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December 9, 2020

FILED ELECTRONICALLY VIA IBFS
Ms. Marlene H. Dortch
Secretary,
Federal Communications Commission
45 L Street, N.E.
Washington, DC 20554

Re: Notice of *Ex Parte* Presentation, Telesat Canada, IBFS File No. SAT-MPL-20200526-00053, Callsign S2976; Space Exploration Holdings, LLC, File No. SAT-MOD-20200417-00037, Call Signs S2983 and S3018; Viasat, Inc., IBFS File No. SAT-MPL- 20200526-00056, Call Sign S2985; RM-11855 and RM-11861

Dear Ms. Dortch:

On December 7, 2020, representatives of Telesat Canada ("Telesat") and Telesat's undersigned counsel met by teleconference with staff from the International Bureau. The meeting participants are set forth in Exhibit A.

The purpose of the meeting was to discuss the slides attached hereto as Exhibit B, which address the interference assessment methodology Telesat used in connection with its above-referenced modification application. Telesat also is filing a copy of this letter in the record of the above-referenced application proceedings involving SpaceX and Viasat, as well as in the two above-referenced petition for rulemaking proceedings, that are referred to in the slides.

Questions with respect to this matter should be referred to the undersigned.

Sincerely,

Henry Goldberg
Joseph A. Godles
Attorneys for Telesat Canada

cc: Karl Kensinger (e-mail)
Sylvia Lam (e-mail)

Attachments

EXHIBIT A

December 7, 2020 Teleconference Participants

<u>Telesat Canada</u>
Michael Schwartz
Elisabeth Neasmith
Mario Neri
Laura Roberti
Henry Goldberg, *Attorney for Telesat Canada*
Joseph A. Godles, *Attorney for Telesat Canada*

<u>FCC International Bureau Staff</u>
Karl Kensinger
Sylvia Lam

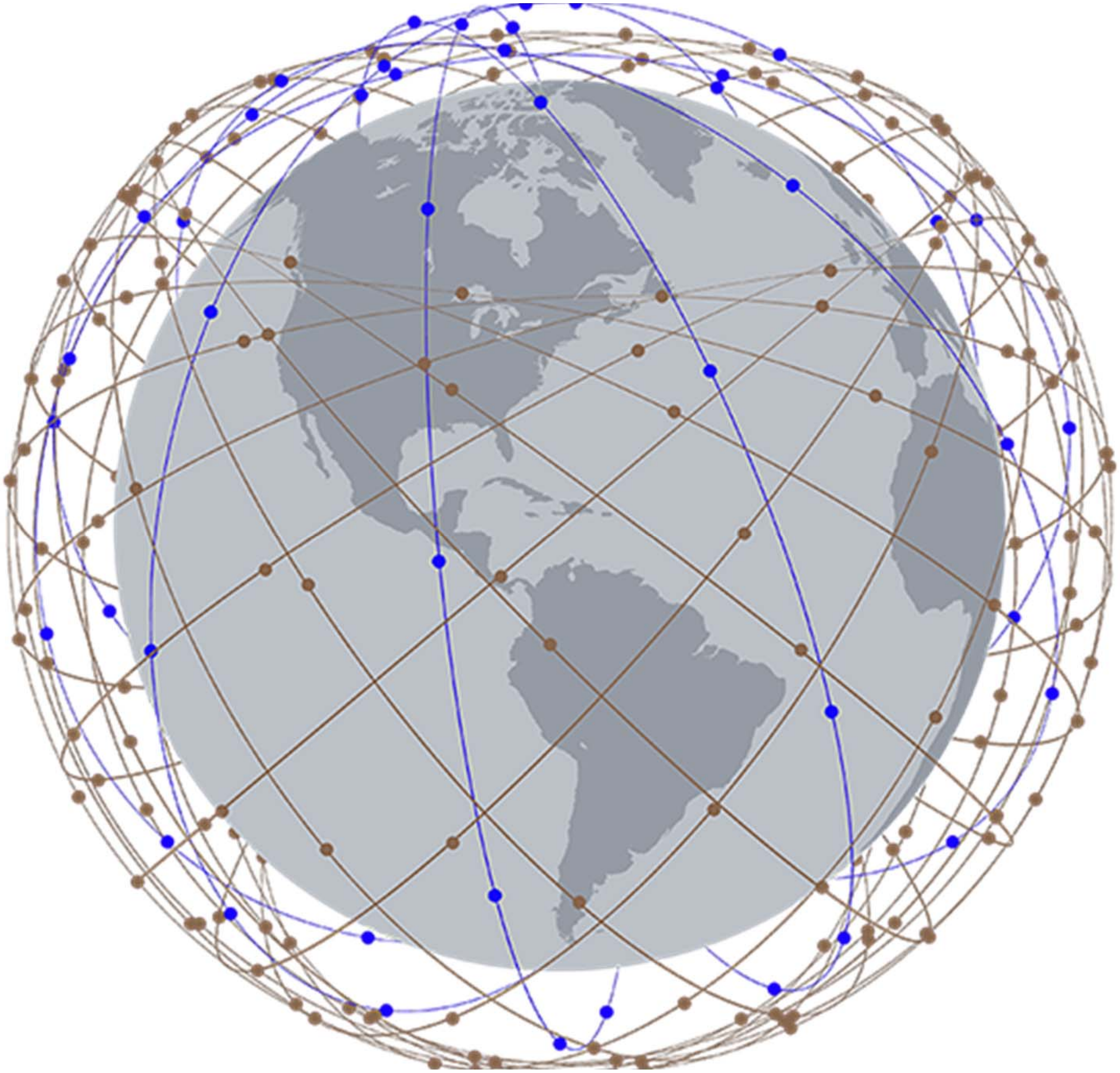
EXHIBIT B

Telesat LEO

Proposed Modification to Market Access Grant

TELESAT

December 7, 2020



Introduction

- Telesat's FCC market access grant for a hybrid constellation of 117 satellites was released on November 3, 2017 as part of the first processing round
  - 72 satellites in polar orbit
  - 45 satellites in inclined orbit
- The "Telesat LEO" constellation design has matured considerably
- Telesat submitted a modification to the grant on May 26, 2020 to increase the constellation size in two phases:
  - Phase 1: To 298 satellites total
  - Adds 6 satellites in polar orbit and 175 satellites in inclined orbit, with compensating adjustments so there is no change in the interference environment
  - Phase 2: To 1671 satellites total
  - Adds additional planes and satellites modularly, to both orbits
- This meeting is to explain the technical basis that supports keeping the Phase 1 modified constellation in the first processing round

