Regulatory Factors Affecting the Efficient Use of the Orbit/Spectrum Resource

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1. Introduction

How should "efficient use" be defined? One objective function for "efficient use" for a given service area for a GSO network could be given by the objective function:

Number of Mbps/degree of orbital arc

Obviously, if the network uses satellite earth station antennas with large diameter (say, 3m or more) then the frequencies could be re-used at closer orbital spacings enabling more satellites per degree of orbital arc to maximize the objective function. This objective function obviously misses a very important consideration and that is the utility (or usefulness) of the service.

Utility of a Satellite Radiocommunication Service

The utility can be more easily qualified than quantified. If satellite connectivity is the only connectivity available then the service has a very high utility. If the satellite can provide cost-effective DTH TV with a large choice of TV channels with an excellent quality, then that service also has a very high utility. Therefore, the utility of the service will depend on the user.

The higher the utility the more the user is willing to pay for the service. Another factor to take into account is the cost of competitive terrestrial services (if available). To receive DTH TV the receiving antenna should be of a reasonable diameter (usually less than 1m) in order to keep costs down. The smaller the DTH TV antenna the higher the utility. Smaller diameter antennas decrease the efficiency as defined by the objective function above. Therefore, increasing the utility may decrease the efficiency as defined by our objective function.

Technical Factors that Maximize the Objective Function

Earth station antenna size

The smaller the earth station antenna diameter the broader the main beam of the antenna and the more orbital separation is required for adjacent satellites to provide co-coverage, co-frequency service. Therefore, large diameter earth station antennas increase the efficiency as defined by the above objective function.

Homogeneity of adjacent satellite parameters

A certain minimum power from the satellite is required to close the link. To overcome the rain fade at higher frequencies additional power is needed. Since the C/I is directly proportional to the difference in EIRP of the adjacent satellites, the chances of interference will be higher the larger the EIRP differences. This principle applies on both the downlink and uplink. This means, that, all other thing being equal, the satellites will need greater orbital separation. Therefore, to maximize the objective function, the satellite parameters should be homogeneous i.e. similar powers on the downlink and similar sensitivities on the uplink.

Spot beams
The use of spot beams is a very effective way of maximizing the objective function. This is due to the re-use of the spectrum across the service area. The same frequency is re-used one or two beams away. This requires large on-orbit satellite antennas but the technology is mature and has been deployed with commercial success in L-, Ku- and Ka-bands.

Modulation
New satellite transmission protocols such as DVB-S2 have achieved great efficiency approaching the Shannon limit, which is the theoretical limit of the maximum amount of information that can be transmitted through a communication channel.

Satellite orbits
The non-GSO orbits such as the scheme originally promoted by SkyBridge enable frequency re-use outside an exclusion zone around the GSO. In the case of the Ku-band this exclusion zone is about +/- 10 degrees around the GSO. Such use represents a very efficient use of the orbit/spectrum resource. Other schemes, such as quasi-GSO networks also represent a re-use of the frequencies used by GSO networks but again away from the GSO. For the purpose of the ITU Radio Regulations, quasi-GSO networks fall into the general class of non-GSO networks.

In summary, the above quick survey of some of the technical aspects of satellite communications shows that much work has been done on these technical aspects to improve the efficiency (as measured by, for example, the number of Mbps/degree of orbital arc). However, the concept of utility is an important consideration. The utility can be different depending on the user of the satellite services. For example, to the consumer, being able to receive a satellite service at a reasonable cost using an earth station with a small diameter antenna has high utility. **Therefore, in addressing the problem of the efficient use of the orbit/spectrum resource both the technical efficiency as well as the utility of the satellite service provided must be considered. In the case of consumer satellite services, maximizing the efficiency as given by Mbps/degree of orbital arc and maximizing the utility to the consumer are conflicting objectives.**

This paper will not address technical factors but only regulatory issues that affect the efficient use of the orbit/spectrum resource. In particular, the paper will address issues that arise because of the present version of the ITU Radio Regulations and its associated Rules of Procedure (or lack of RoP). The following issues will be addressed:

a) Old Assignments in the Master Register
b) Resolution 49
c) lack of regulatory status of monitored data from satellite networks
d) “bringing into use” of assignments using on-orbit satellites
e) suspension of assignments
f) overfiling

The biggest impediment to any significant changes in the Radio Regulations that could remedy the difficulties detailed below is the reluctance of administrations to relinquish their sovereign rights and to transfer this right to a third party. Therefore, it is likely that the status quo will prevail.

