Caribbean Telecommunications Union
Policy Considerations in the New Space Era

Presentation by Amy Mehlman

June 29, 2021

Viasat

Viasat is a global communications company that believes everyone and everything can be connected

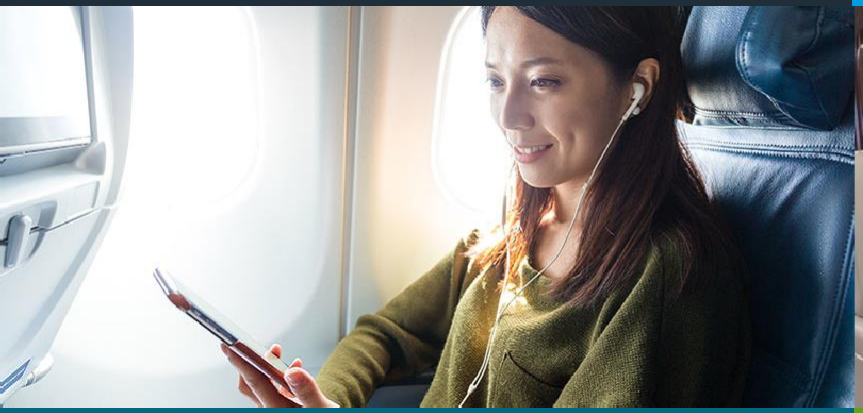
We find better ways to deliver connections with the capacity to change the world — on the ground, in the air, and at sea

Fast connections for consumers and businesses

Unlimited home internet plans mean unlimited possibilities

Business internet and Wi-Fi for hard-to-serve locations

Connecting the unconnected to affordable high-speed internet



The best Wi-Fi in the sky gives every passenger freedom to stream

Stay productive and entertained on private aircraft

Fast, reliable internet for cruise ships, pleasure craft, and other vessels

Viasat

ViaSat-3: game-changing innovation

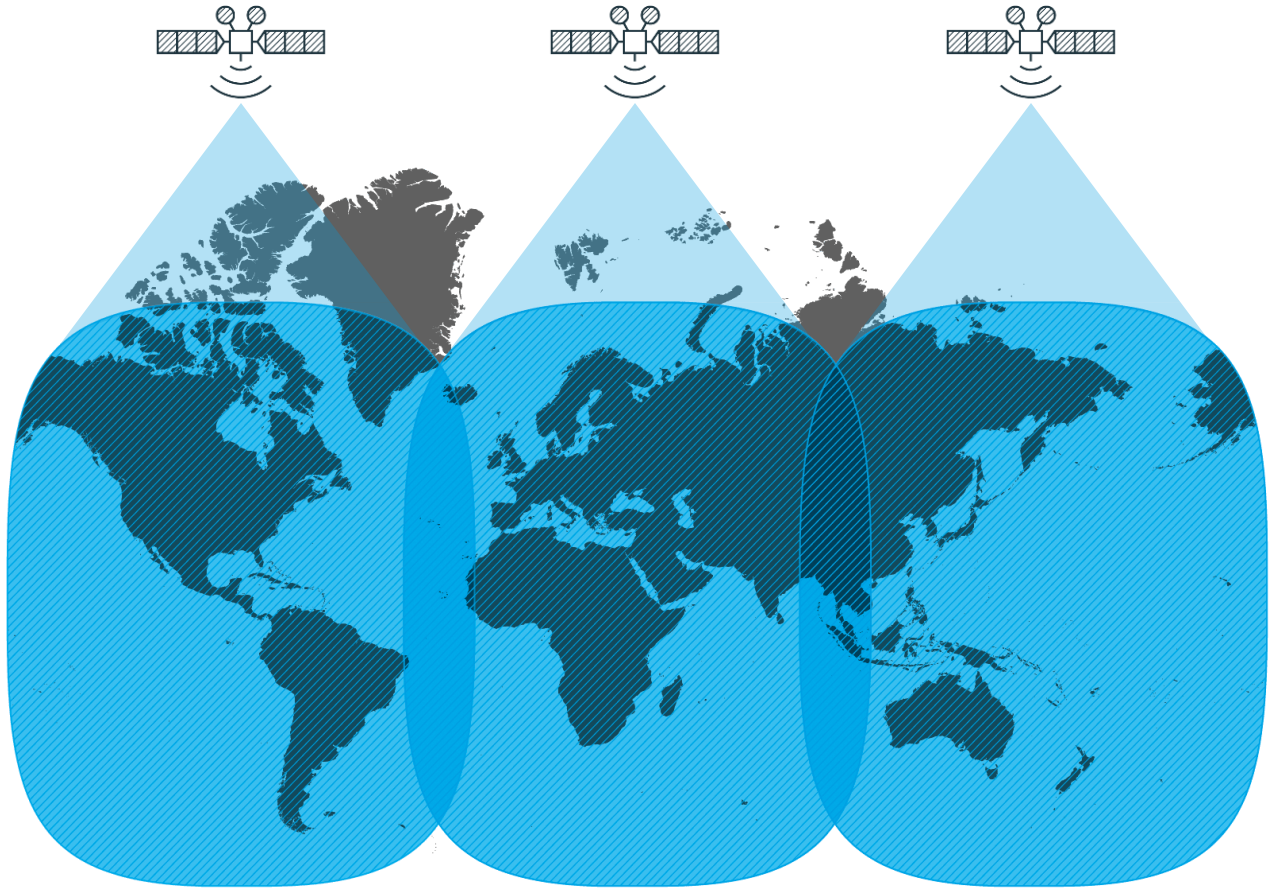
Expected to be the most cost-efficient, integrated, flexible, global satellite broadband infrastructure

