In Column A of Table 3.13.1-4 the case of three visible VIRGO™ satellite can be compared against the long term WRC97 limits, and the "delta" –value is also given. Note that the VIRGO™ system meets the long-term provisional EPFD limits with margins ranging from 6.3 to 19.0 dB, depending on the GSO earth station size considered. Note that more detailed analyses or simulations, taking into account the actual off-axis angle to each VIRGO™ satellite, will result in long-term EPFD levels below those indicated in Table 3.13.1-4.

In Column B of Table 3.13.1-4, the situation of four visible VIRGO™ satellites is considered, but this time for the case of very short periods of time during handover between the "setting" and the "rising" VIRGO™ satellites. In this case the resulting EPFD levels can be compared against the short term WRC97 limits. In this case the VIRGO™ system meets the short-term provisional EPFD limits with margins ranging from 13.0 to 42.8 dB, depending on the GSO earth station size considered. As noted above for the long-term case, more detailed analyses or simulations, taking into account the actual off-axis angle to each VIRGO™ satellite, will result in short-term EPFD levels below those indicated in Table 3.13.1-4.

The overall conclusions from Table 3.13.1-4, together with the analyses of Tables 3.13.1-1 to 3.13.1-3, reinforce the fact that the VIRGO™ system is an ideal spectrum sharing partner for GSO systems.

Table 3.13.1-4: Comparison of Worst-Case EPFD from VIRGO™ System in the 11.2-12.7 GHz * Frequency Band with WRC-97 Provisional EPFD Limits

GSO Rx E/S Diameter (meters)	Service	WRC97 Provisional EPFD Limits: Long-term EPFD	Long-term % Time	Short-term EPFD	Short-term % Time	Column A VIRGO EPFD (3 satellites): EPFD	Column A: Δ rel. to WRC97 Long-Term Limits	Column B VIRGO EPFD (4 satellites): EPFD	Column B: Δ rel. to WRC97 Short-Term Limits
0.3	BSS R1/3	-172.3	99.7	-169.3	100	-183.6	-11.3	-182.3	-13.0
0.45	BSS R2	-174.3	99.7	-165.3	100	-187.1	-12.8	-185.9	-20.6
0.6	FSS	-179.0	99.7	-170.0	100	-189.6	-10.6	-188.4	-18.4
0.6	BSS R1/3	-183.3	99.7	-170.3	100	-189.6	-6.3	-188.4	-18.1
0.9	BSS R1/3	-186.8	99.7	-170.3	100	-193.1	-6.3	-191.9	-21.6
1	BSS R2	-186.3	99.7	-170.3	100	-194.0	-7.7	-192.8	-22.5
1.2	BSS R2	-187.9	99.7	-170.3	100	-195.6	-7.7	-194.4	-24.1
1.8	BSS R2	-191.4	99.7	-170.3	100	-199.2	-7.8	-197.9	-27.6
3	FSS	-186.0	99.97	-170.0	100	-203.6	-17.6	-202.3	-32.3
10	FSS	-195.0	99.97	-170.0	100	-214.0	-19.0	-212.8	-42.8

* Note that the results in the frequency band 10.7-11.2 GHz will be 9 dB better than those given in this table.

Tables 3.13.1.5 to 3.13.1-8 provide very conservative analyses of potential uplink interference from the transmitting VIRGO earth stations into a GSO satellite. These tables each show two analyses: one for the clear-sky condition and one for rain conditions where the uplink power control causes the maximum available increase in transmit power to overcome the rain fade. In fact the clear-sky calculation provides the most realistic assessment of the uplink interference situation because, for the rain fade condition, the interfering signal path can also be assumed to be faded by approximately the same amount as the wanted signal path in the VIRGO™ system. The interference levels shown in the rain condition could only occur if the line-of-sight from the VIRGO™ transmitting earth station to the GSO satellite was unfaded while the line-of-sight to the VIRGO™ satellite was fully faded. Such a condition would be extremely rare, and if it ever existed at all would be of extremely short duration.

In Tables 3.13.1-5 to 3.13.1-8 the calculation methodology is similar to that used for the downlink (Tables 3.13.1-1 to 3.13.1-3) and described above. The transmit power spectral density values represent the maximum that will be transmitted in the VIRGO™ system, and are somewhat higher than those shown in the representative link budgets of Section 3.9 above. However there are some very conservative assumptions made in these uplink interference analyses. Firstly, the GSO satellite is assumed to be using a very high gain spot beam with 45 dBi gain (Ku-band) towards the VIRGO™ earth station, as well as having a satellite receive system noise temperature as low as 600 K (the assumed C-band GSO satellite spot beam gain is 40 dBi). Because of the use of such high gain for the GSO satellite antenna, only two co-frequency interfering VIRGO™ earth stations are taken account of (assuming that there might be near-collocated VIRGO™ earth stations, each transmitting to one of the Northern Hemisphere VIRGO™ sub-constellations. In addition the VIRGO™ transmit earth station antenna is only assumed to meet 36-25log(θ) off-axis gain mask at 40° off axis.

The resulting I_0/N_0 ratios and $\Delta T/T$ values, although somewhat higher than for the downlink interference, are still at least five times lower than the normal criteria used to initiate coordination between two GSO systems ($\Delta T/T$ of 6%). The only exception to this is in the extremely rare instance where the fading on the interfering signal path is not comparable to the wanted VIRGO™ transmission path (as explained above). Even in this unlikely case the interference is still only just over one hundredth of the inherent noise of the GSO satellite receiver.

It is interesting to compare the PFD at the GSO orbit, as given in Tables 3.13.1-5 to 3.13.1-7 with the provisional S.22 APFD levels that were adopted at WRC97 for the 13.8-14.5 GHz band. The provisional APFD limit in this band is –170 $dBW/m^2/4kHz$ for 100% of the time (i.e., never to be exceeded). However, this limit is the aggregate for all co-frequency NGSO uplink transmissions from a single NGSO system. As there are 28 equivalent fully occupied uplink user beams in the VIRGO™ system operating with a 1-in-4 frequency re-use pattern, there could potentially be up to seven co-frequency, co-polar VIRGO™ uplinks within a region. In addition, there could be twice this number of co-frequency, co-polar transmitting earth stations because of the visibility of two VIRGO™ sub-constellations from large parts of a region. Therefore the aggregate PFD at the GSO orbit could be up to 11.5 dB higher than the single-terminal PFD numbers. Taking this factor into account the worst-case numbers, which are in Table 3.13.1-5, are 2.8 dB within the provisional APFD limits for this frequency band.

Table 3.13.1-5: Analysis of Worst-Case Uplink Interference from VIRGO™ Transmitting Earth Station Into GSO Satellite Receiver in the 14.0-14.5 GHz Frequency Band

	Clear Sky	Rain	
Maximum PSD into VIRGO™ Earth Station Antenna in 4 kHz	**-23.0**	**-18.1**	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	-27.1	-22.2	dBW / 4kHz
PFD at the GSO Satellite in 4 kHz	-189.2	-184.3	dBW / m^2 / 4kHz
Frequency	14250	14250	MHz
Assumed Gain of GSO Satellite Rx towards VIRGO™ Earth Station	**45**	**45**	**dBi**
Effective Aperture of GSO Satellite Rx towards VIRGO™ Earth Station	0.5	0.5	dB-m^2
GSO Satellite Rx Interfering Signal Power in 4 kHz	-188.7	-183.8	dBW / 4kHz
GSO Satellite Rx Interfering Signal Power Spectral Density (one VIRGO™ earth station)	-224.7	-219.8	dBW / Hz
GSO Satellite Rx Interfering Signal Power Spectral Density (two VIRGO™ earth stations)	-221.7	-216.8	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	**-20.9**	**-16.0**	**dB**
ΔT/T Degradation to GSO Satellite Rx	**0.813%**	**2.513%**	

Table 3.13.1-6: Analysis of Worst-Case Uplink Interference from VIRGO™ Transmitting Earth Station Into GSO Satellite Receiver in the 12.75-13.25 and 13.8-14.0 GHz Frequency Bands

	Clear Sky	Rain	
Maximum PSD into VIRGO™ Earth Station Antenna in 4 kHz	**-30.0**	**-18.9**	**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	-34.1	-23.0	dBW / 4kHz
PFD at the GSO Satellite in 4 kHz	-196.2	-185.1	dBW / m^2 / 4kHz
Frequency	13500	13500	MHz
Assumed Gain of GSO Satellite Rx towards VIRGO™ Earth Station	**45**	**45**	**dBi**
Effective Aperture of GSO Satellite Rx towards VIRGO™ Earth Station	0.9	0.9	dB-m^2
GSO Satellite Rx Interfering Signal Power in 4 kHz	-195.2	-184.1	dBW / 4kHz
GSO Satellite Rx Interfering Signal Power Spectral Density (one VIRGO™ earth station)	-231.2	-220.1	dBW / Hz
GSO Satellite Rx Interfering Signal Power Spectral Density (two VIRGO™ earth stations)	-228.2	-217.1	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	**-27.4**	**-16.3**	**dB**
ΔT/T Degradation to GSO Satellite Rx	**0.181%**	**2.329%**	

