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LEGAL ASPECTS OF GEOSTATIONARY PLATFORMS IN THE STRATOSPHERE

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Advances in several technologies emerged during the 1990s to make feasible the implementation of long-duration geostationary platforms in the stratosphere. The deployment of such geostationary platforms has been approved at certain millimeter wave frequencies by unanimous decision of the members of the International Telecommunication Union in a treaty document signed in November 1997. Legal questions persist, however, regarding the appropriate legal status of stratospheric platforms. While a literal interpretation of space law treaties would probably exclude stratospheric platforms as objects in outer space. The purposes and principles of space law would be best served by defining geostationary stratospheric platforms as objects in outer space. Consequently, certain space law treaties to deal expressly with stratopheric platforms must be amended.

Two telecommunications architectures can be used to deliver wireless communications service to consumers over mega-metropolitan regions. One approach involves platforms which withstand gravitational attraction by virtue of momentum imparted by a rocket launch--geostationary satellites and nongeostationary satellites. The other approach involves platforms which withstand gravitational attraction by virtue of buoyancy imparted by a helium launch -- stratospheric relays. Eventually gravity wins in both cases. How long it takes is simply a matter of structural engineering and starting conditions. Should such conceptually similar means of telecommunications be governed by disparate or similar legal regimes?

Geometry and hardware engineering factors lead to a technical conclusion that the greatest amount of communications capacity over global mega-metropolitan areas, for an equivalent investment in equipment and bandwidth, will come from the stratospheric architecture. On the other hand, the greatest amount of communications coverage over the entire globe, for equivalent investments in platforms, will come from the rocket-launched platforms. Should such ephemeral differences in telecommunications capability give rise to sharply different legal regimes?

Assessing the Capacity of Distant Platform Wireless Systems

The capacity of a telecommunications system is equal to the number of spot beams that the system provides, all other factors held constant. The number of spot beams that a system can generate goes up with the distance between the radio repeater and the coverage area until the line of sight approaches the outer boundary of the coverage area, and goes down thereafter. For example, a geostationary satellite generates only about one spot beam per metropolitan area using typical state of the art antenna apertures of five meters at 20/30 GHz[1]. However, a single stratospheric telecommunications platform at 21 kilometers altitude can generate approximately 700-1000 spot beams within a single metropolitan area

Table 1.
Broadband Capacity in Metro Areas

Technology	Urban Capacity	Angle of Elevation
Terrestrial Wireless	6 Spot Beams Per Tower	Low
Stratospheric Platforms	700 Spot Beam Per City	High
LEO Networks	6 Spot Beams Per City	High
GEO Satellite	One Spot Beam Per City	Low

As an example, the Sky Station stratospheric platform system envisions 300 MHz of bandwidth in each direction in the 47.2-47.5 and 47.9-48.2 GHz bands[2]. From a 21 kilometer deployment altitude and with an antenna aperature characterized by 27.1 dBW EIRP, the system generates approximately 700 spot beams over an almost 100 kilometer diameter coverage area, out just beyond a 15 degree angle of elevation. Assuming a modest frequency reuse factor of 9 (current cellular phone systems have much higher figures), the total metropolitan capacity of the system is nearly 8 Gbps times the number of covered metropolitan areas. With approximately 250 global metropolitan areas counting one million or more people, a global network of 250 Sky Station platforms would offer a system-wide metropolitan capacity of 2 Tbps (trillion bits per second). This capacity would be time shared by subscribers at virtual T1/E1 rates and higher, resulting in a global subscriber capacity, at 0.1 Erlang utilization, of over 250 million subscribers. Considered alternatively, 250 Sky Station stratospheric platforms could provide a broadband internet channel to every household in China or India, provided each was allocated adequate frequency bandwidth – without a single length of wire or cable being run.

The kind of huge increases in communications capacity and coverage that are the hallmark of stratospheric platforms are precisely the same promises offered by communications satellites. In simply turns out, due to advancing technology, that satellites could remain geostationary at 20 kilometers instead of at 40,000 kilometers. Why, then, should satellites at 40,000 kilometers be deemed "space objects" subject to a regime of space law, whilst satellites at 20 kilometers – serving identical functions – are considered "aircraft" subject to a regime of air law?

High-Density and Low-Density Market Segments

Stratospheric and other wireless systems can be differentiated into high density and low density market segments. All space systems (geostationary and networked nongeostationary) are low density architectures. They do an excellent job of providing some bandwidth everywhere, but cannot compete with terrestrial architectures in providing maximum capacity in metropolitan areas. Stratospheric and ground-based millimeter wave systems are high density architectures. These designs excel at delivering metropolitan consumers the greatest value in terms of cost per unit bandwidth, but are not very cost-effective when it comes to rural service.

In planning for national broadband networks, it is wise to consider the complementary capabilities of high and low density system architectures. The best mix of service appears to come from layering a space-based system for rural low density broadband service with a stratospheric system for metropolitan high density broadband service. In addition, ground-based millimeter wave equipment should be considered for ultra-high reliability links, either in metropolitan or rural geographic areas.