Expected capacity
1+ Tbps per satellite

Global constellation
Construction well underway

Expected design life
~15 years

Efficient asset
Expected to be ~3-4x more cost efficient than VS-2



Viasat + CTU

Viasat around the region: Case Study

- Viasat partnered with ReadyNet per the Ministry of Education's goal to connect schools across Jamaica
  - Collaboration with Jamaican Ministries of Education, Science, Energy and Technology and Spectrum Management Authority
- VSAT license streamlining, and fee reduction led to:
  - 100 sites installed by end of 2020
  - Plans to connect several hundred more sites this year
- Use of Ka band and High-Throughput Satellite technology gives each school 25/5 Mbits/s which allows for simultaneous use of:
  - High-definition video conferencing
  - Multiple video streaming services
  - Connection for on-line education platforms

New Space and Beyond – Policy Considerations

Unsafe & “Unscalable” Approaches in Low Earth Orbit (LEO)

Countries must:

- Address GSO/NGSO spectrum sharing policies
- Ensure equitable access *to limited spectrum and orbital resources* by many different satellite systems
- Prevent unnecessary risk of collision in LEO to other satellites operating in LEO and those who must traverse LEO to get to other orbits

Viasat

Interference Risks from NGSO systems to GSO and other NGSO systems

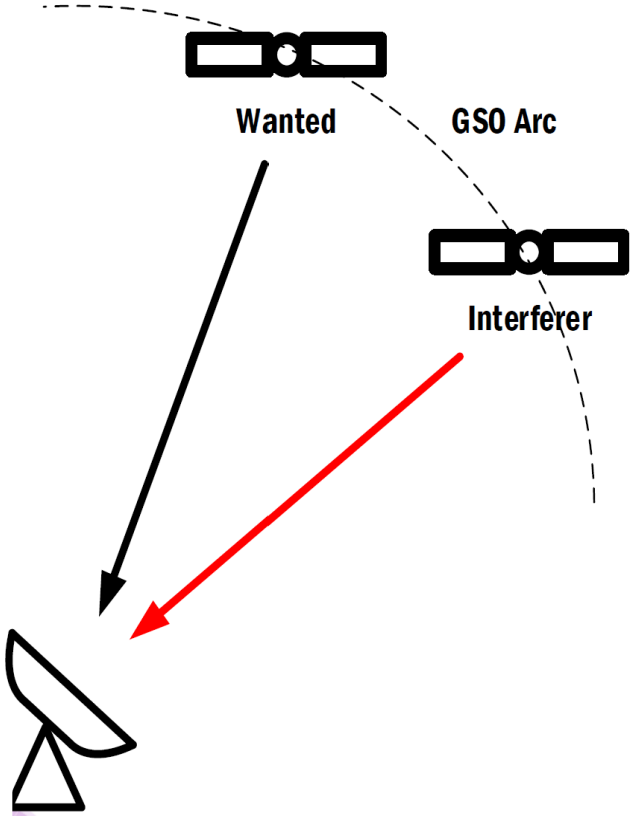
History of GSO/NGSO Spectrum Sharing Rules

