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A balanced approach to enable GSO and NGSO access to spectrum and orbital resources

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Overview

- NGSO and GSO share the same valuable spectrum resources in several frequency bands
- Both GSO networks and NGSO systems provide critical services; therefore, there should be a fair balance of access to spectrum to both
- In segments of the Ku/Ka bands, Article **22** of the ITU Radio Regulations provides equivalent power flux-density (epfd) limits for NGSO to protect GSO, such that, if the limits are met, there is no requirement for NGSO systems to coordinate with individual GSO networks
- There is a disconnect between the evaluation approach used by the BR to prove compliance with single-entry epfd limits and the epfd levels actually generated by real NGSO systems

- **Is there a fair way to address such a disconnect?**

How to evaluate interference from NGSO into GSO?

Two main approaches are included in the Radio Regulations:

Nos. **22.5C**, **22.5D**, **22.5F**

(WRC-2000)

Ka-, **Ku-**bands

Equivalent Power Flux-Density Limits

(EPFD)

Nos. **22.5L**, **22.5M**

(WRC-2019)

Q-, **V-**bands

Reduction in Average Spectral Efficiency

&

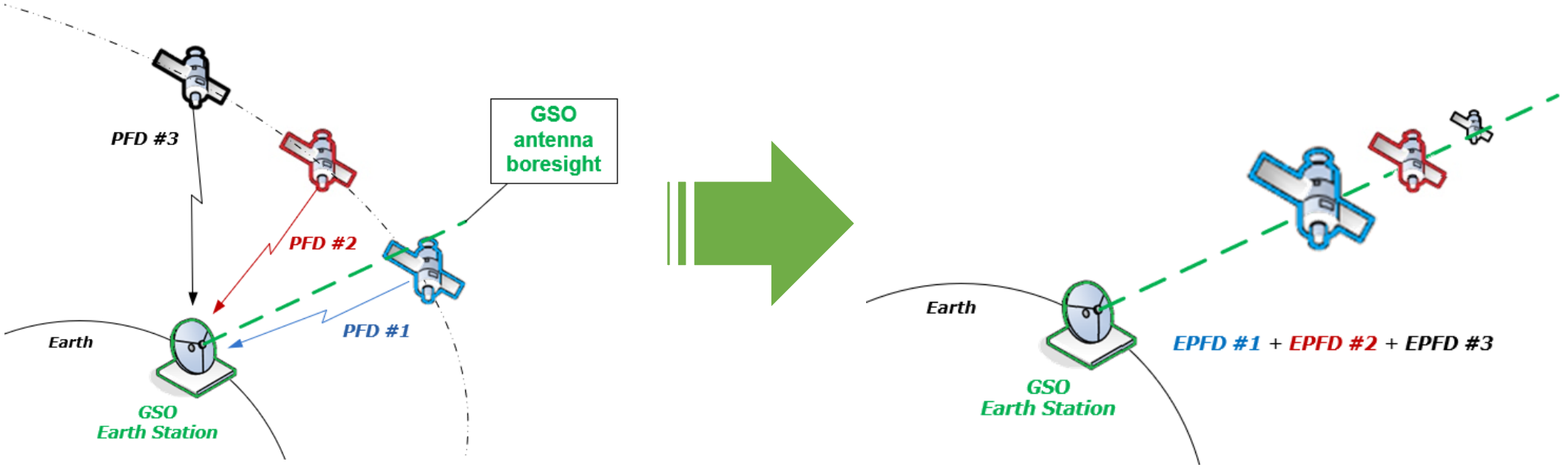
Variation in Unavailability

Can you tell me what EPFD is?

- It is a mathematical way to aggregate several interfering signals considering how differently each of them contribute to degrade the victim link

  Power of interfering signal (W) = EPFD (W/m^2) x Effective area of victim antenna (m^2)

- In case the victim is a GSO link (space-to-Earth):



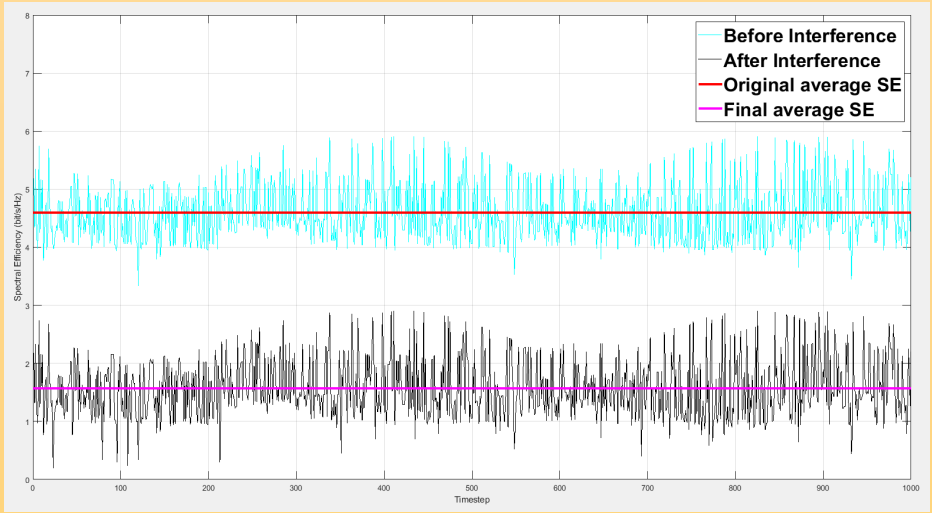
The controversy around Rec. ITU-R S.1503

