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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

February 1, 2002

By Hand

Magalie Roman Salas, Secretary
Federal Communications Commission
445 12th Street, N.W.,
Washington, DC 20554

Re: Ex Parte File Nos. 48-SAT-P/LA-97, 89-SAT-AMEND-97
130-SAT-AMEND-98, ET Docket No. 98-206

Dear Madam Secretary:

On January 31, 2002, Didier Casasoprana, Chief Engineer; Damien Garot, Manager, Products and Services, both of SkyBridge L.P.; and Diane Gaylor and the undersigned, attorneys for SkyBridge, met in person with Monica Shah Desai, Esq., Legal Advisor to Commissioner Kevin Martin, for the purpose of discussing matters identified in the attached documents, which were distributed at the meeting.

Respectfully submitted,

Jeffrey H. Olson
Attorney for SkyBridge L.P.

Attachments

cc (with attachments):
Monica Shah Desai, Esq.

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SKYBRIDGE PLAN FOR NGSO FSS/MVDDS FREQUENCY SHARING

NGSO FSS user terminals located near MVDDS transmitters (in the "Red Zone") will receive harmful interference in the 12.2-12.7 GHz band. Therefore, user terminals in the Red Zone must employ frequency diversity, and operate only outside the 12.2-12.7 GHz band.

Even with frequency diversity, however, limitations on MVDDS power are still required:

- The Red Zone must be small.[1]
- The user terminals in the Red Zone must be protected against saturation.[2]
- The MVDDS out-of-band emissions must be restricted.[3]

Failure to achieve these results will prevent the use of frequency diversity by NGSO FSS systems, undermining the fundamental premise of the sharing plan.

The power limitations must be defined from the point-of-view of the NGSO FSS receiver, *not* the MVDDS transmitter. This is because the interference received by the NGSO FSS user terminals depends not only on the MVDDS transmitter power, but also on antenna pattern, transmitter height, antenna tilt angle, polarization, transmitter density, terrain profile, and transmitter latitude. Limiting just one of these parameters, such as transmitter power, does not ensure protection of NGSO FSS systems. Such a mono-dimensional approach also overly constrains MVDSS systems, by preventing them from using a higher power in cases where such higher power would not pose a threat to NGSO FSS systems.

To meet the above requirements, SkyBridge has proposed a set of three power limits:

- PFD limit of –120 dB(W/m^2/MHz), applicable over 90% of the MVDDS service area
  - limits the size of the "red zone" to 10% of the MVDDS service area[4]
  - gives MVDDS operators significant flexibility in configuring their systems to achieve the necessary protection for NGSO systems
- EPFD limit of –135.1 dB(W/m^2/4 kHz), applicable over 99.8% of the MVDDS service area
  - guarantees that no more than 0.2% of the NGSO FSS user terminals could receive interference near the saturation threshold
  - provides flexibility to MVDDS to exceed the limit near the transmitter
- *operational* EPFD limit of –132.1 dB(W/m^2/4 kHz), applicable over the entire MVDDS service area
  - ensures that every *operational* NGSO FSS user terminal will be protected
  - takes into account the fact that simulations could identify saturation zones that would not pose a threat to any actual NGSO FSS user terminal, thus affording additional operational flexibility to MVDDS operators

