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

In the Matter of	)	
	)	
Allocation and Designation of Spectrum for Fixed Satellite Services in the 37.5-38.5 GHz, 40.5–41.5 GHz and 48.2-50.2 GHz Frequency Bands; Allocation of Spectrum to Upgrade Fixed and Mobile Allocations in the 40.5 – 42.5 GHz Frequency Band; Allocation of Spectrum in the 46.9-47.0 GHz Frequency Band for Wireless Services; and Allocation of Spectrum in the 37.0-38.0 GHz and 40.0-40.5 GHz for Government Operations.	)	IB Docket No. 97-95

COMMENTS OF TELESAT CANADA

Telesat Canada ("Telesat" or "the Company") respectfully submits the following comments in response to the Third Notice of Proposed Rulemaking (NPRM) in the above-captioned proceeding.[1]

Summary

Telesat supports the Commission's proposal to add a Fixed Satellite Service (FSS) space-to-Earth allocation. Telesat acknowledges that the 37.5 -40.0 GHz and 42.0 – 42.5 GHz bands have been 'soft-segmented' in favor of the Fixed Service (FS) and that ubiquitous FS transmitters can be anticipated. It is therefore appropriate that FSS use of these bands be limited to individually-licensed large aperture earth stations that can be coordinated with the FS on the basis of a power flux density (PFD), rather than a distance, criterion.

Telesat believes that a viable geostationary orbit (GSO) FSS network may be established in the 42.0 – 42.5 GHz band using large aperture gateway earth stations that are sufficiently separated from radioastronomy (RAS) stations to ensure that the internationally adopted protection limits for RAS are achieved. We also support the proposed exclusion of Aeronautical Mobile Service stations from the 40.5 – 42.5 GHz band.

The Commission has requested comments on a number of issues related to compensation for rain fade. Telesat believes that non-power ameliorative measures will significantly impact the viability of FSS networks. Telesat believes that adequate protection will be afforded to FS receivers through the application of PFD limits, which is the keystone applied by the ITU as the basis for international regulation. We urge the Commission not to adopt domestic regulations that are overly complicated, restrictive, possibly impractical, and unnecessary.

[1] FCC 10-186 (Nov. 1, 2010).

Introduction

Telesat is the fourth largest fixed satellite services operator in the world. The Company provides reliable and secure satellite-delivered communications solutions to broadcast, telecom, corporate and government customers. Telesat has a fleet of 12 satellites and three additional satellites under construction. Telesat pioneered commercial domestic satellite communications in the C-band (1972), Ku-band (1980) and Ka-band (2004).

The Company believes that in order to satisfy ever-increasing demand for orbital capacity, lower frequency bands will reach saturation and V-band will be the next FSS band to be developed for the provision of commercial satellite services. As the operator of both FSS and BSS systems, Telesat has an interest in the matters raised in the Notice.

Broadcasting Satellite Service and Broadcasting Service in the 42.0 – 42.5 GHz Band

Telesat concurs with the Commission that the PFD limits contained in footnotes **5.551H** and **5.551I** of the ITU's International Table of Allocations place severe limitations on satellite EIRP towards RAS sites in the 42.0 – 42.5 GHz band. These limitations make the band, in the geographic area of RAS sites, a poor candidate for BSS services, which require high satellite EIRP to permit small antennas to be employed at end user premises.

As the Commission notes, the 42.0-42.5 GHz band has been allocated domestically and internationally for high density applications in the fixed service (HDFS). Consequently, it is likely the band will be used for ubiquitous FS applications that do not require site licensing. These circumstances also make the band challenging for BSS, which has traditionally been a ubiquitous service in which earth stations are not individually licensed. Controlling interference between unlicensed, ubiquitous FS transmitters and BSS receivers would likely have to rely on frequency or geographical segmentation that may not be practical.

For these reasons, Telesat believes that the 42.0 – 42.5 GHz band is unlikely to be extensively used for BSS and, as noted in the following section, should be allocated on a primary basis to the FSS. We note, however, that the RAS and FS are afforded protection through PFD limits and that the proposal to delete the BSS allocation in the 42.0 – 42.5 GHz band, will not afford any additional protection to these services. Accordingly, we see no compelling reason to delete the BSS allocation.