Table 3.13.1-7: **Analysis of Worst-Case Uplink Interference from VIRGO™ Transmitting Earth Station Into GSO Satellite Receiver in the 17.3-17.8 GHz Frequency Band**

	Clear Sky	Rain	
Maximum PSD into VIRGO™ Earth Station Antenna in 4 kHz	**-30.0**	**-18.9**	**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	-34.1	-23.0	dBW / 4kHz
PFD at the GSO Satellite in 4 kHz	-196.2	-185.1	dBW / m^2 / 4kHz
Frequency	17550	17550	MHz
Assumed Gain of GSO Satellite Rx towards VIRGO™ Earth Station	**45**	**45**	**dBi**
Effective Aperture of GSO Satellite Rx towards VIRGO™ Earth Station	-1.3	-1.3	dB-m^2
GSO Satellite Rx Interfering Signal Power in 4 kHz	-197.5	-186.4	dBW / 4kHz
GSO Satellite Rx Interfering Signal Power Spectral Density (one VIRGO™ earth station)	-233.5	-222.4	dBW / Hz
GSO Satellite Rx Interfering Signal Power Spectral Density (two VIRGO™ earth stations)	-230.5	-219.4	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	**-29.7**	**-18.6**	**dB**
ΔT/T Degradation to GSO Satellite Rx	**0.107%**	**1.378%**	

Table 3.13.1-8: Analysis of Worst-Case Uplink Interference from VIRGO™ Transmitting Earth Station Into GSO Satellite Receiver in the 5.925-6.425 GHz Frequency Band

	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 GSO Satellite Rx	**0.824%**	**1.721%**	

3.13.2 NGSO FSS

The VIRGO™ satellite is a virtual-geostationary system which means that the active VIRGO™ satellites always appear in the same portion of the sky as seen from the Earth. This is very different from the types of NGSO systems that are proposed to operate in circular orbits, particularly those in Low Earth Orbit ("LEO"). These LEO NGSOs must operate almost from horizon to horizon, as viewed from their earth stations, in order to ensure full-time service with a manageable and affordable number of satellites in the constellation. Typically the satellites of these LEO NGSO systems can appear at some time or another anywhere in the sky down to between 5° and 10° above the horizon.

This fundamental advantage of a virtual geo system compared to a circular orbiting NGSO system gives rise to a situation where many virtual geo systems can operate co-frequency and co-coverage, without necessarily making the virtual geo systems identical to each other. In this approach, the different virtual geo systems are designed so that each one operates with its active satellites in a part of the sky separated in angle, as viewed by their earth stations, from the others. There are many possibilities to explore with this NGSO sharing approach between virtual geo systems.

In addition, it is possible to also interleave virtual geo satellites of different systems within the same orbit planes to further increase the sharing potential between them. This approach, which is similar to that proposed by the circular orbiting LEO NGSO systems, requires a coordinated design approach between the NGSO system operators in order to create homogenous systems.

Sharing between the VIRGO™ system and the proposed circular orbiting NGSO systems can be achieved by exploiting the inherent satellite diversity of these latter systems. In the same way that these systems switch between active satellites to avoid the GSO arc, they are also capable of switching active satellites to avoid alignment situations between the VIRGO™ satellites and VIRGO™ earth stations.

Clearly the issue of sharing between NGSO systems is a complex one, and Virtual Geo is committed to work with the Commission and other licensees to ensure that viable sharing schemes are established.

3.13.3 Inter-Satellite Links

Due to the extremely narrow beamwidth of optical ISL transmit and receive antennas, there should be no sharing problems associated with VIRGO™'s use of the optical ISL frequencies.

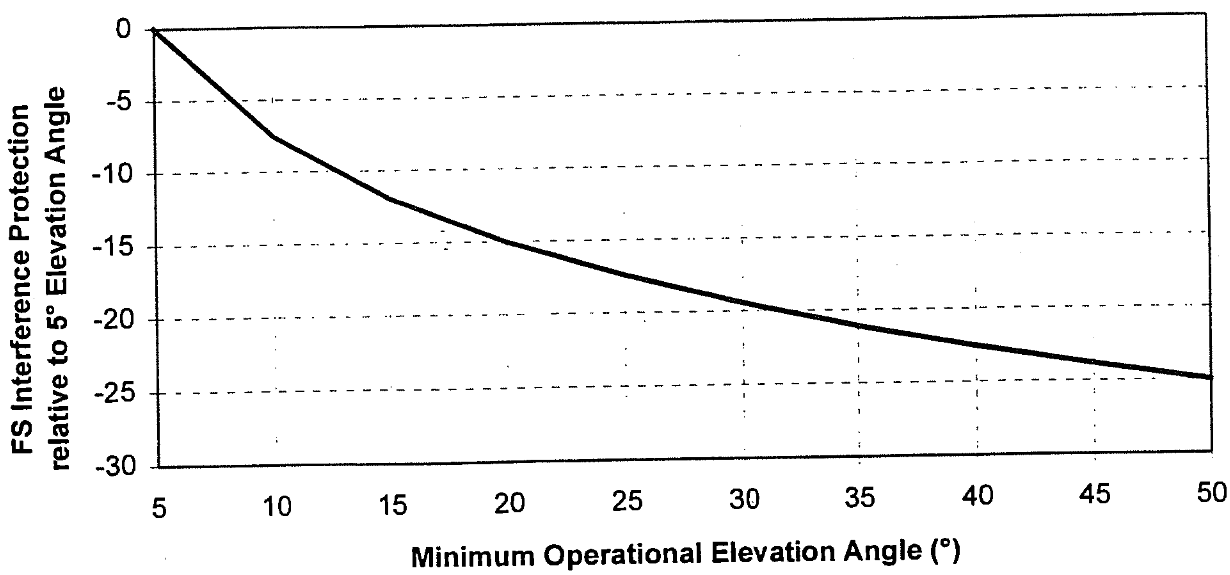
Virtual Geo is committed to working with the Commission and other optical ISL users to develop any sharing conditions that might be necessary for the implementation of the VIRGO™ optical ISLs.

3.13.4 Fixed Service

The orbit parameters of the VIRGO™ system, as described in Sections 3.2 and 3.3 above, have been deliberately selected to ensure that the active VIRGO™ satellite operates only at high elevation angles as viewed from the VIRGO™ earth stations. Not only does this provide excellent link quality in the VIRGO™ system, with low probabilities of signal blockage and reduced signal attenuation due to rain, it also makes the VIRGO™ system an excellent sharing partner with co-frequency terrestrial Fixed Services ("FS"). The gain of the transmitting and receiving VIRGO™ earth stations is very low in directions towards terrestrial FS transmitters and receivers and so the interference coupling, in both directions, is correspondingly reduced. This advantage is shown in Figure 3.13.4-1 where the additional FS interference protection is calculated as a function of the minimum operational elevation angle of the VIRGO™ earth stations, relative to the 5° elevation case which is the typical minimum elevation angles of some GSO and circular orbiting NGSO systems.

Figure 3.13.4-1:

Interference Protection with Respect to FS Systems as a Function of the Minimum Operational Angle of Separation between the Active VIRGO™ Satellite and the GSO Arc



Within CONUS the minimum operational angular separation between the VIRGO™ system and the GSO arc is 50°, which gives an improvement factor of 25 dB from Figure 3.13.4-1. Anywhere within US territory the minimum operational elevation angle is 45°, which gives an improvement factor of 23 dB. Even at the extremes of the VIRGO™ service area the minimum operational elevation angle will always be maintained in excess of 40°, which gives a minimum improvement factor of over 22 dB.

In the United States, frequency overlap with the FS occurs only within the 10.7-11.7 GHz and 12.2-12.7 GHz downlink bands of the VIRGO™ system. The 11.7-12.2 GHz downlink band is not used by the FS in the USA. Of these shared bands, only the 11.2-11.7 GHz and 12.2-12.7 GHz bands are proposed for use by user terminals in the VIRGO™ system. In the event that particular user terminals are found to be in locations where they are subject to FS interference, downlink transmissions destined for these terminals will take place only in the unshared 11.7-12.2 GHz band. The VIRGO™ RNCC will establish a database of any user terminals affected by interference in this way, and assign appropriate frequencies for their use.

The gateway downlink in the 10.7-11.2 GHz band is shared with the FS. For this reason the VIRGO™ gateways, of which there are only four per region, will be located well away from any co-frequency FS links, and frequency coordinated using well established procedures.

In the VIRGO™ uplink frequency bands co-frequency operation with the FS occurs only in the 12.75-13.25 GHz and 17.7-17.8 GHz bands. The 14.0-14.5 GHz uplink band used by VIRGO™ user terminals is not shared with the FS so no coordination problem exists for transmitting VIRGO™ user terminals. In the above listed shared uplink bands, which are only used by VIRGO™ gateway terminals, the same approach will be used as for the gateway downlink to avoid interference into the FS. The gateways will be located well away from any co-frequency FS links, and frequency coordinated using well established procedures.