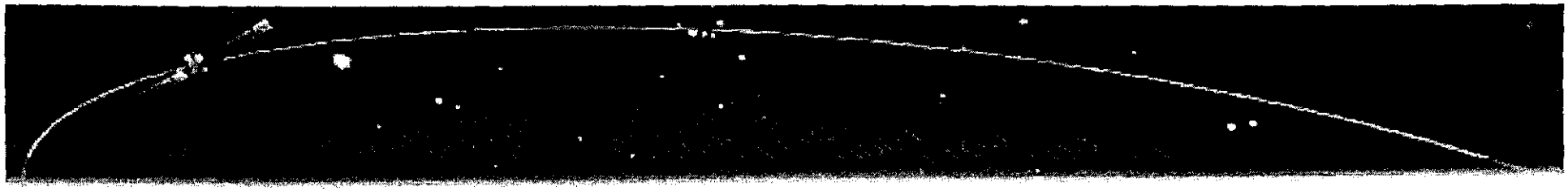
NOTES

1. Use of frequency diversity imposes significant constraints on the NGSO FSS operator, well beyond the obvious reduction in usable bandwidth. If a large number of user terminals receive interference from MVDD operations in the 12.2-12.7 GHz band, this can adversely affect the load of carriers and impede the multiplexing capabilities of satellite systems, reducing system capacity. See SkyBridge Further Notice Comments, ET Docket No. 98-206, March 12, 2001 at 27-28. In the case of the SkyBridge, the need to employ frequency diversity to compensate for MVDDS interference also severely constrains the ability of SkyBridge to deploy its "relay links," which allow it to provide immediate service to rural areas, prior to the full deployment of all U.S. gateways. See *Ex Parte* of SkyBridge, ET Docket No. 98-206, February 18, 2000, at 34. Therefore, the percentage of satellite terminals located in Red Zones must be kept small.

2. Generally, NGSO FSS user terminals will use the entire 11.7-12.7 GHz band. The RF front end of the user terminal is therefore wideband, covering the full 1 GHz frequency range in which carriers can be received. Even when carriers in the lower half of that band (11.7-12.2 GHz) are employed by the NGSO FSS system, MVDDS interference into the upper half of the band (12.2-12.7 GHz) still can present a significant interference problem, because saturation of the NGSO FSS receiver from this interference in the upper band would prevent the user terminal from operating at all even in the lower band. See SkyBridge Further Notice Comments at 28. Therefore, the user terminals in the Red Zone must be protected against saturation.

3. High out-of-band emissions by MVDDS transmitters could, of course, prevent the use of frequency diversity by NGSO FSS systems. The Commission has proposed to require all MVDDS transmitters to meet the emission mask of Section 101.111(a)(2). SkyBridge believes that this proposal would adequately limit MVDDS out-of-band emissions, *so long as the maximum authorized bandwidth is expanded to no more than 24 MHz*, the bandwidth cited by Northpoint for its system. Further expansion of the maximum authorized bandwidth (currently at 20 MHz, see Section 101.109) would relax the emission mask, leaving NGSO FSS systems unprotected. See SkyBridge Further Notice Comments at 38-40.

4. Northpoint has stated that the size of the largest Red Zone for any of the proposed NGSO FSS systems in the Ku-band will be less than 10% of a Northpoint transmitter's service area. See Northpoint NPRM Comments, ET Docket No. 98-206, March 2, 1999, Technical Annex, at 32. Moreover, the 10% figure reflects the needs of NGSO FSS systems. Such a limit would avoid imposition of frequency constraints on too many user terminals, permitting the NGSO FSS operator to maintain reasonable efficiency in the traffic multiplexing capabilities of the system. Higher values would lead to loss of capacity.



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NGSO/NGSO Sharing

IB Docket No. 01-96

Washington D.C., January 31, 2002

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Coordination

In an ideal world, coordination results in the greatest spectrum efficiency, but outcome depends on good faith negotiation by the parties.

In this proceeding, the applicants have diverse incentives, and the proposed systems are at vastly different stages of development.

=> Need a "default solution" for regulatory and business certainty

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Default Solution

The default solution should meet the following objectives:

- **provide sufficient access to spectrum for broadband services**
- **provide equitable access to spectrum for all applicants**
- **be technology neutral**
  - **no orbit is "best"**
    - **orbit selection depends on business decisions**
    - **a variety of orbits will permit a diversity of service offerings**

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Default Solution (2)

(cont.)

- provide regulatory certainty, to permit investment in systems
- encourage coordination, to permit optimum use of the spectrum
- be compatible with non-U.S. regulatory regimes, to permit operation in foreign territories and sharing with non-U.S. licensed systems

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Proposals for NGSO/NGSO Sharing

- ***Band Segmentation*** *(FCC Options I and II)*
- ***Homogeneous Orbits*** *(FCC Option IV)*
- ***Hybrid of Above*** *(Virtual Geo Proposal)*
- ***Avoidance of In-Line Events*** *(SkyBridge Proposal and FCC Option III)*

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Band Segmentation

Band Segmentation fails to meet numerous objectives for the default solution:

- **does not guarantee licensees access to sufficient spectrum to support economically-viable services**
  - **1/"N" of the spectrum is not sufficient for broadband**
  - **availability of spectrum decreases with time, counter to business needs**
  - **limits carrier sizes and access methods**
- **introduces uncertainty regarding availability of bands, forcing operators to design for a variety of scenarios**

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Band Segmentation (2)

(cont.)