Addition of an Allocation for FSS in the 42.0 – 42.5 GHz Band

There is an FSS allocation internationally in the 42.0 -42.5 GHz band. We believe that sharing between certain FSS applications and both RAS and HDFS will be much easier to effect than sharing between BSS and these services. For example, FSS gateways typically have large diameter antennas and therefore FSS downlink transmissions towards gateways require lower EIRP than is required for BSS. Also, as the Commission correctly notes, V-band satellites are likely to employ narrow spot beams for both service and gateway links. Since the PFD limits of **5.551H** and **5.551I** are applicable at RAS locations, gateways could be sited so that the associated downlink beam could transmit below the PFD limit towards any RAS location. Similarly, as discussed below, gateways could be coordinated for areas where HDFS stations have not been deployed. We do not view the resulting imbalance between Earth-to-space and space-to-Earth allocations as a reason not to extend the FSS (space-to-Earth) allocation. Inter-beam isolation often presents a challenge in the design of multi spot beam satellites, and the additional flexibility afforded by additional downlink spectrum could facilitate satellite design. Telesat therefore supports the addition of a primary FSS allocation in the 42.0 – 42.5 GHz band.

Protection for Radioastronomy Operations in the Adjacent 42.5 – 43.5 GHz Band

For the reasons described below, it should be possible for GSO FSS operations in the 42.0-42.5 GHz band to protect RAS sites in accordance with the limits contained in ITU Radio Regulations **5.551I**. However, these international standards are challenging, and the Commission should avoid imposing limits that are even more stringent.

Telesat has developed V-band GSO FSS link designs based on wideband transponders in the 42.0 – 42.5 GHz band and a beam center EIRP of 73 dBW. Taking into account spectral spreading across the transponder bandwidth and additional attenuation from satellite filtering due to the guardband below 42.5 GHz, the resulting PFD typically falls 5-10 dB above the **5.551I** limit. That is, additional attenuation would need to be achieved by satellite antenna discrimination toward any RAS site.

Annex 1 shows an achievable satellite V-band transmit antenna pattern. In this example, we have assumed an orbital position of 91°W, a center of beam at Winnipeg, Canada, and a frequency of 42.3 GHz. With the further assumptions of an unshaped 0.9m single beam reflector with horn at the focus, the resulting peak gain is 50.6 dBi and the 3 dB beamwidth is 0.5°.

It may be seen from this example that attaining the required satellite antenna discrimination from known RAS sites should be achievable by judicious selection of guardband, beam coverage and therefore location of the receiving FSS earth stations. That is, the protection limits in **5.551I** may be met with a reasonable link budget in the band 42.0 – 42.5 GHz through a combination of filtering and satellite antenna roll-off attenuation. The international protection limits were established following prolonged deliberation and discussion amongst interested parties and Telesat sees no justification to impose more stringent limits domestically. Accordingly, Telesat believes that a viable GSO FSS network may be established over areas sufficiently separated from RAS stations if the international limits of **5.551I** apply.

The epfd limits in **5.551H**, which apply to NGSO networks, are 93 dB (nearly two billion times) more stringent than the PFD limits in **5.551I,** which apply to GSO networks. Given the geometry of NGSO networks, the limits in **5.551H** are statistical (cannot be exceeded more than two percent of the time), whereas those in **5.551I** are deterministic (apply 100 per cent of the time). We do not believe that a viable GSO system could be operated in a way that meets the NGSO limits, as illustrated by the simple example given above.

Telesat agrees with the Commission that Aeronautical Mobile Service (AMS) operations in the 40.5-42.5 GHz band have more potential than other Mobile Service operations to cause in-band interference to FSS earth station and HDFS receivers and to cause out-of-band interference to RAS. We therefore support the exclusion of AMS from the 40.5 – 42.5 GHz band.

