International regulation of satellite communication

Milton L. Smith.

Acknowledgements

Use of the geostationary orbit by telecommunication satellites is one of the most important uses of outer space. The regulatory regimes governing that use have recently undergone significant revisions. These revisions, which were made in 1985 and 1988 at the ITU Space WARC, will affect the use of the geostationary satellite orbit by telecommunication satellites for the foreseeable future. This book is the first in-depth assessment of the Space WARC and its impact on the international regulation of satellite telecommunications. The manuscript was originally prepared as a dissertation submitted to the Faculty of Graduate Studies and Research of McGill University in partial fulfillment of the degree of Doctor of Civil Law (DCL). The dissertation was completed in February, 1988. The text has been revised to reflect factual developments, suggested changes, and personal preferences of the author.

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Although many have helped me in this endeavor, I am responsible for any errors that may be contained herein. Furthermore, The views and opinions I have expressed are solely my own; they do not represent official ideas, attitudes, or policies of any agency of the United States Government.

This book is dedicated to my mother, Mrs. Dorothy S. Hare, whose love, support, and encouragement I can always count on.

Milton L. Smith
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List of Acronyms

ADMINISTRATION	ITU member nation
AIAA	American Institute of Aeronautics and Astronautics
ASETA	Association of State Telecommunication Undertakings of the Andean Sub-Regional Agreement
BSS	Broadcasting-Satellite Service
CCIR	International Radio Consultative Committee (ITU)
CCITT	International Telegraph and Telephone Consultative Committee (ITU)
CITEL	International Committee for Telecommunications
COPUOS	Committee on the Peaceful Uses of Outer Space
ESA	European Space Agency
EUTELSAT	European Telecommunications Satellite Organization
FCC	Federal Communications Commission (U.S.)
FSS	Fixed-Satellite Service
GHz	Gigahertz
GSO	Geostationary-Satellite Orbit
IAF	International Astronautical Federation
IEEE	Institute of Electrical and Electronics Engineers
IFRB	International Frequency Registration Board (ITU)
IIC	International Institute of Communications
INMARSAT	International Maritime Satellite Organization
INTELSAT	International Telecommunications Satellite Organization
ITU	International Telecommunication Union
KHz	Kilohertz
MHz	Megahertz
MSS	Mobile-Satellite Service
NASA	National Aeronautics and Space Administration (U.S.)

NASARC	Numerical Arc Segmentation Algorithm for Radio Conferences
NTIA	National Telecommunications and Information Administration
ORB-85	Space WARC First Session
ORB-88	Space WARC Second Session
RARC	Regional Administrative Radio Conference (ITU)
SONA	Satellite Organizations and Their Notifying Administrations
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organization
U.S.	United States of America
USSR	Union of Soviet Socialist Republics
WARC	World Administrative Radio Conference (ITU)

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Introduction

For six weeks during the summer of 1985, and for six weeks during the fall of 1988, delegates from over one hundred countries met in Geneva for the International Telecommunication Union's (ITU) World Administrative Radio Conference (WARC) on use of the geostationary-satellite orbit (GSO) and the planning of the space services that utilize it. The essential objective of this two-session conference, known as the Space WARC, was to guarantee all countries equitable access to the GSO and the frequency bands used by communication satellites.[1] The Space WARC was one of the most important conferences in the history of space telecommunication, and it resulted in significant changes that will affect satellite communication well into the next century. Although many current issues of satellite communication are touched upon, this book focuses on a comprehensive examination of the Space WARC, including its background and results, in order to explore the impact of the Space WARC on the international regulation of satellite telecommunication.

Over 25 years have passed since the first satellite provided a communication link from the GSO. During that period, world telecommunications have been transformed by the use of satellites. Over 100 communication satellites now operate in the GSO, and of all the applications of space technology, satellite telecommunication is the most widely used and the most beneficial to world-wide economic progress. The direct economic impact of communication satellites is considerable. They now generate revenue of over five billion dollars annually,[2] and the construction of communication satellites and associated terrestrial equipment provides a global market of nearly four billion dollars per year.[3] These direct economic impacts will continue to grow; in 1989, over 15 communication satellites were scheduled for launch.[4] Furthermore, satellite communication has a tremendous indirect economic impact on increasing the efficiency of many other economic activities ranging from finance to agriculture.[5]

Telecommunication satellites have such a significant economic impact because they have developed into critical elements of the global telecommunication network. Communication satellites are often the most effective and least expensive long-haul telecommunication system available. Consequently, almost every nation with any appreciable telecommunication infrastructure has joined at least one international satellite organization, and the number of countries with their own satellite system increases yearly.

