Open Research Institute
Bruce Perens,
President
PO Box 8552
Berkeley, California, 94707-8552
bruce@perens.com

Before The
Federal Communications Commission
Washington, D.C. 20554

In the Matter of:	
Streamlining Licensing Procedures for Small Satellites	International Bureau Docket 18-86

Comment of Open Research Institute

8-July-2018

1 Our Organization

a) Open Research Institute is a non-profit organization which makes all of its work available to the public under Open Source licensing.

b) Among our research is:

- A transceiving digital communications system for space satellites based on the existing DVB and DVB-S standards. This system accomodates continent-wide communications by Radio Amateurs for emergency services, research and education, and casual communications, and is intended for other payloads than television broadcasting.
- A high-orbit small satellite program for use by Radio Amateurs, using our digital communications system.
- *Open Cars,* a research program on the possibility of open interfaces in future automobiles that would allow self-driving and telematics equipment to be purchased on the aftermarket, separate from the vehicle.

c) We are incorporated in California and registered as a charitable organization with the state. We are pursuing our application for federal 501(c)3 status with the IRS.

d) More information on us is available at https://OpenResearch.Institute/

2 The Rule As Proposed Pushes University Research Satellite Programs Into The Amateur Satellite Service Inappropriately, And Will Lead To Abuse Of The Amateur Satellite Service, And Subsequently Regulation Untenable To Radio Amateurs

a) Open Research Institute is a strong supporter of university research. Our objection to the potential for university encroachment upon the Amateur Satellite Service, which we see coming from the proposed regulations, *is not meant to oppose university satellite programs.* Rather, we wish FCC to provide them reasonable licensing costs (we like zero cost) and appropriate services in which they can be licensed.

2.1 Licensing Costs Will Be The Sole Reason For The Use Of The Amateur Satellite Service, Rather Than Another Service, By Universities

b) The proposed licensing costs will push university researchers to license their experimental satellites in the Amateur Satellite Service, simply because their budgets will not be able to sustain the licensing fees of any other service. This will tend to cause “gaming” of the Amateur Satellite Service rules by universities that do not presently make use of the Amateur Satellite Service for good reasons: their research programs are not compatible with it.

2.2 University Research Is Often Inappropriate For The Amateur Satellite Service

2.2.1 For-Profit Nature of University Research

c) University research is often carried out with pecuniary interest, even though the university itself may be incorporated as a non-profit. For example, universities often form research partnerships with for-profit companies, for reasons of financial support, to gain access to patented, trade-secret, and copyrighted intellectual property necessary for the research, or to enrich the university and possibly its researchers. Many universities have a significant income stream from patents which they license to commercial companies for a fee, or through lawsuits brought with the intent to force payment of royalties. Often university researchers are offered a reward or even a profit-sharing plan for filing patents.

d) These income streams are far enough separated from the purpose of “research” and “education” to cast doubt upon the non-profit nature of many universities. It is often the case that publicly-funded or non-profit institutions actually produce substantial private income.

e) The problem for the Amateur Satellite Service is that these institutions must somehow encrypt or obscure their telemetry, in order to protect the proprietary income from their research results. Information obscuration strategies are in conflict with the spirit of the Amateur Satellite Service and possibly the regulations as well.

f) Is the case today that many educational satellites licensed in the Amateur Satellite Service render no useful service to Radio Amateurs. In general, they will operate a known telemetry beacon which sends a callsign and some basic data about the operation of the satellite “bus”, not the experiments.