2. Old Assignments in the Master Register

The three stages of coordinating a satellite network are i) advance publication, ii) coordination, and iii) notification and registration. Once assignments have been notified and entered into the Master Register and "definitively" brought into use then they must be protected and will remain in the Master Register for the "period of validity" of the network. This "period of validity" is generally taken to be the lifetime of the satellite although some administrations have submitted "periods of validity" as long as 50 years. Using Resolution **4** the assignments can be renewed with the same technical characteristics for a new "period of validity".

The process of achieving "definitive" notification is long and difficult. Once this has been achieved there is no incentive to delete assignments. Even though No. **11.49** states that assignments no longer in use "shall" (i.e. must) be suspended this is almost never done (see Section 6). Therefore, there are many assignments in the Master Register that are no longer in use. These assignments may at one time have been in use on older satellites which have since reached the end of life and for which no replacement satellite was launched. Also, before WRC-2000, the "bringing into use" of the first assignment of a satellite network allowed the remainder of the assignments to be entered "definitively" into the Master Register. Therefore, some of these old assignments in the Master Register may never have been brought into use.

There have been many efforts by earlier WRC's to clean out the Master Register but these efforts have always been blunted. One such effort was Resolution **49**. Instead of asking what frequency assignments have been brought into use it asks what frequency bands have been brought into use. This procedure is of course open to abuse. One reason that it has been difficult to clean out the Master Register of old assignments is that the administrations with many old assignments have resisted this effort. The result is that it is more difficult for a satellite operator to coordinate capacity for a new satellite.

One way to identify old assignments would be to compare the information in the Master Register with monitored information. (See Section 4.) However, it should be remembered that most satellites operate with a relatively low fill factor (say, up to 60% - 80%). In spite of this, monitoring should at least show some activity for a given satellite at a given orbital location.

3. Resolution 49

An administration can submit notification information no earlier than 3 years before the projected "date of bringing into use" of the assignments. Six months before the expiry date of a satellite network the BR will ask for the notification and Resolution **49** information for the assignments of that network.

Resolution **49** information is the so-called "due diligence" information which includes such information as the satellite manufacturer, delivery date of satellite, launch provider and launch date, etc. The intent is to show that the satellite network is "real" and not just a paper filing meant to warehouse orbital capacity. In the case of the use of an on-orbit satellite to "bring into use" frequency assignments, such information can easily be provided since the satellite to be used is "real" and has been launched. In spite of the detailed information requested some administrations have submitted Resolution **49** information for a "paper" network. One indicator of this is when the satellite name is the network name i.e. there is no commercial name since there is no "real" satellite. In the past the Bureau took information submitted by administrations at face value. Recently, the Bureau has started to question suspect information and has recently deleted some networks. An administration may file an objection with the Radio Regulations Board (RRB) and the RRB may request more information from the administration. In this case, it becomes more difficult to insist that the satellite is "real". An administration not happy with either a Bureau or RRB decision may take its case to the next WRC.

In some cases, administrations claim networks to have been brought into use where monitoring information will show that no satellite was launched into that location or even if a satellite was drifted into the location, no payload was turned on. However, monitored information has no regulatory status. (See Section 4.)

4. Lack of Regulatory Status of Monitored Data from Satellite Networks

Articles **9** and **11** that govern the advance publication, coordination and notification of satellite networks do not make reference to monitored information for satellite networks. Therefore monitored information has no regulatory status. The BR takes the word of an administration as to whether or not assignments have been brought into use.

However, some administrations have recognized the value of reliable monitored data, not to determine whether a satellite network has been brought into use but to investigate interference complaints. For example, in 2003, the 6 countries of Germany, France, UK, Switzerland, The Netherlands and Spain signed an MoU establishing a space monitoring station at Leeheim, Germany.

It is certainly possible to identify old assignments in the Master Register by comparing all assignments in the Master Register with monitored data. Also, NATO information on the orbital location of GSO satellites could be taken into account. However, very few administrations would agree to such an exercise and therefore there is no great hope that old assignments will be cleaned from the Master Register through monitoring.

Although monitored information has no regulatory status it may be useful in the case of a dispute that has gone to the RRB. The RRB can ask for additional information and if there is no operating satellite at a given location it is difficult for the administration to insist on the contrary. Therefore, the administration may have to suspend the assignments in dispute. This gives the administration two years in which to again “bring into use” the assignments. (See Section 6.)