Background

- The FCC has held that, provided there is no increase in bandwidth, applications for modifications of space station authorizations will be granted if the public interest would be served
- Precedent provides that "*If the proposed modification does not present any significant interference problems and is otherwise consistent with Commission policies, it is generally granted*"
- On April 2, 2020, Telesat met (virtually) with the International Bureau who advised Telesat to provide an analysis to show there would be no increase in interference after modification as compared to pre-modification, for each of four scenarios (Telesat as both interferer and as victim, in each of the uplink and downlink)

Scenarios

- The four scenarios are as follows:
  - **Scenario 1**: UPLINK, Telesat as *victim*
  - **Scenario 2**: UPLINK, Telesat as *interferer*
  - **Scenario 3**: DOWNLINK, Telesat as *victim*
  - **Scenario 4**: DOWNLINK, Telesat as *interferer*

- A proposed modification of a NGSO system "passes the test" if it does not affect the interference environment of other NGSO systems in the same processing round[1] in each of the four scenarios

[1] *Although it is outside the scope of our presentation today, we note that we disagree with those who contend that first round NGSO modification applications must protect second round NGSO systems*

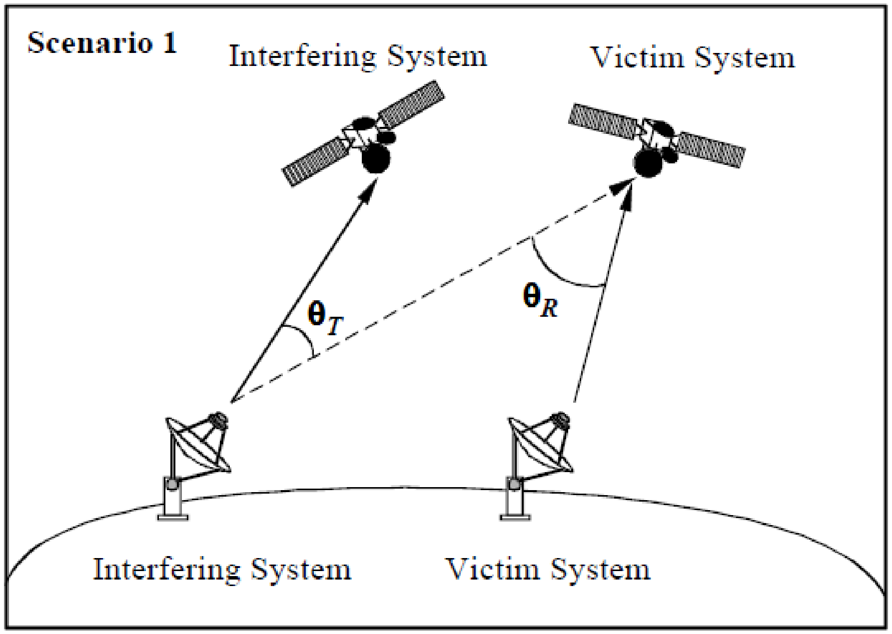
Scenarios, cont'd (Scenarios 1 and 2)

Scenario 1 UPLINK

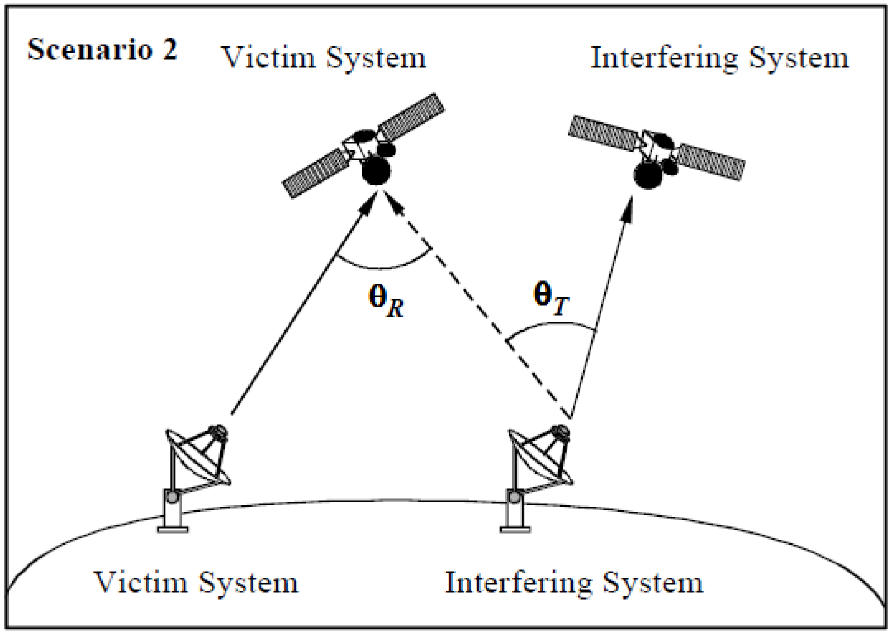
Telesat is the "Victim System" and another applicant in the first processing round is the "Interfering System"

Scenario 2 UPLINK

Another applicant in the first processing round is the "Victim System" and Telesat is the "Interfering System"



= interfering signal



= interfering signal

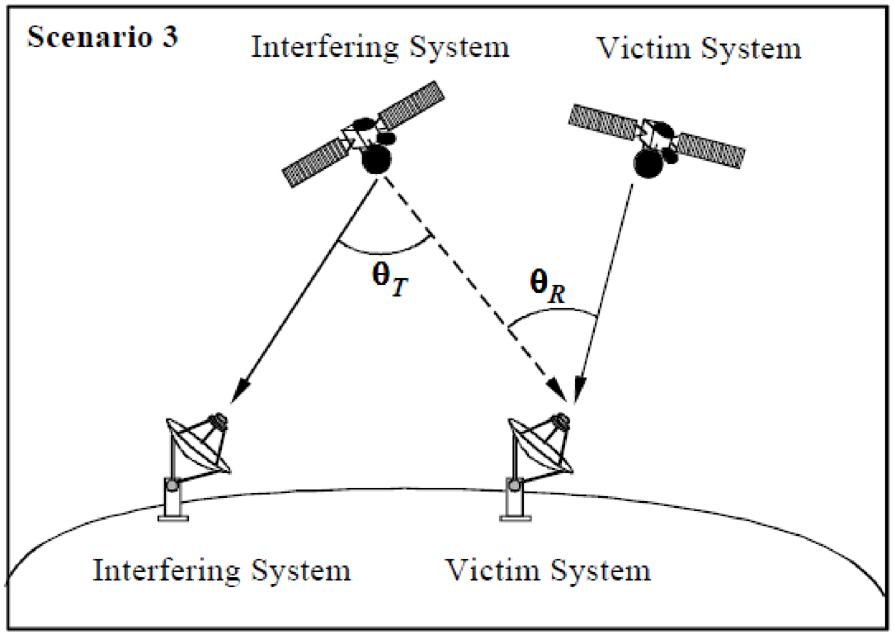
Scenarios, cont'd (Scenarios 3 and 4)

