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NASA AND THE PRACTICE OF SPACE LAW

*S. Neil Hosenball**

NASA and Space Law

Since the primary mission of the National Aeronautics and Space Administration is the exploration and use of space to achieve the national objectives established by the President and Congress, it is logical to assume that if there is a unique branch of law that can be labeled "space law," NASA lawyers would primarily engage in the practice of "space law."

Are these assumptions correct? Is there a unique branch of law than can be labeled "space law?" Do NASA lawyers practice space law, and if so, how much and in what way?

It is quite clear that since the launch of Sputnik some 28 years ago, the establishment of NASA in October 1958,[1] and the creation by the United Nations in 1959 of a Standing Committee on the Peaceful Uses of Outer Space,[2] there has indeed developed a large body of international law governing space activities - a body of law as substantive as air law or the law of the sea.[3]

Treaties Relevant to Space Activities

In order to gain an appreciation of the magnitude of space law, it will be useful to list a few of the treaties, conventions, agreements and regulations which directly relate to space activities. Among them are the Limited Nuclear Test Ban Treaty of 1963,[4] which barred nuclear explosions in the atmosphere and in space; the 1967 Outer Space Treaty;[5] the Treaty for the Prohibition of

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[1]National Aeronautics and Space Act of 1958, 42 U.S.C. §§ 2451-84 (1982).

[2]Paragraph 1(d) of the General Assembly resolution of 13 December 1958, adopted at its 792nd plenary meeting, reads as follows: "[t]he General Assembly . . . 1. Establishes an Ad Hoc Committee on the Peaceful Uses of Outer Space . . . and requests it to report to the General Assembly at its fourteenth session on the following . . . (d) The nature of legal problems which may arise in the carrying out of programs to explore outer space . . ." A/RES/1348 (xiii).

[3]*See* Convention on the Law of the Sea, U.N. Doc. A/Conf. 62/L.78 (1981).

[4]The Limited Nuclear Test Ban Treaty of 1963, was *opened for signature* on August 5, 1963, and *entered into force* October 10, 1963 [1963] 14 U.S.T. 1313, T.I.A.S. 5433, 480 U.N.T.S. 43.

[5]The Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, was *signed* on January 27, 1967, and *entered into force* October 10, 1967, [1967] 18 U.S.T. 2410,

Nuclear Weapons in Latin America;[6] the Astronaut Rescue and Return Agreement of 1968;[7] the Liability Convention of 1972;[8] the Biological and Toxic Weapon Convention of 1972;[9] the Anti-Ballistic Missile Treaty between the United States and the Soviet Union;[10] the Registration Convention of 1974;[11] the ITU Convention and its Radio Regulations;[12] the INTELSAT Agreement[13] which provides international satellite telecommunications for some 140 nations, and its Eastern-bloc counterpart, the Intersputnik Agreement;[14] the U.S. and European Space Agency (ESA) Agreement[15] which provided for the building of a Spacelab that has already flown on a previous Space Shuttle mission, and its Eastern-bloc counterpart, the Intercosmos Agreement;[16] the INMAR-

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T.I.A.S. 6347, 610 U.N.T.S. 205.

[6]The Treaty for the Prohibition of Nuclear Weapons in Latin America, was *opened for signature* on February 14, 1967, and *entered into force* December 11, 1969, 22 U.S.T. 762, T.I.A.S. 7137, 634 U.N.T.S. 281.

[7]The Agreement on the Rescue of Astronauts, the Return of Astronauts, and the Return of Objects Launched into Outer Space, was *signed* on April 22, 1968, and *entered into force* December 3, 1968, [1968] 19 U.S.T. 7570, T.I.A.S. 6599, 672 U.N.T.S. 119.

[8]The Convention on International Liability for Damage Caused by Space Objects, was *signed* on March 29, 1972, and *entered into force* October 9, 1973, [1973] 24 U.S.T. 2389, T.I.A.S. 7762.

[9]The Biological and Toxic Weapon Convention of 1972, was *signed* on April 10, 1972, and *entered into force* March 26, 1975, [1975] 26 U.S.T. 583, T.I.A.S. 8062.

[10]The Treaty on the Limitation of Antiballistic Missile Systems, was *signed* on May 26, 1972, and *entered into force* October 3, 1972, [1972] 23 U.S.T. 3435, T.I.A.S. 7503.

[11]The Convention on the Registration of Objects Launched into Outer Space, was *opened for signature* on January 15, 1975, and *entered into force with respect to the United States*, December 3, 1978 [1978] 28 U.S.T. 695, T.I.A.S. 8480 (*effective* September 15, 1976).

[12]The International Telecommunication Convention of 1973, was *signed* on October 25, 1973, and *entered into force with respect to the United States*, April 7, 1976, [1976] 28 U.S.T. 2495, T.I.A.S. 8572.

[13]The International Telecommunications Satellite Organization Agreement, was *opened for signature* on August 20. 1971, and *entered into force* February 12, 1973, [1973] 23 U.S.T. 3813, T.I.A.S. 7532.

[14]The International System and Organization of Space Communications Agreement, was *opened for signature* on November 15, 1971, and *entered into force* July 12, 1972, 862 U.N.T.S. 3.

[15]The U.S. and European Space Agency Agreement, was *signed* on August 14, 1973, and *entered into force* August 14, 1973, [1973] 24 U.S.T. 2049, T.I.A.S. 7722.

[16]The agreement on Co-operation in the Exploration and Use of Outer Space for

SAT Agreement,[17] which is similar to INTELSAT but deals primarily in maritime communications; and finally, the Moon Agreement of 1979.[18]

Domestic Laws and Regulations Governing Space Activities

There exists a similar body of U.S. domestic law and federal regulations which govern space activities. What follows is perhaps not an exhaustive list but the list is bound to grow in the next few years if the multitude of Congressional bills dealing with space activities, particularly as they affect non-governmental activities in space, are enacted.

The 1958 NASAct, which established NASA, is the major federal statute governing space law and policy.[19] In recent years, the number of regulations affecting the private sector and the public have increased significantly. These include, for example, the shuttle pricing policy regulations which govern the price NASA will charge commercial users of the Space Shuttle.[20] Also included are the very recent regulations relating to flying citizens in space.[21] Additionally, there are regulations which govern the command and control procedure on Shuttle flights,[22] and the indemnification of Shuttle users against third-party liability,[23] to mention but a few.

Congress, on NASA's recommendation, passed patents and customs legislation[24] which will facilitate U.S. commercial launch activity and increase the ability of the U.S. to compete against foreign launch services. The Federal Aviation Administration (FAA) has had a long standing regulation governing the launch of privately owned rockets and missiles through controlled air space[25] and the United States probably issued the first private license to do so. The

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Peaceful Purposes (INTERCOSMOS) was *opened for signature* on July 13, 1976, and *entered into force* May 24, 1977, [1977] 28 U.S.T. 7624, T.I.A.S. 8732.

[17]The Convention on the International Maritime Satellite Organization, was *opened for signature* on September 3, 1976, and *entered into force* July 16, 1979, [1979] 31 U.S.T. 1, T.I.A.S. 9605.

[18]Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, U.N. GAOR, 34th Sess., Supp. H. No. 20 (Doc. A/34/20).

[19]*See supra* note 1.

[20]14 C.F.R. § 1214.1 (1984).

[21]14 C.F.R. § 1214.17 (1984).

[22]14 C.F.R. § 1214.7 (1984).

[23]42 U.S.C. § 2458(b) (1982).

[24]42 U.S.C. § 2457(k) (1982); Pub. L. No. 97-446, § 116 (duty free entry of items returned from space). *See* 14 C.F.R. 1214.1502 (1984).

[25]14 C.F.R. §§ 101.21-.25 (1984).

federal Communications Commission (FCC) controls the allocation of space frequencies and regulates the assignment and allocation of the geostationary orbit. The Department of State, through its Munitions Control Board, has asserted jurisdiction over commercial space launches, deeming them to be an "export."[26] In addition, Title 18 of the U.S. Code has been amended to extend the extraterritorial jurisdiction of federal criminal laws to space vehicles in outer space.

In response to the launching of Sputnik, Congress enacted the NASAct which granted to NASA broad authority to enter into those transactions which were deemed necessary for the implementation of the policies voiced in that Act. The relevant provision has been interpreted by a Court of Appeals case[27] in which the Court said that, in response to the launch of the Soviet Sputnik, Congress did in fact give NASA broad authority.[28]

In recent years, NASA has used this authority in confronting and resolving the problems associated with the development of a reusable launch capability and space commercialization.

NASA's Legal Work

NASA has a legal staff of approximately eighty lawyers, 22,000 civil servants, hundreds of thousands of acres of real estate at ten locations across the United States and spends approximately eighty-five percent of its budget of over seven billion dollars for the procurement of goods and services from the private sector.

NASA is a mission agency whose business is research and development in aeronautics and space, and since the mid-sixties has also been providing launch services for satellite communications organizations, private corporations, international organizations and foreign governments. Therefore, in our NASA practice of law, we are not unlike an in-house corporate counsel whose corporation is in a specialized field of endeavor.

As corporate counsel for a drug company, one worries about personnel problems, real estate problems, labor relation problems, tort liability problems, contract matters, litigation and in particular, the food and drug laws that are of special interest to the company. NASA lawyers do much the same with their special interest being in international and municipal laws that affect the NASA space mission. For example, NASA has worked very closely with the insurance community both in this country and abroad in negotiating the first Space Shuttle liability policy.[29] which incidentally contained some new space law as-

[26]14 C.F.R. § 121.19 (1984).

[27]1858, American Federation of Government Employees v. Webb, 580 F.2d 496, 501 (1978).

[28]42 U.S.C. 2473(c)(5) (1982).

[29]The first Space Shuttle liability policy was negotiated with Lloyds of London to cover Satellite Business Systems, a partnership then composed of COMSAT, IBM and

pects. First, it was necessary to determine the nature of the legal obligations of the insurer to the insured. In most insurance policies it is provided that the insured will be paid that amount which the insurer is *legally obligated* to pay.[30] But the applicable Liability Convention does not provide for binding awards but rather provides for a recommendatory award. Thus, it was necessary to resolve the question of whether if the award is recommendatory, as provided under the Liability Convention, the insurer is in fact legally obligated to compensate the insured.[31] In addition, since the insurance provided under the Space Shuttle liability policy was intended to protect U. S. citizens and given the government's role in the Space Shuttle program, it is necessary to determine the potential restrictions placed on a citizen's recovery under the Federal Tort Claims Act. To that end, a provision was inserted in the Space Shuttle liability policy which prevents insurance companies from asserting the defense of sovereign immunity without the express authority of the Department of Justice.[32]

As a further example of the NASA practice of space law, NASA lawyers have, since the establishment of the U.N. Committee on the Peaceful Uses of Outer Space, played a significant role in the debate and negotiations that have taken place in the Committee. NASA legal counsel have, since the establishment of the Committee in 1957, served as members of the U.S. delegation and have served as heads of the delegation on several occasions.

Trend Toward Privitization

In terms of the future prospects of commercializing the space shuttle transportation system, it should be noted that NASA's history contains several examples of where, after completing research and development of a given technology, it has spun off the technology to another agency to operate. For instance, NASA developed remote sensing satellites and in 1983 turned over control to NOAA. Additionally, there is presently legislation to spin it off from NOAA to the private sector.[33] NASA has also been in the process of trying to commercialize the current government launch technology and Congress has now enacted legislation on it.[34] If history is a guide to the future, some say the

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the Aetna Insurance Company. *Editor's note*: a copy of the policy was not available.

[30]*See, e.g., Aerospace and Comprehensive General Liability Insurance Policy, Ltd.*, between Satellite Business Systems and J.H. Minet & Co., underwriters (November 19, 1979).

[31]Liability Convention of 1973, *supra* note 8, art. 19, para. 2.

[32]"Insurers shall not assert a defense of sovereign immunity without the prior consent of the United States."

[33]Land Remote Sensing Commercialization Act of 1984, Pub. L. No. 98-365, 98 Stat. 451 (1984).

[34]Commercial Space Launch Act of 1984, Pub. L. No. 98-575, 98 Stat. 3054 (1984).

chances are that if the shuttle can be a profitable operation, private industry will take over its operation.

Occasionally, interesting questions may arise which involve some aspect of space law. When Skylab was coming down, for example, some public spirited citizen filed suit in a district court in Cleveland, Ohio, to enjoin the return of Skylab,[35] thus apparently trying to change the law of physics as well as the common law and statute law as we know it.

And, the more amusing instance relates to a reporter who not long ago raised the hypothetical question of whether NASA could quarantine ET, and the answer was where did ET land? If he had landed at a NASA facility, there would have been quarantine regulations going back to Apollo days to apply, but if he landed some place out in the country, NASA would have no authority to quarantine ET. Next, the reporter thought of the Agriculture Department, the Public Health Service and the immigration authorities because they appeared to have all sorts of authority. So he inquired at the Agriculture Department, but was told that unless it was an animal, vegetable or mineral, they had no jurisdiction. If it had any intellect at all, they had nothing to do with it. He then talked to the Public Health Service and found out that they had quarantine authority, but only if ET had a specific disease that was listed in the Presidential executive order.[36] Regarding any other disease which was not on that executive order, they had no jurisdiction. As a last resort, the reporter called the Immigration Service but allegedly they would not talk to him.

Conclusion

As commercial space activities increase, corporate and private counsel will find themselves in the active practice of what is to be a very substantial body of space law and participating in meetings and symposia on international space law. The public has also become aware that there is something called space law largely as a result of the re-entry over Canada of the Soviet Cosmos 952 and the later re-entry of the U.S. Skylab. But as space activities become more commercialized it will be necessary for private enterprise to feed into government more information about their activities to assure that international treaties are not developed that will in any way interfere with the development of a strong, viable and profitable commercial space business.

The time has not yet arrived, however, where lawyers will make money out of the full-time practice of space law, but a knowledge of it today is essential if one represents an insurance broker or an underwriter insuring communication satellite companies or a communication company either in the negotiation of a launch services agreement, or in a proceeding for the allocation of frequencies or of an orbital slot. Such knowledge is also indispensible for those who represent companies that are expecting to enter the commercial space launch

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[35]Herrick v. NASA, slip op. no. C-79-1017 (N.D. Ohio May 18, 1979).

[36]Exec. Order No. 12,452, 48 Fed. Reg. 56,927 (1983).

business or the industry of materials processing in space, which is in an experimental and formative but very promising stage of development. Finally, such knowledge is indispensible for those who envision other commercial ventures in space.

INTELLECTUAL PROPERTY AND SPACE ACTIVITIES†

*Barbara Luxenberg**
and
*Gerald J. Mossinghoff***

As space activities enter their second quarter century, private sector activity will increase dramatically. Space communications, which has been a viable industry since the 1960's, will continue to grow and diversify. The space shuttle has demonstrated that space manufacturing has a bright future and holds the potential of a multi-billion dollar industry within the next two decades. Use of data remotely sensed from the Earth holds commercial promise for the coming decade. Other potential industries include space launch services and orbital services. The advent of the space station, with the increased orbital time it will provide for all space activities, will herald a blossoming of commercial space activities.

Although many issues remain to be resolved for the commercial potential of space to be achieved, protection of data and products and ideas and inventions will be crucial to industry. The law affecting space activities has evolved over the past two and a half decades primarily in response to governmental activities. With the shift toward private entrepreneurial space ventures foreseen for the next few decades, industry will be looking for, and the law will evolve toward, means to protect private creative endeavors in space.

Private entities investing in commercial space ventures will spend large amounts of money over long periods of time before a return on investment can be expected. Those entities will require assurance that they can protect the ideas and inventions (the intellectual property) resulting from their space station activities. Without strong protection for patents, trade secrets, and proprietary data and know-how, companies will not have the incentive to invest in developing the commercial potential of a space station.

Many nations have systems for protecting intellectual property on Earth. Protection of intellectual property in space will undoubtedly be based in part on the existing international space agreements and in part on extension of national law, practice and regulation. In addition, developing case law nationally and perhaps internationally will set precedents for resolution of intellectual

†The opinions and conclusions expressed in this article are those of the authors and do not necessarily represent the views of the Department of Commerce or the Pharmaceutical Manufacturers Association.

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property issues in space.

Concern over protecting intellectual property in space is not new at either the national or international level. But those concerns have been more theoretical then real, at least until recently. Now, increased capabilities to use space in a variety of ways have brought such issues to the forefront of attention. To highlight examples of consideration of intellectual property protection in both the international and national arenas, this paper outlines international interest in selected copyright issues in space communication and remote sensing, sets forth the U.S. national policy on space commercialization, and briefly summarizes U.S. national involvement in intellectual property protection issues.

International Law Of Outer Space

The substantive law of outer space consists of the United Nations' treaties: the Outer Space Treaty,[1] the Astronaut Rescue Agreement,[2] the Liability Convention,[3] the Registration Convention,[4] and the Moon Treaty.[5] These treaties form the largest and most important body of international space law. Although they primarily address the space activities of sovereign states, they also contemplate non-governmental entities engaging in space activities. Thus, the existing law of outer space lays some restrictions and obligations on private endeavors in space. Article I of the 1967 Outer Space Treaty provides that, just as with governmental activities, private space activities are to be for peaceful purposes and carried out for the benefit of all countries. Further, private space activities under Article VI of the Treaty must be under the authorization and continuing supervision of the launching state, with that state bearing international responsibility for its activities, both private and governmental.

Existing international space law does not address protection of private

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[1]Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, commonly referred to as the Outer Space Treaty, *opened for signature*, Jan. 27, 1967, and *entered into force* Oct. 10, 1967.

[2]Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, *opened for signature* April 22, 1968, and *entered into force* Dec. 3, 1968.

[3]Convention on International Liability for Damage Caused by Space Objects, *opened for signature* March 29, 1972, and *entered into force* Oct. 9, 1973.

[4]Convention on the Registration of Objects Launched Into Outer Space, *opened for signature* Jan. 14, 1975, and *entered into force* Sept. 15, 1976.

[5]Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, commonly referred to as the Moon Treaty, *opened for signature* Dec. 5, 1979, and *entered into force* July 11, 1984. The United States is not a signatory to this treaty. The five states which have ratified the treaty are Chile, the Philippines, Austria, the Netherlands and Uruguay.

sector interests in general, much less private sector rights in intellectual property. One particular aspect of private sector rights, which has generated a great deal of discussion at the United Nations, is the question of the meaning of space activities carried out "for the benefit and interests of all countries" (Article I of the Outer Space Treaty). In practice, that phrase has been interpreted in the United States to mean that all countries should share in the benefits from space activities, but not that any country must share its proprietary technology or its profits.[6] Thus, this provision of the Outer Space Treaty has been interpreted as a philosophical guide.[7] Benefits of space activity do reach nations and people throughout the world, as the commercial use of satellites for worldwide instantaneous communication clearly demonstrates, even though profits may go to a particular corporation or organization which owns the satellite.

The Moon Treaty, which was entered into force this past July, though it has yet to be ratified by a major space power, may raise the theoretical question of whether the "common heritage of mankind" concept embodied in that treaty would extend to proprietary technology. In the authors' view it clearly would not. In any event, the United States does not adhere to the Moon Treaty nor to the idea that "common heritage" means common ownership of space resources and majority control over their disposition.[8] Without a reasonable opportunity to receive a return on investment, private industry would be unlikely to devote the resources to develop commercial space activities.[9]

Copyrights and Space Communication

As technology for satellite transmission and reception has progressed, the question of the protection of property rights in space transmission has become increasingly important. Protecting copyrighted works transmitted by satellite from unauthorized interception and use has been an international concern since the 1960's. International communications law, as embodied in the International Telecommunication Convention and the Radio Regulations of the International Telecommunication Union (ITU), does not appear to provide sufficient protection for copyrighted material transmitted by satellite.[10] Though

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[6]Pikus, *Law and Security in Outer Space: Private Sector Interests*, 11 J. SPACE L. 112-13 (1983).

[7]Trimble, *The International Law of Outer Space and its Effect on Commercial Space Activities*, 11 PEPPERDINE L. REV. 560 (1984).

[8]SENATE COMMITTEE ON COMMERCE, SCIENCE AND TRANSPORTATION, POLICY AND LEGAL ISSUES INVOLVED IN THE COMMERCIALIZATION OF PRT., S. Doc. No. 98-102, 98th Cong., 1st Sess. 32 (1983).

[9]Hoover, *Law and Security in Outer Space From the Viewpoint of Private Industry*, 11 J. SPACE L. 123 (1983).

[10]International Telecommunications Convention (Malaga-Torremolinos 1973) (Nairobi 1982), as completed by the International Radio Regulations.

Article 22 of the Convention and Article 17 of the Regulations require member states to keep certain telecommunications secret, their relevance to interception of satellite signals is uncertain. Further, ITU sanctions may not be strong enough to make this an effective tool. Existing international copyright agreements such as the Universal Copyright Convention (UCC), to which the United States adheres, and the Berne Convention for the Protection of Literary and Artistic Works were not drafted to take into account unauthorized interception of satellite transmissions.[11] The protection either treaty might provide for broadcast material transmitted in space is unclear.

Because of the perceived deficiencies in international protection for material transmitted in space, various United Nations' agencies became active in the late 1960's in studying the copyright problems of satellite transmission.

In 1968, the United International Bureaus for Protection of Intellectual Property (BIRPI), the predecessor to the World Intellectual Property Organization (WIPO), convened a working group to study the problems which might arise for copyrights and neighboring rights in radio and TV program transmissions using communications satellites. The next year, UNESCO, together with BIRPI, started considering whether to amend existing international agreements or to negotiate a completely new multilateral convention.

A Committee of Governmental Experts met three times (1971, 1972 and 1973) to find appropriate solutions to copyright issues raised through increasing use of satellites for broadcast communication. WIPO and UNESCO jointly called a Diplomatic Conference in Brussels in May 1974 to draft a new international agreement. The resulting Convention Relating to the Distribution of Program-Carrying Signals Transmitted by Satellite (more commonly known as the Brussels Satellite Convention) was opened for signature on May 21, 1974.[12] Fifteen states, including the United States, signed the Convention at the end of the Conference. The Convention was entered into force on August 25, 1979, when the required five states had ratified the Convention.

The Brussels Satellite Convention deals with the signals and not the messages that those signals carry, i.e., the container and not the content. States party to the Convention pledge to take "adequate measures to prevent the distribution on or from its territory of any program-carrying signal by a distributor for whom the signal emitted to or passing through the satellite is not intended." The Convention leaves it to each contracting state to determine what those "adequate measures" are. That is, each state could use civil, commercial or regulatory measures, at its own discretion, to implement the treaty. Direct broadcast satellite signals are expressly excluded from the scope of the Convention. The Convention contains special provisions for developing coun-

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[11] Universal Copyright Convention (Paris 1971). Berne Convention for the Protection of Literary Works (Paris 1971).

[12] Convention Relating to the Distribution of Programme-Carrying Signals Transmitted by Satellite, commonly known as the Brussels Satellite Convention (Brussels 1974).

tries for educational or informational use of parts of programs, i.e., "fair use."

As the United States considered adherence to the Brussels Satellite Convention, questions arose as to whether existing U.S. law was adequate to meet the Government's obligations under the treaty. Recently, the U.S. Government concluded that existing U.S. law provides a sound legal basis for implementation of the Convention. On August 16, 1984, the President transmitted the treaty to the Senate for advice and consent to ratification. The Senate gave its advice and consent on October 12, 1984, and the United States deposited its instruments of ratification on December 7, 1984.[13]

The emergence of direct broadcast satellite technology also raises copyright issues. Direct broadcast satellites (DBS) can be used to broadcast directly into individual home receivers. In such broadcasting, the originating organization itself makes the distribution and, thus, carries out a broadcast in the conventional sense. On the Earth's surface, then, DBS broadcasts are clearly subject to existing copyright laws. The situation becomes complex, however, when tracing how the licensing of copyrighted material for use in different countries via a direct broadcast satellite will work. The distinction between who is the originator and who is conducting a simple transmission, and when a public performance of the protected work occurs, may blur. As direct broadcast satellite technology develops, further copyright protection issues will undoubtedly be raised. The World Intellectual Property Organization maintains an active interest in the effects of broadcasting technology on intellectual property rights. This March, WIPO and UNESCO will jointly sponsor a meeting on copyright problems of direct broadcast satellites.

In the United Nations, protection of property rights in intellectual property is intermingled with consideration of human rights and sovereign rights. Thus, transmission of data, whether terrestrially or by communications satellite, can present thorny issues to resolve. The main bodies in the United Nations which have dealt specifically with the intellectual property are UNESCO and WIPO. The UN Committee on the Peaceful Uses of Outer Space (COPUOS) has extensively considered satellite broadcasting technologies such as DBS, but not in terms of property rights in the transmission, but rather in terms of free flow of information versus some undefined "right" to restrict the flow of information.

Commercialization of Remote Sensing from Space

Recent remote sensing commercialization activities in the United States and internationally highlight unresolved intellectual property protection issues. The French Earth Observation Satellite (SPOT), scheduled for launch in 1985, raises a thorny copyright issue. SPOT data will be offered for sale as both standard data and value-added products. What rights the parent company,

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[13]To date, the following countries have ratified the Brussels Satellite Convention: the Federal Republic of Germany, Italy, Kenya, Mexico, Morocco, Austria, the United States of America and Yugoslavia. Nicaragua acceded to the treaty.

SPOT Image, may retain over remote sensing data enhanced by one of the distribution centers and sold as a derived product, a map for example, remains to be resolved.

Because copyright does not protect data but only its form of expression, further problems will have to be resolved to protect remote sensing data itself. Just where the boundaries are drawn, and what is the "protectible expression" of remote sensing data, remain to be worked out.

At present in the United States, unenhanced remote sensing data from LANDSAT is sold to all customers at cost and on a nondiscriminatory basis. The United States claims no copyright, or other proprietary interest, in its further distribution. Under this Administration's policy directive and newly enacted statute,[14] however, the United States is proceeding with privatization of the Government's remote sensing system, LANDSAT, through the competitive bid process. Title VI of Public Law 98-365, enacted this past summer, addresses the copyright-like rights that the private system operator will have in the data. The operator will have the exclusive right to sell all unenhanced data for a period not to exceed ten years from the date the data is sensed. After that period, the data comes into the public domain. Further, the unenhanced data may be sold by the system operator on the condition that such data will be sold on a nondiscriminatory basis to all potential users.