The potential interference from the VIRGO™ satellite downlink into the FS receivers is addressed by means of the Commission's (and ITU's) PFD limits in the various downlink bands where FS sharing exists. As stated in Section 3.10 the downlink transmissions of the VIRGO™ satellites are below the PFD limits that apply, even ignoring the angle of incidence to the Earth's surface. If the high elevation angles of the active VIRGO™ satellites are taken into account, there is at least a 10 dB margin with respect to these PFD limits.

Finally, it is expected that interference from terrestrial FS transmitters into the VIRGO™ satellite receivers will not be a problem, again due to the high elevation angles from the VIRGO™ beam coverage areas to the active VIRGO™ satellites.

3.13.5 BSS Downlinks

The 17.3-17.8 GHz frequency band is planned to be used after 1 April 2007 for BSS downlinks. If and when this band is used in this way the VIRGO™ gateway uplinks in this frequency band will be operating in a reverse-band direction. This will give rise to the possibility of interference from the VIRGO™ transmitting gateway earth stations into the BSS receivers. For this reason the VIRGO™ gateway terminals, of which there are only four per region, will be located well away from metropolitan areas where the BSS receivers are most likely to be deployed in large numbers. By careful selection of the VIRGO™ gateway site, and through the use of RF shielding where necessary (either natural or man-made), the impact on the BSS service areas should be negligible. Again, the use of high operational elevation angles in the VIRGO™ system will minimize the coordination distances and possible incursion into the BSS service area of the two-to-four U.S. gateways.

The reverse-band mode of operation in this band also gives rise to the potential for interference from the transmitting BSS satellites into the VIRGO™ satellites. The characteristics of the VIRGO™ constellation, particularly the part of the orbit where the satellites are active, are such that this interference path should not be a problem. The levels of interference will be a function of the sidelobe and backlobe performance of the VIRGO™ satellite receive antenna and the sidelobe performance of the BSS satellite transmit antenna. These performance parameters are not well-defined at present, and further performance definition and study are required to ensure that no unacceptable interference occurs.

Virtual Geo is committed to work with the Commission and with potential BSS operators in this band to ensure that mutually satisfactory sharing conditions are implemented to adequately protect both systems.

3.13.6 Earth Exploration-Satellite and Space Research Services

The VIRGO™ satellite system avoids using the 13.75-13.8 GHz band which is used by NASA for the TDRSS operations. Therefore no interference to this service will occur.

3.13.7 U.S. Government Radiolocation Service

The U.S. Government radiolocation service ("RLS") in the 13.75-14.0 GHz is a potential source of interference into the 13.8-14.0 GHz gateway uplink band proposed to be used by the VIRGO™ system. By careful siting of the VIRGO™ gateway uplink sites, and hence the positioning of the VIRGO™ satellite gateway uplink beams, the interference from the RLS should be manageable.

The secondary U.S. Government RLS operations in the 17.3-17.7 GHz band could also potentially affect the VIRGO™ uplinks in this band until the year 2007 when the expected implementation of the BSS allocation will require the RLS operations to be severely restricted. The current transmit power limits on these RLS radars in the direction of the GSO arc may also incidentally protect the high elevation VIRGO™ satellites during their active orbit arc. In addition the careful positioning of the VIRGO™ gateway sites may also be used to reduce uplink interference from the RLS in this band, as for the 13.8-14.0 GHz band.

Virtual Geo is committed to work with the Commission and the NTIA to coordinate the VIRGO™ gateway uplinks in these bands to avoid unacceptable interference.

3.13.8 Mobile Service

There are existing terrestrial Mobile services in the 12.75-13.25 GHz and 17.7-17.8 GHz bands. Both of these bands are proposed to be used in the VIRGO™ system for gateway uplinks only. Therefore, because of the use of only four VIRGO™ gateway terminals per region, the fact that the gateway sites must be located well away from metropolitan centers, and the use of high operational elevation angles to the VIRGO™ satellites, there should not be any unacceptable interference to these mobile services. Conventional frequency coordination of the gateway terminals will be used to ensure there is no problem in this respect.

3.13.9 Radio Astronomy Service

The Radio Astronomy Service ("RAS") has existing operations in the 10.6-10.7 GHz band which is immediately adjacent to the proposed VIRGO™ gateway downlink band. Interference protection of the RAS will be achieved by a combination of the above:

- The downlink EIRP spectral density in the adjacent 10.7-11.2 GHz gateway downlink band is already 9 dB lower than that proposed in the user terminal downlink band 11.2-12.7 GHz, because of the use of large gateway receive earth station antennas. The beam peak in-band PFD in the adjacent 10.7-11.2 GHz band is defined in Section 3.6.2 above.
- The gateway downlink spot beams will be directed only towards the gateway downlink sites, of which there are four per region. Depending on the eventual selection of these gateway sites, this may give additional attenuation of the downlink signals due to the roll-of of the VIRGO™ satellite transmit beam gain.
- The VIRGO™ downlink transmissions will be adequately filtered to further reduce the out-of-band emissions in the 10.6-10.7 GHz band and provide the additional signal attenuation required to adequately protect the RAS in this band.

Virtual Geo is committed to work with the Commission and with the RAS community to ensure that the RAS sites that use the 10.6-10.7 GHz frequency band are adequately protected.

3.14 SATELLITE DESCRIPTION

3.14.1 General Description

The spacecraft manufacturer for the VIRGO™ satellites has not yet been selected, and Virtual Geo does not wish to show preference by providing any data specific to any one manufacturer in this application. The design of the satellite has been based around the known characteristics of the latest spacecraft available from all major US suppliers (Boeing, Hughes, Lockheed Martin and Space Systems Loral). Therefore the feasibility of implementing the VIRGO™ satellite system is assured.

Virtual Geo will provide the Commission with full and precise spacecraft physical characteristics when the final supplier and product has been selected.

3.14.2 Power and Mass Budgets

The VIRGO™ satellite communications payload requires approximately 10.5 kW d.c. end-of-life power, which is within the capability of all three candidate suppliers, including sufficient margin at end of life and full eclipse capability. Beginning-of-life power will be approximately 14 kW. The communications payload mass will be approximately 1058 kg. The total spacecraft mass in turn will be around 3030 kg at launch. The satellite operational lifetime will be approximately 12 years, including stationkeeping fuel requirements and required reliability.

Table 3.14.2-1: VIRGO™ Satellite Power Budget

	Maximum (W)	Average (W)
Forward	11503	
Return	3395	
Total Payload	14898	9900
Bus		693
Total Spacecraft		10593

Table 3.14.5-3: VIRGO™ Satellite Mass Budget

Subsystem	**Mass (kg)**
Payload	1058
Spacecraft Bus	
Propulsion, Attitude Control	212
TT&C	32
Prime Power (array, drive, batteries, PC&DU)	936
Support (structure, thermal, harness, balance)	540
Total Bus	1720
Total Dry Mass	**2778**
Propellant	252
Launch Mass	**3030**

