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**Via Hand Delivery**

Magalie Roman Salas, Secretary
Federal Communications Commission
445 12th St., S.W., Room TW-B204
Washington, D.C. 20554

Re: Ex Parte Presentation
File Nos. 48-SAT-P/LA-97, 89-SAT-AMEND-97,
130-SAT-AMEND-98, Docket No. ET 98-206

Dear Ms. Salas:

On November 8, 2000, Mark MacGann, Vice President of SkyBridge LLC ("SkyBridge"), Guy Christiansen, SkyBridge Director of Regulatory Affairs, and Damien Garot, SkyBridge Senior Engineer, and the undersigned counsel to SkyBridge, met with the following members of the International Bureau to discuss matters relevant to the above-referenced proceedings: Don Abelson, Thomas Tycz, Cecily Holiday, Christopher Murphy, Jennifer Gilsenan, Julie Garcia and Alex Royblat. At the meeting, copies of the attached materials were distributed and discussed.

No. of Copies rec'd 0+10
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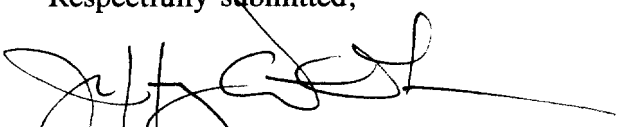
If there are any questions regarding this matter, please contact the undersigned.

Respectfully submitted,



Jeffrey H. Olson
Attorney for SkyBridge L.P.

Attachment

cc: Don Abelson
Thomas Tycz
Cecily Holiday
Christopher Murphy
Jennifer Gilsenan
Julie Garcia
Alex Royblat

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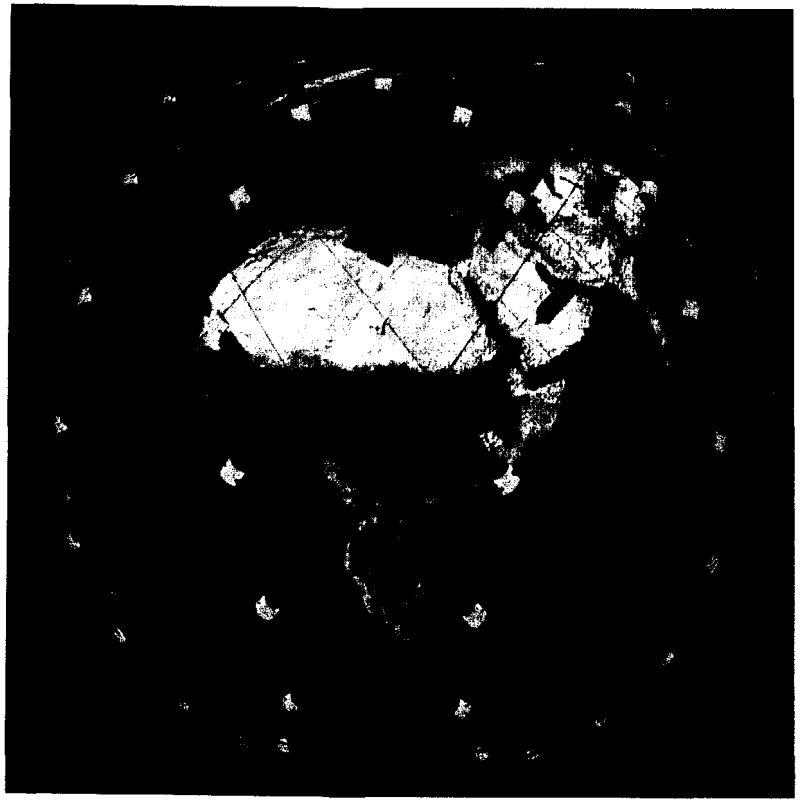

# Methods for sharing between NGSO systems in the Ku-band

Washington D.C., November 8 2000

*SkyBridge L.P.*

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# Characteristics of the sharing between NGSOs in Ku-Band

- ***The interference has a time-varying nature***
- ***Directive antennas are used***
- ***Small aperture terminals are employed***
- ***Systems are broadband***
- ***Different constellation designs: LEO/MEO/HEO***

➡ ***Several sharing scenarios***

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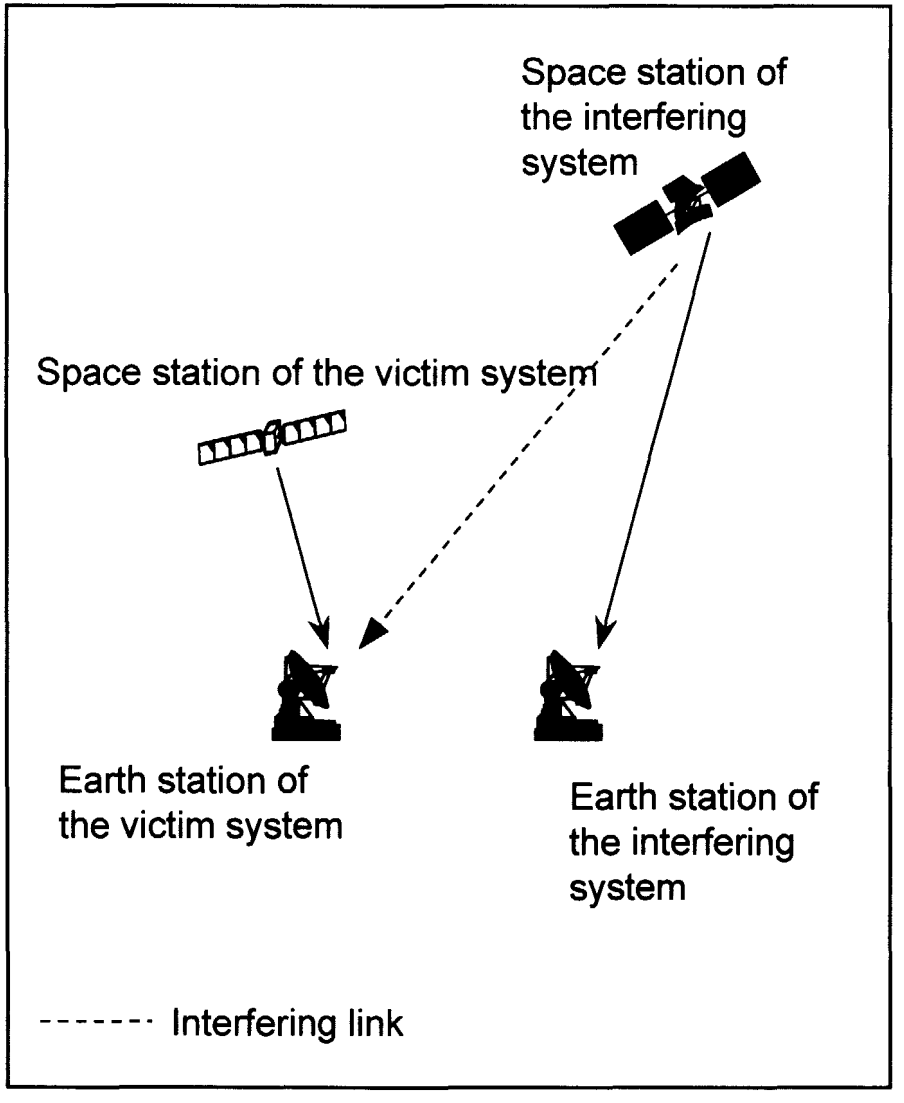
# Interference between NGSOs
# Downlink configuration