2.2.2 Secrecy and Intellectual Property Restrictions Are Inappropriate For The Amateur Satellite Service

a) The problem for the Amateur Satellite Service is that these institutions must somehow encrypt or obscure their telemetry, *simply to protect the researcher and university’s right to be the first to publish the research information collected by the satellite.*

b) Researchers have a pecuniary interest in priority of publication, because it effects whether their employment is continued and they are promoted, whether the institution grants them tenure, and whether they are offered positions in other institutions, and prestige for their work up to and including the Nobel Prize. The university is similarly motivated by the increased potential for grants, tuition, and partnerships that comes from priority in research publication and the recognition that great researchers work there.

c) There is also often motivation to protect potential proprietary income from research results.

d) Information obscuration strategies which support researcher priority and proprietary income are thus in conflict with the spirit of the Amateur Satellite Service and possibly the regulations as well, which restrict its use for pecuniary interest.

e) Is the case today that many educational satellites licensed in the Amateur Satellite Service *render no useful service to Radio Amateurs.* In general, they will operate a telemetry beacon on an announced frequency which sends a callsign and some basic data about the operation of the satellite “bus”, but not the experiments. The format and definition of experimental data used by satellites licensed in the Amateur Satellite Service is often not publicized. Amateurs may be able to receive and even decode the raw bytes, but are not granted the information necessary to understand their meaning.

2.3 This Will Lead To Abuse Of The Amateur Satellite Service

a) Continuation of high licensing fees, existing and proposed, for University satellite programs will force Universities to license through the Amateur Satellite Program. They will treat the Amateur Satellite Program as a

source of cheap licensing and frequencies, rather than anything to do with Radio Amateurs.

b) Their participation will tend to block true Amateur Satellite projects driven by Radio Amateurs, due to the potential for interference. Many low-earth-orbit satellites will use a finite number of frequencies which are also shared with terrestrial Amateur use, non-Amateur services in other nations, and frequency piracy such as the South American taxicab operations which are unintentionally re-transmitted by Amateur Satellites today. Universities will probably complain about terrestrial Amateur service and Amateur Satellite operations that interfere with their satellite operations. If they gain regulatory sympathy, this will force Radio Amateurs off of the air.

2.4 The Influx Of University Satellites Will Lead To Regulation That Is Unsistainable By Radio Amateurs

a) The encroachment of university satellite programs upon the Amateur Satellite Service shall lead to that service being administered as an exclusive domain of university research, rather than a service operated by Radio Amateurs. While universities complain about *their* expenses, their budgets are much larger than those of individual Radio Amateurs and Amateur Radio organizations. The Amateur Satellite service can not sustain any significant licensing expense.

b) Again, Open Research Institute doesn't object to university satellite programs. We simply desire FCC to provide them with reasonable licensing expenses and services where they can operate their satellites appropriately.

2.5 Conditions For University Use Of The Amateur Satellite Service That Will Protect The Service And Radio Amateurs

a) Appropriate and productive partnerships between university and governement researchers do exist, and should be allowed to continue.

b) Several recent projects have converted on-orbit satellites into Amateur Radio Repeaters upon the end of their research mission, thus providing a tangible benefit to Radio Amateurs. Most of these projects have also transferred control of the satellite to Amateur Radio operators and organizations.

c) Radio Amateur organizations have a higher success rate in their missions than university satellite programs. This is mostly due to experience: Amateurs have run a the longest-duration private space program, with their first launch in 1961 and over 90 satellites launched as hitch-hikers on other missions. And yet, this amazing program is largely unknown.

d) About half of university small-satellite missions fail. The main causes are inappropriate communications systems (often the 1980's AX.25 digital

communications over narrow-band FM) and poor hardware design choices. The success rate of Radio Amateur satellite programs is not perfect, but significantly higher than university programs.

e) Amateurs have designed better systems which universities can use in their satellite programs, such as the digital satellite modem designed by Phil Karn KA9Q. Karn's design is much more reliable than the communication systems often used, and can survive signal fades approaching one minute long without data loss.

f) Amateur Radio organizations, including ORI, are open to appropriate partnerships with universities, in which the Amateur organization provide an operating satellite, ground stations, and experienced operators; the university provides the experiments and the launch; and the satellite provides services to Radio Amateurs during or after the research mission.