3.14.3 Communications Payload

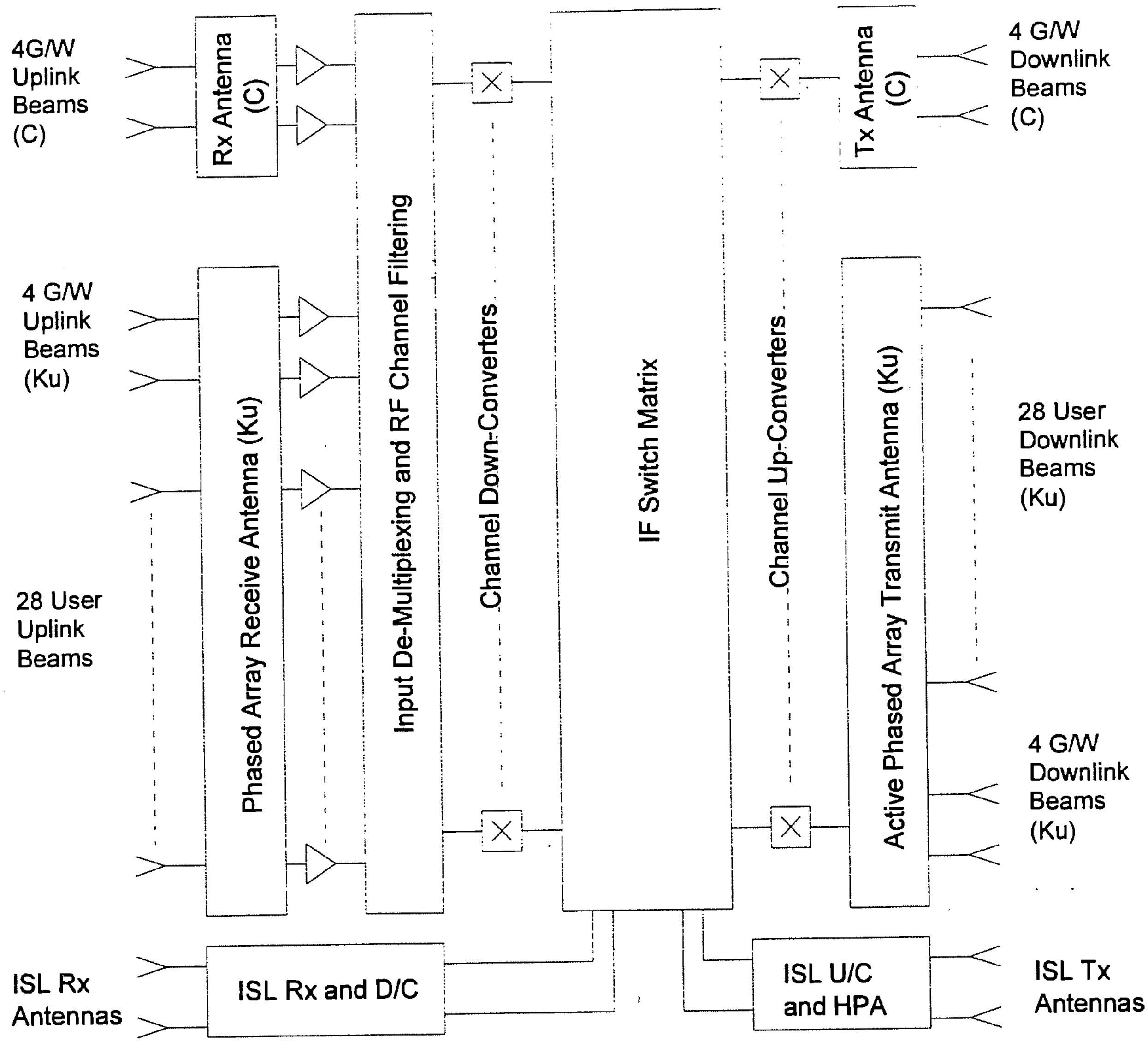
The VIRGO™ satellite communications payload uses phased array antennas in order to be able to configure the beam coverages, in real-time, to give near-constant geographic coverage. These antennas generate all the Ku-band beams for both the user terminal beams and the gateway terminal beams.

At the output of the receive antennas the signals are first amplified and then de-multiplexed and channelized before being down-converted to an IF frequency. A switch matrix is then used to connect appropriate uplink channels to downlink channels, as well as to allow for some sub-channel connectivity to the inter-satellite links. At the output of the IF switch matrix the signals are up-converted and sent to the inputs of the active phased array transmit antenna.

The functions described above are shown in the payload schematic of Figure 3.14.2-1.

The aggregate RF transmit power capability of the Ku-band active phased array antenna is approximately 2 kW. The aggregate C-band gateway downlink RF transmit power is approximately 100 Watts.

Figure 3.14.2-1 VIRGO™ Satellite Communications Payload Schematic



3.14.4 TT&C System

The Tracking, Telemetry, and Command (TT&C) subsystem will utilize a small portion of the feederlink frequency band for both on-station operation and transfer orbit or abnormal operation with use of omni antennas. The subsystem will provide the reception, storage, and distribution of commands for control of spacecraft bus and communication systems using a 32 kbps command uplink with authentication protocol. The subsystem will also collect and process telemetry and data, store and format the date, and transmit the information to the ground TT&C stations with a 32 kbps downlink stream. The TT&C subsystem will be fully redundant and will autonomously switch over to backup hardware in the event of a hardware or software failure as detected.

The spacecraft is designed to have at least 12 years of the active service life. Within its lifetime, the spacecraft on-station position can be maintained within the tolerances shown in Table 3.14.4-1.

Table 3.14.4-1: VIRGO™ Orbital Maintenance Tolerance

Inclination	Pointing	Altitude	In Track
±0.05°	±0.25°	±10 km	±1° MA

3.14.5 Attitude and Orbit Control Subsystem ("AOCS")

The spacecraft will employ a three-axis stabilized system with momentum wheels and small monopropelled thrusters for momentum dumping as well as on orbit control and station-keeping. The satellite will employ a GPS receiver and use on-board processing for orbit determination. Each satellite will employ absolute station-keeping, and will autonomously compute and execute (subject to on-ground monitoring) the corrective maneuvers to maintain the satellite within specified values for the orbital parameter limits. Key characteristics of the VIRGO™ spacecraft are provided in Tables 3.14.5-1, -2, and –3 below.

Table 3.14.5-1: VIRGO™ Spacecraft Key Characteristics

Stabilization:	3 axis
Mission Life:	> 12 years
Positioning Sensor:	GPS
Communication Payload:	See Section 3.14.3
TT&C:	Omni antennas Command and Telemetry: C-band; Link calculations for the TT&C are given in Table 3.9-6
Attitude Control & Station Keeping:	Monopropellant hydrazine thrusters and reaction wheels (considering electric propulsion)
Thermal Control:	Passive design with heaters
Solar Array:	Gallium Arsenide
Battery:	Nickel Hydrogen, 600 A-hours
Bus Dimension:	4.6 x 2.8 x 1.0 meters
Average DC Power:	10593 W
Launch Mass:	3030 kg

3.15 LAUNCHER DESCRIPTION

The VIRGO™ spacecraft are compatible with a several commercially available launch vehicles. A decision on the actual launcher to be used has not yet been made, as this is heavily influenced by the selection of spacecraft supplier.

3.16 GROUND SEGMENT AND OPERATIONS

3.16.1 User Terminals

These small and low-cost earth stations will be deployed in vast numbers throughout the service areas of the VIRGO™ system. Within the main service areas the user terminal antenna size will be equivalent to 45 cm in diameter. although somewhat larger antennas will be available for situations where transmit power is at a premium (such as for a wide-band uplink). The baseline user terminal design will be a phased array capable of tracking both the "rising" and the "setting" VIRGO™ satellites, although transmissions to and from the VIRGO™ satellites will only take place when the satellites are at latitudes above 45°. The user terminals will automatically switch between the active VIRGO™ satellites to provide continuity of service, under the control of the gateway terminals via the order wire links. This satellite switching, which occurs only once every 4.8 hours, will be completely transparent to the user and will not degrade the circuit performance.

In the early stages of deployment of the VIRGO™ system, it is possible that the user terminals will be implemented using more conventional feed/reflector antennas, specially designed to provide the ability to simultaneously track the "rising" and "setting" VIRGO™ satellites over the narrow angular ranges of the active part of their orbits.

All user terminals will be equipped with beacon tracking capability to enable them to accurately track the required VIRGO™ satellite. In addition, the user terminals will have the "intelligence" through built-in software to initially acquire the active VIRGO™ satellite by being able to predict the orbit path based on a knowledge of the approximate latitude and longitude of the terminal location, which is entered by the installer of the terminal. Once this orbit path has been established the user terminal will scan the orbit track until it locates an active VIRGO™ satellite by means of its downlink beacon signal. When the first VIRGO™ satellite has been acquired in this way the user terminal will continue to track the entire VIRGO™ constellation based on the known orbit parameters. With communications established in this way the ephemeris data for the entire VIRGO™ constellation is transmitted to each user terminal via the order wire link, and updated on a regular basis, by the SOCC/RNCC/gateway. With this data the user terminal is able to accurately "free-wheel" through any periods of time during which it might temporarily lose tracking of the active VIRGO™ satellite. The use of these techniques results in a highly reliable satellite tracking capability without incurring significant expense in the user terminals.

It is expected that most data/Internet user terminals will have two-way (i.e., transmit/receive) capability, but applications that make use of receive-only user terminals, such as video DTH receivers will be addressed.

User terminals with transmit capability will be equipped with uplink power control to ensure that the receive signal level at the satellite is accurately set. Not only does this allow the uplink to overcome rain fades and thereby maintain link quality without causing unnecessary interference to other users of the spectrum, it also ensures that the transmitted signal does not consume more satellite power than is necessary which would reduce the overall capacity of the system and possibly increase intermodulation noise. This feature also compensates for the variation in distance between the user terminals and the VIRGO™ satellite as it passes through the active part of its orbit. The setting of uplink power control is under the control of the gateway terminal with which the user terminal is communicating. The gateway monitors the corresponding downlink signal and, taking account of downlink rain fades by means of observing the beacon signal fading, determines whether the transmitting earth station needs to adjust its uplink power. Any need for adjustments are transmitted by the gateway to the user terminal via the order wire links.

3.16.2 Gateway Terminals

Each gateway terminal will consist of two conventional large tracking earth station antennas plus associated communications electronics and processing capability. The gateway antennas will be at least 5 meters in diameter. Each gateway operates over the ranges of Ku-band frequencies given in Section 3.4.2.2 above in order to be able to serve the large numbers of user terminals within the user beams that it supports.

