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December 20, 2001

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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

Ms. Magalie R. Salas
Secretary
Federal Communications Commission
445 12th Street, SW
Washington, DC 20554

Re: Ex Parte Presentation: Application of Virtual Geosatellite, LLC For Launch and Operating Authority, File No. SAT-LOA-19990108-00007; and ET Docket No. 98-~~208~~ 98-206

Dear Ms. Salas:

Pursuant to Section 1.1206 of the Commission's Rules, 47 C.F.R. Sec. 1.1206, Virtual Geosatellite LLC, through counsel, provides notice that on December 19, 2001, Mr. Gerald Helman, Mr. Jay Brosius and the undersigned, met with Commissioner Abernathy and Mr. Bryan Tramont. We discussed Virtual Geosatellite LLC's comments on proposals for Ku-band NGSO-NGSO spectrum sharing and Virtual Geosatellite technology as set out in the attachment to this letter.

The original and one copy of this letter with attachment are submitted for inclusion in the record of the referenced proceedings.

Please contact the undersigned with any questions.

Respectfully submitted,

Raul R. Rodriguez
Counsel to Virtual Geosatellite, Inc.

RRR:sakc
Attachment
cc (w/attch. by email): Mr. Bryan Tramont

No. of Copies rec'd 0+1
List ABCDE

The Virtual Geostationary Opportunity

Presentation

before the

FCC

Virtual Geosatellite, LLC

Jay Brosius

Gerry Helman

19 December 2001

The Skies Are Filling!!

- 36 MHz-equivalent transponders expected to increase from 5,281 in 1997 to 8,506 in 2003 -- a 61% increase in 5 years
- By 2008, expected increase to 13,699 36 MHz-equivalent transponders -- a 159% increase over 10 years
- Expansion will more than exhaust the available orbital slots for C- and Ku-band

Additional Supply Needed to Maintain 15% Margin Over Demand

	2000	2001	2002	2003	2004
Additional Transponders Needed	390	1,250	2,515	3,880	4,949

Source: Merril Lynch

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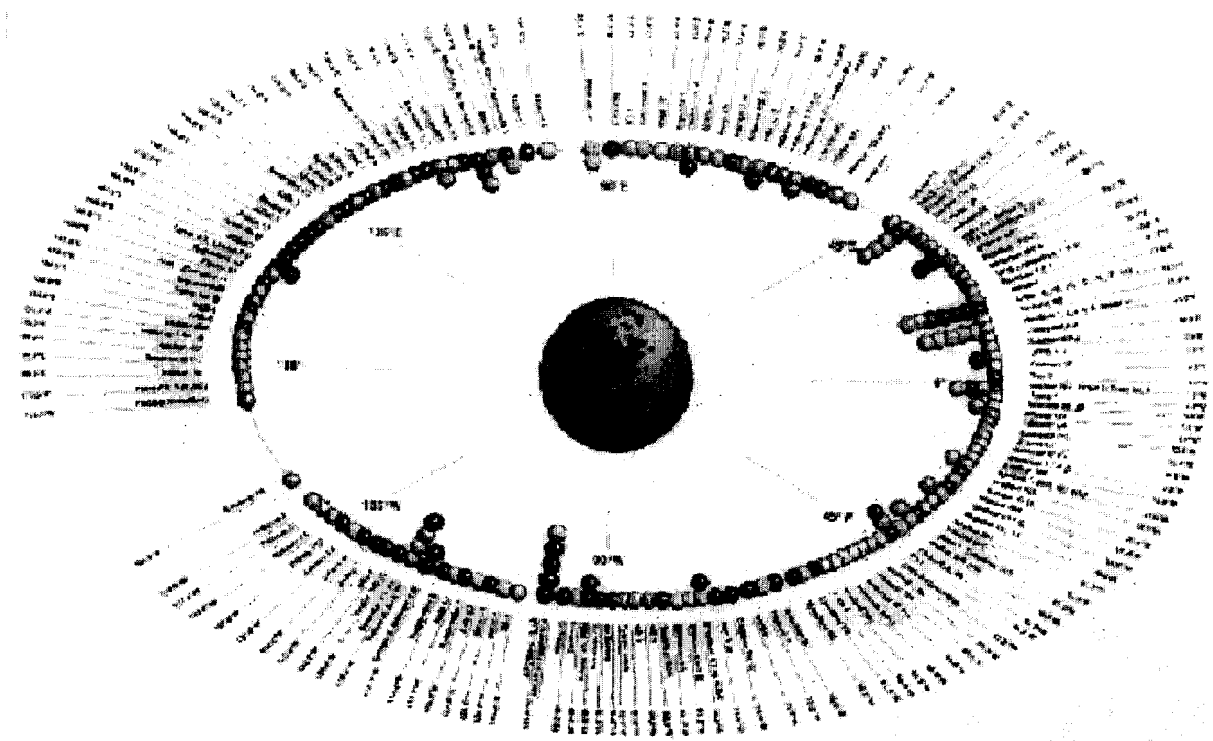
The Extremely Valuable, Increasingly Scarce Geostationary Orbit Resource



Demand is increasing

Supply is dwindling

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The FCC Recently Opened a Filing Window for Non-GEO Fixed Systems

---

Virtual Geosatellite LLC has proposed

VIRGO

Serving Broadband Users Worldwide

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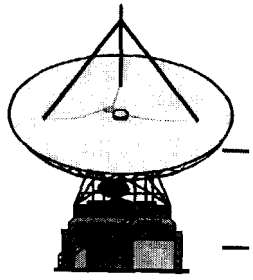
Virtual Geosatellite, LLC - Proprietary Information

Virgo

- A global space-based networking and internet access service
- Using a patented* Virtual GEO elliptical constellation of satellites
  - Optimize coverage of land masses
  - Minimize interference to other services

- **Supports:**
  - High speed, multi-megabit per second digital traffic and applications
  - Modest sized user terminals (18" antennas)
  - Locations anywhere on the Globe, pole to pole



*patent no's 5,845,206; 5,957,409; and others pending

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High Speed, Low Cost Access!

- **Cheaper than LEOs:**
  - Hundreds of short-life LEOs are prohibitively costly to build, launch, operate, and maintain.
- **Comparable to GEOs:**
  - 5-satellite Virtual Geostationary ("Virtual GEO") constellation similar to 3-GEO constellation,
    - Smaller satellite for same capability
    - Lower overall launch costs — lower total ΔV & lower wt/sat
  - With better hemispheric coverage and elevation angles.
- **Competitive service pricing**

Virtual GEO orbits and slots are the secret to success!!

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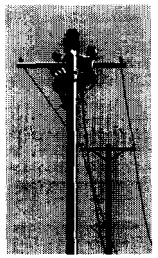
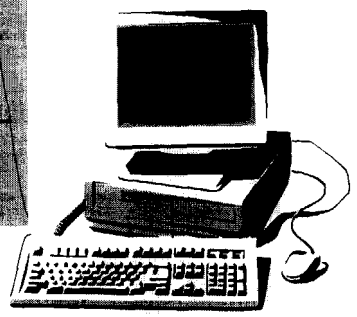
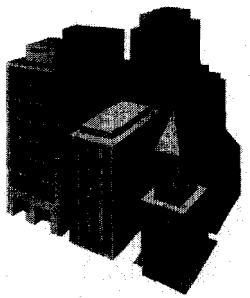
Multiple Markets





- **Three primary customer targets:**
  - *Broadband Carriers* **such as telecom carriers and ISPs requiring high-speed trunks from and to any place on earth.**
  - *Corporate and Institutional Networks* **requiring bandwidth-on-demand and direct-to-user services.**
  - *Small Offices-Home Offices*, **Small and Medium Enterprises, and Households will be offered the VIRGO Powered-PCTV suite of services.**