- It is the only available ITU-approved modelling of the *envelope* of a non-GSO system to compute EPFD statistics. The Bureau uses a software based on it to assess compliance with single-entry EPFD limits
- But, is Rec. ITU-R S.1503 accurate enough for modelling *real operations* of all current and future non-GSO systems?

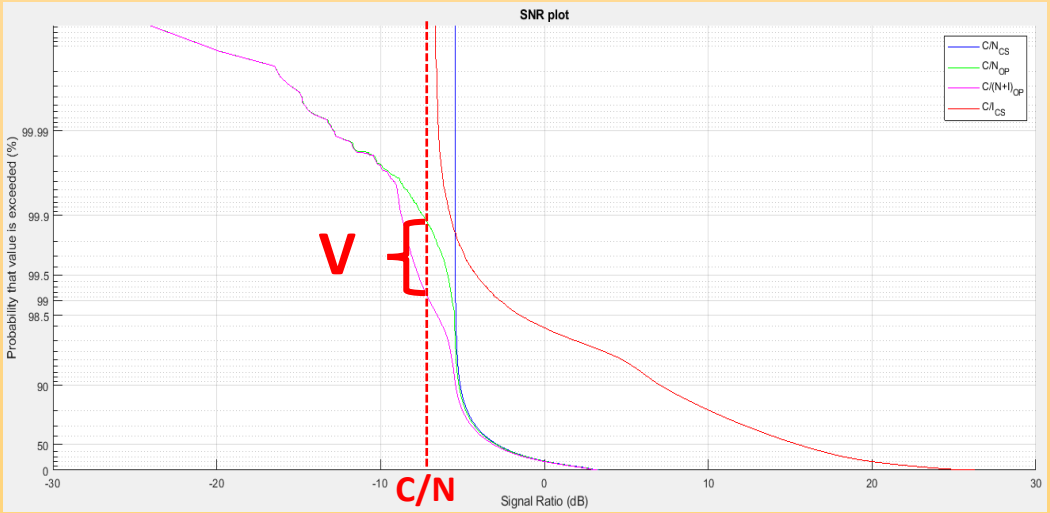
The NGSO modelling embedded in Recommendation ITU-R S.1503…	
…possibly *overestimates* interference into GSO	**…possibly *underestimates* interference into GSO**
NGSO beams always "ON" and operating at max levels	Current examination only looks at one GSO geometry
NGSO/GSO always co-frequency and at the same time	WCG does not consider alignment of multiple satellites
Worst-case NGSO selection strategy	Not all side-lobe NGSO interference is considered
Back-lobe gain of GSO e/s may be unrealistic	Only GSO symmetrical antennas are modelled
One single envelope power mask for various services	In Ka-band, only GSO diameter > 70cm / 1m considered

And what about the other approach?

Reduction (R) in Average Spectral Efficiency



Variation (V) in Unavailability



- This method:
  - Convolves the statistics of interference with those of rain fade, that, above Ku-band (included) have significant effects on link performance
  - Considers Adaptive Coding and Modulation techniques that are widely used today

A wish-list for the 2023-2027 activity of SG 4

1. Explore any new ways to enable a more accurate modelling of modern NGSO systems
   - The application of Rec. ITU-R 1503 should be limited to the current examination practice of the Bureau
   - It is unlikely that Rec. ITU-R S.1503 will be able to model all complex NGSO systems (e.g.: how to take into account real traffic load, different NGSO terminal types, etc.?)
   - We should avoid a scenario in which Rec. ITU-R S.1503 is the main driver for the design of future satellite systems – it should be the other way around
   - This may benefit other workstreams (e.g., Res. **76 (Rev WRC-15)**, Res. **85 (WRC-03)**)
2. Running a comparison of the different GSO/NGSO coexistence regimes (e.g. **EPFD** vs **Reduction in Average Spectral Efficiency & Variation in Unavailability**)
   - An apples-to-apples comparison may inform views of the membership on fair rules to access spectrum and orbital resources
   - Any new regime should:
     - Foster efficient NGSO system design and spectrum use by taking into account modern GSO and NGSO features
     - Ensure that already deployed and/or planned GSO networks will still be adequately protected