

## Unresolved coexistence issues with large NGSO systems in Ku, Ka, Q and V band:

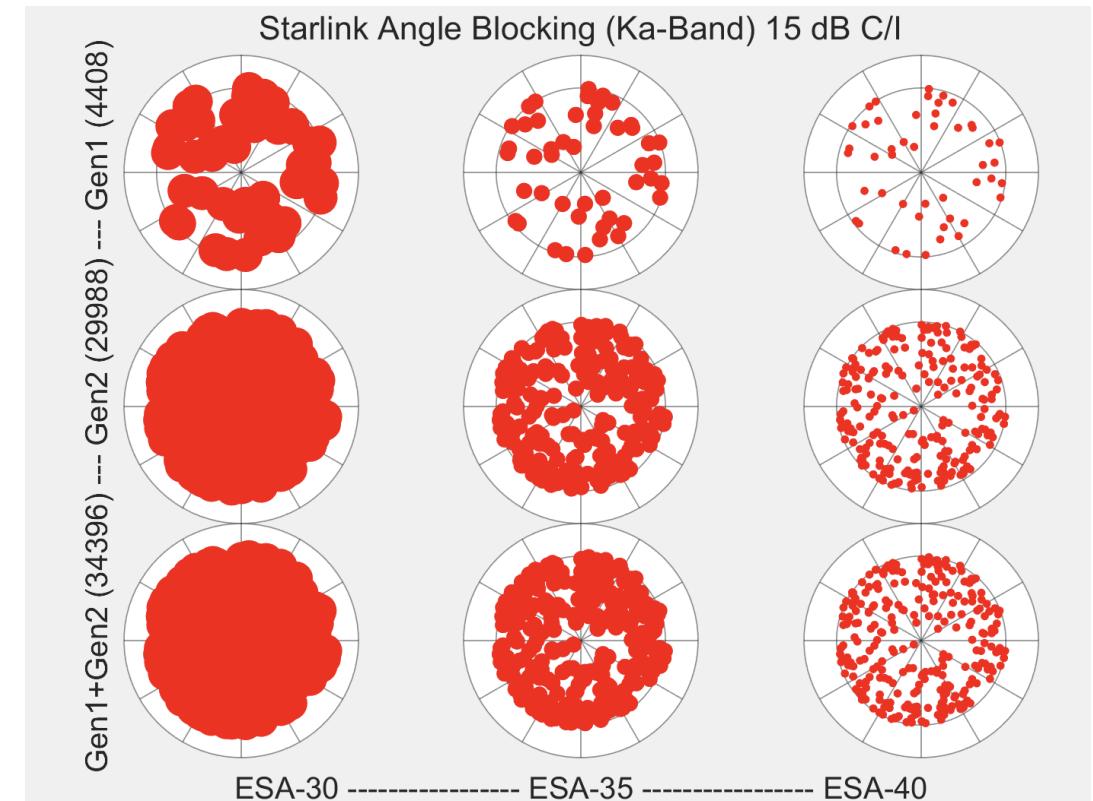