The statute defines the unenhanced remote sensing data sold by the private system operator as "unprocessed or minimally processed signals for film products collected from civil remote sensing space systems. It further defines minimal processing to include "rectification of distortions, registration with respect to features of the Earth, and calibration of spectral response." Minimal processing expressly excludes "conclusion, manipulations, or calculations derived from such signals or film products or combination of the signals or film products with other data or information." Thus, value-added data are not subject to the system operator's exclusive rights in the unenhanced data. Clearly, developing value-added data involves a creative process. How the expressions of this creative process, the value-added or enhanced data, will be protected remains to be seen. Copyright protection would appear to apply. In practice, the distinction between the system operator's exclusive rights to minimally processed data versus purchasers' rights to enhance the data using intellectual processes may need more precise definition. It seems likely that such distinctions will be made through case law as the United States gains experience with private sector operation of land remote sensing systems.

U.S. National Policy on Space Commercialization

As the United States moves toward commercialization of a range of space

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[14]Land Remote Sensing Commercialization Act of 1984, Pub. L. No. 98-365, 98 Stat. 451 (July 17, 1984). *See,* J.V. Byrne, Administrator of the National Oceanic and Atmospheric Administration, statement delivered at news conference, U.S. Department of Commerce (March 8, 1983).

activities, intellectual property protection in space is being considered at the highest levels of government. In the State of the Union Message to the American people last January, President Reagan called for development of space as the next frontier.[15] He labelled this as one of four great goals for the 1980's. The President directed NASA to develop a permanently manned space station within a decade, noting that "we will soon implement a number of executive initiatives, develop proposals to ease regulatory constraints, and, with NASA's help, promote private sector investment in space."[16]

Since that time, government and private industry have intensively studied issues relating to space commercialization and potential commercial space initiatives. On July 20, 1984, the President released the National Policy on the Commercial Use of Space.[17] This policy contains economic, legal and regulatory, and research and development initiatives, as well as initiatives to implement the new policy. Significantly, though the policy statement is brief, one of the specific initiatives is to provide additional protection of proprietary information through the NASA Act.[18] This initiative calls for an amendment to the NASA Act to provide for a limited exemption from Freedom of Information Act provisions for proprietary industry data submitted to NASA and relating to space commercialization.

This initiative demonstrates the Administration's sensitivity to industry's concerns in this key area. Lead times are very long in space programs generally, and space commercialization endeavors may not see a payback for 7 to 10 years, if then, rather than the 3 to 5 years industry usually relies on to receive a return on investment. The details of the implementation of the National Policy on Commercial Use of Space will be elaborated on by the Working Group on the Commercial Use of Space. This Working Group, also established under the new commercial space policy, reports to the Cabinet Council on Commerce and Trade and is chaired by a representative of the Department of Commerce, with a vice chairperson from NASA. Creation of this working group, which gives high-level, national focus to commercial space issues, shows the seriousness of the Administration's commitment to removing the barriers inhibiting commercial activities in space.

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[15]Message From the President of the United States Transmitting a Report on the State of the Union, H.R. Doc. No. 98-162, 98th Cong., 2d Sess. 5 (1984).

[16]President Ronald Reagan's Radio Address to the Nation, 20 WEEKLY COMP. PRES. Doc. 113 (Jan. 28, 1984).

[17]The White House, Office of the Press Secretary, National Policy on the Commercial Use of Space, Fact Sheet (July 20, 1984).

[18]National Aeronautics and Space Act of 1958, *as amended*, Pub. L. No. 85-568, 72 Stat. 426.

NASA and Protection of Intellectual Property

In resolving issues relating to protection of intellectual property in space, the Working Group will certainly be able to benefit from the precedents already established by NASA. Some believe that an amendment to the NASA Act to provide additional protection for proprietary information relating to commercial space activities may not be necessary; that is, that NASA's current authority to protect such information has been used successfully and can meet future requirements. Others believe that a specific amendment to the NASA Act must be sought in order to guarantee industry the security it requires to expend the funds necessary for development of commercial space activities. A final decision on this has yet to be made, but when it is, it will undoubtedly take into consideration the NASA experience.

Through the years, NASA has developed flexible intellectual property policies which have worked extremely well to protect proprietary interests and to encourage industrial participation in commercial space activities. These NASA policies are summarized below.[19]

Section 305 of the NASA Act sets forth the property rights in inventions made under NASA contract.[20] Though title to such inventions rests with the Government, NASA has a broad waiver policy, retaining only a nonexclusive, royalty-free license for government use and the right to "march-in" if the contractor is not developing the invention. Historically, NASA has granted most requests for waivers.

In addition, NASA has interpreted Section 305 as applying only to contracts which are for the performance of work of an inventive nature (or research and development) for NASA. As a result of its interpretation of the definition of a contract, NASA has been flexible and innovative in dealing with patent rights and the private sector.

On February 18, 1983, President Reagan signed a Memorandum on Government Patent Policy intended to foster commercialization of new technology.[21] The 1983 policy statement directs all U.S. Government agencies, to the extent permitted by law, to give contractors or grantees the first option to retain title, i.e., commercial rights to all inventions they make under government sponsorship. The Government retains a broad royalty-free license, and statutory "march-in rights." The President's statement basically reaffirmed what had been NASA's historical practice of using its patent policies to encourage

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[19]For more detailed discussions on NASA regulations and practice, see Mossinghoff, *Intellectual Property Rights in Space Ventures*, 10 J. SPACE L. 107 (1982), and G.J. Mossinghoff, *Protecting Intellectual Property in Space Activities*, in ENCOURAGING BUSINESS VENTURES IN SPACE TECHNOLOGIES, Appendix 5 (National Academy of Public Administration 1983).

[20]National Aeronautics and Space Act of 1958, *as amended*, Pub. L. No. 85-568, § 305, 72 Stat. 426, 440.

[21]1 PUB. PAPERS 248 (1983).

commercialization of technology developed under NASA funding. NASA is now specifically applying the criteria for the 1983 policy, in acting on requests for waiver of rights to inventions made in the performance of work under NASA contract.[22]

Rights to data, i.e., rights to valuable technical, commercial and financial information, may equal patents in importance to industry in developing commercial space activities. NASA has no express statutory requirements directing its use of data produced during the performance of a contract. Use of such data, however, must conform to Section 203(a)(3) of the NASA Act, which requires that NASA "provide for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof."

Further, the provisions of the Freedom of Information Act (FOIA)[23] must be considered when developing policy on distribution and use of data. The Freedom of Information Act requires government agencies to release records upon request unless those records fall under nine specific exemptions. Exemption (b)(4) relates to trade secrets and confidential business information. In the last Congress, the Reagan Administration strongly supported S.774, a Freedom of Information Act reform bill, which would have, among other things, provided greater procedural protections for submitters of confidential information under Exemption (b)(4). Greater procedural protections would have been provided by allowing those submitters to participate in agency decisions on whether to release such information.[24] In this Congress, the question of additional protection for confidential business information is likely to be considered again.

NASA's policy on rights in technical data takes into account these two statutory provisions. For procurement contracts, NASA normally acquires the data produced in performance of the contract with "unlimited rights;" that is, without restriction regarding its publication, use or disclosure. NASA's policy is not to acquire "protectible" data unless there is a real need for it. If acquiring such data is necessary, however, NASA's policy is to acquire it with "restricted rights," i.e., under express agreement or understanding not to use or disclose it in any way which would compromise it as in intellectual property right.

This policy applies also to data furnished to NASA by companies competing for NASA contracts. For example, under the request for proposals for space station definition and design, NASA will have unlimited rights to all data contained in the proposals unless the offeror states specifically that such data constitutes a trade secret and/or information that is commercial, or financial and confidential, or privileged. All data to be furnished to NASA under the space station definition and design contract, or resulting from conduct of that con-

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[22] 48 Fed. Reg. 22132-33 (1983).

[23] Pub. L. No. 89-554, 89 Stat. 383 (1966) *as amended. See* Pub. L. No. 94-409, 90 Stat. 1247 (1976).

[24] The Freedom of Information Reform Act, S.774, 98th Cong., 2d Sess. (1984).

tract, will be with unlimited rights. The only exception will be for contractor claims to copyright in scientific and technical articles based on data produced in performance of the space station contract and published in academic, technical and professional journals. This is the standard NASA policy for copyrights involved in data produced under NASA contracts.[25] Generally, a contractor must have permission from NASA to claim a copyright in data first produced under contract. NASA grants such permission automatically at the time of contracting.

Two recently enacted statutes demonstrate the importance to industry and the government of delineating who retains what rights to technical data when competing for government contracts. These two measures, P.L.98-525 and P.L.98-557, both require the Executive Branch to define by regulations the legitimate rights of the United States and of contractors and subcontractors in technical data.[26] Technological innovation in any field, as well as in space activities, can best be encouraged if contractors and the Government alike have a clear understanding of their respective rights in technical data. From industry's perspective, excessive restrictions on data could threaten product rights in commercial markets. Thus, these two measures, which seek a balance between excessive restrictions and the Government's legitimate interests in technical data, form part of the existing body of law affecting intellectual property.

Historically, NASA has tried not to acquire "protectible" data unless it is essential and then only acquire it with limited rights. This has been true for reimbursable launch services. Under reimbursable launch service agreements, the user will retain all patent and data rights. The user only has to supply NASA with data sufficient to verify peaceful purposes, i.e., ensure launch vehicle safety, and ensure Government compliance with existing laws and Government obligations.

A number of companies are now interested in developing their own launch vehicles, and other companies are interested in purchasing U.S. launch vehicles to operate them commercially. In February 1984, the President named the Department of Transportation as the lead agency for licensing private sector expendable launch vehicles.[27] The Department of Transportation must obtain, just as NASA has in launching private payloads, sufficient data from the owners of private launch vehicles to assure that launches will be for peaceful uses, that launches will meet safety requirements and that U.S. Government obligations will be met and existing laws complied with. As industry explores new areas of potential commercial application, such information may increasingly be seen by industry as sensitive. Some observers predict that what has worked well in the past, with NASA-required data for reimbursable launches, may not

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[25]48 C.F.R. §§ 18-52.227-74 (1984).

[26]Defense Procurement Reform Act of 1984, Pub. L. No. 98-525, Title XII, 98 Stat. 2492, and Small Business and Federal Procurement Competition Enhancement Act of 1984, Pub. L. No. 98-577, Titles I-IV, 98 Stat. 3066.

[27]Exec. Order No. 12465, 20 WEEKLY COMP. PRES. DOC. 263-64 (Feb. 24, 1984).

work as well for industry as it moves to use commercial expendable launch vehicles and to explore possible commercial products that could be manufactured in space. This is an area that the Department of Transportation is studying carefully to see how best U.S. oversight of commercial space launches may be carried out without requiring disclosure of commercially sensitive data. To this end, the Department of Transportation will shortly publish a Policy Statement and Advance Notice of Proposed Rulemaking on Licensing Procedures for Expendable LaunchVehicles.

Future space activities will provide greater opportunity for reimbursable commercial use than the shuttle now does. The question of who should hold rights in inventions made by reimbursable users on the space station, for example, is vital to potential users. NASA's current policy for reimbursable shuttle users has worked well and will probably be the basis for allocation of rights on the space station. This policy, as set forth in the regulations on shuttle reimbursement, is that the user should retain all patent and data rights.[28]

The policy states that "NASA will not acquire rights in inventions, patents, or proprietary data privately funded by a user, or arising out of activities for which a user has reimbursed NASA under the policies set forth herein." One important provision of the regulation states that for activities which may significantly affect public health, safety or welfare, NASA may obtain assurances that the results will be made available to the public. Such assurances, if determined necessary by the NASA Administrator, will be written into the agreement before it is entered into, not after an invention has been made. Under NASA's policy for reimbursable shuttle users, the only data the user is required to furnish to NASA are those sufficient to verify peaceful purposes, to ensure shuttle safety, and to ensure NASA's and the U.S. Government's continued compliance with existing laws and Government obligations. NASA has no plans to acquire proprietary data from shuttle users.

The space shuttle and the Spacelab have increased the opportunity for experimentation in space. Materials processing, particularly, holds great promise for the future. Through its ability to structure new arrangements with the private sector, NASA has been able to form joint endeavors with industry to explore promising areas with an eye toward commercialization.

Joint endeavors are usually arrangements between NASA and a private party to undertake a project of mutual benefit without any transfer of money or title to property. Joint endeavors can involve use of equipment, facilities, services, personnel or information made available by one party for the use of the other. Because such joint endeavors are not defined as "contracts" under Section 305(a) of the NASA Act, NASA has been able to negotiate intellectual property rights, including both patents and proprietary data rights, to encourage private participation in commercial activities in space. Though each such joint endeavor has been, and will continue to be, negotiated on an individual basis, in general the private party has been able to retain rights to inventions and proprietary data produced in carrying out its responsibilities

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[28]14 C.F.R. § 1214.104 (1981).

under the agreement. NASA has contingent rights to assure access to the technology should the private participant not carry out its responsibilities under the agreement. NASA also retains the right to a contingent royalty-free license to practice any such inventions in the space environment only for the Government. Also, the joint endeavor agreements generally take into consideration public needs in health, safety and welfare.

A very successful, and the best known, joint endeavor agreement is the 1980 agreement between NASA and McDonnell Douglas on using electrophoresis for drug processing in space.[29] To promote innovation in the technology covered by this agreement, NASA agreed not to fund or engage in another joint endeavor on this specific materials processing technology. NASA may, however, continue to work in related areas and may sell flight time on the shuttle, on a fully reimbursable basis, to other organizations involved in other space processing endeavors.

McDonnell Douglas believes that such process exclusivity is essential to its obtaining a return on its investment. By the early to mid-1990s, McDonnell Douglas predicts, space processing will generate $1 billion in annual sales for its initial drug product.[30] The McDonnell Douglas processor has been carried on several shuttle flights and has demonstrated the feasibility of the process. On Mission 41D this past August, the shuttle carried the McDonnell Douglas developmental electrophoresis machine and the company's engineer, Charles D. Walerk, to run the machine. The company targets 1987 for the first public sale of the drug, a full ten years since the initiation of the project in 1977. McDonnell Douglas expects to be processing up to ten new drugs by the late 1990s. To gain more processing time than is available during the week long shuttle missions, McDonnell Douglas is looking at renting Leasecraft satellites and even development of a special factory spacecraft.

The joint endeavor agreement clearly can be a very effective tool to interest the private sector in devoting the resources to develop potential commercial processes. NASA has signed three other joint endeavor agreements covering patent rights. These three agreements were signed with Microgravity Research Associates for production of gallium arsenide crystals in space, with Fairchild Industries for development of the Leasecraft Spacecraft, and with Spaceco, Ltd., for a shuttle payload bay monitoring instrument.

NASA also has technical exchange agreements under which NASA and a private party can exchange know-how, but only that which can be used without restriction. Exchange of any "protectible" information would only be as provided in the agreement and all such information would be maintained in confidence.

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[29]Agreement Between the National Aeronautics and Space Administration and McDonnell Douglas Astronautics Company for a Joint Endeavor in the Area of Materials Processing in Space, *signed* Jan. 25, 1980.

[30]*Medicine Sales Forecast at $1 Billion*, 120 AVIATION WEEK & SPACE TECH. 52 (1984).

With the prospect of an operating space station within a decade, protection of intellectual property rights will assume even greater importance as more industries, including nonaerospace industries, take advantage of the increasing opportunities for involvement in space. The American Institute of Aeronautics and Astronautics (AIAA) recently compiled a list of over 350 companies which are involved in various aspects of space commercialization.[31] Some of these companies were formed specifically to explore commercial space opportunities. Not all of them will be successful, but new ones will continue to take the place of those that fall by the wayside. During the process, being able to protect and commercialize new technology and data developed in space, on the shuttle, on free-flying laboratories and on the space station, will play a large role in fostering commercialization.

Though NASA policies, practices and procedures have been flexible and have met industry's need for security of proprietary interests, the space station may raise new issues and questions to be resolved, particularly in view of the fact that use of the station will almost certainly be international and development of it may well be. The countries and companies involved in the space station will require absolute protection for their proprietary interests in the hope of recovering the large front-end costs of space commercialization.

A prime question is whether intellectual property rights based on intellectual property law would remain valid in outer space which is, by definition in the Outer Space Treaty, nonnational territory. Does U.S. patent law, or any national patent law, have extra-territorial reach into space? Will a U.S. space station be considered American territory? What about a U.S. space station with privately or foreign owned plug-in manufacturing modules? Or a European space station used by U.S. companies? These are the kinds of issues that will need to be addressed as space station planning progresses. In the United States, NASA is studying the necessity for an amendment to the Space Act to clarify and provide certainty for jurisdictional issues relating to patent protection in space.

Another issue concerns whether an invention made in space can be proved to show first inventorship. The United States is one of only three countries in the world (Canada and the Philippines being the other two) which uses a first-to-invent system. All other countries use a first-to-file system. Thus, for U.S. patents, an inventor must be able to prove first invention on the space station, space shuttle or free-flying space laboratory. There is no case law on this yet. A sign of the maturing of commercial space activities will undoubtedly be when proving first inventorship in space becomes an issue.

It may well be that various governments with active space programs, especially those which are going to be involved in space station activities, will have to resolve jointly the status of patent protection in space, and protection of other intellectual property as well. As the members of the European Space Agency meet in Rome at the end of January to discuss participation in the

[31]List compiled by the American Institute of Aeronautics and Astronautics, 1633 Broadway, New York, NY 10019 (April 1, 1984).

U.S. space station, controls on the transfer of intellectual property will undoubtedly be on the agenda.

Industry, as well as government, will be interested in protecting proprietary information and products as they become increasingly involved in commercial space activities. Companies will need the incentives of strong intellectual property systems to continue to invest in the developmental programs which are the initial steps into space commercialization. Concern with strengthening intellectual property protection is international. Resolving the many unanswered questions and issues will undoubtedly require international involvement.

NASA has developed quite successful regulations, procedures and policies to handle intellectual property during the first quarter-century of the space age. It is likely that NASA's experience and practice will serve as a basis, or at least a starting point, for resolution of these issues as space commercialization activities continue to increase.

CUSTOM AS A SOURCE OF INTERNATIONAL LAW OF OUTER SPACE

*Vladlen S. Vereshchetin**
and
*Gennady M. Danilenko***

One of the principal features of the process by which the international law of outer space is formulated is that, in contrast to the formation of the traditional parts of the law of nations, the creation of this new branch of international law, which regulates the relations of states in the exploration and use of outer space, even at the early stages was dominated by the making of treaty law. The advent and rapid development of human activities in the exploration and use of outer space more than a quarter of a century ago has led to the prompt conclusion of a number of important multilateral treaties in this field. The foundation of the international legal order in outer space was established by the 1967 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies[1] which laid down the general principles and rules of the law of outer space.The predominance of treaty over custom in the formation of international space law is the result of the operation of at least three factors which have exerted a particular influence on the norm-creating process in this new field of state activity.

The first factor is the number of states participating in the exploration and use of outer space and in the norm-creating processes that produce legal norms for the regulation of the activities of states in this field. Until recently, only a small number of states have participated in either space activities or the relevant lawmaking activities. Participating states were able to reach a consensus on a number of problems within a very short period of time, and this has led to the conclusion of universal legal documents establishing the existing system of the treaty principles and rules of space law. However, the number of states participating in space activities in one form or another is growing. The expansion of space activity and the development of new uses of space technology increasingly affect the legal rights and interests of almost all members of the international community. Thus, the awareness of the importance of space-

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[1]The Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, was signed on January 27, 1967, and entered into force October 10,1967,[1967] 18 U.S.T. 2410, T.I.A.S. No. 6347, 610 U.N.T.S. 205.

related activities and the significance of the legal problems connected with these activities is also growing. Consequently, these problems draw the attention of various states, including those which, as yet, do not possess any capacity to engage in space activities. The active participation of an increasingly large number of states in the process of creating treaty law leads to a situation in which the adoption of new conventional rules of universal acceptance, governing new types of activities or new problems, becomes a more difficult task.

The second factor favoring treaty as a source of international law of outer space is the specific character of the problems which arise in the field of space-related activities. A considerable number of these problems arise in various fields of technical cooperation in the use of outer space and, as a result, require the creation of detailed rules which could clearly spell out the rights and obligations of the states concerned. It is obvious that only international treaties can serve as a source of the specific and detailed legal regulation of the relations of states. In this case, custom remains in the background because, as a source of international law, it can produce only general and broad legal obligations.

The third factor is a tendency to the more rapid development of legal regulation of space activities as compared with the development of the actual practice of states in the exploration, use and exploitation of outer space. This tendency dominated the early stages of the formation of outer space law. During the formation of this branch of international law, a number of treaty rules were being created and became legally binding before the problems governed by these rules could be realized in space activities.

Treaty, as a source of international law, can be used as an instrument of anticipatory legal regulation of future types of activities or future situations which do not exist at the moment of the conclusion of a treaty. Custom, in contrast to treaty, cannot serve as a source of anticipatory creation of legal rights and obligations because it is based on the practice of states. Customary international law, as Judge V. Koretsky put it, "turns its face to the past."[2] Where the formation of the law is influenced to a considerable extent by the tendency toward anticipatory treaty regulation, the role of custom is bound to be reduced to a minimum, at least in the areas in which agreement on such an anticipatory treaty regulation has been achieved.

All these factors, however, could not lead to a complete disappearance of the role of custom as a source of the international law of outer space. First, the importance of customary rules of general international law which establish the basis of the international law of outer space should be mentioned. Second, practice has shown that custom served as a source for the creation of a number of important general rules and still serves as a form of the existence of these rules. It should also be borne in mind that the modern practice of states in the exploration and use of outer space continues to produce new customary rules.

Notwithstanding the peculiarities of the formation of various branches of international law, the role of custom as a source of the creation and as a form

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[2] I.C.J. REPORTS 156 (1969).

of the existence of legal rights and obligations of states is conditioned by the structure of the international community. The absence of international legislation is the reason why international law-making is a very specific process having, among others, the following features: (1) the conventional and customary norms can be created only by the agreement of interested states; (2) the broad agreement leading to the creation of customary norms, which are constituted by the constant and uniform practice of states, can be achieved before these states reach an agreement concerning the specific normative content of relevant conventional norms in the framework of the formal treaty norm-creating procedure; (3) the legal norms laid down in a codifying act do not automatically bind all the members of the international community.

It follows, therefore, that international custom will play a significant role in the following two situations: (1) custom serves as a source of legal rights and obligations of states in those fields of their mutual relations, in which the treaty regulation is absent for one reason or another; (2) custom regulates the relations of states which are non-parties to a codifying convention, the relations of states which are parties to a convention and of states which are non-parties.

The practice of international law of outer space shows that states find it necessary to rely on rules of customary international law of outer space in both of these situations.

Customary Rules of Modern International Law of Outer Space

In the first situation referred to above, international custom leads to the creation of legal rights or obligations of states independently of the existence of any treaty regulation. As a specific norm-creating procedure, international custom is based on the constant and uniform practice of states. The emergence of a constant and uniform state practice in a new field of international relations, which requires legal regulation, leads to the establishment of new rules of customary international law if certain requirements laid down by international law are met. These requirements include those of generality, consistency, uniformity and *opinio juris*.[3]

The practice of states constituting an international custom is the result of the interaction of legal claims put forward, in one form or another, by some states in the domain of interstate relations, and of active or passive reaction to these claims on the part of other states whose interests are affected. The interaction of legal claims, which are the expression of a legal standpoint of a given state with respect to a particular problem, and reaction to these claims, is a specific process of "negotiations" among the states concerned. These "negotiations" are conducted not in the framework of formal procedure, but by way of actions, unilateral and/or multilateral acts and statements. This process gradually leads to the emergence of consensus among interested states as to the rec-

[3]*See* Danielenko, *Customary Rule Formation Process in Contemporary International Law*, in SOVIET Y.B. INT'L L. 151-70 (1983) (in Russian, with English summary).

ognition of a rule of conduct established by constant and uniform practice as a rule of customary international law.

The analysis of the practice of states before the conclusion of the 1967 Outer Space Treaty shows that historically custom was the first source of the international law of outer space. The state practice in the field of exploration and use of outer space has led to the emergence of a number of important principles and rules of international space law.[4]

Among the fundamental principles and rules which were created by the practice of states before the conclusion of the 1967 Outer Space Treaty, and which were subsequently codified by this Treaty, the most important are the following: outer space is open and free for exploration and use by all states; the sovereignty of states does not extend to outer space; outer space is not subject to national appropriation; and states retain jurisdiction and control over space objects launched into outer space.

These principles have emerged in the practice of states within a very short period of time. The acceleration of the formation of customary principles relating to outer space was brought about not only by the fact that all actions of states in the field of exploration and use of outer space were immediately known all over the world, but also by the adoption of a number of United Nations General Assembly resolutions. These resolutions include the General Assembly Resolution of December 13, 1963,[5] which contained a Declaration of Legal Principles Governing Activities of States in the Exploration and Use of Outer Space.[6]

The passage of only a short period of time after the beginning of the exploration and use of outer space did not prevent the customary norms of the international law of outer space from coming into existence. In contrast to certain systems of municipal law, international law does not require the existence of practice from "times immemorial" for the creation of its customary rules. Furthermore, in modern international law the requirement of a long period of

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[4]*See* M. LACHS, THE LAW OF OUTER SPACE: AN EXPERIENCE IN CONTEMPORARY LAW-Making, 136 (1972); Marcoff, *Sources du droit international de l espace*, 568 RECUEIL DES COURS 60-61 (1980).

[5]Declaration of Legal Principles Governing Activities of States in the Exploration and Use of Outer Space, *submitted by* Committee on Peaceful Uses of Outer Space, Resolution 1962 (XVIII), *adopted unanimously* by the General Assembly on December 13, 1963 (1280th meeting), as recommended by First Committee A/5656, Draft Resolution 1.

[6]This does not mean, however, that the practice of inter-state relations in the field of the exploration of outer space has led to the emergence of "instant" customary international law, as some authors believe. *See* B. Cheng, UNITED NATIONS RESOLUTIONS ON OUTER SPACE: "INSTANT" INTERNATIONAL CUSTOMARY LAW?, 5 INDIAN J. INT'L L. 36 (1965). Customary international law can not come into being "instantly" because custom is based on constant and uniform practice. The consolidation and recognition of general, constant and uniform state practice require the existence of a number of precedents. It is obvious, that custom calls for the passage of at least a certain period of time.

time, which was valid in the traditional law of nations, has gradually lost its importance owing to the rapid development of interstate relations. The International Court of Justice confirmed the generally recognized rule when it stated that "the passage of only a short period of time is not necessarily, or of itself, a bar to the formation of a new rule of customary international law." [7]

During the 1960's, on the doctrinal level there were two different points of view as to the question concerning the role and importance of custom in the formation of the emerging law of outer space. Reflecting the traditional approach to the problem of the sources of international law, some western writers have expressed the view that custom would be the main source of space law. In this connection, Myres McDougal, for example, wrote as early as 1965 that "the implicit communications of customary behavior play a much more important role than agreement or other deliberate formulation."[8] The development of space law has shown that, at least with respect to this branch of international law, this statement does not correspond to reality. It should be noted, that even Myres McDougal had to admit that in the area of law relating to space activities, custom was not an adequate source for the legal regulation of some specific technical problems such as in the field of telecommunications, which called for detailed treaty regulation.[9]

The opposing position was that custom could not be an adequate source of the international law of outer space. For example, P. I. Lukin has stated that the "international law of outer space can find the reliable source of its inception and subsequent development only in international agreements."[10] This extreme point of view did not reflect the practice of international law of outer space because, among other things, it led to the unacceptable conclusion that, before the 1967 Space Treaty, states had conducted space activities in a legal vacuum.