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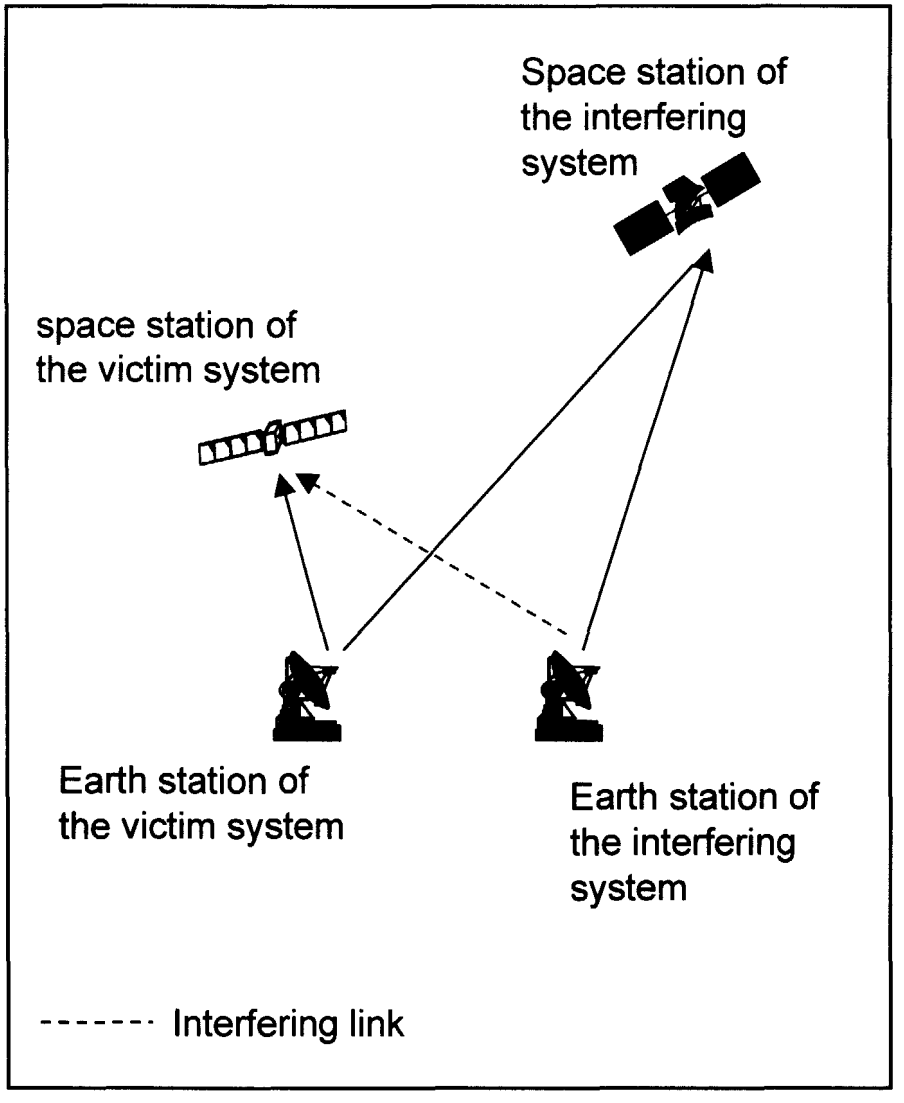
# Interference between NGSOs
# Uplink configuration

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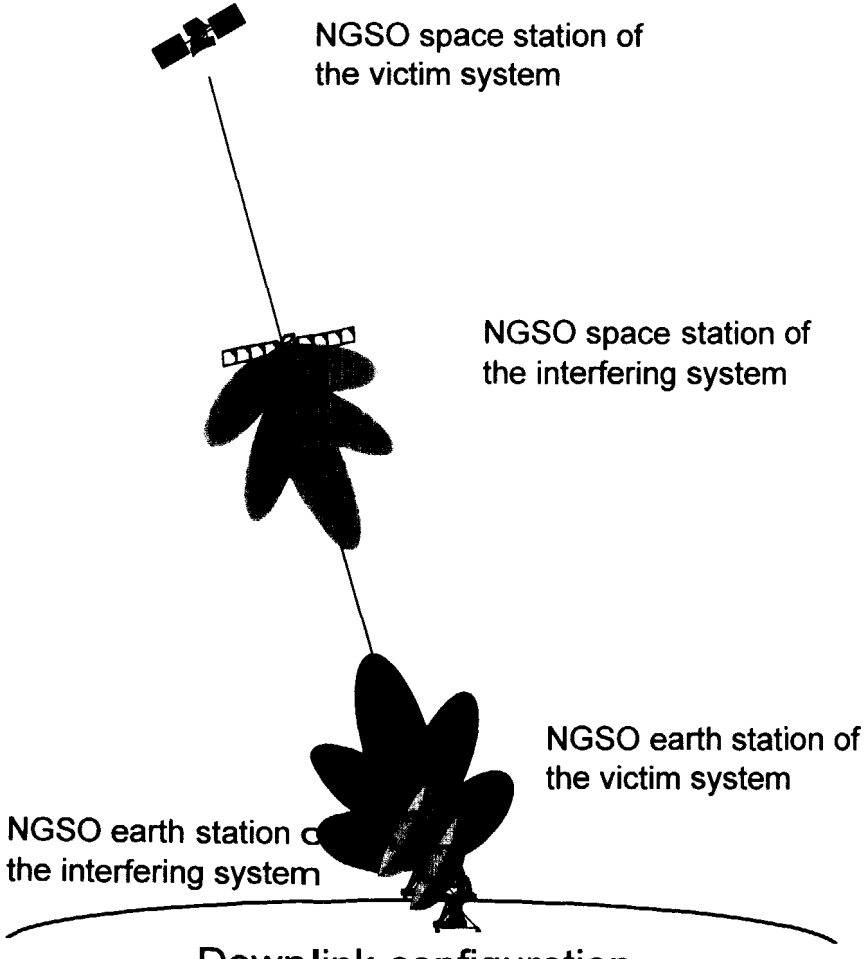
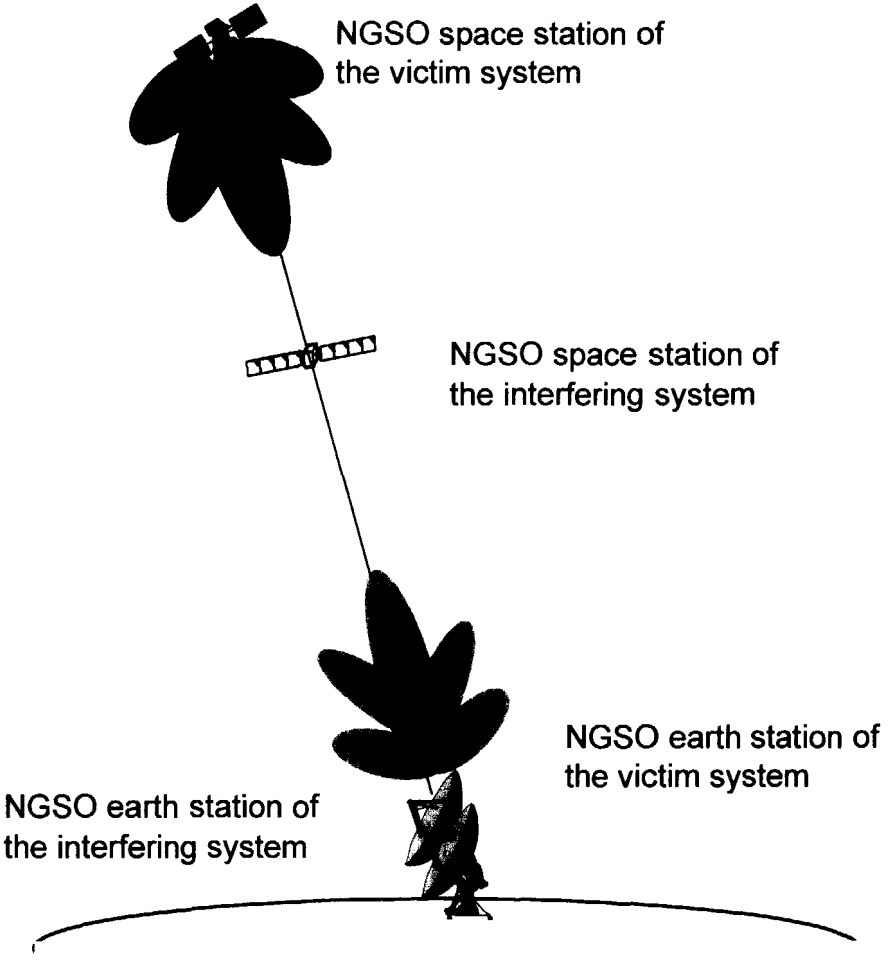
# Interference between NGSOs the Main beam to Main beam case

