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November 21, 2000

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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

Ms. Magalie R. Salas
Secretary
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

Re: Notification of *Ex Parte* Presentation in ET Docket No. 98-206

Dear Ms. Salas:

Pursuant to Section 1.1206 of the Commission's Rules, 47 C.F.R. Sec. 1.1206, this letter serves as notice that on November 17, 2000, Gerald Helman, Vice President of Ellipso, Inc., acting on behalf of Virtual Geosatellite LLC ("Virtual Geo"), Dr. John Brosius, Chief Scientist, Ellipson, Inc., acting on behalf of Virtual Geo, and undersigned counsel, met with the International Bureau staff members copied below to discuss the use of virtual geosatellite orbits and their ability to share spectrum without interfering with other users. The attached slides were used in the presentation.

An original and one copy of this letter are submitted for inclusion in the record of the referenced proceeding.

Respectfully submitted,

Raul R. Rodriguez
Counsel to Virtual Geosatellite, LLC

Attachments

cc (w/o att.): Ms. Cecily Holiday
Ms. Jennifer Gilsenan
Mr. Paul Locke
Mr. Sankar Persuad

No. of Copies rec'd 0+1
List A B C D E

Virtual Geostationary Orbits
A New, Rich, Coordination-Friendly Resource for Orbital Slots

November 2000

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The Extremely Valuable, Increasingly Scarce Geostationary Orbit Resource

Demand is increasing

Supply is dwindling

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The Virtual Geostationary Orbital Regime

Offers Promise as our

Next Multi-Slot Orbital Resource

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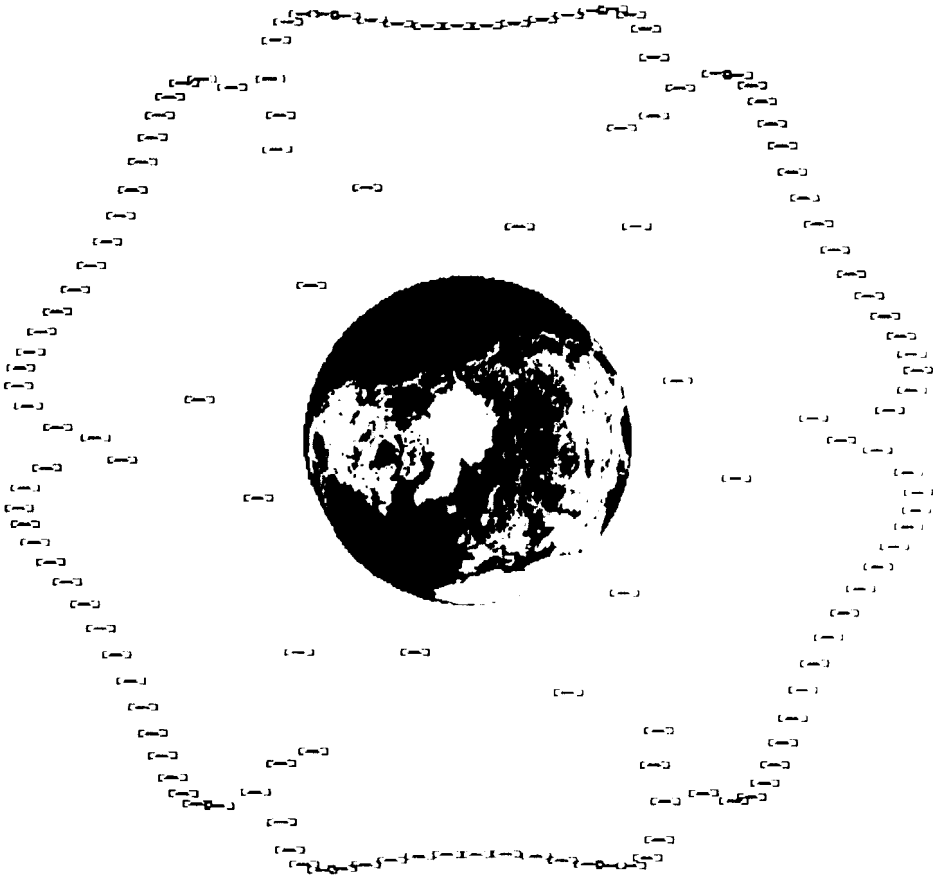
The New Orbital Slot Resource



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What are Virtual Geostationary Orbits?

What are their Benefits?