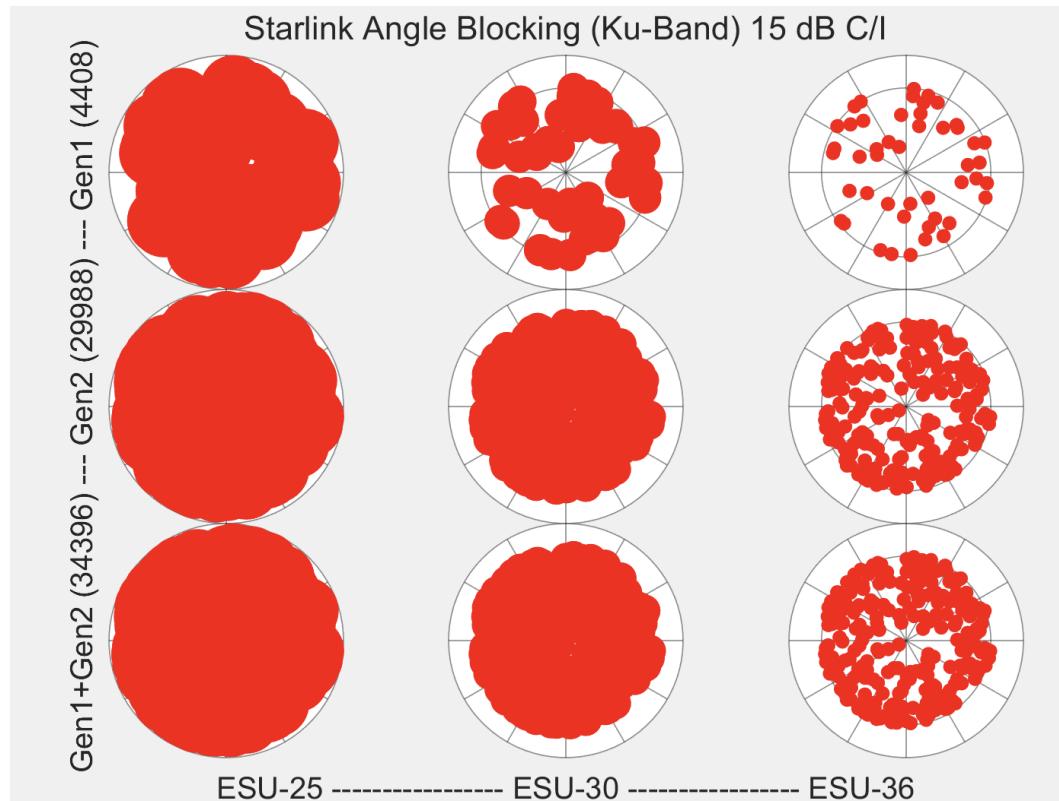
Underestimation of NGSO interference and impacts