3 Proposed Ground-to-Space Use Of ISM Bands May Interfere With The Amateur Satellite Service

g) There are proposals for ground-to-space communications to take place using the ISM bands, under the theory that such communications will be below the received noise level for local users of those bands for other purposes such as WiFi and other short-range communications. However, some of those frequencies are already authorized for *space* use in the Amateur Satellite Service, either in the United States or other nations, with currently-existing use by in-orbit satellites that is *not* protected from interference by new services. Where allocations overlap with the Amateur Satellite Service in the US or eleswhere, authorization of commercial ground-to-space communications on the same frequencies would cause interference to a licensed service.

4 Amateur Satellite Service Rules Regarding Paid Personnel Are Becoming Unworkable As Regulation Requires More Active Control of Satellites

4.1 FCC's Definition of *Pecuniary Interest* In The Amateur Satellite Service Regulations Is Over-Restrictive and Not Aligned With ITU or Other Nations

4.2 The Increased Requirements For Orbit Changes And Other Satellite Control Are Incompatible With A Volunteer Operating Staff

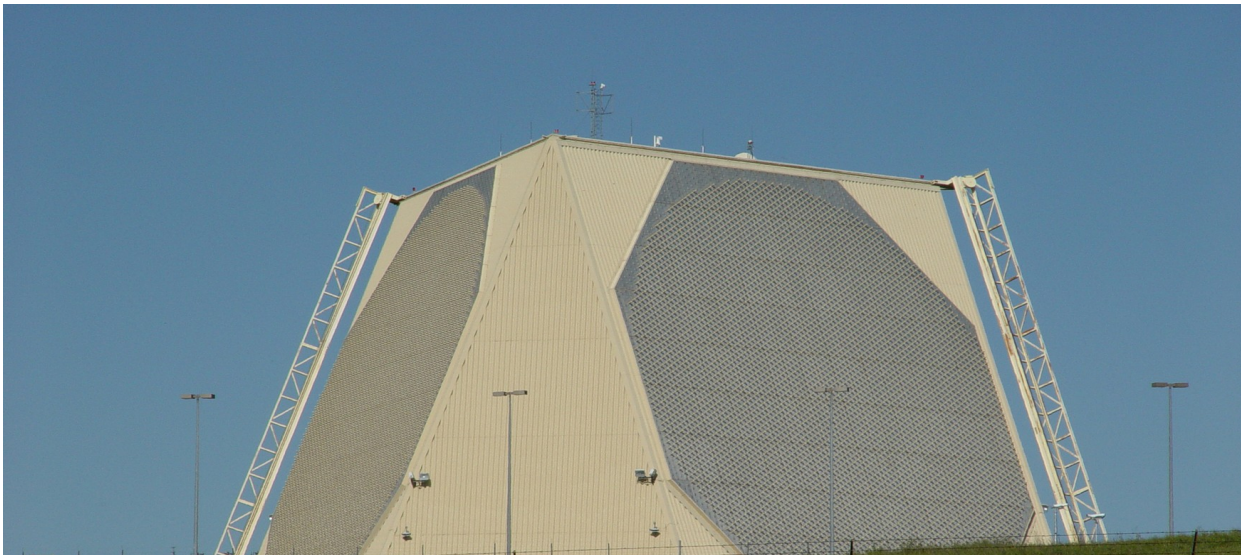
5 Minimum Allowable Size and Number of Small Satellites

5.1 Kessler Syndrome

h) We recognize the possiblity of the *Kessler Syndrome,* also referred to as colisional cascading or an ablation cascade, to render earth-orbital space unusable for generations. This must be avoided at all costs.

i) De-orbit requirements, limitation of the overall number of satellites, and control of permissible orbits and other parameters through the licensing process is justified in the name of avoiding that catastrophe.