- does not make efficient use of the spectrum
  - decreases amount of spectrum a system can use, even when no interference would result
  - reduces useable spectrum, due to need for guard bands
  - impedes development by operators of more spectrum-efficient solutions
- discourages use of interference mitigation techniques
  - encourages hording of exclusive spectrum rights
  - hinders service in foreign territories and sharing with non-U.S. licensed systems

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Forced Homogeneity

Forced Homogeneity fails to meet a number of objectives for the default solution:

- **It is not technology neutral:**
  - takes business decisions away from the licensees, and places them in the hands of the FCC
  - thwarts the business plan of a number of applicants
  - there is no rationale criteria by which the FCC could select a "winning design;" no system is inherently superior
  - prevents diversity of service offerings, and ability of new entrants to compete
- **It places US-licensed systems at a disadvantage in regions or countries that have adopted alternative sharing regimes:**
  - orbit-planning has been rejected internationally, with full U.S. concurrence and support

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Virtual Geo Proposal

The Virtual Geo proposal fails to meet a number of objectives for the default solution:

- **fails to ensure equal access to the spectrum**
- **fails to ensure sufficient access to the spectrum**
- **fails to prevent spectrum warehousing**
- **fails to facilitate coordination**
- **fails to achieve an outcome dictated by the service market, rather than regulatory decision**
- **is not technology neutral, and Virtual Geo claims to hold the intellectual property rights to its orbit**
- **fails to facilitate sharing with non-U.S. licensed systems that do not employ the same orbit**

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Virtual Geo Proposal (2)

Virtual Geo's Orbit is Not Superior to Other NGSO Orbits:

- **The transmission delay impedes interactive applications and use of TCP/IP-transparent architectures.**
- **The orbit is not optimum for global services. As Virtual Geo concedes, the Virgo orbit is really more appropriate for regional GSO-like services.**

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Virtual Geo Proposal (3)

The chief benefit Virgo ascribes to its orbit is its ability to accommodate a large number of systems. However,

- **The number of systems says nothing about what sorts of services can be provided, and at what cost.**
- **It has not been demonstrated that maximally-packed Virgo constellations yield any greater capacity than maximally-packed constellations of any other kind.**

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Virtual Geo Proposal (4)

The problem Virtual Geo claims to solve does not exist:

- **All of the current applicants can be accommodated under the method of avoiding in-line events.**
- **The demand for future entry of Virgo-orbit systems is speculative at best.**

The spectrum requirements of existing projects should not be thrown aside to warehouse spectrum for a class of systems for which no future demand has been demonstrated. The marketplace should decide.

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Avoidance of In-Line Events

Spectrum sharing via avoidance of in-line events solves the above problems:

- supported by majority of applicants
- provides equal and sufficient access to the spectrum
- is spectrum efficient
  - only satellites in interference configurations need to take steps to mitigate
  - leaves operators free to use all of the spectrum for as much of the time as possible
- prevents spectrum warehousing
- facilitates and encourages coordination among applicants

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Avoidance of In-Line Events (2)

(cont.)

- is technology neutral
  - permits technology and service choices to be dictated by the market, not the Commission
  - suitable for all proposed systems
    - satellite diversity is not required
    - uniform transmitter power is not required
- places U.S. licenses in an excellent position to adapt to foreign regulatory regimes and to coordinate with non-U.S. licensed systems