In the modern international law of outer space, custom serves as a source of the creation and as a form of the existence of a number of rules governing the relations of states in those areas in which, up to now, there was no treaty regulation.

The expansion of the activities of states in the exploration and use of outer space, and the use of new technologies in outer space, create new situations which require legal regulation. As the result of the influence of a number of factors, however, including the increasingly large number of states participating in the making of treaty law, the progress in the formulation of new conventional rules of space law is not as fast as it was before. In some areas, the formulation of new conventional rules is not keeping pace with the require-

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[7] I.C.J. REPORTS 43 (1969).

[8] McDougal, THE EMERGING CUSTOMARY LAW OF SPACE, 58 NW. U.L. REV. 625 (1965).

[9] *Id.* at 637, 640.

[10] Lukin, *To the Question of the Sources of Space Law*, in QUESTIONS OF INTERNATIONAL LAW 141 (1963) (in Russian).

ment of international practice. In these areas, custom plays an important role and serves as a primary source for the creation of international legal rights and obligations of states.

It should be noted that international custom, as a rule, is the result of the agreement of states on a broad principle which only defines the general outlines of the proper and permissible conduct of states and other subjects of international law in a given sphere. This explains the shortcomings of custom as an instrument of legal regulation because, in certain instances, the application of customary law to specific problems fails to give precise results. Nevertheless, as international practice shows, customary law can be successfully used for resolving controversies in the fields of international law where there is no treaty regulation. If there is an international legal dispute, existing customary rules can give an answer at least to the question of what direction should be taken for resolving this dispute.

Among the problems which are not governed by treaty law, the most important one is the problem relating to the delimitation of air space and outer space. During the negotiations on the 1967 Outer Space Treaty, the participating states were unable to reach agreement on this problem. Thus, the Treaty does not contain any rules defining the sphere of its application. Efforts to establish special treaty regulation of the problem have been unfruitful notwithstanding the fact that the issue of delimitation has been discussed in the United Nations Committee on the Peaceful Uses of Outer Space since 1967.

The practice of states in the exploration and use of outer space by means of artificial satellites, has led to the emergence of a customary rule of space law to the effect that the region at and above the line determined by the lowest perigee of satellites so far placed in orbit (approximately 100 km above sea level) is not subject to the sovereignty of underlying states and therefore is outer space. This rule was expressly or tacitly recognized by all, or almost all, members of the international community. That was the reason the Soviet representative stated, during the discussions in the Legal Subcommittee on the United Nations Committee on the Peaceful Uses of Outer Space, that "it had become an international legal custom to regard the boundary between air space and outer space as passing through the altitude of minimum satellite perigee, i.e., at approximately 100 km above sea level."[11]

The problem of delimitation is closely connected with the problem of a right of peaceful or innocent passage for spacecraft of a state through the territorial air space of another state at altitudes lower than 100 km for the purposes

[11]U.N.Doc. A/AC.105/C.2/SR.392, at 4 (April 5, 1983). *See* Danielenko, *The boundary between air space and outer space in modern international law* (in Russian with English summary), 9 J. SOVIET STATE & L. 71-79 (1984). *See also, inter alia,* Cheng, *The Legal Regime of Airspace and Outer Space: The Boundary Problem, Functionalism Versus Spatialism: The Major Premises,* 5 ANNALS AIR & SPACE L. 323-61 (1980); Gorove, *International Space Law in Perspective: Some Major Issues, Trends and Alternatives,* 181 RECUEIL DES COURS 361-62 (1983); Zhukov, *Delimitation of Outer Space,* in PROC. OF THE 23RD COLLOQUIUM ON THE LAW OF OUTER SPACE 221 (1980).

of reaching the orbit and returning from the orbit to Earth. The recognition of the right of free passage for spacecraft through the air space of other states is of particular importance for states having small territories because, for physical reasons, these states can only reach outer space by passing through the air space of adjacent states. Thus, without the right of passage, these states would be unable to enter outer space.

Some authors have expressed the view that at this stage there exists,[12] or at least is emerging,[13] a rule of customary law allowing free passage of space objects through the national air space of the other states.

The analysis of international practice shows, however, that it is hardly possible to talk about the existence of a general customary rule governing the relations of all states in this field notwithstanding the fact that there seems to exist a genuine *opinio juris sive necessitatis* on the part of the international community. Up to now, the practice of passage of space objects through foreign air space did not have the required level of generality. It seems that the passage has been carried out only through the air space of some states adjacent to the major space powers. In some cases, the practice of passage has been continued and repeated. Thus, it can probably be argued that this practice is of a longstanding character.

During the 1960s, some of the soviet space probes passed through the air space of adjacent states for the purpose of landing in the territory of the Soviet Union. The Soviet probe Zond-6, for example, descended to Earth from the southern part of the hemisphere and, as it was reported in the Soviet press, had landed in the territory of the U.S.S.R. at a point which was "9,000 km distant from the area of the southern part of the Indian Ocean where the station plunged into the atmosphere."[14] It is obvious that, while engaged in landing in the territory of the launching state, a space object of this type requires passage through the air space above the territory of the adjacent and, perhaps, not far distant states at the altitudes below the established boundary between air space and outer space. With regard to the United States, at least one clear precedent was established during the landing of the shuttle orbiter Challenger on October 13, 1984. The shuttle Challenger flew directly over Canada through its territorial air space and crossed the U.S. border at the height of 222,000 feet, i.e., 6,767 kilometers.[15]

The existence of such practice is bound to have legal consequences for the relations of the states concerned. In this connection, it should be emphasized

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[12]*See*, V. BORDUNOV, *Space Shuttle Flights and Correlation of Legal Regimes of Air Space and Outer Space*, in PROC. OF THE 25TH COLLOQUIUM ON THE LAW OF OUTER SPACE 212 (1982).

[13]*See* REPORT OF THE 59TH CONFERENCE OF THE INTERNATIONAL LAW ASSOCIATION 183 (Belgrade, 1980) (remarks by Mr. Chowdrury).

[14]Izvestia, April 11, 1969.

[15]*See* 122 AVIATION WEEK & SPACE TECH. 24 (1984).

that the passage of space objects through the area which, according to the generally recognized rule, is under the sovereignty of underlying states, can and does affect the legal rights and interests of these states. At the same time, the states concerned did not protest against the passage of space objects through their national air space. According to international law currently in force, the absence of protests on the part of states whose interests are affected, amounts to acquiescence in the practice relating to the passage of space objects. In other words, the failure to protest creates a presumption of a tacit recognition of the right of passage for space objects.[16]

Although the existing practice concerning the passage of space objects through foreign air space is not yet able to create a general rule of customary international law, because of its local nature, it is quite possible that this practice has given rise to a local or particular custom governing the relations of neighboring states.[17] In the course of time, and with the development and consolidation of general, constant and uniform state practice in the field of passage of space objects, this local custom may be gradually transformed into a general rule of customary law that is binding upon all states.

At this stage of the development of the international law of outer space, there are other rules of customary law relating to space activities. It is generally recognized, for instance, that the wide-spread and longstanding practice of the remote sensing of the earth and of its natural resources, has given rise to a rule of customary law according to which there is a right to carry out remote sensing programs without the prior consent of the sensed states.[18]

The problem of the legal regulation of space activities connected with the exploration of the natural resources of Earth by means of remote sensing has been discussed in the U.N. Committee on the Peaceful Uses of Outer Space for a long period of time. Initially, some of the developing states expressed the view that remote sensing, without the prior consent of the sensed state should be prohibited.[19] However, at this stage of the negotiations on the principles governing remote sensing, there is a consensus among states with respect to the recognition of a right of all states to freely conduct remote sensing programs in outer space. Thus, the major issue in this field has shifted from the existence of the right to carry out remote sensing without the consent of the sensed

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[16]For this reason we cannot agree with a different view expressed by W. Schwenk. *See* Schwenk, *Der Durchflug von Weltraumrecht durch den nationalen Luftraum*, 31 ZEITSCHRIFT FUR LUFT-UND WELTRAUMRECHT 8 (1982).

[17]*See* E. MALENOVSKY, *To the Problem of the Right of the Passage Through the Airspace of Other States During the Post-Take-Off and Return Phases of Space Flights*, in PROC. OF THE 25TH COLLOQUIUM ON THE LAW OF OUTER SPACE 134 (1982).

[18]*See* Haraszti, *Outer Space and Sovereignty*, in INTERNATIONALE FESTSCHRIFT FÜR ST. VEROSTA 143 (1980); C. CHRISTOL, THE MODERN INTERNATIONAL LAW OF OUTER SPACE 757 (1982).

[19]See, for example, the proposal for the regulation of remote sensing put forward by Argentina and Brazil. U.N.Doc.A/C.1/1047 (October 15, 1974).

stated, to the problems relating to the dissemination of data and information acquired by remote sensing.

With respect to these problems, there is great dissention among various groups of states. The practice in this field also shows a lack of consistency and uniformity. Some western states, championing the free dissemination of data, have sought to establish a general customary rule allowing the unlimited freedom of dissemination of data obtained by remote sensing. Such unlimited dissemination and analyzed information based on those data, including data concerning natural resources of foreign states, have met with the considerable opposition of a large number of other states. These states represent the view that data above a certain threshold of resolution should not be disseminated without the consent of the sensed state. The opposition was expressed not only in the official statements of various states which objected to the dissemination of data acquired within their territory without their prior consent, but also in the treaty practice. A very important precedent in this field was established by a group of socialist states which concluded the Convention on the Transfer and Use of Data of the Remote Sensing of the Earth from Outer Space.[20] The Convention restricts the dissemination of the acquired data with a spacial resolution finer than 50 meters.

In regard to the question of the right to carry out the remote sensing, it should be noted that the remote sensing has been conducted by states possessing space capabilities for a long period of time, yet the states conducting remote sensing programs sought no permission. This practice has not encountered protests from the states whose interests were affected, notwithstanding the fact that in the early stages of the discussions on this problem, in the U.N. Committee on the Peaceful Uses of Outer Space, there were differences in opinions among various states.

The existence of general consent to current practice, and to the underlying claim on the part of the space powers to the right to engage in remote sensing activities in outer space without the consent of the sensed state, is not only the result of the active sensing practices of the space powers and the passive attitudes of the sensed states which have acquiesced in the legal standpoint claimed by space powers. A growing number of states lacking space capabilities, actively participate in various forms of international cooperation in the field of remote sensing. Further, these states actively establish, operate or plan to construct groundbased receiving stations, and acquire and use the data obtained by the existing remote sensing programs for their economic development. An active practice of this type is strong evidence of recognition on the part of the community of states of the legality of the remote sensing of foreign territory without the prior consent of the sensed state.

Custom as a source of international law, leads to the recognition of the legality of the existing practice if there is general consent, expressed in one form or another, to the observable rule of conduct on the part of the members of the international community. In this respect, the operation of custom in the

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[20] U.N.Doc. A/33/162 (June 29, 1978).

field of remote sensing is not an exception. In this connection, an American commentator has observed that "when the National Aeronautics and Space Administration sent the first ERTS (remote sensing satellite) up into outer space it also sent it into a relative legal vacuum as an instrument which may, orbit after orbit, carve out for itself the necessary norm permitting it to do legally what it was sent out to do in the first place."[21]

The Relationship Between Treaty and Custom in the Modern International Law of Outer Space

Custom as a source of international law is of great importance even in the areas of law where there is a multilateral convention. In this situation, custom operates alongside of the convention and may extend the sphere of the validity of certain general rules contained in the convention. This is of great significance for various branches of international law, including the international law of outer space, where existing multilateral conventions do not formally bind all members of the international community. Thus, the effectiveness of fundamental legal rules in this field depends on the relationship between treaty and custom aimed at extending the scope of application of application of general international norms of conduct relating to space activities.

It is generally recognized that treaty and custom interrelate on the following two main levels:

(1) A treaty may incorporate and confirm the existing customary law. The treaty rules reflecting existing customary law are legally binding on all states independently of their participation in the treaty containing these rules. The International Law Commission has stated in this respect that "a principle or rule of customary international law may be embodied in a bipartite or multipartite agreement so as to have, within the stated limits, conventional force for the states parties to the the agreement so long as the agreement is in force; yet it would continue to be binding as a principle or rule of customary international law for other states."[22]

(2) A treaty may also contain new rules which regulate new problems or change the existing norms. New rules of conduct contained in a treaty can become rules of customary law binding on all states, if there is a general, constant and uniform state practice accepted as law. The possibility of the extention of the scope of application of treaty rules via custom is recognized by the Vienna Convention on the Law of Treaties.[23] According to Article 38 of the Convention, a rule set forth in a treaty could become "binding upon a third state as a customary rule of law, recognized as such."

The two main levels of the relationship between treaty and custom are of

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[21]Z.J. Slouka, *International Law-making: A View from Technology*, in LAW-MAKING IN THE GLOBAL COMMUNITY 164 (N.G. Onuf ed. 1982).

[22]Y.B. INT'L L. COMM'N 368 (1950).

[23]U.N. Doc. A/CONF. 39/27 Rev.1 (1970).

particular importance for the universal validity of a number of fundamental principles and rules of space law embodied in the 1967 Outer Space Treaty. At present, the 1967 Treaty formally binds a little more than 80 states. The analysis of the practice of states, however, shows that there is ground for the assumption that, notwithstanding the fact that there is no universal formal recognition of the Treaty, all the members of the international community are bound by the fundamental principles and rules contained in it because these principles and rules have acquired the status of general customary law. It follows that, independent of the formal participation in the 1967 Outer Space Treaty, all states should observe the obligations arising from its provisions because these provisions are binding as rules of customary law.

A lucid illustration of the importance of the relationship between treaty and custom is the legal situation created by the claims of the equatorial states to segments of the geostationary orbit.

Some of the equatorial states which are not parties to the 1967 Outer Space Treaty, claimed that they are not bound by the principles embodied in the Treaty. In particular, these states claimed that they are not bound by the principles relating to the freedom of exploration and non-appropriation of outer space contained in Articles 1 and 2 of the Outer Space Treaty independent of a formally agreed to and accepted international agreement.[24]

The overwhelming majority of states have rejected the arguements of the equatorial states on the ground that the provisions of the Outer Space Treaty reflected the existing general customary law which binds all states independently of the Treaty. Thus, in the course of the discussion in the Legal Subcommittee of the U.N. Committee on the Peaceful Uses of Outer Space, the representative of Czechoslovakia stated that the provisions of the 1967 Treaty relating to free and equal exploration of outer space "reflected the fundamental principle of space law, which had been declared prior to the elaboration of the Treaty and had become a customary rule in the practice of states."[25] The representative of Italy pointed out that customary international space law allowing for free and equal use of, and free access to, outer space existed before the conclusion of the 1967 Treaty and was codified in it. In this connection, he stated that the "principles embodied in the 1967 Treaty could not be regarded as binding only upon states which had ratified that Treaty."[26] The representative of Japan expressed the opinion that the principle contained in Article 1 of the 1967 Outer Space Treaty, namely that outer space was free for exploration and use by all states, "had already been established in general international law."[27] The representative of the Soviet Union stated that the principles of

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[24]See, for example, the statement by the representative of Colombia in the U.N. Committee on the Peaceful Uses of Outer Space. U.N. Doc. A/AC.105/PV.173, at 56 et seq. (1977).

[25]U.N.Doc. A/AC.105 C.2/SR.297, at 4 (1978).,

[26]*Id.* at 8.

[27]U.N.Doc. A/AC.105/C.2/SR.356, at 3 (1981).

freedom of scientific investigation in outer space and of non-appropriation of outer space, embodied in the 1967 Outer Space Treaty, "had now acquired the status of norms of customary international law and were binding even upon states which had not yet signed the Treaty."[28]

It should be noted that the doctrine of international law is unanimous on the question of the universally binding character of the fundamental principles laid down by the 1967 Outer Space Treaty. This point of view is generally recognized by the Soviet and western writers and, what is of particular importance in this case, by the writers from the developing countries. An important point made in the legal literature in this connection is that "the fundamental principles of international space law, confirmed and declared by the Outer Space Treaty, have been formulated and recognized and accepted by express consent or acquiescence by virtually all countries, developed as well as developing."[29]

The International Law Association has taken a similar view with respect to the principle of the freedom of outer space. The resolutions adopted at the 53rd and 58th Annual Conferences declared that "the freedom of outer space for exploration and use is a principle of general international law and thus a principle valid independent of any treaty."[30]

It is generally recognized that in some instances a convention may exert an influence on the general practice of states and the development of customary international law even if that convention is not yet in force. It is also recognized that a particular provision in a convention in force may possess certain precedential value even if this convention has received few ratifications. In this connection it is interesting to inquire into the question of whether the rules contained in the 1979 Agreement Governing the Activities of States on the Moon and Other Celesital Bodies[31] have altered the state of general customary international law. Of particular interest in this respect, is the provision of Article 11 of the Agreement which stipulates that "the Moon and its natural resources are the common heritage of mankind."

It has been contended that the principle of the common heritage of mankind is an existing or, at least, an emerging rule of customary international law

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[28]Doc.0 A/AC.105/C.2/SR.373, at 6 (1982). See also the statement by R.B. Owen, Legal Adviser, Department of State, to the U.S. Senate. Mr. Owen stated that certain principles laid down in the 1967 Outer Space Treaty, e.g., that outer space and celestial bodies are not subject to material appropriation, are now accepted as "customary international law." *The Moon Treaty: Hearings before the Subcommittee on Science, Technology and Space, of the Senate Committee on Commerce, Science and Transportation*, 96th Cong., 2d Sess. 21-22 (1980).

[29]R.S. Jakhu, *Developing Countries and the Fundamental Principles of International Space Law*, in NEW DIRECTIONS IN INTERNATIONAL LAW 362 (1982).

[30]REPORT OF THE 58TH CONFERENCE OF THE INTERNATIONAL LAW ASSOCIATION 2 (Manila 1978).

[31]U.N.Doc. A/Res.34/68 (1979) (entered into force on July 11, 1984).

of outer space.[32] It seems, however, hardly possible to accept such a contention for the following reasons. First, one should take into account that, in its abstract formulation, the principle of the common heritage of mankind does not create any new legal obligations. Hence, in discussing the problem of whether this principle has emerged as a new rule of customary law creating new obligations for the states concerned, one should turn to the specific aspects of the principle constituting that new right or obligations of states. Because the principle of the common heritage of mankind applies to the exploitation of the natural resources of the Moon, the specific aspects of this principle find their expression in the relevant provisions of the 1979 Moon Agreement and, in particular, in the detailed provisions of Article 11. Paragraph 5 of this Article provides that "states parties to this Agreement hereby undertake to establish an international regime, including appropriate procedures, to govern the exploitation of the natural resources of the Moon as such exploitation is about to become feasible."

The meaning, if any, of the principle of the common heritage of mankind can be interpreted in different ways. But, it is quite clear that the future regime of the exploitation of the natural resources of the Moon is of considerable importance for the realization of the objectives of this principle.

The detailed provisions of Article 11 of the 1979 Moon Agreement are the result of the tendency toward the anticipatory regulation of a situation which does not exist at this time but is possible in the future. Because there is no actual state practice indicating that these provisions have been applied and accepted in the relations of the members of the international community, one can hardly maintain that the principle of the common heritage of mankind, as embodied in the 1979 Agreement, has passed or is passing into the general customary law of outer space. In any event, one thing that can be said with certainty is that custom, as a source of international law, cannot create legal obligations concerning the future exploitation of the natural resources of the Moon before such exploitation becomes feasible and the relations of states with respect to this problem acquire the necessary level of consistency and uniformity. A treaty, as an instrument of legal regulation, can create rules aimed at regulating future problems, but the actual influence of such a treaty on the future general practice and the development of customary law can only be ascertained when the expected problems become the real and practical issues of interstate relations.

Conclusion

The practice of the international law of outer space shows that custom, as a source of legal rights and obligations of states, can be established within a short period of time even before the states concerned reach an agreement on

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[32] R.V. Dekanozov, *Forming of the Principle "Common Heritage of Mankind" and The Rules of Customary International Law of Outer Space*, in PROC. OF THE 25TH COLLOQUIUM ON THE LAW OF OUTER SPACE 219 (1982).

the provisions of a treaty aimed at governing their relations in a given area. After the conclusion of a treaty, custom regulates the relations of states which do not participate in the treaty and the mutual relations of both states who are parties to the treaty and states which are not. In both situations, custom plays an important role in the maintenance of the international legal order in outer space.

EVENTS OF INTEREST

A. Past Events

(a) Reports

1. Thirteenth Annual Friedmann Conference on the Global Telecommunications Revolution, Columbia University School of Law, March 29, 1985

This annual conference, hosted by the Columbia Society of International Law, was held once again in commemoration of the late *Wolfgang Friedmann*, eminent Columbia law professor and outstanding international legal scholar. As the organizer of this year's conference, this writer had the honor to open the meeting and introduce *Professor Richard N. Gardner* of Columbia Law School who, in turn, presented *Leonard Marks*, chairman of the Foreign Policy Association and former director of the United States Information Agency. *Mr. Marks* set the tone by providing a perspective for the issues to be discussed. Referring to the role of communications in economic development, the right to communicate and the disparity in abilities to communicate across the world, he illuminated the gravity of these issues in the world today.

The first panel addressed the problems facing the 1985 WARC, the issue of access to orbital slots. *Professor Stephen Gorove*, the founder and editor of the *Journal of Space Law*, acting as moderator of the panel, introduced the topic by giving an overview of the development of "equitable access" and highlighting some of the relevant issues and alternatives. *Nandasiri Jasentuliyana*, deputy chief of the U.N. Outer Space Affairs Division and native of Sri Lanka, discussed the desires of developing countries for guaranteed access and better planning, possibly *a priori* planning. *Janice Obuchowski*, legal assistant to the chairman of the FCC, explained the United States position which, while guaranteeing access to satellite communications, would allow for the flexibility needed to accomodate American objectives. The need for regulation was also acknowledged. Taking a realist's perspective, *Christopher Vizas*, Executive Vice President of ORION Telecommunication, Ltd., noted the widespread world support for a stricter planning system. He hoped that specifications would be rational and would allow for flexible coordination, but questioned whether the United States would formally accept a rigid plan. He noted that even if the United States did accept such a plan, it would never work.

The second panel, entitled "Obstacles to Direct Broadcasting Satellites," explored copyright and program content concerns relating to DBS. *Gary Epstein* of Latham, Watkins and Hills discussed practical difficulties facing American companies. *Henry Geller*, director of the Washington Center for Public Policy, cited problems in coming to an international concensus on DBS regulation, including the traditional and cultural values that differ radically from country to country. An overview of attempts to come to a working international agreement was given by *Vladimir Kopal*, chief of the United Nations Outer Space Affairs Division. *Yuri Kolosov*, from the USSR Ministry of Foreign Affairs, explained the ideological difficulties in DBS. Use of the mass media for the purpose of ideological competition is not favored by the Soviet Union due to different conceptions in freedom of speech and the potential for serious conflicts between nations at governmental levels. *Professor Michael Botein*, director of the Communications Media Center at New York Law School, moderated.

The luncheon which followed the morning sessions was attended by prominent panelists and guests. *Professor Oscar Schachter* of Columbia Law School, introduced *Richard Colino*, Director General and Chief Executive Officer of INTELSAT, who gave the keynote address on current developments in U.S. policy affecting INTELSAT. He stressed that INTELSAT is the result of a multilateral commitment of the United States to establish an international telecommunications cooperative system in which each member nation shares the costs and benefits of a global satellite system.

Included in its membership are many developing countries which would otherwise be unable to overcome the economic and technological obstacles to maintaining a satellite system on their own. INTELSAT's network not only channels over two-thirds of the world's international telephone calls but also transmits 97% of all intercontinental television broadcasting including the Olympics and the Academy Awards.

Controversy has stirred since *President Reagan* determined last November that "separate" international satellites are in the U.S. "national interest," and formally endorsed the idea of allowing privately-owned U.S. satellite companies to compete with INTELSAT. In the current wave of deregulation and in the wake of the AT&T divestiture, the administration's policy has changed the outlook for INTELSAT. According to *Colino*, at least three issues become apparent: INTELSAT's ability to compete, overconsumption of strategic orbital slots by private systems, and foreign policy ramifications of discontinuing multilateral commitments to other INTELSAT nations.

INTELSAT's ability to compete and to continue to operate as it has in the past is doubted by *Colino*. As INTELSAT is a cooperative, it is operated to break even, not make a profit. Costs are spread throughout the membership with a rate averaging structure. Usage rates for the system are not distance sensitive, as are domestic and international telephone rates, but are uniform for all transmissions. In order to compete with private American companies, INTELSAT needs pricing flexibility which, according to *Colino*'s sources, are not legally provided for in INTELSAT's structure as the FCC claims. Furthermore, forcing INTELSAT to compete could wither away many of the marginal programs which provide necessary and beneficial functions of little commercial advantage.

Secondly, according to *Colino*, competition will cause several different satellite systems to be developed, wasting valuable orbital slots on satellites' serving unnecessary duplicate functions. While INTELSAT efficiently coordinates its satellites for all of its members, independent systems could virtually use up all the key slots in the geostationary orbit. This is of great concern to developing countries which may not now be capable of establishing their own systesm but may want to in the future. Latecomers, in essence, will be wholly dependent on other systems. *Colino* noted how people in developing countires see the deregulatory fervor of the United States in putting up ten separate satellite systems and thus fear that private companies will take up more of the space. He stressed that as the 1985 World Administrative Radio Conference (WARC) approaches, most developing countries, fearing the results of deregulation and competition with INTELSAT, favor an *a priori* planning system which would guarantee access to orbital slots by allocating them from the onset. If adopted, this policy would conflict with U.S. policy and could limit the effectiveness of any one satellite system; in addition, the reserved orbital slots will go largely unused.

Lastly, *Colino* emphasized how a unilateral pronouncement by the U.S. undermining INTELSAT could change one of the keystone achievements of U.S. foreign policy. INTELSAT, as it has been in the past, could be a positive force at WARC. However, with the proposed policy of the *Reagan* administration that will allow for competition with INTELSAT, other nations will be forced to protect their interests in ways likely to be inconsistent with private sector objectives.