The gateway terminals will be capable of performing all the satellite tracking functions described above for the user terminals. They will also operate uplink power control to overcome rain fades based on observing beacon signal fading. In addition a small amount of uplink power control will be applied to compensate for the variation in distance between the user terminals and the VIRGO™ satellite as it passes through the active part of its orbit.

All gateway terminals will have full-time land-line connections to both the RNCC and the primary SOCC.

3.16.3 Regional Network Control Centers

There will be three Regional Network Control Center ("RNCC"), each located to serve three VIRGO™ service areas (two in the northern hemisphere and one in the southern hemisphere). This facility will be connected by land-line to the Spacecraft Operations Control Center ("SOCC") and to the gateway terminals within the same regional service area. One of these gateway terminals (designated the "master gateway") will be used by the NCC to transmit the network control information to the user terminals. The RNCC manages the satellite resources for the region and responds to requests from user terminals for satellite capacity. It also monitors usage of the system and prepares billing data. The RNCC acts as the contact point within the region on all interference issues that might arise, and works in conjunction with the SOCC to resolve them.

3.16.4 Spacecraft Operations Control Center and TT&C Earth Stations

There will be a single primary Spacecraft Operations Control Center ("SOCC") in the VIRGO™ system and it will be located in the USA. In addition there will be a back-up SOCC in the event of a catastrophic failure of the primary facility. The location of the back-up SOCC has not yet been determined.

The primary SOCC will be connected via land-lines to TT&C earth stations in each of the regional service areas that have line-of-sight visibility of the VIRGO™ satellites during the active part of their orbit, and for portions of their orbit either side of the active period. These TT&C earth stations will simply act as "RF pipes" for the tracking, telemetry and command data that passes between the VIRGO™ satellites and the SOCC. The TT&C earth station function may be collocated with one of the regional gateways.

The primary SOCC will be responsible for the control of the entire VIRGO™ satellite constellation, including both operational and spare satellites, and will take over this responsibility upon contractual handover from the satellite system supplier shortly after launch of the satellites. All satellite housekeeping and maintenance will be performed from the SOCC. The detailed status of each of the satellites will be monitored and appropriate commands will be generated. The full ephemeris data of the entire constellation will be maintained at the SOCC.

4 Financial Qualifications (47 C.F.R. § 25.114(13))

At present, the question of the appropriate financial qualification standard, if any, to be applied to nongeostationary FSS systems that would operate in the Ku-band frequencies that are the subject of the instant application is unresolved. The Commission, in its recent *Ku-Band NPRM*, has proposed a standard different from the one in Section 25.140(c) of the Commission's Rules that was developed for geostationary FSS systems in bands where there are more applicants than available locations.[10] It noted as well that, "[h]istorically, the Commission has fashioned financial requirements for satellite services on the basis of entry opportunities in the particular service being licensed."[11]

To be sure, the Commission has, in recent years, adopted varying financial standards for satellite services based on a number of factors, including the particular characteristics of the service and the relative availability of spectrum to meet demand from applicants.[12] Notwithstanding the Commission's stated intention in the public notice to require all applicants in these bands to include the information specified in Section 25.114 of the Commission's Rules, including information showing an applicant's "ability to proceed expeditiously with construction and launch,"[13] this "intention" has not been reflected in any rule that applies to all of the frequency bands covered by the Public Notice or to nongeostationary systems in particular.[14] As a result, there is no currently applicable financial qualification standard for these bands.

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10 *Ku-Band NPRM, FCC 98-310, slip op. at 45.*

11 *Id. (citations omitted).*

12 *See e.g., Rulemaking to Amend Parts 1, 2, 21, and 25 of the Commission's Rules to Redesignate the 27.5-29.5 GHz Frequency Band, to Reallocate the 29.5-30 GHz Frequency Band, to Establish Rules and Policies for Local Multipoint Distribution Service and for Fixed Satellite Services*, 12 FCC Rcd 22310, 22318 (1997) ("*Ka-Band Service Rules*"); *Amendment of the Commission's Rules to Establish Rules and Policies Pertaining to a Non-Voice, Non-Geostationary Mobile-Satellite Service*, 8 FCC Rcd 8450, 8451-52 (1993).

13 *See* Public Notice, Report No. SPB-141, at 2.

14 It is only in the *Ku-Band NPRM* that the Commission proposes for the first time to add many of the frequency bands covered by the Public Notice and instant application to Section 25.202(a) of the

In Virtual Geo's view, not only has there been no individualized financial standard(s) adopted for the nongeostationary FSS in the Ku-band and C-band spectrum covered by the instant application, there are very good reasons for the Commission to determine that a standard different both from the one in Section 25.140 of the Commission's Rules and from the standard proposed for application in the *Ku-Band NPRM* should apply to applicants such as Virtual Geo. Most significantly, if the Commission were to require applicants for nongeostationary systems in the subject bands to utilize systems similar to the virtual geostationary configuration proposed by Virtual Geo for VIRGO™, two things would happen: (1) the "congestion" of the geostationary orbital arc cited by the Commission would become irrelevant, as there is complete transparency between virtual geostationary systems and geostationary systems; and (2) the number of possible VIRGO™-like nongeostationary systems that could operate on a co-frequency basis would likely be substantial.[15]

Under these circumstances, the Commission's traditional rationale for applying a financial qualifications standard – as opposed to relying on strict enforcement of implementation milestones – is not applicable. Indeed, these circumstances require application of the reasoning and decision the Commission reached just last year in its *Ka-Band Service Rules* decision. There, the Commission, finding that it was able to grant all pending applications in the two processing rounds before it (one geostationary and one nongeostationary) without precluding use

Commission's Rules – the provision that specifies the frequencies in the fixed-satellite service for purpose of the Commission's Rules (including the financial qualification standard in Section 25.140 that applies to C-band and Ku-band geostationary FSS systems). *See Ku-Band NPRM*, FCC 98-310, slip op. at 56.

15 Virtual Geo intends to elaborate on this point further in its comments in response to the *Ku-Band NPRM*. However, it now appears that multiple VIRGO™-like nongeostationary systems could co-exist on a co-frequency basis.

of the band by other applicants for FSS systems, decided to waive its financial requirements for all first round applicants.[16]

Although Virtual Geo advocates similar treatment here, and will participate in the *Ku-Band* rulemaking proceeding, it hereby requests a waiver of any currently applicable financial qualification standard on grounds of inappositeness, and requests further a reasonable opportunity to comply with whatever standard, if any, the Commission imposes on Virtual Geo and other first-round Ku-band nongeostationary applicants at the conclusion of its proceeding in ET Docket No. 98-206.

4.1 Projected System Costs

Total projected costs to construct, launch and operate the VIRGO™ system for one year are $2.64 billion. These costs are broken down as follows:

Table 4-1: VIRGO™ Projected System Costs

	Subtotals	Totals
Satellite Construction (incl NRE)	$ 1104 million	
Launch Services/Insurance	$ 1153 million	
Total Space Segment		$ 2257 million
Ground Segment (TT&C/Gateway/Net)		$ 273 million
Pre-Operating/Development	$ 83 million	
First Year Operations	$ 25 million	
Total Operating Expenses Through 1st Year		$ 108 million
TOTAL VIRGO™ SYSTEM COSTS		**$ 2638 million**

16 *See Ka-Band Service Rules*, 12 FCC Rcd at 22318. *See also Teledesic Corporation,* DA 97-527, slip op. at ¶ 13 (Int'l. Bur., released March 13, 1997).

4.2 Source of Funds

Virtual Geo will rely on a combination of equity and debt funding to finance the establishment of the VIRGO™ system. Virtual Geo will rely in part on capital contributions made by investors in the VIRGO™ system, and will supplement these capital investments with public and/or private placements of debt and equity instruments.

5 Non-Common Carrier Status (47 C.F.R. § 25.114(c)(14))

Virtual Geo elects under Section 25.114(c)(14) of the Commission's rules to provide all capacity on its proposed VIRGO™ system on a non-common carrier basis. Virtual Geo will tailor services to meet the needs of individual customers.

