The Current and Future State of Non-Geostationary Orbit (NGSO) Fixed-Satellite Service (FSS) Interference Regulation Metrics

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Outline

1. **Current Spectrum Sharing Rules**
2. **Revising Spectrum Sharing Rules**
3. **Degraded Throughput**
4. **Future Spectrum Sharing Rules**

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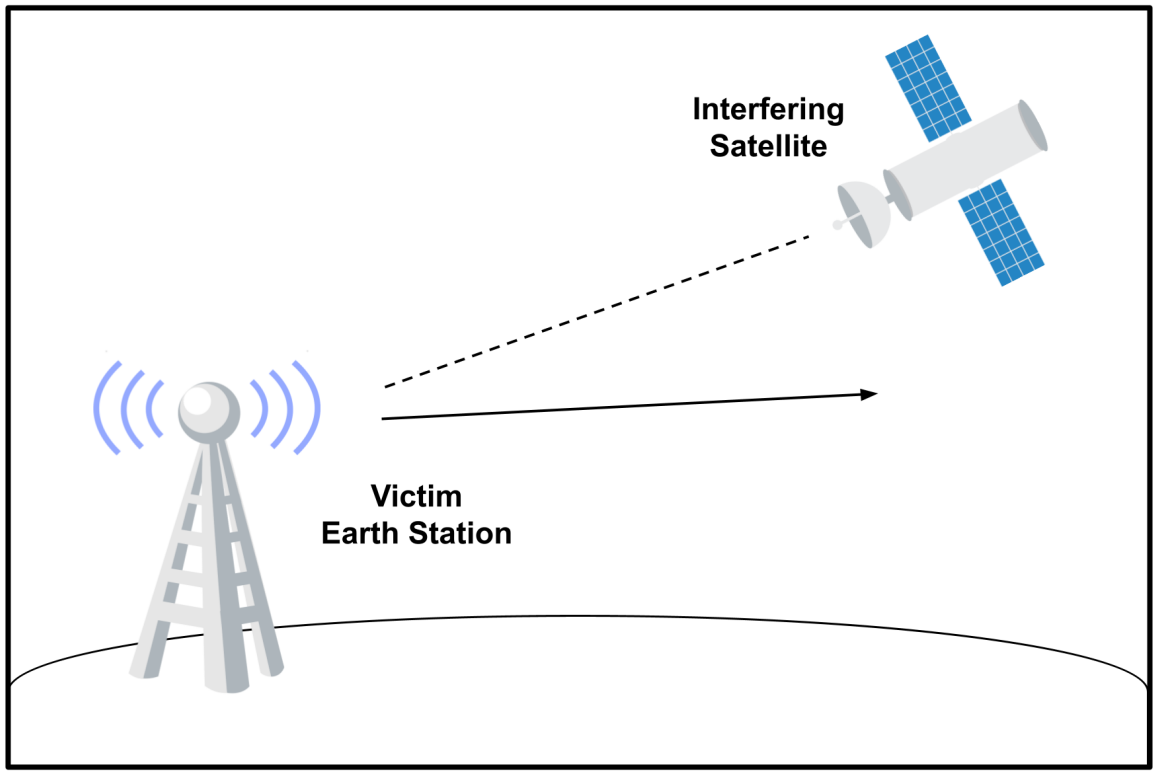
Current Spectrum Sharing Rules