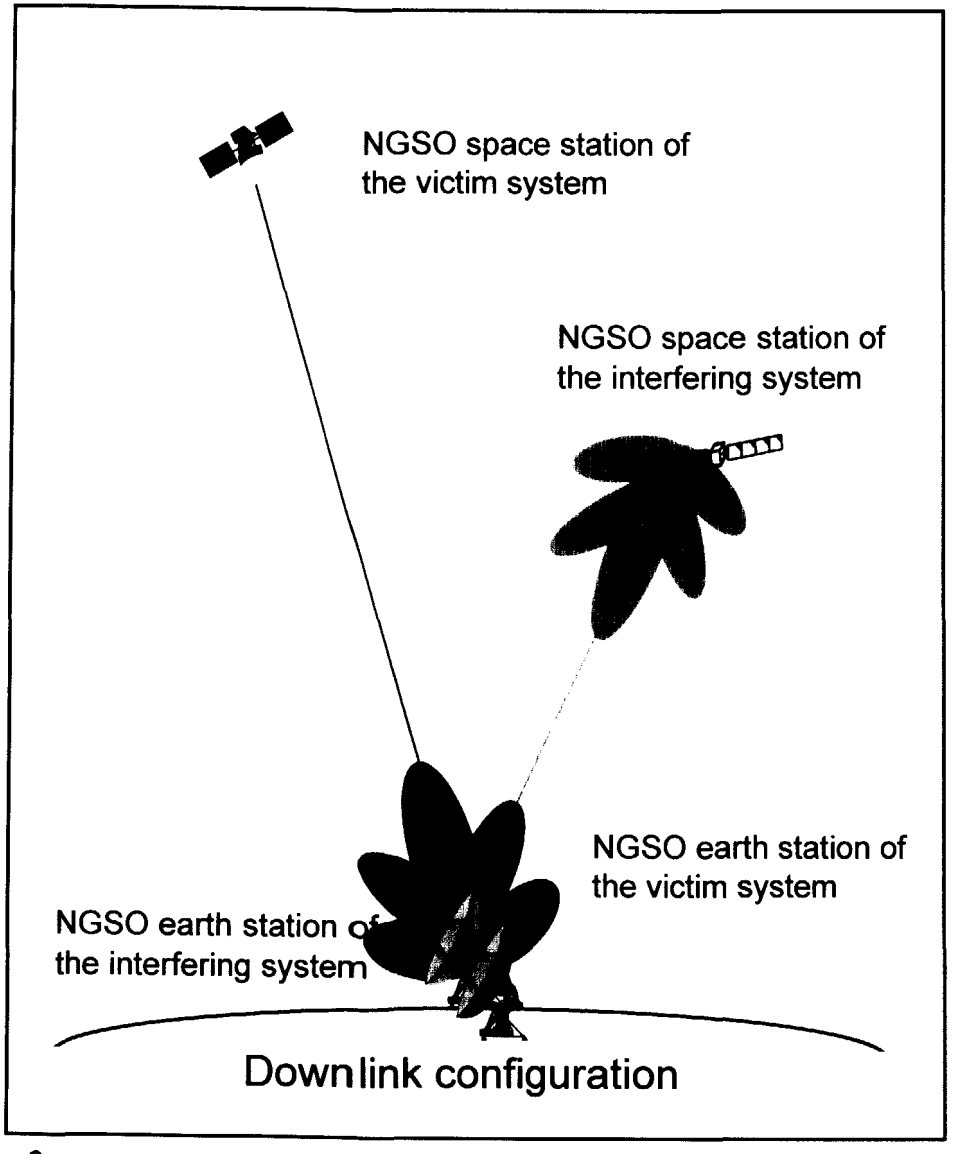


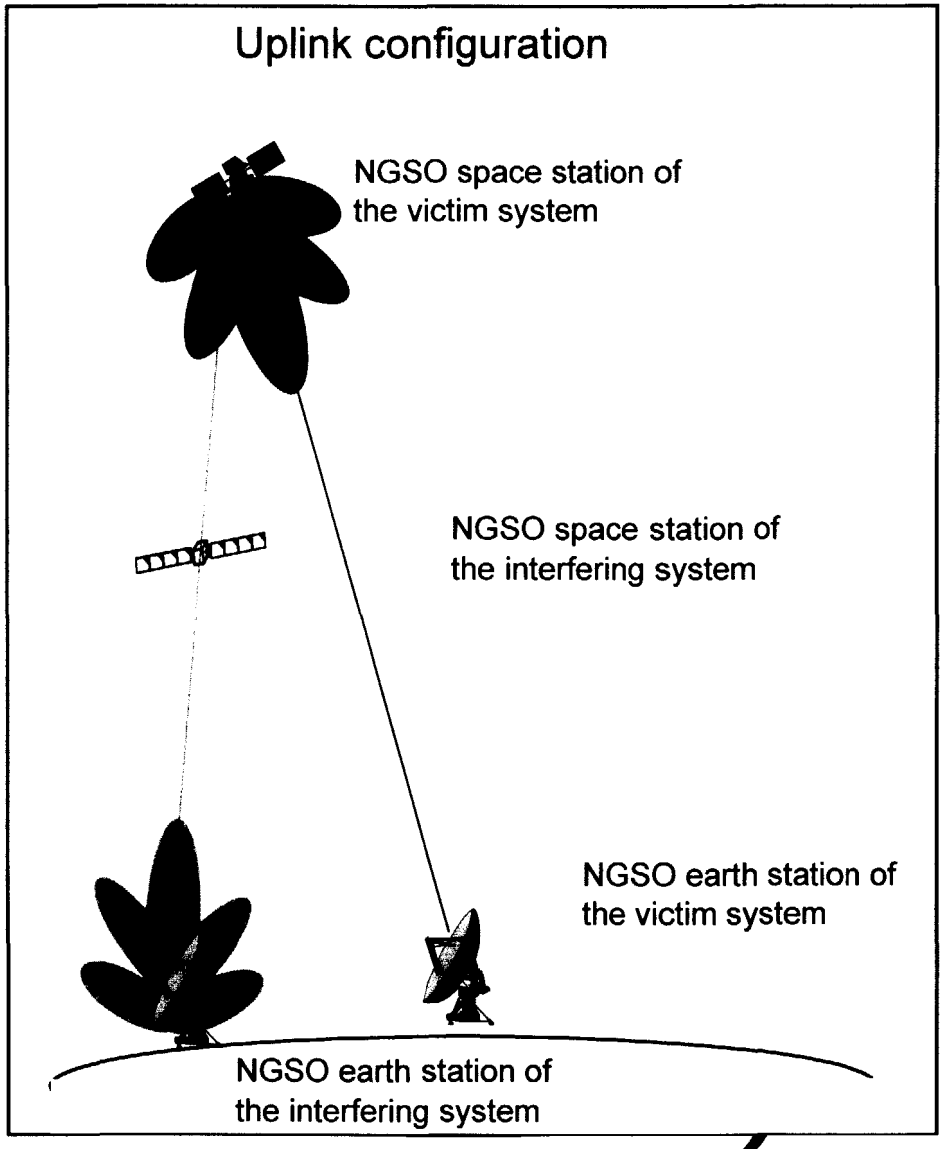

Downlink configuration

Uplink configuration