6 Schedule of Implementation (47 C.F.R. § 25.114(c)(15))

Virtual Geo's proposed scheduling milestones for the deployment of the VIRGO™ system are shown with schedule dates referenced to the date of final Commission approval of the instant application:

FCC Approval	**Month 0**
Commence construction	Month 12
Complete construction VIRGO™ Satellite A1	Month 36
Complete construction VIRGO™ Satellite A2	Month 38
Complete construction VIRGO™ Satellite A3	Month 40
Launch VIRGO™ Satellites A1-A2	Month 41
Complete construction VIRGO™ Satellite A4	Month 42
Complete construction VIRGO™ Satellite A5	Month 43
Complete construction VIRGO™ Spare SA1	Month 44
Launch VIRGO™ Satellites A3-A4	Month 45
Launch VIRGO™ Satellites A5-SA1	Month 47
Complete construction VIRGO™ Satellite B1	Month 47
Commence AURORA I™ Service	**Month 48**
Complete construction VIRGO™ Satellite B2	Month 48
Complete construction VIRGO™ Satellite B3	Month 49
Complete construction VIRGO™ Satellite B4	Month 50
Launch VIRGO™ Satellites B1-B2	Month 51
Complete construction VIRGO™ Satellite B5	Month 51
Complete construction VIRGO™ Spare SB1	Month 52
Launch VIRGO™ Satellites B3-B4	Month 53
Complete construction VIRGO™ Satellite C1	Month 53
Complete construction VIRGO™ Satellite C2	Month 54
Launch VIRGO™ Satellites B5-SB1	Month 55
Complete construction VIRGO™ Satellite C3	Month 55
Commence AURORA II™ Service	**Month 56**
Complete construction VIRGO™ Satellite C4	Month 56
Launch VIRGO™ Satellites C1-C2	Month 57
Complete construction VIRGO™ Satellite C5	Month 57
Complete construction VIRGO™ Spare SC1	Month 58
Launch VIRGO™ Satellites C3-C4	Month 59
Launch VIRGO™ Satellites C5-SC1	Month 61
Commence AUSTRALIS™ Service	**Month 62**
Complete Worldwide VIRGO™ Service	**Month 62**

Note that service from the sub-constellations is independent from each other.

7 Public Interest Considerations (47 C.F.R. § 25.114(16))

The grant of Virtual Geo's instant application for authority to launch and operate the VIRGO™ system will promote the public interest in several distinct ways.

Initially, Virtual Geo observes that the United States has a national interest in promoting broad band telecommunications access both domestically and internationally. Such policies not only benefit U.S. companies by helping them sustain their global leadership in telecommunications, they also contribute substantially to the growth and strength of the global economy. Broadband satellite communications historically have proceeded through exploitation of the geostationary plane and associated frequencies. Both that plane and those frequencies are increasingly congested. The national interest, accordingly, lies in the promotion of technologies and orbital architectures that can efficiently convey broadband services and use spectrum which has been allocated for FSS and BSS services without interfering with existing geostationary satellites. Virtual Geo's proposed VIRGO™ system, with its transparency to existing and future geostationary satellites, as well as its compatibility with existing terrestrial users, ably fits this bill.

In addition, VIRGO™ will both fan the flames of demand for high-efficiency, affordable broadband capacity, and help meet that demand. VIRGO™ will provide a wide and wide open range of affordable digital services, including high-speed Internet access and direct-to-home data and video streams, to small user terminals in most of the populated areas of the world.

The number of homogeneous virtual geostationary systems that can operate on a co-frequency basis exceeds the three-to-six homogeneous low-Earth orbit nongeostationary systems that other applicants have suggested could co-exist.[17] Virtual Geo thus provides valuable opportunities with VIRGO™ for competitive multiple entry in a manner that does not impact negatively on existing or future geostationary satellite operations.

Although sharing between nongeostationary satellite systems of the VIRGO™ design and low- and medium-Earth circular orbit systems is somewhat more complex, Virtual Geo nevertheless believes that it should be possible to achieve co-frequency sharing between disparate types of nongeostationary FSS systems in certain instances analagous to that achieved in the MSS industry feeder link sharing arena. Virtual Geo is prepared to undertake a comprehensive examination of the situation in all appropriate fora.

In sum, the VIRGO™ system proposed herein by Virtual Geo offers tremendous public interest benefits with regard to its ability to operate co-frequency with geostationary systems, fixed service systems, and homogeneous nongeostationary systems. VIRGO™ will also satisfy the exponentially growing demand for state-of-the-art, affordable satellite services. The Commission should, on these bases, readily find that grant of Virtual Geo's application to establish VIRGO™ is consistent with the public interest.

17 In the *Ku-Band NPRM*, the Commission reported that one applicant for a low-Earth orbit nongeostationary system in these bands, SkyBridge L.L.C., "state[d] that up to six SkyBridge-like systems can co-exist without harmful interference to each other." *Ku-Band NPRM*, FCC 98-310, slip op. at 37 (footnote omitted).

8 U.S. and International Interference Coordination (47 C.F.R. § 25.114(c)(17))

Virtual Geo will comply with all applicable domestic and international requirements in coordinating the proposed system. The applicant will provide the Commission with Advance Publication materials to be sent to the ITU. Virtual Geo respectfully requests that the Commission forward such Advance Publication documents to the ITU as soon as possible in order to preserve U.S. interests.

In addition, and to the extent applicable, Virtual Geo will comply fully with the consultation requirements of Article XIV of the INTELSAT Agreement, and any other relevant international obligations.

9 Legal Qualifications

Virtual Geo is legally qualified to be licensed by the Commission, as demonstrated in the FCC Form 312 attached to this application as Appendix A.

10 Other Items (47 C.F.R. §§ 25.114(c) (18)-(21))

Subsections 18-21 of Section 25.114(c) of the Commission's Rules apply to specific types of satellite service that Virtual Geo does not propose herein to provide. Accordingly, these subsections are inapplicable to this application.

11 Requested Waivers of the Commission's Rules

As explained in Section 4 above, Virtual Geo requests a waiver, to the extent it may be necessary, of the Commission's financial qualifications standard for its application to launch and operate a nongeostationary satellite system that would provide fixed-satellite services using Ku-band and C-band frequencies.

Virtual Geo also requests a waiver of Section 25.210 of the Commission's Rules, 47 C.F.R. § 25.210. This rule contains technical requirements that apply generally to fixed-satellite service spacecraft. The particular provisions of this rule, however, are tailored to the typical design specifications of geostationary satellites, and are technically inapplicable to nongeostationary satellites (which are inherently incapable of meeting the specific requirements set forth in Section 25.210). Notwithstanding the facial inapplicability of the rule, Virtual Geo's VIRGO™ system is consistent with the purpose of Section 25.210 to the extent that they maximize the efficient use of the spectrum in which its satellites will operate. Until such time as Section 25.210 is modified to clarify the provisions applicable to nongeostationary fixed-satellite service spacecraft, Virtual Geo requests a waiver thereof to the extent necessary to permit grant of this application.

In this last regard, Virtual Geo also requests a waiver of those elements of Section 25.114(c) that are not pertinent to the VIRGO™ system described in this application. For example, Section 25.114(c)(5) requests information pertaining to the relationship between the satellite receive antenna gain pattern and the gain-to-temperature ratio and the saturation flux density for each antenna beam. *See* 47 C.F.R. § 25.114(c)(5). As Virtual Geo notes in Section 3.7.1.2 above, the concept of saturation flux density is not relevant to the linear broad-band communications channels of the VIRGO™ satellites. Similarly, the requirement of Section 25.114(c)(7) calling for orbital-location based antenna gain contours is not relevant. *See* 47 C.F.R. § 25.114(c)(7).Thus, this requirement, along with portions of other subsections of Section 25.114(c) that Virtual Geo will not try to list here, are inapposite to the advanced satellite technology that Virtual Geo is proposing to employ on VIRGO™. Because VIRGO™, as described herein, is an innovative, spectrum-efficient design that advances the public interest, Virtual Geo hereby believes that the semi-open-ended waiver it is requesting here is warranted and should be granted.

Virtual Geo, to the extent it may be necessary, also seeks waivers of Section 25.202(a) and Section 2.106 of the Commission's Rules, 47 C.F.R. §§ 25.202(a) and 2.106, to enable Virtual Geo to be assigned the frequencies it requests herein for its proposed VIRGO™ system. These sections contain the identification of fixed-satellite service frequencies available for non-government use in the United States. The bands that are requested in this application for VIRGO™ are not all included in these two rules, even though the excluded bands are covered by the Commission's November 2, 1998 public notice (Report No. SPB-141) establishing the cut-off deadline pursuant to which the instant application is being filed, and are the subject of the Commission's rulemaking proceeding in ET Docket No. 98-206.[18]

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18 To the extent that the frequency assignments requested herein vary in certain respects from the breakdowns of gateway and user links the Commission has proposed to adopt in its *Ku-Band NPRM*, Virtual Geo will address these matters in its comments on the notice of proposed rule making. Virtual Geo is confident that the unique attributes of its virtual geostationary concept, as reflected in this application, will persuade the Commission to modify its proposed band plan structure to accommodate VIRGO™. If the outcome of the *Ku-Band* rulemaking proceeding is inconsistent with Virtual Geo's proposal, it will be afforded the opportunity to bring its system proposal into conformance with the final rules. For now, Virtual Geo is content to observe that its frequency use proposal for Ku band, while not in total harmony with the *Ku-Band NPRM*, is at least responsive to the Commission's November 2, 1998 Public Notice (Report No. SPB-141).