Background

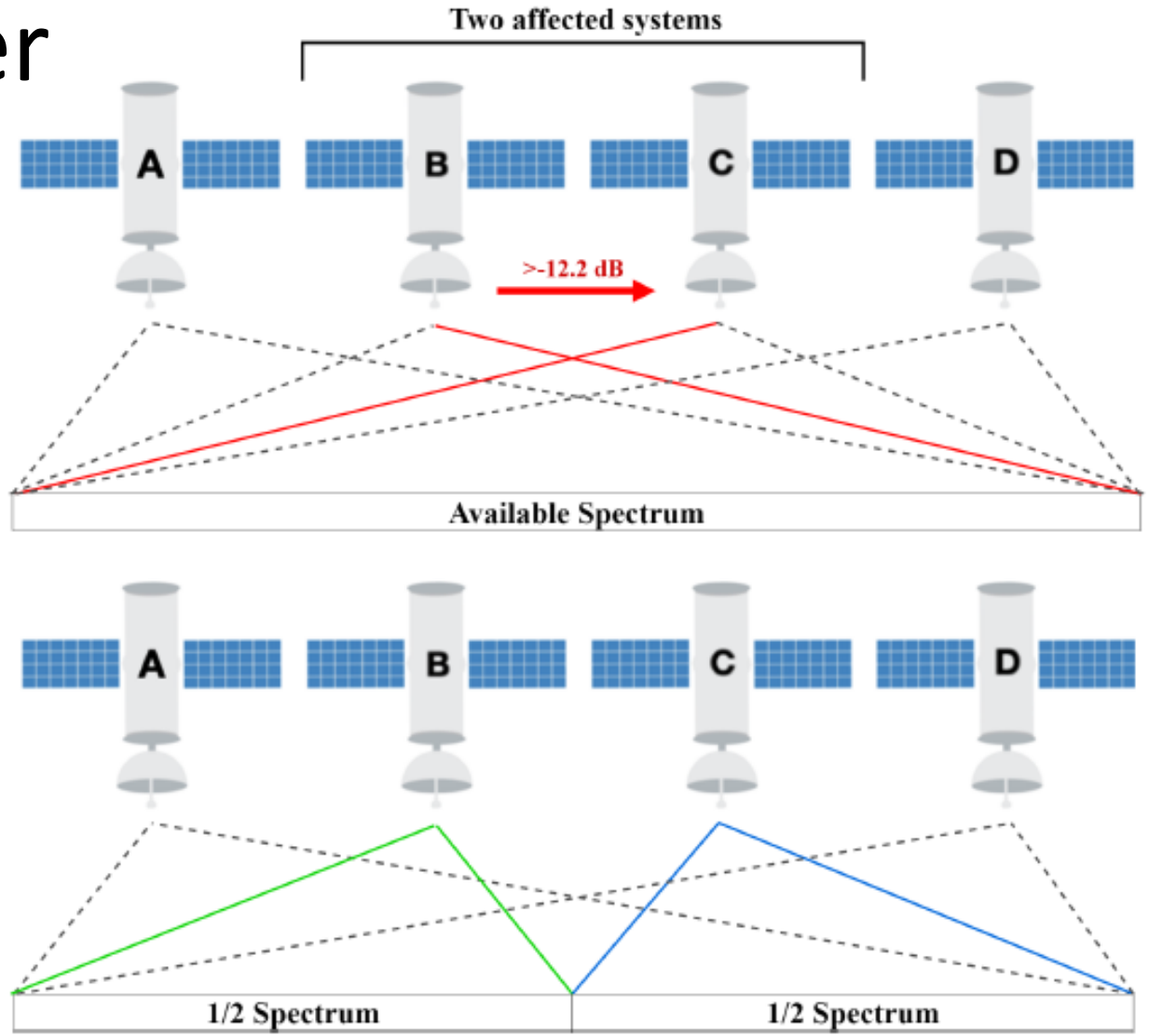
- The Federal Communications Commission (FCC) and the International Telecommunications Union (ITU) define radiocommunication rules and spectrum allocations
- Spectrum sharing rules require review to protect existing systems from harmful interference and promote efficient use of spectrum