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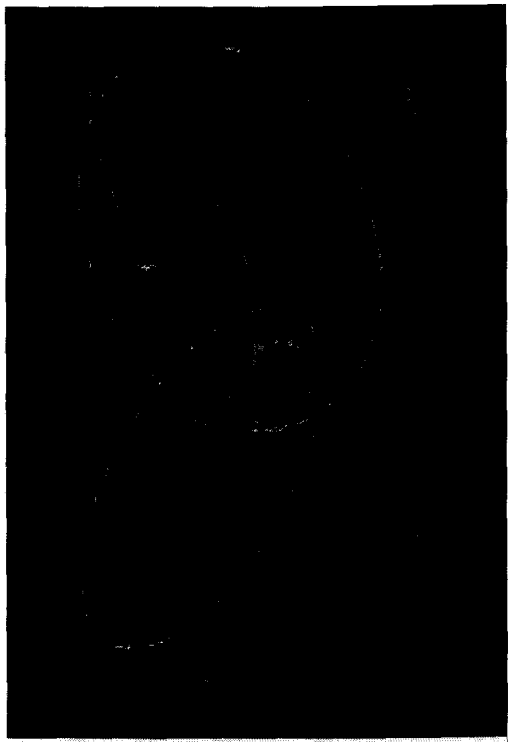
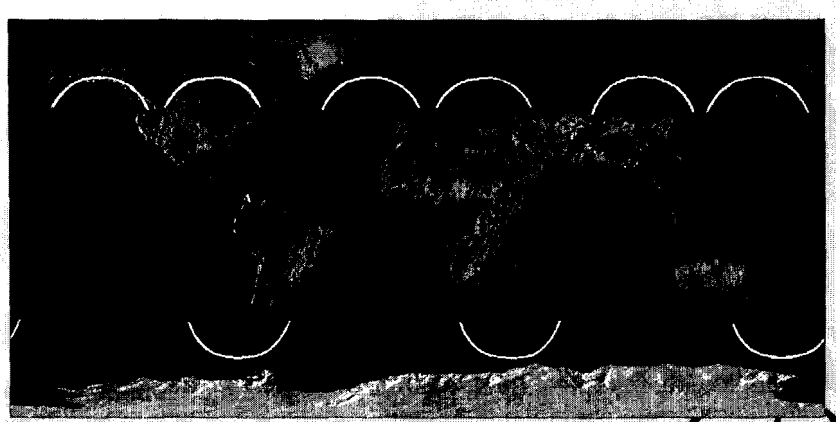
VIRGO uses Virtual GEO Orbits and Active Arcs



- Active arcs fixed over important markets
- 6 in Northern Hemisphere and 3 in Southern
- Providing Global Pole to Pole coverage and service



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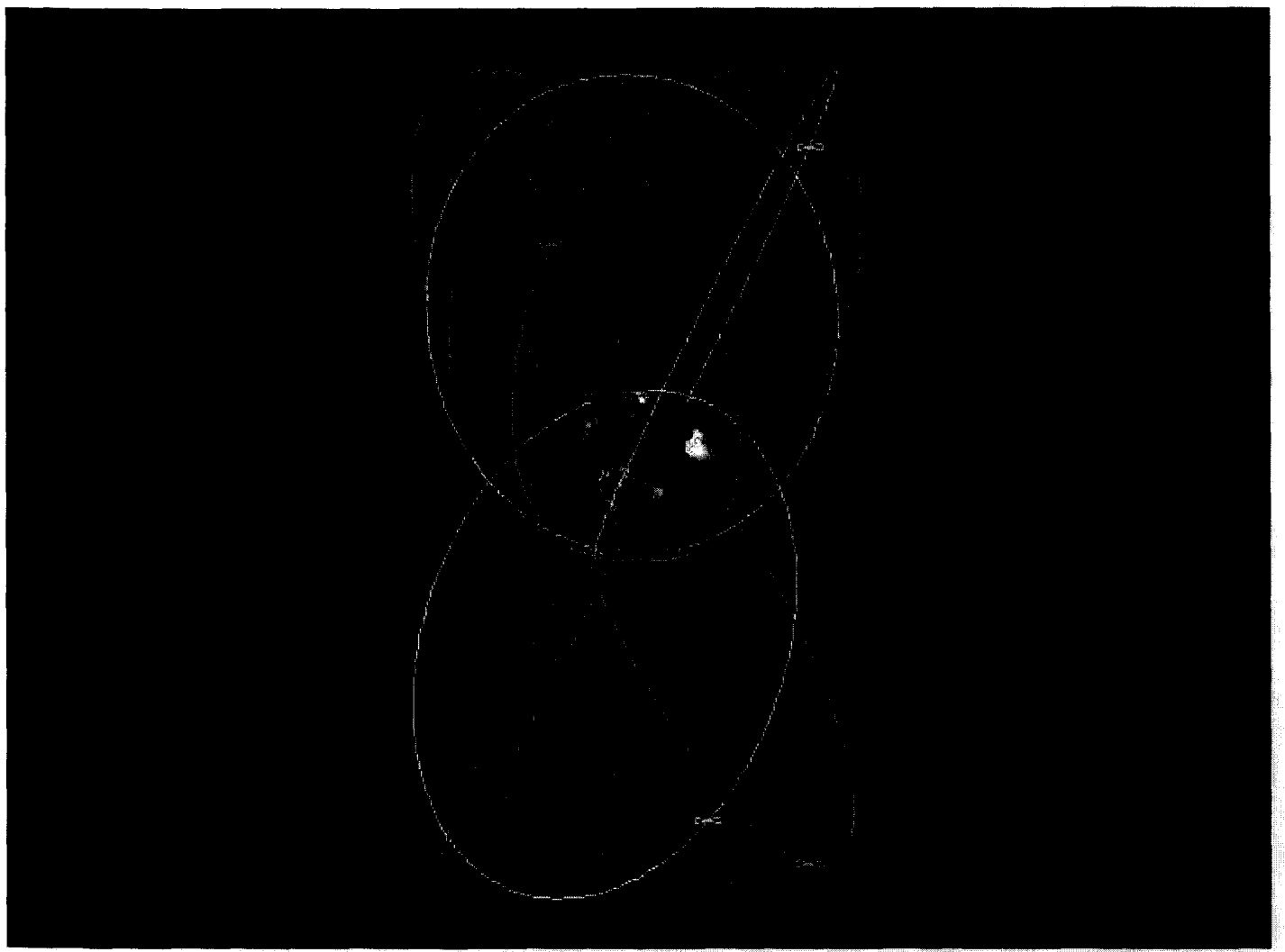
Virtual Geo in Perspective



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What are Virtual Geostationary Orbits?

What are their Benefits?

...for the satellite community

...for the public interest

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Virtual Geosatellite, LLC - Proprietary Information

The Beauty of GEO Orbits

Stationary coverage over served areas

- ↳ International agreement on and adoption of orbital parameters
  - ↳ Coordinated flight among many satellites
    - ↳ Consistent separation
    - ↳ No crossing interference
      - ↳ Extensive frequency reuse and multiple entry
      - ↳ **Hundreds of Sharing Systems!**

But everything hangs on international agreement and adoption!

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Are There Other Possibilities?

- That...
  - Loiter over Service Areas?
  - Stay out of each other's way?
  - Permit re-use of GSO frequencies?
  - Permit many, perhaps hundreds of more assignments?
  - That are easy to coordinate?