5. Bringing into Use of Assignments Using On-Orbit Satellites

It has become standard practice to use an existing on-orbit satellite to "bring into use" assignments of a filing whose assignments are about to expire. This practice is especially useful in the case of extended delays so that the satellite cannot be launched within the 7-year lifetime of the satellite network. This practice can be abused and raises some questions:

a) Can any on-orbit satellite be used?
b) To what extent should the technical characteristics of such a satellite reflect the filed characteristics of the network whose assignments are being brought into use?
c) How long should the satellite be left in location?

There is an earlier decision by the RRB that partially answers questions a) and b). In the mid-1990's Eutelsat wanted to develop the 29°E orbital location. It performed the in-orbit-tests of its new satellites constructed for 13°E at 29°E before moving the new satellite to 13°E. At the same time, SES wanted to develop the 28.2°E orbital location. SES lodged a complaint with the RRB. The RRB ruled that the Eutelsat procedure did not constitute "bringing into use" of the assignments of a network filing at the location at which the new satellite was tested. The RRB also recommended that the "date of bringing into use" (as defined in **AP4**) be revised by WRC-2000. Accordingly, WRC-2000 revised the definition to read as follows:

"The date of bringing into use denotes the date at which the frequency assignment is brought into regular operation[1] to provide the published radiocommunication service with the technical parameters within the technical characteristics notified to the Bureau."

The revision consisted essentially of adding the word "regular" in front of "operation" and adding the phrase "within the technical characteristics notified to the Bureau".

Discussion

- The term "regular operation" has not been defined but generally any type of traffic is considered sufficient;
- The term "within the technical characteristics notified to the Bureau" is interpreted to mean that the satellite network is operated is such a manner that it does not cause more interference or require more protection than what is implied by the filing.

With respect to question c) the only guidance given by the Radio Regulations is that assignments no longer in use shall be suspended. (See Section 6.)

The use of on-orbit satellites to "bring into use" assignments raises another question. Can the same satellite be used to "bring into use" more than one satellite network at different orbital locations?

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[1] Pending further studies by ITU-R on the applicability of the term "regular operation" to non-geostationary satellite networks, the condition of regular operation shall be limited to geostationary
satellite networks

6. Suspension of Assignments

In accordance with No. **11.49** frequency assignment "shall" (i.e. must) be suspended if they are no longer in use. Suspended assignments can be brought back into use with all rights retained provided they are brought back into use within 2 years of the date of suspension. If they are not brought back into use within this time period they are deleted and no longer taken into account.

Virtually no satellite operator suspends assignments "no longer in use" since this starts the clock on itself. If administrations suspended assignments "no longer in use" it would clean out the Master Register of old assignments and facilitate the coordination of new networks. At the writing of this paper administrations had suspended the assignments of only 18 satellite networks. See: http://www.itu.int/ITU-R/space/snl/list1149/index.asp

Administrations usually only suspend a network if they are challenged by another administration. In the case of a dispute, an administration will often submit its case to the RRB and the RRB can ask for additional information. In such a case, in the absence of a "real" satellite it is difficult to insist that the assignments are still in use and the administration may be forced to suspend the assignments of the network in question.

If administrations suspended assignments of old networks no longer in use, it would clear the Master Register of old assignments and solve the problem outlined in Section 2. However, since the coordination and notification process is very time-consuming and expensive, there is no incentive for an administration to suspend assignments and possibly not be able to bring them back into use and in this way lose the rights to the spectrum assets that such assignments represent.

7. Overfiling of Satellite Networks

There is overfiling of satellite networks. In some cases, such overfiling is caused by the uncertainty of the coordination process that makes it difficult to predict the outcome of the frequency coordination. The adoption of Cost Recovery has considerably reduced the submission of speculative filings.

The large satellite operators have learned to live with the overfiling and they have the financial means to submit many filings in anticipation of developing new orbit/spectrum resources. However, a country with no satellite network finds it confusing and costly to try to file for a new network. In most cases, the popular C- and Ku-bands (and increasingly the Ka-bands) are crowded both with actual operating satellites and with filings and a newcomer has very little hope of being able to coordinate a network at these frequencies. This has led to Resolution **80** which seeks some way of giving priority to administrations that do not yet have a satellite network.

In the case of a particular portion of the arc, the concerned administrations could cooperate and sign an MoU that specified coordination conditions that are more restrictive than those found in the ITU Radio Regulations and ITU-R Recommendations or they could agree to more stringent Resolution **49** (due diligence) conditions. This is what has been done at the L-band which is much more congested than the unplanned FSS bands.