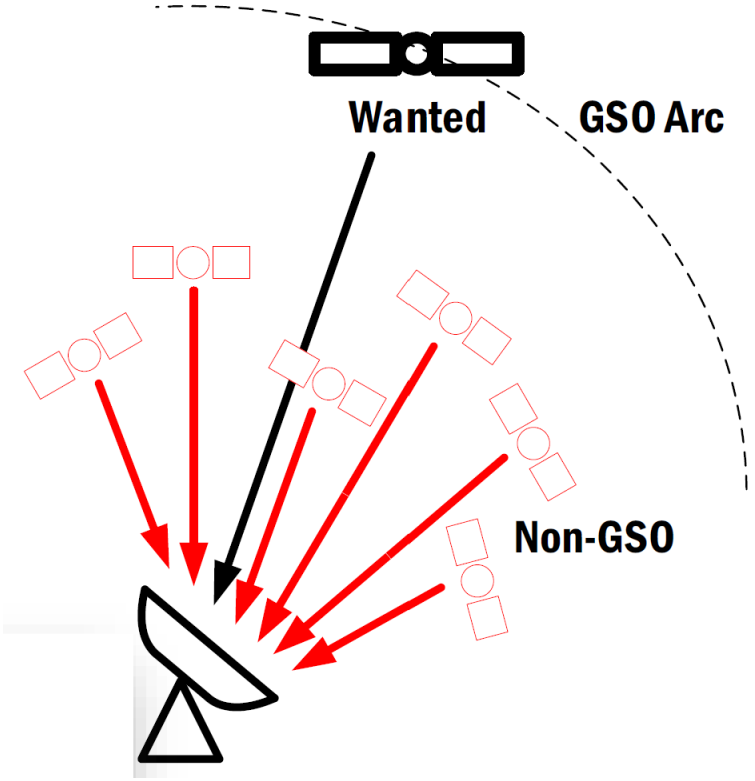
- NGSO systems led by Teledesic and SkyBridge in 1990's fizzled.
- However, legacy of 1990's NGSO interest was development of regulations, including Equivalent Power Flux Density (EPFD) limits over a patchwork of frequencies, to protect valuable GSO arc --- allowing GSO and non-GSO to co-exist in the same frequency bands based on networks at the time.
- Rules were based on systems like Teledesic which had a proposed 840 satellite constellation.
- Now, systems of thousands and tens of thousands are being proposed and launched.
- Given large numbers of satellites in each constellation plus each additional constellation, great risk of substantially higher anticipated levels of aggregate sidelobe and backlobe interference.

