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EXISTING ELEMENTS OF TRAFFIC MANAGEMENT IN THE FIELD OF TELECOMMUNICATIONS

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Abstract:

The use of the frequency spectrum by satellite services has exploded within the last ten years, forcing the ITU to adapt itself to a rapidly evolving environment. Space traffic management is primarily concerned by radio frequency utilization rules that aim at allowing sound communications between satellite operators. Technology innovation for both geostationary and low earth orbits satellite systems is strong and leads towards a profound renovating process of ITU radio regulations. While still being framed by rules that have mostly been crafted before the progressive world radio conferences of the second half of the 1990s, an evolutionary process seems to be initiated to accommodate new services within the fragile outer space environment in order to allow for their being used for the benefit of all.

Introduction

Telecommunications traffic rules as they exist now with reference to the geostationary orbit (GSO) and to the low earth orbits (LEOs) are different because of the fact that the GSO provided satellite system operators with the physical advantage to place a satellite in an apparent stationary position in relation to the Earth. As a consequence, being more easily operational than the other orbits, they have been utilized almost since the beginning of the commercial space adventure for telecommunications and television services, while LEOs have only been utilized since the mid-1980s for commercial remote sensing services and since the mid-1990s for mobile satellite services. Both sets of rules are in the process of being revised for different reasons in order to continue offering a rational and efficient utilization of the frequency spectrum. GSO telecommunication rules are threatened by the clogging of satellites on a limited number of available orbit slots, while rules for the low earth orbits are not elaborate enough to accommodate the heavy

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utilization of LEO systems in a close future. We will therefore successively address (i) traffic rules for the GSO, (ii) traffic rules for the LEOs and, (iii) the present evolutionary for both sets of rules.

I – Telecommunication traffic rules for the geostationary orbit

Telecommunications rules are set by the ITU and have been in use as to satellite operations for the last three decades. Two situations should be considered, the one of the allocation of frequencies before the project is under elaboration, and the situation when the satellite(s) is (are) in orbit. To sum up the whole procedure in one sentence, we can say that existing telecommunications traffic rules are centred around the use of a limited dual resource: the radio frequency-orbital slot (RF-OS) resource. The specific identification of orbital slots on the GSO makes the RF-OS a very unique resource in the sense that for one orbital position, there are several radio frequencies that can be used, but since there is only one available orbital position, there is a bottleneck effect on that orbital position, which resembles to an inverted triangle resting on one of its head (the orbital position) while the available frequencies lie on top of it. Hence the need to coordinate the use of those frequencies because they correspond to different services that can be used by different satellite operators, while there is only one orbital position available.

For the sake of the reader, let us first recall the role of the ITU and, second, its legal consequences offering suggestions for possible changes in the future.

1.1. The role of ITU as a coordinator

Contrary to a largely spread opinion, ITU is the oldest specialized agency of the United Nations and acts not as a regulator but as a coordinator. The whole ITU coordination procedure is a consequence of Article 44 of its Constitution that requires a use of radio-frequency spectrum and orbit that is *rational*, *efficient* and *economical*, together with *equitable access*, while Member States retain jurisdiction on the objects they launch into Outer Space. ITU principles incorporate two basic principles, which rule the use of radio communications in Outer Space by Member States, which have ratified the various space treaties and conventions:

(i) Direct and absolute state responsibility backs any activity that one of its registered nationals may conduct in outer space (Liability Convention, Art. VI).

(ii) The Member State itself must fill-in a registration procedure in order to place a satellite on the geostationary orbit (Registration Convention, Art. II).

ITU's role is directly played towards Member States or international institutions whose members are also members of ITU, and not towards corporate operators. Member States must follow several steps, knowing that, it is the "*first come, first served*" rule which applies in the distribution of slots on the geostationary orbit. And since it is a limited resource and there is no priority privilege granted to anyone, this rule becomes a *de facto*

rule, which gives an advantage to those nations that have the capacity to place a satellite on orbit or to have it being placed by somebody else. Advance notification and registration by the Radio Regulations Board is requested in order to identify possible incompatibilities. The Board then examines (i) the conformity of the demand with the ITU Convention, (ii) the conformity with the Table of frequency allocation, (iii) the conformity with the procedure of pre-notification, and (iv) the probability of harmful interference. When the national administration has accepted the notified orbital position and frequency, it is recorded in the Master Register. It should be noted here that an assignment which would not conform to the Convention could still be used and be recorded in the Master Registry, provided that it does not provide interference.[2] There is a possibility of legal loophole here, since the responsibility of the operating plan of the system lies with the operator of such system and, in last resort, with the state of registration.