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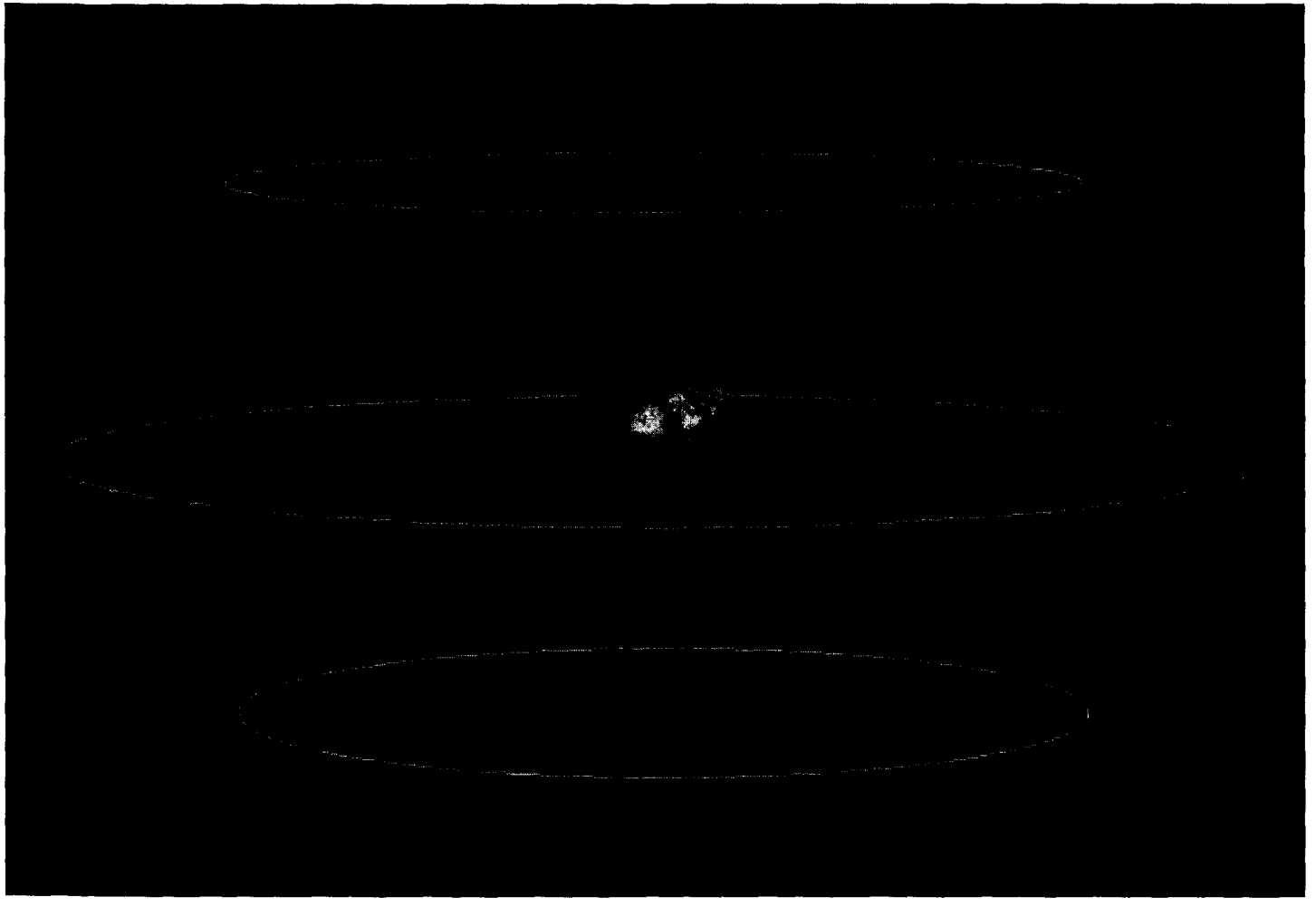
What We'd Like to Do



...but can't

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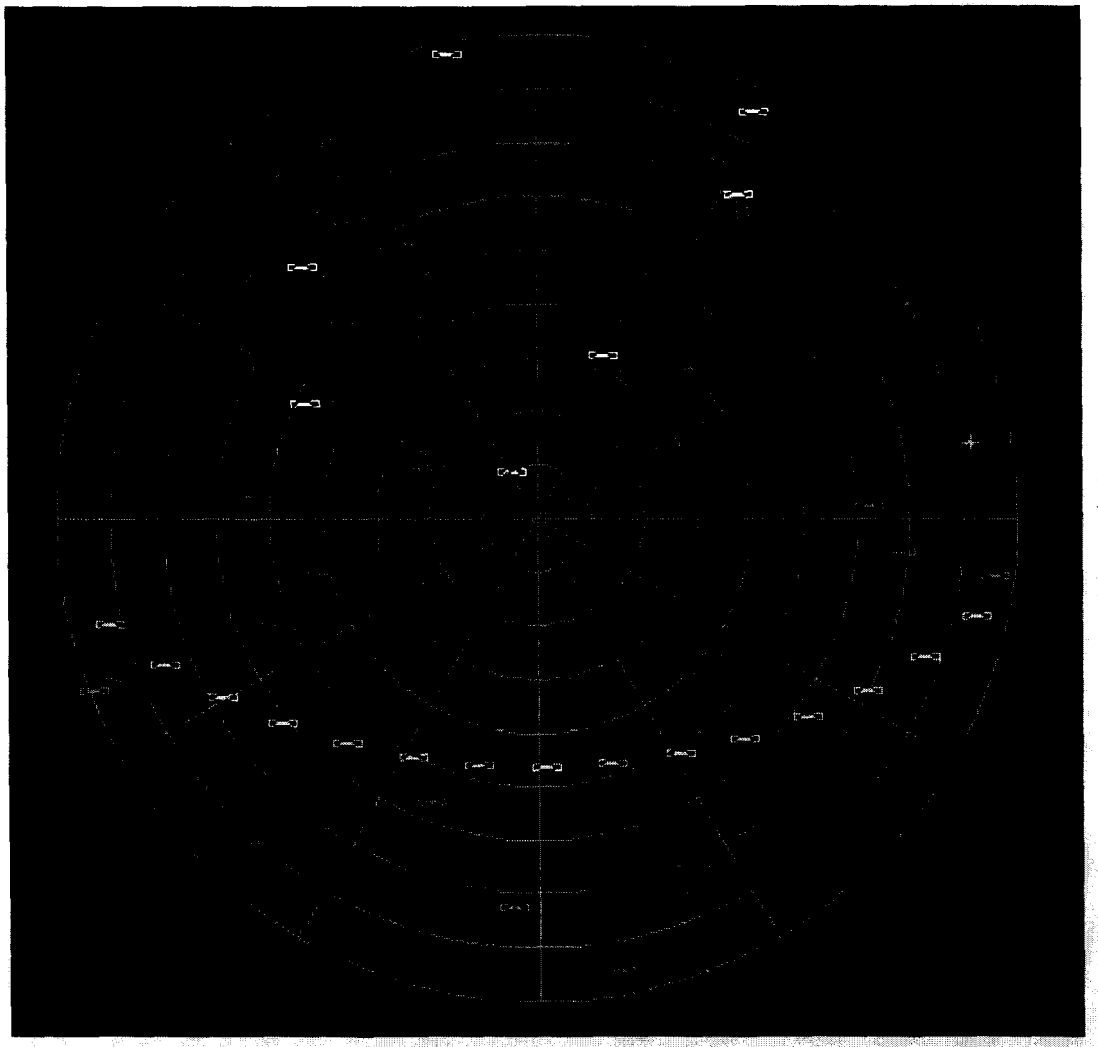
No Standard: A Potential Mess



Depicts Ku-band NGSO satellites notified to ITU

Yellow is GEO

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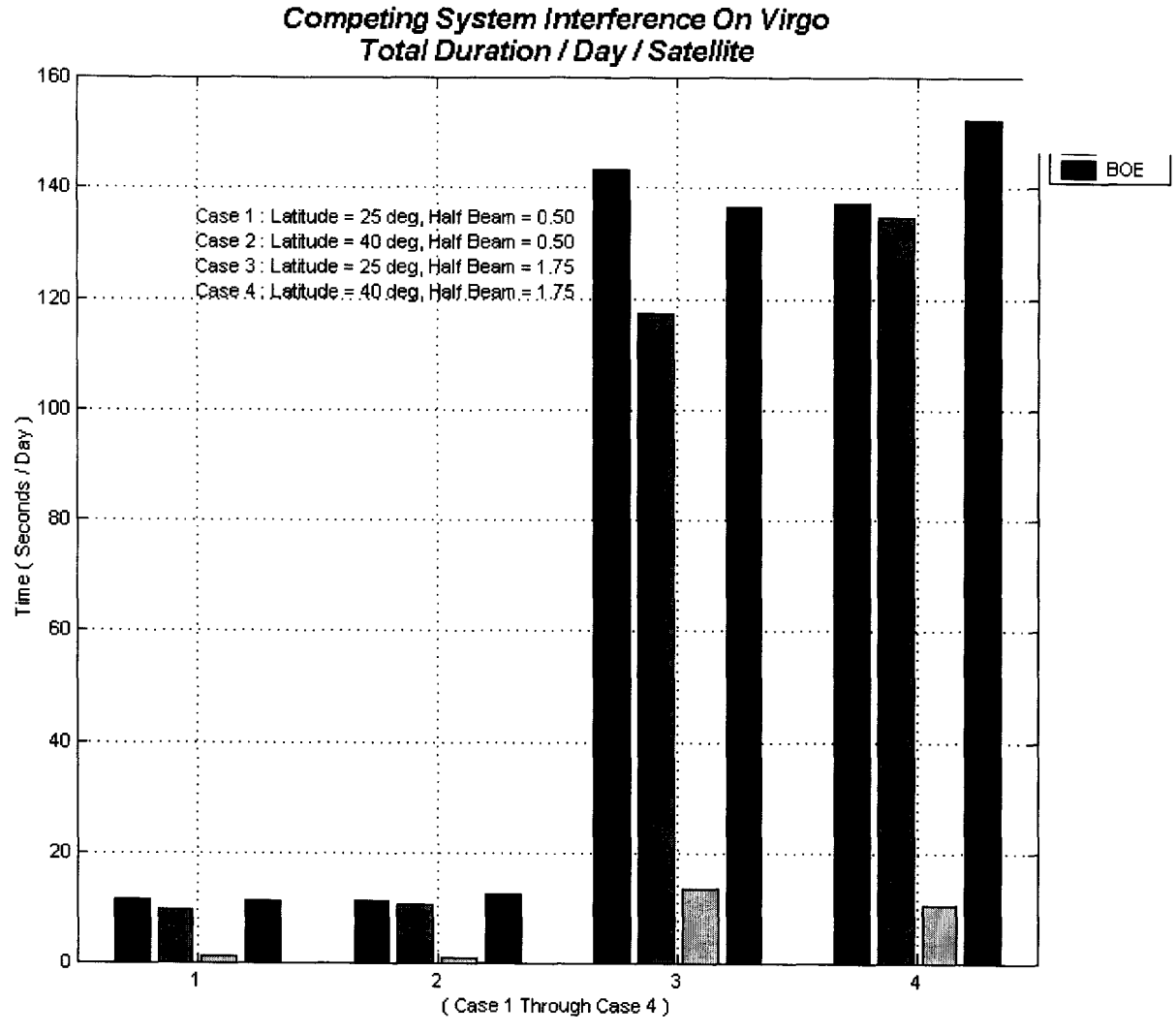
Interference from Uncoordinated Systems