Coordination between FSS Gateway Earth Stations and FS Stations in the 37.5 – 40.0 and 42.0 – 42.5 GHz Bands

Telesat acknowledges that the 37.5 -40.0 GHz and 42.0 – 42.5 GHz bands have been 'soft-segmented' such that ubiquitous FS transmitters can be anticipated and the operator of an FSS receive earth station, in order to obtain interference protection, must obtain a Part 101 license or enter into a sharing agreement. Ubiquitous deployment of receive earth stations is not be feasible under these conditions, since such stations would be subject to unpredictable interference. It is therefore appropriate that FSS use of these bands be limited to large aperture earth stations such as gateways, which do not serve individual consumers. Since a relatively small number of such earth stations is needed, site selection may be carefully determined, first to ensure protection of RAS sites, as discussed above, and secondly to minimize the risk of interference from the FS into the earth station.

Coordination between FSS earth stations and FS stations would be better effected using PFD limits rather than using a distance criterion from an FS service area. As the Commission correctly notes, the PFD approach takes into account the attenuation from terrain shielding, and therefore more accurately represents the actual interference situation. Further, taking into account terrain shielding reduces the required separation between FS transmitters and earth station receivers, thus enhancing spectral efficiency. Finally, coordination based on PFD limits is desirable because it would enable the Commission to align its domestic coordination requirements with international obligations resulting from bilateral agreements with Canada. For this reason, the two-tiered PFD limits specified in the bilateral agreements[2] should be applied in a similar manner[3] domestically.

Compensating for Rain Fade of FSS Signals in the 37.5 – 40.0 GHz Band

[2] See http://www.fcc.gov/ib/sand/agree/files/can-nb/24-38fin.pdf at 4.2.1.b
[3] Ibid at 4.2.2, 4.2.3 and 4.2.4

Atmospheric attenuation will be the controlling factor in V-band link design. Telesat believes that adequate protection will be afforded to FS receivers through the application of PFD limits, which is the keystone applied by the ITU as the basis for international regulation. Telesat commends the Commission for the thorough technical analysis and extensive discussion on this topic. However, we are concerned that many of the suggested mechanisms to protect the FS are problematic. A summary of Telesat's position on various issues raised by the Commission follows, with a more thorough discussion contained in Annex 2.

Non-power ameliorative measures

The Commission requested comments[4] concerning the levels of non-power ameliorative measures required of FSS operators. Specifically, comment is requested on whether the requirement to limit PFD increases from FSS to overcome rain fade, as experienced by FS links, to a maximum of 1.5 percent of the time, balanced with a requirement for the FSS to reduce its system capacity no more than 73 percent, is an appropriate implementation in the context of soft segmentation.

FSS operators would strive to avoid non-power ameliorative measures that reduce system capacity unless absolutely necessary to maintain link availability. A 73% reduction of capacity is significant. Operators would likely trade-off link availability with throughput, depending on service level agreement and would judiciously locate gateways in areas where rain fade is minimized. Current V-Band capacity models utilize power control followed by non-ameliorative methods to maximize capacity. It would be a significant departure to use non-power ameliorative measures, followed by power control and then possibly additional non-power ameliorative measures.

The Commission sought comment on other non-power ameliorative measures.

Other potential non-power ameliorative measures require on-board processing. However, regenerative payloads have a higher probability of obsolescence during the 15 to 18 year operational period of GSO FSS satellites.

Practicality of non-power ameliorative measures

The Commission sought comment[5] on whether the approach described in Appendix A of the NPRM could be implemented using technology currently available to FSS operators.

The current technology for non-power ameliorative measures of TDMA return (ground terminal to gateway) links requires switching to alternate carriers. Spectrum must therefore be reserved for these fade mitigation techniques.

The Commission asked whether limiting FSS operators to increasing PFD only after non-power ameliorative measures are used during rain fade conditions would overly constrain FSS operations or overly protect HDFS operations.

As stated in the NPRM, the reduction in throughput due to non-power ameliorative measures is significant and a constraint to the FSS. FSS operators would be disadvantaged if they have to implement

[4] NPRM at 48
[5] NPRM at 49

non-power ameliorative measures prior to power adjustment in coverage areas that do not have FS terminals or if the discrimination available from the FS antennas due to elevation and azimuth angle would provide adequate protection from FSS PFD.

Signal availability

The Commission asked for validation of their assumption in Appendix A, that FSS operators desire 99.9 percent signal availability.