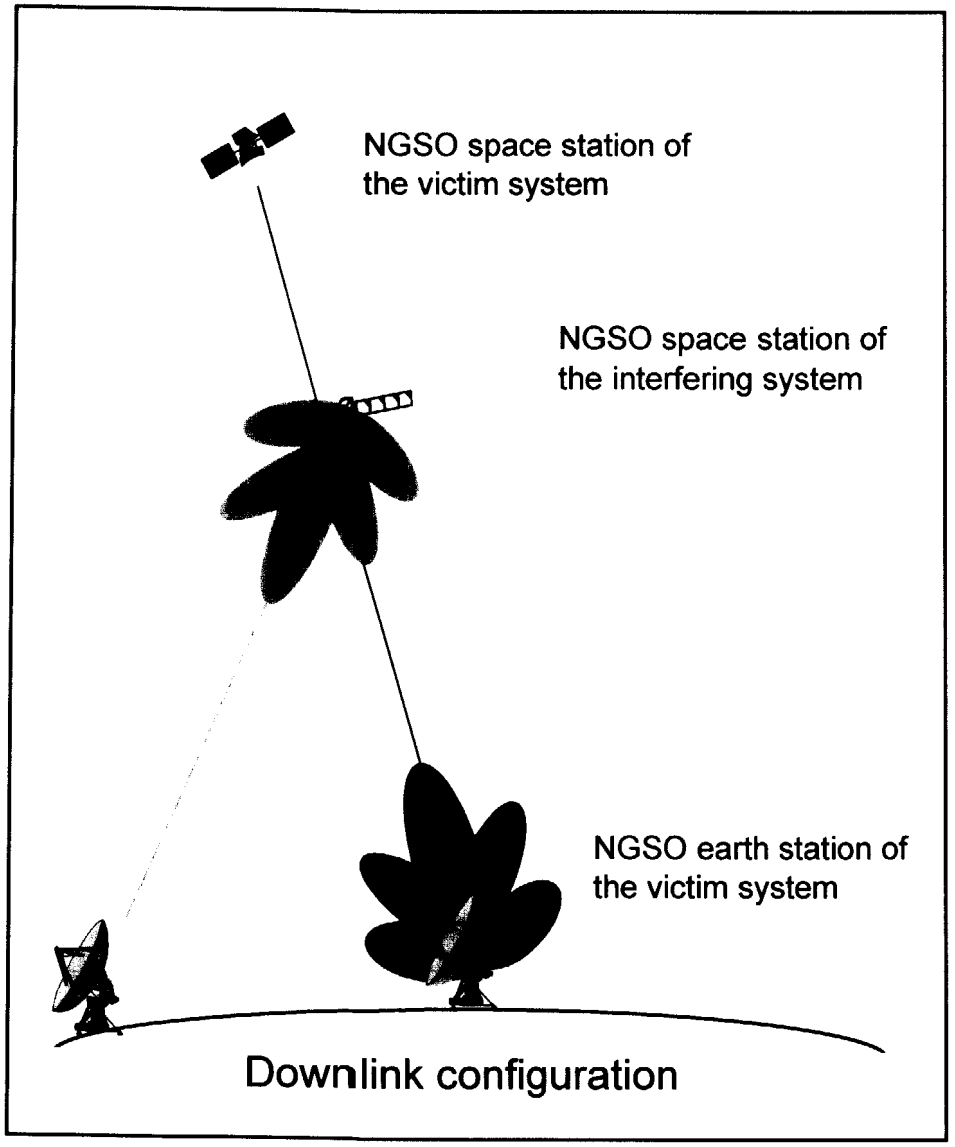


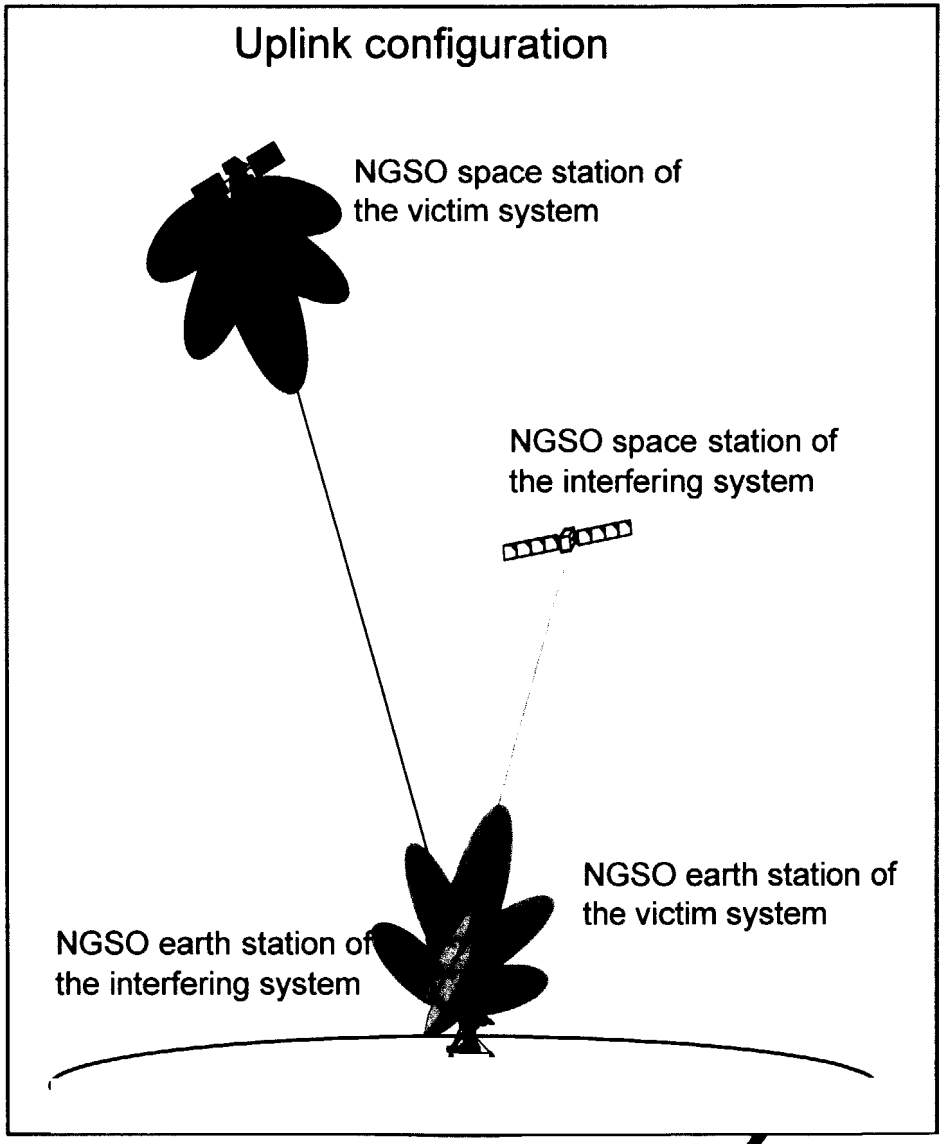
# Interference between NGSOs the Main beam to Sidelobe case