Current Metric: Interference to Noise



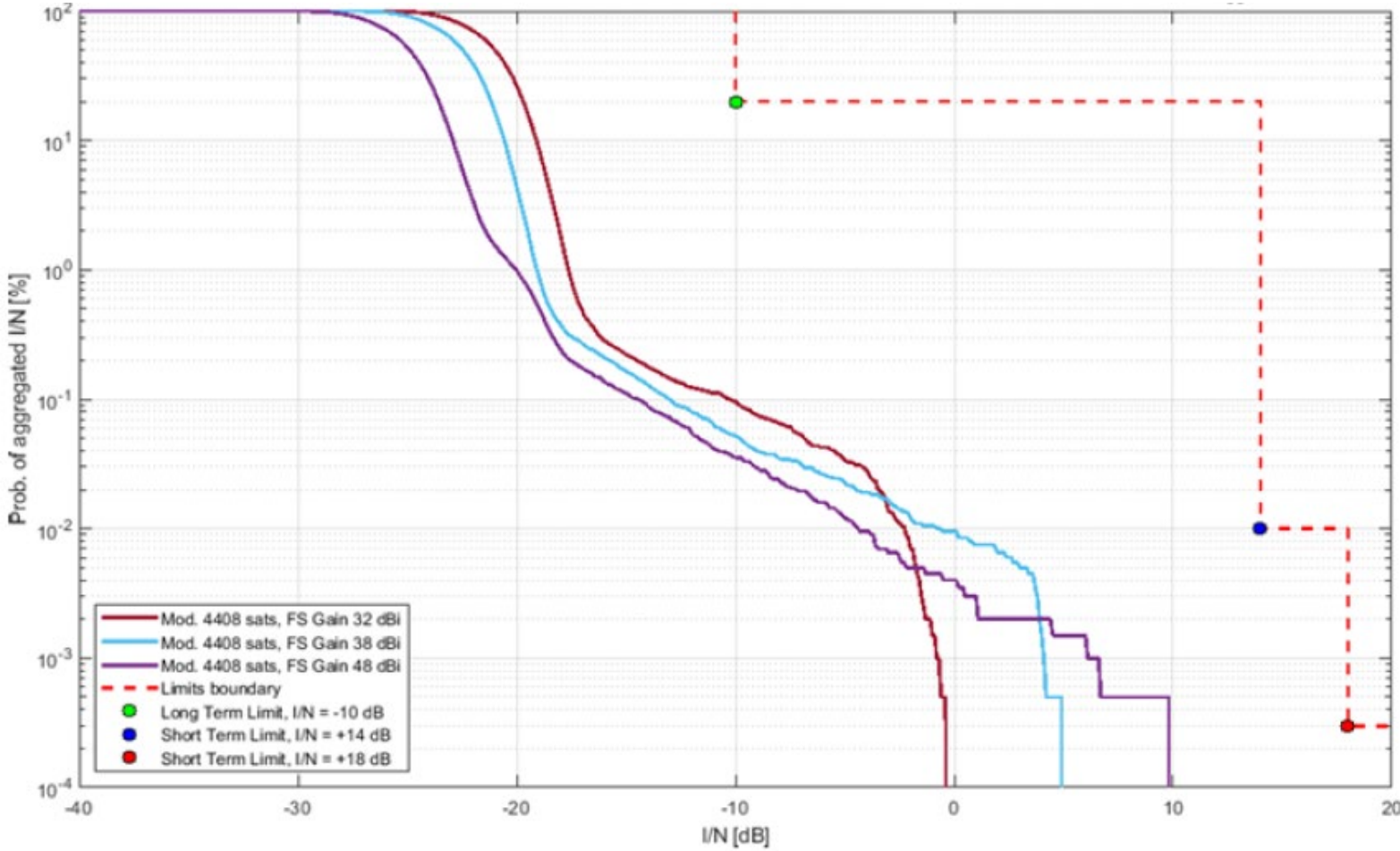
I/N Coordination Trigger

- -12.2 dB I/N threshold
- **ITU:**
  - Coordination agreement
- **FCC:**
  - Coordination agreement or demonstrate they will not cause harmful interference
  - Default spectrum splitting procedure



Dynamic I/N Thresholds

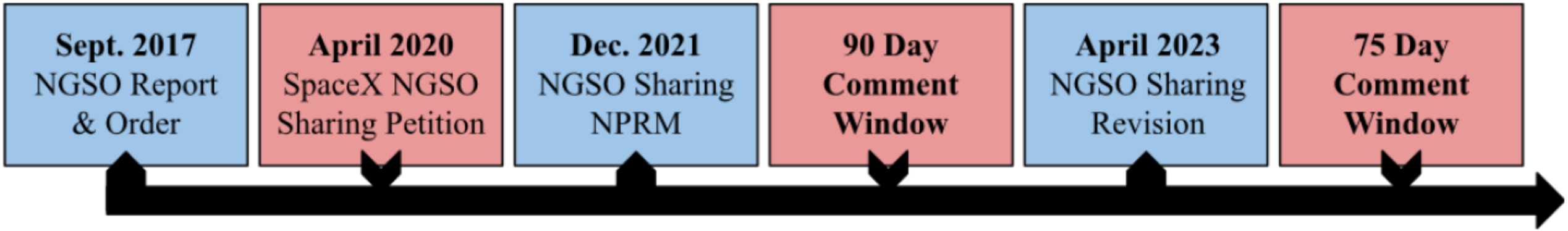
- ITU-R F.1495 permissible interference regulation:
- **Long-term:** I/N should not exceed –10 dB for more than 20% of any year.
- **Short-term:** I/N should not exceed +14 dB for more than 0.01% and +18 dB for more than 0.0003% of any month.