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Any Other Possibilities?

- We note:
  - Satellites in Elliptical critically inclined (frozen apogee) orbits loiter near apogee
  - Selected critical Elliptical orbits also repeat ground tracks and favor selectable regions
    - But may not permit effective slotting in angle
    - Hence little multiple entry

But one variation of critical elliptical orbits does!

...And maintains large angular separation from the GEO arc!

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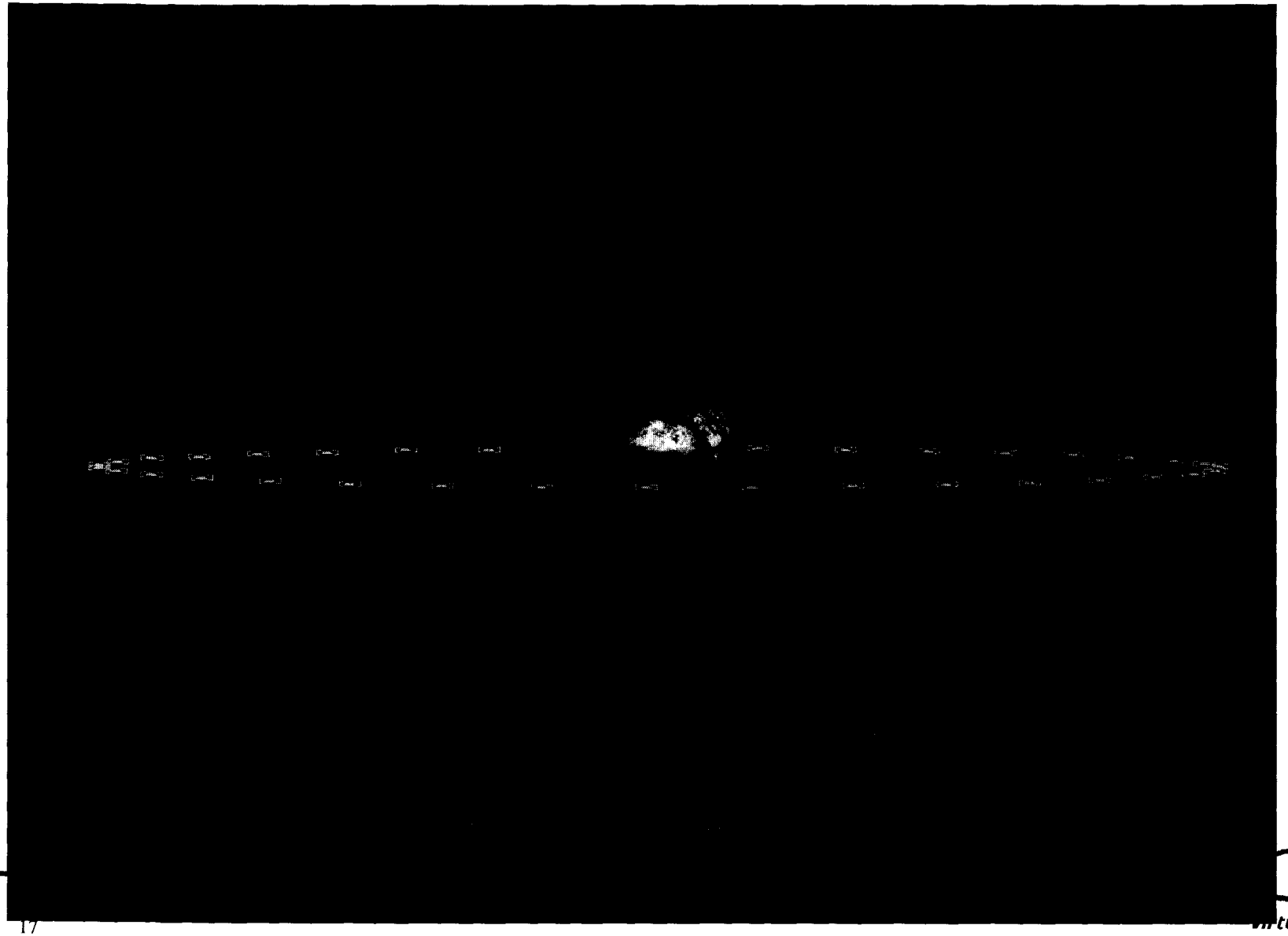
What We *Can* Do



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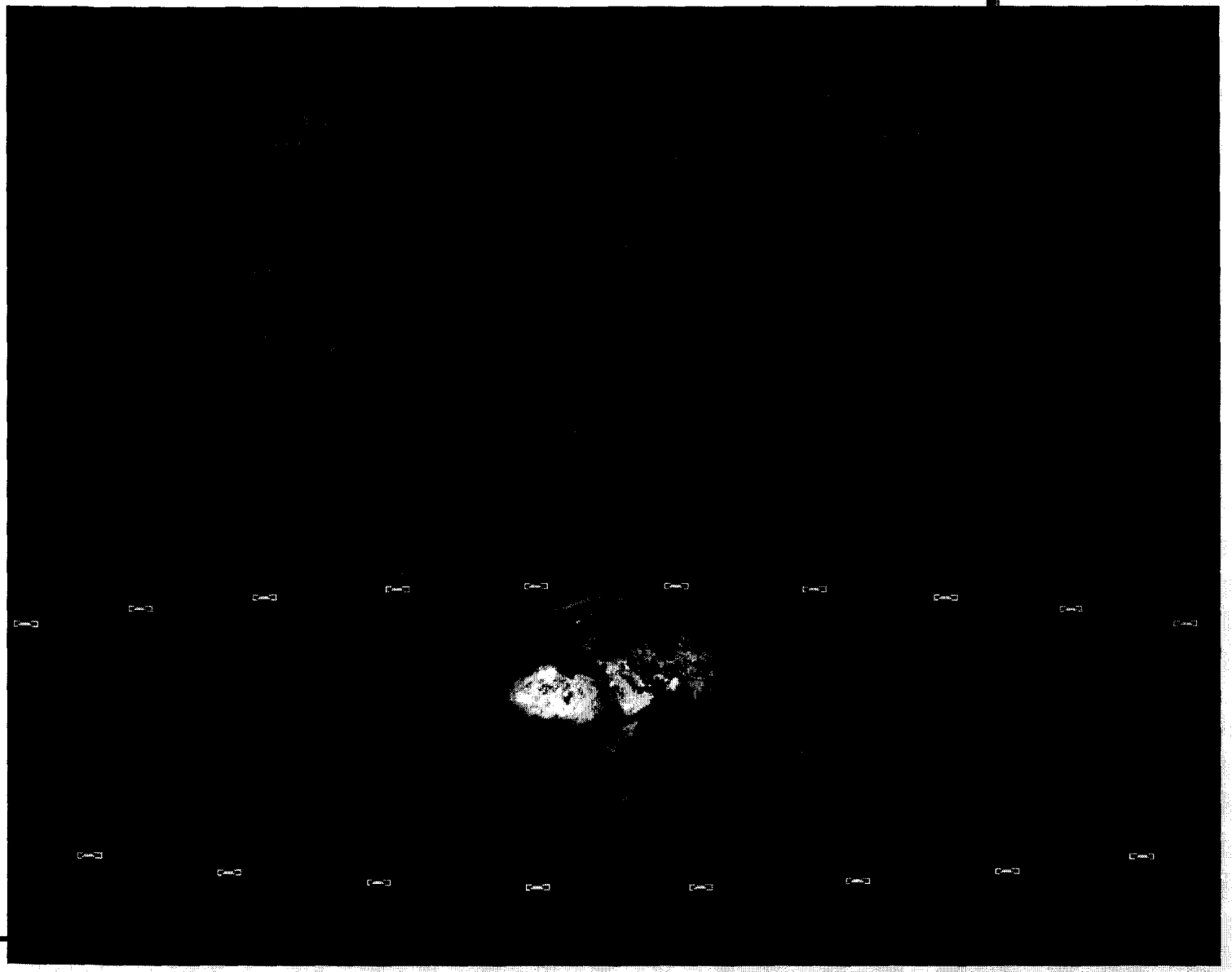
Virtual GEO Satellites in Perspective