# Large-scale NGSO issues must be resolved before more spectrum is opened up or modified for NGSO use at WRC-27. Underestimation of interference

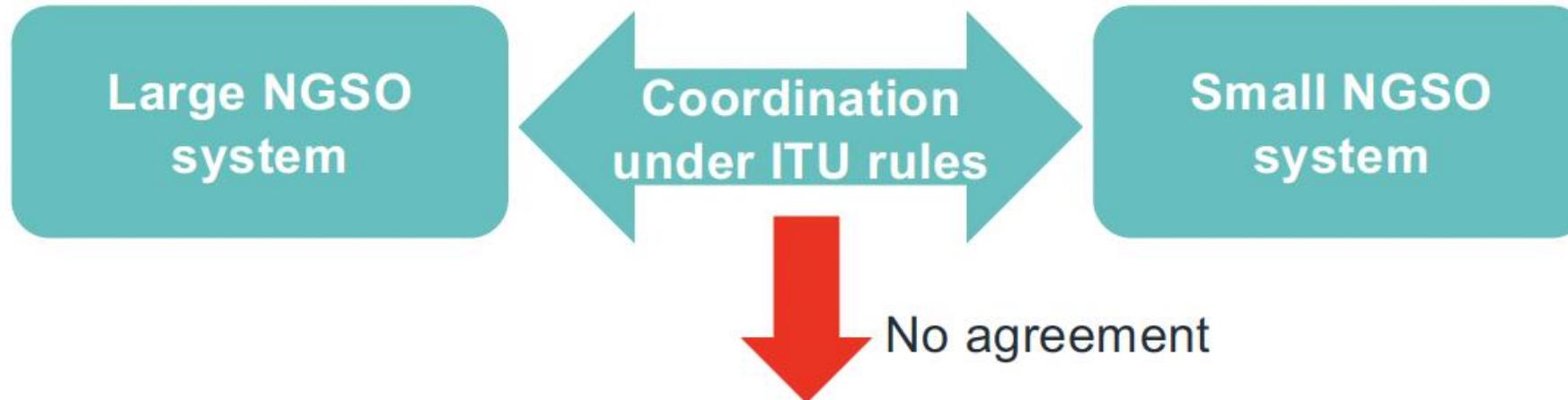
WRC-27 Agenda Item	Issues
AI 1.1	Existing Q/V band GSO-NGSO framework <b>does not contemplate ESIM operations</b> , which in the case of aeronautical and maritime ESIMs, occur without the same level of rain attenuation that is otherwise assumed to exist under the existing Q/V band approach. <b>As a result, interference towards GSOs is underestimated</b>
AI 1.2	Removing the limitations on the minimum earth station size of an NGSO system and consequential deployment of smaller earth stations in this band would <b>further constrain NGSO-NGSO sharing environment, exacerbate look angle blocking by mega-constellations</b>
AI 1.3	Existing GSO-NGSO framework in adjacent band should not be reflexively extended to 51.4-52.4 GHz. <ul style="list-style-type: none"><li>• It underestimates the interference caused by NGSOs and its impact on GSO service level agreements (SLAs),</li><li>• It is incomplete, and;</li><li>• Due to its reliance on GSO reference links in Radio Regulations and S.1503, <b>does not provide limits to protect GSO operations outside worst-case geometry</b></li></ul>
AI 1.4	Existing single-entry and aggregate EPFD limits must be applied in this band, ITU coordination inadequate for NGSO-NGSO sharing. Needs to consider <b>how to apply aggregate limits, which is yet to be resolved</b> .