Generic versus System-Specific Parameters

- **ITU:** Generic victim fixed service earth station parameters
- **FCC:** Accepts filings based on either system-specific or ITU-recommended generic parameters
- Standard reference antenna mask and noise temperature value

Timeline of Rulemaking



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Revising Spectrum Sharing Rules

2020 SpaceX Spectrum Sharing Petition

- **Proposal 1:** Limit the default spectrum-splitting procedure to systems authorized within the same processing round.
- **Proposal 2:** Later-round systems should protect earlier-round systems up to a specified I/N level.
- **Proposal 3:** This protection should sunset.
- **Proposal 4:** Systems be required to share beam-pointing information to facilitate interference analyses.

2021 FCC Spectrum Sharing NPRM

- Developing a dynamic I/N limit
- Burden on applicants
- May not sufficiently protect sensitive antennas
- Could disincentivize coordination

I/N Limit

Against I/N:

amazon | project kuiper

TELESAT

O3b Networks

BOEING

The Public Interest

Viasat

For static I/N:

SPINLAUNCH ↑ 1 dB

OneWeb ↑ 1 dB

KEPLER ↓ -15.2 dB

For dynamic I/N:

SPACEX

HUGHES

AST SpaceMobile

Degraded Throughput

Against:

HUGHES

O3b Networks

For:

amazon | project kuiper

The Public Interest

AST SpaceMobile

INTELSAT

Viasat

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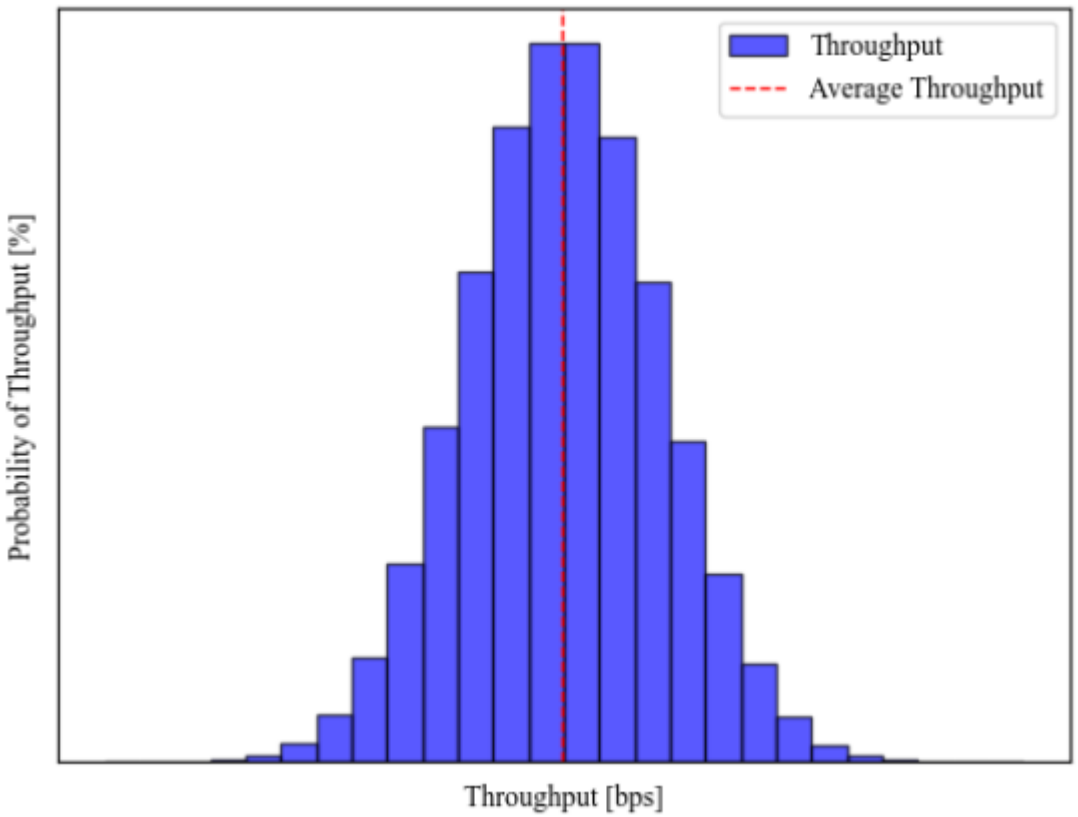
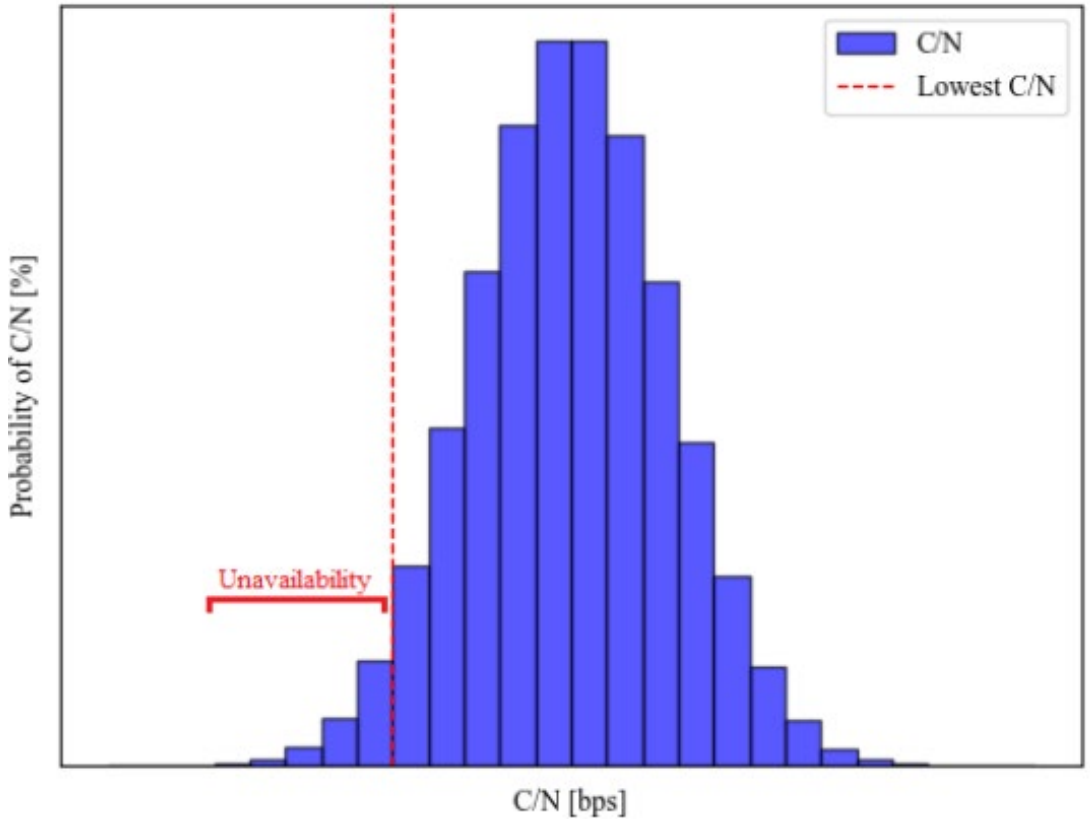
Degraded Throughput