Colino stressed how he believes that the decision made by the executive branch was based on inadequate analysis. He hopes for the Department of State to make a finding that a separate satellite system would cause significant economic harm to INTELSAT. He noted that such a finding would show that the United States takes its partnership very seriously and places great weight on good relationships, perhaps as much as it does on economic ideology. He also mentioned the possiblity of amending the INTELSAT agreement to allow it to compete effectively. Emphasizing the need for a "give and take," he urged that unilateralism would not work.

Colino also discussed the recent controversy over the possibility of the Soviet Union joining INTELSAT. Having returned from Moscow recently, *Colino* said that it was merely part of a liaison trip where INTELSAT was discussed for only one minute, with most of the discussion focusing on technical things of mutual interest. In responding to a query, the Soviet Union indicated that they have the issue of joining INTELSAT under study. *Colino* said he would like to see a merger of INTERSPUTNIK, the Eastern bloc satellite system, with INTELSAT. He expressed his disappointment with the immediate U.S. reaction to any proposed linkage of the Soviet Union and INTELSAT, which was one of worry over technology transfers, and labeled it a "non-issue."

The final panel, moderated by Columbia *Professor Eli Noam*, confronted the issue of "Evaluating a Need for International Regulation of Transborder Data Flows." *Peter Robinson*, from the Canadian Department of Communications, discussed the difficulties in regulating the flow of data. He said that the most that could be done is to establish a few "rules of the game," but no extensive regulation. *Lucy Hummer*, deputy assistant legal advisor at the Department of State, described U.S. policy relying on principles of unrestricted flow of information and competition. Voicing the viewpoint of American business, *Cynthia Rich*, Director of Informatics at the U.S. Council for International Business, saw the need for an International Agreement and acknowledged that the issue can be viewed as either a trade issue or a technical issue. *Russell*

Pipe, editor of the *Transnational Data Reporter*, equated transborder data flow to direct broadcasting, except for the distinction that media issues are not raised by TDFs. In concluding, he called for a sorting out of the bundles of issues under the heading, "Transborder Data Flows," in order to more adequately approach the problem.

This year's conference was sponsored by the Julius Silver Program in Law, Science and Technology at Columbia Law School; AT&T; Satellite Business Systems; MCA; COMSAT; and GTE Telenet.

Katherine M. Gorove,
Chair, Thirteenth
Annual Friedmann
Conference, Columbia University

2. *An Agenda for International Co-operation in Sharing the Benefits of Space Exploration*†

Three major reports on space activities, which were proposed by the UNISPACE 82 Conference,* have been prepared by the United Nations. The studies concern aid to countries in assessing their remote sensing needs, use of the geostationary orbit and direct broadcasting satellites for educational purposes.

Each study was prepared by a group of international experts appointed by the Secretary-General of the United Nations. The Scientific and Technical Sub-Committee of the United Nations Committee on the Peaceful Uses of Outer Space reviewed the studies at its February 1985 session and they were submitted for final consideration and action at the Outer Space Committee's June 1985 session. Annexes to each of the studies contain comments of the Scientific and Technical Sub-Committee.

Remote Sensing

The UNISPACE 82 Conference discussed how all States could take advantage of space technology for economic and social development and benefit from using satellite remote sensing to develop and monitor their natural resources

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† The views contained herein are those of the author and do not necessarily reflect those of the United Nations.

* The Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE 82) was convened in Vienna, Austria, in August 1982, in part to assess the new developments in space technology and to assess the adequacy and effectiveness of institutional and co-operative means of realizing the benefits of space technology. *See* N. JASENTULIYANA AND R. CHIPMAN, *International Space Programmes and Policies—Proceedings of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE 82)*, Vienna, Austria, August 1982; North-Holland, 1984.

and the environment.

The Conference pointed out that in the short term at least, access by all countries to the full range of space activities will require co-operation between the developed and developing countries at the regional and international levels. It was noted that many space activities require resources beyond those available to most countries and that groups of countries could combine their resources in order to undertake major space programmes. In cases where countries are undertaking similar activities, co-ordination of systems could ensure compatibility and complementary programmes in order to maximize benefits to all countries. It concluded that through active participation of international organizations, countries can promote knowledge and information, co-ordination of activities and evolution of legal and organizational framework to ensure that space activities benefit all countries.

The purpose of the new study was to consider these questions in greater detail in order to provide guidance to States in planning and developing their satellite remote sensing activities, including aspects of regional and international co-operation.

The report points out that among the various possible approaches for international co-operation in remote sensing might be simple, low-cost, internationally-owned satellite data systems that could make information obtained form space readily available to all nations. Such a system could be based on technology of proven reliability and would be able to make data available to all countries on a continuing basis through relatively simple national or regional ground stations. The system could be managed at a significantly lower cost than the experimental satellites that individual nations would continue to operate.

The report examines some proposals for broad-based organization to coordinate or even own and operate remote sensing satellites, which could be modeled on such organizations as the World Meteorological Organization (WMO) which co-ordinates activities of nationally-owned and operated weather satellites, or the International Telecommunications Satellite Organization (INTELSAT) which operates its own communication satellites. INTELSAT members contribute to the actual expenses of its system by paying in proportion to use, and users pay commercial fees for services. The study finds that if user countries want a satellite system able to meet its needs continually, a forum for voluntary co-ordination is not sufficient. An international organization to design and operate the satellite would be required, as well as a global network of national and regional ground stations, with financial participation of all countries wishing a voice in the decision-making process. With the wide participation, such a system could provide assurances of continuity even if individual countries joined or withdrew.

The study further notes that expensive satellite technology would prevent a commercial fee-for-service operation like INTELSAT. The study notes that such a subsidized public service organization could take as a model the participation of European countries in the European Space Agency (ESA) and the newly created European Meteorological Satellite Organization (EUMETSAT). The international remote sensing satellite system would, in this case, be made of countries agreeing on a common programme, a common budget and division of expenses among themselves. The system could be open to all countries that wish to join, while staffing of the organization and contracting of work could accord with the financial share of each member. The report states that there seems to be little advantage to organizing an integrated global network of ground stations. Informal international co-operation between regionally or nationally owned and operated stations would suffice.

The study also recommended:

(a) consideration of a proposal for a three-year United Nations project to define remote sensing systems to satisfy developing-country needs, possibly followed by establishment of an international consortium to build and operate remote sensing satellites;

(b) involving developing countries in specific remote sensing projects through which they can get practical experience with a view to providing them with the possibility of being involved in the process of designing new satellite systems or providing them certain of their components. There are already examples of such capability and should be encouraged in the future to assist developing countries to reach this level of participation;

(c) compiling a regularly updated catalogue of how satellite remote sensing is being used, including such information as project description, sponsors and major results, which could form a part of United Nations Space Information Service;

(d) creating a worldwide or regional archive of remote sensing data for research in developing countries;

(e) setting up "centres of excellence" in countries or regions to advise scientists and institutions in developing countries on processing, applications, distribution and verification of remote sensing data;

(f) establishing bilateral and multilateral partnerships for assistance in interchanging advanced materials of interpreting satellite data;

(g) creating national repositories of satellite information, a worldwide index on satellite imagery and a system to exchange these data through a global network of computer terminals.

The report concluded that for the next several years, at least, remote sensing systems will remain national undertakings—designed, built, financed and operated by one country that sets terms for making data or ground station agreements available to others. However, by the mid-1990s, if remote sensing activities were pursued nationally or co-operatively in a rigorous manner, the technology would be firmly established. Noting that plans are already under way for a second generation of regionally and nationally owned satellite systems to be in place by the 1990s, the study points out that preparations for a third generation high resolution remote sensing satellite system, for use in the late 1990s or the first decade of the 21st century, should be undertaken now, taking into consideration identified needs and existing and planned systems.

The study: assistance to countries in studying their remote sensing needs and assessing appropriate systems for meeting such needs—was prepared with the assistance of a group of experts from Argentina, Austria, Burkina Faso, Chile, China, Egypt, France, German Democratic Republic, Netherlands, Philippines and the USSR. Technical specialists from UN, UNDP, FAO, UNESCO and WMO also participated as advisers. The report has been published as UN document A/AC.105/339/Rev.1 dated 19 April 1985.

Geostationary Orbit

The UNISPACE 82 Conference noted the explosive growth in recent years in the use of the geostationary orbit, especially for communication satellites. The Conference noted that the present system of registration and co-ordination might need to be improved to guarantee in practice, for all countries, equitable access to the geostationary orbit and frequency bands allocated to space services. Two sessions of a World Administrative Radio Conference (WARC) on the use of the geostationary orbit are scheduled to meet in 1985 and 1988.

UNISPACE 82 also noted that most nations accept that the geostationary orbit is a part of outer space and, as such, is available for use by all States, in accordance with the 1967 Outer Space Treaty. However, equatorial countries consider that the geostationary orbit is a physical phenomenon related to the earth's gravity. For this reason, these countries maintain, it should not be included in the concept of outer space and its use should be regulated under a *sui generis* regime.

The purpose of the new study is to consider in greater detail the question of increasing the capacity of the geostationary orbit by reducing the spacing between satellites within the context of the general conclusions and recommendations of UNISPACE 82 in order to provide guidance to States in planning their use of satellites in the geostationary orbit, including their programmes of regional and international co-operation.

The study concluded that closer spacing of satellites in the geostationary orbit is feasible and certain technologies exist to allow greater overall efficiency in the orbit's use. Some technologies and techniques are already in the implementation phase and others could be implemented on a large scale in the next 5 to 10 years. The efficient use of the orbit is expected to increase noticeably. However, full advantage of the benefits can be achieved only when new techniques are widely used.

The most crowded parts of the orbit, the study noted, are the arcs from 49°E to 90°E (over the Indian Ocean), from 135°W to 87°W (serving North America) and from 1°W to 35°W (over the Atlantic Ocean). For some parts of the orbit, such as over the western Pacific, there would appear to be little prospect of congestion. Since each country or region can only use a portion of the orbit for its communication needs, any competition for positions will be between a certain number of countries and not global.

The study pointed out that under present procedures, although some countries have had difficulties adapting their proposed satellites to existing assignments, no country has been denied access to the geostationary orbit for any satellite. Technological advances, including those contributing to a reduction in spacing could help to ensure continuing access. Given that satellite and Earth station technology will continue to develop and that a growing number of systems using different technologies will be introduced, the potential minimum spacing between satellites will vary with time and with position in the geostationary orbit.

The report noted that advantages offered by communication satellites for telecommunications and broadcasting have influenced planners in developing countries, who want access to space technology. A systematic effort must be made, it said, to assist developing countries in achieving indigenous capability through transfer of know-how. Such assistance should also include education and training in the planning and design of communication satellite systems and operation and maintenance of ground systems. While it is neither possible nor desirable for all countries to establish independent research and development programmes in the field of satellite communications, every country should be able to participate bilaterally, regionally or internationally in such programmes.

If a country or group of countries has decided to acquire a satellite system or ground system, a key question is the choice between designing and building satellites and Earth stations or buying systems from other countries. A decision to build domestically may have implications for satellite spacing, in that a country new to the technology of satellite or Earth station design may have difficulty incorporating the most advanced technology that could maximize communication capacity or minimize spacing.

Special efforts should be made, the report said, by the International Telecommunication Union (ITU) to assist developing countries in assessing future satellite communication requirements and identifying optimum orbital positions and frequency bands for their satellite communication needs.

The report further concluded that:

(a) The number of objects in the geostationary orbit, including active satellites, dead satellites and associated fragments and debris, is increasing steadily, and with it the probability of collisions. Any collision is likely to put an active satellite completely out of service. The problem of collisions between active and dead satellites is somewhat greater than between active satellites. Large amounts of small untrackable debris in orbits intersecting the geostationary orbit, for example due to explosions of propulsion systems or through fragmenting collisions, will increase the risk of collision substantially.

(b) The probability of collision can be reduced if inactive satellites are removed from the geostationary altitude, with the final thrust of station-keeping propulsion. An increase in altitude of about 200 km is believed to be able to prevent a satellite from passing through the geostationary orbit. Some satellites have already been removed from the geostationary orbit at the end of their useful lives in this way. Once satellites have lost their manoeuvring capability, they can be removed from the geostationary orbit only by expensive scavenging missions which are not possible with current technology. The danger of collisions, although very small at present, could in the future impose certain constraints on the number and size of satellites in the geostationary orbit. A systematic study of the problem of collisions may be needed to find ways to avert them.

(c) Spacing between satellites must take into account the possibility of radio interference between communication satellites. In the foreseeable future, only communication satellites in the fixed-satellite service and broadcasting satellites are likely to be affected by congestion of the geostationary orbit and the available frequency bands.

(d) The International Telecommunication Convention which contains principles to govern international telecommunication, states that radio frequencies and the geostationary satellite orbit are limited natural resources and that they must be used efficiently and economically, so that countries or groups of countries may have equitable access to both, taking into account the special needs of the developing countries and the geographical situation of particular countries.

The study: the feasibility of obtaining closer spacing of satellites in the geostationary orbit—was prepared with the assistance of a group of experts from Columbia, Czechoslovakia, Italy, Japan, Kenya, Pakistan, Sweden, the USSR and the United Kingdom. Technical specialists from ITU also participated as advisers. The report has been published as UN document A/AC.105/340/Rev.1 dated 22 April 1985.*

Direct Broadcasting Satellites

The UNISPACE 82 Conference suggested that countries examine the feasibility of using direct broadcasting satellites to aid the spread of education, and explore the possibility of sharing the space segments of a direct broadcasting system, including the possibility of using any existing or planned satellites.

Developing countries, it noted, had to improve their educational infrastructure, not only to educate the young, but also to provide a continuing source of information, knowledge and know-how to the adult population. While the use of space technology could not provide instant solutions to these problems, it could complement conventional methods to accelerate the spread of education and improve its quality, particularly in remote rural areas.

Interested countries should examine the feasibility of a satellite space segment owned internationally or regionally for providing direct broadcast television service, the Conference stated. Existing organizations might choose to consider developing broadcasting satellite systems which could be used for educational purposes. Community receivers linked to a direct broadcasting satellite system could fullfil many needs in diverse fields, including school education, health, family planning, nutrition, agriculture and teacher training.

The purpose of the new study is to consider in greater detail the feasibility of using direct broadcasting satellites for education and of the possibility of regional and international co-operation for this purpose in order to provide guidance to States in studying or planning the use of direct broadcasting satellites for education.

The study concluded that from a technological viewpoint, the use of direct

* For detailed exerpts from the text of U.N. Doc. A/AC.105/340/Rev.1 (April 22, 1985), see Document II in the Current Documents section *infra*.

broadcasting satellites for educational purposes is feasible. Direct broadcasting satellites and earth stations are operational and the technology is expected to improve fairly rapidly in the near future, particularly in the 12 GHz band, resulting in lower costs for satellites and small receiving stations and making direct broadcasting economically attractive.

The study pointed out that using satellites results in lower costs for coverage of larger areas with few or no existing transmission and distribution facilities. For large areas, a satellite system operates at less expense than a terrestrial system. If there are enough receivers in the area, the cost of community rebroadcasting stations or cable distribution systems would more than be paid for by savings resulting from use of ordinary television receivers. A direct broadcasting system may also be preferred, it said, for remote, rural and unserved areas, or to provide a "national channel" or university-level broadcasts to all the colleges in a country.

Noting that educational broadcasting outside of the formal educational system, whether in the form of pre-school education, correspondence courses, general adult education or continuing adult education is being successfully used in a number of countries, the study concluded that it seems particularly suited to part-time education while its value in providing basic elementary education for children with no access to regular schools is not clear.

It noted that a number of projects using broadcast television as a primary component of school education have encountered major organizational difficulties. Since these difficulties are not technological in nature and only partly economic, they will not be solved simply by introducing direct broadcasting satellites. The future of educational direct broadcasting within existing educational systems depends on the future role of television in a system. The introduction of new media technologies into as fundamental a part of a country's culture as the education system is likely to be a slow process even if it proves to be feasible and desirable. Any country should undertake small-scale pilot projects before launching a large-scale satellite-based project.

The study noted that while efforts should be made to make Earth station technology available to all developing countries planning educational broadcasting systems, for most countries using a direct broadcasting satellite only for educational purposes is not currently economically feasible. Countries interested in educational direct broadcasting should therefore consider providing channels for this purpose on communication satellites, multi-purpose satellites, or regional or international satellites. While groups could consider domestic and regional systems, the study noted that, international organizations could consider the possibility of an international direct broadcasting system offering channels on a short or long-term basis to interested countries, providing access to developing countries for educational programming on favourable terms.

The report pointed out that cost estimates for space segments of existing direct broadcasting satellite systems, depending on their sophistication, range from \$35 to \$140 million. Additional costs for launching the satellites, running into the tens of millions of dollars, must also be incurred. The cost of an operational direct broadcasting satellite system might be a minium of \$200 million to cover three satellites, two launches and the ground control and transmission facilities. Costs of associated receiving stations, programme production and support activities for a large-scale operation would also be substantial. The study noted that a significant cost for programme production, broadcasting and support services must be met. The SITE programme, for example, using simple equipment but including graphics and on-location recording, produced 1,400 hours of programming for about $4,000,000 or $3,000 per hour of programming. About two-thirds of this was for hardware and one-third for production costs.

The report also made the following conclusions:

(a) Countries could also use a channel part-time, with other countries. Time-sharing of channels depends on agreement on time slots for each country. For example, one country might use the satellite for daytime school programmes and a second country for evening adult education programmes, or both the day and evening periods could be divided into two time slots. Sharing could be facilitated if the countries were several time zones apart, thus allowing both countries to use the most desirable local times such as early evening. The sharing of actual broadcasts by two or more countries would substantially reduce costs, but would require similar cultural, educational and socioeconomic systems.

(b) Exchange of educational programmes between countries can reduce the cost of programme production, and provide more variety in programing and provide programmes that could not be produced domestically. Science or mathematics programmes could serve the needs of many countries and foreign programmes on geography, history and culture could be useful in different countries. Imported programmes might prove valuable for study of foreign languages. There is also the question of whether even educational programmes are completely value-free and, if not, whether importing programmes also implies importing the associated values. Each country must produce indigenously as much of its educational programmes as possible, and imported programmes should be used after due screening and caution, according to the report.

(c) While technical difficulties and costs have posed some problems, the main obstacles have been organizational, in particular, the problem of integrating television into the traditional educational structure. Many educational television projects using terrestrial broadcasting in developing countries have been terminated or substantially reduced for a number of reasons, including teacher resistance. Direct broadcasting satellites should not be expected to revolutionize education, at least not in the short-term.

The study: the feasibility of using direct broadcasting satellites for educational purposes and of internationally or regionally owned space segments, was prepared with the assistance of a group of experts from Australia, Brazil, Bulgaria, Canada, the Federal Republic of Germany, India, Indonesia, Mexico, Romania, Sweden and the USSR. The report has been published as UN document A/AC.105/341/Rev.1 dated 29 April 1985.

N. Jasentuliyana
Deputy Chief,
Outer Space Affairs Division
United Nations

3. American Society of International Law Meeting on "Arms Control and U.S. Policy: 'Star Wars,' MAD, MX, and Pershing IIs," New York City, April 26, 1985

A panel discussion on "Arms Control and U.S. Policy: 'Star Wars,' MAD, MX, and Pershing IIs," was held at the Roosevelt Hotel in New York on April 26, 1985. The discussion was part of the Seventy-Ninth Annual Meeting of the American Society of International Law (ASIL), and was co-sponsored by the Association of U.S. Members of the International Institute of Space Law and by the Interest Group on Space Law of the ASIL.

The discussion was chaired by *Professor Stephen Gorove* of the University of Mississippi Law Center and included as panelists: *Harry H. Almond, Jr.*, Faculty Member at the National War College; *Martin A. Feinrider*, Associate Professor of Law at Nova University; *Irwin M. Pikus*, Senior Adviser on International Policy at the National Science Foundation and *Igor I. Yakovlev*, Senior Counsellor at the Permanent Mission of the Union of Soviet Socialist Republics to the United Nations. *Edward R. Finch*, Partner in Finch & Schaeffler of New York, served as commentator.

In his opening address, *Professor Gorove* expressed his pleasure at the information, earlier in the day, of an ASIL Interest Group on Space Law which initially plans to pursue studies in the fields of space stations (living and working in space), arms control and space telecommunications. Turning to the subject matter, he recalled some of the conclusions he arrived at during the 1982 ASIL panel discussion which, unlike the current session, focused exclusively on Arms Control in Outer Space.

The types of issues that could be addressed by the current panel were broader. Some of the questions *Professor Gorove* suggested for consideration included the following: What are the short and long-term objectives of arms control, national and international? Is one of the objectives to make nuclear arms ineffective or impotent? What is the meaning of the Strategic Defense Initiative (SDI)? Is it an imperfect system? Can it be made 90% or more effective? What about counter-measures, vulnerability the development of new technology and cost effectiveness? Is SDI a good substitute for the notion of mutually assured destruction (MAD) which underlies the ABM Treaty? Is it a bargaining chip? What are the legal implications of SDI? How far can one proceed under the ABM Treaty? Is any phase of SDI prohibited? What are the interpretations? Are lasers and particle beams weapons, weapons of mass destruction? If so, under what circumstances? If one wanted to make a deployment to see whether SDI works, would one have to abandon the ABM Treaty? What are the alternatives to withdrawal from the treaty? Can the treaty be renegotiated? What is the interrelationship between ASATs and SDI? What about verification of any phase of SDI? What are the U.S. and Soviet perspectives and expectations regarding activities of each other? Are there any arms control measures regarding outer space that could be agreed upon irrespective of SDI?

Following the introductory remarks by the chair, *Professor Almond* began with an analysis of the long-range and short-term goals of the United States arms control policy. He stressed that the United States seeks a common strategy with the Soviet Union and other states to lessen, deter and if possible prevent a war using nuclear weapons or other weapons of mass destruction from erupting, and, further, to prevent other wars, or other incidents by terrorists or third states, from leading to such wars.

Professor Almond was of the view that U.S. policy is also aimed at establishing through the arms control agreements the security of a minimum public order that it believes must be shared among all states. The policy implies, though not fully expressed, that effective and enforceable arms control agreements will depend increasingly upon the attainment both of greater public order and upon improved relations dependent upon common interests in promoting the values of human dignity throughout the world. The policy by implications perceives that the critical element in maintaining minimum public order is to be found in reaching more effective and enforceable undertakings regarding the regulation of the use of force among states in their relations, and in formulating, adopting and applying community policies and standards in such regulation of force.

As to the ABM Treaty, *Professor Almond* felt that both the United States and the Soviet Union have been engaged in strategic defense activities but such activities have not gone beyond the research stage and have not violated the ABM Treaty.

Professor Feinrider was the next panelist to speak. He began by espousing that there has been a disturbing trend recently, whereby the importance of international law as a controlling factor in key governmental decisions such as those related to war and peace with the nuclear arms race has diminished. He stated that many of his colleagues regularly denied or excused international lawlessness on the part of the United States in the name of world order or as a result of some policy-oriented analysis. On his part, he believed in *pacta sunt servanda* and regarded international law as binding on all nations, including both super powers. He also believed that the job of an international lawyer revealing treaty texts and state practice was to ascertain fairly the intentions of the parties and the resulting legal obligations and then to analyze subsequent practice with a view of furthering the good faith performances of such obligations and not with a view to avoiding these obligations. It was not appropriate, in his view, for an international lawyer to rely on strange readings of texts and disingenious presentations of fact to erode legal obligations and thus rationalize the avoidance of constraints on state behavior.

Professor Feinrider then focused his remarks on the bilateral/multilateral international law bearing upon *President Reagan's* strategic defense initiative, more commonly known as Star Wars. *Feinrider* suggested that the erosion of the conditions under which the ABM Treaty was concluded, was due in part to intentional actions on the part of the United States and perhaps as well on the part of the Soviet Government.

Referring to the Vienna Convention on the law of treaties and the *rebus sic stantibus clause, Feinrider* said that one can not invoke one's own conduct as a basis for claiming that there was a fundamental change of circumstances, especially when the possible change was envisaged when the treaty was drafted. It was nonsensible to take a treaty that bans antiballistic missile systems and to amend it to build a whole world regime on such missile systems. If a decision is made to switch to another mode of keeping the two super powers in balance, then, in *Feinrider*'s view, one has to end the ABM treaty and start over again.

While *Feinrider* expressed serious doubts about the legality of Star Wars, he emphasized that his comments should not be taken as in any way endorsing the current Soviet negotiating position. He noted with dismay that the military plans of the Soviet Union, unlike those of the United States, were not comparably available and the resulting *de facto* immunity from informed criticism should not be taken to imply anything less than suspicion with respect to Soviet plans and skepticism regarding Soviet intentions.

The next panelist, *Dr. Pikus*, said that the strategic defense initiative was born of a frustration in trying to come to grips with an overwhelming number of offensive weapons. He felt that this was a creative tact. He pointed out, however, that SDI raises issues in the technical, political and legal areas. The technical problems have to do with whether the technologies can be developed to actually intercept and destroy and prevent nuclear weapons from being delivered to their targets. A political issue that has not been perceived far enough is the question of how to relate a perfectly successful strategic defense, should such be developed, to the reduction of offensive arsenals.

As to the legal issues, *Dr. Pikus* stressed that lawyers have to be very sensitive to both the technical and the political questions and that there are other prerogatives that the people who make decisions will have besides accomodating the legal question. Thus a successful solution to the problem is going to involve the development and accommodation of the law in the light of political realities which cannot be ignored. Insofar as the ABM Treaty was concerned, *Dr. Pikus* felt that a defensive system based on new technologies was not, technically speaking, a violation of that treaty. Nonetheless, it was necessary to undertake a good faith discussion of the limitation of these new technologies.

Turning to Article III of the 1967 Outer Space Treaty, *Dr. Pikus* emphasized that there was a need to better understand what maintains international peace and security and how it relates to all the things that go on in space. If one is to use space to maintain international peace and security, in order to be consistent, one would have to prohibit the passage of nuclear weapons through space, even though it may be difficult to achieve such ban. As to weapons of mass destruction, *Dr. Pikus* raised the question of whether a weapon that could destroy a million, a thousand or a hundred people or could down an aircraft would be considered a weapon of mass destruction. He also felt that there was a need to clarify further what a defensive weapon is. In conclusion, he said that lawyers have to confront SDI as a potential political reality and understand what the legal ramifications are and how they can accommodate the rule of law to political realities.