Links are routinely designed for specific service requirements. For example, FSS V-Band models for consumer services would likely use 99.7% one-way availability.

Non-power ameliorative measures before increasing power

The Commission suggests the alternative[6] of requiring all FSS operators to apply a uniform minimum of non-power ameliorative measures before increasing power.

A uniform standard is not the optimal solution for determining the threshold for applying non-power ameliorative measures versus power measures, since geographical location will be selected to maximize link availability and throughput and gateway location will impact system design.

Limitation of Beam Centers

The Commission is considering adopting a rule[7] that would require that the pointing centers of FSS satellites' spot beams cannot fall over any of the top 200 cities in the continental United States, where FS is presumed to operate.

V-Band gateway spot beams could be designed to allow gateways to be located close to, but outside, major city centers in proximity to critical infrastructure for FSS services.

Monitoring of FS Locations

The Commission requested comments[8] on the practicality of requiring the satellite operators to determine where each FS station is located and further determine whether the FS station is experiencing the same rain fade as the earth station making the power request.

Telesat believes that the associated database and real-time monitoring requirements would not be practical, given that FS V-band is used primarily for HDFS.

Effect of multiple satellites

The Commission is seeking comments[9] on whether the maximum PFD limits should account for the additive effects of signals from multiple satellites reaching the same area on the ground.

---

[6] NPRM at 50
[7] NPRM at 51
[8] NPRM at 52
[9] NPRM at 53

Telesat notes that the international framework is based on single-entry limits. Regulating cumulative limits would be extremely challenging, taking into account the different licensing administrations, space-to-Earth geometries, coverage, flux densities and frequency plans of satellites across the arc. Furthermore, the ground and satellite systems for V-band are likely to be adaptive in power and non-power ameliorative measures. . Regulating cumulative limits would require the FSS operator to plan for the eventuality of new PFD limits and the resulting change in capacity due to subsequent co-frequency, co-coverage satellites entering operation.

Impact of international agreements

Commenters were asked to address[10] the possible impact of existing international agreements or letters of understanding on the Commission's proposals. The United States currently has an arrangement with Canada that specifies that FSS operators will not raise PFD above current clear-air limits without coordination with Canada.

Should the United States allow FSS operators to increase PFD limits, it will be necessary to coordinate with Canada where there is coverage of Canadian territory. If Canada were to adopt similar rules, it would facilitate FSS system design and coordination between the two countries.

Asymmetric uplink and downlink

The Commission noted[11] that there is an asymmetrical designation in the uplink and downlink spectrum allocation and suggested one alternative to reduce unwanted power at the FS site would be to limit the FSS to a maximum of 1 GHz of downlink within the 2.5 GHz wide 37.5-40.0 GHz band.

Asymmetry could be used for innovative approaches to maintain FSS capacity and should therefore be retained.

The Commission also requested comments on requiring FSS to use spectrum spreading to take advantage of the larger downlink bandwidth prior to increasing PFD.

Employment of this technique would require an ability to change power from the spacecraft payload in real time. The spacecraft would also require on-board processing to spread the signal. Neither is common in commercial satellite systems.

In summary, Telesat believes that adequate protection will be afforded to FS receivers through the application of PFD limits. We urge the Commission not to adopt domestic regulations that are overly complicated, restrictive, possibly impractical, and unnecessary.

