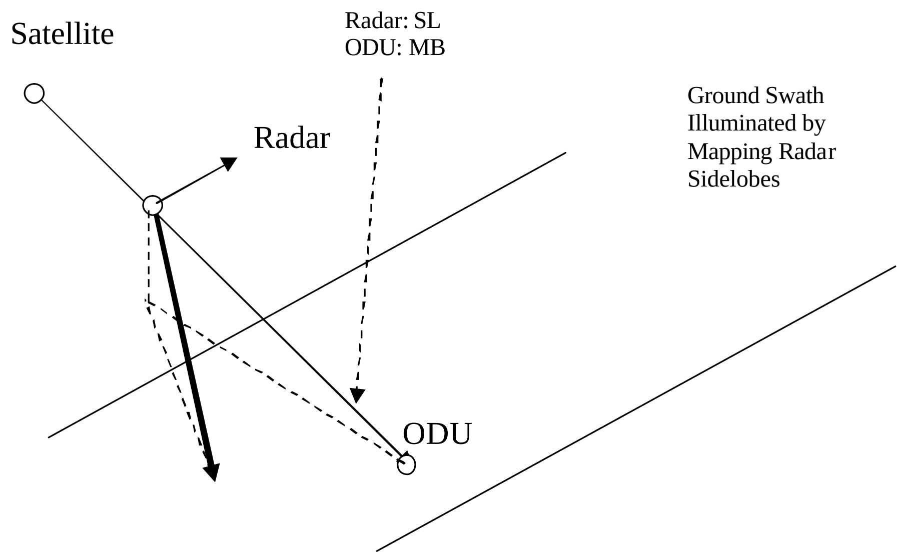

Figure 8. Sidelobe-to-Main Beam Interference

The probability that the airborne radar within the radio horizon of the subscriber terminal is flying within the main beam of that terminal is p_{ODU}, which was shown to be 1.5×10^{-4}. When this interference situation occurs the airborne radar would remain in the main beam of the subscriber terminal for 878 ft / 500 fps or 1.8 seconds, assuming an aircraft flying at 500 fps.

The I/C in this scenario is similar to that for Scenario 2, as the same 30 dB reduction in interference power would occur, albeit for a different reason (*i.e.*, the reduced sidelobe gain of the airborne radar). The interference profile for this scenario is also shown in Figure 7.

Scenario 4: Airborne Terminal Sidelobe-to-Subscriber Terminal Sidelobe Interference (S-S)

In this interference scenario, the airborne radar antenna points away from the subscriber terminal, and is out of the main beam of the subscriber terminal. This results in a case of sidelobe-to-sidelobe interference, as depicted in Figure 9.

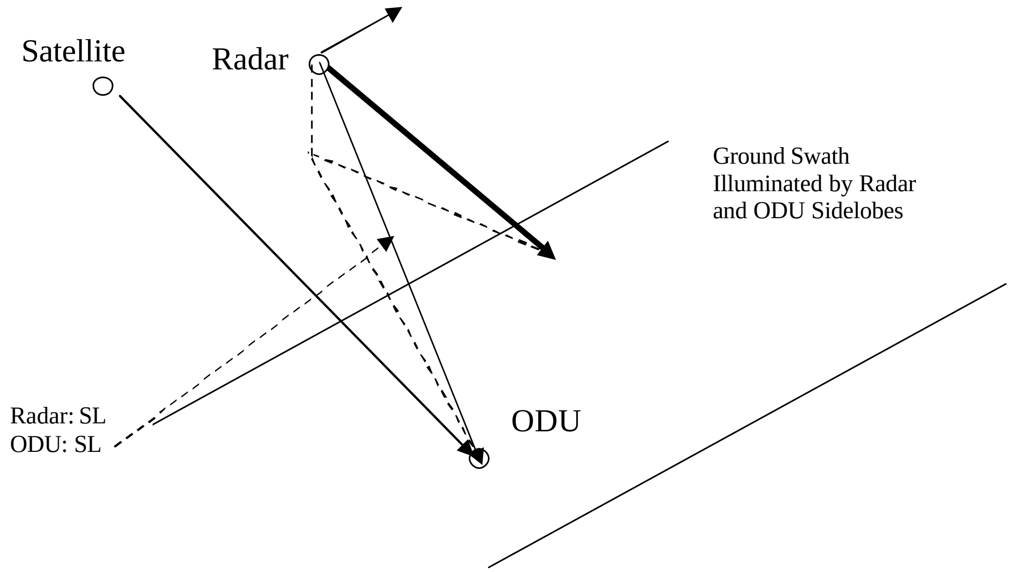

Figure 9. Sidelobe-to-Sidelobe Interference

The probability for this scenario is simply $1 - p_{RAD} \times p_{ODU} - p_{RAD} - p_{ODU} \cong 1$. Accordingly, this will be the interference scenario for the overwhelming majority of the time in which an airborne radar is flying within the radio horizon of a subscriber terminal.

Since the airborne radar antenna sidelobes and the subscriber terminal antenna sidelobes are each assumed to be 30 dB below their respective main beam values, the I/C for this case is improved by 60 dB from Scenario 1, as shown in Figure 10.