The last panelist, *Dr. Yakovlev*, stressed that while he was speaking in an unofficial capacity as the other panelists were, he would touch upon certain official proposals which were advanced by the Soviet Union. Among them he referred to the 1983 Soviet treaty proposal to prohibit the use of force in outer space and from space against the Earth. He listed five important prohibitions in that proposal: first, the prohibition of testing and deployment, by placing in orbit around the earth or stationing on celestial bodies or in any other manner, of any space-based weapons for the destruction of objects on the earth, in the atmosphere or in outer space; second, the ban to utilize space objects in orbit around the earth, on celestial bodies or stationed in outer space in any other manner as a means to destroy any targets on the earth, in the atmosphere or in outer space; third, the prohibition of destroying, damaging or disturbing the normal functioning or changing the flight trajectory of space objects of other states; fourth, the ban to test or create new anti-satellite systems and the requirement to destroy any anti-satellite systems that the states parties may already have; and fifth, the prohibition of testing or using manned spacecraft for military, including anti-satellite, purposes. He deplored the fact that the United States has not responded by making a counter-proposal with respect to the Soviet draft to prohibit the use of force in outer space and from space against the earth. The Soviet Union's goal was to prevent the militarization of outer space.

Following the presentations by the panelists, *Mr. Finch* highlighted some of the points made by the speakers and observed that we are beginning to see some agreement between the United States and the Soviet Union regarding the need for a revision of the Registration Convention. He referred to the Cosmos 954 and 1402 incidents and expressed the view that there should be a provision in that treaty prescribing positive notification of accidents. He also stated that the United States and the Soviet Union were in complete agreement that the geostationary orbit is not subject to national appropriation.

A lively discussion among the panelists and questions and comments from among members of the audience and responses by the panelists ended the highly interesting and challenging session which drew an overflow audience in the Oval Room of the Roosevelt Hotel.

Stephen Gorove
Chair, Session on
Arms control and U.S
Policy, ASIL 1985 Annual
Meeting

(b) Short Accounts

4. Annual Meeting of the AALS Session of the Aviation and Space Law Section, Washington, D.C., January 6, 1985

As part of the 1985 Annual Meeting of the Association of American Law Schools, held in Washington, D.C. on January sixth, the Aviation and Space Law section presented a program on the "Geostationary Orbit: Prospects for the 1985 WARC." *John W. Reifenberg, Jr.*, of Detroit College School of Law, presided and *Professor Stephen Gorove* of the University of Mississippi, served as program chairman.

In his introduction, *Professor Gorove* reviewed international regulations pertaining to equitable access to the geostationary orbit, and expressed the hope that the panelists would address some of the alternatives in finding acceptable criteria for the determination of the meaning of "equitable access."

Among the speakers were *John B. Gantt*, a Washington, D.C.-based attorney who reviewed past experiences pertaining to the commercialization of space. *Steven A. Levy*, a Washington, D.C.-based attorney, stressed that the dispute in relation to the geostationary orbit, was in the nature of a legal-political controversy and not a North-South conflict, but more of a traditional type.

Dean A. Olmstead, an official of the State Department and an adviser to *Ambassador Dougan*, gave a few insights into the policy formulation process as it related to the consideration of geostationary orbit issues by the 1985 WARC. He reviewed the various structural elements, discussed the synthesis process and provided an overview of the work which remained to be done in preparation of the forthcoming conference.

Martin Rothblatt, another Washington, D.C.-based attorney, discussed the implications of the space WARC, for international satellite communications and the tensions between national and international satellite services. He also reflected upon other space resources which are analagous to the geostationary orbit.

Also making a presentation, was *Ronald F. Stowe* of Satellite Business Systems, McLean, Virginia, who looked at the issues from the viewpoint of private industry and the national interest.

Stephen Gorove
Program Chair,
AALS Session of the
Section on Aviation and
Space Law

5. Establishment of a National Commission on Space and Appointment of its Members on March 29, 1985

The National Commission on Space was authorized by Congress under Public Law 98-361 and established by Executive Order 12490 dated October 12, 1984. On March 29, 1985, the President announced his appointments to the Commission which include:

Dr. Thomas D. Paine, one-time administrator of NASA, Chairman;
Dr. Laurel L. Wilkening, Dean of Planetary Science, University of Arizona, Vice Chairman;
Dr. Louis W. Alvarez, Professor Emeritus, Lawrence Berkeley Laboratory;
Mr. Neil A. Armstrong, Apollo Astronaut, CTA, Inc.;
Dr. Paul J. Coleman, Department of Earth and Space, UCLA;
Dr. George B. Field, Director, Smithsonian Astrophysical Observatory;
Lt. General William H. Fitch, U. S. Marines (Ret'd);
Dr. Charles M. Herzfeld, Vice President R & D, ITT Corp.;

Dr. Jack L. Kerrebrock, Professor of Aeronautics and Astronautics, MIT;
Ambassador Jeane J. Kirkpatrick, Professor, Georgetown University;
Dr. Gerard K. O'Neill, President, Geostar Corp.; Professor Emeritus, Princeton University;
General Bernard A. Schriever;
Dr. Kathryn D. Sullivan, Astronaut, NASA Johnson Space Center;
Dr. David C. Webb, Chairman, National Coordinating Committee for Space;
Brig. General Charles E. Yeager, USAF (Ret'd);

The purpose of the Commission is chartered as follows:

> It is the singular task of the National Commission on Space to look decades into the future to recommend to the President and the Congress a national space enterprise that over the next twenty years will move the U.S. and cooperating nations far beyond the bounds of Earth. In particular the Commission is to study existing and proposed U.S. goals in space; define longer-range opportunities, policy options and objectives, and formulate a bold new agenda for the U.S. in space.

This is no small challenge and no small responsibility—something of which the Commission is well aware. It offers, however, an opportunity for the general public, speaking through the Commission, to significantly affect the future orientation and direction of our move into space, something that has not been possible heretofore. To speed that process, the Commission will be holding meetings in as many cities across the nation as is possible, given the demanding timeline of having to produce its report and recommendations at the end of twelve months.

In announcing the formation of the Commission, the President made his own expectations quite clear:

> The Commission, with the participation of the brightest minds in and out of the space community, will bring into focus a vision of America's future opportunities and develop a strategy to ensure America is ready for tomorrow. The Commission will outline for us an operational plan, including objectives, agents and resources. The members will talk with a broad sampling of Americans to keep our space efforts on target with the hopes, dreams and aspirations of the people.

Our task, then, is to produce a visionary but workable 20-year plan for our nation's space program that stems from and will be supported by the people. We can do no less. We must do no less if America is to remain in the forefront of mankind's move into space.

Dr. David C. Webb
Chairman, National Coordinating
Committee for Space

6. 1985 Conference on International Space Policy: Options for the Twentieth Century and Beyond, Georgia Institute of Technology, May 16-17, 1985

Organized by *Dr. John R. McIntyre* and *Dr. Daniel S. Papp*, both of the Georgia Institute of Technology's School of Social Sciences (Program in Science, Technology and International Affairs), a two-day conference on international space policy was held May 16 and May 17 on the Georgia Tech campus. Some 200 people attended, among whom were 30 active invited participants who delivered referred papers and took part in four panels.

The first set of papers were grouped in the "U.S. Domestic Context: Select Issues Panel" and included analyses of the protection of intellectual property in space by *Ms. Barbara Luxenberg*, Special Executive Assistant to the U.S. Commissioner on Patents and Trademark. Issues of national security and technology transfer controls were considered by *Dr. W. J. Jones* of Memphis State University while *Dr. James Katz* of the LBJ School of Public Affairs of the University of Texas considered the U.S. domestic policy context in which space policy has been made.

On Friday, May 17, the diplomatic and legal dimensions panel, chaired by *Dorinda Dallmeyer*, Director of Research at the Dean Rusk Center of the University of Georgia Law School, considered four sets of issues: *Dr. Goldman* of the University of Texas reviewed the evolution of international space law regimes; *Dr. Soroos* of North Carolina State University analyzed the impact of telecommunications on space policy as a subset of foreign policy; *Dr. Meeks* of the University of Georgia provided a critical analysis of U.S. foreign policy and its interaction with space policy; finally, *Dr. Ray Williamson* of the Office of Technology Assessment presented a report on recent international cooperation in civilian space activities and what the future portends in this area.

The panel on economic and competitive issues was chaired *Dr. Frederick Rossini* of the Office of Interdisciplinary Studies, Georgia Institute of Technology. Papers included the interaction of the commercialization of space technology and the spread of ballistic missiles by *Aaron Karp* of Columbia University; the relevance of economic analysis to the growing space market by *Dr. Henry Hertzfeld*, senior economist at NASA; the historical implications of earth resources satellites by *Dr. Pamela Mack* of Virginia Polytechnical Institute and State University; and finally an analysis of the reasons for ESA-NASA collaboration in space by *Dr. Joan Johnson-Freese* of the University of Central Florida at Orlando.

The last panel dealt with the militarization of space. *Dr. Grant Hammond*, chair of international studies at Rhodes College of Memphis, put the current strategic defense initiative in its proper military history context. *Dr. Hans G. Brauch* of Stuttgart University offered a European perspective on SDI; *Dr. H. M. Hensel* of the U.S. Air Command and Staff College, Alabama, considered Soviet images of superpower space policy. *Dr. Sergei Rogov* of the Soviet Embassy, Washington, presented a Soviet view of the SDI.

Closing remarks were delivered by Callaway Professor of the History of Technology, *Melvin Kranzberg*, on the theme of "The Future of the Space Program: The 'Top Line'." *Dr. Kranzberg* is the current chairman of the National Historical Advisory Committee set up by NASA.

The plenary session address was delivered by *Dr. John M. Logsdon* of George Washington University. His presentation reviewed perennial themes of space policy and the future evolution for the balance of the century. A keynote banquet address was delivered by *Mr. James Morrison,* Deputy Director, Office of International Affairs, NASA, Washington, on the theme "Should Space Policy Encourage International Affairs?"

The conference participants considered that space capabilities have not yet fundamentally affected the economics, military strategies or politics of major countries yet, unlike the recent argumentation of *Walter McDougall.* However, space policy is entering a new age in which it becomes a distinct possibility that space will impact fundamental economic and strategic policies on earth. These impacts were considered.

Proceedings will be published in book form by the American Astronautical Society Science and Technology Policy book series within half a year.

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7. *L-Band Update*

The L-Band which roughly covers frequency ranging from 1400 to 1800 MHz has been a source of considerable attention at the Federal Communications Commission (FCC). The FCC recently received a dozen applications requesting L-Band allocations to provide mobile satellite service (MSS). Three of these applicants—Omninet Corporation, McCaw Space Technologies and a subsidiary of Mobile Communications Corporation called MCCA American Radiodetermination Corporation (MARC)—also requested that they be granted authority to provide radio determination service (RDSS) as well.

The applicants are generally asking for frequencies in the range of 1500 to 1600 MHz, with a variety of additional requests for frequencies in the UHF and Ku-Bands. Most applicants are requesting up to 8 MHz of bandwidth in UHF frequencies, and bandwidths ranging from 1 to 30 MHz in the L-Band. Some have also requested additional frequency allocations ranging from 50 to 200 MHz in the Ku-Band.

The Commission has already determined that there is sufficient difference between the services and system configurations of RDSS and MSS to warrant separate proceedings for both types of satellite service. *See Notice of Proposed Rulemaking,* FCC 84-319 (Released September 7, 1984) and *Notice Of Proposed Rulemaking,* FCC 85-238 (Released May 7, 1985). RDSS is an all-digital service which provides geographic positioning and radionavigation by calculating velocity components. It also enables transmission of short digital messages. MSS is a narrowband channelized service which provides voice and low-speed data transmissions and can be interconnected to regular telephone systems. While MSS can also provide crude positionings, it is not possible to use the system for purposes of radionavigation.

Presently, frequencies between 1435-1530 MHz are used by non-government entities that manufacture aircraft to test various equipment on board aircraft as well as for purposes of telemetry. INMARSAT and the Soviet Volna systems also use the L-Band to provide maritime mobile services. Portions of the L-Band are also allocated for aeronautic mobile and radionavigation satellite services such as those offered by the GPS Navstar and Glonass systems. Starting in 1986, the L-band will also be used via a Geo-star RDSS package on board an RCA-manufactured satellite, "GTE GStar." Finally, radioastronomers make important use of portions of the L-band for interstellar and intergalactic studies.

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8. *Other Events*

The Second Annual Space Law Symposium of the University of Bridgeport School of Law, held on March 23, 1985, had as its theme "Transnational Law in the Space Age," and was moderated by *Professor Myres S. McDougal*. Presentations were made by NASA, DOT, Space Services, U.S. Aviation Underwriters, Federal Express and RCA.

The International Telecommunication Union and the American Bar Association sponsored a World Telecommunication Forum in April 1985, in Washington, D.C. Among the presentations were lectures on "International Communications Law and Treaty Conferences," "Service Guarantees and User Responsibilities," "Limitations and Restrictions to International Telecommunications," "The Structure of Telecommunications Markets and Regulation" and "Communications From the Perspective of Trade in Services Agreements."

The L-5 Society, The National Space Institute, Students for the Exploration and Development of Space, The American Astronautical Society, The American Space Foundation and Spacepac sponsored the Fourth Annual Space Development Conference in Washington, D.C. on April 25-28, 1985. Among other topics, the conference dealt with space stations, space politics, industry, communities in space and aspects of international cooperation. The keynote speaker was *Dr. Gerard K. O'Neill.*

A conference on space manufacturing was held at Princeton University on May 8-11, 1985. Among other things, it dealt with international/economic considerations and was chaired by *Irwin M. Pikus* of the National Science Foundation. The presented papers included: "Legislative Perspective on the Climate for Space Development" by *Darrell R. Branscome*, "Intellectual Property and Space Development" by *Gerald J. Mossinghoff*, "Financial Climate for Space Development" by *Wolfgang Demisch* and "Private Rights and Legal Interests in the International Development of Outer Space" by *Stephen Gorove.*

Telecom Singapore and the International Telecommunication Union organized the Asia Telecom '85 which was held in Singapore on May 14-18, 1985.

Two informal IISL sponsored programs were presented in the United Nations. The first one, organized by *Dr. Martin Menter* was held on April 4, 1985 before the Legal Subcommittee of the U.N. Committee on the Peaceful Uses of Outer Space and dealt with issues of telecommunications. The second program, organized by *Professor Stephen Gorove* was held on June 18, 1985 before the U.N. Committee on the Peaceful Uses of Outer Space and focused on two topics: Soviet Space Stations and Planetary Exploration in the Search for Extraterrestrial Life.

9. Brief News

The Federal Communications Commission is proceeding with plans for 2-deg. orbital spacing of communications spacecraft in geosynchronous orbit. . . . The United States, the Soviet Union and countries in Western Europe plan a broad range of cooperative activities to investigate the reappearance of Haley's Comet. . . . Arianespace and the French CNES Space Agency expect to begin operations with the new Ariane 5 Heavyweight launcher in 1995; the payload of the Ariane 5 will range from 5,200 kg to more than 8,000 kg. . . . The fourth space shuttle, Atlantis, was rolled out of the Rockwell International production facility in April 1985. . . . "Phase B" Space Station Definition Studies will be conducted by the space agencies of the United States, Europe, Japan and Canada. . . . France's CNES Space Agency is expected to choose a prime contractor for its Hermes Manned Shuttle Vehicle by mid-year. . . . Discussion continues regarding Soviet membership in INTELSAT which would require some coordination with the INTERSPUTNIK Soviet satellite system. . . . By the end of 1985, EUTELSAT plans to be the principal distributor in the world of international satellite television programming. . . . Ireland, Spain and Portugal have agreed to form a DBS venture by sharing an Irish satellite to broadcast to the United Kingdom and Iberia. . . . Preparations are in progress for the introduction of DBS to Italy in mid-1987. . . . The shuttle pallet satellite (SPAS), developed by MVV/ERNO of West Germany and under contract to the European Space Agency, could carry approximately 75 different experiments, including space station demonstrations. . . . Black holes are believed to be objects so compact that their gravitational pull allows nothing to escape—not even light. . . . A Saudi Arabian prince, a Frenchman and five U.S. astronauts manned a shuttle flight that launched four satellites.

B. Forthcoming Events

As previously reported, the 1985 IISL Colloquium will be held in Stockholm, Sweden, October 7-12, 1985. The Colloquium topics include the following: 1. Maintaining Outer Space for Peaceful Uses; 2. Comparison Between Sea and Space Law, Especially in View of Exploration and Exploitation Activities; 3. Legal problems of Registration of Space Objects; and 4. Space Activities as a Subject of Space Law.

The Scientific Legal Roundtable will be held on October 8, 1985, on the subject of "Legal and Technical Implications of Space Stations."

BOOK REVIEWS/NOTICES

International Space Law, by Gennady Zhukov and Yuri Kolosov (translated from the Russian by Boris Belitzky; published by Praeger in cooperation with Novosti Press Agency, New York, 1984), 224 pages.

It is uncommon, if not unique, that western scholars would have the opportunity to read in English a recently published book on international space law co-authored by two eminent Soviet authorities who present a rare insight into the Soviet position throughout the book. *Professor Zhukov*, a very well-known and prolific writer on space law, and *Dr. Kolosov*, an author of several important works on international law, are identified in the Foreword to the book by *Leonid Sedov*, a member of the Soviet Academy of Sciences, as being "among the founders of international space law who have been personally involved in formulating the rules of international space law in the United Nations and other international bodies."

In introducing their subject matter, the authors discuss the concept, sources and principles of international space law which is regarded by Soviet scholars "as a new branch of general international law in its own right." In disagreement with *Professor Myres S. McDougal* who, in the authors' view, "would like international custom to be assigned the overriding goal in the establishment of the rules of international space law," the authors assert that while "international custom does play a definite part in the process, the main role in it clearly belongs to the international treaty." (P. 14).

The writers point out that Soviet legal doctrine rejects both natural law interpretations of international space law as well as the notion of a "legal vacuum", since general principles of international law may be applied to space activities with due consideration for their specific features — outer space and celestial bodies. Some analogies with the law of the sea and air law, such as mechanical transfer of the "common heritage of mankind" concept from the international law of the sea to the moon and other celestial bodies, their natural resources, and also to geostationary orbits over the high seas, is inappropriate because of the aforementioned specific features.

As to U.N. activities in working out the rules of international space law, it is noted that they "depend, to a large extent, on the USSR and the USA acting in concert," but in the authors' view, international space law is developed "at the initiative of the Soviet Union and the other countries of the Socialist community. . . ." (Pp. 18, 39).

Soviet doctrine fully supports the principle of the nonappropriation of outer space or celestial bodies and, in view of this, the authors disagree with *Wilfred Jenks*, who did not preclude the possibility that outer space might be appropriated by the United Nations.

With reference to arms control provisions in the 1967 Outer Space Treaty, the writers refer to complete "demilitarization" of celestial bodies. It would appear that by the term "demilitarization" they do not mean the complete absence of the military, inasmuch as the use of military personnel for scientific research or for any other peaceful purposes is permitted under the treaty. Instead, the term "demilitarization" is used to denote the treaty's ban on the establishment of military bases, installations and fortifications, the testing of any type of weapons and the conduct of military maneuvers on celestial bodies. According to *Zhukov* and *Kolosov*, the Soviet Union advocates a ban on the use of outer space for military purposes. They believe that there is a firm legal basis for the principle of the non-use of force or threat of force to the activities of states in outer space. At the same time, they also believe that the United States and other western countries have the aim of gaining military advantage at the expense of the defense potential of the Soviet Union.

A controversial issue in the general literature of space law has been the question of the exercise of sovereignty and/or sovereign rights in outer space. While the 1967 Outer Space Treaty prohibits "national appropriation" by claim of sovereignty or by any other means, there is no other reference to sovereignty or sovereign rights in the treaty. Nonetheless, the authors equate the retention by states of jurisdiction and control over launched space objects and personnel in outer space with the exercise of "sovereign rights". To this writer, this appears to be quite a sound conclusion despite the lack of specific reference to "sovereign rights" in the treaty. According to the authors sovereign rights may be exercised by the state of registry not only with respect to space objects and their component parts but also over the debris of such an object. This position strongly underlines the reasons for Soviet objection to any kind of right that would permit removal of space objects, including component parts and debris, without the consent of the appropriate state party. In this connection, Soviet legal experts have also raised the question of the possible establishment of safety zones around space objects. In their view, the establishment of such zones would not be tantamount to appropriation of territory, even though the states on whose registry the objects are carried would exercise their sovereign rights of jurisdiction and control over such zones.

The part of the book on International Systems of Space Communications summarizes the framework and operation of INTERSPUTNIK, INTELSAT and INMARSAT and credits Soviet diplomatic efforts for the acceptance of the principle of universal participation in INMARSAT. Among the mass media, direct television broadcasting by satellite is seen as a powerful instrument whose abuse could create a serious threat to peace. While the authors concede that the right to freedom of information appears "to rank among the fundamental human rights in contemporary society", they assert that "the specific forms in which this right is exercised are fixed by states independently, with due consideration for national, historical, and other factors." (P. 134). For this reason, solution to DBS problems must be sought "at an inter-state level."(P. 129).

Insofar as remote sensing of the earth from outer space is concerned, the authors restate the Soviet view that "the freedom to explore and use outer space — whenever the object of exploration is not space itself, but sovereign territories on Earth studied by means of space facilities — must not prejudice the principle of national sovereignty, still less prevail over it." (P. 142). To accomplish this one must create "the necessary guarantees, in terms of international law, to safeguard the sovereign rights of states to their natural resources and prevent any possibility of economic espionage or other misuse of remote sensing." (P. 142).

In discussing the delimitation of outer space from air space, *Zhukov* and *Kolosov* believe that the established customary rule of international law, whereby the freedom to explore and use outer space extends to the flights of space objects in a minimum perigee earth orbit has to be given the status of a contractual rule. (P. 163). Such contractual delimitation of outer space, in the authors' view, should recognize "the now fully vindicated practice of the free flight of space objects at altitudes not below 40 km for the purposes of reaching outer space and returning to earth. Flights below 40 km would be permitted only by agreement with the state exercising sovereignty over that air space." (P. 167).

It is also noted in the book that there are no "outer" limits of space beyond which there would be some other medium in which the universe exists. In interpreting the phrase "celestial bodies" the view is advanced that meteorites and comets can hardly be identified as celestial bodies.

With respect to the 1979 Moon Agreement, the authors point out that the inclusion of the "common heritage" concept in the agreement has not created a precedent "for the legal regulation of other space activities of states, such as the harnessing of solar energy to satisfy the Earth's energy needs." (P. 186). The "common heritage" concept should not undermine so fundamental a principle as respect for national sovereignty, especially since in the era of peaceful co-existence of states the competition between different socio-economic systems continues and this "precludes any possibility of replacing the sovereignty of states with supranational bodies." (P. 187).

In conclusion, the authors foresee a host of legal problems which are likely to arise in connection with the definition and utilization of international orbital space stations, including those in earth orbit as well as those in orbit around the moon or other celestial bodies, or on their surface. It will be important to determine the issues of registration, jurisdiction and control, particularly if the stations have an international crew. In addition, ownership rights with respect to the various parts of such stations, issues of crew safety, and international responsibility for damage by space stations will have to be addressed. Many of these issues, including those pertaining to international manned space flight, the legal status of personnel brought to a station by a transport craft, and problems of competing jurisdiction with respect to spacemen who have made an emergency or unintended landing on the territory of another state are not answered by existing rules of international space law.

In the future there will be a need for some kind of international space traffic regulation and the authors recommend the conclusion of an appropriate international agreement regarding control and jurisdiction over a space object and its personnel while they pass through the air space of a foreign state. The writers also believe that consideration should be given to the greater use of space technology to monitor compliance with international agreements. At the same time, they do not believe that there is a need to artificially hasten the development of international space law in such areas as the legal regulation of the use of nuclear power sources in outer space because in their view, this could jeopardize further advances in space research.

The book is undoubtedly an important contribution by two leading Soviet authorities to the growing literature on international space law. It is well organized and clearly presented with a wealth of annotations and references not only to Soviet writings but also to a number of works and articles written by western scholars. While on many space law issues, including those relating to DBS, remote sensing, arms control and delimitation of outer space, many western and Soviet experts find themselves on opposite sides of the fence, the book reveals that there also are quite a few issues on which there are no substantial differences in the views held or advanced. For this reason, international space lawyers and policy makers, seeking to understand Soviet positions and searching for possible solutions and alternatives to unresolved issues, will find this work more than helpful.

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JOURNAL OF SPACE LAW

International Space Programmes and Policies, edited by N. Jasentuliyana and Ralph Chipman (Elsevier Science Publishers B.V., Amsterdam, The Netherlands 1984), pp. 551.

This book is a record of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE), which took place in Vienna, Austria, from August 9-20, 1982. Ninety-four states participated in the conference. Issues arising from space sciences, technologies and applications were discussed from the scientific, technical, political, economic, social and organizational points of view. The discussions also encompassed legal implications of the issues on the agenda and international concern over military activities in space.

The book is divided into three parts. Part I is a publication of a report adopted by the conference. The report deals with prevention of an arms race in space, the need and opportunities for technology transfer, coordination in the use of the geostationary orbit, remote sensing from space, space transportation and space platform technology, protection of the near earth environment, the role of the United Nations and other matters.

Part II contains selected portions of papers presented by participating countries. The papers, presented by sixty-one countries, were written to provide a basis for discussion, and to describe their national and international space programs, policies and organizations.

Part III summarizes the proceedings with concluding statements and the Resolution adopted by the conference. Included in Part III are references to a number of activities, including technical meetings, regional seminars, space technology and space demonstrations. Annexed to the book are messages from the heads of State, a summary of the recommendations of the Conference and a list of officers. Conference participants included not only the participating countries, but also representatives of forty-five intergovernmental and nongovernmental organizations and several thousand visitors. Also in attendance were nearly 400 members of the press who lauded the Conference as highly successful.

International Space Programmes and Policies is an especially valuable contribution to the body of space-related literature. This book summarizes one of the most important conferences ever held in the field, and was edited by two key participants, *Mr. Jasentuliyana*, the Executive Secretary of the Conference and *Mr. Chipman*, Secretary of Committee I.

Maintaining Outer Space for Peaceful Uses, edited by Nandasiri Jasentuliyana (United Nations University, Tokyo, 1984), pp. 333.

This book consists of edited and partly expanded papers which were presented at a symposium on the Conditions Essential for Maintaining Outer Space for Peaceful Uses (The Hague, 12-15 March, 1984). The Symposium was organized by the United Nations University and the International Institute of Space Law, to address issues of the increasing militarization of outer space. The proposed objectives of the Symposium were to identify 1) conditions essential for maintaining outer space for peaceful uses, 2) problems whose solutions are inadequately provided for in international law and 3) legal measures that could mitigate or solve such problems.

The basic view shared by the participants was a sense of risk and danger; the risk being that of an armed conflict in outer space and the danger being the extension of the arms race into outer space. The Symposium, and the papers presented, emphasized the need for actual good faith in negotiations, particularly between the Soviet Union and the United States. Participants included not only academians, but also diplomats and government officials interested in the subject.