GSO Arc is a Valuable Natural Resource and Should be Protected

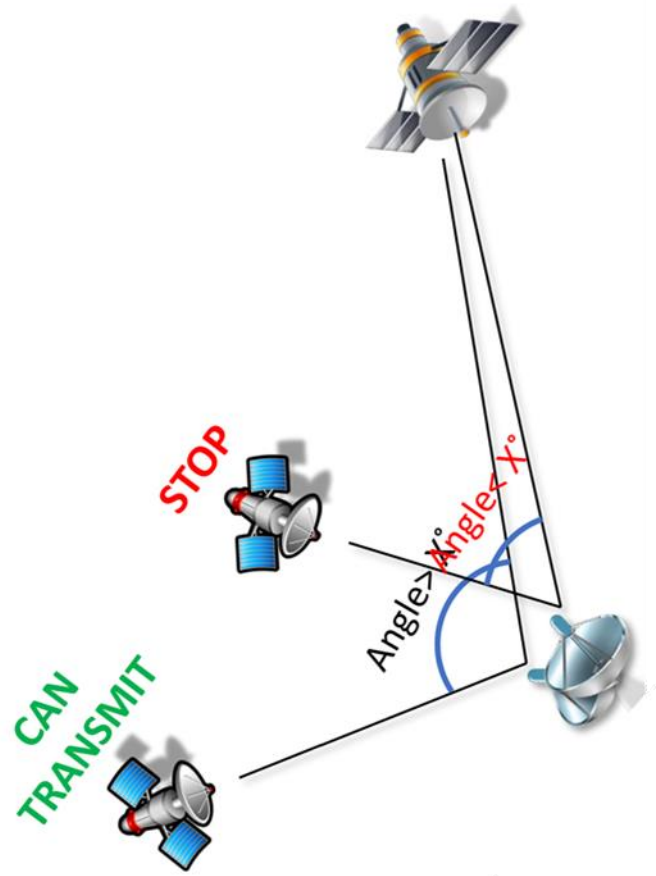
- National licensing conditions are required for non-geostationary satellite orbit (NGSO) systems to ensure protection of existing and planned geostationary orbit (GSO) networks.
- The best available mechanism for ensuring the protection of future and advanced GSO networks, including advanced ultra-high-throughput (UHTS) GSO networks, from NGSO radio spectrum interference is by conditioning NGSO systems' market access on "angular avoidance" of the GSO arc by their system's operational satellites when serving a given location on Earth.

GSO-GSO Sharing is Simple Compared to GSO-NGSO





GSO Arc Avoidance



Technical solution for **NGSO** is to avoid pointing antennas to **GSO** orbit or avoid operating satellite when there is insufficient GSO arc avoidance angle between direction to **NGSO satellite** and closest point on **GSO** when viewed from **NGSO earth station**

GSO-NGSO Radio Frequency Co-existence

- NGSO constellations will cause interference to GSO networks, reducing capacity, unless appropriate constraints are implemented on NGSO systems by regulators at market access stage:
  - require NGSO system operators to employ GSO arc angular avoidance (non-operation) across all co-frequency bands – simple mechanism, straightforward implementation and monitoring
  - calculate permitted NGSO system emissions in same frequency bands as GSO networks on a "per constellation basis"
    - Do not allow use of multiple ITU filings by a single NGSO system operator to circumvent single system EPFD limits
  - ensure that *aggregate interference* is constrained from main beams *and sidelobes* from the millions of user terminals and antenna beams from many thousands of satellites being deployed
    - Requires demonstration of effective mechanism for managing *aggregate* interference --- not theoretical calculations based on software with known limitations

Viasat

NGSO-NGSO Orbit Resource Sharing

"It's a race to the bottom in terms of getting as much stuff up there as possible to claim orbital real estate."

Associate Professor Moriba Jah, Dept. of Aerospace Engineering and Engineering Mechanics, Univ. of Texas at Austin

Probability of Satellites in NGSO System B Blocking All Satellites in NGSO System A

	NGSO System B		
NGSO System A	300 Satellites	3,000 Satellites	30,000 Satellites
300 Satellites	2.7%	31.2%	100%
3,000 Satellites	0%	18.5%	100%
30,000 Satellites	0%	0%	100%

Typical orbital parameters; user terminal modelled at representative location of 19.3^{0}N, 99.1^{0}W (Mexico City, Mexico)