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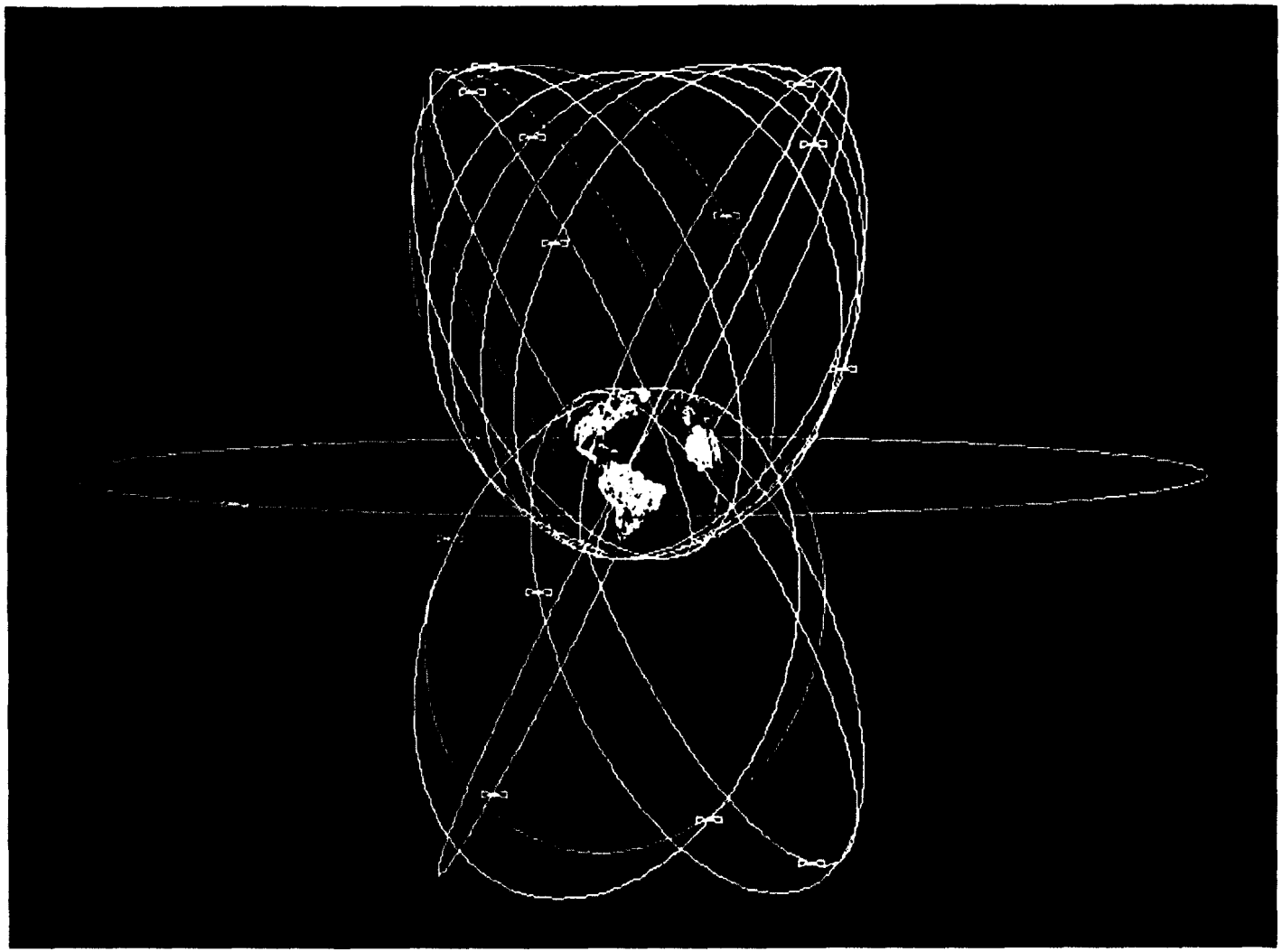
A Virtual Geostationary Constellation



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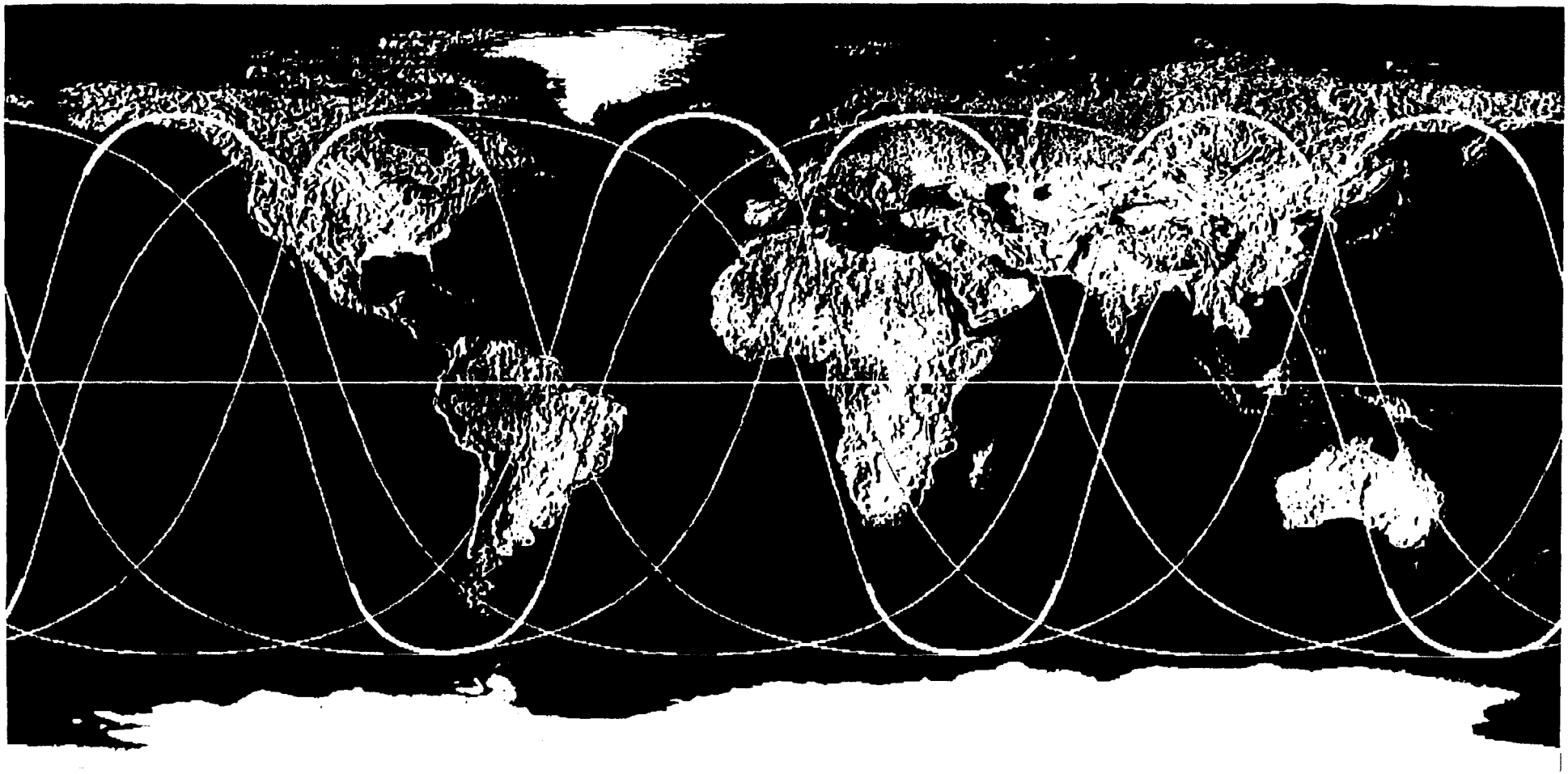
Virtual Geostationary Active Arcs