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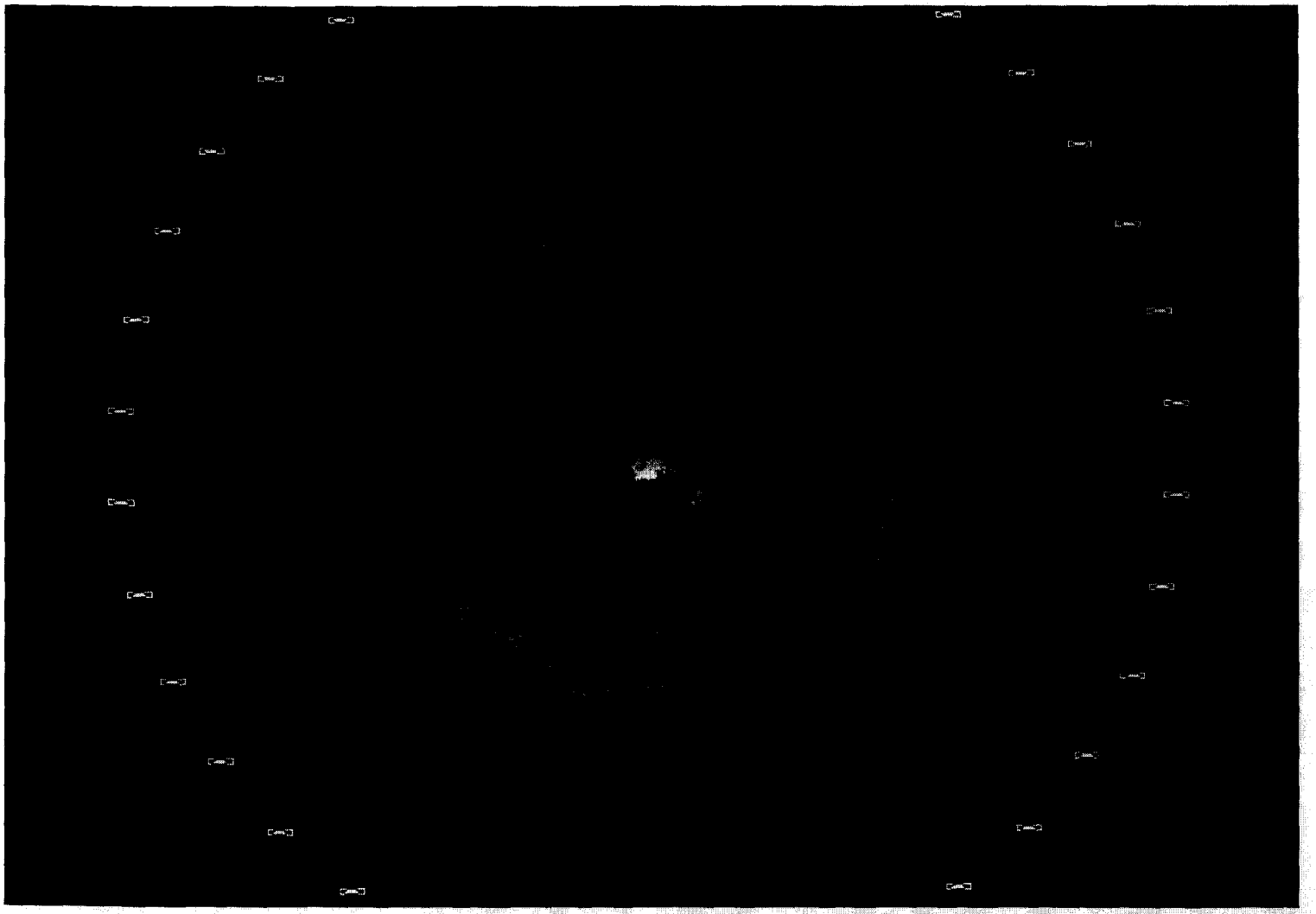
Virtual GEO Slots from the North



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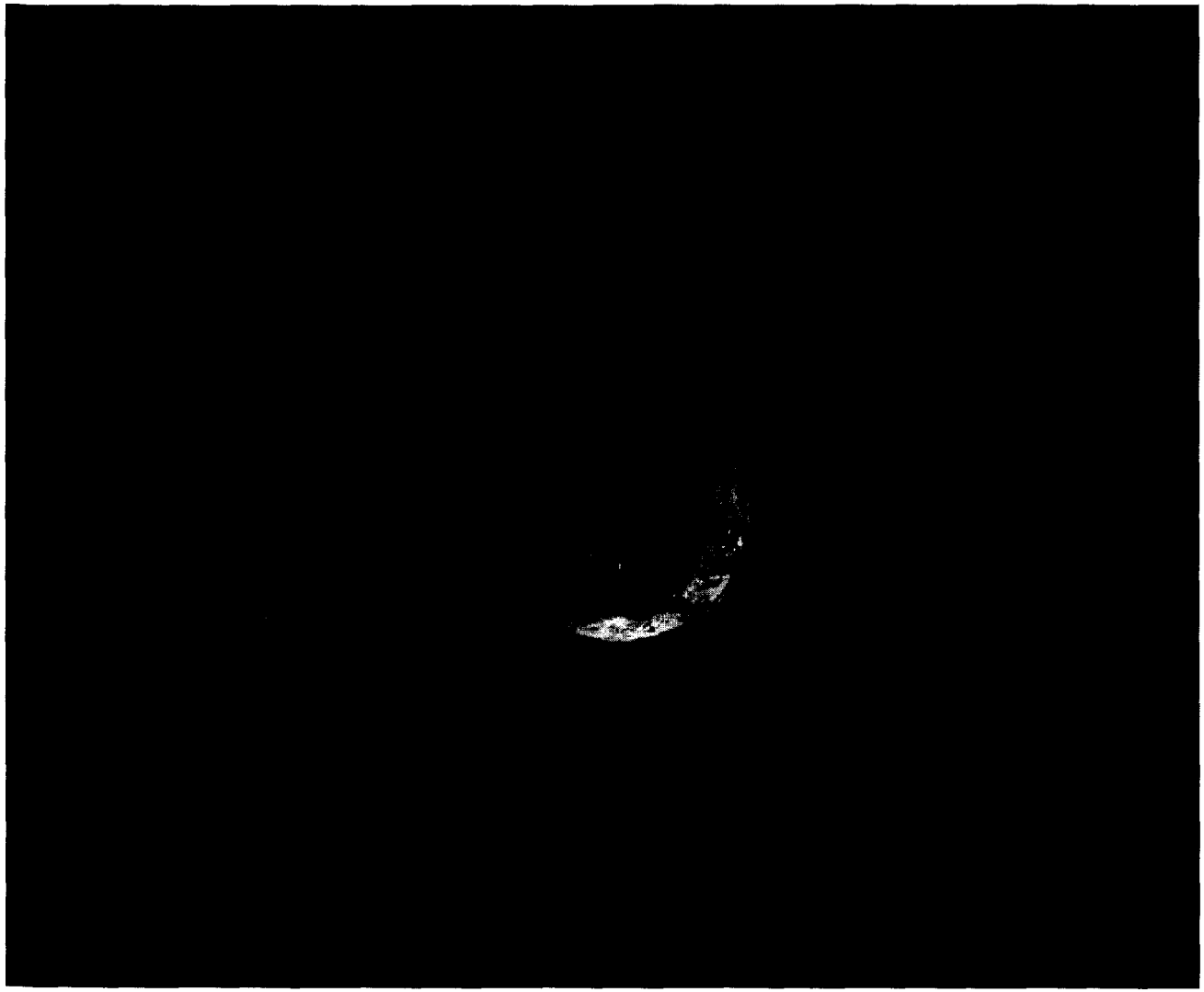
Active Satellites from the North