Many developing as well as developed countries have found communication satellites to be an indispensable part of their telecommunication systems. Since the 1960's, an increasing number of developed countries have been using communication satellites for international and domestic traffic, both through INTELSAT and their own satellites. In the late 1960's, developing countries started using communication satellites for their international needs through INTELSAT, and in the 1970's some developing countries began to use INTELSAT satellites for domestic telecommunication needs as well. In the late 1970's, as the benefits that flow from telecommunications became more evident, a few developing countries began to establish satellite systems of their own. Although most developing countries still do not have sufficient national telecommunication infrastructure or traffic requirements to justify establishment of their own satellite communication system, they want to preserve their potential for future access to the resources necessary for satellite communication systems, particularly on a subregional basis.

Over the past 25 years, technological advancement has resulted in increasingly efficient use of the GSO and the radio frequency spectrum, together referred to as the orbit/spectrum resource. Nevertheless, as a result of the increasing demands being placed upon that resource, many nations, particularly developing nations, became concerned that the capacity of the resource might be reached or access to it made prohibitively expensive. Furthermore, those nations became particularly dissatisfied with the regulatory regime governing use of the orbit/spectrum resource. They considered it to be inherently discriminatory because they believed that it protected early users of the orbit/spectrum resource to the detriment of subsequent users.

The regulatory regime for satellite communications that has been established within the ITU serves a very important function. Development of satellite communications depends on the existence of a stable legal regime that will provide adequate international protection for the large investments required to establish a satellite communications system. The ITU's regulatory regime provided the requisite stability for satellite communications to thrive. Developing countries, however, questioned the equitability of the system. Thus, a movement by developing nations was initiated to change the legal and regulatory regime applicable to satellite communications. The Space WARC was the culmination of that movement.

When the Space WARC began in 1985, two groups were brought together that had very different opinions regarding the proper course for the future international regulation of satellite communications. Most developing countries wanted to partition the orbit/spectrum resource and allot a specific orbital position and associated frequencies to every country regardless of current need. This type of "*a priori*" planning was considered necessary to guarantee future access to the orbit/spectrum resource. Additionally, it was part of a larger effort by developing countries to secure access to and benefits from resources in areas that are not subject to national sovereignty.

On the other extreme, most developed countries wanted to preserve the existing regulatory regime that had served them well. Any system of *a priori* planning, they argued, would waste the orbit/spectrum resource by giving countries an allotment that they had no need for or ability to use. Furthermore, such planning would be inefficient since an *a priori* plan must be based upon current technology even though the plan may have a long duration. Developed countries pointed to the great advances being made in satellite communications and asserted that those advances guaranteed future access to the orbit/spectrum resource for all countries.

The basis for those differing opinions, the manner of their resolution over a period of years, and the changes brought about by the regulatory regimes that emerged, are the key subjects of this book. The first five chapters establish the background of the international regulation of satellite communication. Chapter 1 reviews the technology of satellite communication. A general understanding of this complicated technical subject is required for an appreciation of the issues underlying international regulation. Chapter 2 analyses the international framework of satellite communication. This framework is composed of international and regional organizations as well as nations. Chapter 3 summarizes the pre-Space WARC regulatory regime of satellite communication. The aspects of this regime that most concerned the developing countries are highlighted. Chapter 4 provides the historical background of the international regulation of satellite communication leading to the Space WARC. It traces the development of the ITU regulatory regimes. This chapter sets the stage for the 1985 session of the Space WARC. Chapter 5 examines the goal of the Space WARC – equitable access to the orbit/spectrum resource. The legal concept of equity, the concept of equitable access in the ITU, and the circumstances relevant to equitable access are explored.