5.2 Restrictions Serving National Defense and NORAD Continental Defense Purposes



a) We suspect that many of the commenters in this proceeding will not understand why the minimum size of satellites and the number of satellites authorized per license is limited.

b) However, there are excellent reasons that while NORAD can catalog *astonishingly* tiny debris, including what may be a *wire-tie* dropped by a spacewalking astronaut (1998-67NS [43498]), FCC must insist on a *much larger* minimum size for small satellites, and a limited number of satellites allowed under any one license.

c) For the security of North America, it is essential that foreign powers remain unaware of fine details of the capability of NORAD, the U.S., and Canada to track small or *un-reflective* objects in orbit. “Stealth” technology for reducing radar reflections allows larger objects to given the radar-reflective profiles of un-stealthed smaller ones. The minimum radar-reflective profile capable of being tracked by NORAD and its member nations must remain unknown, as should the number of very small objects that can be tracked without difficulty.

d) Thus, no object should be licensed for launch if its radar-reflective profile in any orientation is close – within a classified amount – to the minimum tracking capability of NORAD, the U.S., or Canada. As technical capabilities improve, the minimum licensable size should be reduced, however the size allowed must always be some classified amount larger than the actual minimum radar profile that can be reliably tracked.

e) Thin or flat objects, such as printed-circuit boards, are particularly problematic due to their un-reflective composition and their very small radar profile in an edge-on orientation. It can be expected that the minimum allowable size must be applied to the orientation of such an object which provides the smallest radar profile. The relatively un-reflective properties of non-metallic materials such as the fiberglass and resin used to make printed circuit boards complicate the licensure of “flying PCBs” which have no metallic enclosure. Licensing such objects by the actual amount of radar reflection may be possible, but would tend to reveal more about NORAD and national radar capabilities than is desirable.

f) In addition to the radar-reflective profile which can be readily tracked, we expect that there is a limitation on the *number of objects* of any particular size (radar-reflective profile) that can be readily tracked with equipment that is currently deployed and available to NORAD. This information is also vital to North America’s defense and must not become known to enemies.

g) We must consider a number of potential degradations of our space surveillance capabilities:

- The release of “chaff”, small and lightweight highly-reflective orbital debris that is intended to overwhelm the US and NORAD’s tracking capability.
- Deliberate jamming or unintentional interference such as a “stuck” satellite transmitter.
- Facility shutdown due to routine maintenance, mishap, or attack. For example, a 2017 Vandenberg Wildfire degraded the nation’s polar launch capability for months, and perhaps some classified facilities.

h) To cope with these possibilities, the US and NORAD must maintain a "reserve" of additional tracking capability greater than the amount of satellites licensed.

i) Thus, the number of satellites authorized overall, and the number of satellites within a particular range of radar-reflective profiles which are authorized, must be limited to significantly less than classified parameters determined by the military, where the parameters authorized are significantly lower than the actual military capabilities, in order to keep those capabilities secret.

j) The most effective way to enforce this limit is to limit the number of satellites authorized under any particular license, the total number of licenses, and the radar-reflective profiles authorized through the licensing process.

k) Thus, proposed authorization of constellations of *hundreds* of satellites under a single license may be unworkable at present from a national and continental defense perspective. Proposed authorization of "flying PCBs" and other objects with very low radar-reflective profiles in some orientations may be similarly unworkable at this time.

l) That said, ORI is interested in launching constellations of many very small satellites into LEO, where their orbits would decay to re-entry within a few years and they could not be expected to be a long-term collision hazard. Other organizations, commercial and non-profit, are similarly interested.

m) This may require an upgrade of military tracking capability, *which should be pursued by legislature and government in the interest of facilitating commercial utilization of space.*

n) We urge FCC to allow licensing of smaller satellites and larger constellations of them *as soon as this is possible within the constraints of national and North American defense.*

6 Planned On-Orbital Lifetimes

a) The 44-year-old Radio Amateur satellite *AO-7* is in current operation. On-orbit lifetimes of a single decade are *normal,* but should not be established as a limit for **high-orbit** satellites that are not a risk to ISS or other manned missions. The Amateur Satellite Service should be expected to operate long-lived high-orbit satellites, and this may also be true for some university missions as well. Thus, some high-orbit satellites should be exempted from requirements to de-orbit at the end of any *assumed* mission lifetime. The reality is that these satellites can, and *should,* be expected to be used until failure renders them uncontrollable. Satellite licensing regimes should probably include specifications of permissible orbits for such operation.