Three main different tasks are shared by three different actors: the Radio Regulations Board (RRB) controls the "*allocation*" procedure, ITU conferences control the "*allotment*" procedure, while national administrations control the "*assignment*" procedure.[3] It follows that the RRB implements the frequency assignments that have been decided by the Member States after specific frequencies have been allotted by ITU conferences.

The purpose of these procedures is to let the RRB organize an orderly recording of frequencies which have been allotted to specific uses by international conferences. States themselves, whether or not they are members of ITU and are within the orbital position they have been allotted, assign specific frequencies to those of their national operators which have presented a request, the technical characteristics of which correspond to the general allotment parameters which have been identified for all states.

In case interference should occur during time, in the use of radio communications, interfering stations must, upon receipt of advice, immediately eliminate the harmful interference. Every user has a right of international protection against harmful interference when using the GSO, provided (i) it has an assigned orbital position and (ii) this position has an allocated radio frequency.

A national administration may suspend the use of any of its recorded frequencies or orbital positions during 18 months, provided it informs the RRB. If the suspension was to last for a longer period, say more than six months, the assignment would no longer be protected and could be reassigned to some other operator. The Board may also cancel or

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[2] For satellite radio-broadcasts, it is an "*a priori*" procedure which is used, which implies a fairly rigid plan and freezes the orbital slot and the technical characteristics once they are identified.

[3] Excerpts from: *ITU Radio Regulations*, volume 1, chapter 1, section II: Specific terms related to frequency management:
2.1: *ALLOCATION* (of a frequency band): Entry in the Table of Frequency Allocations of a given frequency band for the purpose of its use by one or more terrestrial or space radiocommunication services or the radio astronomy service under specified conditions ...
2.2: *ALLOTMENT* (of a radio frequency or radio frequency channel): Entry of a designated frequency channel in an agreed plan, adopted by a component conference, for use by one or more administrations for a terrestrial or space radiocommunication service in one or more identified countries or geographical areas and under specified conditions.
2.3: *ASSIGNMENT* (of a radio frequency or radio frequency channel): Authorisation given by an administration for a radio station to use a radio frequency or radio frequency channel under specified conditions.

modify a recorded assignment, if the use of the frequency or of the position was not in conformity with the Convention and after having consulted with the national administration, since the use of frequencies on the GSO is derived from a right of access (even perpetually) and not from ownership. One country may allow another country to use its allotted positions provided that an agreement with respect to Convention obligations is signed by the receiving nation. The registered nation may replace a dead satellite and may have more allotted slots than it has satellites.

These rules conceal an important flaw: they are *de facto* directed towards the use of the geostationary orbit, i.e. the only orbit where one can precisely assign orbital positions. Consequently, with regard to low Earth orbits satellite systems, the international community, i.e. the ITU, only has the harmless interference rule at its disposal in order to discipline the arrival of the LEO constellations of satellites and impose a code of satellite circulation.

1.2. Legal consequences of the use of the frequency spectrum by outer space systems

On the GSO, ITU rules are fairly well established and have only been slightly altered by recent conferences.[4]

1.2.1. A right to "use" and not to "own"

This is a direct consequence of space law principles: the recording of an assigned orbital position does not confer national property rights, whether those rights have been granted on a "first-come, first-served" basis, or on an "a priori" plan.

1.2.2. A right to use perpetually

The general rule is that the notifying country is allowed continuous use without a time limitation. However, in the "a priori" plan, the procedure is designed to meet the requirements of the concerned country for specified periods of time.

1.2.3. A right to barter a GSO slot

This right does not officially exist, since the right to use a particular orbital position/radio frequency is non transferable. This right is the *de facto* consequence of the established "a priori" procedure which opens the way for adjacent countries to exchange allotments in situations when the proposed modification or inclusion of a new frequency assignment could affect the nearby allotments.