Scenario 3 DOWNLINK

Telesat is the "Victim System" and another applicant in the first processing round is the "Interfering System"

Scenario 4 DOWNLINK

Another applicant in the first processing round is the "Victim System" and Telesat is the "Interfering System"



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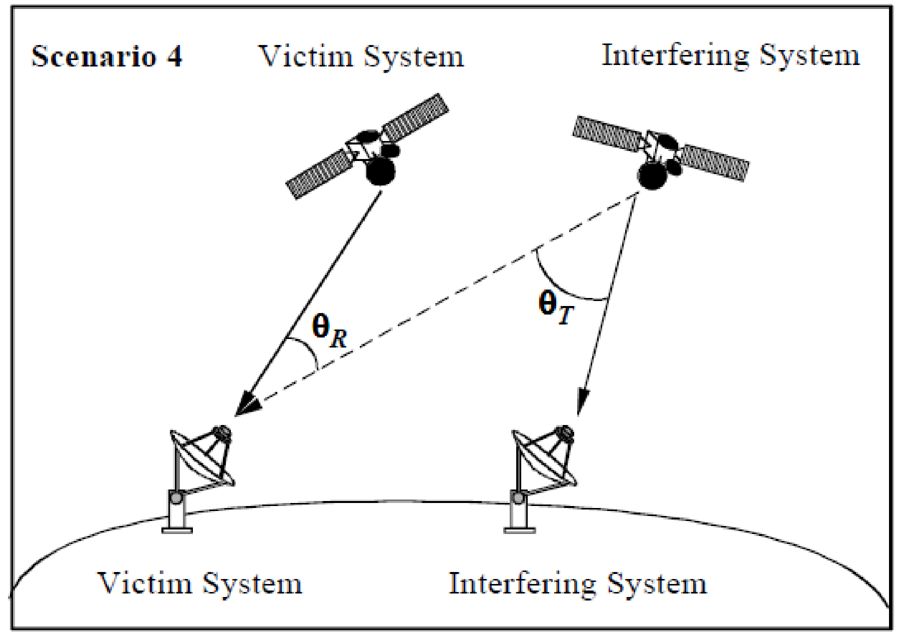

– – – – – ► = interfering signal

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Methodologies to assess interference

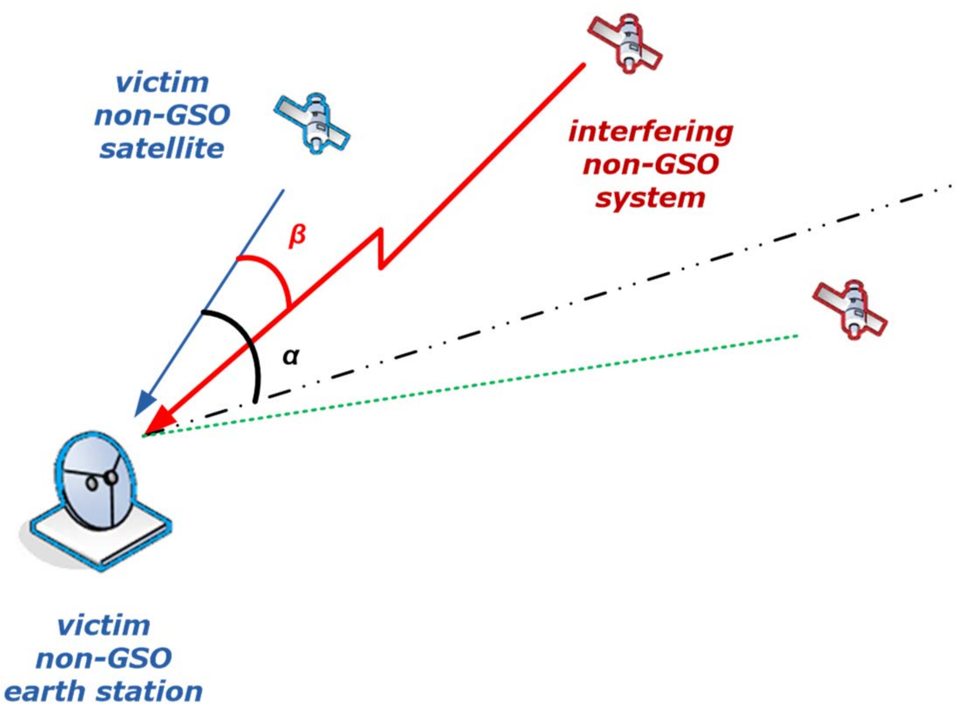
- In broad terms, parties have used three methodologies to attempt to show the change in interference environment for various scenarios
- Method 1 – Count of geometrical “in-line events”
- Method 2 – Count of “in-line interference events”
- Method 3 – Computation of I/N statistics

- The following slides illustrate these three methods, focusing on the downlink direction (similar considerations can be made for the uplink direction)

- As discussed below, only Method 3 accurately reflects the change in interference environment whereas the first two have obvious limitations and shortcomings

Method #1: Count of geometrical "in-line events" (1/4)

- Some parties[2] have defined an "in-line event" purely from a geometrical perspective: such an event would occur if the separation angle **β** between the wanted and interfering satellite, as seen from the interfered-with earth station, would fall within a fixed, pre-defined angle **α**