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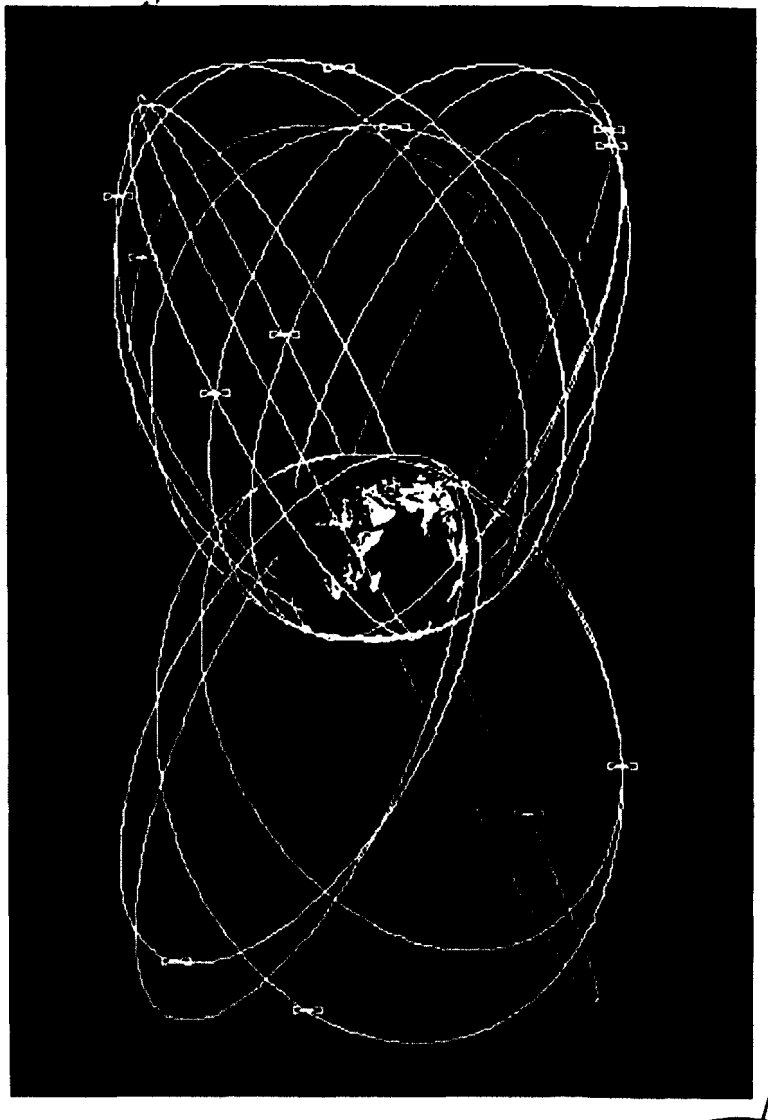
Virtual Geostationary Orbits

- General
  - 15 Satellites:
  - 3 ground tracks of 5 each
  - 8 hour elliptical, critically inclined orbits, 1 plane per satellite



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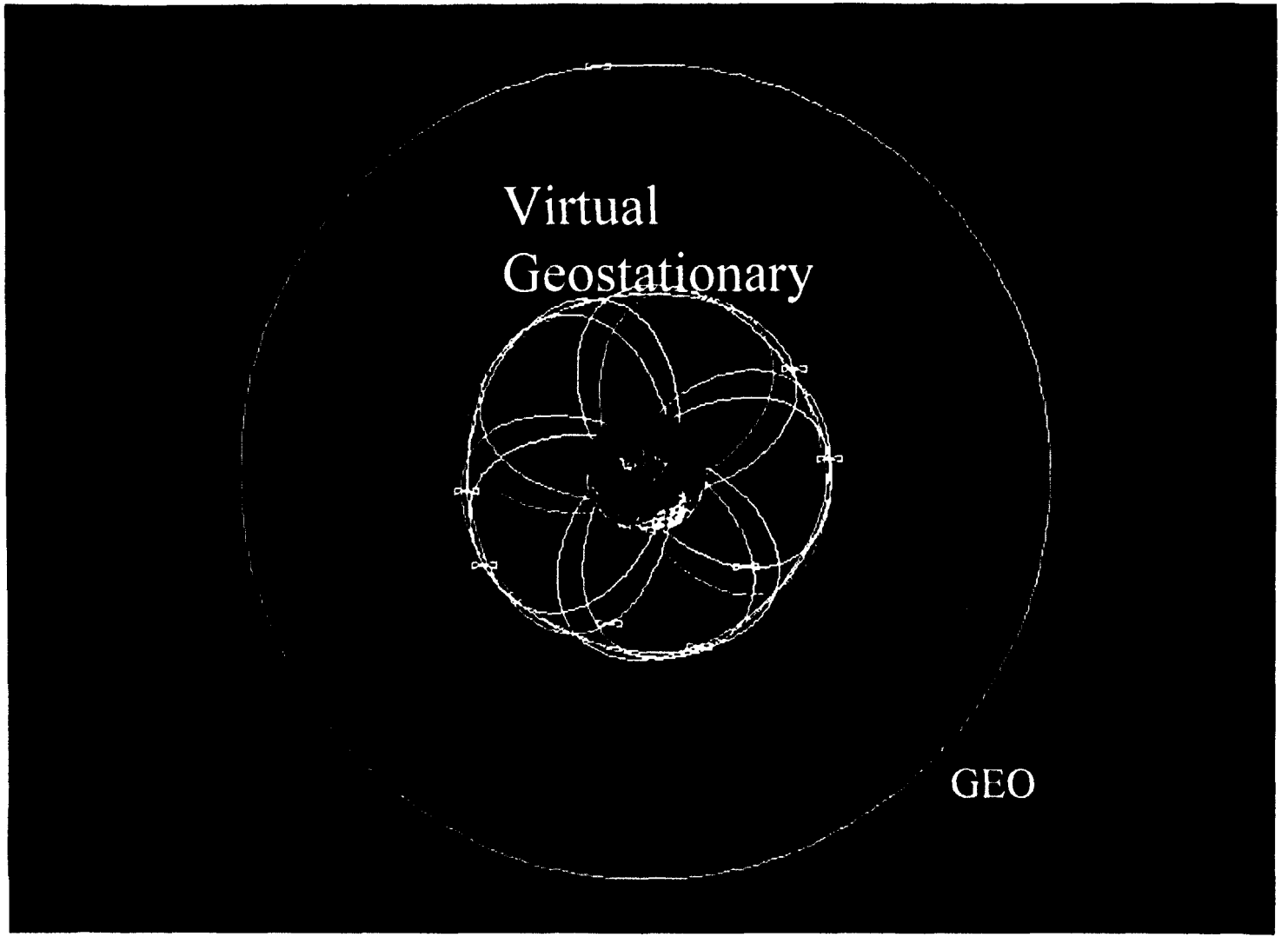
Virtual Geostationary from the North