1.2.4. A right to replace a dead satellite

The protection of assigned frequencies against harmful interference requires that any change be notified with regard to an assignment which has been recorded in the Master Registry. What is at stake here in terms of identification is the name of the space object and the effective use of the frequency. In practical terms, nothing prevents a nation from

[4] For a more in depth study, please see Ram Jakhu, *International Regulations of Satellite Communications*, pages 78-101, in: Legal Aspects of Space Commercialization, Edited by K. Tatsuzawa, CSP Japan, 1992. Professor Francis Lyall of the University of Aberdeen is also a regular commentator on ITU issues.

simply replacing an expired satellite with an identical one which carries the same technical characteristics. This leads to consider that the "temporary" use of frequencies translates itself into a *de facto* permanent or even quasi-appropriation of the orbital/frequency position.

1.2.5. A right to more recorded assignments than satellites

The reasons why such situation may occur for a nation, could come from the need to hoard positions for future use or to make the best use of available satellites in providing service wherever and whenever needed. This led to the "paper satellite" controversy that was raised in the early 1990s and showed the limit of the regulatory procedure.

II – Traffic rules for non-GSO orbits

For non-GSO orbits there is a regulatory vacuum if we want to be exhaustive in the expectation of a complete set of rules as those which do exist for the GSO. Actually, the vacuum is not total since space systems are constrained by the interference-free obligation which emanates from Article IX of the 1967 OST.[5] When we say "obligation", this is not true since consultation should occur in relation with the activity causing the interference. Beyond what we would qualify as being a quasi-obligation, the assignment of positions is totally free. Moreover, the recording of orbital parameters required by Article IV of the 1976 Registration Convention may reveal itself to be incomplete or may lack precision in case of large size satellite constellations.[6] When we think of large projects that were much heralded not long ago, we easily can imagine the complexity of management and maintenance difficulties such fleets will create and how easily it can turn into a technical (and legal) nightmare for both the owner and other satellite system operators.

III – Traffic rules for LEO systems

When considering the making of ITU Radio Regulations, it appears that the mindset of the redactors did not anticipate the fantastic development of satellite communications. Even with "standard" GSO-dedicated World Radio Conferences, it is only recently that the international community became conscious of the soon-to-come *de facto* extremely massive utilization of near-Earth outer space, i.e. the LEO area in the close vicinity of the Earth.

Apart from standard regulations concerning the use of radio frequencies and until WRC-

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[5] Article IX of the 1967 Outer Space Treaty (extract) : « ... A State Party to the Treaty which has reason to believe that an activity or experiment planned by another State Party in outer space ... would cause potentially harmful interference with activities in the peaceful exploration and use of outer space ... may request consultation concerning the activity or experiment ».