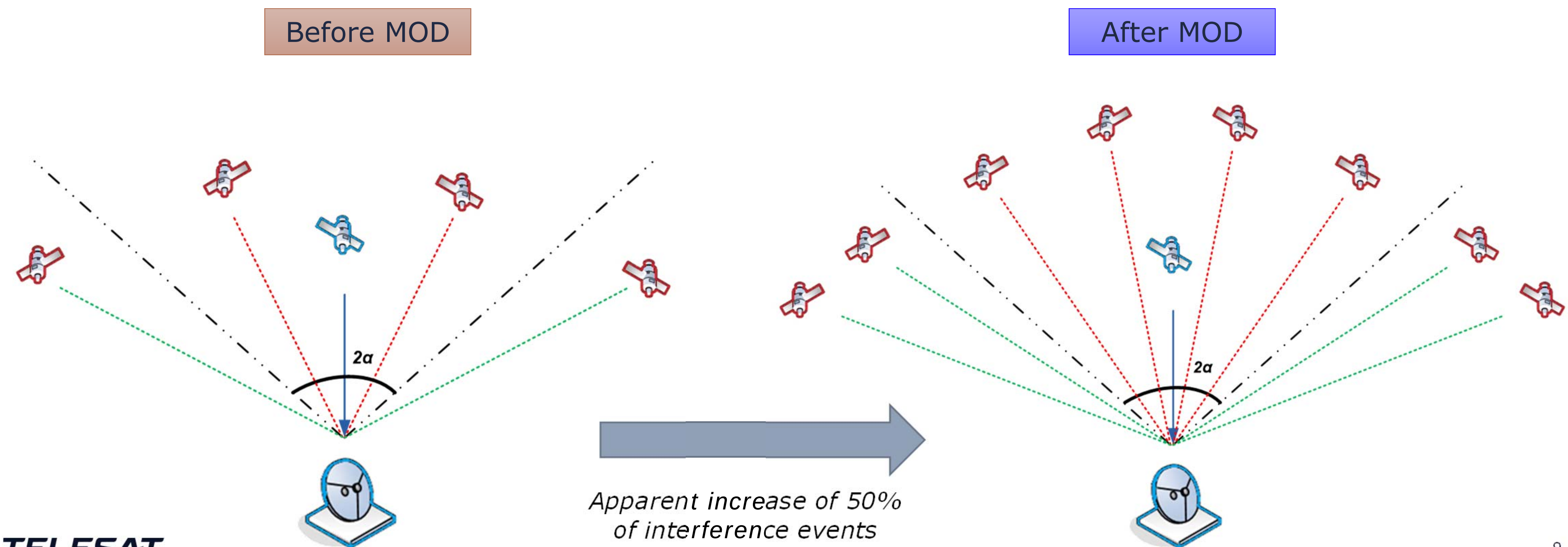


Since **β** < **α**, for one of the two visible satellites of the interfering system, an "in-line" event occurs in this geometry

[2] *see, for example, SES Petition to deny SpaceX MOD-3, Technical annex at 5)*

Method #1: Count of geometrical "in-line events" (2/4)

- A simple count of the change in geometrical "in-line events" inherently assumes that **all satellites** which are "in-line" with the victim earth station **transmit** towards it on frequencies the earth station is using
- In fact, only satellites that actually transmit on frequencies the earth station is using can cause interference
- Therefore, this method will significantly overstate the impact of a modification



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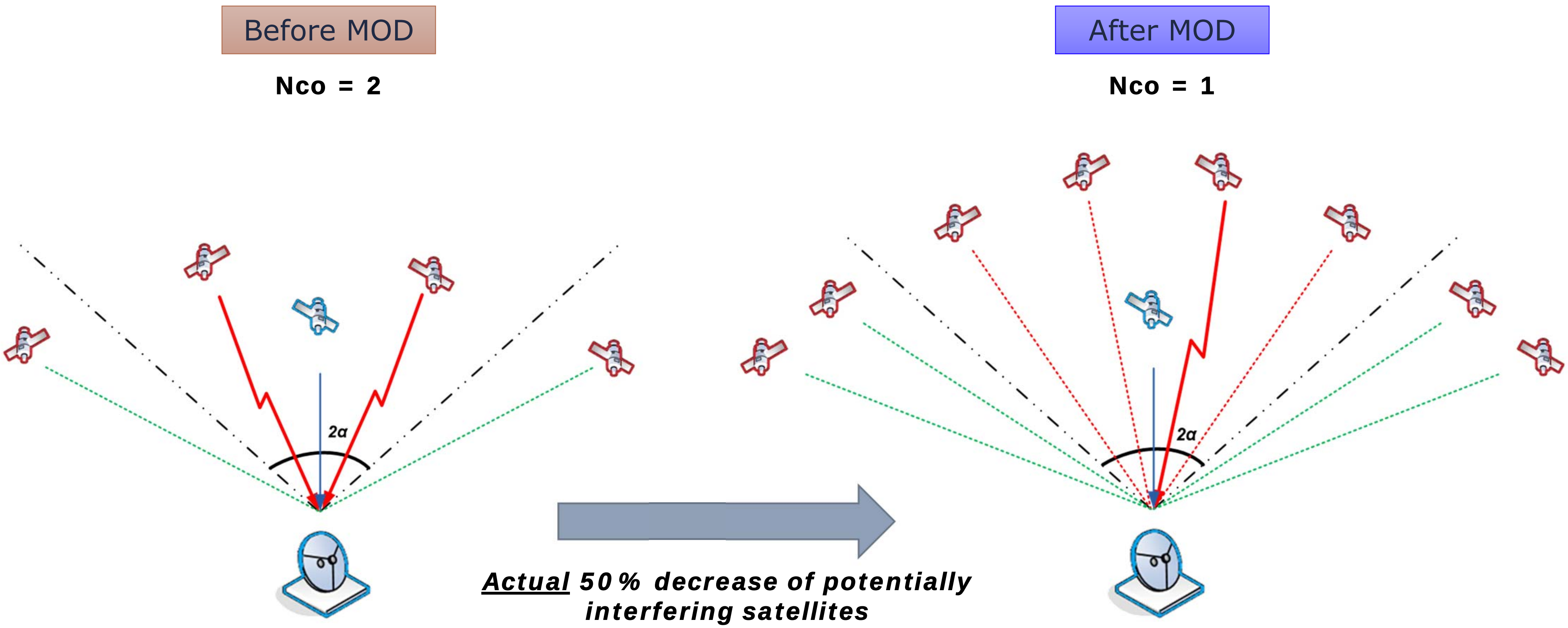
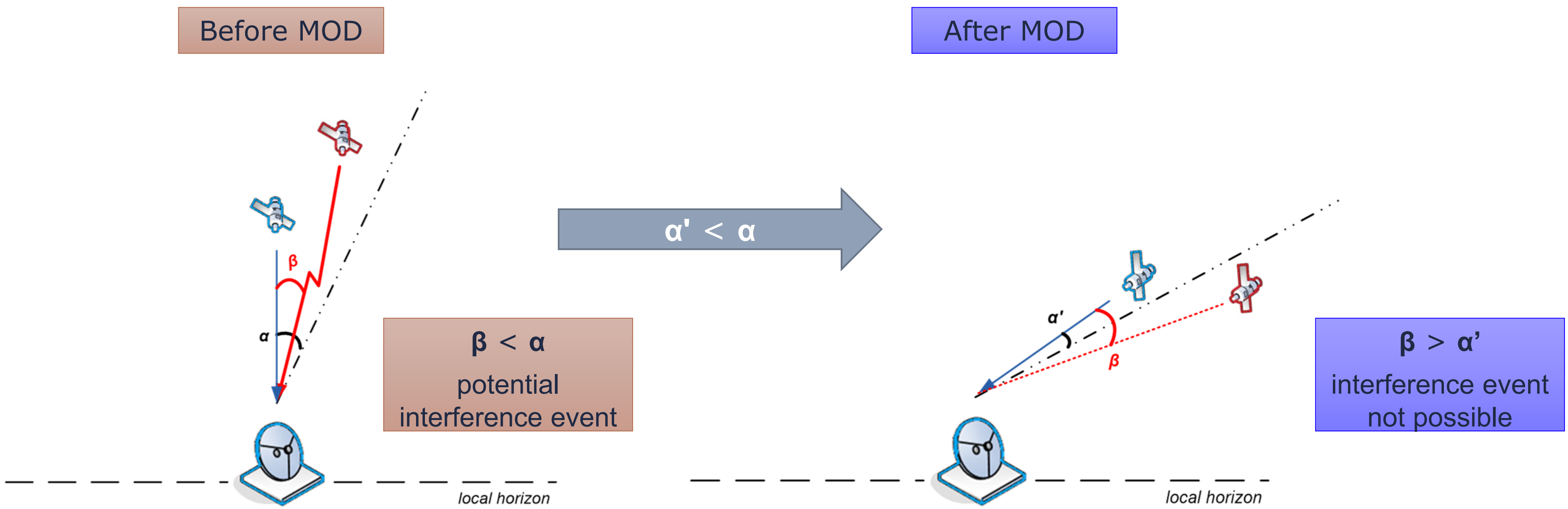
Method #1: Count of geometrical “in-line events” (3 / 4)