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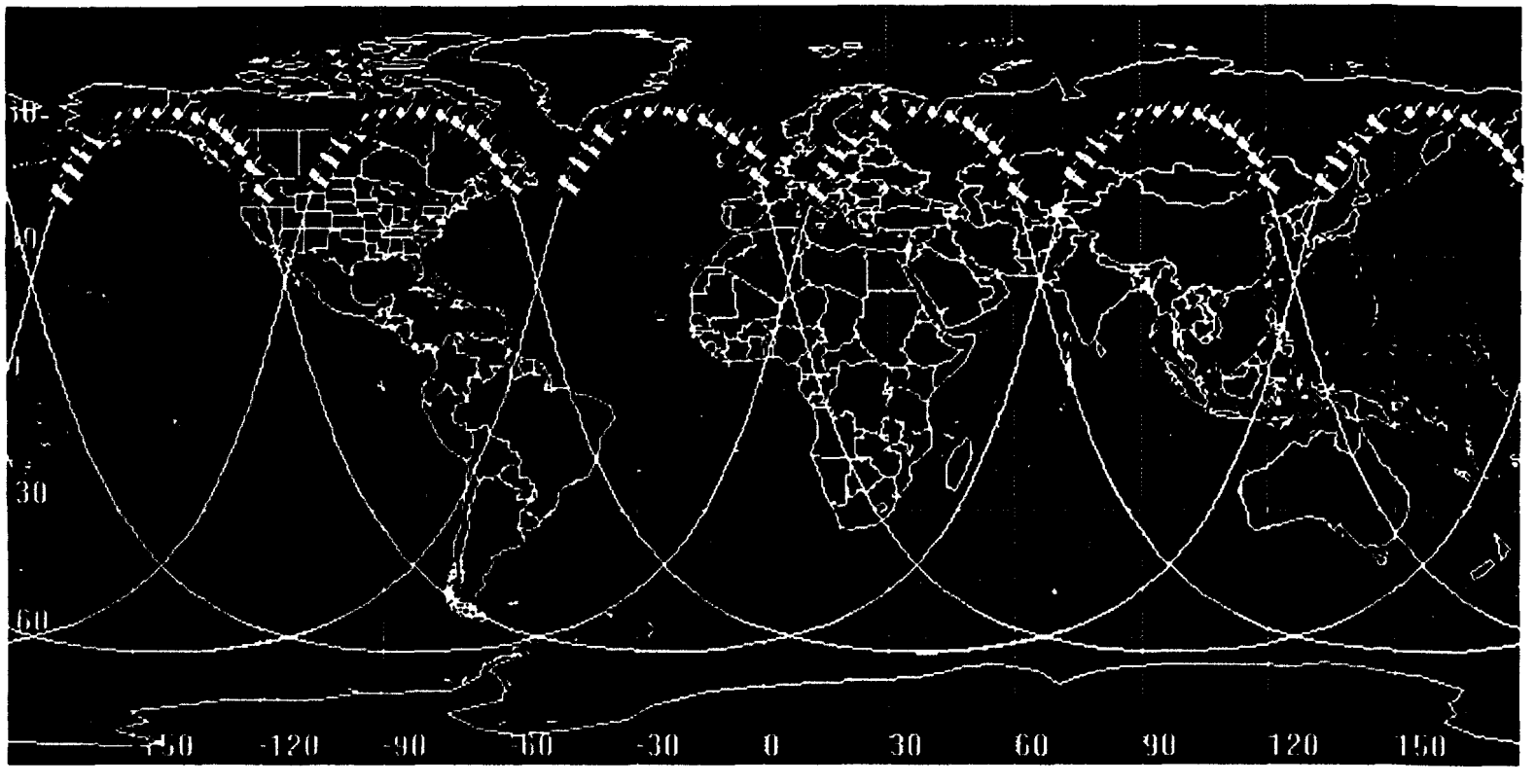
Virtual Geostationary Multiple Entry Using GSO-like Slots