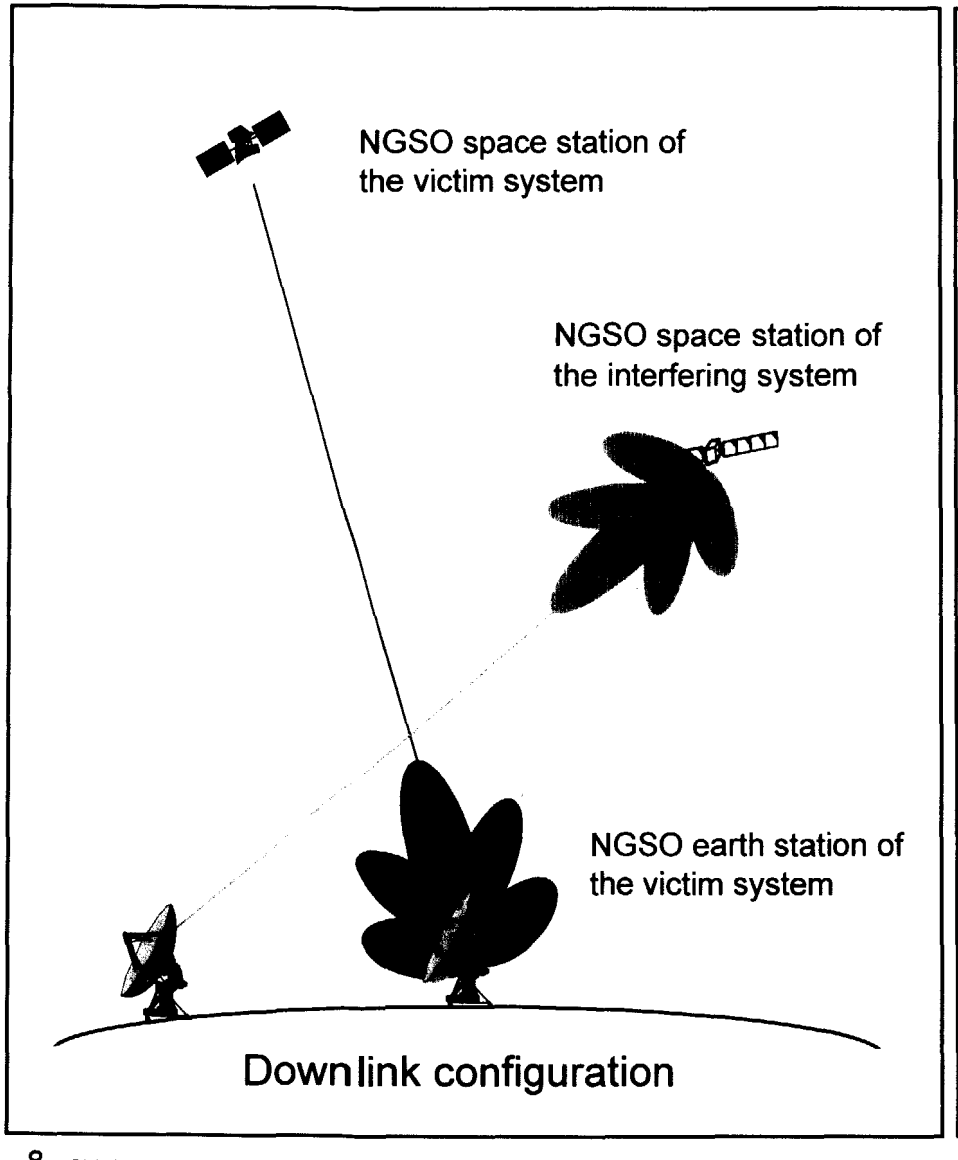



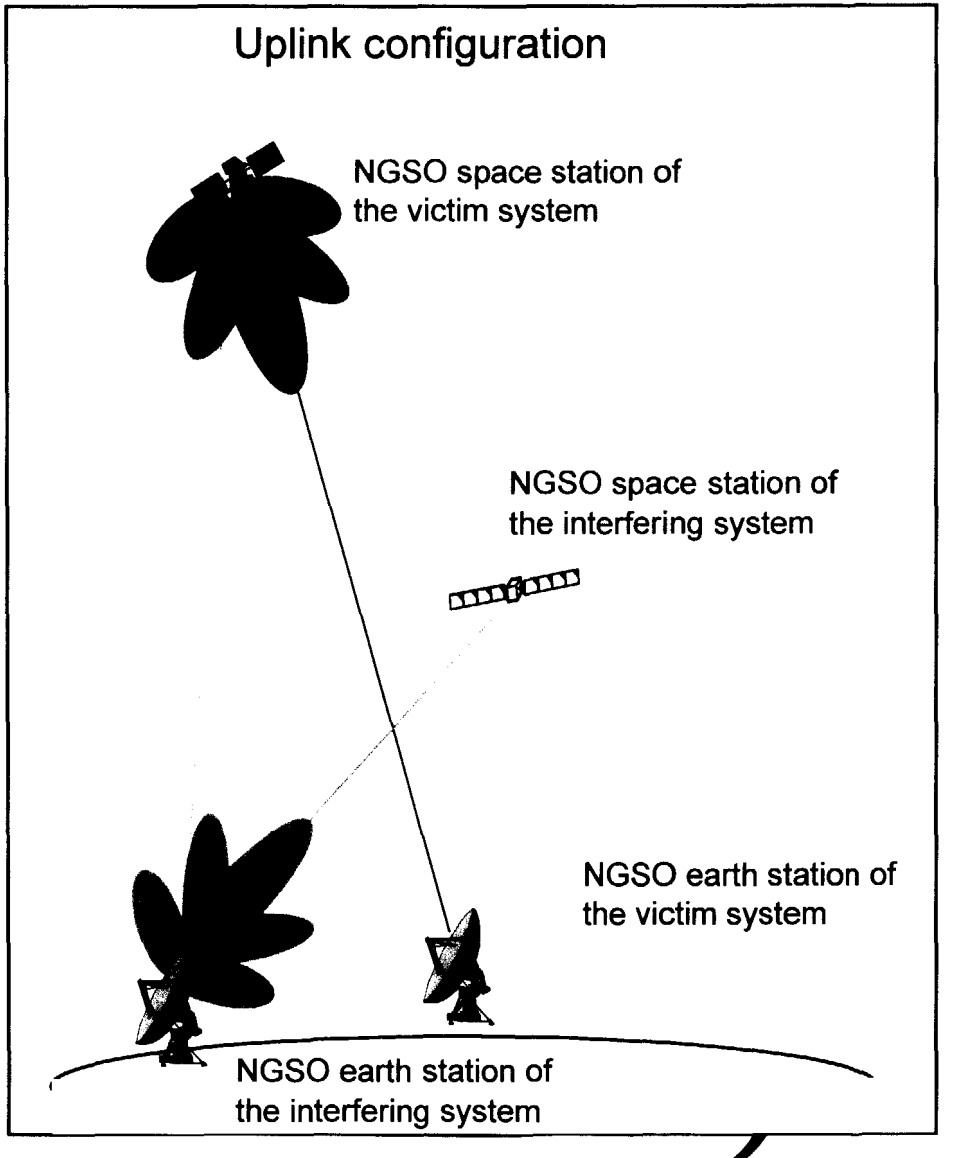
# Interference between NGSOs the Sidelobe to Main beam case



# Interference between NGSOs the Sidelobe to Sidelobe case



# Mitigation techniques Classes

## *2 classes of mitigation techniques:*

## *By design: cannot be changed once built*

- ✓ homogeneous constellations
- ✓ Spacecraft antenna side lobes
- ✓ Earth station antenna side lobes

## *By operational features: can be adapted to the sharing scenario*

- ✓ Satellite diversity
- ✓ Satellite selection strategy
- ✓ link balancing
- ✓ frequency diversity/polarization

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# Mitigation techniques "By design"
# Homogeneous orbits

## *Homogeneous constellations*

✓ use of nearly identical orbital parameters

✓ interleaving orbital planes / satellites

## *Permits*

✓ avoidance of in-lines events

## *But*

✓ not compatible with existing filings: a NGSO constellation design results from trade-offs (services, business plan, technology, cost) and lead to different results

➡ Not adaptable to the current situation

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# Mitigation techniques "by design"
# Spacecraft and terminal antennae

***Increase the performance of the antenna sidelobes:***

- ✓ improve the sharing situation by reducing interference in the sidelobe to main beam and sidelobe to sidelobe cases
- ✓ Changes in the spacecraft and terminal antenna design have a major impact in terms of cost and complexity for the NGSO system
- ✓ Modification of the terminal performance may jeopardize the viability of small (inexpensive) terminal concept

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# "Operational" Mitigation techniques
# Satellite diversity

## *The satellite diversity*

- ✓ Capability of a NGSO system to have several satellites available to serve Earth stations
- ✓ In-line events are avoided by switching traffic to another available satellite

## *An operational feature*

- ✓ Dependent on the working plan defined by the mission control center
- ✓ All systems have repeating ground tracks: the same geometrical configuration appears after a few weeks

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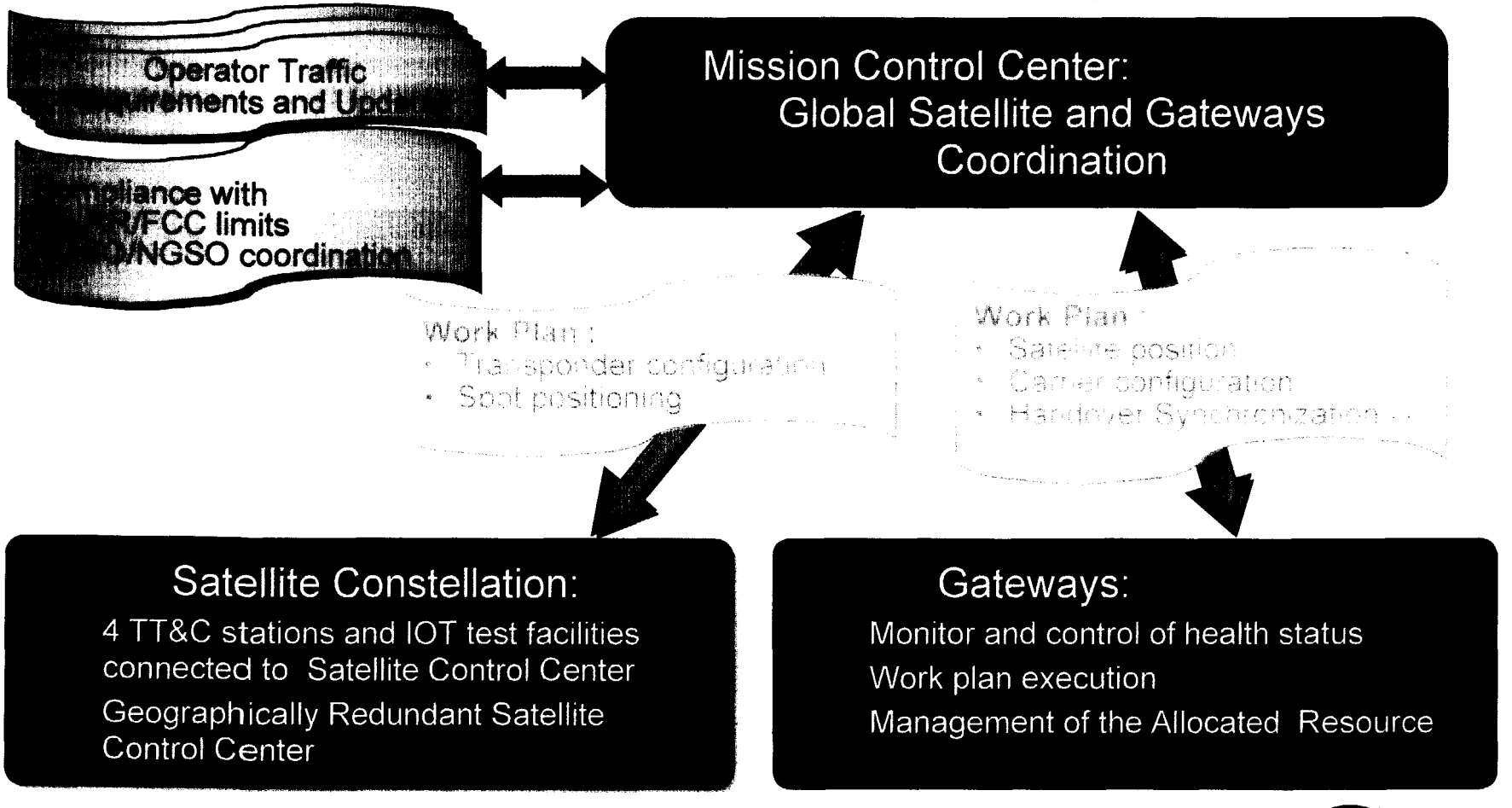
# Satellite diversity management: SkyBridge Control System