Actual ***50 % decrease of potentially interfering satellites***

Method #1: Count of geometrical “in-line events” (4/4)

- In 47 CFR § 25.261, the Commission has established a criterion based on interference-to-noise (I/N) ratio to assess the interference environment for NGSO licensees
- A method based on a fixed, pre-determined angle **α** is clearly not compatible with such a criterion
- In fact, an in-line event defined by an angle may be a potential interference event at one elevation but not at another elevation. Or, equivalently, **the angle at which the same I/N ratio is measured varies with the geometry considered** (see Annex)



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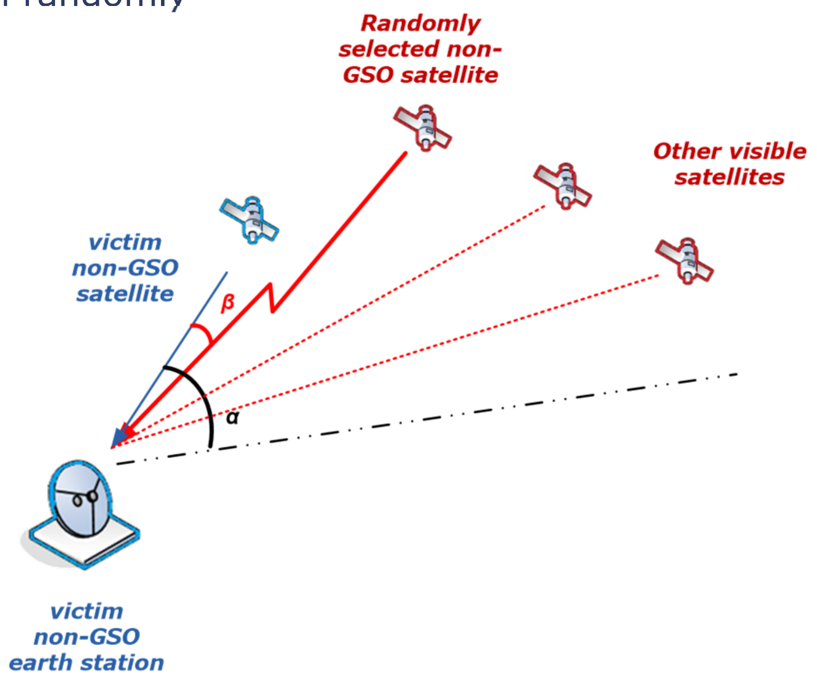
Method #2: Count of "in-line interference events" (1/2)

- Some other parties[3] have analyzed the number and duration of "in-line interference events", which are very similar to the "in line events" discussed earlier (Method #1)
- Once again, an "in-line interference event" occurs if the separation angle **β** between the wanted and interfering satellite, as seen from the interfered-with earth station, would fall within a certain fixed, pre-defined angle **α**, with the only difference that the interfering satellites are not all those in view but are this time chosen randomly



β < **α** for all three interfering satellites but only one "in-line interference event" occurs