[10] NRPM at 54
[11] NPRM at 55

Respectfully submitted,

Telesat Canada

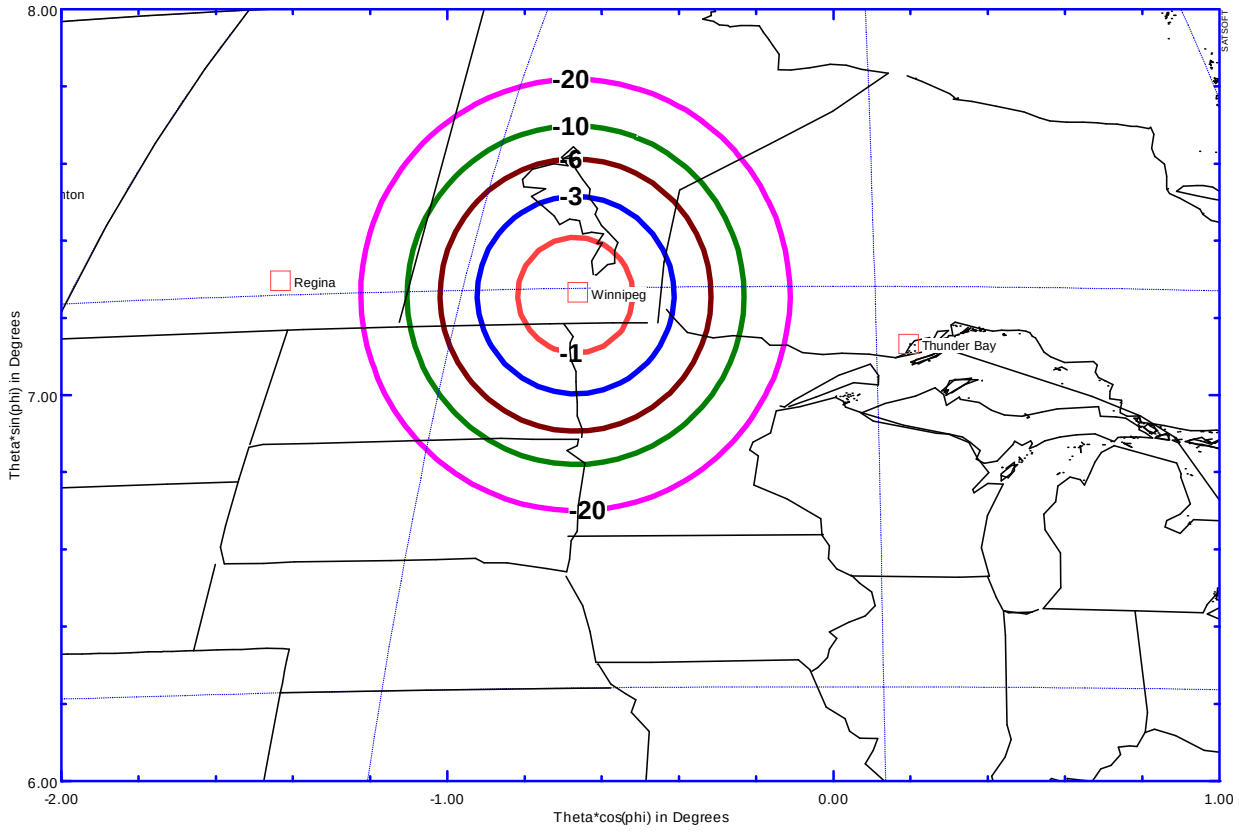
/s/ Robert Condurso

Robert Condurso
Director, Government and Regulatory Affairs
Telesat Canada
135 Routes 202/206
Bedminster NJ 07921
Tel: (908) 698-4882

OF COUNSEL:
Joseph A. Godles
GOLDBERG, GODLES, WIENER
& WRIGHT
1229 Nineteenth Street, N.W.
Washington, DC 20036
(202) 429-4900
Counsel for Telesat Canada

January 6, 2011

Annex 1- Sample Satellite V-band Transmit Antenna Gain Contours



- Orbital location: **91^{0}W**
- Frequency: **42.3GHz**
- Reflector diameter: **0.9m**
- Peak gain = **50.6 dBi**
- 3 dB BW= **0.5^0**

Annex 2

Compensating for Rain Fade of FSS Signals in the 37.5 – 40.0 GHz Band

Non-power ameliorative measures

The Commission requested comments[12] concerning the levels of non-power ameliorative measures required of FSS operators. Specifically, comment is requested on whether the requirement to limit PFD increases from FSS to overcome rain fade, as experienced by FS links, to a maximum of 1.5 percent of the time, balanced with a requirement for the FSS to reduce its system capacity no more than 73 percent, is an appropriate implementation in the context of soft segmentation.

We agree that FSS operators would strive to avoid non-power ameliorative measures that reduce system capacity unless absolutely necessary to maintain link availability. A 73% reduction of capacity is significant. Operators would likely trade-off link availability with throughput, depending on service level agreement.

