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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, Open Data, and Open Publication licensing. We thus have no secrets. Everyone worldwide may use our work under liberal licensing terms, without any royalty or fee.

b) Among our research is:

- A transceiving digital communications system for space satellites based on the existing DVB and DVB-S standards. This system is intended to eventually implement a continent-wide digital communications network for Radio Amateurs, supported by a geosynchronous satellite. We expect this system to be used for emergency services, research and education, and casual communications. Unlike the original DVB and DVB-S systems, it is intended to be used mainly for other communications payloads than television broadcasting. Two-way digital voice and textual communications are expected to be common modes.
- 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, operating not-for-profit, and registered as a California charitable organization. We are pursuing our application for federal 501(c)3 tax-deductible status with the IRS.

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

2 The Rules As Proposed Push University Research Satellite Programs Into The Amateur Satellite Service Inappropriately, And Will Lead To Abuse Of The Amateur Satellite Service, And Subsequently To 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 university satellite programs with reasonable licensing costs (we like zero cost) and appropriate services other than the Amateur Satellite Service 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

a) 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.

b) 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

a) University research is often carried out with pecuniary interest, even though the university itself may be incorporated as a non-profit.

b) 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.

c) 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 some 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.

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

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

b) Trade-secret protection strategies for satellite downlink data carried on the Amateur Satellite Service, which support researcher priority and proprietary income, are in conflict with the spirit of the Amateur Satellite Service and, in the case of encryption, the letter of the regulations as well.

c) 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.

d) 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.

e) There is also often motivation to protect potential proprietary income from research results, such as that which may come from patent licensing, or by implementation of research results in a product by a commercial partner.

f) Is the case today that many educational and research 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 or even deliberately obscured. 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 Service. They will treat the Amateur Satellite Service only as a

source of cheap licensing and usable radio 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 Service 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 Unsustainable By Radio Amateurs

a) The encroachment of university satellite programs upon the Amateur Satellite Service shall lead to that service being administered as a domain of university research, rather than a service operated by Radio Amateurs.

b) 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 or regulatory expense. Thus, if the Amateur Satellite Service comes to be regulated as a university service, this will drive Radio Amateurs out of participation.

c) 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 government researchers with Radio Amateurs and Amateur Radio organizations do exist, and should be allowed to continue.

b) Several recent government or university 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 since then, 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 an inappropriate choice of communication system (often the 1980's AX.25 digital communications over narrow-band FM) and poor hardware component choices for space operation. The success rate of Radio Amateur satellite programs is not perfect, but is significantly higher than university programs. One important factor is continuity of the researchers. Researchers go on to other projects and students graduate and move on, while engineers often remain assoicated with Amateur Radio organizations for a lifetime.

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 AX.25-over-narrow-band-FM communication systems often used by university satellite programs. It provides processing gain to facilitate a robust link power budget, and can survive signal fades approaching one minute long without data loss.

f) Amateur Radio organizations, including Open Research Institute, are open to appropriate partnerships with universities. In such a partnership, the Amateur organization might provide an operating satellite, ground stations, expertise, and experienced operators; the university could provide the experiments and the launch; and the satellite would be designed to provide 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

a) 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

a) The understanding of the prohibition on pecuniary interest within the Amateur Satellite Service held by ITU staff and committees, and by concerned parties in most nations, is that pecuniary interest consists of:
   - A financial interest in the content of the communication.
   - Monetary compensation directly for the task of acting as license grantee or control operator.

b) In contrast, FCC applies a much more strict definition, which prohibits being the license grantee or control operator as part of one's employment as a full-time paid researcher or full-time staff of a university.

c) Aligning FCC's definition of pecuniary interest with ITU and the rest of the world would help many university satellite programs, but would be insufficient to help with the challenges now facing Radio Amateurs.