A preface to the book is provided by *Edward W. Ploman*, Vice Rector of the United Nations University, in which he indicates that the papers must be considered in the context of several important developments which have taken place since the conclusion of the Symposium. Two of the more important of these developments are 1) that the Moon Agreement went into effect on July 11, 1984, and 2) that the U.S.S.R. submitted a proposal to the United Nations, in September 1984, for a new legal instrument ("Use of Outer Space Exclusively for Peaceful Purposes for the Benefit of Mankind"). *Judge Manfred Lachs* of the International Court of Justice, who was one fo the primary figures in the preparation and organization of the Symposium, delivered the opening address, "Preserving the Space Environment." An overview of the Symposium is included by *Eilene Galloway*, honorary director of the International Institute of Space Law. The presented papers are divided into four categories: historical background, review of space law, related international law and regulations and prospects for further demilitarization.

Chapter I gives a historical background. The distinguished contributors range from *Professor Aldo Armando Cocca* to *Vladimir Kopal,* who is chief of the United Nations Outer Space Affairs Division. *Dr. Cocca,* in his presentation, outlines the development of international law, the role which both bilateral and multilateral treaties have played in maintaining the peace, and in a rather concise manner identifies forces that promote the active militarization of man's environment. The ultimate responsibility, he believes, lies with mankind as a whole. *Ambassador A.H. Abdel-Ghani,* a member of the Egyptian Higher Committee on Outer Space Activities and also past chief of the U.N. Outer Space Affairs Division, believes that the creation of a Satellite Monitoring Agency would supply the mechanism necessary to govern outer space. A major concern which he expressed, and which is shared by peoples of all nations, is the effect on the earth's inhabitants of super-power activities in space.

In the review of space law, which is the topic of Chapter II, *Dr. Stephen Gorove* offered some specific alternatives for further arms control measures. *Gyula Gâl* and *Priyatna Abdurrasyid* made informative observations on the Rescue Agreement, while *I.H. Ph. Diederiks-Verschoor* provided a series of interesting observations on the Registration Convention. All, however, is not academic or political. A business perspective is provided by *Ronald Stowe,* on the Liability Convention of 1972 and how this treaty operated after the crash of Cosmos 954. *Mr. Jasentuliyana* also provided an excellent analysis of the 1979 Moon Agreement.

Chapter III deals with international laws and regulations which are of particular concern to the field of space law. This chapter might be more properly called "further review of space law," for the subjects with which it deals are so intimately related to the subject of space law as to be considered part of the body of space law (as opposed to international law in general). The papers presented in this chapter deal with the institutions formed internationally to ensure peace in outer space, space and radiocommunications, the Test Ban treaty and the Convention on the Prohibition of Military or Any Other Hostile Uses of Environmental Modification Techniques (the 1978 convention which drafted a limited multilateral arms control agreement).

The final major section of the book is devoted to proposals for further demilitarization. One of the most interesting of these is the "First Draft for a Convention on the Settlement of Space Law Disputes" by *Karl-Heinz Böckstiegel,* which was presented at the Symposium for further discussion at the request of the International Law Association. Other papers include topical treatments of how militarization is outpacing legal control in outer space, legal implications of present and prospective military uses of outer space, anti-satellite weapons, the U.S.S.R. initiative in maintaining space for peaceful purposes and how space law is related to the attitude toward disarmament now present in the United Nations.

The attitude of the Symposium seems to the reader to be one of "helpmate" to the United Nations, particularly the superpowers who bear a large share of the responsibility for maintaining peace in space. The Untied Nations must look for a security agenda that will serve not only each individual nation's interest, but that of mankind as a whole. This book provides keen insight to the problems and possible solutions in the creation of such an agenda.

The work is not indexed, and there is no separate bibliography, but the bibliography for each paper is included. Moreover, the source materials are among the latest in the field. These papers were prepared and presented by those scholars most recognized and involved in the formulation and interpretation of principles of space law. The stature of the authors, combined with the high caliber of the editing and the papers themselves, makes this work one of educational and international legal significance.

Space Commerce by Nathan C. Goldman (Ballinger, Cambridge, Massachusetts, 1984), pp. 186.

The purpose of this book is twofold. First, the author presents the reader with an overview of past and future commercial activities. Space transportation, telecommunications, manufacturing, mining, energy, domestic and international space programs and domestic policies are examined. Tables usefully illustrate the type and degree of participation by foreign governments, the United States and U.S. corporations. Second, the author discusses how space will be important if key governmental and private sector action is taken. This book focuses on analysis of the economic, business and policy implications of past and future commercial activities.

Chapter 9, of the book (15 pp.) is of interest to the reader concerned with the legal issues arising from commercial activity. The author notes the conflict between governmental and private sector interest in communications, remote sensing, transportation and manufacturing. Current and future laws and regulations are discussed. An appendix contains reprints of selected international and national legal documents. Unfortunately, the discussion is already outdated in light of recent developments in the law such as the Land Remote Sensing Commercialization Act of 1984, the Commercial Space Launch Act of 1984, and the Presidential determination of November 28, 1984, that separate international communication satellite systems are in the national interest.

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SPACE LAW AND DOMESTIC LAW

ROUNDTABLE DISCUSSION
Present and Expected Uses of Outer Space and Problems of Protecting the Space Environment

SPACE ACTIVITIES AND INTELLECTUAL PROPERTY INCLUDING INDUSTRIAL PROPERTY

NUCLEAR POWER SOURCES IN OUTER SPACE

LEGAL ASPECTS OF LARGE SPACE STRUCTURES

CONDITIONS ESSENTIAL FOR MAINTAINING OUTER SPACE FOR PEACEFUL USES

CURRENT DOCUMENTS

I.

WORKING DOCUMENT SUBMITTED BY THE CHAIRMAN OF THE WORKING GROUP ON AGENDA ITEM 3: LEGAL IMPLICATIONS OF REMOTE SENSING OF THE EARTH FROM SPACE, WITH THE AIM OF FORMULATING DRAFT PRINCIPLES*

Principle I

For the purpose of these principles with respect to remote sensing activities:

(a) The term "remote sensing" means the sensing of the Earth's surface from space by making use of the properties of electromagnetic waves emitted, reflected or diffracted by the sensed objects, for the purpose of improving natural resources management, land use and protection of the environment;

(b) The term "primary data" means those raw data which are acquired by remote sensors borne by a space object and which are transmitted or delivered to the ground from space by telemetry in the form of electromagnetic signals, by photographic film, magnetic tape or any other means;

(c) The term "processed data" means:

The products resulting from the preprocessing of the primary data needed in order to make such data usable;

The products derived from the products of preprocessing and resulting from further processing or inputs of data and knowledge obtained from other sources;

(d) The term "analysed information" means the information resulting from the interpretation of processed data;

(e) The term "remote sensing activities" means the operation of remote sensing space systems, primary data collection and storage stations, and activities in processing, interpreting and disseminating the processed data.

Principle II

Remote sensing activities shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic, social or scientific and technological development, and taking into particular consideration the needs of the developing countries.

Principle III

Remote sensing activities shall be conducted in accordance with international law, including the Charter of the United Nations, the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, and the relevant instruments of the International Telecommunication Union.

Principle IV

Remote sensing activities shall be conducted in accordance with the principles contained in article I of the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, which, in particular, provides that the exploration and use of outer space shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, and

*Taken from U.N. Doc. A/AC.105/352 (April 11, 1985).

stipulates the principle of freedom of exploration and use of outer space on a basis of equality. These activities shall be conducted on the basis of respect for the principle of full and permanent sovereignty of all States and peoples over their own wealth and national resources, with due regard to the rights and interests, in accordance with international law, of other States and entities under their jurisdiction. Such activities should not be conducted in a manner detrimental to the legitimate rights and interests of the sensed State.

Principle V

States carrying out remote sensing activities shall promote international co-operation in these activities.

To this end, they should make available to other States opportunities for participation therein. Such participation should be based in each case on equitable and mutually acceptable terms.

Principle VI

In order to maximize the availability of benefits from remote sensing activities, States are encouraged, through agreements or other arrangements, to provide for the establishment and operation of data collecting and storage stations and processing and interpretation facilities, in particular within the framework of regional agreements or arrangements wherever feasible.

Principle VII

States participating in remote sensing activities should make available technical assistance to other interested States on mutually agreed terms.

Principle VIII

The United Nations and the relevant agencies within the United Nations system should promote international co-operation, including technical assistance and co-ordination in the area of remote sensing.

Principle IX

In accordance with article IV of the Convention on Registration of Objects Launched into Outer Space and article XI of the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and other Celestial Bodies, a State carrying out a programme of remote sensing shall inform the Secretary-General of the United Nations. It shall, moreover, make available any other relevant information to the greatest extent feasible and practicable to any other State, particularly any developing country which is affected by the programme, at its request.

Principle X

Remote sensing shall promote the protection of the Earth's natural environment.

To this end, States participating in remote sensing activities shall disclose all information in their possession identified as capable of averting any phenomenon harmful to the Earth's natural environment.

Principle XI

Remote sensing shall promote the protection of mankind from natural disasters.

To this end, States participating in remote sensing activities which have identified processed data and analysed information that may be useful to States affected by natural disasters, or likely to be affected by impending natural disaster, shall transmit them to the latter as promptly as possible.

Principle XII

As soon as the primary data and the processed data concerning the territory under its jurisdiction are produced, the sensed State shall have access to them on a non-discriminatory basis and on reasonable cost terms. The sensed State shall also have access to the available analysed information on the same basis and terms.

Principle XIII

To promote and intensify international co-operation, especially with regard to the needs of developing countries, a State carrying out remote sensing of the Earth from outer space should, upon request, enter into consultations with a State whose territory is sensed in order to make available opportunities for participation and enhance the mutual benefits to be derived therefrom.

Principle XIV

In compliance with article VI of the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, States operating remote sensing satellites shall bear international responsibility for their activities and assure that such activities are conducted in accordance with these principles and the norms of international law, irrespective of whether such activities are carried out by governmental or non-governmental entities or through international organizations to which such States are parties. This principle is without prejudice to the applicability of the norms of international law on State responsibility for remote sensing activities.

Principle XV

Any dispute resulting from the application of these principles should be resolved through the established procedures for peaceful settlement of disputes in accordance with the United Nations Charter.

II.

THE FEASIBILITY OF OBTAINING CLOSER SPACING OF SATELLITES IN THE GEOSTATIONARY ORBIT*

Part One

THE STUDY

INTRODUCTION

A. Mandate and organization

1. The Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE 82), held at Vienna from 9 to 21 August 1982, made a series of recommendations which are given in its report (A/CONF.101/10 and Corr.1 and 2). These recommendations, which were subsequently endorsed by the General Assembly in resolution 37/90, include recommendations for a number of studies to be carried out by the United Nations system.

2. The Committee on the Peaceful Uses of Outer Space (COPUOS) and its Scientific and Technical Sub-Committee, at their meetings in 1983, considered the question of the implementation of those recommendations and recommended that three of the studies should be carried out on a priority basis, including a study on the

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*Taken from U.N. Doc. A/AC.105/340/Rev.1 (April 22, 1985).

feasibility of obtaining closer spacing of satellites in the geostationary orbit and their satisfactory coexistence, which would also entail a closer examination of techno-economic implications, particularly for developing countries, in order to ensure the most effective utilization of this orbit in the interest of all countries.

3. The decision to undertake the present study was made by the General Assembly in resolution 38/80 endorsing the recommendations of COPUOS. By the same resolution, the General Assembly decided that the Legal Sub-Committee, at its twenty-third session, should establish a working group to consider, on a priority basis, matters relating to the definition and delimitation of outer space and to the character and utilization of the geostationary orbit, including the elaboration of general principles to govern the rational and equitable use of the geostationary orbit.

4. The Committee recommended that this study be carried out in co-operation with the International Telecommunication Union (ITU) and other organizations. Accordingly, ITU, the European Space Agency (ESA), the International Telecommunications Satellite Organization (Intelsat) and the International System and Organization of Space Communication (Intersputnik) were invited to provide technical information for use in preparing the studies. ITU was also invited to provide technical advisers to participate in the meeting of the Group of Experts.

5. As recommended by the Committee, its member States were invited to provide working papers on the subject. Working papers were provided by Argentina, China, Colombia, Czechoslovakia, the Federal Republic of Germany, Pakistan, Sweden and the Union of Soviet Socialist Republics. The information provided in these papers has been used in preparing this study. In addition, various ITU texts referred to in the bibliography have been taken into account. Technical information provided by Intelsat has also been used.

6. As further recommended by the Committee, member States selected in accordance with procedures and criteria established by the Committee were invited to nominate experts to participate in a group of experts to assist in the study. The members of the Group of Experts were appointed by the Secretary-General and included experts from the following countries: Colombia, Czechoslovakia, Italy, Japan, Kenya, Pakistan, Sweden, USSR and the United Kingdom of Great Britain and Northern Ireland. Representatives of ITU also participated in the meeting as technical advisers. The experts participated as individuals and the views expressed in this study do not necessarily reflect the views of their Governments. The representatives of ITU participated in an advisory capacity and the views expressed in this study do not necessarily reflect the views of their organization. The names and affiliations of the experts and technical advisers are given in the annex.

7. The Group of Experts met from 20 to 23 March 1984, during the session of the Legal Sub-Committee, to review a preliminary draft study prepared by the Secretariat and to consider revisions to be made for the draft final study to be submitted to the Scientific and Technical Sub-Committee for review at its session in February 1985.

B. Background

8. The Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space was convened in part to assess new developments in space technology, to exchange information and experience on their present and potential impact, and to assess the adequacy and effectiveness of institutional and co-operative means of realizing the benefits of space technology. In particular, the Conference considered the implications of the use of the geostationary orbit, the need and possibilities for optimizing that use, as well as of the measures to be taken to that end.

9. The Conference noted that the geostationary orbit is a unique natural resource of vital importance to a variety of space applications, including communications, meteorology, broadcasting, tracking and data relay for satellites in low Earth orbits and other applications. It noted that the geostationary orbit is a limited though not depletable natural resource, that its optimal utilization requires co-ordination, planning and/or arrangements, and that consideration of the utilization of the orbit must include consideration of the use of the radio frequency spectrum and the possibility of physical collision.

10. The Conference further noted the explosive growth in recent years in the use of the geostationary orbit, especially for communication satellites, and the concerns that have been expressed relating to the availability of orbital positions and frequency assignments for countries which have not yet placed satellites in the orbit. It noted that while there now seems to be general awareness of these concerns and certain regulations have been adopted, the present system of registration and co-ordination may need to be improved to guarantee, in practice, for all countries, equitable access to the geostationary orbit and the frequency bands allocated to space services. A World Administrative Radio Conference (WARC) on the use of the geostationary orbit is scheduled to meet in two sessions, in 1985 and 1988. The Group of Experts for the present study noted, nevertheless, that there was no evidence that any satellite system had not been accommodated in the geostationary orbit after it had passed through the existing co-ordination procedures.

11. On the question of the legal nature of the geostationary orbit, the Conference noted that it is accepted by most nations that the geostationary orbit is a part of outer space and, as such, it is available for use by all States, in accordance with the outer space Treaty of 1967. However, the equatorial countries consider that the geostationary orbit constitutes a physical phenomenon related to the reality of our planet in that its existence depends exclusively on its relation to gravitational phenomena generated by the Earth and that, for this reason, it should not be included in the concept of outer space and its utilization should be regulated under a sui generis régime.

12. The Conference also considered the special needs of the developing countries with respect to the geostationary orbit. In particular, the international goal of increasing the effective communication capacity through technological advances in order to accommodate the communication needs of all countries may conflict with the goal of developing countries to increase their self-reliance in space technology. The Conference recommended that any planning method and/or arrangement that is evolved should recognize and accommodate the future needs of developing countries and should not result in unnecessarily hastening their plans to the detriment of their financial and self-reliance interests.

13. Within the United Nations system, the Conference noted ITU has played a major and important role in the systematic planning, management and regulation of space communication activities through allocation, co-ordination, notification and registration of radio frequencies and positions on the geostationary orbit for the various radio communication services using space techniques. ITU organizes frequent World Administrative Radio Conferences (WARCs) to review and, where necessary, revise the pertinent portions of the ITU Radio Regulations, inter alia, (a) to take into account technical progress in the various fields and new requirements in radio communication services submitted by all countries in the light of article 33 of the International Telecommunication Convention which provides for equitable access to, and efficient and economical use of the geostationary satellite orbit and the radio frequency spectrum by all countries, and (b) to provide the basis for countries in a position to do so to develop techniques designed to improve the utilization of the radio frequency spectrum and the geostationary satellite orbit with a view to increasing the total radio communication facilities available to the world community. The Conference further noted the important role in promoting co-operation in space telecommunication activities that is played by other international organizations including Intelsat, Intercosmos, Intersputnik, ESA, the International Maritime Satellite Organization (Inmarsat), the Arab Satellite Communications Organization (Arabsat) and the European Telecommunications Satellite Organization (Eutelsat).

14. The purpose of the present study is to consider in greater detail the question of increasing the capacity of the geostationary orbit by reducing the spacing between satellites within the context of the general conclusions and recommendations of UNISPACE 82 in order to provide guidance to member States in planning their use of satellites in the geostationary orbit, including their programmes of regional and international co-operation.

15. The question of the spacing between satellites, however, cannot be isolated from the general question of the effective utilization of the geostationary orbit. The study also takes into account, therefore, the related questions of frequency allocations, frequency re-use, other new techniques and the use of non-geostationary orbits to reduce the demand on the geostationary orbit.

16. The present study is based on information provided by member States and international organizations in working papers and other material submitted for the study. Information provided by member States and international organizations for UNISPACE 82 and published technical reports were also used.

17. Further information on the questions considered in the present study can be obtained from the documents listed in the selected bibliography attached to the study.

I. THE GEOSTATIONARY ORBIT

A. Definition and characteristics

18. The geostationary orbit (also known as the geostationary satellite orbit or GSO), as defined theoretically using the highly simplified assumption that the Earth is an isolated, perfectly spherical, spinning mass, is a circular orbit around the Earth approximately 35,787 km above the equator. At this altitude, a satellite orbits the Earth with a period of 23 hours 56 minutes, synchronously with the Earth's rotation. If the orbit were directly above the equator, with the satellite revolving in the same direction as the Earth rotates, from west to east, the satellite would appear from the ground to remain stationary. Such a perfectly geostationary orbit would be unique in providing a constant orientation between the satellite and any fixed point on the ground within view of the satellite, so that there would be no need for ground antennas to move to track the satellite.

19. In practice, a satellite cannot remain in a perfectly circular orbit with fixed orientation. Gravitational forces from the Sun and Moon, radiation pressure from the Sun, and variations in the Earth's gravitational field due to departures from perfect spherical symmetry cause slow, periodic variations in the eccentricity and inclination of the orbit, resulting in movement of the satellite from its desired geostationary position. In the case of inert satellites and debris, the orbital variations grow, resulting in orbits that are quite different from the geostationary orbit but which regularly intersect it, giving rise to the possibility of collisions which will be discussed below. Active satellites have station-keeping propulsion systems to counteract the disturbing forces and maintain the satellites close to their desired positions.

20. Station-keeping manoeuvres greatly reduce but do not eliminate departures from the theoretical geostationary orbit. The operational geostationary orbit, therefore, should be considered not as a circle, but as a three dimensional ring or torus encircling the Earth. With current station-keeping capabilities, geostationary satellites vary in altitude by about 30 km and move through a band about 150 km wide extending north and south of the equator. In the east-west direction, along the geostationary orbit, the typical station-keeping ability of $\pm 0.1^{\circ}$ of longitude with respect to the ground corresponds to a range of 150 km. The operational orbit can therefore be considered to be a ring 150 km wide (north-south) and 30 km thick (altitude) with an active satellite remaining within a 150 km long (east-west) segment of the ring.

21. The term geosynchronous or synchronous applies to all satellites having a period corresponding to the Earth's rotational period, i.e. about 23 hours 56 minutes. It thus applies not only to geostationary satellites but also to satellites having orbits which are substantially eccentric (non-circular) and/or

inclined (non-equatorial). A satellite in a circular-inclined orbit will appear from the ground to move daily through a figure-eight pattern centred on a fixed point on the geostationary orbit, while a satellite in an eccentric equatorial orbit will move eastward and westward along the geostationary orbit. Various combinations of eccentricity and inclination will result in various patterns of movement including a simple loop about a fixed point on the geostationary orbit. These inclined or eccentric orbits retain the advantage of providing continuous contact between a satellite and Earth stations, but generally require Earth stations with steerable antennas to follow the satellite in its daily motion through the sky. Steerable Earth station antennas are not needed, however, if the angular dimension of the loop is less than the beamwidth of the main lobe of the antenna. No operational satellites are currently in inclined or eccentric geosynchronous orbits, but the technique has been proposed as a method for relieving pressure on the geostationary orbit, as will be discussed in chapter III.

22. Apart from the question of whether or not ground antennas need to be able to track a nominally geostationary satellite, which is dependent partly on antenna beamwidth and satellite station-keeping accuracy and partly on the potential need to transfer service to a satellite at another location, the reasons why potential users may prefer geostationary orbits to other types of orbit lie in three main areas, the strength of the preference varying considerably for different satellite system characteristics:

(a) The service area within which all points on the ground enjoy continuous visibility of the satellite is at a maximum when the satellite is geostationary, extending (for 5° minimum elevation) to more than 76° north and south latitude at the same longitude as the satellite, and to more than 76° east and west along the equator. As the relative movement of the satellite increases, so the area of continuous visibility is reduced. Maximizing the service area is of considerable importance for a system providing intercontinental communications, but of less importance for a system providing local services to an area near the equator.

(b) A technically advanced satellite may carry several spot-beam antennas aimed at different points on the Earth's surface. If the satellite were to move far from a nominal geostationary orbital position, the relative pointing angles to the aiming points would change, and instead of simply adjusting the satellite attitude, it might become necessary to provide separate pointing facilities for each antenna, at additional complexity and cost. This would not apply to a simple satellite with a single antenna beam.

(c) If for any reason the satellite movements are such that the available area of continuous visibility is inadequate for the system requirements, then it becomes necessary to use more than one satellite, with pairs of ground antennas simultaneously tracking satellites entering and leaving the operational arc of the orbit and switching transmissions between them. While such a system may be necessary to provide high latitude coverage, the substantial extra costs tend to make it unattractive if a geostationary satellite would be a suitable alternative.

B. Communication satellites

23. The major use of the geostationary orbit is for communication satellites for which continuity of service, large area of coverage and fixed pointing antennas are great advantages. The great majority of communication satellites currently in use are in the geostationary orbit. Satellites in the fixed-satellite service relay telephone signals, telex messages, television programmes and data transmissions between fixed - as opposed to mobile - Earth stations. Telephony has constituted the bulk of the traffic until now, but television distribution from central distributing centres to large numbers of local receivers has been growing rapidly, and business services including data transmission, facsimile services and video conferencing are expected to grow rapidly in the future.

24. A communication satellite system comprises the space segment, including operational satellites, spare satellites in orbit and spare satellites on the ground, and the ground segment, including one or more main Earth stations for tracking the satellite and monitoring and controlling its operations and a large number of Earth stations serving the communication network. The satellites receive

signals transmitted from their associated Earth stations on the up-link frequency, amplify the signals and retransmit them to the ground on a different down-link frequency. The amplification and frequency translation are carried out by transponders of which a typical satellite might carry 12 to 24.

25. The signals transmitted by a satellite, whether they consist of telephone calls destined for one specific place or television programmes being distributed across an entire country, are generally broadcast to every Earth station served by the satellite. Each Earth station then decodes the signals and passes along those intended for its local area.

26. Similarly, on the up-link, a satellite can generally receive signals from any Earth station in its service area at any time. If many Earth stations are to transmit messages simultaneously, the signals must be either transmitted at different radio frequencies - the frequency division multiple access (FDMA) technique - or digitized and interleaved in very brief time intervals - the time division multiple access (TDMA) technique.

27. A satellite antenna focuses the transmitted power into a beam that covers the desired service area on the ground with a relatively uniform power distribution and focuses the received power from the Earth stations onto a detector with a gain similarly constant over the service area. Depending on the service area and communication traffic pattern, an antenna may be designed to have a wide global beam covering the entire visible hemisphere, an irregularly shaped beam to cover a specific geographic area or a very narrow spot beam covering a small area with a high traffic density. A satellite may have a single antenna covering the entire service area or a number of antennas covering different areas within the service area.

28. The size of the area that can be served by a geostationary communication satellite is limited by the angle with respect to the horizon at which an Earth station can reliably transmit to and receive from the satellite. An Earth station at a distance of 9,050 km from the subsatellite point will see the satellite right on the horizon. Even if there are no topographic obstacles, the long atmospheric path may interfere with transmissions. Typically, a 5° elevation, corresponding to a range of 8,500 km, or a 10° elevation, corresponding to a range of 8,000 km, is taken as the lower limit of reliable communications. Using 5° as the lower limit, a satellite with an appropriate beam could relay signals between any two Earth stations within a circle of radius 8,500 km, corresponding to 76.3° of latitude, about the subsatellite point on the equator, a total area of 195 million sq km, about 38 per cent of the Earth's surface. Thus a geostationary satellite above the prime meridian (0°N-S, 0°E-W) could cover a circular area extending from 76.3°E to 76.3°W in longitude and from 76.3°N to 76.3°S in latitude. The width of the coverage area from east to west decreases with latitude away from the equator, declining from about 17,000 km on the equator to 11,000 km at 45°N and 6,900 km at 60°N.

29. If a communication satellite is to serve Earth stations spread out over a specific geographic area of this size, the satellite must be located at the geostationary longitude corresponding to the centre of the area. For many satellite systems, however, the Earth stations are located within a much smaller service area, and the satellite can be located anywhere along a geostationary orbital arc whose length is equal to the difference between the longitudinal extent of the visibility area and the longitudinal extent of the service area.

30. For a given service area, however, the positions along the possible orbital arc are not all equally desirable. Whenever possible, communication satellites are located west of the service area in order to facilitate continuity of service during the eclipse periods. These eclipses occur whenever a geostationary satellite passes through the Earth's shadow, and therefore loses power from the solar panels, for periods of up to 72 minutes on each of 44 consecutive nights around the spring and fall equinoxes. Continuity can be provided through power from on-board batteries or by switching to another satellite, but in any case, the problem is minimized if the satellite is west of the service area so that the eclipses occur after midnight in the service area when traffic volume is reduced.