## *Satellite Constellation and Capacity Management*

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# "Operational" Mitigation techniques
# Satellite diversity

## *Satellite diversity capability*

- ✓ Available in all proposed MEO and LEO systems
- ✓ HEO systems may have satellite diversity capabilities

## *Associated sharing solutions*

- ✓ angular separation between the constellations
- ✓ sharing arrangements by elevation tiers

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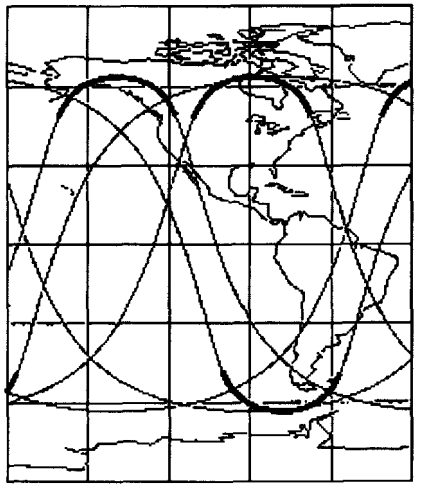
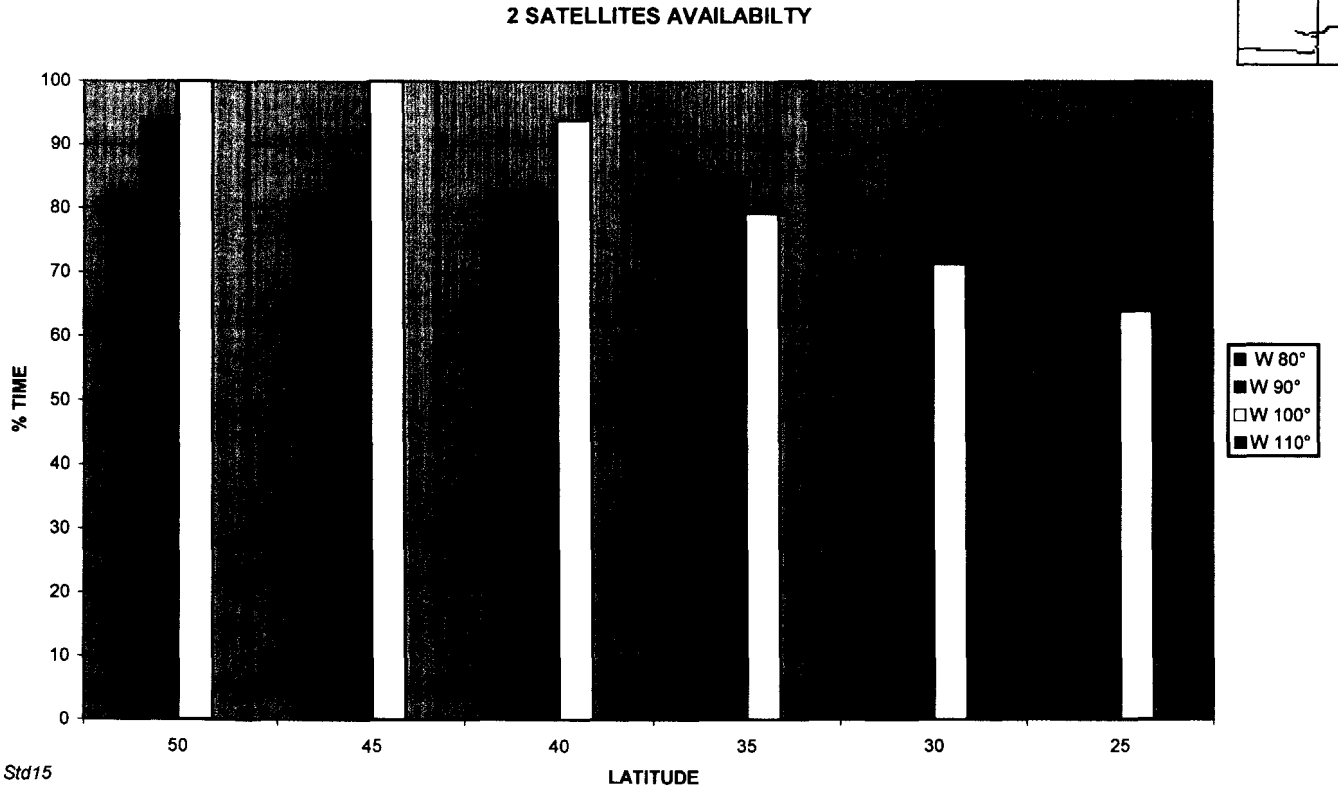
# "Operational" Mitigation techniques
# HEO Satellite diversity: Virgo

## *Tracking strategies requirements*

- ✓ Angular separation with GSO larger than 40°
- ✓ Elevation higher than 40°



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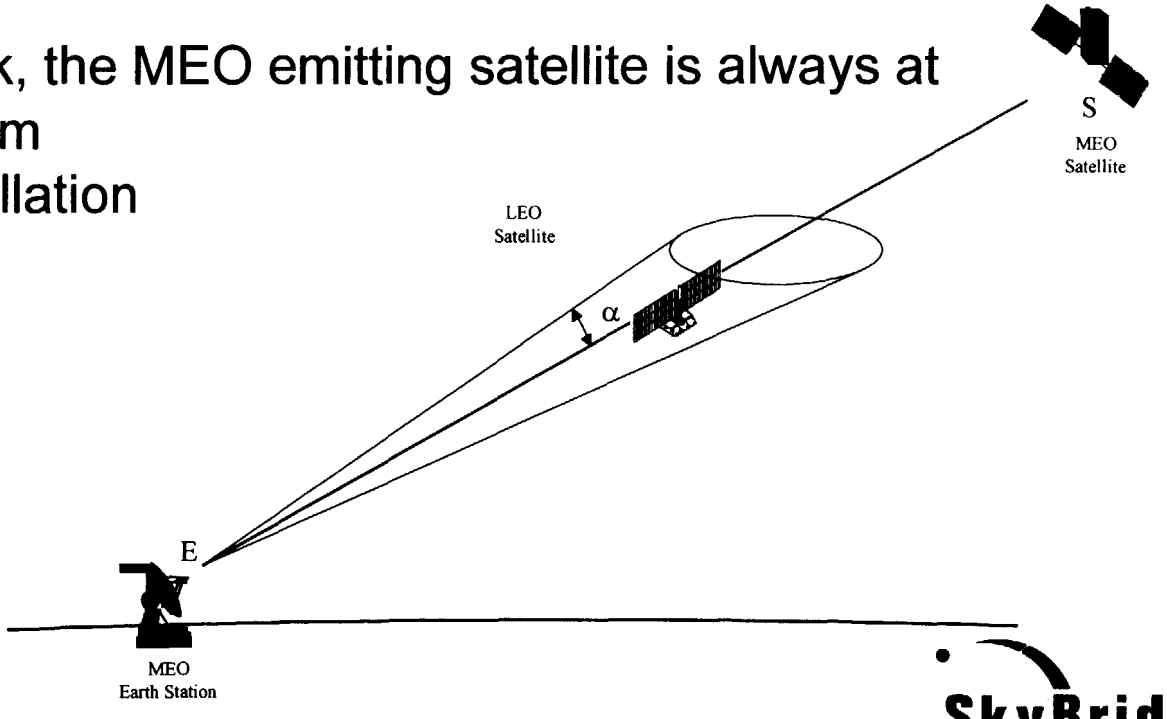
# Satellite diversity
# Example of a MEO protecting a LEO

## *2 angles α and β are defined*

- ✓ α is an earth-based angle / β a space-based angle in the interfering system reference
- ✓ They define zones where emissions of the interfering system are prohibited
- ✓ On the downlink, the MEO emitting satellite is always at more than α from the LEO constellation