This study then progresses to the period of the Space WARC. The conduct of the First Session of the Space WARC and its results are the subjects of Chapter 6. This contentious session set the basic outline of the new legal regime for satellite communications. However, it left many questions unanswered and much important work to be done in the intersessional period before the second, and final, session of the Space WARC. Chapter 7 covers the work done during the intersessional period. This work was essential to the ultimate success of the Space WARC. The key preparations of various ITU organs, other organizations, and nations are reviewed. Chapter 8 reviews the Second Session of the Space WARC. The work of the Conference is reviewed and the key results are summarized.

A more detailed analysis of the key decisions of the Conference is then undertaken. Chapter 9 examines the new ITU regulatory regime for the fixed satellite service. This was the service of main concern to developing countries, and was the service impacted to the greatest extent by the Space WARC.

Having explored the regulatory aspects of space telecommunications law, this study moves to a discussion of international space law. Since communication satellites operate in outer space, international space law is a necessary aspect of the international regulation of satellite telecommunications. Chapter 10 analyses the compliance of the new ITU regulatory regimes with space law, and Chapter 11 discusses the key issues of space law that were raised at the Space WARC.

Finally, conclusions are drawn in chapter 12 about the impact of Space WARC decisions on the future of satellite communication and the relationship of the Space WARC to other international developments.

This book is intended to aid in the understanding and interpretation of the complex changes to the international regulation of satellite communication brought about by the Space WARC. It is hoped that a general feeling for that Conference will be conveyed to the reader.

NOTES

1. ITU, World Administrative Radio Conference on the Use of the Geostationary-Satellite Orbit and the Planning of the Space Services Utilizing It, Administrative Council Resolution No. 895 (May, 1983). Although the term "Space WARC" is used herein, other terms such as "WARC-ORB" and the "Orbit Conference" are often used in other sources. Moreover, the 1985/88 Space WARC should not be confused with the 1971 WARC-ST, that some have also refered to as the Space WARC. *See infra* ch. 4, section F.
2. *"Strong Orders Signal End of Slump for Communications Satellite Market,"* Aviation Week & Space Tech., Dec. 19, 1988, at 85. *See also*, Aerospace Industries Association of America, Inc., A Current Perspective on Space Commercialization (1985).
3. Aviation Week & Space Technology, *supra* note 2, at 86.
4. *Id.*
5. *See generally* The Missing Link (1984) (Report of the Independent Commission for World Wide Telecommunications Development).

CHAPTER ONE

The Orbit/Spectrum Resource and the Technology of Satellite Telecommunications: An Overview

Telecommunication satellites use two primary resources: the geostationary satellite orbit (GSO) and the radio frequency spectrum, together forming the orbit/spectrum resource. The purpose of this chapter is to present, in layperson's terms, a review of the technical factors underlying the policy issues surrounding the Space WARC. One simply cannot comprehend the concerns of developing nations without a basic understanding of the inherent limitations on the orbit/spectrum resource. Likewise, one cannot grasp the concerns of developed nations without a corresponding knowledge of the great technological advances in satellite telecommunication that have directly affected use of the orbit/spectrum resource.

A. THE GEOSTATIONARY SATELLITE ORBIT/SPECTRUM RESOURCE

Radio frequencies and the GSO have been declared by treaty to be "limited natural resources."[1] In practice, these resources must be used together and are therefore called the orbit/spectrum resource. The limits of the orbit/spectrum resource can best be understood by examining the limits of its components.

1. The geostationary satellite orbit: uses and limitations

A satellite that orbits the earth above the equator at an altitude of approximately 36,000 km (22,300 mi) will have a period of revolution approximately equal to that of the earth. Because the satellite revolves at the same rate as the earth, it appears to be motionless and stationary relative to a viewing point on the earth. Such a satellite is called a geostationary satellite, and the path it follows is the GSO.[2] There is only one GSO.