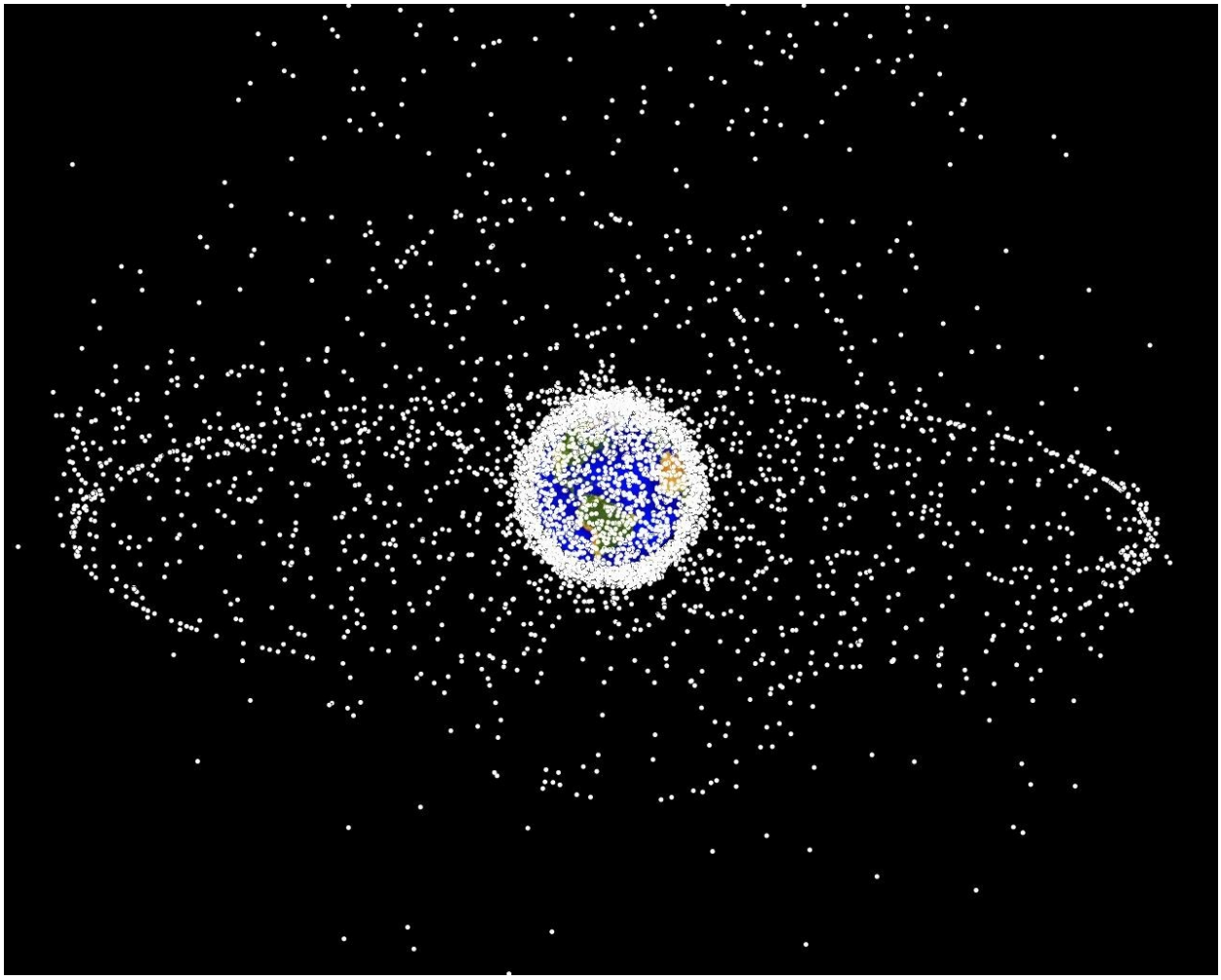
4.2 The Increased Requirements For Orbit Changes, Transmitter Control, And Other Satellite Control Are Incompatible With A Volunteer Operating Staff

a) To satisfy modern requirements upon orbital satellites, it appears that Radio Amateurs will be asked to be available on short notice to command a small satellite to perform orbital adjustments in order to avoid the chance of a collission, to be able to cut off the transmitters, and to be able to cut off remote sensing instruments which might provide imaging of war zones or other sensitive locations.

b) **The instant availability required is a lot to ask of unpaid volunteers.** For this reason, Open Research Institute recommends that the rules for the Amateur Satellite Service allow the employment of operators, just as rules for the terrestrial Amateur Service now allow some participation in emergency communications communications drills by paid employees. The restriction on pecuniary interest should still prohibit a financial interest by the operator and their employer in the data received from the satellite.

5 Minimum Allowable Size and Number of Small Satellites

5.1 Kessler Syndrome



An illustration of satellites currently orbiting the Earth, greatly enlarged for clarity. Public-domain image.

a) 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.

b) De-orbit requirements, requirements for orbital adjustment upon notification, limitation of the overall number of satellites, and control of permissible orbits and other parameters through the licensing process *are justified* in the name of avoiding that catastrophe.

5.2 Restrictions Serving National Defense and NORAD Continental Defense Purposes

A space surveilance radar at Beale Air Force Base, Northern California. Public-domain image.

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 must be 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, including spy satellites and missiles, to be 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. 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. It is theorized that PCB traces on such objects may act as dipole antennas at particular frequencies and in particular orientations, but in general these objects have low reflection in some edge-on orientations. The minimum allowable size of an authorized satellite must be applied to the orientation which provides the *smallest* radar profile. 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 size of 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* 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 their tracking capability and mask the presence of threatening objects.
- 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 Air Force Base wildfire degraded the nation’s polar launch capability for months, and probably some classified facilities.

h) To cope with these possibilities, the US, Canada 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 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, Open Research Institute 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 capabilities, which should be pursued by the 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.

b) Alternatives to de-orbit schemes for high-orbit satellites should be authorized, such as transfer to a “graveyard” orbit like the one currently used for spent geostationary satellites, transfer to lunar and solar orbits, lunar or solar impact.