2° spacing

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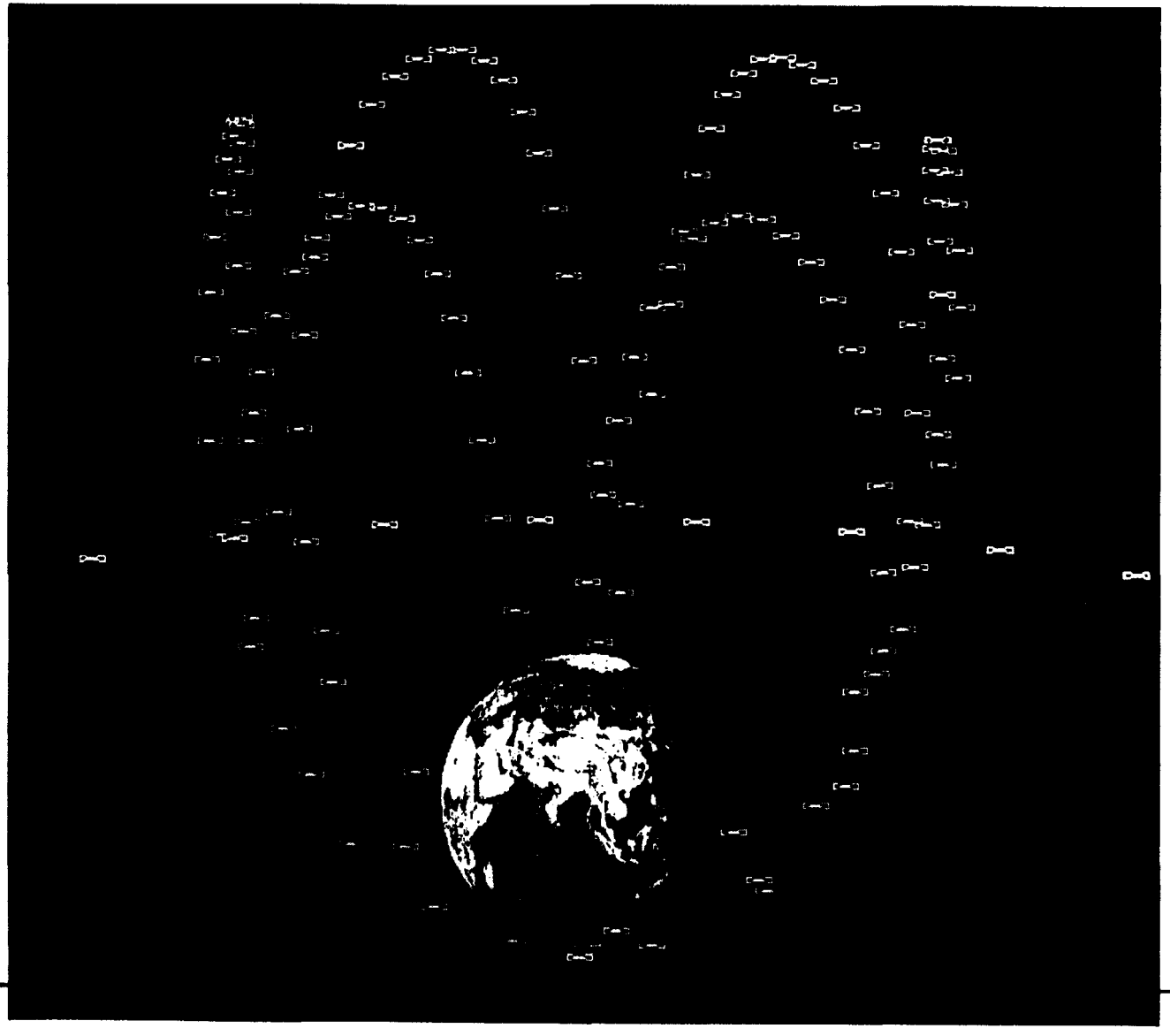
Virtual GEO Satellites in Perspective



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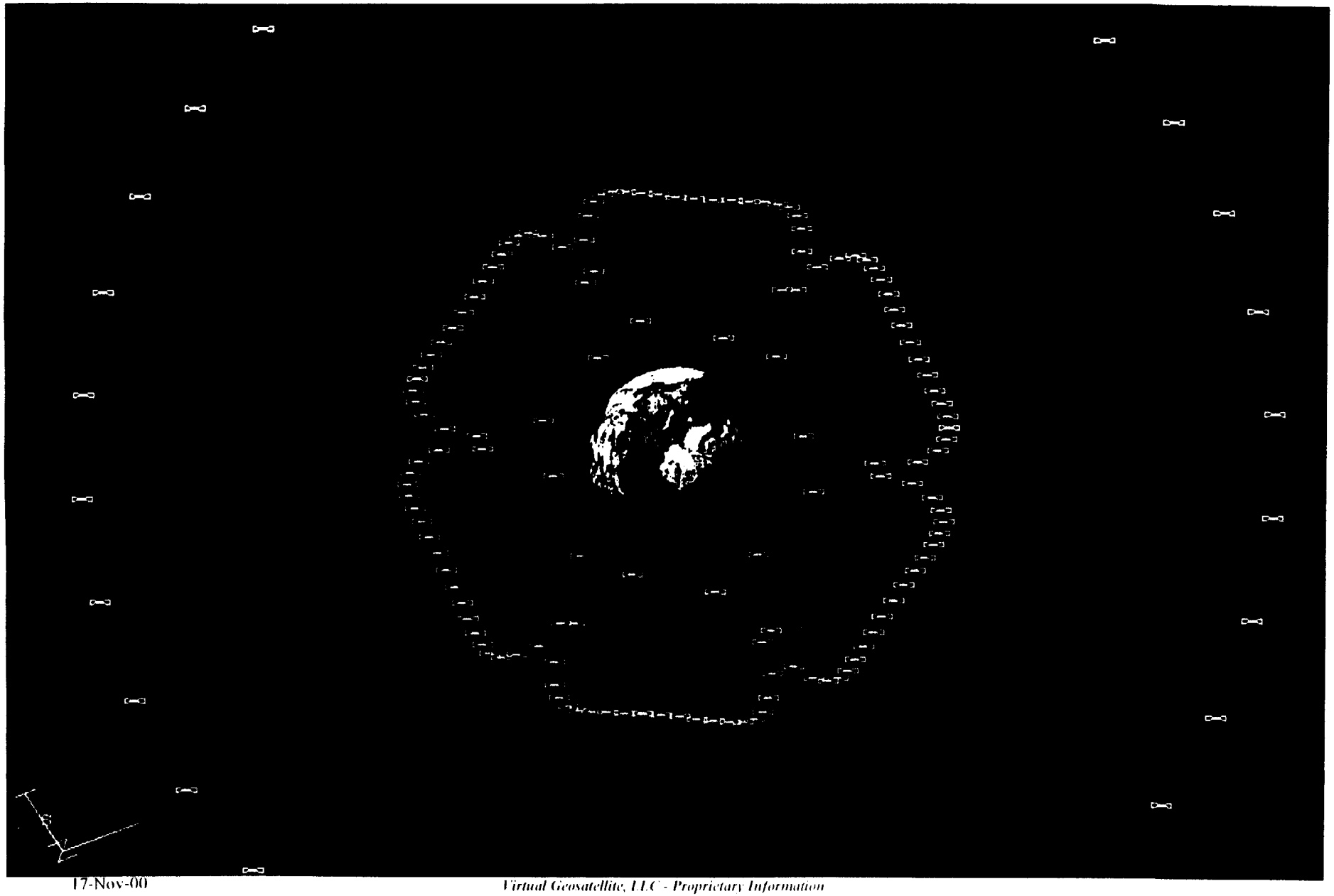
Virtual GEO Slots from the North