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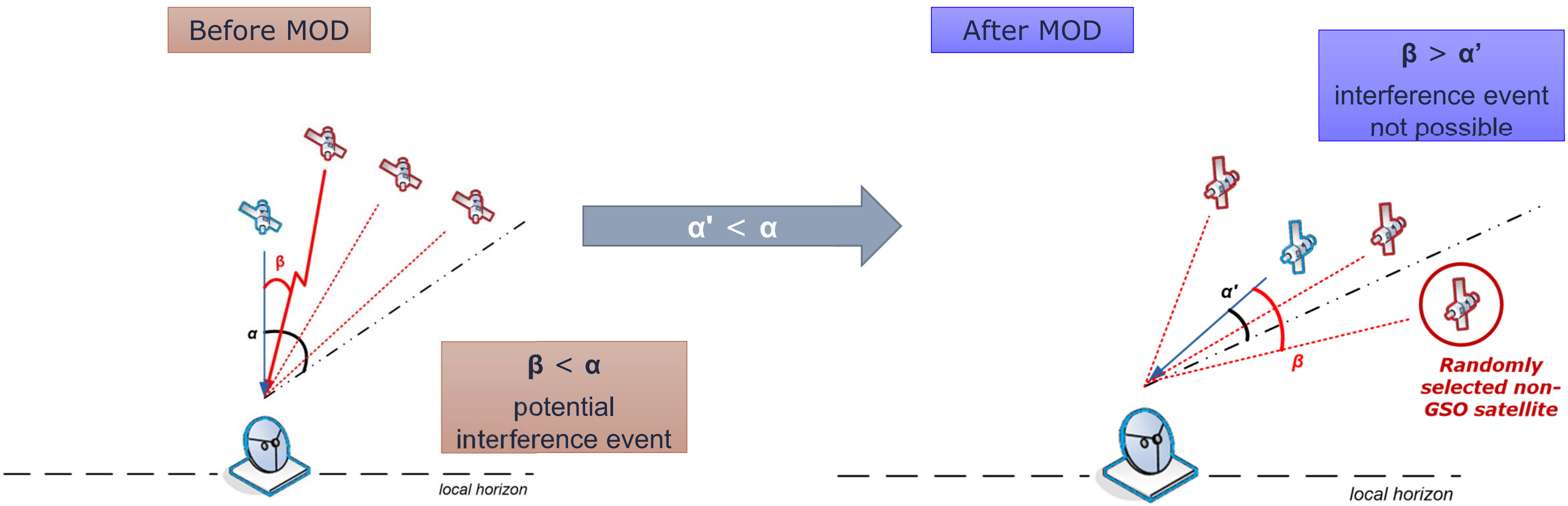
[3] *See*, e.g., Kuiper's petition to deny Viasat MOD-2 (13-Jul-20)

Method #2: Count of "in-line interference events" (2/2)

- This approach suffers from the same limitation as that applicable to the previous method (see slide 11), in that **the angle at which the same I/N ratio is measured varies with the geometry considered**
- The Commission has also concluded that a "*single avoidance angle method previously adopted has […] been shown to not address all of the varieties of new proposed systems*[4]"



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4 *See*, REPORT AND ORDER, Update to Parts 2 and 25 Concerning Non-Geostationary, Fixed-Satellite Service Systems and Related Matters - 2017, Sep. 27

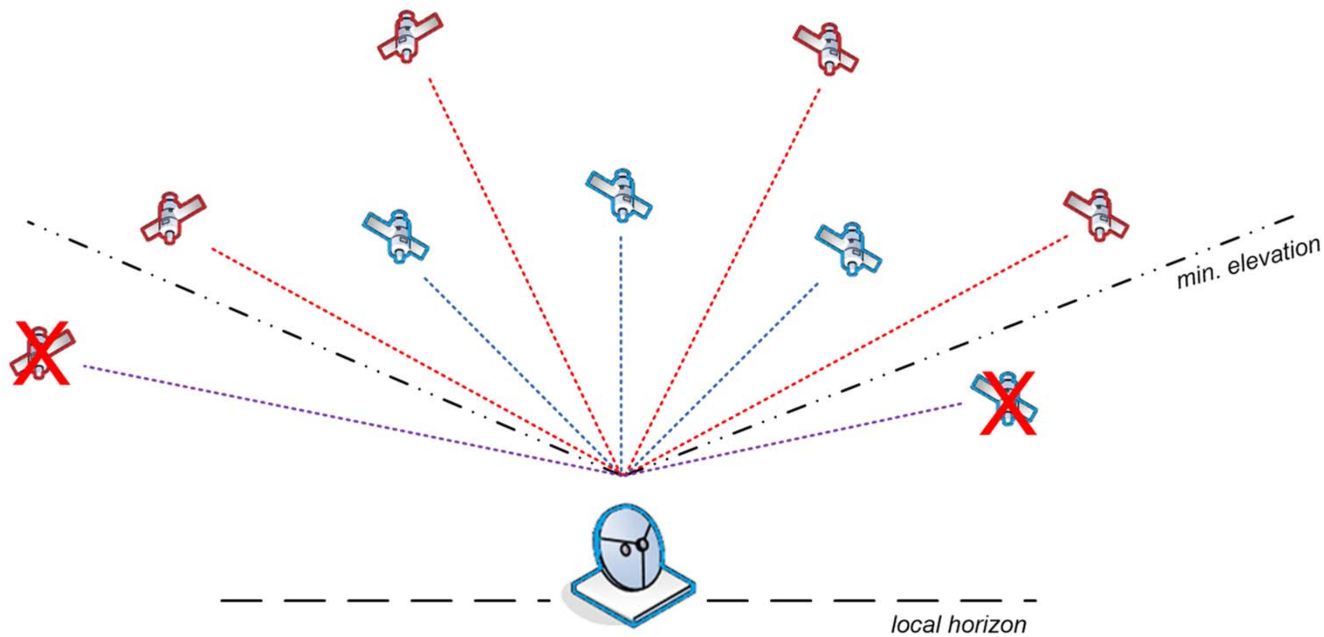
Method #3: Computation of I/N statistics (1/5)

- A correct evaluation of the change in interference environment after a MOD requires an actual assessment of the interference environment both before and after MOD
- Such an assessment requires a computer simulation that, at every time-step, models the following:
  a) The earth stations of the victim and interfering systems are collocated (*this is the worst case*)
  b) Each earth station can communicate with any satellite in its own system following the rules applicable for that system (e.g. compliance with the GSO avoidance angle and/or minimum elevation angle)
  c) The Nco satellites of the interfering system offering service at the location studied are chosen randomly
  d) All possible valid links for the victim system are considered in evaluating the CDF of the I/N ratio at the input of the victim receiver
- As it can be seen from the example which follows, this approach best models a real-world sharing environment, because:
  - At every time-step, only Nco satellites of the interfering system are assumed to be operating towards the location studied, rather than all those visible, which is unrealistic; and,
  - The impact of potential interference into the victim links does not depend on any particular geometry. In other words, the impact is measured in terms of I/N, rather than being based on a fixed, pre-determined angle α
- The example in the following slides shows an application of the correct algorithm in the downlink direction. Similar considerations can be made when considering the uplink direction

Method #3: Computation of I / N statistics (2 / 5)