Kuiper's Proposal

- Kuiper proposed adopting a metric providing that a later-round NGSO FSS system may cause:
  - "(1) at most an increase of 3% of the **time allowance for the earlier-round system's lowest carrier-to-noise ratio (C/N) value**; and
  - (2) at most a 3% reduction in the **time-weighted average spectral efficiency** of an earlier-round system, calculated on an annual basis."
- Advances harmonization with ITU

What is Degraded Throughput?





Benefits of Degraded Throughput

- NGSO satellites are subject to dynamic effects
  - Dynamic path loss, antenna gain, rain attenuation
  - Adaptive control and modulation (ACM) balances availability and throughput
  - Recognize resiliency to decreases in availability and throughput
- Compare system performance with and without interference
  - Tailored protection of victim systems allows efficient use of spectrum

Drawbacks of Degraded Throughput

- Complexity of calculation
- Generic or system-specific parameters
  - With generic: does not protect all systems equally
  - With specific: tailored protections, increases burden on applicants
- Definition of lowest C/N of a system

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Future of Spectrum Sharing Rules

2023 FCC Spectrum Sharing Revision

- **Change 1:** Limit default spectrum-splitting procedure to same-round systems.
- **Change 2:** Later-round systems must complete coordination agreements with earlier-round systems or demonstrate that they will protect earlier-round systems using a **degraded throughput methodology**.
- **Change 3:** This protection will sunset.
- **Change 4:** NGSO FSS grantees must coordinate with each other in good faith.
- Comments on “appropriate values and assumptions”

Methodology Considerations

- Rain Attenuation
- Aggregate Interference
- Modeling Assumptions
- Threshold Values
- Degraded Throughput Analysis Tool

Conclusion

- Degraded throughput as a replacement for I/N could increase spectral efficiency and modernize satellite interference regulation.
- However, further clarification and specificity about the methodology for calculation is needed.

Thank you! Any Questions?