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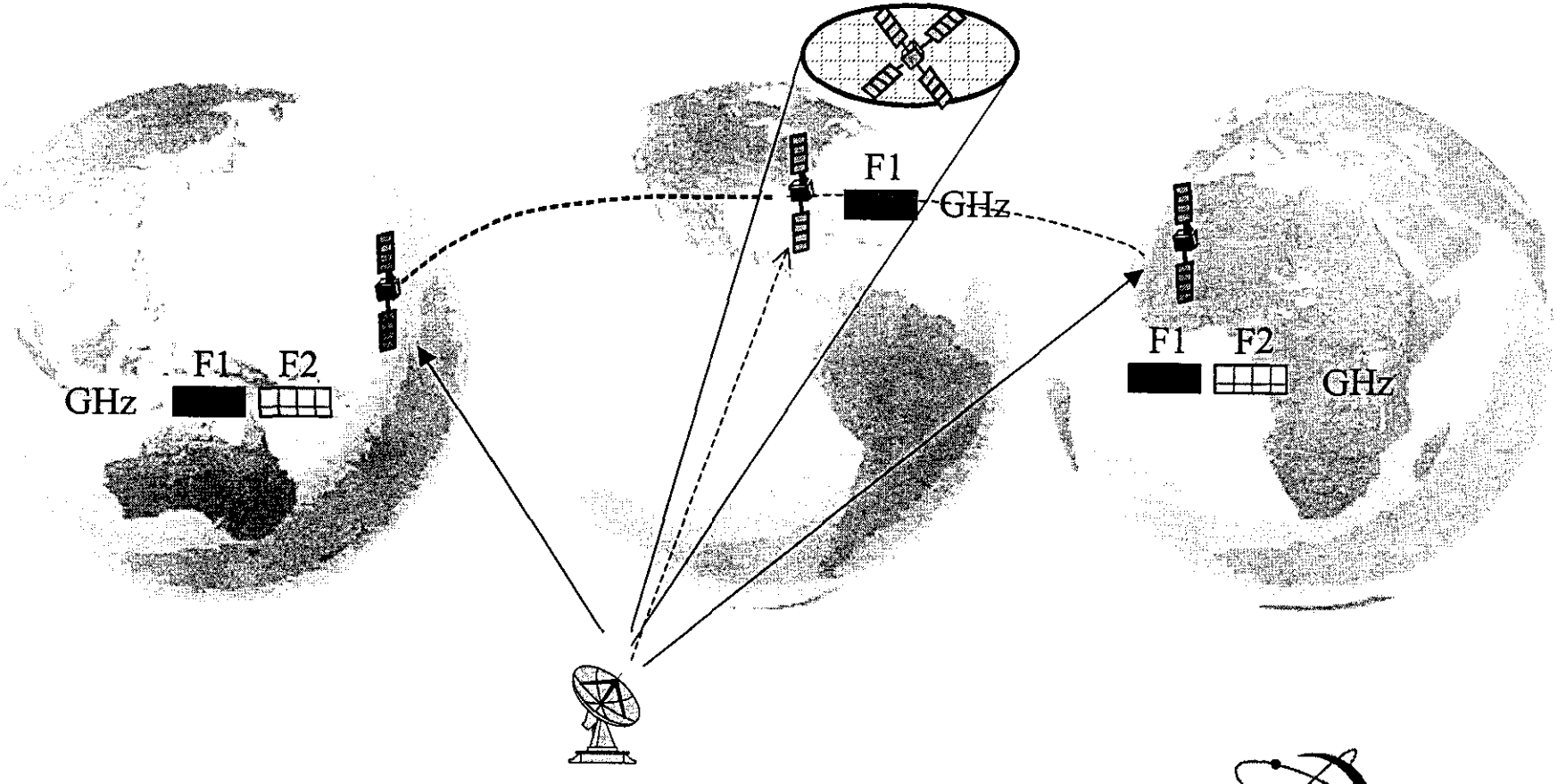
Implementation of In-Line Avoidance



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Implementation of In-Line Avoidance (2)

Elements that need to be defined:

- ***Definition of "in-line event"***
- ***Spectrum arrangement during in-line events***

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Defining "In-Line Event"

SkyBridge has proposed two possibilities:

- **"arbitrarily" select a benchmark angular separation, say 10º ("simple approach")**

or

- **select more optimum angular separations specific to each pair of constellations ("detailed approach")**

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Defining "In-Line Event" – Simple Approach

Simple Approach:

1. Select a default angle (e.g., 10°) applicable to in-line events between most systems.

2. Provide a method for taking into account "high-power" links.

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Defining "In-Line Event" – Simple Approach (2)

10° is an appropriate balance for the angular separation between most systems.