For conventional bent pipe satellite payloads and star (hub based) ground segment, fade at the gateway is compensated, in addition to non-power ameliorative measures, by increasing in-route power from the multiple ground terminals homing on the gateway. Ground terminals increase their transmit EIRP to counter fade that could be local to the terminal or local to the gateway, or both, in order to maintain link symbol energy to noise ratio (Es/No) above threshold. Gateway fades will cause all terminals to increase their EIRP, resulting in higher total transponder power utilization and an increase in space-to-Earth PFD. Link design and ground segment uplink power control systems ensure that the transponder remains within its linear operating region and the ground terminal high power amplifier is below saturation, unless it is designed to operate near or at saturation. Many systems only monitor the resulting Es/No of the carrier received at the gateway and therefore do not differentiate whether fade was caused by the uplink or downlink.

If a satellite beacon is available from the spacecraft, it could be used to determine if the source of the fade is local to the gateway. To compensate for gateway fade, it would be better to control transponder power instead of ground terminal transmit EIRP. However, transponder power is normally controlled via telemetry command and not interfaced to service gateways. Even though feasible, control from a service gateway would be a significant departure from current operational practice, and would require careful management to avoid possible damage to the satellite payload and / or increased adjacent satellite interference.

Current V-Band capacity models utilize power control followed by non-ameliorative methods to maximize capacity. It would be a significant departure to use non-power ameliorative measures, followed by power control and then possibly additional non-power ameliorative measures.

Unlike power ameliorative measures, non-power ameliorative approaches are designed with hysteresis to ensure the fade condition is not a random short duration event. Further, response times are not instantaneous due to messaging between the gateways and terminals over the satellite link and processing time to queue data for the

[12] NPRM at 48

appropriate modulation and coding stack. Trigger or switch points are selected to ensure link integrity while maximizing throughput, depending on expected fade slope. The switch points will be different for a carrier moving from a higher to lesser protected state than for a carrier moving from a lesser to a higher protected state, in order to ensure seamless transitions and near error free data transmission while at the same time maintaining link integrity. For these reasons, a detailed model needs be developed to determine the practicality, efficiency and throughput of using both power and non-power ameliorative techniques.

Some of the non-power ameliorative techniques available for ground equipment require allocation of clear sky carriers and fade mitigation carriers. The ratio of clear sky and fade mitigation carriers is based on propagation characteristics of the served area and the desired link availability. The allocation of the two types of carriers is usually not executed in real time, as it is a longer term network planning activity. In most cases spectrum allocated to fade mitigation carriers is not be available for traffic because the lower symbol rate carriers do not support the throughput capacity expected during clear-sky operation. Newer generation systems such as DVB-RCS NG would support non-power ameliorative approaches with constant symbol rate, but these systems are not yet available or fully developed.

The Commission sought comment on other non-power ameliorative measures.

Other potential non-power ameliorative measures require on-board processing. Regenerative payloads have a higher probability of obsolescence during the 15 to 18 year operational period of GSO FSS satellites. If these commercial and technical challenges are addressed, payloads could be designed to route some of the carriers to alternate gateways when the primary gateway experiences fade. It is usual for gateways to be connected via high capacity terrestrial links to ensure continuity of service. Such alternate routing would impact the spectrum reuse design and could require additional spectrum. Payload designs that ensure seamless on-board switching or routing would be ideal but require demodulation and regeneration of data packets. IF switching or routing would be simpler to implement.

Practicality of non-power ameliorative measures

The Commission sought comment[13] on whether the approach described in Appendix A of the NPRM could be implemented using technology currently available to FSS operators.

The current technology for non-power ameliorative measures of TDMA return (ground terminal to gateway) links requires switching to alternate carriers. Spectrum must therefore be reserved for these fade mitigation techniques. It is expected that next generation return links will employ constant symbol rate with a wide selection of coding and modulation for both SCPC and TDMA system architectures. Adaptive Coding Modulation is currently implemented in TDM forward (gateway to ground terminals) links and SCPC forward and return links. For TDM systems, Es/No is measured by the demodulator at the ground terminals and reported to the gateway, which then queues data intended for the ground terminal to the appropriate stack. For SCPC systems, Es/No is measured by the demodulator at the remote end and reported to the originating modem, which then queues data to the appropriate stack. For TDMA return links, Es/No is measured at the gateway, which executes the switching decision.