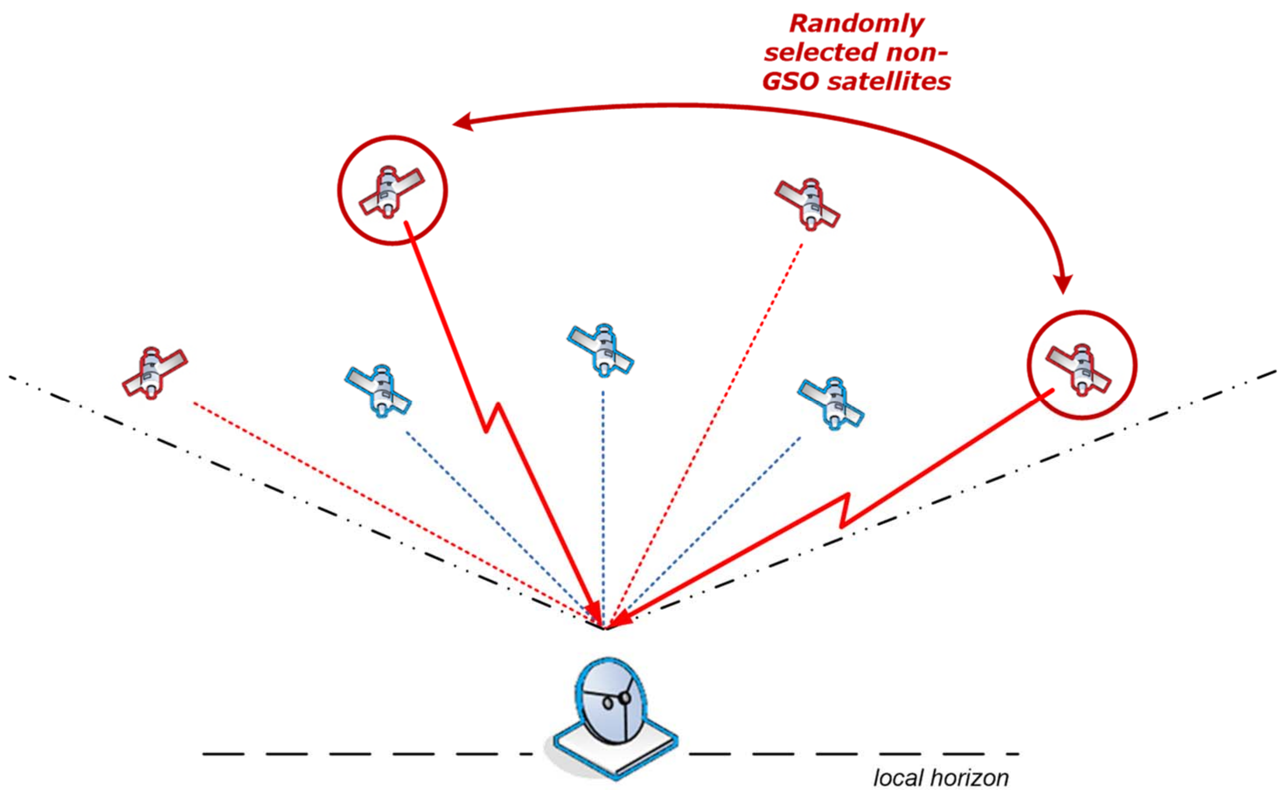
▲ **Step 1:** identify all eligible satellites of the victim and interfering systems

- **Victim:** 3 satellites
- **Interfering:** 4 satellites



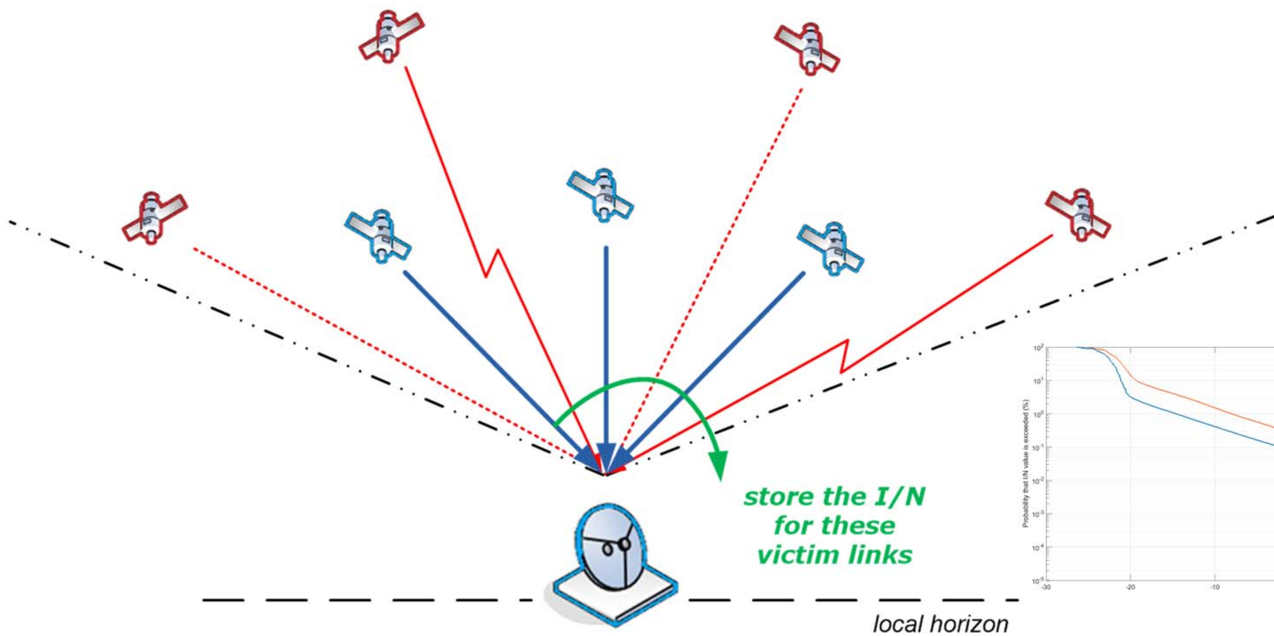
Method #3: Computation of I / N statistics (3 / 5)

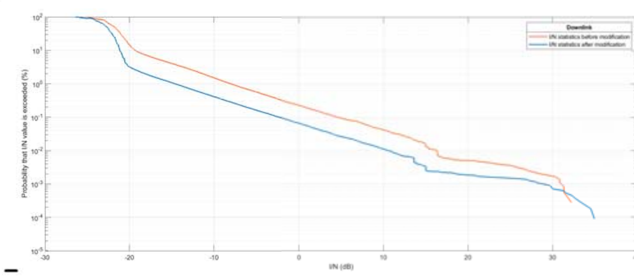
- **Step 2:** randomly choose Nco satellites of the interfering system
  - In this example, two random satellites of the interfering system out of the four eligible are assumed to be operating towards the victim earth station