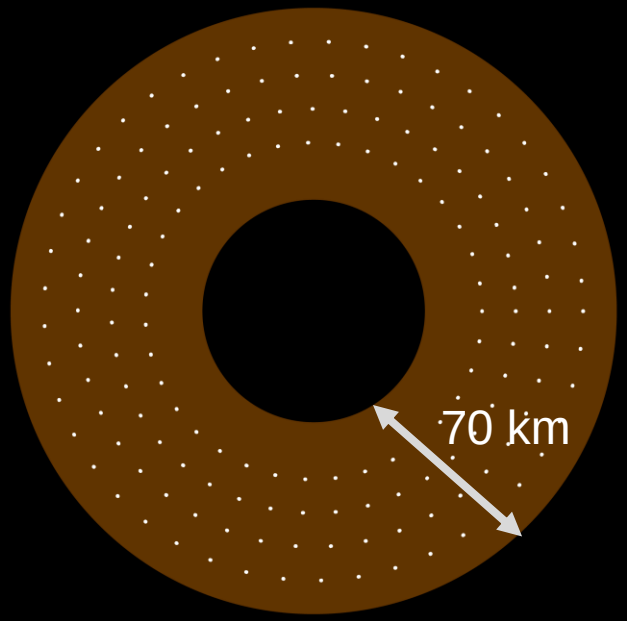
Viasat

Access to Limited Orbital Resources

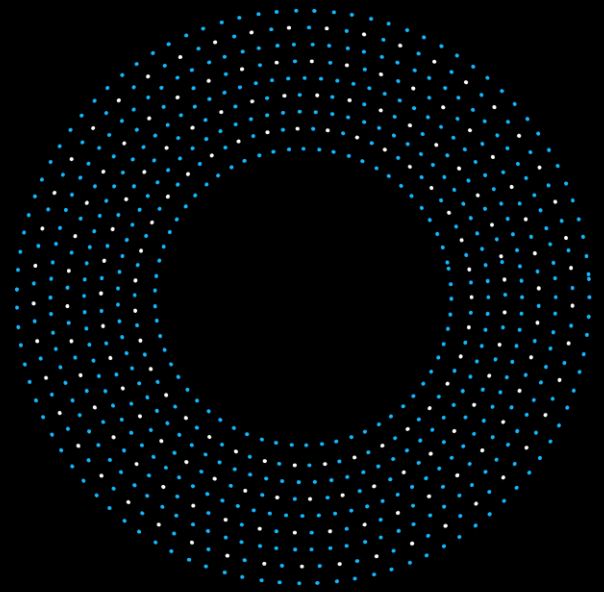
Viasat™

Reasonable Orbital Tolerances are Pro-Competition

- Other constellations and administrations **must be able to** also occupy valuable orbits



- 10 km spacing
- ±30 km altitude tolerance
- ±0.5˚ inclination tolerance



- 10 km spacing
- ±2.5 km altitude tolerance
- ± 0.1˚ inclination tolerance

- **One operator is being allowed to claim every altitude from 510 to 580 km**
- **However, they only need < 1 km tolerance for station keeping**
- **Multiple constellations should be allowed to co-exist!**