[13] NPRM at 49

The Commission asked whether limiting FSS operators to increasing PFD only after non-power ameliorative measures are used during rain fade conditions would overly constrain FSS operations or overly protect HDFS operations.

As stated in the NPRM, the reduction in throughput due to non-power ameliorative measures is significant and a constraint to the FSS. Typically, ground systems use power to compensate for fade prior to implementing non-ameliorative measures. Increasing transponder power instead of ground equipment EIRP is feasible but would have to be controlled though telemetry, as these systems are not usually interfaced to ground control systems of gateways. A major change in operating practices would be required. If it is absolutely essential to protect HDFS operations, it should be on a coordinated basis, which is specific to the FSS spotbeam coverage area. FSS operators would be disadvantaged if they have to implement non-power ameliorative measures prior to power adjustment in coverage areas that do not have FS terminals, or if the discrimination available from the FS antennas due to elevation and azimuth angle would provide adequate protection from FSS PFD.

Signal availability

The Commission asked for validation of their assumption in Appendix A, that FSS operators desire 99.9 percent signal availability.

The Commission's choice of 99.9% one-way availability for V-Band is at the upper range. An FSS operator would likely consider reducing the availability below this figure as an additional trade-off with power and non-power ameliorative measures and still be able to offer services at V-Band that are commercially viable. For example, FSS V-Band models for consumer services would likely use 99.7% one-way availability.

Links are routinely designed for specific service requirements. For example, direct-to-home broadcast services to consumers typically have link availabilities of 99.7%. C-Band one-way link availability is typically 99.95%, while Ku-band link availability is typically 99.8%.

Non-power ameliorative measures before increasing power

The Commission suggests the alternative[14] of requiring all FSS operators to apply a uniform minimum of non-power ameliorative measures before increasing power.

This would be less complicated for FSS operators and the Commission than using a variable approach, because it would avoid disagreements over the application of statistical weather data for a given area and whether six dB is the appropriate figure as a uniform standard.

The lesser the amount of capacity reduction due to non-power ameliorative measures, the greater would be the value of the soft segmented spectrum for FSS operators. Gateways would be located in regions that statistically have low rain rate, have access to terrestrial backhauls, reliable electrical power and other resources. These gateways would be served by narrow gateway spot beams. If economically justified, the operator would implement a secondary site within a reasonable distance from the primary gateway, as dictated by rain cell patterns, to increase service availability in addition to providing physical

[14] NPRM at 50

infrastructure diversity. With this architecture, PFD to the FS would be less likely to increase, since the diversity gateway would be unlikely to experience fade at the same time as the primary gateway.

Hence, a uniform standard is not the optimal solution for determining the threshold for applying non-power ameliorative measures versus power measures, since geographical location will be selected to maximize link availability and throughput.

Limitation of Beam Centers

The Commission is considering adopting a rule[15] that would require that the pointing centers of FSS satellites' spot beams cannot fall over any of the top 200 cities in the continental United States, where FS is presumed to operate.

Gateways will preferably be located in low rain zones that are in close proximity to reliable electrical power, terrestrial fiber backhauls and Internet transits. V-Band gateway spot beams in the order of 0.15 degrees would be considered using on-board star trackers to reduce pointing error. Such narrow beams would allow gateways to be located close to but outside major city centers in proximity to critical infrastructure for FSS services.

Monitoring of FS Locations

The Commission requested comments[16] on the practicality of requiring the satellite operators to determine where each FS station is located and further determine whether the FS station is experiencing the same rain fade as the earth station making the power request.

If an FS registration database were available and a real-time monitoring system to locate rain cells in real time were available, it is conceivable that a gateway control system could retrieve the information and make the necessary power adjustment to reduce PFD. Neither condition seems likely. Aspointed out by the Commission, FS V-Band stations are used primarily for HDFS; as such they are likely employed in private networks that would not be connected to a wide area network such as the Internet. Requiring other FS connections to report fade related metrics or addition of an external device to report weather station information would likely be impractical.