# Mega-constellation Look Angle Blocking in Ku and Ka band

- Solution needed to address **ineffectiveness of ITU Article 9 coordination and look angle blocking**, else limited NGSO services will be available, harming the India market
- This problem becomes even more acute with small mobile NGSO antennas, like ESIM



# Challenges with NGSO-NGSO sharing



- Large NGSO system with many thousands of satellites use their multiple satellite selection options to protect itself from interference.
- Smaller NGSO system gets blocked from providing service and with fewer satellites to select from, receives interference
- And even when coordination is “agreed”, it often comes with a commercial price since mega-constellations also own a large portion of the launch market!

# Existing Q/V band framework for protection of GSO from NGSO interference is flawed and incomplete

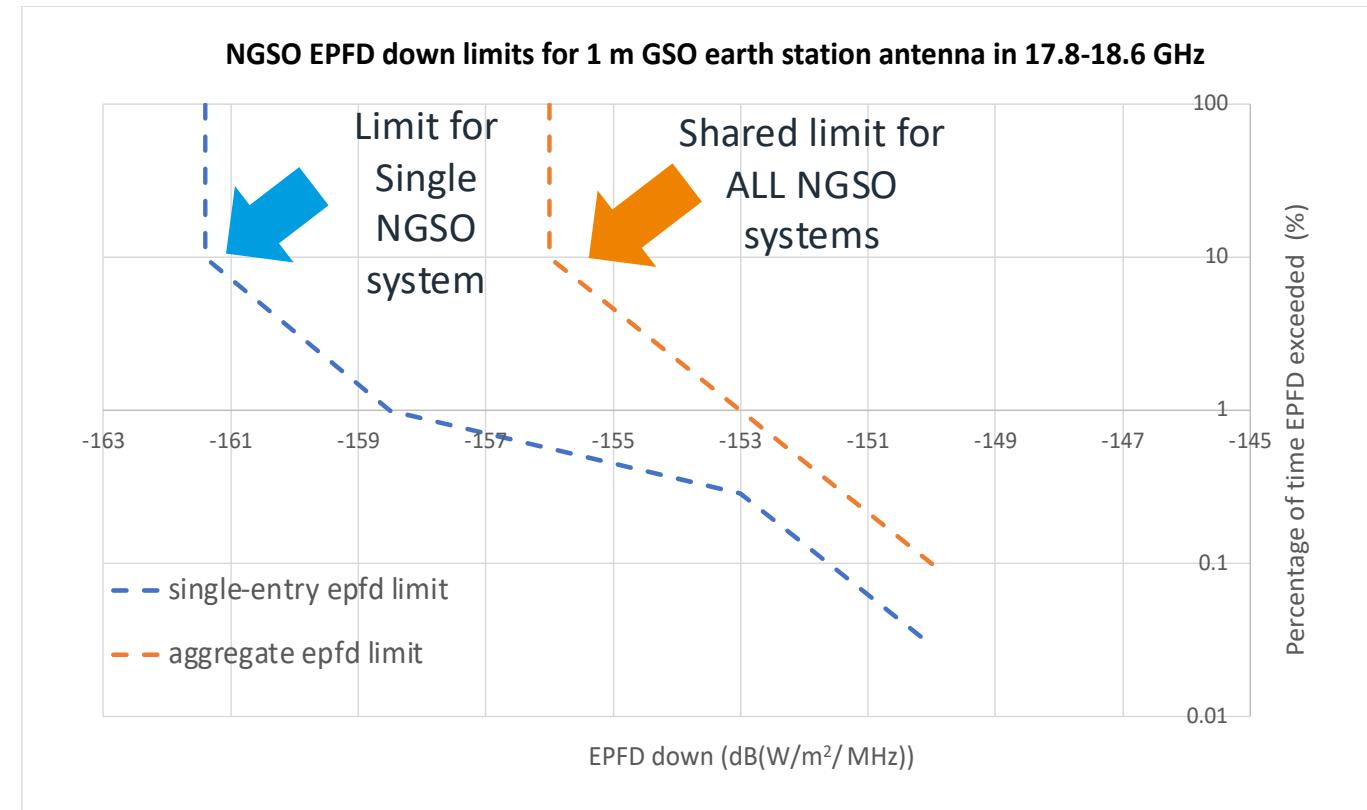
- The existing provisions of RR (No. 22.5L and 22.5M) and methodology in Resolution 770 and 769 in the adjacent band is inadequate for constraining NGSO interference into GSO networks:
  - The average throughput degradation metric **underestimates the interference** caused by NGSOs and its impact on GSO service level agreements (SLAs)
  - The framework is incomplete and required studies as per Resolution 769 have not been conducted
    - Aggregate interference from all NGSOs
    - Development of Supplemental GSO links for compliance assessment
    - Use of multiple C/N objectives in GSO links to assess NGSO system compliance with protection criteria
  - The framework is theoretical, does not provide limits to protect GSO operations and the interference cannot be quantified or taken into account in GSO network design