31. A large number of communication satellite systems are now in operation and additional systems are being planned and built. Two global systems, Intelsat and Intersputnik, provide world-wide service and are open to any country which wishes to join. Intelsat has 108 member States and owns and operates 18 satellites over the Atlantic, Pacific and Indian Oceans providing international voice, television and data communications. In addition to the international services, Intelsat leases spare capacity to some 24 countries for domestic communications. Intersputnik has 14 member States and leases capacity on USSR satellites over the Atlantic and Indian Oceans to provide telephone and television communications.

32. On the regional level, the European Communications Satellite (ECS) system was developed by ESA and is now being operated by Eutelsat, providing telephone and television communication services to its 23 member States. Arabsat is planning to launch its first satellite in 1984 to provide services to the member States of the Arab League.

33. On the national level, domestic communication satellite systems are being operated by Canada (Anik), India (Insat), Indonesia (Palapa), Japan (CS), USSR (Ekran, Gorizont, Raduga, Molniya, Loutch) and the United States (Comstar, Galaxy, RCA Satcom, SBS, Westar). Brazil, France, the Federal Republic of Germany and Sweden now have systems under construction and other countries are planning systems.

C. Mobile and broadcasting satellites

34. In addition to the communication satellites in the fixed-satellite service described above, geostationary satellites are also used operationally for maritime communications and broadcasting services. Satellite systems for aeronautical and land mobile communications are being studied. These satellites differ from satellites in the fixed-satellite service primarily in having more powerful transmitters so that the signals can be received by smaller and less expensive earth stations. Inmarsat, currently with 40 member States, provides telephone services globally to ships and marine platforms and is studying the possibility of providing aeronautical and land mobile communication services. In the USSR, the Volna satellite system has been established for maritime and aeronautical mobile service. While such mobile satellite services will certainly grow over the next decade, the number of satellites involved will, for the foreseeable future, remain small compared to the number of satellites in the fixed-satellite service.

35. Geostationary satellites can also be used to relay data from satellites in low earth orbit to a central ground station thereby allowing real-time world-wide coverage by the orbiting satellites without a global network of receiving stations. The United States Tracking and Data Relay Satellite System (TDRSS), which has linked the Space Shuttle and Landsat 4 to a ground station, is an example of such a system. Such satellites are also unlikely to contribute significantly to congestion in the orbit.

36. Direct broadcasting satellites for transmitting television programmes to small inexpensive home or community receivers have been used by some countries. While a large number of countries have indicated an interest in this technology for both general programming and education, the economic and social costs and benefits are not yet clear so that estimates of the numbers of such satellites to be launched remain highly speculative.

37. Direct broadcasting satellites, which transmit signals at higher power than conventional communication satellites, are limited in their capacity by the amount of power that can be generated from available solar panels. Whereas satellites in the fixed-satellite service typically have a capacity equivalent to 24 television channels, some currently planned direct broadcasting satellites have a capacity for three channels. Since the frequency band allocated to direct broadcasting is divided into many channels - into 32 channels in ITU Region 2 (the Americas) for example - a very large number of such satellites would be required to use all channels from all positions.

38. It should be noted that there is no clear division in practice between satellites for conventional telecommunications and those for direct broadcasting to home or community receivers. Recent advances in receiver technology have reduced

the satellite power required for reception by small Earth stations, allowing direct broadcasting services to community and even home receivers from satellites whose power levels are within the limits set by the Radio Regulations for the fixed-satellite service.

D. Other applications

39. Meteorological satellites in geostationary orbit provide frequent observations of cloud cover, cloud and surface temperature and water vapour and allow determination of wind velocity at cloud level. The geostationary satellites complement orbiting satellites which provide coverage of the polar zones and vertical profiles of temperature and water vapour. World-wide coverage from 60°S to 60°N is provided by the following geostationary satellites: the Geostationary Operational Environmental Satellites GOES-East at 70°W and GOES-West at 135°W (United States), Meteosat at 0° (ESA), GMS at 140°E (Japan) and the Indian National Satellite (Insat) at 74°E. The USSR plans to launch its Geostationary Operational Meteorological Satellite (GOMS) and station it near 70°E. These satellites form the space-based portion of the Global Observing System in the World Weather Watch co-ordinated by the World Meteorological Organization. In addition to acquiring meteorological imagery and other environmental data and transmitting it to ground stations, the satellites also collect and relay meteorological and other environmental data between ground stations. Data from these satellites are made available to all countries. The volume of data acquired and relayed by these satellites is small compared to the volume of data relayed by communications satellites and is not expected to grow rapidly.

40. The geostationary orbit has also been used for space research satellites including the International Ultraviolet Explorer (IUE) for astronomical research and the Geostationary Earth Observation Satellite GEOS-2, for studying the magnetosphere. In the geostationary orbit these satellites can remain in constant contact with their ground stations. The number of such satellites and the amount of data they transmit are extremely small compared with communication satellites.

41. There have been proposals to place remote sensing satellites in the geostationary orbit but for the moment there are no plans to do so. Such satellites could selectively observe areas of interest and could provide virtually continuous coverage of rapidly changing phenomena such as floods. The disadvantages of the geostationary orbit for remote sensing are the difficulties of obtaining high resolution from such an altitude and the need for a number of satellites for global coverage, along with orbiting satellites for coverage above 60°N and 60°S. In any case, the number of satellites and the volume of data would be small relative to communication satellites.

42. Other technologies that have been proposed for the geostationary orbit include large multi-mission space platforms, solar power satellites, manned space stations and co-ordinated clusters of satellites. These, however, are at a very early stage of feasibility study and are unlikely to be implemented within the next 10 years. If and when they are implemented, they could either increase the congestion in the geostationary orbit, as might be the case with large numbers of extensive solar power satellites, or reduce the congestion, as might be the case with communication platforms using advanced technologies to maximize efficiency of use of the available radio frequency bands. The development of such systems and their impact on the use of the geostationary orbit is therefore entirely speculative.

E. Collisions

43. The number of objects in the geostationary orbit, including active satellites, dead satellites and associated fragments and debris, is increasing steadily, and with it the probability of collisions between objects. Since these objects may be travelling with relative speeds up to many kilometres per second, any collision is likely to put an active satellite completely out of service. Collisions between objects can be divided into three categories: collisions between two active satellites, collisions of an active satellite with a dead object and collisions between two dead objects.

44. Active satellites normally maintain their position in the geostationary orbit to within $\pm 0.1^\circ$, both along the orbit and across the orbit, through periodic station-keeping manoeuvres. Two satellites which maintain nominal positions separated by 0.2° or more will therefore stay apart with no risk of collision. If two active satellites operating at different frequencies are assigned to the same nominal positions there is a low probability of collision.

45. The risk of collision between satellites assigned to the same position could be reduced or eliminated through co-ordinated formation-keeping between satellites. This would require precision tracking of the satellites relative to each other and precision orbital control manoeuvres, which could be done either from the ground, from a master control satellite or by each of the satellites in the formation. All of these possibilities, however, would require advances in tracking and orbit control technology.

46. The problem of collisions between active satellites and dead satellites is somewhat greater, and the probability of collision is growing slowly but steadily. As noted above, the orbits of inactive satellites are generally eccentric and inclined to the geostationary orbit such that they pass through the geostationary orbit periodically. The probability of a collision is proportional to the number of active satellites and to the number of inactive satellites and increases with the cross-sectional area of the satellites. In spite of the small probability of collisions, when satellite tracking indicates that a dead object will pass dangerously near an active satellite, an evasive manoeuvre can be made by the active satellite to eliminate the risk.

47. The probability of collision could also increase substantially if the amount of small untrackable debris in orbits intersecting the geostationary orbit becomes very large, for example through explosions of propulsion systems or through fragmenting collisions. Since small fragments at high altitude cannot be observed or tracked, it is not possible to estimate the probability of collision from such objects or to avoid collisions through evasive manoeuvres.

48. Since the main danger arises from inactive satellites damaging active satellites, the probability of collisions can be reduced if inactive satellites are removed from the geostationary altitude with the last of their station-keeping propulsion. It appears that an increase in altitude of about 200 km will effectively prevent a satellite from passing through the geostationary orbit. A number of satellites have already been removed from the geostationary orbit at the end of their useful lives in this way, including USSR communication satellites, Intelsat satellites, United States geostationary meteorological satellites, the Franco-German Symphonie satellite and the ESA GEOS-2 and Orbital Test Satellite. Once satellites have lost their manoeuvring capability, they can be removed from the geostationary orbit only by scavenging missions which are not possible with current technology and would certainly be very difficult and expensive.

49. The danger of collisions, although very small at present, could in the future pose certain constraints on the number and size of satellites in the geostationary orbit. It does not appear to directly affect the spacing between active satellites but further studies may be required.

50. Another consideration regarding relatively close approaches to an active satellite by other objects is that reflections off these objects might cause interference to attitude control sensors on the active satellite, thus causing attitude disturbances resulting in breaks in service.

II. THE RADIO FREQUENCY SPECTRUM

A. Radio interference

51. The question of the spacing between satellites is essentially a question of radio interference between communication satellites. As has been noted in the preceding sections, other uses of the geostationary orbit do not contribute significantly to congestion in the orbit and the danger of collisions may not be a significant constraint. The question then is essentially how closely satellites can be spaced along the orbit before the signals to be relayed by one satellite prevent the successful communication of messages through the neighbouring satellites.

52. Two communication systems can be said to interfere if signals transmitted by one are received by the other. While interference is never desirable per se, low levels of interference may be acceptable in that they do not prevent satisfactory communication. Efforts to eliminate all interference would unnecessarily limit use of radio communication. What must be controlled, therefore, is the harmful interference which degrades, obstructs or interrupts a radio communication service. Harmful interference depends on both the nature of the signals transmitted by the interfering system and the sensitivity of the receiving system to the interfering signals. The interference can in principle be reduced to an acceptable level by adaptation of either the system that emits the interference or the system that is interfered with.

53. Interference to a satellite communication system can arise from both terrestrial communication systems and other satellite systems. Most of the frequency bands used for satellite communications are also used for terrestrial communication services. Since terrestrial signals are generally much stronger than the signals received from satellites, Earth stations are commonly located away from cities and protected by hills from terrestrial transmitters, thereby reducing terrestrial interference to acceptable levels. Transmitters of terrestrial systems, which generally have highly directive antennas, can also interfere with satellite receivers if their transmitted beams intersect the geostationary orbit and if they are operating in a shared frequency band. This type of interference is rare and satisfactory techniques exist to eliminate it when it does occur. Terrestrial interference, like any other source of interference or noise, can complicate the problem of achieving closer spacing of satellites but is not a determining factor.

54. Interference can arise between satellite systems that are using the same frequency bands, that are close together in the geostationary orbit and that serve areas that are close together on Earth. One important factor for avoiding interference is antenna design. Given the low risk of collision, satellites that operate at different frequencies or polarizations or that cover well separated service areas can be located at the same nominal position in the geostationary orbit.

B. Frequency bands

55. Within the electromagnetic spectrum, the range of frequencies up to 3,000 GHz is called the radio frequency spectrum. While frequecies up to 275 GHz have been allocated for space services, the frequencies currently available for use by satellites range from about 100 MHz to about 60 GHz, lower frequencies being limited by reflection from the ionosphere and higher frequencies by atmospheric absorption and the currently available technology. Specific frequency bands are allocated to specific communication services by the World Administrative Radio Conferences (WARCs) of the ITU. For space activities, frequency bands have been allocated for space research, meteorological satellites, Earth exploration satellites, maritime communication and radio-navigation satellites, aeronautical communication and radio-navigation satellites, communication satellites in the fixed-satellite service, broadcasting satellites and inter-satellite links. In general, each service is allocated a number of bands, and bands are commonly shared by more than one service.

56. As indicated in chapter I, it is only for communication satellites in the fixed-satellite service and broadcasting satellites that there is likely to be any congestion of the geostationary orbit and the available frequency bands in the foreseeable future. We will therefore consider further only the frequency allocations for those two services.

57. For communication satellites in the fixed-satellite service, the frequency bands in operational use are the 6/4 GHz band and the 14/11 GHz band. In the 6/4 GHz band, frequencies of 5.925-6.425 GHz are used for the up-link and 3.7 to 4.2 GHz for the down-link, a bandwidth of 500 MHz in each direction. In the 14/11 GHz band, the up-link is 14-14.5 GHz while the down-link is either 10.95-11.2 GHz and 11.45-11.7 GHz or 11.7-12.2 GHz, in either case a bandwidth of 500 MHz in each direction. In the 30/20 GHz band, a much larger bandwidth, 3,500 MHz, has been allocated, but only very limited use has been made of this

band, partly due to the technical difficulties of working at these high frequencies and partly due to the attenuation of these frequencies by rain. The 1979 WARC approximately doubled the bandwidth of the 6/4 GHz and 14/11 GHz bands, but the extra bandwidth is not yet in use. The frequencies now available are 3.4 to 4.2 GHz and 4.5 to 4.8 GHz for down-link and 5.85 to 7.05 GHz for up-link transmissions.

58. Broadcasting satellites have been allocated frequencies around 12 GHz for their broadcasting transmissions, with 500 MHz of bandwidth allocated in ITU Region 2 (the Americas) and Region 3 (Asia), and 800 MHz in Region 1 (Europe and Africa). This band is unique in that specific frequencies and positions in the geostationary orbit have been assigned to specific countries as defined by detailed plans adopted by the 1977 WARC for Regions 1 and 3 and by the 1983 Regional Administrative Radio Conference (RARC) for Region 2. For Region 1, 40 television channels are designated in the 11.7-12.5 GHz band and 34 orbital positions separated by 6° are designated in the geostationary orbit between 37°W and 170°E. As a rule, four to five channels are assigned to each country with the direction, size, shape, polarization and power of each antenna beam specified. In some cases, the same orbital position and frequency have been assigned to two countries that are sufficiently separated geographically to avoid interference between the signals. For Region 2, the 1983 RARC divided the 12.2-12.7 GHz band into 32 channels and allocated orbital positions with specified beam characteristics to each country. Positions serving the same or adjacent areas using the same channels were separated by 9° while positions serving well separated areas were separated by as little as 1°. In cases where countries required less than the full available bandwidth, up to eight countries were assigned the same position using different channels.

C. Frequency re-use and bandwidth compression

59. Satellites can be assigned to the same nominal orbital position and the same frequency band if the signals are polarized differently or if the beams are limited to well separated areas, techniques referred to as frequency re-use. Signals transmitted to or from satellites can be polarized either linearly or circularly, and two separate signals can be transmitted by using orthogonal linear polarizations or right and left circular polarizations. Currently, this technique is used to approximately double the communication capacity of satellites in the fixed-satellite service within a given frequency band.

60. Satellites can also use directional antennas to focus signals on the desired service area while minimizing the power transmitted outside the service area. By appropriate design of the antenna and the signal feed, an antenna beam can be shaped to match roughly the shape of the service area. Another antenna of the same or another satellite can then be used to transmit a separate signal on the same frequency to a separate service area. The communication capacity can be increased roughly proportionately to the number of separate beams that are used.

61. The communication capacity of a satellite can also be increased by techniques of signal processing. Through the use of such techniques, either already developed or under development, speech and television signals, which make up the bulk of communication traffic, can be converted to digital signals and processed into a smaller volume of digital signals with a narrower bandwidth while retaining all of the essential information. These techniques are independent of frequency re-use or reducing satellite spacing, but contribute to the same ultimate objective, increasing the communication capacity of the geostationary orbit.

62. A satellite system is capable of providing an average efficiency of 15 telephone channels per 1 MHz of bandwidth if analog FM/FDMA transmission is used. The efficiency can be increased to at least 35 channels per MHz using digital pulse code modulation (PCM) with TDMA and digital speech interpolation (DSI), and will reach 70 channels/MHz or more when the 32 Kbit/s advanced digital PCM (ADPCM) modulation scheme is introduced. The International Telephone and Telegraph Consultative Committee (CCITT) is expected to adopt a standard for the latter in 1984, and its operational implementation in satellite systems can be foreseen by the end of this decade. It is therefore expected that digital techniques will increase capacity relative to the present analog techniques by a

factor of close to 5. Further development in this direction is already foreseen for the 1990s, a 16 Kbit/s modulation scheme being already under study.

63. Analog circuit multiplication techniques such as compressed/expanded (companded) FM is also available and in limited use and could be very effective for thin route satellite networks.

III. SATELLITE SPACING

64. In principle, the minimum spacing between satellites will be the spacing at which the combined interference and noise into each communication system is just below the level that would seriously degrade the signal quality. If all satellites and Earth stations were of identical design and carried identical communications, the minimum spacing would be uniform and fairly easy to determine.

65. In practice, communication satellites and their associated Earth stations vary substantially in their characteristics, the technology is developing quite rapidly, and the number of systems and their geographical distribution is changing. The standards for Earth stations, for example, include specifications for antenna diameter ranging from 1 m to 30 m according to the communication service requirements. Different systems will therefore require different spacing and the positions assigned must allow enough tolerance for changes in traffic patterns and the introduction of new systems.

A. Earth station design

66. The primary factor which determines the minimum spacing between satellites is the design of the Earth station antennas. The signal power which an antenna radiates to satellites other than the intended satellite must be sufficiently low not to disturb those satellites' ability to receive signals from their own Earth stations. Similarly, the Earth station must have a low sensitivity to signals received from directions other than that of its intended satellite if its own signals are to be received clearly. Since Earth stations generally use the same antenna for transmitting and receiving, the angular distributions of radiated power and reception sensitivity are similar.

67. The pattern of radiated power and reception sensitivity is usually considered in two segments, the main lobe and the side-lobe radiation patterns. Quantitatively, an antenna is characterized by the gain as a function of angle from the axis, the gain being the ratio of power radiated in a given direction to the power emitted in all directions by an isotropic antenna with the same power input.

68. The angular width of the main lobe depends on the size of the antenna and the wavelength of the radiation. For a parabolic antenna of diameter D operating at wavelength λ, with D and λ expressed in the same units, the width of the beam in degrees at the points where the power is one half the maximum power, i.e. 3 dB down, is given by the formula:

$$\theta = 70 \frac{\lambda}{D}$$

For the purposes of satellite Earth stations, this is perhaps more conveniently expressed as:

$$\theta = \frac{21}{f \times D}$$

where f is the frequency in GHz and D the diameter in metres. Thus the beamwidth decreases as the frequency and the diameter increase. Of the two frequencies used for up-link and down-link transmissions, the higher frequency is generally used for the up-link to minimize the transmitted beamwidth. For an Earth station operating at 6 GHz, a 30 m diameter antenna would have a 0.12° beam and a 10 m antenna a 0.35° beam. An Earth station transmitting at 14 GHz could achieve the same beamwidths with antennas of 13 m and 4 m, respectively. For satellite broadcasting at 12 GHz, an 80 cm home receiver would have a reception beamwidth of about 2°, about 1° on either side of the axis.

69. Not all of the radiated power goes into the main beam or lobe. Even in an ideal antenna, power is also radiated into side lobes which decrease in amplitude away from the main beam. It is therefore not sufficient that an adjacent satellite be outside the main beam; it must be outside the side lobes whose amplitudes are high enough to cause harmful interference. While there is a theoretical minimum to the amplitude of these side lobes, in practice the amplitude is determined by the structure of the antenna and in particular, the structure of the feed system. The feed horn and/or sub-reflector distort the radiation pattern and increase the side-lobe levels.

70. The International Radio Consultative Committee (CCIR) has established a reference curve of side-lobe amplitude as a function of off-axis angle. For large antennas ($D/\lambda > 100$, e.g. over 5 m at 6 GHz), the gain of the antenna (G) should be not more than 32 dB at 1° off-axis and should decline with increasing angle (θ) according to the formula:

$$G(dB) = 32 - 25 \log \theta \qquad 1^\circ < \theta < 48^\circ$$
$$G(dB) = -10 \qquad 48^\circ < \theta < 180^\circ$$

At least 90 per cent of the side-lobe peaks are to fall below this reference curve. For smaller antennas ($D/\lambda < 100$) a modification of this formula is used, allowing a somewhat higher side-lobe gain.

71. Recent developments in antenna technology have resulted in antennas significantly better than the standard. In 1982, CCIR recommended a new standard for large antennas ($D/\lambda > 150$) installed after 1987, with a side-lobe gain a factor of 2 (3 dB) smaller than the previous standard for angles less than 20°:

$$G(dB) = 29 - 25 \log \theta \qquad 1^\circ < \theta < 20^\circ$$

For smaller antennas ($D/\lambda < 150$), a new standard was not agreed on. If the side-lobe levels for both transmission and reception for all antennas can be reduced by 3 dB, a reduction of about 25 per cent in the minimum spacing between satellites could be achieved at a given level of acceptable interference.

72. The current standards for side-lobe levels will generally prevent harmful interference if satellites are spaced 4° apart. If satellites are spaced 3° apart, high-power large-bandwidth signals that are relatively resistant to interference, such as television or high-speed data signals, do not generally experience harmful interference, but the more susceptible low-power narrow bandwidth signals, such as the single-channel-per-carrier (SCPC) telephone signals, can suffer degradation. With the new standards, 3° spacing should be possible without harmful interference. A reduction in spacing to 2° would require further improvements in Earth station design and other measures to reduce interference.

73. Most Earth stations are currently of the Cassegrain design with the feed horn in the centre and a subreflector above the main parabolic reflector. While this is a simple and inexpensive design, the location of the feed horn, the subreflector and the subreflector supports in the middle of the main beam results in relatively high side-lobe levels. Substantial improvement can be achieved by locating the feed horn and subreflector off the axis of the main reflector and outside the main beam. This results in some loss of gain in the main beam, but an even greater reduction in the side-lobe levels and hence a net positive contribution to reducing satellite spacing. The design is more expensive than the Cassegrain design and does require a greater power input to achieve the same signal strength. The improvement of existing Earth stations through incorporation of offset and/or weakly excited defocused feeds would be a major effort in view of the large number of small Earth stations requiring modification.

74. Earth station antenna technologies currently under study for further reducing side-lobe levels include the use of dual offset reflectors, shaped reflectors, improved feed horns, adaptive array reflectors, dielectric lenses and phased array antennas. It will be some years, however, before these techniques are available for operational use.

75. In general, the smallest and least expensive Earth stations, such as those used for reception of television signals, are the most likely to be adversely

affected by a reduction in spacing. Studies for a possible reduction in spacing to 2° indicate that the small (5 m or less) antennas currently used for home or community television reception at 4 GHz might no longer be usable.

B. Satellite design

76. Some of the important technical factors that could affect satellite spacing are satellite antenna pattern, station keeping and antenna pointing.

77. The satellite antenna pattern is one of the main factors affecting the interference between satellite systems and thereby influencing the minimum spacing requirements between satellites. Interference can be reduced if the gain of the main beam has a high gain slope outside the service area and the side-lobe levels are very low compared to the main beam level.

78. Increase in orbital capacity can be achieved with improvement in longitudinal station-keeping accuracy. The 1979 WARC decided that in general the longitudinal station-keeping accuracy should be improved from $\pm 1°$ to $\pm 0.1°$ and that this should be effective no later than 1987. The present state of technology makes such improved accuracy of station keeping feasible with little additional requirement for propulsion fuel.

79. Antenna pointing errors lead to increased interference, particularly at the edge of the coverage areas of satellites having main beams with high gain slope. An improvement in the satellite antenna pointing accuracy can be achieved by techniques such as the control of antenna beam direction.

C. System design

80. As noted above, harmful interference depends not only on the radiation patterns of Earth stations and satellite antennas but also on the power, bandwidth and type of signals. In general a high-power signal (e.g., television) is least susceptible to interference, but is also most likely to cause interference. A low-power signal (e.g., voice, telex) is less likely to cause interference but is more susceptible to it. Harmful interference can be reduced if the use of frequencies on adjacent satellites can be co-ordinated, for example by using the same frequencies for SCPC transmissions and other frequencies for television. Similarly, interference can be reduced by cross polarization between transponders on adjacent satellites using the same range of frequencies or by shifting transponder frequencies so that the centre frequency of a transponder on one satellite falls in the unused guard band in between transponder frequencies in the adjacent satellite.

81. Such co-ordination of transponder usage can be fairly straightforward between satellites operated by the same organization or country. For satellites operated by different countries, such co-ordination would be administratively more difficult. The proposals for achieving closer spacing by using different characteristics in alternating satellites also pose problems for new entries into the orbit. Since it is difficult or impossible to modify a satellite's characteristics after it is in orbit, these proposals might require the introduction of satellites in pairs or the repositioning of many satellites to accommodate a new satellite.

82. While certain technical parameters are established by the Radio Regulations, are recommended by the CCIR, or are determined by available technology, other factors may differ for each satellite system. Power levels, polarization, transponder bandwidth, signal characteristics and satellite antenna size and design all vary from system to system, and all affect, in a complex interrelated manner, the required spacing between satellites.

83. One approach to frequency co-ordination would be international agreement on band segmentation whereby each frequency band would be divided into segments with each segment assigned to a particular type of transmission. While this approach could result in a significant reduction in spacing, it would reduce the flexibility with which satellite operators could respond to changing demands for communication

services. Some flexibility could be provided through different band segmentation plans for different segments of the geostationary orbit.

84. Satellite spacing can be reduced not only by reducing interference levels between neighbouring satellites, but also by raising the threshold at which interference degrades communications. If a source of interference can be identified and characterized, it may be possible to use signal processing techniques to selectively cancel the interfering signals. Compared with frequency modulation (FM), which is the most widely used modulation technique, digital modulation and coding techniques allow greater resistance to interference and closer spacing of satellites. While the use of digital techniques may involve substantial costs for interfacing such systems to terrestrial analog networks, these costs are an investment which will be repaid in a short time.

85. A satellite antenna will receive, in addition to the desired signals from its Earth stations, interference from other Earth stations and noise from cosmic, atmospheric and terrestrial sources. Current satellites amplify the interference and noise along with the signal for relay to the receiving Earth stations which also receive interference from other satellites and noise. In a satellite which had a signal processing capability in addition to the amplification function, the up-link interference and noise could be eliminated rather than being added to the down-link interference and noise, thereby reducing total interference.

86. In general, the minimum spacing between two satellites is determined by the system that is most susceptible to interference. For example, if two satellite systems, one of which could operate with 2° spacing between its satellites and the other requiring 4°, occupied alternating orbital positions, all of the satellites might have to be separated by 4°. Similarly, two systems, each by itself capable of operating at 3° spacing, but with different power levels and signal types, might require significantly more than 3° if occupying adjacent positions. Spacing can therefore be reduced if satellites with similar characteristics are grouped together, the concept of arc segmentation.

87. If two satellites operating at the same frequency have well separated service areas, it is possible for the satellites to be assigned the same orbital position provided that highly directional satellite antennas are used to limit the power radiated outside the desired service area. If the separation of the service areas is not sufficient to reduce interference from colocated satellites to an acceptable level, the partial isolation provided by directional satellite antennas can be combined with partial isolation provided by less than normal spacing to provide adequate reduction of interference. In these cases, improvements in satellite antenna technology can reduce satellite spacing.