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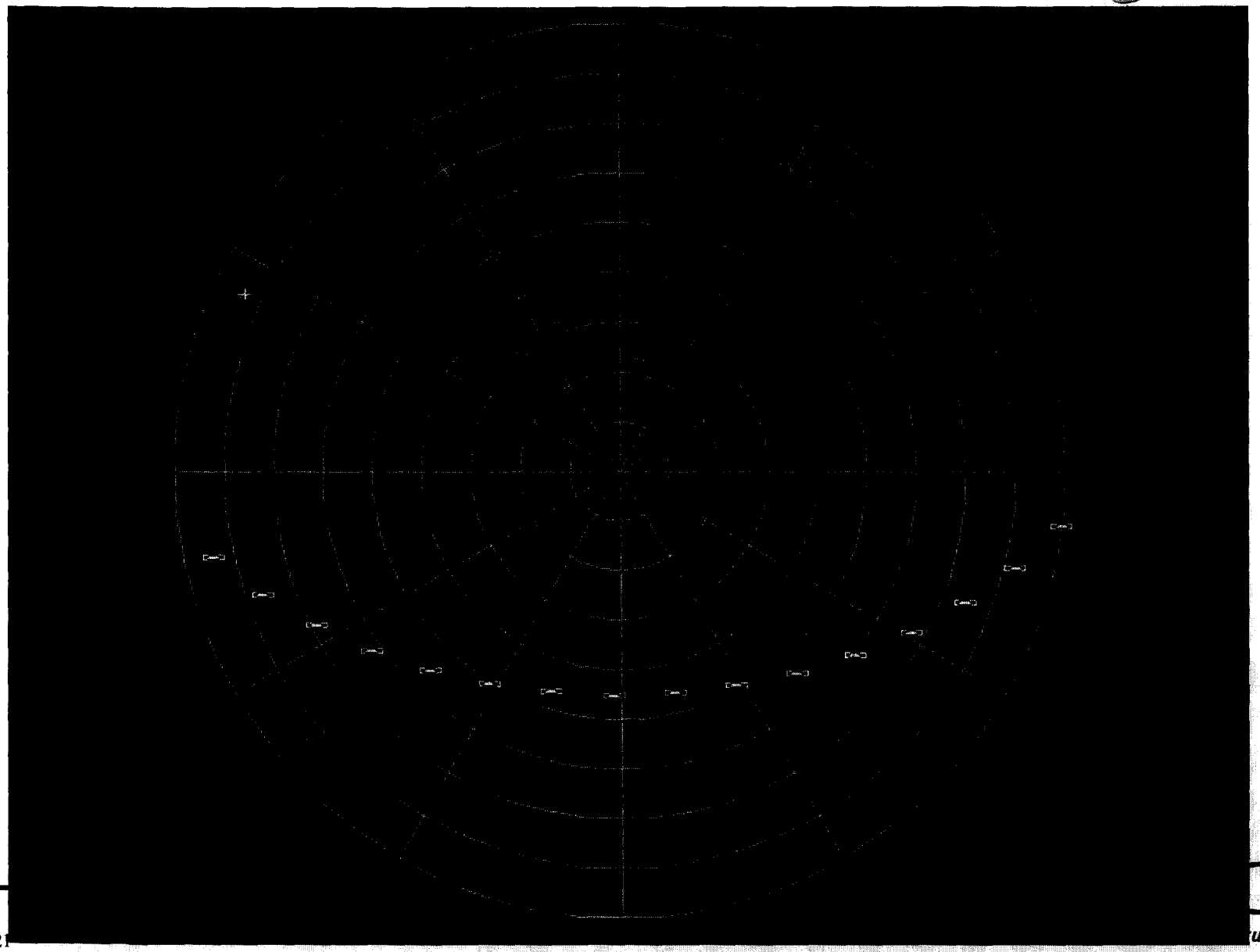
Virtual GEO Satellites from Washington



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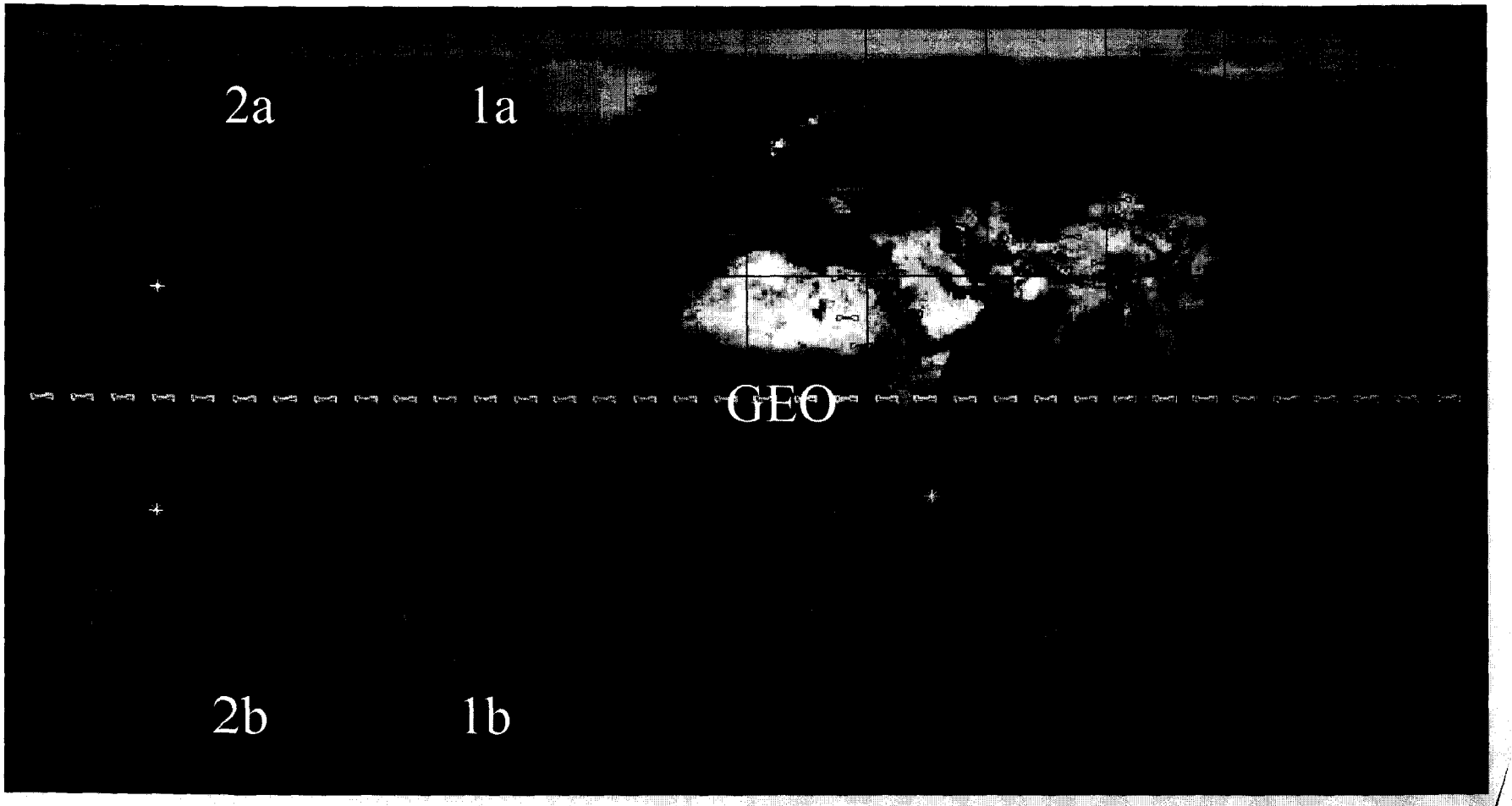
Virtual Geostationary Multiple Entry Using GSO-like Slots