Method #3: Computation of I/N statistics (4/5)

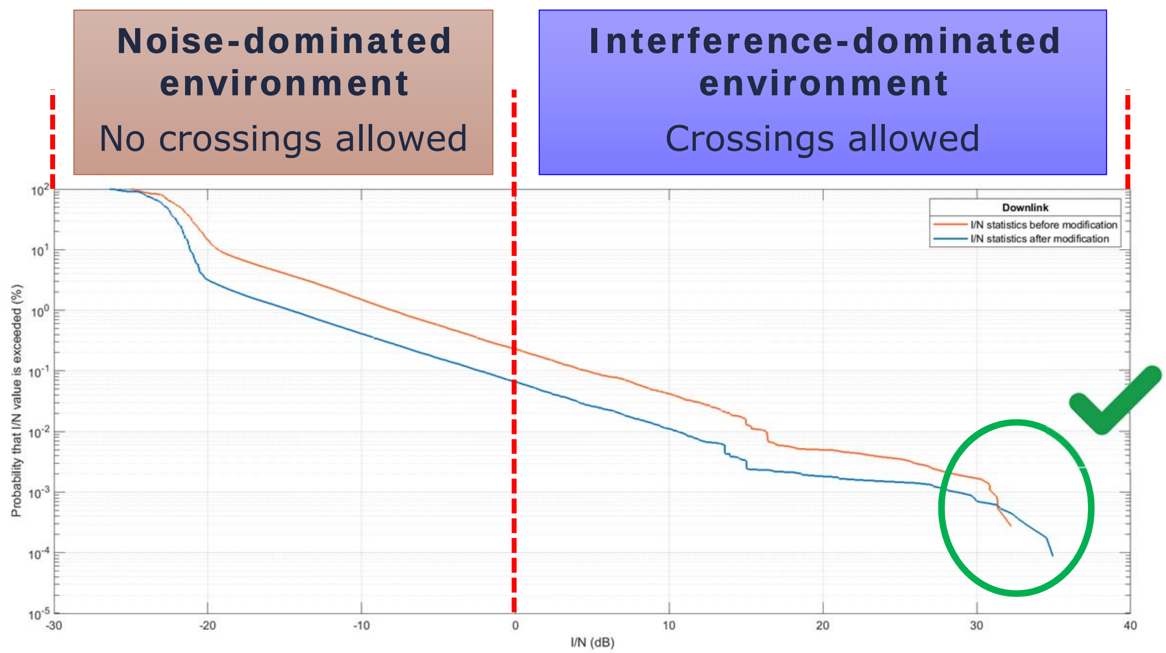
- **Step 3:** measure the I/N ratio at the input of the victim receiver for all eligible victim links and store the relative values
  - Once the simulation time is complete, compute the Cumulative Density Function (CDF) of the I/N ratio
  - Applying this approach to the original and modified NGSO system will provide two CDF curves, respectively





Method #3: Computation of I/N statistics (5/5)

- It can be concluded that the proposed modification of a NGSO system would not affect the environment of another NGSO system if, for each of the four scenarios, the CDF curve of the I/N ratio at the input of the victim receiver ***after MOD*** does not cross the correspondent CDF curve ***before MOD*** in the noise-dominated environment of the victim link (i.e. for I/N ≤ 0 dB)
- It should not matter whether the CDF curve ***after MOD*** crosses the CDF curve ***before MOD*** in the region where the environment in which the link operates is dominated by interference (i.e. for I/N > 0 dB), because in the "interference-dominated" environment, a link is very likely to be unusable already



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Methodologies Summary

- In summary, Method 1 and 2 are incorrect, and Method 3 is correct, for the following reasons:
  - Method 1 – Count of geometrical "in-line events"
    - This methodology erroneously assumes that (i) all satellites that are "in-line" are actually transmitting co-frequency and that (ii) "in-line" events should be identified on the basis of a fixed, pre-determined angle α
  - Method 2 – Count of "in-line interference events"
    - This methodology erroneously assumes that "in-line interference events" should be identified on the basis of a fixed, pre-determined angle α
  - Method 3 – Computation of I/N statistics
    - This methodology correctly models a real-world interference environment, as (i) only Nco among the visible satellites of the interfering system are assumed to be operating at any given time-step and (ii) the I/N ratios of all possible interfered-with links are considered, independently from the separation angle between the wanted and interfering satellites

Summary

- Telesat's May 26, 2020 modification application includes an analysis of the four required scenarios (i.e. as victim and as interferer, in each of uplink and downlink) using the correct Method 3 (computation of I/N statistics) methodology
- The results show the Telesat LEO modified constellation of 298 satellites does not change the interference environment with respect to other first round applicants, as compared to the Telesat LEO original constellation of 117 satellites
- As there is no change in interference environment, the Commission should authorize the Telesat LEO modified constellation of 298 satellites in the first processing round
- There is no reason to initiate a rule-making, as SpaceX and Amazon have proposed, as case-by-case showings can be readily provided using Method 3, based on the computation of I/N statistics

Annex

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Assumptions to compute the avoidance angle in methods #1 and #2

TABLE 1

System characteristics

Parameter	Unit	Value
Victim/interfering earth station location	-	Co-located
Victim earth station noise temperature	K	250
Victim earth station antenna pattern	-	APEREC015V01
Victim earth station antenna diameter	m	0.5 to 1.0
Victim earth station antenna efficiency	-	60%
Victim system minimum elevation angle	°	10
Frequency	GHz	19
Interfering satellite orbit altitude	km	1000
Interfering EIRP spectral density	dB(W/Hz)	-40 to -50
I/N threshold	dB	-12.2

Assumptions to compute the avoidance angle in methods #1 and #2

TABLE 2

Results

Victim earth station antenna diameter (m)	Interfering EIRP density (dB(W/Hz))	Victim satellite elevation angle (°)	Required avoidance angle (°)
0.5	-40	90	27.02
		10	11.98
	-45	90	17.05
		10	7.56
	-50	90	10.76
		10	4.77
1.0	-40	90	12.94
		10	5.74
	-45	90	8.17
		10	3.62
	-50	90	5.16
		10	2.29

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Telesat LEO

Proposed Modification to Market Access Grant

December 7, 2020

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