It is important to not confuse low density market segments with developing parts of the world. Indeed, most of the world's most rapid metropolitan growth is expected to come from the developing world. The developing world's mega-cities – from Lagos and Cairo to Beijing and Bombay – are high-density market segments which need the stratospheric architecture in order to ensure mass access to the broadband channels which are essential to rapid economic development. The use of communications satellite technology for the "benefit of all mankind", and for the "common benefit of humanity", and for the benefit of the "developing countries in particular," have all been important hallmarks of the space age.

Rather surprisingly, at the same time as aerospace technology has enabled us to reach ever further into the expanses of the interplanetary, interstellar and even intergalactic voids, it has also enabled us to provide all of the hallmark benefits of satellite communications at ever lower altitudes. The continuity of wide area communications -- once thought to be the exclusive domain of geostationary satellites -- was ultimately usurped by low-earth orbiting interlopers such as *Iridium* and *Globalstar*. This trend of aerospace technology development has now reached further down into the earth-space continuum so that continuous wide-area coverage communications can be provided by stratospheric platforms operating in the 20-30 kilometer altitude range. Why then, we are forced to ask, should the legal regime be that of space law for communications platforms at a descending array of altitudes from 40,000 kilometers to 100 kilometers, but then instantly transmogrify into a regime of air law once the communications platform is located in the 20-30 kilometer regime? The lofty global development purposes of the platforms are the same. The utter dependence of these global telecommunications development advantages upon a "global resource" – unbreathable air-space continuum – is the same whether the platforms be 20 kilometers high or 40,000 kilometers high. Yes, it is true that the air is thinner at 40,000 kilometers than at 20 kilometers, but the difference would make no difference to no man. Both locales are utterly unlivable by any terran creature. Both locales are made useable only through the advent of advanced aerospace technology.

Other Justifications for Keeping Stratospheric Platforms Out of Space Law

It has also been said that space law exists to help ensure the recovery of space objects, the receipt of compensation for damage caused by space objects, and the avoidance of territorial disputes in a non-terran expanse. However, each of these arguments apply just as well to stratospheric platforms. It is in all countries' interests to keep the stratosphere free of military encampments such as permanent flotillas of armed airships. It is in all countries' interests to provide for absolute liability in the case of damage or harm caused by a fallen airship, in accordance with the *International Convention on the Liability for Damage Caused by Space Objects*.[3] And it is in all countries interests to ensure that any airships that are downed outside the launching states' territorial borders be promptly returned.

It may also be observed that space objects are not subject to terran law because terran law cannot practically be enforced in space. Hence, there was little point to one country objecting to the orbital traversals of its sovereign domain – historically a conal section reaching downward to the center of the earth and projecting upward to the most distant heavens – by other countries' late 1950s era low-earth orbit satellites. What could be done about it? Then, as now, there is no reliable technology to shoot down objects in space.

This "limits of force dictates limits of law" justification also, however, does not logically support banning stratospheric platforms from the progressive corridors of space law. Only a handful of countries have the technology to prevent a stratospheric platform from residing 20 kilometers above land (at that altitude they are visible only at twilight via reflected light). And even those that might want to shoot a stratospheric airship down could be foiled via defensive and mobile maneuvers. Consequently, even "might makes right" does not justify differential legal regimes for stratospheric and non-stratospheric satellites.

Summary

There does not appear to be any logical reason to exclude stratospheric airships from the domain of space law. The exclusionary reasons offered are anachronistic, self-serving or inconsistent. In point of fact, the early Sputniks made a mockery of traditional "celestrial" notions of national sovereignty. To save face, a demarcation was tacitly acknowledged, although never enshrined in positive space law. This demarcation has variously been based on the round number of 100 kilometers, the lowest altitude at which earth-orbit can be maintain (until friction with air takes over), or *a priori* notions regarding how little air might exist before a toroidal sector is deemed "outer space" and not "airspace." It is now time for these face-saving airspace demarcation fantasies to be brushed aside. There is nothing magic about 100 kilometers or fractions of a unit percent of difference in air pressure. If an object can function like a satellite as a result of helium pressure instead of orbital mechanics, then it should be treated like a satellite. Law should be based on function and desired result, not happenstance coordinates.

The law of outer space has proven itself in creating a beneficial realm of human activity in which huge economic value has been created. Based on the advent of stratospheric platforms, it is now time to extend the range of space law down to the 20 kilometer regime above controlled airspace where the satellites of tomorrow will reside.

1. "Application of Hughes Communications Galaxy, Inc.," Before the United States Federal Communications Commission for Two Ka Band Domestic Fixed Communications Satellites, December 3, 1993, Page 40.

2. These frequencies were allocated to stratospheric platforms by the International Telecommuniation Union in 1997 at its World Administrative Radio Conference in Geneva, Switzerland.

3. M. Rothblatt, *International Liability of the United States for Space Shuttle Operations*, 13 International Lawyer 471 (1979).