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Active Arcs

- Longitude of Apogee specified for Americas Active Arcs
  - 65° West for Ground Tracks 1a and 1b
  - 125° West for Ground Tracks 2a and 2b
- Other two Active Arcs in ground track offset by ±120 degs

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Active Arcs

- Active Arcs span 72 to 288 degrees Mean Anomaly for each assigned orbit
  - Plus 3 minutes at each end of Active Arc for switchover, housekeeping
  - Satellite RF Radiation suppressed by at least 60 decibels relative to authorized power when out of Active Arc
- Each Assignment granted an Americas Active Arc time of entry for January 1, 2005
  - Time separation provides angular separation
  - Entry time can be calculated for other days as needed

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Standard Orbital Parameters

Mean Motion	3.004: freeze ground track (including correction for regression of nodes to freeze ground track)
Inclination	63.435°: freeze apogee (to freeze rotation of line of apsides)
Eccentricity	0.63: perigee > 1000 km
Argument of Perigee	270° – Northern arcs 90° – Southern arcs
Longitude of Apogee over Americas	65 or 125° West Longitude defines coverage areas

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Sharing Potential of Virtual Geostationary Orbits

The "Virtual Slot"

- 12 Possible Active Arcs (6 in Northern Hemisphere, 6 in Southern)
- Approximately 2 degrees of separation at apogee between satellites create GEO-like slots
- Space at a minimum for 300 satellites -- 180 active at any given time

Number of "Systems"

At a minimum...

- 30 full global systems or...
- 60 hemispheric systems or...
- 180 regional satellite operators

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Virtual GEO and Band Sharing

Virtual Geosatellite, LLC - Proprietary Information

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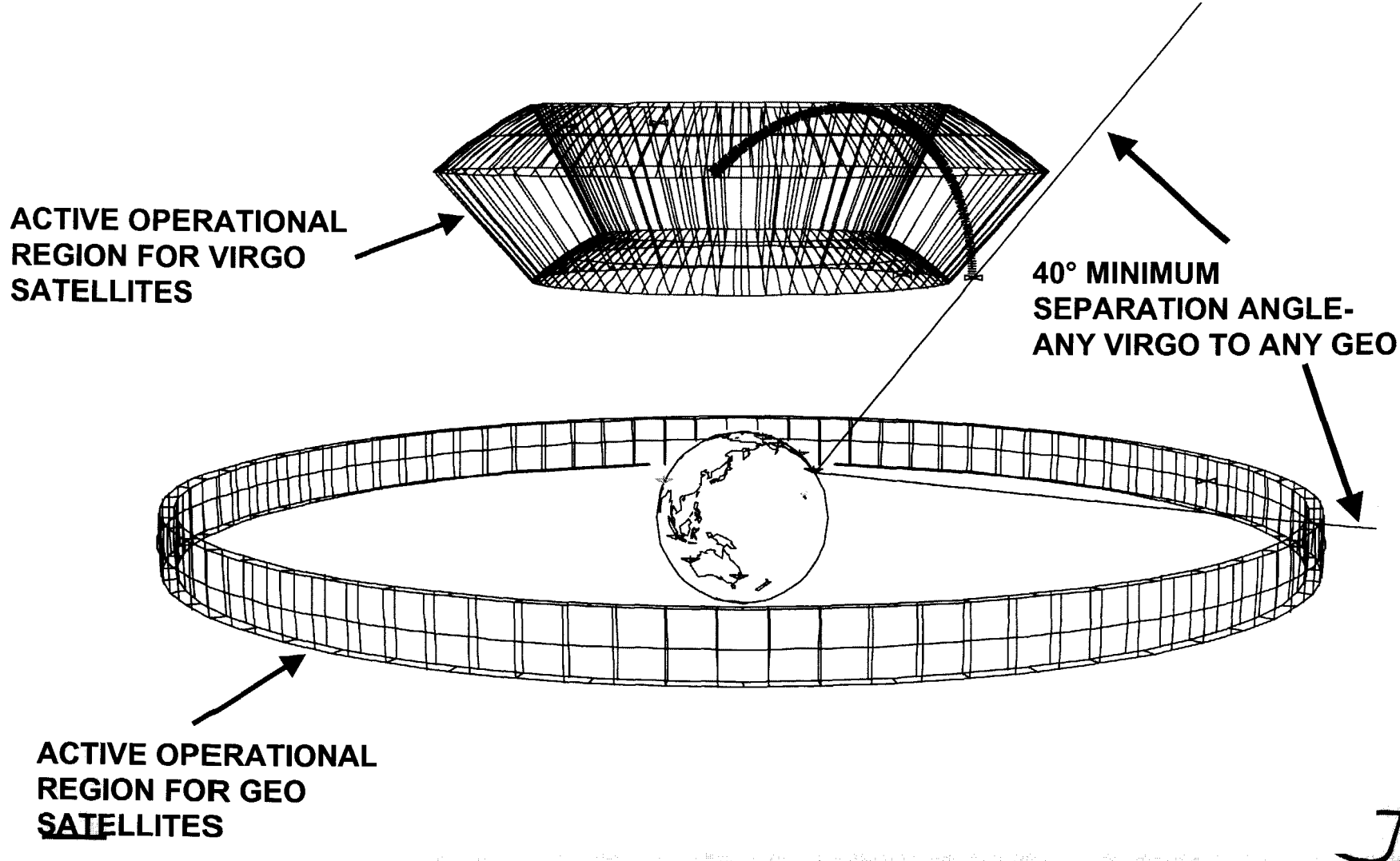
Comparison of Virtual GEO and GSO Operating Regions



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Geostationary Arc Separation

- Actually always more than 45 degrees
- Guarantee always more than 40 degrees
- Lowest for terminals at far North and far South latitudes
- Always >50 degrees in CONUS

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Relative GSO Arc Protection Factors