- **With appropriate tolerances there is room for many NGSO systems**

Viasat

Preventing collisions in LEO

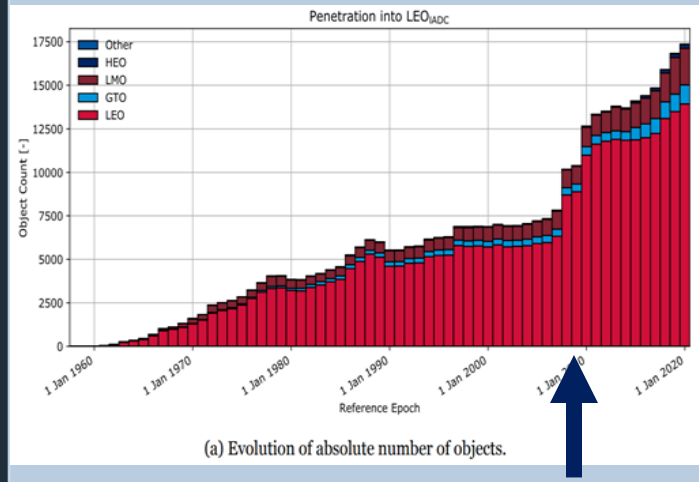
Viasat™

Aggregate Collision Risk Limit is Needed

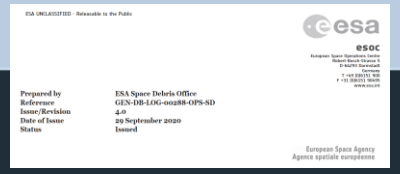
Single-satellite limit

- 4,408 satellites
  - 260 kg
  - 190,000 cm^2
  - 4.4 collisions every 5 years

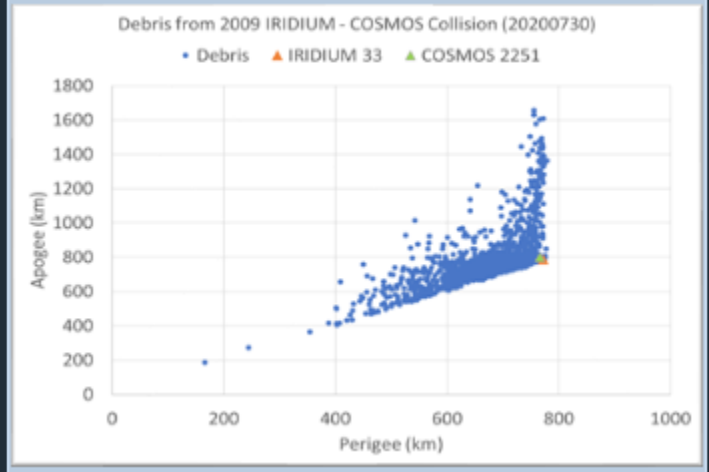
Collision effect on debris



(a) Evolution of absolute number of objects.



Collision effect on orbits



Viasat

Consequences of Collisions

Decay times for debris from collisions at 550 km

- Collisions of these satellites at 550 km risk polluting orbits many 100s of km above and below with large fields of fast-moving shrapnel
- That debris would:
  - Traverse those other orbits for decades or even centuries
  - Impair use of those orbits and harm many other users
  - Reduce launch windows

Apogee (km)	Decay Time
550	13.7 years
650	17.8 years
750	28.6 years
850	42.9 years
950	59.9 years
1050	79.7 years
1150	96.5 years
1250	> 100 years
1350	> 100 years

Decay time calculated assuming 550-km perigee, typical debris 0.01 m^2/kg area-to-mass ratio, and 2020 start of decay

Viasat

Aggregate Collision Risk Limit Must Consider Satellite Failures and Residual Risks

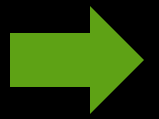
Maneuverability Failures

Over 20 failed satellites, in one constellation alone, (>1.6%) still in orbit are non-maneuverable, failed satellites can't avoid collisions

Residual Risks

Very, very large number of very low probability events means multiple collisions are expected

(Conjunctions intentionally not avoided and, avoiding one collision and causing another)



Aggregate Collision Risk

Proposed limit:
1 in 1,000 (0.1%) chance of collision **per constellation**

Viasat

Must Address Constellation as a Whole

Assessing a single satellite's risk of collision is insufficient

# of Satellites in Orbit	Allowed Mean Time Between Collisions (years) Assuming 5-Year Satellite Life
1	5,000
10	500
100	50
1,000	5
5,000	1
10,000	0.5 [180 days]
50,000	0.1 [36 days]
100,000	0.05 [18 days]

Table 1: Application of single-satellite collision probability metric

Viasat

Aggregate Collision Limit Critical to Manage Excess Risk Before it Becomes Unmanageable

Remediation = plan to contain and manage excess risk

As compared to **ignoring** risk

Viasat

Recap: Suitable Limitations are Needed on LEO Systems

Addressing these matters at the market access stage is critical

1. Defined spectrum use parameters
2. Orbital trajectory tolerances
3. *Aggregate* collision risk and remediation