- ***Any smaller, and we risk interference in the main-lobe of the terminals***
- ***Any larger, and we over-burden the operations of the systems (See Table below)***

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Defining "In-Line Event" – Simple Approach (3)

Co-existing constellation	SkyBridge	Boeing	HNet	Virgo	HLink	KuBs	Pentriad
Reference constellation							
SkyBridge							
5		98.5	96.6	99.1	98.8	95.5	99
10		93.5	88.97	96.2	95.4	82	95.3
15		86	81.2	91.2	89.4	62	88.7
20		75.7	73.2	83.9	81.2	41.6	78.6
Boeing							
5	98.6		99	99.5	99.4	97.3	97.8
10	94		95.5	89	95.7	89.8	92.2
15	86.6		89.5	82.8	83.5	73.2	73.3
20	75.2		81.9	70	66.8	53.5	57.5
HNet							
5	97.2	98.2		98.4	98.3	97.4	98.4
10	90.5	92.7		93.8	93.2	89.8	93.6
15	82	83.8		87.2	85.2	78	86.4
20	71.6	73.1		79.4	75.2	63.7	77.4
Virgo							
5	99.2	99.4	99.6		99.3	97.7	100
10	97.2	98.7	98.2		97.9	91.7	97.9
15	93.8	93.2	96.3		95.3	83.5	97.1
20	89.4	87.9	94.3		93	73.5	93.3
HLink							
5	97.7	99	97.9	99.3		98.8	99.4
10	91.1	93.8	92.6	96.9		93.7	97.5
15	80.8	81.8	84.6	93.4		82	92
20	68	64.9	76.2	87.7		71	88
KuBs							
5	96.7	98.7	97.3	98.9	99.6		97.7
10	87.8	95.8	91.4	94	97.2		92.7
15	75	90	84	86	93		85
20	60	80	76	76	86		75
Pentriad							
5	98.4	95.7	98.6	87.9	99.3	96	
10	91.1	88.9	94.2	63.3	97.5	84.6	
15	83	72	87	48	94	63	
20	65	60	78	35	86	33	

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Defining "In-Line Event" – Simple Approach (4)

10° separation may be insufficient to protect a system against another system using significantly higher power levels and higher off-axis gain.

- **This is not an issue on the downlink. The EPFD limits constrain all systems to similar power levels.**
- **On the uplink, however, systems are not as tightly constrained.**

It is therefore necessary to define an alternative separation angle for the potential case where 10° does not adequately protect a system from a "high-power" uplink of another system.

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Defining "In-Line Event" – Simple Approach (5)

Defining "high-power" uplink:

"an on-axis EIRP in excess of 18 dBW/m^2/40 kHz

and

an off-axis EIRP at 10° or above in excess of –10 dBW /m^2/40 kHz

for any system terminal"

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Defining "In-Line Event" – Simple Approach (6)

Both prongs of the definition are important:

- **A terminal with a relaxed antenna pattern may not adversely affect other systems if its power is low (which may be the case for a LEO).**
- **A terminal with a high on-axis power (such a MEO or HEO) may not adversely affect another system if its antenna performance or diameter is high.**

10° separation angle is insufficient only when a system employs both a high power and a relaxed antenna pattern.

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Defining "In-Line Event" – Simple Approach (7)

If a system employs "high-power" uplinks:

- **The system can decrease its power and/or increase its antenna diameter and/or performance to reduce its off-axis power density,**

or

- **During in-line events with another system, both systems can employ a larger separation angle, such as 20°.**

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Defining "In-Line Event" – Detailed Approach

As an alternative to the "simple" approach of selecting a single benchmark separation angle, it is also possible to customize the angle based on the link budget and performance objectives of each system:

- **Based on methodologies used within the ITU-R to develop the regime for GSO/NGSO sharing**
- **Avoids the need to deal separately with the "high-powered" links**

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Defining "In-Line Event" – Detailed Approach (2)

1. Determine sync loss threshold of the victim system (I/N_{TH}).
2. Select an initial value for the angular separation of the systems (start with a small angle).
3. Run a complete simulation generating the distribution of I/N levels created by the interfering system.
4. Convolve it with the rain fade to get the total degradation distribution.
5. Compare the total degradation with the degradation due only to rain to determine the unavailability increase due to the interfering system.
6. If the unavailability increase is greater than 7%, select a larger angular separation and repeat from step 3. If it is less than 7%, select that angle.