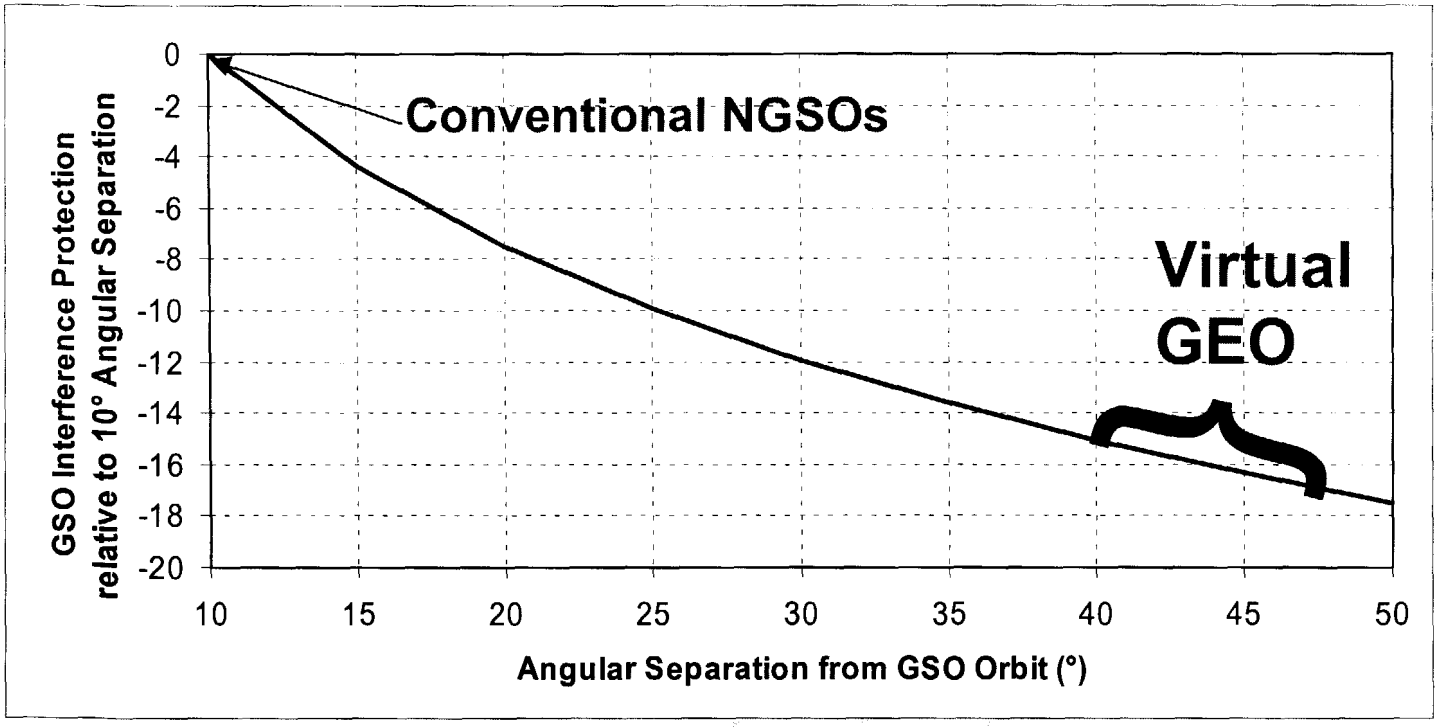

Chart based upon 25logΘ rolloff

Equivalent to a 40 degree separation on the GSO Arc!

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Interference to C-Band GSO Earth Station

Ku Band Similar

Maximum PFD of VIRGO™ satellite in 4 kHz	**-165**	**dBW / m^2 / 4kHz**
GSO orbit avoidance angle	**40**	**°**
GSO Rx Earth Station gain towards VIRGO™ satellite	-8.1	dBi
Frequency	4000	MHz
Effective Aperture of GSO Rx Earth Station towards VIRGO™ satellite	-41.5	dB-m^2
GSO Rx Earth Station Interfering Signal Power in 4 kHz	-206.5	dBW / 4kHz
GSO Rx Earth Station Interfering Signal Power Spectral Density	-242.6	dBW / Hz
Increase in interference due to 3 simultaneously visible VIRGO™ satellites	4.8	dB
GSO Rx Earth Station Interfering Signal Power Spectral Density (3 VIRGO™ satellites)	-237.8	dBW / Hz
GSO Rx Earth Station System Noise Temperature	**80**	**K**
GSO Rx Earth Station System Noise Power Spectral Density	-209.6	dBW / Hz
I_0/N_0 at GSO Rx Earth Station Input	**-28.2**	**dB**

ΔT/T Degradation to Earth Station 0.15%

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Interference to C-Band GSO Satellite Receiver

Ku Band Similar

	Clear Sky	Rain	
Maximum PSD into VIRGO™ Earth Station Antenna in 4 kHz	**-25.0**	**-21.8**	**dBW / 4kHz**
GSO orbit avoidance angle	**40**	**40**	**°**
VIRGO™ Tx Earth Station gain towards GSO Satellite	-4.1	-4.1	dBi
VIRGO™ Tx Earth Station EIRP Spectral Density towards GSO Satellite in 4 kHz	-29.1	-25.9	dBW / 4kHz
PFD at the GSO Satellite in 4 kHz	-191.2	-188.0	dBW / m^2 / 4kHz
Frequency	6325	6325	MHz
Assumed Gain of GSO Satellite Rx towards VIRGO™ Earth Station	**40**	**40**	**dBi**
Effective Aperture of GSO Satellite Rx towards VIRGO™ Earth Station	2.5	2.5	dB-m^2
GSO Satellite Rx Interfering Signal Power in 4 kHz	-188.6	-185.4	dBW / 4kHz
GSO Satellite Rx Interfering Signal Power Spectral Density (one VIRGO™ earth station)	-224.7	-221.5	dBW / Hz
GSO Satellite Rx Interfering Signal Power Spectral Density (two VIRGO™ earth stations)	-221.7	-218.5	dBW / Hz
GSO Satellite Rx System Noise Temperature	**600**	**600**	**K**
GSO Satellite Rx System Noise Power Spectral Density	-200.8	-200.8	dBW / Hz
I_0/N_0 at GSO Satellite Rx Input	**-20.8**	**-17.6**	**dB**

ΔT/T Degradation to Satellite Receiver 0.82% (1.7% rain)

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Virtual Geo's Relationship to FS

- **VGSO Earth Stations use GEO-type directive, narrow beam Antennas in FS-shared spectrum**
  - ***Antenna off-axis attenuation adds coordination flexibility***
- **VGSO uses high elevation sky-tracks**
  - ***VGSO accommodates low elevation angle restrictions***
- **VGSO satellites follow one sky-track per arc,**
  - ***Not many, as for other NGSO***
  - ***Permits greater azimuth coordination flexibility relative to NGSO***
- **VGSO improves slot choices worldwide**
  - ***Makes more higher-elevation angle slots available***

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Virtual GEO Coverage and Protection to FS

- Coverage optimized over land masses
  - **US Coverage Factor*** — **Improvement**
    - ***Always > 42 degrees in CONUS*** — ***23 dB***
    - ***>30 degrees for VI, PR*** — ***19 dB***
    - ***>35 degrees for Hawaii*** — ***21 dB***
  - **Global Coverage: - Elevation Angles**
    - ***Exceed 30 degrees for 50% of land areas*** — ***19 dB***
    - ***Exceed 20 degrees for 90% of land areas*** — ***15 dB***
    - ***Exceed 10 degrees for 99.9% of coverage area*** — ***8 dB***
  - **Lowest elevation angles occur off land over Atlantic, Indian, and Pacific Oceans**

* *Relative to 5° minimum elevation angle*

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NGSO Designs Present Significant Sharing Difficulties

- **The GSO arc is a coordinated, agreed-upon orbit**
  - **Offers visibility advantages — positioning over desired markets**
  - **Greatly facilitates frequency sharing among many systems**
- **NGSO systems presently use uncoordinated orbits**
  - **Frequent crossing interference events**
    - *More systems add more crossing interference to everyone*
  - **Limited entry possible**
    - *Possible requirement for spectrum subdivision — limiting capacity*
    - *Possible exclusion of future entrants*
  - **Expensive, non-productive measures necessary to limit effects of crossing interference**
    - *Diversity — more satellites or ground stations needed*
    - *Interruptions*
  - **Limited isolation from GSO**

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Virtual Geostationary Arcs Overcome "NGSO" Difficulties

- **VGSO arcs create new GSO-like opportunities**
- **Spectrum allocated for this new standard permits:**
  - *Visibility advantages — loitering over desired markets*
  - *Many more systems possible*
    - *Slotted, like GEOs*
    - *No Crossing interference*
  - *Additional interference mitigating resources not required*
  - *More and often better choices for satellite positioning*
  - *No interference to GSO arc or to each other*
  - *Future entry not barred, Coordination simplified*
  - *Reuses existing GEO spectrum*

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How Do GEO and VGEO Satellites Compare??

	GEO	VGEO
EIRP (reduced ranges for VGEO)	$P_t G_t$	$0.57*P_t G_t$
DC Power (lower avg active alt & duty cycle for VGEO)	P_{dc}	$0.51*P_{dc}$
Satellite Antenna Gains (larger cone angles for VGEO)	G_t	$0.57*G_t$
Radiation Shielding (more for VGEO)	Standard	Added for payload and arrays
Satellite Antenna Costs (higher for VGEO)	C_a	$2.5*C_a$
Satellite weight (same performance, w/ shielding)	W_s	$0.62*W_s$
Satellite Cost, wet	C_s	$0.78* C_s$
Satellite Launch Costs (reduced wt *and* ΔV for VGEO)	C_l	$0.37*C_l$
Per Satellite Cost on Orbit	C_{so}	$0.60* C_{so}$
Net Constellation Costs (3 sats for GEO; 5 sats (3 active arcs) for VGEO, Hughes GEO equiv)	Same	

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The Virtual Geostationary Orbit Standard

- New Operating Vantage Points
- Simple Existing Assignment Rules
- Easier Coordination

Scores, perhaps hundreds of new, interference-free VGSO assignments now possible!

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Virtual Geosatellite, LLC - Proprietary Information