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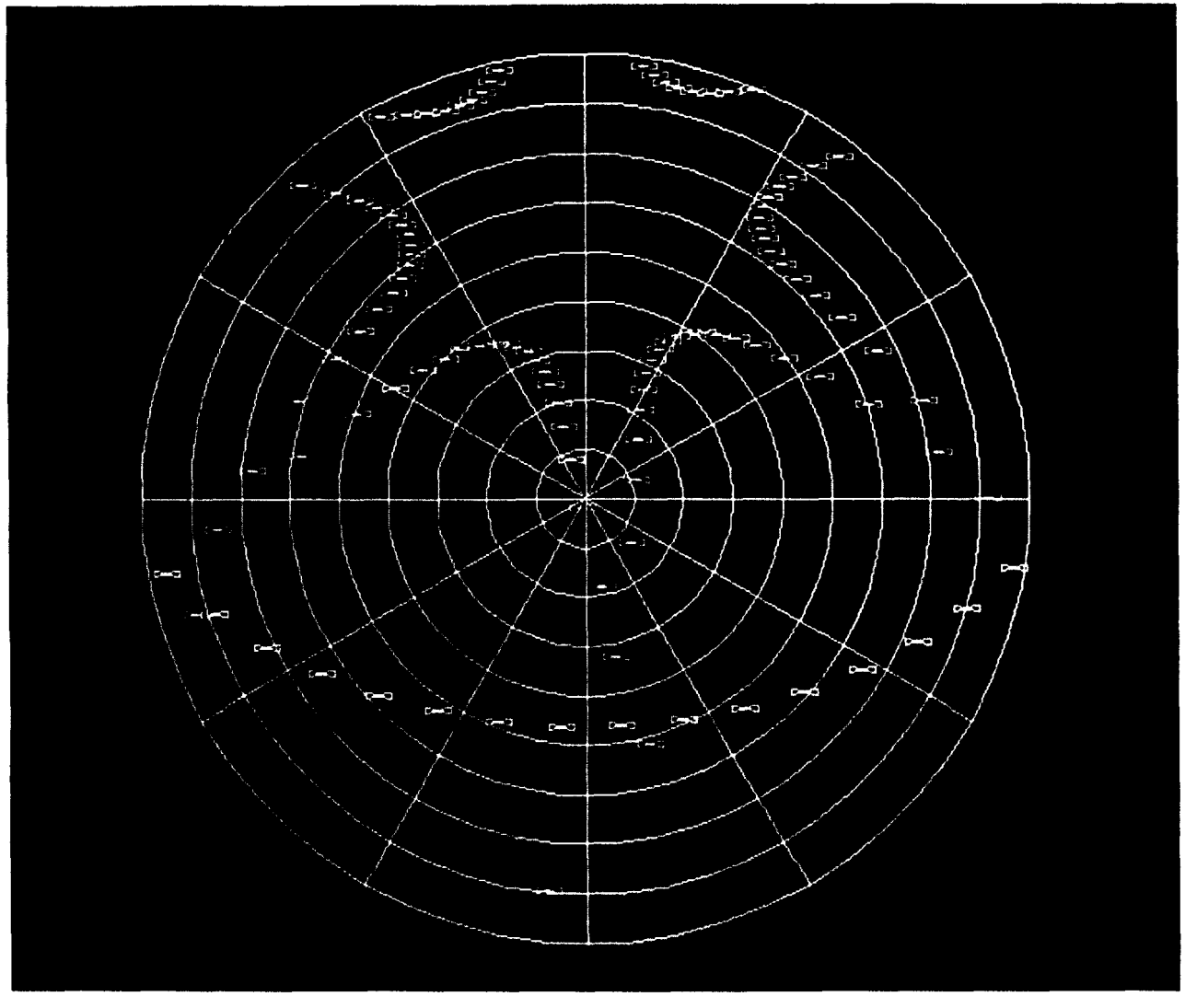
View of Virtual GEO Satellites from Mid US



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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 288 satellites -- 168 active at any given time

Number of "Systems"

At a minimum...