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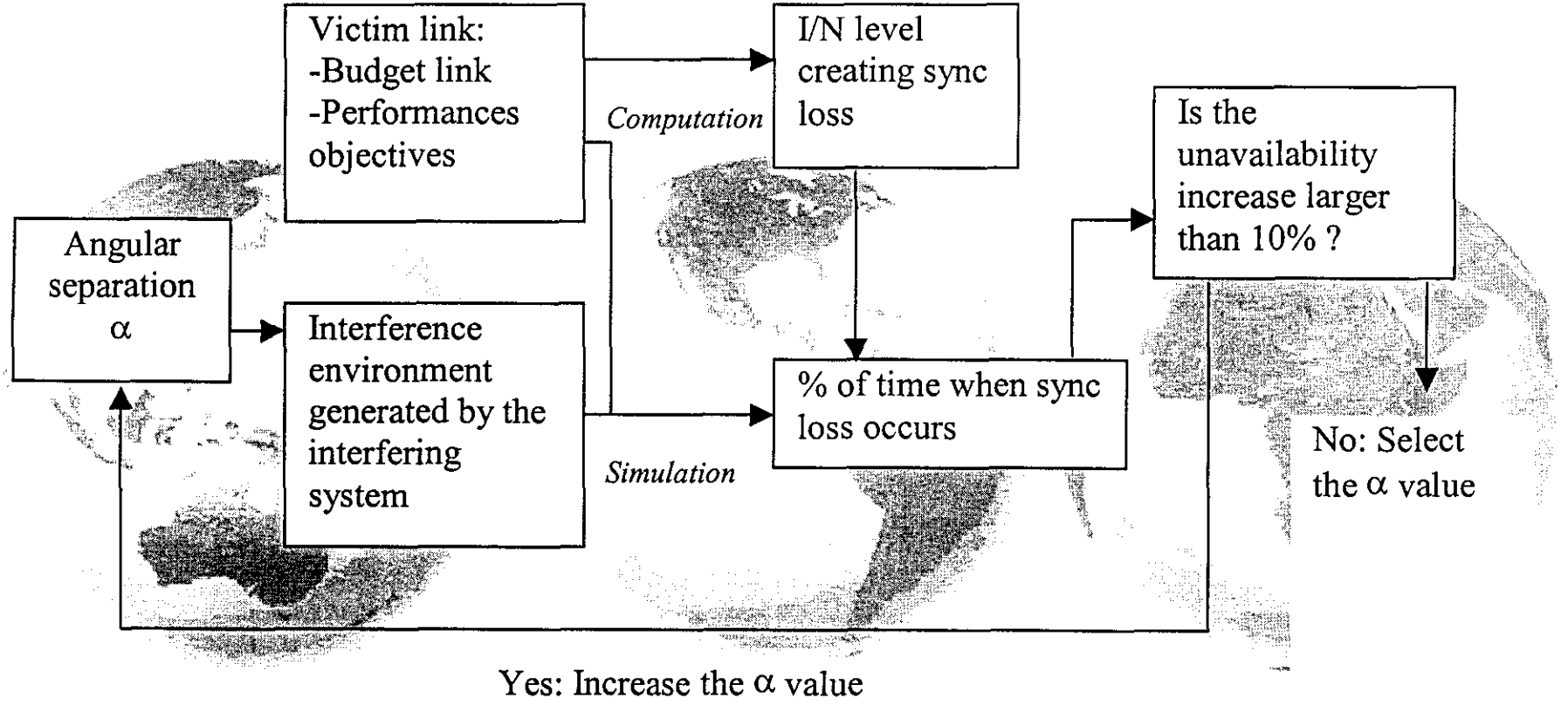
Defining "In-Line Event" – Detailed Approach (3)



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Defining "In-Line Event" – Detailed Approach (4)

Simulations should represent "typical" operations, not worst-case:

- **Assume one full-time, full-power terminal per center of each beam of the interfering satellite**
- **Assume interfering system terminal is co-located with the victim earth station**
- **Assume "best-elevation" tracking**

ITU-R Recommendation 1325 provides guidance on appropriate assumptions.