# Underestimation of Large-scale NGSO interference:

## Starlink/ Amazon proposal to degrade ITU EPFD rules

# Aggregate EPFD: EPFD Limits Constrain Total Interference from All Non-GSOs

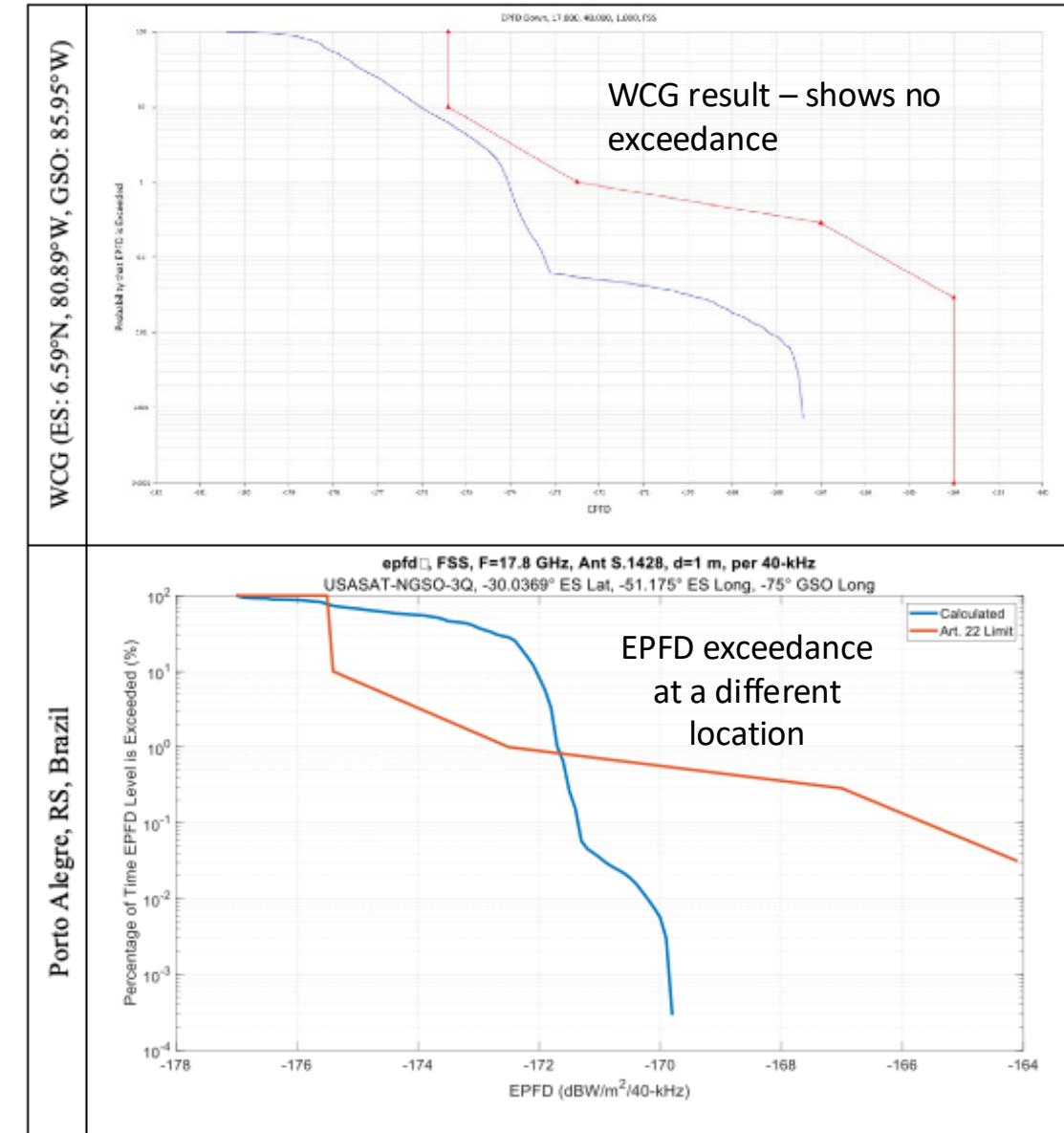
- WRC-23 (Dubai 2023) decided that administrations should conduct consultation meetings to:
  - assess and ensure compliance by NGSO systems with the aggregate EPFD limits
  - reduce EPFD levels of NGSO systems if limits are exceeded
- Single-entry limits is an apportionment of Aggregate EPFD limits which has to be shared amongst all NGSO systems
- Two large NGSO operators together claim 86% of the EPFD allowance today for ***all NGSOs in the world***
- Where would other NGSOs fit?



**Critical to finalize aggregate EPFD evaluation methodologies, ensure equitable sharing of aggregate EPFD budget and reduce aggregate EPFD proportional to the contribution of each NGSO system**