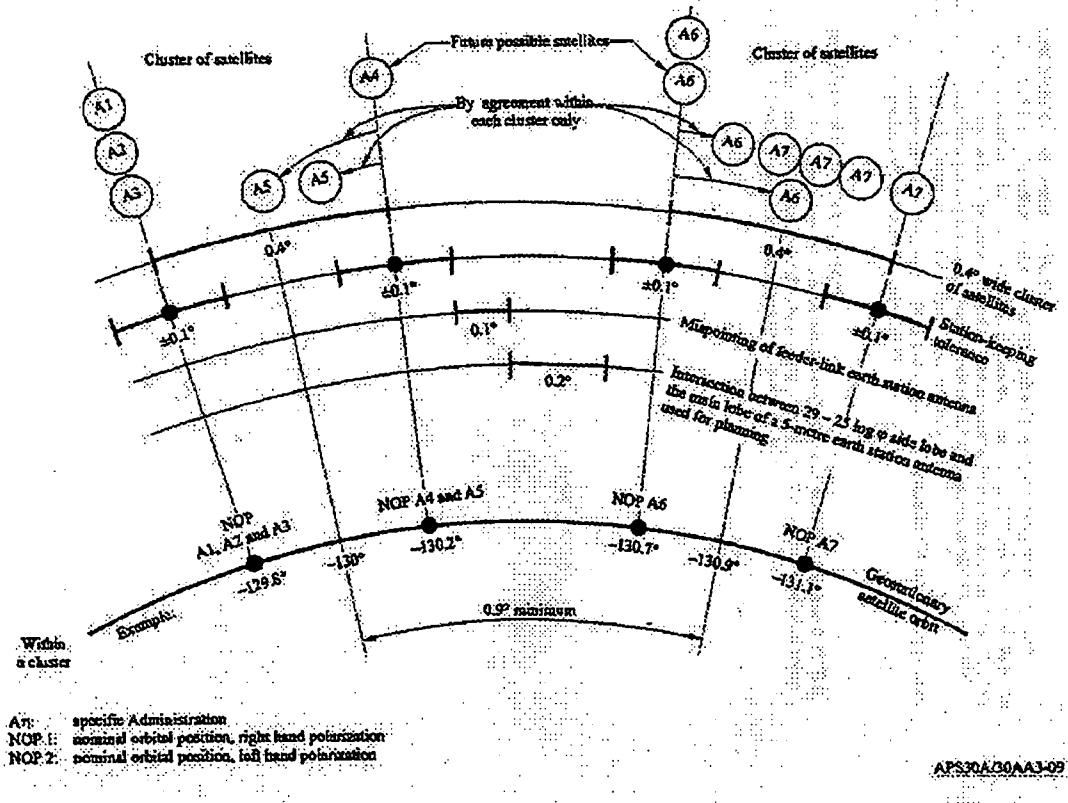
[6] Article IV of the 1976 Registration Convention (extract) : « 1. Each State of registry shall furnish to the Secretary-General of the United Nations, as soon as practicable, the following information concerning each space object carried on its registry : .(a) Name of launching State or States ; (b) An appropriate designator of the space object or its registration number ; (c) Date and territory or location of launch ; (d) Basic orbital parameters, including : (i) Nodal period, (ii) Inclination, (iii) Apogee, and (iv) Perigee ; (e) General function of the space object ...

3. Each State of registry shall notify the Secretary-General of the United Nations, to the greatest extent feasible and as soon as practicable, of space objects concerning which it has previously transmitted information, and which have been but no longer are in earth orbit ».

95, there were no specific ITU regulations for the use of non-GSO orbit locations. Even now, the use of non-GSO orbits is not really addressed, since ITU only focuses on the use of specific radio frequencies which will be used by these systems. So far, multi-million $ non-GSO satellite systems are concerned by ITU regulations only to the extent that they use radio frequencies, just like any individual or isolated amateur radio.

In the end, the only constraint that does exist emanates from the ITU Radio Regulations as it is illustrated by the diagram of the exploded view of the location of several satellites on closely located orbital spots, which appears on the following page. But this is only of concern to geostationary satellites. No such constraints exist for LEO satellites, for the simple reason they are in motion relative to one another, while GSO satellites are fixed relative to one another. At that stage, engineers have to tell us what is feasible and what is not in terms of assigning specific LEO locations (meaning "orbit plans" within which the satellites are moving) and their available spectrum frequencies for which only the non-interference rule exist, in association with the implied non-physical assault (collision) rule that always exist in a legal environment, because of the legal pursuits that it would trigger.

FIGURE 9
Exploded view of geostationary satellite orbit



IV – The evolution of the present system for both the GSO and the LEOs

Evolution is now engineered into the ITU regulatory process that will impact on both GSO and LEO system operators in their handling of the radio frequency spectrum. It is of concern to GSO systems because of the limited accommodation capacity of the GSO, and to LEO systems because of the non-regulated dimension of these orbits apart from the non-interference obligation and the general care duty that emanates from international obligations, mostly from the Outer Space treaty.

Different resolutions have been adopted by previous World Radiocommunication Conferences (WRC), timidly starting with WARC-95 until the last WRC-2000 held in Istanbul. They illustrate technical solutions that are ventured in order to face potential difficulties in the utilization of radio frequencies by an increasing number of space stations and platforms of all types on both types of orbits.