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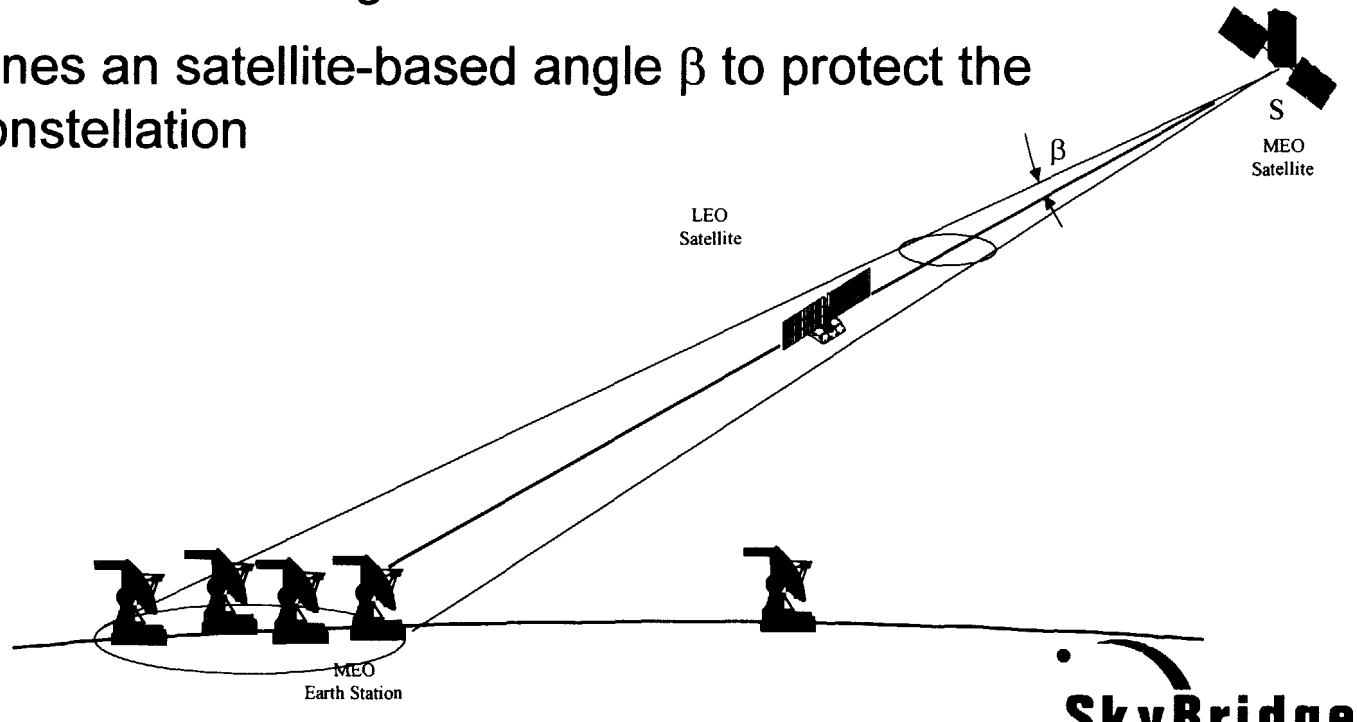
# Satellite diversity
# Example of a MEO protecting a LEO

## *On the uplink*

- ✓ in-line between satellite appears at different regions of the Earth
- ✓ near in-line Earth stations create harmful interference around the in-line configuration
- ✓ this defines an satellite-based angle β to protect the other constellation

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# "Operational" Mitigation techniques
# Tracking strategies as a mitigation technique

## *Tracking strategies*

- ✓ assumes satellite diversity is implemented
- ✓ Example: the resource allocation algorithm can select the satellite with the largest angular separation from the other constellations
- ✓ operational technique that can be implemented and adapted to the sharing scenario
- ✓ improves the sharing in the mid-term and long term cases with respect to the satellite diversity technique

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# "Operational" Mitigation techniques
# Link Balancing

## *The link balancing*

- ✓ consists of homogenizing transmission parameters between the systems: similar power levels improve the sharing situation
- ✓ on the downlink, forces systems to generate near equal pfd on the ground
- ✓ on the uplink, forces earth stations of all NGSO systems to have close off-axis e.i.r.p

➡ To date, most systems accepted for filing have coherent power levels

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# "Operational" Mitigation techniques
# Frequency diversity

***Frequency diversity is the ability to operate in a sub-band***

- ***Band segmentation***
  - ✓ does not take into account the directivity of the antennas
  - ✓ ignores the dynamics of the NGSO systems
- ***Beam / Beam coordination***
  - ✓ Systems can coordinate their systems to have beams employing separate sub-bands during in-line events
- ***Alternate polarization***
  - ✓ Can be employed during in-line events between 2 systems using similar polarization(i.e. linear or circular)

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# Mitigation Technique Conclusion

- ✓ Several mitigation technique are available for each system to take its part of burden sharing
- ✓ Several mitigation techniques can be employed simultaneously by NGSO systems to achieve coordination
  - mitigation techniques can be selected during detailed discussions between NGSO operators in a coordination process
- ✓ Each mitigation technique has a cost:
  - balance of burdens can be achieved through coordination only

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# To go further

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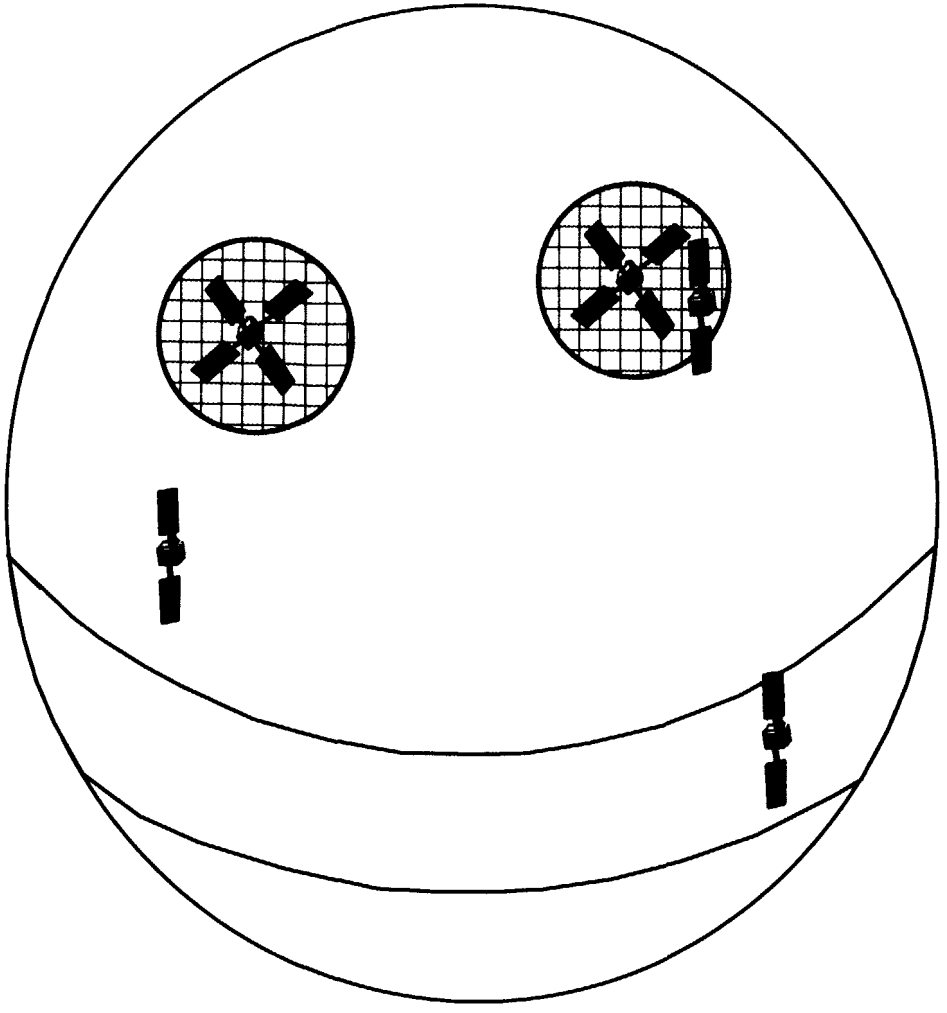
# Home Zone
# Example with 2 systems