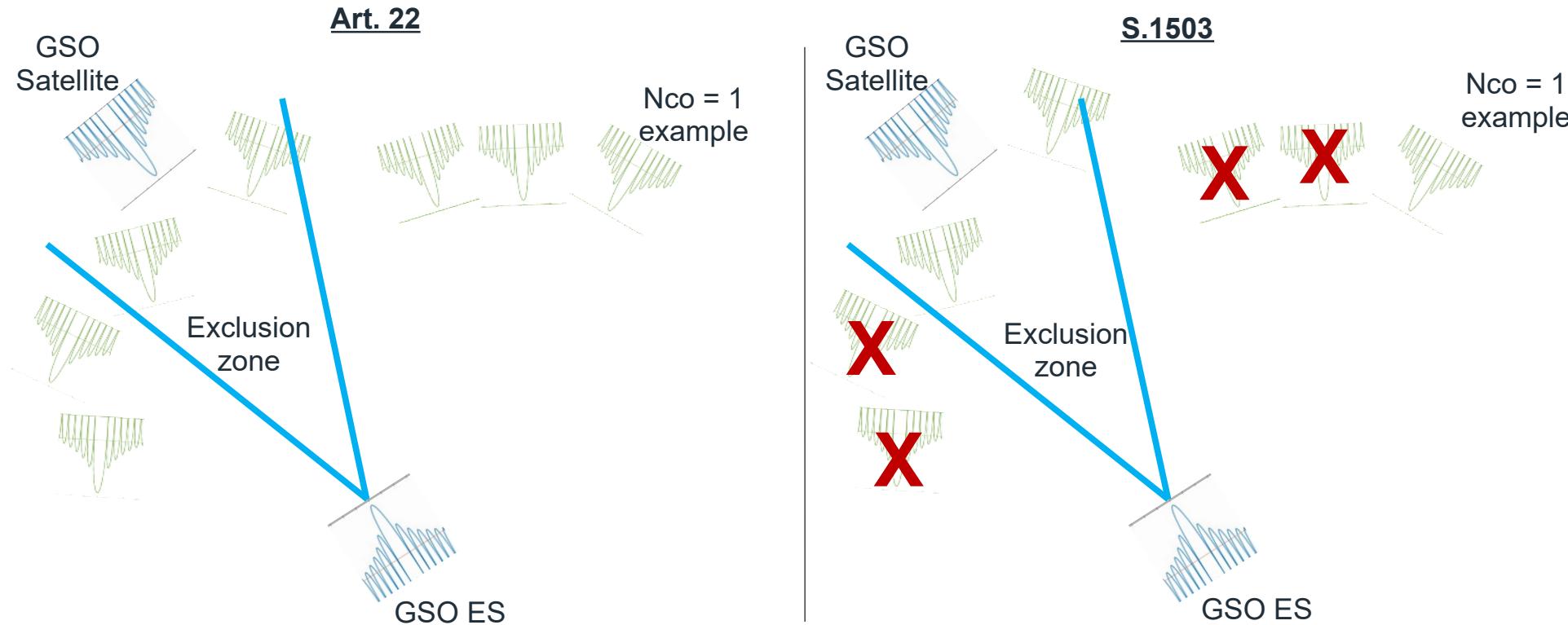
# NGSO EPFD limit exceedances at various locations

- The Worst Case Geometry is defined by the locations of the GSO earth station and GSO satellite that analysis suggests would cause the highest epfd value from a single satellite
- This is the only geometry that ITU assesses for NGSO EPFD limit compliance; has no bearing on whether NGSO system can meet EPFD limits at other geometries
- It typically is not a representative GSO service location
- RR 22.5C requires the downlink EPFD levels to be met
  - at any point on the Earth's surface visible from the geostationary-satellite orbit
  - for all GSO earth stations and pointing angles towards GSO arc
  - remains necessary for NGSO operator to meet EPFD limits for all geometries (per S.1503)
- Taking advantage of WCG only examination, one mega-constellation operator has submitted “manipulated” PFD mask to deliberately force WCG at the equator using an orbital shell (604 km) that is not even authorized by its filing administration – without that shell, system exceeds EPFD even at WCG