First, we may consider that increased harmful effects could be created as a consequence of the backlog in satellite filings at the ITU. This may simply result from the acceleration of the filing procedure by the ITU, considering that current efforts to solve this backlog issue may be shortened for the sake of being pragmatic (i.e. leaving the registering State assuming the consequences of licensing a "careless" satellite project that would be authorized without due supervision). Oddly enough, we may think that this backlog has a positive side-effect in slowing the access of new satellite systems into Outer Space by means of lack of proper registration. But this is done under the responsibility of the registering state.

Second, additional spectrum seems to be the immediate and only solution in order to accommodate new users of the spectrum. For a non-engineer it seems as simple as that, we may certainly envision constraints with regards to this perspective, because the use of spectrum may not be extendable to the infinite.

Third, the view of developing countries should also be taken into consideration. The re-planning of specific services (BSS) in Regions 1 and 3 has been agreed at WRC-2000, which will lead to a review of power limits during WRC-2003. This is concurrent to the principle of equity of access to spectrum that may border the expansion of satellite systems by developed countries.

Fourth, WRC-2000 tried to balance the sharing of constraints between GSO and non-GSO systems. We have here a wealth of new services such as high speed Internet, corporate intra/extranets, e-commerce, videoconferencing and other interactive services that are planned to be offered by means of satellites. Such constraints also aim at protecting terrestrial uses that operate in the same frequency bands.

Fifth, newly engineered projects, such as High Density Systems, have been allocated specific frequencies and protected by power limits from other systems. We are here at the vanguard of these new services that may benefit very much to developing countries. Other services that we already know, such as High Altitude Platform Stations, Earth

Exploration Services and Radioastronomy Service, have also benefited from new allocations of spectrum.

Sixth, allocations have also been made to the promising and front-guard radionavigation systems in order to allow for the expansion of the existing services like the GPS and GLONASS, while allowing for the coming of Galileo that has just been officially approved by European authorities.

Quite obviously, mentioning these new approaches is not enough, engineers have to tell us about their technical feasibility and how far they allow for their compatibility with other services and systems.

Conclusion

Space Telecommunications are the ultimate frontier of standard telecommunications that we all know on earth, which are so important to socio-economic development. The most recent UN Report on Human Development has stressed the positive impact of high technology exports for developing countries in their development. So far, it appears that the evolution of the rational and efficient use of the frequency spectrum inevitably leads to the additional allocation of new frequency bands for new types of services and networks. Economic interests are huge, they are worth billions of dollars for those who engineer those systems, as well as for those who operate them, and also to those who benefit from them as users. This translates into offering and having access to new services that did not exist before or to services that did exist before but at a higher price. WRC-2003 will be a new milestone in this evolution towards a increased use of the frequency spectrum by satellite systems for the betterment of mankind.

However, before ending this brief presentation, we must bring a slightly minoring tone to our reasonable optimism. A very strong commercialization trend has been developed since the mid-1990s, whereby space powers are increasingly considering that national security considerations coupled with self-imposed budget constraints justify the dual use of commercial satellites for both private and public strategic purposes. In parallel, commercial satellites serving sole private business purposes that represent financial assets in large amounts are increasingly considered to be exposed to all sorts of malfunctions, if not to straightforward intentional destruction by adverse interests. This raises the topic of space warfare that will increase in importance in the coming years. Radiocommunications are extremely vulnerable to warfare, whether traditional or high technology, for the simple reason that telecommunications have historically always been a strategic instrument, and it will remain so in the future.

The vulnerability of Outer Space as an environment has been recognized since the beginning of the space adventure and this recognition should, and must, allow for a different approach of space matters so that they are not dragged into earthly-considerations. Some space analysts and practitioners already say that Outer Space is a mere extension of the air space that States control with their sovereign rights when their

strategic needs are threatened, very similar to the right of "hot pursuit" in standard public international law. In our opinion, this is the ground on which the debate will inevitably relocate in the next years. This will prevail on the standard discussions on the sharing of frequency spectrum by various services, especially because huge financial interests are at stake. More than the sharing of radio frequencies, the debate will concentrate on the sharing or lack of sharing of benefits to be returned from an extensive utilization of the frequency spectrum, yet, a natural resource that belongs to all.