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Spectrum Arrangements During In-Line Events

It will be easy for each operator to program its system to adhere to the plan:

- **In-line events will be predictable in advance.**
- **The pattern of events will be repetitive over time.**

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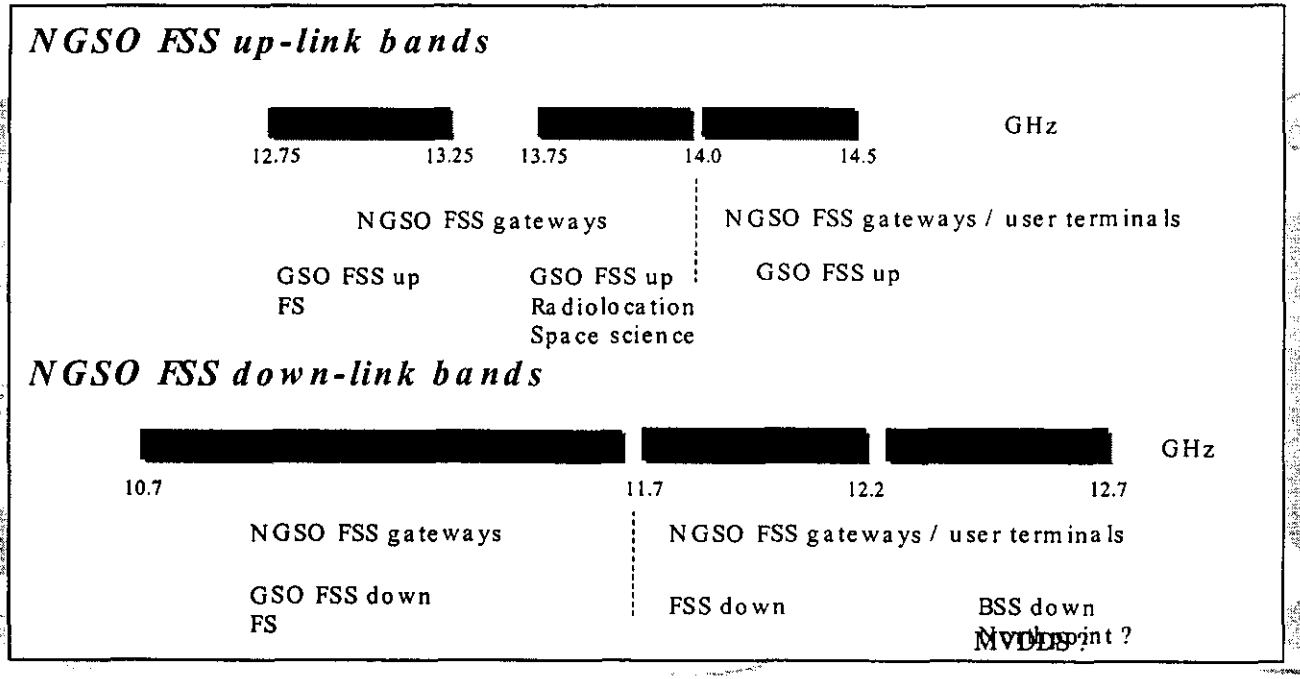
Spectrum Arrangements During In-Line Events (2)

Available Ku-band segments come with various sharing conditions. They are not fungible.



The spectrum arrangement should provide each system equal access to bands with similar sharing conditions.

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Spectrum Arrangements During In-Line Events (3)

Each similar band segment needs to be split among the two or more systems involved in a given in-line event.

- **default**
  - **based on, for example, date of launch**
- **permit licensees to agree among themselves based on individual preferences**