- 28 full global systems or...
- 56 hemispheric systems or...
- 168 regional satellite operators

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V-GEO and Band Sharing

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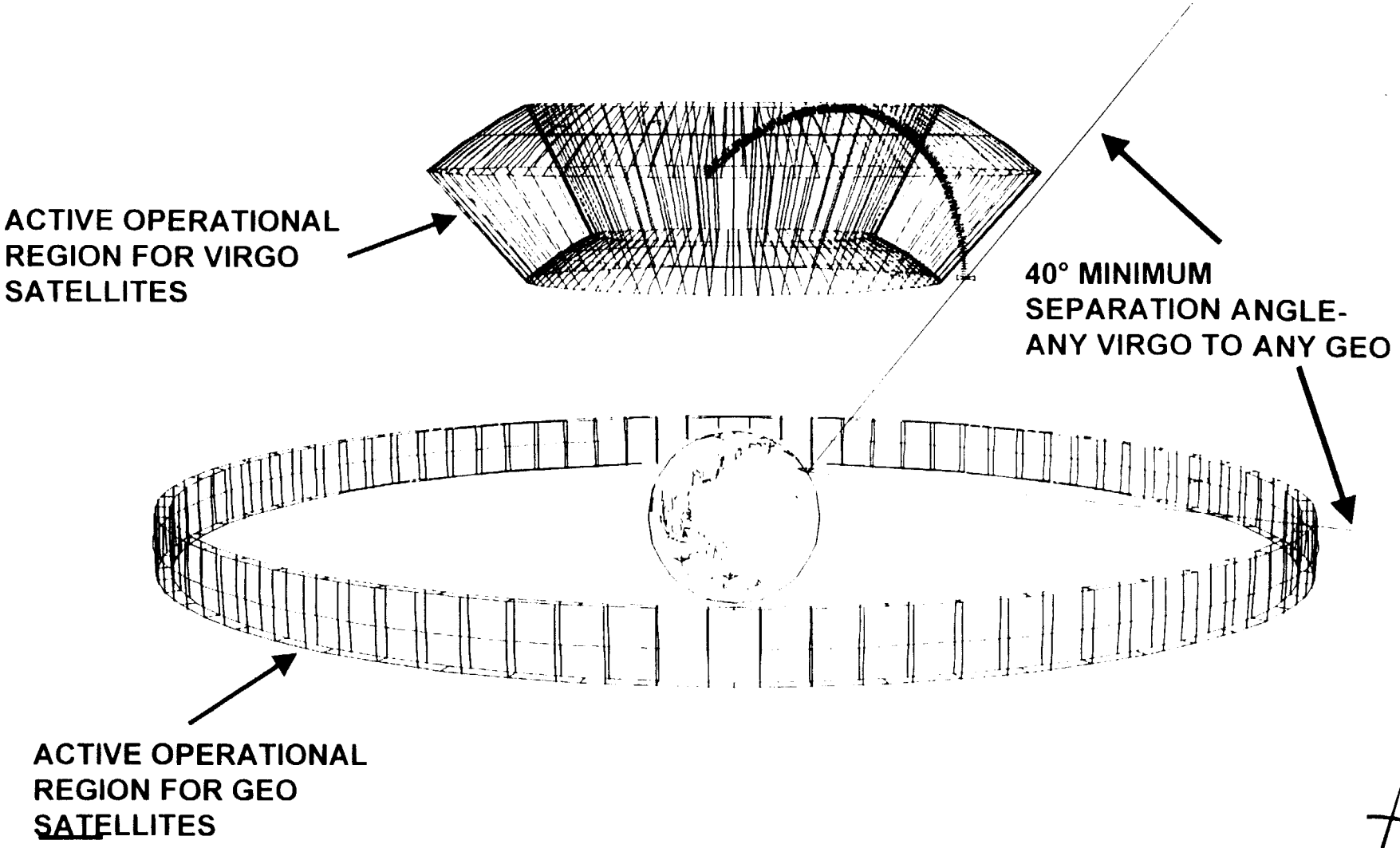
Comparison of Virtual GEO and GSO Operating Regions



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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

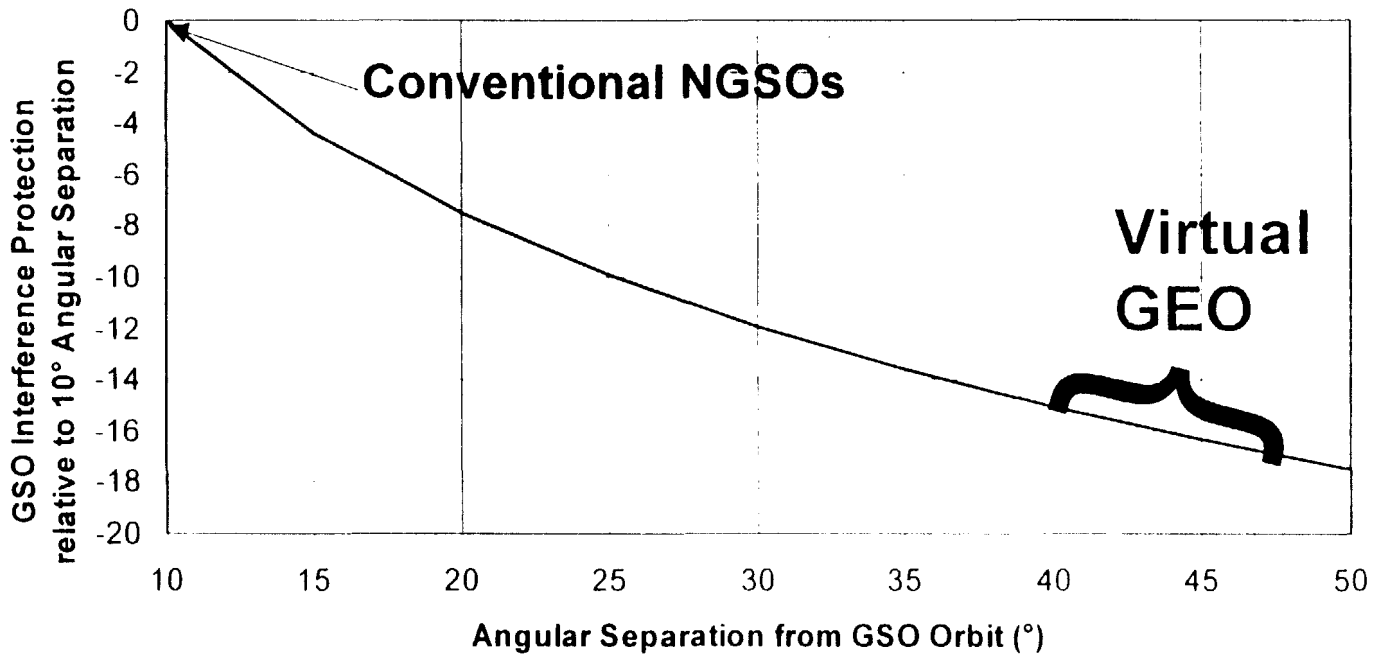

Chart based upon 25logΘ rolloff

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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 / m² / 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
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