The GSO is actually a band around the earth with three dimensions and a finite volume. Because of numerous forces acting upon it, a geostationary satellite is not exactly stationary. Rather, it moves in a figure-eight pattern within the orbit volume.[3] Station-keeping maneuvers must be executed periodically for the satellite to maintain its nominal position. A satellite is usually maintained within 0.1 degree east or west of its nominal position on the equatorial plane. This results in the satellite moving within an area of about 150 km around its nominal position, at an altitude that varies by about 30 km. Thus, the GSO is a band around the earth 36,000 km above the equator, about 30 km thick and 150 km wide.[4]

Telecommunication satellites placed in the GSO have many advantages. From the GSO, a satellite can have line-of-sight communication with over one-third of the earth.[5] A beam from one satellite can cover the whole of almost any country. A system of three satellites can provide nearly global coverage. Thus, geostationary satellites can be important links in domestic and international telecommunication networks.

Geostationary satellites also generally form the least expensive telecommunication satellite system available. Although telecommunication satellites can operate in other orbits, they are not always at a fixed position relative to a point on the earth. This has two significant consequences for non-geostationary satellites: first, for continuous communication to and from a particular point on earth, more than one satellite is needed;[6] second, earth stations with trackable antennas are required to track the satellites across the sky. This necessitates significantly more complicated and more expensive earth stations. Therefore, the GSO offers the best location for communication satellites.[7]

Given the expanding use of telecommunication satellites and the practical need to position them in the GSO, it is important to explore the physical capacity of the orbit. Any orbit may contain only a limited number of satellites. An orbit becomes physically saturated when it is impossible to insert a new satellite without significantly increasing the probability of collision with an existing satellite.[8] Theoretically, with the current station-keeping accuracy of plus or minus 0.1 degree, 1,800 satellites could be uniformly spaced 0.2 degrees apart in the 360 degrees of the GSO arc without any risk of collision.[9] There are less than one tenth that many operational satellites in the GSO.[10] Therefore, although this theoretical calculation has major weaknesses,[11] it is generally accepted that the danger of collision is remote. Orbital saturation is not a significant constraint on use of the GSO.[12] The primary limitations lie elsewhere.

2. The radio frequency spectrum: uses and limitations

To perform a useful function, satellites must communicate with earth via the radio frequency spectrum.[13] Several factors constrain use of the radio frequency spectrum by satellites.

As a result of the physical characteristics of radio waves, only certain frequencies are suitable for communication via satellite. For example, in the lower end of the radio frequency spectrum, signals tend to follow the curvature of the earth. In the upper end of the spectrum, signals suffer significant propagation losses (i.e., reflection, refraction, and absorption) when they travel through the earth's atmosphere.[14] For these and other physical reasons, the groups of frequencies, or "bands," optimally suited for most satellite telecommunication purposes lie between 1 to 10 GHz.[15] However, advancing technology has extended the upper range of frequencies suitable for use by telecommunication satellites, and bands up to 15 GHz are now routinely used.[16]

In addition to physical constraints, there are two types of ITU regulatory constraints on the frequencies that satellites can use. Both result from the ITU's task of preventing harmful interference to users of the radio frequency spectrum. To minimize interference problems, the ITU is responsible for evaluating the needs of the various radiocommunication "services"[17] and for allocating frequencies to them.[18] ITU allocations to services constitute the first type of regulatory constraint.

Although there are many space services that use the GSO, only a few have or plan to have a significant number of geostationary satellites. The major use of the GSO is for communication satellites.[19] There are three communication satellite services using the GSO. The largest by far is the "fixed satellite service" (FSS). This service is for communication via satellite between fixed earth stations,[20] and was the first type of satellite communication system developed. The FSS carries television, telephone, telegraphic, and telex traffic, and it has the capability to carry other types of information.[21] More than ninety-five percent of the geostationary satellites that are operational or planned are in the FSS.[22]

The other two space telecommunication services are the mobile satellite service (MSS) and the broadcasting satellite service (BSS). The MSS is for communication via satellite with earth stations located on ships, aircraft, and land vehicles.[23] This service initially progressed slowly, but commercial interest "has increased dramatically over the past several years."[24] The traffic volume and frequency requirements for this service are considerably less than those for the FSS.[25] The BSS carries television or radio signals, via satellite, from a fixed earth station to large numbers of small, inexpensive receiving stations.[26] There are few BSS satellites, and their frequency requirements will not be a problem for the foreseeable future.[27]

The FSS, due to its intensive utilization, was the focus of the Space WARC.[28] The ITU has allocated several frequency bands with differing