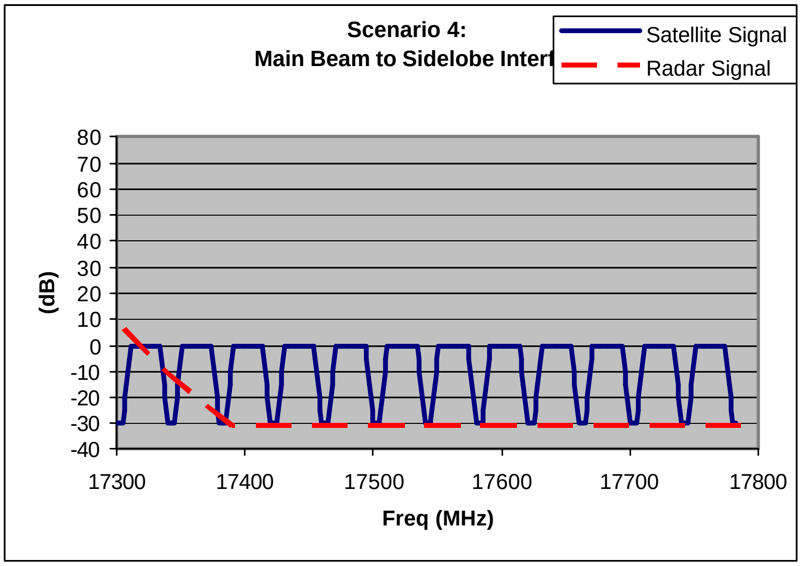

Figure 10. I/C Versus Frequency for Interference Scenario 4

The first transponder can still experience an I/C as high as 9.1 dB, but the next transponder will see a rapid transition to -31 dB, and the remaining 12 transponders will be at the negligible -31 dB I/C level.

GENERAL DISCUSSION OF RESULTS OF ANALYSIS

The *BSS NPRM* indicates that replacement radar systems in the 15.7-17.3 GHz band are expected to have average power at least as high as current systems, but with higher duty cycles and lower peak powers. All of the analysis above is based upon peak pulsed interference levels, and thus any reduction in peak power for replacement systems would help to improve the potential compatibility between adjacent band radiolocation systems and 17/24 GHz BSS subscriber terminals. In order to refine the interference analysis and devise appropriate strategies for mitigation and sharing, the Commission should facilitate a further dialog between industry and NTIA on the possible technical characteristics of future radar systems in this band.

The *BSS NPRM* also cites measurements performed by NTIA[4] on the effects of pulsed co-channel interference on a 4 GHz digital earth station receiver. These results suggest that that use of forward error correction and/or data interleaving in the digital receiver may help to mitigate the effects of pulsed interference considerably. In the cases reported, the 4 GHz digital receiver was able to tolerate pulsed interference levels considerably greater (up to 70 dB in one case) than the desired signal level.

One of the key results in this report, however, implies that the maximum tolerable threshold interference level is tied directly to the ratio of interference pulse length to information symbol length, and that the maximum tolerable interference level increases as this ratio approaches 1. This makes good intuitive sense as well. As the length of the interference pulse approaches the length of a single symbol, only one, or perhaps two, symbols would be lost in the receiver and the error correction would be quite effective at repairing data corrupted in this way. The technical details of Appendix C indicate that the pulse widths for the radars under consideration vary from 18.2 to 443 microseconds. This would equate to symbol rates of approximately 55 kS/s to 2.3 kS/s. The symbol rates of digital BSS systems will be considerably higher than this (on the order or 20 or 30 MS/s), and thus several hundred symbols would be lost to interfering radar pulses. It is unclear at this point whether error correction coding or data interleaving could counteract the loss of such bursts of data, and this would require further study.

The *BSS NPRM* also notes that the 17.3-17.7 GHz band is allocated on a secondary basis to the Radiolocation Service for use by Federal Government systems. It goes on to report that numerous types of ship, ground and airborne radiolocation stations have been operated in this band, and that there may be future systems that seek to operate

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[4] *See BSS NPRM* at n. 216.

in this spectrum on a secondary basis. In addition, NTIA states that, notwithstanding their secondary status, radiolocation systems may have to be accommodated in certain portions of the 17.3-17.7 GHz band at a limited number of geographical locations. Neither NTIA nor the *BSS NPRM* provides any technical details whatsoever for these systems, other than the fact that they are required to restrict their maximum operating power to less than 51 dBW EIRP.

Given this lack of information, it is very difficult to comment upon what measures may need to be adopted to ensure protection of BSS subscriber terminals in the presence of secondary radiolocation systems. It is also quite difficult to comment upon the typical interference scenarios that could occur between BSS subscriber terminals and these radiolocation systems, or what criteria or methods could be specified to accommodate the continued operation of these secondary systems. This problem is further compounded by the fact that the Commission is asking that protection levels be specified for a primary service to define protection from a secondary service, which raises serious regulatory questions and could create a problematic regulatory precedent.

The U.S. Government clearly desires to continue operation of radiolocation systems over a limited portion of the 17.3-17.7 GHz band at specific geographic locations,[5] and it may be possible to adopt case-by-case solutions to accommodate such operations. DIRECTV believes that the best way to make this determination is to have a broader exchange of information between industry and federal government interests in order to develop a more complete understanding of this interference situation.

Finally, as stated in the initial assumptions for all of the interference scenarios analyzed above, this analysis is predicated upon the assumption that the airborne radar

5 *See* April 8 NTIA Letter at 3.

systems are flying within the radio horizon of the BSS subscriber terminals. Clearly, if the airborne radar is outside the radio horizon of the BSS subscriber terminal, no interference will occur to that terminal. Therefore, a dialog between industry and NTIA in which information is shared on the operational scenarios for these radar systems would help tremendously in assessing the potential impact such systems could have on BSS subscriber terminal availability overall and at particular locations.