Weather data collected from radar imagery or weather satellites would not likely be sufficient in resolution and timeliness of data concerning a passing rain cell to allow accurate adjustment of power levels.

If there were sufficient FSS terminals in the gateway spot beam, a composite map could be determined by the FSS network showing trends across the spot beam and, based on location, azimuth and elevation angle of the FS, determine the appropriate PFD. This technique would be practical only if the distribution of FSS terminals approximated that of FS terminals, which is unlikely to be the case. Further investigation would be required to determine the distribution of remote terminals that would be required to provide reliable rain cell fade data.

[15] NPRM at 51
[16] NPRM at 52

Telesat believes that the associated database and real-time monitoring requirements of these techniques would not be practical, given that FS V-band is used primarily for HDFS.

Effect of multiple satellites

The Commission is seeking comments[17] on whether the maximum PFD limits should account for the additive effects of signals from multiple co-frequency satellites reaching the same area on the ground.

The ground and satellite systems for V-band are likely to be adaptive in power and non-power ameliorative measures. The FSS operator would have to plan for the eventuality of new PFD limits and the resulting change in capacity due to subsequent satellites entering operation.

Further, the Commission is considering requiring that all satellite operators transmitting to the same location on the surface of the earth with overlapping beams in the same frequency band coordinate their power increases so that the total cumulative increase does not exceed the allowed value of 12 dB.

This would require satellite operators to cooperate in the beam designs and frequency plans to minimize co-frequency, co-coverage PFD. Coordination in real time between satellite operators would be more complex and costly. An industry led organization would need to manage the database and access under a cost sharing arrangement. PFD of overlapping spot beams would have to be calculated at the onset, then actual power monitored and relayed to the central server. Such sharing would likely be perceived as exchanging of proprietary data, and there would have to be an exacting standard on the reporting format and reporting frequency.

Impact of international agreements

Commenters were asked to address[18] the possible impact of existing international agreements or letters of understanding on the Commission's proposals. The United States currently has an arrangement with Canada that specifies that FSS operators will not raise PFD above current clear-air limits without coordination with Canada.

Should the United States allow FSS operators to increase PFD limits, it would be necessary to coordinate with Canada where there is coverage of Canadian territory. If Canada were to adopt similar rules, it would facilitate FSS system design and coordination between the two countries.

Asymmetric uplink and downlink

The Commission noted[19] that there is an asymmetrical designation in the uplink and downlink spectrum allocation and suggested one alternative to reduce unwanted power at the FS site would be to limit the FSS to a maximum of 1 GHz of downlink within the 2.5 GHz wide 37.5-40.0 GHz band.

The asymmetry is not conducive to bent pipe designs where uplink signals are received and translated for transmission to earth. However, a payload could be designed to crosslink the one gigahertz of uplink spectrum from multiple spot beams, to the 2.5 GHz wide downlink transmitted to the various gateways,

[17] NPRM at 53
[18] NRPM at 54
[19] NPRM at 55

using on-board IF processing or fully regenerative packet routing. The full one gigahertz would be downlinked to the secondary gateways when the primary gateway is experiencing fade. The signal would then be backhauled to the primary gateway via terrestrial fiber. Alternatively, with regenerative payloads, part of the traffic could be routed to the secondary gateway and part transmitted to the primary, after application of non-power ameliorative measures.

Asymmetry could be used for innovative approaches to maintain FSS capacity and should therefore be retained.

The Commission also requested comments on requiring FSS to use spectrum spreading to take advantage of the larger downlink bandwidth prior to increasing PFD.

As the Commission noted, employment of this technique would require an ability to change power from the spacecraft payload in real time. The spacecraft would also require on-board processing to spread the signal. Neither is common in commercial satellite systems. Bent pipe spacecraft payloads are transparent to carrier modulation and coding. Regenerative payloads could be designed with the necessary capabilities, but commercial viability would be driven by technical complexity and risk, mass and power tradeoffs, and obsolescence. Regenerative payloads would have to evolve with ground enhancements to ensure compatibility.