Spectrum available for system

Whole spectrum

Half of the spectrum

GSO arc avoidance: no spectrum

Fish-eye view from a terminal

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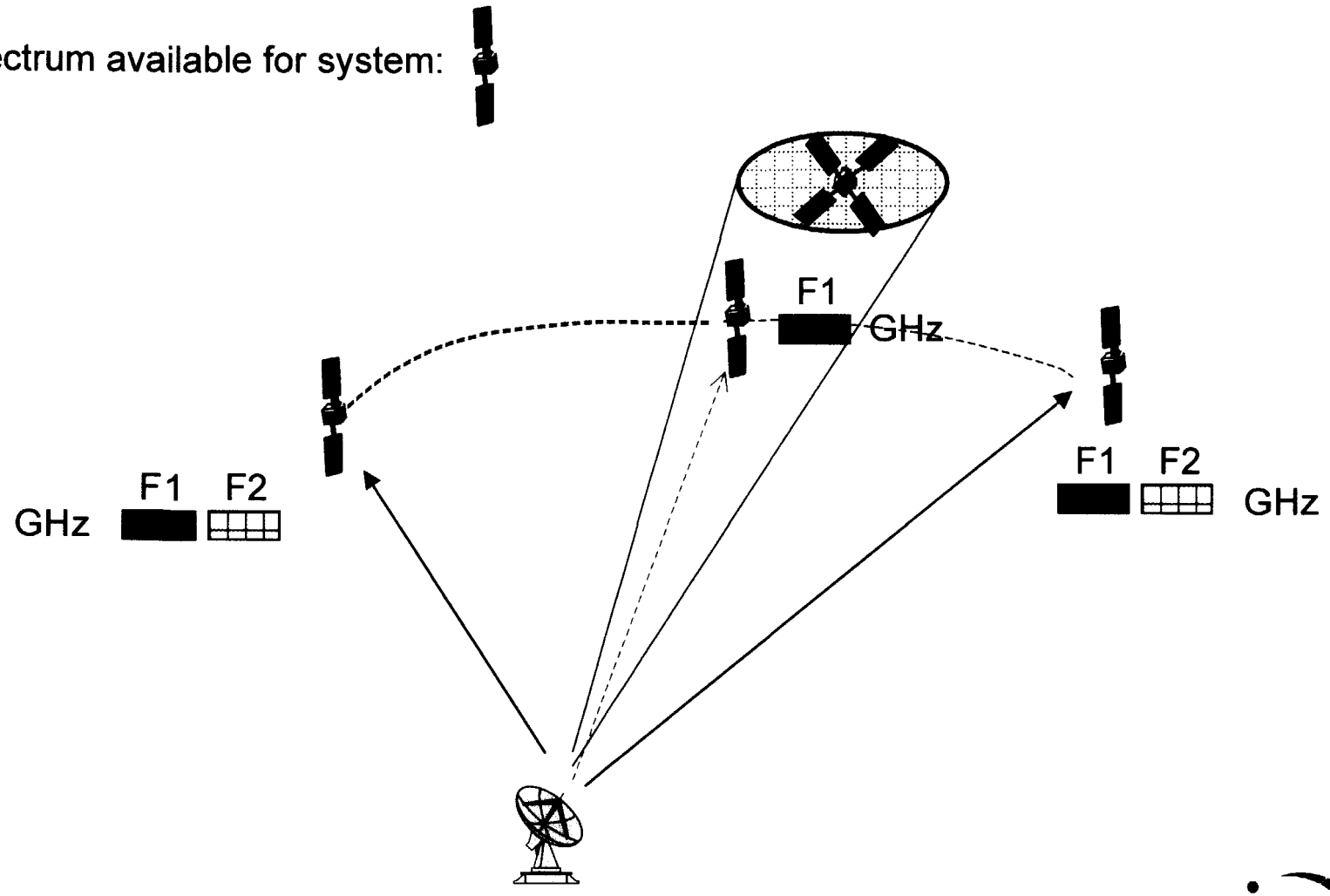
# Home Zone
# Dynamical example with 2 systems

Spectrum available for system:

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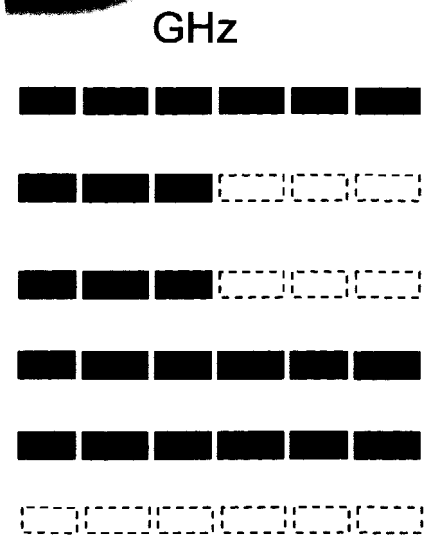
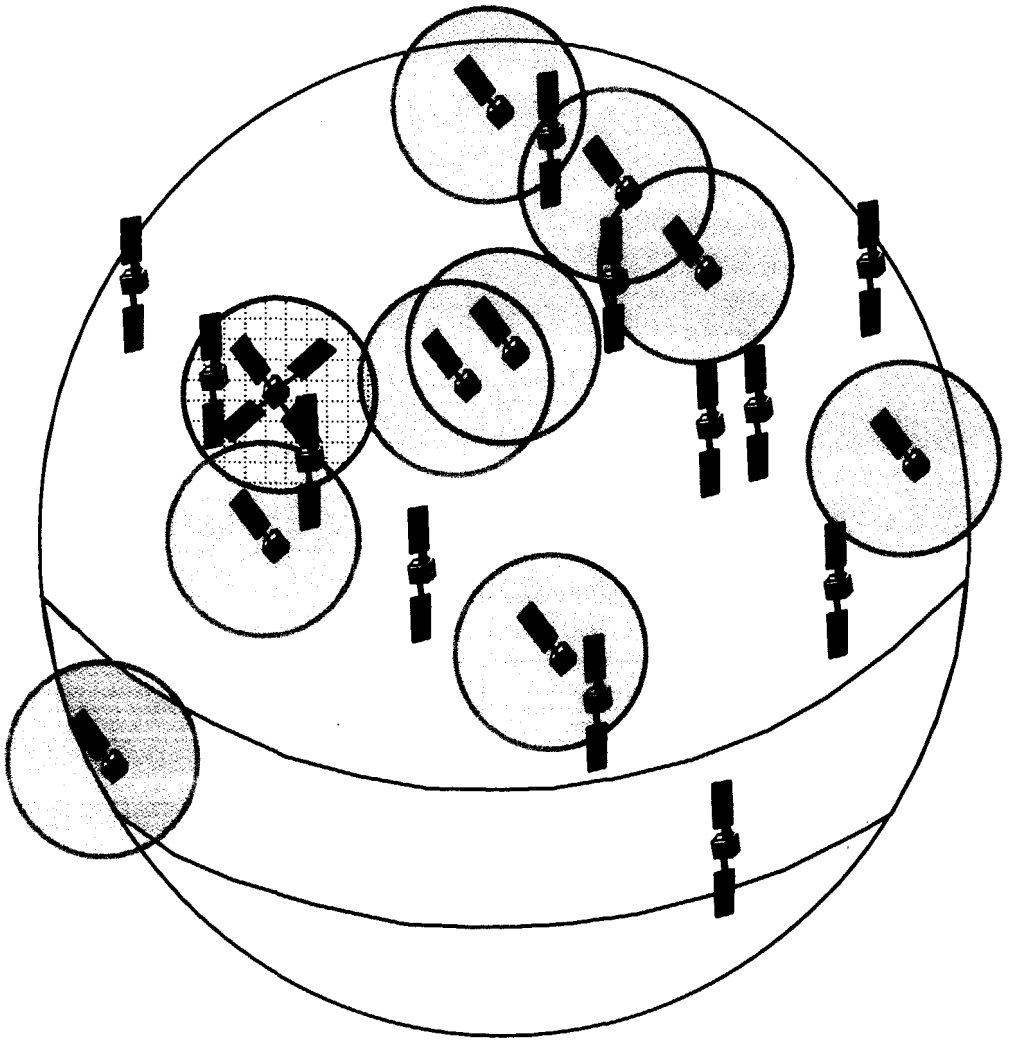
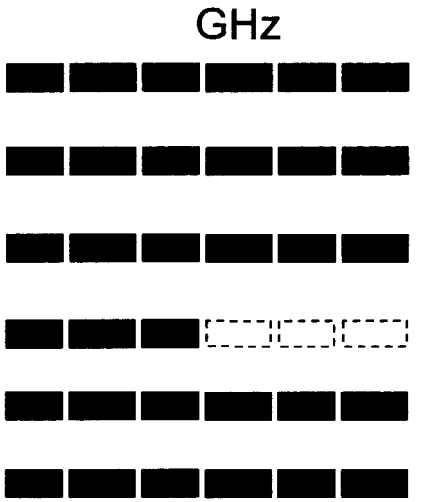
# Home Zone
# Example with 3 systems



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