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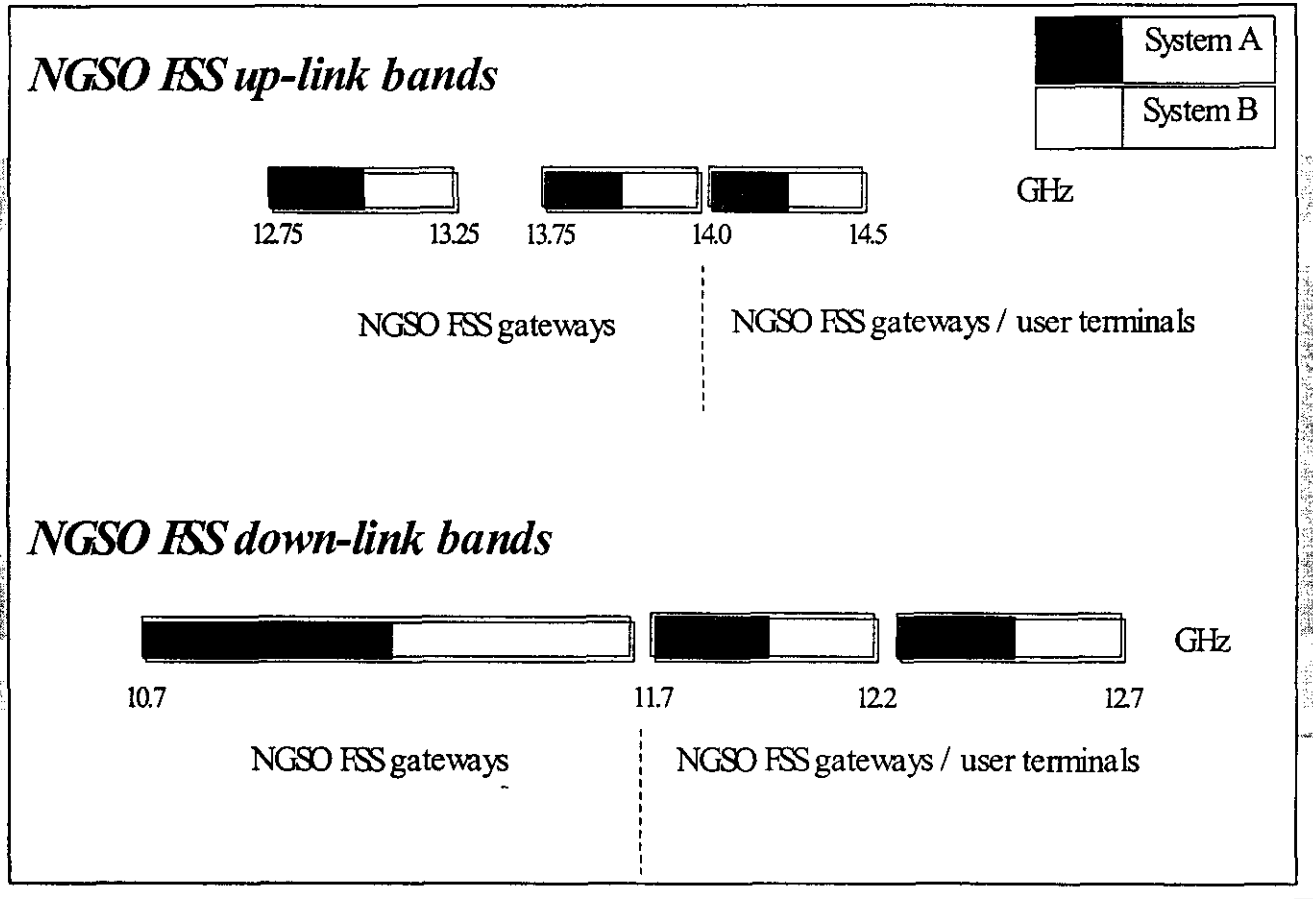
Spectrum Arrangements During In-Line Events (4)

Example for Two Systems:



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In-Line Avoidance - Impact on Systems

Most of the time, systems will be unconstrained.

During in-line events, systems can cope with the necessary frequency constraints via a number of techniques:

- **Satellite diversity**
  - **Circular orbit systems have this ability**
  - **HEO orbit systems should have this ability**
    - **Denali states that its system has some such ability.**
    - **Examination of the Virgo system indicates that it does too.**
- **Frequency diversity**
- **Design to operate in less bandwidth**
  - **Virgo proposes to operate in less than half the allocated spectrum.**

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In-Line Avoidance - Impact on Virgo

Virtual Geo not only states that it can operate in less than half of the spectrum, but offers to do so.

Virgo would be constrained only in the event of in-line configurations involving three or more systems, the likelihood of which Virtual Geo finds so remote that it has proposed ignoring the possibility. *(Virtual Geo NPRM Comments, App. 1, at 4)*

- **Virgo can operate under Option III without any significant system modifications and without any significant reduction in capacity.**
- **In fact, Virgo would have greater spectrum access under Option III than under its own proposal, and would essentially never have less than its stated requirements.**

Virgo's proposal does nothing but promote Virtual Geo's business objectives for its patented orbit, and completely disrupts the technical and business plans of the other applicants.

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Avoidance of In-Line Events

- Accommodates all proposed systems in an equitable manner, without requiring significant system modifications
- Is simple to implement, avoiding long-term FCC involvement in administering the sharing regime

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