Finally, Virtual Geo reiterates that the Commission is only now beginning to consider the regulatory framework that will be applied to nongeostationary FSS systems at Ku-band, and has not, until now, faced a request from a commercial system to use conventional C-band frequencies for any type of nongeostationary FSS service. The Ku-band issues are being addressed in the newly-initiated rulemaking proceeding in ET Docket No. 98-206, in which Virtual Geo will be an active participant. The C-band issues have not yet been made the subject of a formal rulemaking proceeding. The Commission has stated that applicants in this processing round will be given an opportunity to amend their applications as necessary to conform to any requirements and policies that may be adopted subsequently for space stations concerning the provision of NGSO fixed-satellite service in the Ku-bands. Virtual Geo expects that a similar approach would be taken for C-band if a rulemaking proceeding is deemed necessary there. Virtual Geo hereby requests a general waiver of any rules or policies that, while potentially applicable now to VIRGO™, will be modified or removed during the course of future proceedings.

12 Conclusion

The VIRGO™ satellite system is an innovative concept that will be capable of providing affordable and highly desirable satellite services to businesses and end users in most of the heavily populated areas of the world. VIRGO™ is a model of how the orbital/spectrum resource can be shared on a co-frequency basis by multiple services in order to maximize efficiency, and will help maintain U.S. leadership in commercial satellite technology.

For all of the reasons set forth in this application, Virtual Geo respectfully urges the Commission to grant this application and authorize it to launch and operate the VIRGO™ system, so that the promised public interest benefits will be realized as rapidly as possible.

Respectfully submitted,

VIRTUAL GEOSATELLITE, LLC

By: ______________________
David Castiel
President and Manager

Dated: January 8, 1999

Of Counsel:

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APPENDIX A

FCC 312
Main Form

Approved by OMB 3060-0678

Est. Avg. Burden Hours Per Response: 11 Hrs.

FCC Use Only
File Number:
Call Sign:
Fee Number:

FEDERAL COMMUNICATIONS COMMISSION

APPLICATION FOR SATELLITE SPACE AND EARTH STATION AUTHORIZATIONS

APPLICANT INFORMATION

1. Legal Name of Applicant: Virtual Geosatellite, LLC

2. Voice Telephone Number: (202) 466-5599

3. Other Name Used for Doing Business (if any): N/A

4. Fax Telephone Number: (202) 466-4493

5. Mailing Street Address or P.O. Box: 1133 21st Street, N.W.
8th Floor
ATTENTION: David Castiel

6. City: Washington

7. State / Country (if not U.S.A.): D.C.

8. Zip Code: 20036

9. Name of Contact Representative (If other than applicant): Stephen D. Baruch

10. Voice Telephone Number: (202) 429-8970

11. Firm or Company Name: Leventhal, Senter & Lerman P.L.L.C.

12. Fax Telephone Number: (202) 293-7783

13. Mailing Street Address or P.O. Box: 2000 K Street, N.W.
Suite 600
ATTENTION:

14. City: Washington

15. State / Country (if not U.S.A): D.C.

16. Zip Code: 20006

CLASSIFICATION OF FILING

17. Place an "X" in the box next to the classification that applies to this filing for both questions a. and b. Mark only one box for 17a and only one box for 17b.

- [ ] a1. Earth Station
- [X] a2. Space Station

- [X] b1. Application for License of New Station
- [ ] b2. Application for Registration of New Domestic Receive-Only Station
- [ ] b3. Amendment to a Pending Application
- [ ] b4. Modification of License or Registration
- [ ] b5. Assignment of License or Registration
- [ ] b6. Transfer of Control of License or Registration
- [ ] b7. Notification of Minor Modification
- [ ] b8. Application for License of New Receive-Only Station Using Non-U.S. Licensed Satellite
- [ ] b9. Letter of Intent to Use Non-U.S. Licensed Satellite to Provide Service in the United States
- [ ] b10. Other (Please Specify):

18. If this filing is in reference to an existing station, enter:
Call sign of station: N/A

19. If this filing is an amendment to a pending application enter:
(a) Date pending application was filed: N/A
(b) File number of pending application: N/A

TYPE OF SERVICE

20. NATURE OF SERVICE: This filing is for an authorization to provide or use the following type(s) of service(s): Place an "X" in the box(es) next to all that apply.

- [X] a. Fixed Satellite
- [ ] b. Mobile Satellite
- [ ] c. Radiodetermination Satellite
- [ ] d. Earth Exploration Satellite
- [X] e. Direct to Home Fixed Satellite
- [ ] f. Digital Audio Radio Service
- [ ] g. Other (please specify) ______

21. STATUS: Place an "X" in the box next to the applicable status. Mark only one box.

- [ ] a. Common Carrier
- [X] b. Non-Common Carrier

22. If earth station applicant, place an "X" in the box(es) next to all that apply. N/A

- [ ] a. Using U.S. licensed satellites
- [ ] b. Using Non-U.S. licensed satellites

23. If applicant is providing INTERNATIONAL COMMON CARRIER service, see instructions regarding Sec. 214 filings. Mark only one box. Are these facilities: N/A

- [ ] a. Connected to the Public Switched Network
- [ ] b. Not connected to the Public Switched Network

24. FREQUENCY BAND(S): Place an "X" in the box(es) next to all applicable frequency band(s).

- [X] a. C-Band (4/6 GHz)
- [X] b. Ku-Band (12/14 GHz)
- [X] c. Other (Please specify) 17.3 - 17.8 GHz (Earth-to-Space)

TYPE OF STATION

25. CLASS OF STATION: Place an "X" in the box next to the class of station that applies. Mark only one box.

- [ ] a. Fixed Earth Station
- [ ] b. Temporary-Fixed Earth Station
- [ ] c. 12/14 GHz VSAT Network
- [ ] d. Mobile Earth Station
- [X] e. Space Station
- [ ] f. Other (Specify) ______

If space station applicant, go to Question 27.

26. TYPE OF EARTH STATION FACILITY Mark only one box. N/A

- [ ] a. Transmit/Receive
- [ ] b. Transmit-Only
- [ ] c. Receive-Only

PURPOSE OF MODIFICATION OR AMENDMENT

27. The purpose of this proposed modification or amendment is to: Place an "X" in the box(es) next to all that apply. N/A

- [ ] a -- authorization to add new emission designator and related service
- [ ] b -- authorization to change emission designator and related service
- [ ] c -- authorization to increase EIRP and EIRP density
- [ ] d -- authorization to replace antenna
- [ ] e -- authorization to add antenna
- [ ] f -- authorization to relocate fixed station
- [ ] g -- authorization to change assigned frequency(ies)
- [ ] h -- authorization to add Points of Communication (satellites & countries)
- [ ] i -- authorization to change Points of Communication (satellites & countries)
- [ ] j -- authorization for facilities for which environmental assessment and radiation hazard reporting is required
- [ ] k -- Other (Please Specify) ______

ENVIRONMENTAL POLICY

28. Would a Commission grant of any proposal in this application or amendment have a significant environmental impact as defined by 47 CFR 1.1307? [ ] YES [X] NO
If YES, submit the statement as required by Sections 1.1308 and 1.1311 of the Commission's rules, 47 C.F.R. §§ 1.1308 and 1.1311, as an exhibit to this application.

A Radiation Hazard Study must accompany all applications as an exhibit for new transmitting facilities, major modifications, or major amendments. Refer to OET Bulletin 65.

ALIEN OWNERSHIP

29. Is the applicant a foreign government or the representative of any foreign government?	☐ YES	☒ NO
30. Is the applicant an alien or the representative of an alien?	☐ YES	☒ NO
31. Is the applicant a corporation organized under the laws of any foreign government?	☐ YES	☒ NO
32. Is the applicant a corporation of which more than one-fifth of the capital stock is owned of record or voted by aliens or their representatives or by a foreign government or representative thereof or by any corporation organized under the laws of a foreign country?	☐ YES	☒ NO
33. Is the applicant a corporation directly or indirectly controlled by any other corporation of which more than one-fourth of the capital stock is owned of record or voted by aliens, their representatives, or by a foreign government or representative thereof or by any corporation organized under the laws of a foreign country?	☐ YES	☒ NO
34. If any answer to questions 29, 30, 31, 32 and/or 33 is Yes, attach as an exhibit, the identification of the aliens or foreign entities, their nationality, their relationship to the applicant, and the percentage of stock they own or vote.		