# Sidelobe contribution must be included in EPFD calculation

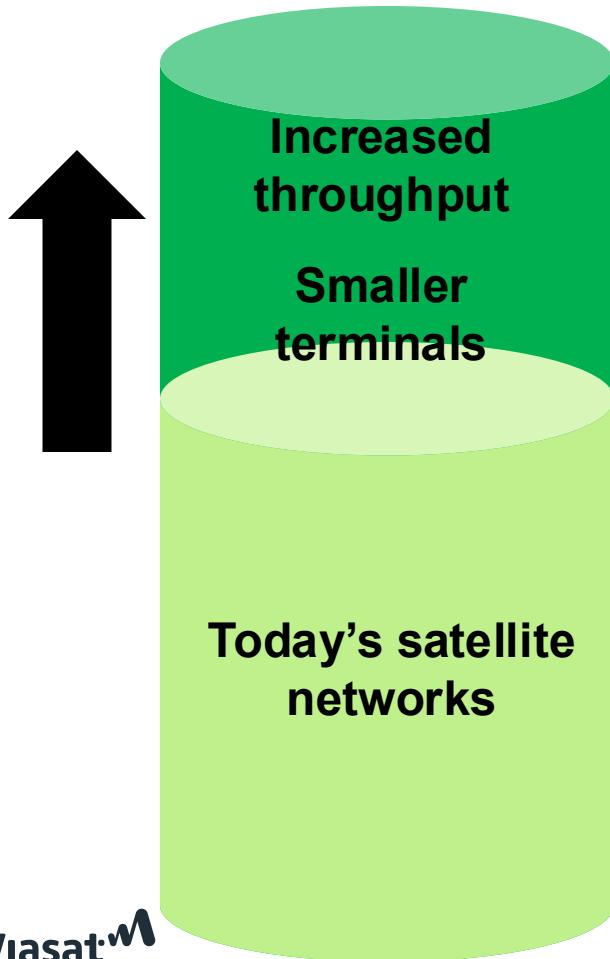
- › ITU S.1503 tool does not take into account all emissions of NGSO system as shown below.
- › As per Art 22 (left), all NGSO satellite emissions must be taken into account. S.1503 (right) ignores many sidelobes



- › Analysis submitted to WP4A shows that the exclusion of sidelobe emissions in calculation of EPFD significantly underestimates EPFD

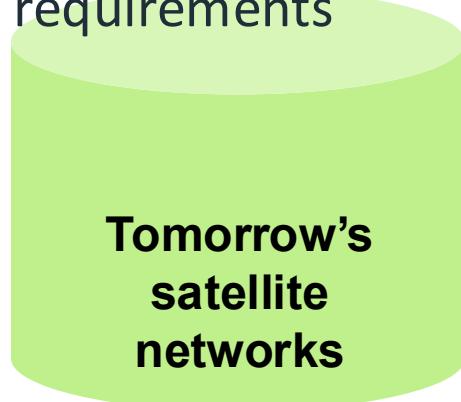
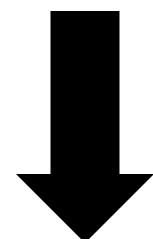
# Proposals from two Large-Scale NGSOs to degrade EPFD ITU Rules: Hobble Competition from GSO/Multi-Orbit and Small NGSO Systems

Under long-standing rules



SpaceX/Amazon proposal

- › Significantly more interference
  - › Degraded throughput – Double the capacity loss
  - › Degraded availability – Absolute reduction in mission availability
- › Technology advances stifled
- › Other systems constrained in meeting requirements



Critical GSO/ Multi-Orbit operations – search and rescue, eye in the sky, in route command and control, HoS transport

# Conclusions: large-scale NGSOs are a real risk

The industry and administrations must understand:

- Large NGSO system blocking issues created by general ITU coordination rules
- Undue consumption by large NGSO systems of the total allowance for all permitted NGSO interference into GSOs.
- The GSO interference issues (S.1503 and aggregate EPFD) already present in the Ku and Ka bands, as well as Q/V band due to flawed and incomplete framework
- Mega-constellation proposal to degrade EPFD limits and block competitive responses from GSO operators and smaller NGSO constellations