- Many Virtual Geostationary constellations use large, narrow beam (e.g. feeder link) Earth Station Antennas in spectrum shared with FS
  - Antenna off-axis attenuation adds coordination flexibility
- Virtual Geostationary satellites follow sky-tracks with high elevation angles within US areas
  - Virtual Geostationary operation is able to accommodate restrictions on low elevation angle Earth Station operation
- Virtual Geostationary satellites follow one sky-track per arc, not as many as for other NGSO
  - Permits greater azimuth coordination flexibility relative to NGSO

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Virtual Geo's Relationship to FS

- Virtual Geostationary option yields more north and south slot choices
  - More high elevation angle slots are available for the Satcom Industry
- Virtual Geostationary satellites are dormant when near the horizon
  - Off axis FS antenna attenuation increases coordination flexibility
  - Possible Exception: Earth-grazing satellite in an opposite region
  - Satellite antenna steering or pattern shaping reduces satellite radiation to earth limbs

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Virtual GEO Coverage and Protection to FS

- **Coverage optimized over land masses**

US Coverage	Improvement Factor*
• *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 These Difficulties

- Virtual Geostationary arcs create new GSO-like opportunities
  - ***Visibility advantages — loitering over desired markets***
  - ***Many more systems possible***
    - ***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***

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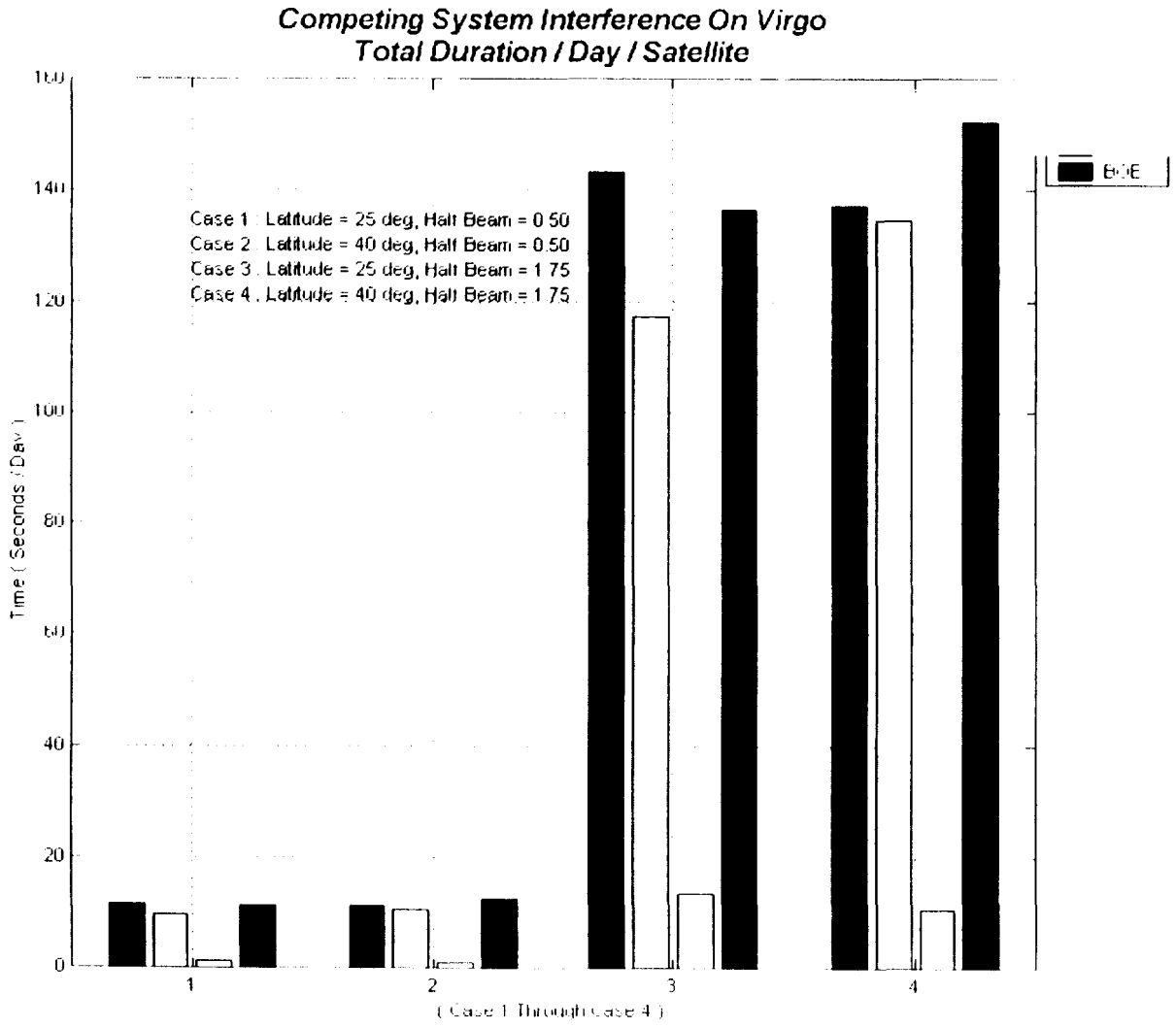
Competing System Interference on Virtual Geostationary Satellites



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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 ares) for VGEO, Hughes GEO equiv)	Same	

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Satellites can be slot-assigned in V-GEO tracks just as in the GSO arc

— <u>without</u> Crossing Interference —

Scores, perhaps hundreds of new assignments are possible

New Operating Vantage Points

Simple Existing Assignment Rules

Easier Coordination

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