BASIC QUALIFICATIONS

35. Does the applicant request any waivers or exemptions from any of the Commission's Rules? If Yes, attach as an exhibit, copies of the requests for waivers or exceptions with supporting documents. See Exhibit No. 1	☒ YES	☐ NO
36. Has the applicant or any party to this application had any FCC station authorization or license revoked or had any application for an initial, modification or renewal of FCC station authorization, license, or construction permit denied by the Commission? If Yes, attach as an exhibit, an explanation of the circumstances.	☐ YES	☒ NO
37. Has the applicant, or any party to this application, or any party directly or indirectly controlling the applicant ever been convicted of a felony by any state or federal court? If Yes, attach as an exhibit, an explanation of the circumstances.	☐ YES	☒ NO
38. Has any court finally adjudged the applicant, or any person directly or indirectly controlling the applicant, guilty of unlawfully monopolizing or attempting unlawfully to monopolize radio communication, directly or indirectly, through control of manufacture or sale of radio apparatus, exclusive traffic arrangement or any other means or unfair methods of competition? If Yes, attach as an exhibit, an explanation of the circumstances.	☐ YES	☒ NO
39. Is the applicant, or any person directly or indirectly controlling the applicant, currently a party in any pending matter referred to in the preceeding two items? If Yes, attach as an exhibit, an explanation of the circumstances.	☐ YES	☒ NO
40. If the applicant is a corporation and is applying for a space station license, attach as an exhibit the names, addresses, and citizenship of those stockholders owning of record and/or voting 10 percent or more of the Filer's voting stock and the percentages so held. In the case of fiduciary control, indicate the beneficiary(ies) or class of beneficiaries. Also list the names and addresses of the officers and directors of the Filer. See Exhibit No. 2		
41. By checking Yes, the undersigned certifies, that neither the applicant nor any other party to the application is subject to a denial of Federal benefits that includes FCC benefits pursuant to Section 5301 of the Anti-Drug Act of 1988, 21 U.S.C. Section 862, because of a conviction for possession or distribution of a controlled substance. See 47 CFR 1.2002(b) for the meaning of "party to the application" for these purposes.	☒ YES	☐ NO
42a. Does the applicant intend to use a non-U.S. licensed satellite to provide service in the United States? If yes, answer 42b and attach an exhibit providing the information specified in 47 C.F.R. § 25.137, as appropriate. If no, proceed to question 43.	☐ YES	☒ NO
42b. What administration has licensed or is in the process of licensing the space station? If no license will be issued, what administration has coordinated or is in the process of coordinating the space station? ______		

43. Description. (Summarize the nature of the application and the services to be provided).

Virtual Geosatellite, LLC ("VGL") seeks authority to launch and operate an innovative, state-of-the-art constellation of non-geostationary satellites in elliptical, subgeosynchronous, continent - following orbits. VGL's system, called "VIRGO," will provide fixed-satellite services (including direct-to-home service) through gateway and user links in C-band and Ku-band frequencies (including the 17.3 - 17.8 GHz band, Earth-to-Space).

Exhibit No.	Identify all exhibits that are attached to this application.
1	Requests for Waiver of Commission Rules (Question 35)
2	Ownership of Virtual Geosatellite, LLC (Question 40)

CERTIFICATION

The Applicant waives any claim to the use of any particular frequency or of the electromagnetic spectrum as against the regulatory power of the United States because of the previous use of the same, whether by license or otherwise, and requests an authorization in accordance with this application. The applicant certifies that grant of this application would not cause the applicant to be in violation of the spectrum aggregation limit in 47 CFR Part 20. All statements made in exhibits are a material part hereof and are incorporated herein as if set out in full in this application. The undersigned, individually and for the applicant, hereby certifies that all statements made in this application and in all attached exhibits are true, complete and correct to the best of his or her knowledge and belief, and are made in good faith.

44. Applicant is a (an): (Place an "X" in the box next to applicable response.)

☐ a. Individual ☐ b. Unincorporated Association ☐ c. Partnership ☐ d. Corporation ☐ e. Governmental Entity ☒ f. Other (Please specify) Limited Liability Company

45. Typed Name of Person Signing: David Castiel

46. Title of Person Signing: President and Manager

47. Signature: [signature]

48. Date: January 8 , 1999

WILLFUL FALSE STATEMENTS MADE ON THIS FORM ARE PUNISHABLE BY FINE AND/OR IMPRISONMENT (U.S. Code, Title 18, Section 1001), AND/OR REVOCATION OF ANY STATION AUTHORIZATION (U.S. Code, Title 47, Section 312(a)(1)), AND/OR FORFEITURE (U.S. Code, Title 47, Section 503).

Appendix A: FCC Form 312 Application

Exhibit 1 -- Requests for Waiver of Commission Rules
Exhibit 2 – Ownership of Virtual Geosatellite, LLC

EXHIBIT NO. 1

Virtual Geosatellite, LLC
FCC Form 312
Question 35
January 1999

Requests for Waiver of the Commission's Rules

Virtual Geosatellite, LLC ("VGL") requests a waiver, to the extent it may be necessary, of the Commission's financial qualifications standard for its application to launch and operate a nongeostationary satellite system that would provide fixed-satellite services using Ku-band and C-band frequencies. The waiver request is contained in Section 4 of the main application to which this Form 312 application is annexed.

Section 25.210 of the Commission's Rules contains technical requirements that apply generally to fixed-satellite service spacecraft. The particular provisions of this rule, however, are tailored to the typical design specifications of geostationary satellites, and are technically inapplicable to nongeostationary satellites (which are inherently incapable of meeting the specific requirements set forth in Section 25.210). Notwithstanding the facial inapplicability of the rule, VGL's VIRGO system is consistent with the purpose of Section 25.210 to the extent that it maximizes the efficient use of the spectrum in which its satellites will operate. Until such time as Section 25.210 is modified to clarify the provisions applicable to nongeostationary fixed-satellite service spacecraft, VGL requests a waiver thereof to the extent necessary to permit grant of this application.

VGL, to the extent it may be necessary, also seeks waivers of Section 25.202(a) and Section 2.106 of the Commission's Rules to enable VGL to be assigned the frequencies it requests herein for its proposed VIRGO system. These sections contain the identification of fixed-satellite service frequencies available for non-government use in the United States. The bands that are requested in this application for VIRGO are not all included in these two rules, even though the excluded bands are covered by the Commission's November 2, 1998 public notice (Report No. SPB-141) establishing the cut-off deadline pursuant to which the instant application is being filed, and are the subject of the Commission's rulemaking proceeding in ET Docket No. 98-206.

Finally, VGL notes that existing rules and policies that apply to Ku-band and C-band geostationary satellite systems may be modified or deemed inapplicable to nongeostationary fixed-satellite service systems during the course of ongoing or future rulemaking proceedings. To the extent that there are currently applicable policies and rules that fall into this category, VGL requests that these rules and policies be waived with respect to VIRGO. As noted in Section 11 of the Application with which this FCC Form 312 application is associated, this last request includes those elements of Section 25.114(c) of the Commission's Rules that are not relevant to the advanced satellite technology that VGL will employ on VIRGO.

Virtual Geosatellite, LLC
FCC Form 312
Question 40
January 1999

Ownership/Management of Virtual Geosatellite, LLC

Management of Virtual Geosatellite, LLC:

David Castiel is the President and Manager of VGL. There are no other officers of the company.

Owners of 10% or More of Virtual Geosatellite, LLC ("VGL"):

The following entities own 10% or more of Virtual Geosatellite, LLC:

Virtual Geosatellite Holdings, Inc. ("VGHI") owns 88 percent of VGL. Ellipso, Inc. ("Ellipso") owns 12 percent of VGL.

VGHI is 100 percent owned by DC Family Trust II, of which David Castiel is the Trustee. The beneficiaries of DC Family Trust II are David Castiel and his minor children.

Ellipso holds 100 percent of the stock of Mobile Communications Holdings, Inc., the licensee of the Ellipso™ "Big LEO" mobile-satellite service system, either directly or through its wholly-owned subsidiary, Ellipso Private Holdings, Inc. Only Ellipso Private Holdings, LLC, of which David Castiel holds a majority interest, has greater than a 10 percent interest in Ellipso.

The address of VGHI and DC Family Trust II is as follows:

1133 21st Street, N.W., Suite 800
Washington, D.C. 20036
(202) 466-5599

The address of Ellipso, Inc. and Ellipso Private Holdings, LLC is as follows

1133 21st Street, N.W., Suite 800
Washington, D.C. 20036
(202) 466-4488

Technical Certificate

The undersigned hereby certifies, under penalty of perjury, that I am the technically qualified person responsible for the preparation of the technical information contained in the foregoing application, that I am familiar with Part 25 of the Commission's Rules, and that I have either prepared or reviewed the technical information in the foregoing application and found it to be complete and accurate to the best of my knowledge and belief.

Jack R. Anderson
Acting Technical Officer
Virtual Geosatellite, LLC

January 8, 1999

REQUIRED CERTIFICATIONS

Pursuant to Section 304 of the Communications Act (47 U.S.C. § 304), Virtual Geosatellite, LLC ("Virtual Geo") waives any claim to the use of any particular frequency or of the electromagnetic spectrum as against the regulatory power of the United States because of the previous use of the same, whether by license or otherwise.

The undersigned further certifies, under penalty of perjury, that neither Virtual Geo nor any party to this application is subject to denial of federal benefits pursuant to Section 5301 of the Anti-Drug Abuse Act of 1988, 21 U.S.C. § 862.

The undersigned certifies under penalty or perjury, individually and for Virtual Geo, that the statements made in this application are true and correct to the best of his knowledge and belief, and are made in good faith.

David Castiel
President and Manager
Virtual Geosatellite, LLC

January 8, 1999