D. Non-geostationary orbits

88. The use of geosynchronous but non-geostationary orbits and of non-geosynchronous orbits has been proposed as a means of increasing satellite communication capacity and thereby reducing the pressure on the geostationary orbit. The only non-geostationary communication satellite system currently in operation is the USSR Molniya system which uses satellites in highly elliptical orbits with a period of about 12 hours. The orbits are inclined at about 63°, the inclination at which the orientation of the orbital ellipse is not subject to disturbance by the Earth's equatorial bulge. The satellites spend a relatively short time near the 500 km perigee which remains over the southern hemisphere and most of their time near the 40,000 km apogee over the northern hemisphere. Three such satellites in appropriately phased orbits can provide continuous coverage, with the Earth stations tracking each satellite through its northern arc. In addition to easing the demand on the geostationary orbit, this system has the advantage of providing coverage of the far north, beyond the range of geostationary satellites. The disadvantages are that Earth stations must have precise tracking ability and several satellites are required to provide continuous service.

89. Circular geosynchronous orbits inclined to the equator have also been suggested. Satellites in such an orbit follow an Earth-track resembling a figure-eight centred on the equator. The minimum satellite separation depends on the width of this figure, which depends in turn on the orbit inclination. At

moderate inclinations, several satellites could be spaced along the same Earth-track with adequate separation while effectively occupying only one geostationary orbit position.

90. Use has also been suggested of geosynchronous orbits which are both eccentric and inclined. In general, satellites in such orbits may, with a suitable choice of orbit parameters, follow an Earth-track forming a simple loop, crossing the geostationary orbit at two separate longitudes. However, eccentric orbits are subject to powerful perturbations caused by the Earth's equatorial bulge, causing rotation of the perigee. Further study is required before definitive conclusions can be reached, but a tentative assessment is that advances in station-keeping propulsion technology, such as the successful development of electric propulsion, would be necessary before the more potentially attractive schemes could become feasible. Given such advances, it might be possible to substantially increase the number of satellites that could be accommodated to the geostationary orbit with a given minimum separation, but there would be considerable administrative problems in doing so.

IV. CO-ORDINATING THE GEOSTATIONARY ORBIT

91. The international co-ordination of the use of the geostationary orbit and the radio frequency spectrum are affected by the provisions contained in the ITU Radio Regulations as established through its various organs: the Plenipotentiary Conference, the WARCs and RARCs, CCIR and the International Frequency Registration Board (IFRB).

92. The International Telecommunication Convention is the basic document containing internationally agreed principles to govern international telecommunication. The Convention is reviewed and revised periodically by the Plenipotentiary Conference which met most recently in 1982. Of particular interest in the context of the present study is article 33 of the Convention which, as amended by the Plenipotentiary Conference in 1982, reads as follows:

> "In using frequency bands for space radio services Members shall bear in mind that radio frequencies and the geostationary satellite orbit are limited natural resources and that they must be used efficiently and economically, in conformity with the provisions of the Radio Regulations, so that countries or groups of countries may have equitable access to both, taking into account the special needs of the developing countries and the geographical situation of particular countries."

93. The allocations of radio frequency bands to the various communication services is the function of the WARCs. The first allocations for space communications were made at the 1959 WARC, which was followed by the 1963 Extraordinary Administrative Radio Conference organized specifically to allocate frequency bands for space radiocommunication purposes. More recently, the allocations for space communications have been revised and extended by the 1979 WARC.

94. The 1979 WARC also adopted three resolutions relating to the use of the geostationary orbit. Resolution No. 2 provides that existing frequency assignments should not provide any permanent priority to geostationary orbit positions and should not provide an obstacle to the establishment of satellite communication systems by other countries.

95. Resolution No. 4 introduces, on an experimental basis and subject to review by the 1985/1988 WARC (see below), a procedure for limiting the period of validity of frequency assignments in the geostationary orbit. The resolution provides that, as part of the co-ordination procedures, the period of validity of an assignment, limited to the designed lifetime of the system, shall be indicated, and that at the end of the period, the assignment shall be deemed discontinued, the administration concerned will be invited to cancel it, and if it is not cancelled, the assignment will be indicated as not being in conformity with the resolution. It should be noted that an assignment is not restricted to a single satellite, but may be used by a sequence of satellites as long as their communication characteristics are the same. The resolution allows for the extension of an assignment, at least three years before its expiration, by an administration if there is no change in the

communication characteristics, and by an administration with the approval of IFRB if a system has changed characteristics that do not increase the probability of interference with other systems.

96. In accordance with resolution No. 3, a World Administrative Radio Conference on the Use of the Geostationary Satellite Orbit and the Planning of the Space Services Utilizing It will be held in two sessions, the first session, to be held for five and a half weeks starting 8 August 1985, to establish the principles and criteria for planning, and the second session, for 6 weeks from June to August 1988, to implement the decisions of the first session.

97. The Radio Regulations contain, among other things, the allocations of frequency bands to the space communication services, plans for the broadcasting satellite service and the procedures for co-ordination and registration of frequency assignments to specific systems. They provide that any administration planning to operate a satellite system should co-ordinate the proposed frequency and orbital position assignments for the satellites and the associated Earth stations with any other administration whose assignments might be affected. The co-ordination is initiated by the circulation of a notice giving the characteristics of the proposed system. Any administration which considers that its systems might be affected can then enter into bilateral co-ordination discussions, with the assistance of the IFRB if necessary, to resolve the difficulties. When the proposed system has been successfully co-ordinated with existing systems, it can then be recorded in the Master International Frequency Register maintained by IFRB, ensuring its right to protection against interference from subsequently introduced systems.

98. These co-ordination procedures do not apply to the broadcasting satellite service in the 12 GHz band for which frequency and orbital position assignments were made by the 1977 WARC for ITU Regions 1 and 3 and by the 1983 RARC for Region 2. The 1983 RARC also established a plan for the 17 GHz band for feeder-links to satellites in the broadcasting satellite service. These plans define the spacing for broadcasting satellites until such time as the plans are revised. Provision, however, is made, for modifications to the plan, including additional satellites, subject to co-ordination procedures similar to those for other services. The plans for Regions 1 and 3 and Region 2 are intended to satisfy the needs of countries at least until 1994, but could be revised by a WARC either before or after that date.

99. As indicated above, for communication satellites in the fixed-satellite service, the Radio Regulations do not require a specific spacing. The position of each satellite and thereby the spacing between each pair of satellites is determined by a series of bilateral co-ordination procedures as each new system is planned. While this procedure allows maximum flexibility in reducing spacing in orbital segments where there are a number of adjacent satellites of the same system or under the authority of the same administration, it may pose difficulties in orbital segments where a number of different administrations have satellites and for administrations seeking a slot in the geostationary orbit, especially in certain frequency bands and orbital arcs. A general reduction in spacing would normally require changing the assigned positions of every satellite in the orbital segment, and this would require multilateral co-ordination involving all administrations with satellites in the segment. While the current procedures do not prevent multilateral co-ordination, neither do they make any provision for it.

100. Despite the advantages of uniform satellite system characteristics in terms of reducing satellite spacing, it is clear that different countries will have different capabilities, needs and priorities for the foreseeable future. Furthermore, since the lifetimes of satellites, currently about 7 to 10 years, are increasing, the steady introduction of new technology will result in a range of technologies being operational in orbit at any one time. Earth station technology can be more easily modified, but the need for different Earth station designs for different users and the need to amortize the cost of Earth stations over a period of some years will similarly result in a range of earth station technologies being operational. Any co-ordinated effort to reduce satellite spacing should be flexible enough to allow for a certain amount of necessary diversity while encouraging the introduction of new technology.

101. The need to increase the communication capacity of the geostationary orbit to meet the needs of all countries is not uniform over the length of the orbit. The most crowded parts of the orbit are the arcs from 49°E to 90°E (over the Indian Ocean), from 135°W to 87°W (serving North America) and from 1°W to 35°W (over the Atlantic Ocean), taking account of all the satellites launched to date. However, in order to evaluate future congestion, satellites still in the co-ordination and registration process and not yet in orbit would also have to be taken into account. Nevertheless, for some parts of the orbit, such as over the western Pacific, there would appear to be little prospect of congestion.

102. Since each country or region can only use a portion of the orbit for its communication needs, any competition for positions will be between a certain number of countries and not global. Even countries covered by the same segment of the orbit can avoid competition if the additional bands allocated by the 1979 WARC to the fixed-satellite service are utilized or if the service areas involved are sufficiently separated geographically, at the cost of using satellite technology for shaped beams, which may be more economical in terms of efficient utilization of available satellite power.

103. Under the present co-ordination procedures, although there have been some cases in which countries have had difficulties adapting their proposed satellites to existing assignments, no country has been denied access to the geostationary orbit for any satellite. Technological advances, including those contributing to a reduction in spacing, could certainly help to ensure continuing access.

104. CCIR, through its Study Groups and Working Parties, carries out technical studies and makes recommendations that provide an important basis for the revision of the Radio Regulations by the WARCs. The Study Groups and Working Parties are open to any member State of ITU that wishes to participate as well as to qualified recognized private operating agencies, scientific and industrial organizations and international organizations, as well as regional telecommunication organizations. The Study Groups make recommendations on technical parameters of communication systems, for example the standard for Earth station antenna side-lobe gain. While these recommendations do not have the authority of the Radio Regulations, they set standards to which all countries are expected to adhere. Of particular interest in the context of the present study is CCIR Study Group 4 on the fixed-satellite service and its Interim Working Party 4/1 which, since 1969 has been studying the efficient use of the geostationary orbit. Interim Working Party 4/1, and Interim Working Parties of other concerned CCIR Study Groups have prepared provisional technical reports which were considered by a Conference Preparatory Meeting (CPM) of CCIR (Joint Meeting of Study Groups) in June/July 1984. A consolidated technical report prepared by CPM and covering the relevant technical items of the agenda of the 1985 WARC will be submitted to that Conference.

105. Given that satellite and Earth station technology will continue to develop and that a growing number of systems using different technologies will be introduced, the potential minimum spacing between satellites will vary with time and with position in the geostationary orbit. The realization of this potential minimum spacing would require co-ordination and planning followed by adjustments in the positions of satellites. In principle, the entry of any new satellite could result in movement of all satellites in that part of the orbit. Such adjustments might group similar satellites together and keep the interference level for each satellite from all other satellites just below the maximum tolerated level. In reality, such a procedure would be difficult to implement and frequent movements would disrupt service and consume station-keeping fuel, thereby reducing the satellites' lifetimes.

V. ECONOMIC AND ORGANIZATIONAL FACTORS

106. Techniques for reducing the spacing between satellites or for increasing the efficiency of use of the geostationary orbit by other methods have both costs and benefits. The costs are generally the higher costs of building satellites and Earth stations with more advanced technology. The benefits are the general benefits that accrue from having greater communication capacity available for use by everyone. Some of the new techniques and technologies are in the process of being implemented.

107. The introduction of new Earth station technology, for example, the replacement of Cassegrain antennas by offset-feed antennas, can substantially reduce satellite spacing at the cost of more expensive Earth stations. Large offset-feed antennas are rather expensive and it is not clear that the benefits outweigh the current costs. Since reductions in satellite spacing currently tend to be limited more by small antennas than by large, it appears that significant reductions could be obtained at some cost by improving small antennas. The costs of offset-feed antennas would probably decline if demand increased with wide adoption of the design. The establishment of improved standards for Earth station side-lobe levels has the further advantage of not requiring changes in the current co-ordination procedures.

108. Other technologies for reducing satellite spacing would similarly result in higher costs for the space or ground segments. Improved orbit control systems and on-board signal processing would increase the cost of satellites, and interference cancellation systems and signal modulation and encoding techniques to increase tolerance of interference would increase Earth station costs. These technologies are currently being developed, both in terms of technical feasibility and in terms of economic viability. It would appear that even in the absence of any internationally established regulations or procedures, these techniques will gradually be introduced as they become economically attractive for particular systems. In general, such new techniques will be introduced first into the largest international and domestic systems.

109. The use of different frequency bands and techniques for frequency re-use, as discussed in chapter II, contributes to the total communication capacity of any one position or set of closely spaced positions in the geostationary orbit. In general, this capacity can be used by one satellite or divided between a number of satellites. In the geostationary orbital arc serving North America, for example, there are cases of 14/11 GHz band satellites positioned close to 6/4 GHz band satellites and the plans for broadcasting satellites provide for a number of nominally colocated satellites using different frequencies and spot beams to avoid interference. In general, however, the current trend is towards the development of high capacity satellites, such as the Intelsat V satellites which use the 6/4 and 14/11 GHz bands, dual polarization and spot beam separation to increase the capacity of individual satellites.

110. The communication capacity of the geostationary orbit can be maximized by using different series of satellites for different frequency bands, by alternating positions of satellites with opposite polarizations and by combining spot beam isolation with physical separation. Economically, however, for systems requiring a large capacity, it is more attractive to combine these techniques into a single satellite since one large capacity satellite and one network of Earth stations generally cost less than an equal capacity divided between two or more satellites and two or more networks of Earth stations. However, a large territory is simply impossible to cover with a single satellite.

111. Only a relatively small number of countries can currently justify very high capacity systems for domestic use. For many countries, and in particular for most developing countries, the need is for inexpensive, relatively low capacity systems. The question then is whether there will be a large number of small national satellites or whether domestic needs for most countries can best be met through a smaller number of high capacity regional or international systems. For countries with modest requirements, a share in a large satellite will generally be less expensive than a small satellite of equivalent capacity, and a large system can provide greater reliability. Furthermore, a smaller number of high capacity satellites would facilitate the co-ordination process and the introduction of new technology to reduce satellite spacing. On the other hand, a drawback of large satellites operated in international systems is that they are not fully national and the users are subject to the rules and regulations of the international systems. Deployment of standardized low capacity satellites for the majority of developing countries will provide a more cost-effective solution with the necessary flexibility of a dedicated national satellite.

112. From an economic point of view, it is important to distinguish between the total communication capacity that is available through satellites and the capacity that is actually used. In general, the larger the ea a satellite system covers,

the greater the population served and the wider the range of services offered, the more efficiently and fully the capacity can be used. A satellite that serves several time zones, for example, will have a more even traffic load than a satellite which serves a single time zone. Satellites which offer services with flexible timing, such as data transmission during off hours, can achieve a greater average utilization of capacity than a system offering only services with specific time requirements such as business telephone service.

113. It should be noted in this respect that Intelsat, in addition to providing international communication services, leases capacity to some 24 countries, mostly developing countries. Capacity on the Indonesian Palapa satellites is leased to Malaysia, the Philippines and Thailand for domestic communications, and the member countries of ESA have jointly developed the European Communication Satellites (ECS) for domestic as well as regional communications. This international and regional co-operation increases the efficiency of utilization of existing capacity, thereby reducing the need for additional satellites.

114. There is a large potential for increasing the communication capacity of the geostationary orbit. The realization of this potential requires research and development with respect to both technical feasibility and economic viability. Currently, this research and development is being carried out almost exclusively by the international and regional organizations and the technologically advanced countries which are building and operating satellite systems.

115. Relatively little research and development is being done on problems that are specific to developing countries. While most of the technology being developed for building and launching satellites benefits all countries, there is a need for more research and development on systems for thin route communications, simple low-cost Earth stations, appropriate power supplies for rural areas, reliability in high precipitation areas and other needs of developing countries taking into account the question of reducing satellite spacing. Nevertheless, provisions for this type of network have already been implemented. For example, there is a new low-density telephone service, operated through relatively small Earth station antennas, adopting a low-cost modulation and multiple access scheme, most efficient for thin route networks. Other technologies, which have been developed in the past and more recently with international organizations operating satellite networks, are beneficial for thin route networks: namely, the centralized or distributed demand assignment systems, SCPC transmission techniques and simple low-cost Earth stations for business communication developed in the 6/4 and 14/11 band technologies.

116. It would appear neither possible nor desirable for all countries to establish independent research and development programmes in the field of satellite communications. None the less, given that the technology has economic and social implications for every country, it is desirable that every country be able to participate bilaterally, regionally or internationally in such programmes.

117. While international and regional co-operation can certainly yield great technical and economic benefits, the difficulties of financing, administering and managing multinational programmes must not be underestimated. These difficulties will generally result in a multinational project being somewhat more complex to administer and slower to implement than a purely national project. For such projects to succeed, there must be a genuine political commitment on the part of the participating countries.

118. If a country or group of countries has decided to acquire a satellite system or ground system, a key question is the choice between designing and building satellites and Earth stations or buying systems from other countries. When large numbers of relatively simple components are needed, such as small receive-only Earth stations, it may be possible to build more appropriate systems at a lower cost domestically. For smaller numbers of products and for more complex products, however, the advantages of custom design and development of indigenous skills must generally be weighed against the higher cost of developing a new capability. A decision to build domestically may also have implications for satellite spacing in that a country new to the technology of satellite or Earth station design may have difficulty incorporating the most advanced technology that could maximize communication capacity or minimize spacing.

VI. CONCLUSIONS

119. Clearly there is a need to maximize the efficiency of use of the geostationary orbit and the frequency spectrum, bearing in mind the need to guarantee equitable access for all countries. Various possible measures for meeting this need have been discussed in this report. Equally clearly, however, there is no simple solution to the problem of how to meet the needs of all countries in an equitable fashion. Any solution must be based on technical realities and possibilities, economic and social needs, political priorities and agreements and the general principles of international law. The 1985/1988 WARC, organized by ITU, will consider all aspects of the co-ordination of activities in the geostationary orbit, including the question of the spacing between satellites. ITU (CCIR) is conducting detailed studies of relevant technical questions. Other international, regional and national agencies should consider how they might contribute to the Conference.

120. It is clear, however, that the success of the WARC will require a maximum of constructive co-operation between countries in the preparations for the meetings, during the decision-making process and in the implementation of the decisions. A thorough understanding of the technical issues by all countries, enabling them to participate fully and constructively in the deliberations will undoubtedly promote co-operation. It can be difficult for developing countries in particular to keep pace with the rapid developments in technology, and there is a need for improved mechanisms to ensure that all countries have access to up-to-date information, both in the short term in preparation for the WARC and in the longer term. The technical co-operation and assistance programmes of ITU, the United Nations Programme on Space Applications and other international, regional and national technical assistance agencies should be increased to meet the increasing needs of developing countries for education and training in space technology and applications.

121. Closer spacing of satellites in the geostationary orbit is feasible and certain technologies exist to allow greater overall efficiency in the use of the orbit. Some of the technologies and techniques are already in the implementation phase, others could be implemented on a large scale in the next 5 to 10 years. The efficiency of the use of the orbit is expected to increase noticeably. However, full advantage of the benefits can be achieved only when the new techniques are widely utilized. This will be strictly connected to the cost of implementing these techniques which will depend on the scale of production.

122. Under the present co-ordination procedures, although there have been some cases in which countries have had difficulties adapting their proposed satellites to existing assignments, no country has been denied access to the geostationary orbit for any satellite. For the future, there exists evidence that possible congestion might be avoided. Nevertheless, some problems due to radio frequency interference between satellite systems might occur in particular arcs of the geostationary orbit, particularly in the 6/4 GHz band, which is the most heavily used. The optimum and full utilization of the overall band assigned by the 1979 WARC could alleviate this problem. The question of the use of the geostationary orbit, including the planning of the space services using it, is the subject of a forthcoming WARC (1985/1988) and continues to be under study within ITU through its appropriate organs with a wide participation by member States.

123. Though the possibility of collisions between satellites and other objects in the geostationary orbit is not serious yet, it may be necessary to carry out systematic study of the problem of such collisions and devise ways and means of averting such collisions. This will certainly require further development of tracking and monitoring capabilities.

124. Advantages offered by communication satellites for provision of fixed and broadcasting services have certainly influenced the thinking of planners in the developing countries, who would certainly like to have access to as much space technology as possible. A systematic effort to guide and help the developing countries achieve indigenous capability through transfer of know-how must be made. This education of the developing countries will help achieve more efficient utilization of the available orbital arcs and the frequency spectrum.

125. Particular consideration should be given to greater research and development regarding the specific problems of developing countries. International

organizations, in particular ITU, should increase their efforts in this direction and regional communication research and development programmes should be established or strengthened. Programmes to increase co-operation between programmes in developing countries should be encouraged.

126. In view of the agreement between ITU and the United Nations, in which ITU is recognized as the specialized agency responsible for taking action to promote the development of technical facilities for telecommunications and, in particular, to promote and to offer technical co-operation and assistance to developing countries in the field of telecommunications, special efforts should be made by ITU and its members to assist the developing countries to the maximum extent possible in assessing their future satellite communication requirements as well as in identifying optimum orbital positions and frequency bands for their satellite communication needs, if any country so wishes.

127. In view of the fact that only a very small percentage of developing countries are currently using the geostationary orbit and the frequency bands for which well-tested systems are available, the special needs of developing countries should be taken into account in the uses of these resources of the geostationary orbit and the frequency spectrum.

128. If developing countries are to develop their own capabilities in satellite communications while using technology that maximizes the communication capacity of the geostationary orbit, they will, in many cases, need assistance in using the most advanced techniques. Such assistance can best be provided by the international, regional and national organizations that are designing, building and operating satellite systems and carrying out the research and development activities that will provide the technology for future satellite systems. The countries and organizations with advanced technological capabilities should make a particular effort to provide technical assistance to developing countries in order to provide the greatest possible access to communications to all countries. Such assistance will also have to include education and training in the planning and design of communication satellite systems and operation and maintenance of ground systems.

129. Countries which identify telecommunications as a priority can seek financial assistance through existing funding agencies including UNDP, the Financing System for Science and Technology for Development, the World Bank and other international, regional and bilateral funding agencies.

130. Further studies of the long-term possibilities for relieving the pressure on the geostationary orbit by use of other geosynchronous orbits should consider particularly the orbital perturbations and consequent station-keeping requirements in such orbits as well as the advances in spacecraft technology that might be needed.

* * *

Part Two

COMMENTS AND PROPOSED AMENDMENTS

1. Some delegations expressed the view that the study provided a generally good introduction to the relevant space technology and would be useful for member States, and in particular the developing countries, in planning their space activities.

2. The view was expressed that the study made a useful contribution to the collective understanding of the complexities involved in the use of the geostationary orbit without attempting to minimize the inherent difficulties in reaching any understanding on its use. Furthermore, the study stressed the technical context within which such questions must be considered and was therefore a particularly good guide for the activities of Governments and an introduction to forthcoming developments in ITU.

3. The view was expressed that the subject of the current report was diverted from the original problem, that of safeguarding the equal rights of all countries to equitable access to the geostationary orbit, to a new problem, that of how to increase the number of satellites that could utilize the geostationary orbit

resource as a non-renewable international resource. It was noted that it was quite obvious that as technical standards of equipment were raised and as regulations governing the use of that technology were made more rigorous, more and more satellites could be placed in the geostationary orbit. However, those developments had direct implications on the cost of satellite systems. That was the original problem that was neglected in the study. What developing countries were asking for was a utilization plan for the geostationary orbit that would allow them a fair share of access to the orbit at reasonable cost. According to this view, this could be achieved by various means such as:

(a) Diverting to other geosynchronous orbits some of the satellite services needed by the developed countries, particularly those countries that have intensive and diversified needs and have the technology to do so.

(b) Allowing the developing countries to use the lower microwave frequencies, up to, say, 15 GHz, since the cost, reliability and level of technology depend on the frequency. These factors either increase or become more complicated as the frequency increases.

(c) Changing the Radio Regulations in such a way that the number of satellite systems allowed for each country depends dynamically on the needs of all other countries. The operational approval granted by IFRB should therefore be revised every few years depending on international demand.

(d) Drawing up a priori plans for certain satellite services that are in greatest demand such as the fixed-satellite service.

(e) Changing the Radio Regulations in such a way as to make it mandatory to remove inactive satellites from the geostationary orbit. It is recognized that this is not possible at the present time, however, the removal operations remain the responsibility of the launching country and thus should be undertaken as soon as the technology for such operations becomes available.

4. The view was also expressed that the study showed that reducing the spacing between satellites increased costs and demanded a more sophisticated technology - conditions which were not within the reach of the developing countries and would make access to the utilization of the orbit more difficult for those countries. It was regretted that an explicit conclusion in this sense was not included in the study as it would have indicated that one must look, not for transitory solutions, but rather for permanent solutions at the level of the United Nations. The reference to the fact that there was no evidence that any satellite system had not been accommodated in the orbit did not mean that the last one to arrive (according to the principle of "first-come first-served") would not have to make an effort to find a location when the orbital arcs and frequencies were congested, while the first ones to arrive required a smaller effort, a situation which was not equitable. Because of this, it was considered necessary to change the current regulations through permanent legal regulations and a priori technical planning.

5. Some delegations expressed reservations concerning particular conclusions and proposed amendments to the study. Those comments and proposed amendments are given below.

Paragraph 11

The view was expressed that while the statement "the geostationary orbit constitutes a physical phenomenon related to the reality of our planet, in that its existence depends exclusively on its relation to gravitational phenomena generated by the Earth" was undeniably true, it was also true for all other Earth orbits, high or low, and that it was a fact, a law of physics.

Paragraph 20

The view was expressed that it was important to note that the study reiterated the definition of the operational geostationary orbit as a ring 150 km wide, 30 km thick and 150 km long, i.e. describing it as a geometrical region in space.

Paragraph 25

The view was expressed that this paragraph ignored multi-beam satellites, of which there would be an increasing number in the future. It was noted that where there were several beams, it would be senseless to transmit the same information on more than one unless that information was meant to be broadcast. Hence, only Earth stations within one beam coverage would be able to receive the same information and not, as stated in the text at present, "every Earth station served by the satellite."

Paragraph 45

It was proposed that the following sentence be added at the end of the paragraph:

"The practicality of this approach requires further study."

Paragraph 66

It was proposed that the following sentences be added to the end of the paragraph:

"Generally speaking, the use of large antennas reduces the power level transmitted towards adjacent satellite systems because, the gain of the antenna being higher, the power to be fed into it is lower and thus the power in the sidelobes is reduced. Also the level of the interfering signals relative to the level of the unwanted signal is lower when large antennas are used."

Paragraph 72

It was proposed that, for clarification purposes, the words, "For co-coverage situations" be inserted at the beginning of the first sentence. At the end of the paragraph, the following sentence should be added:

"Where there is no co-coverage, the isolation provided by the spacecraft antenna combined with that of the Earth stations can allow the co-location of satellites; i.e. zero degree separation."

It was explained that "no co-coverage" in that context meant, for example, that one satellite might be communicating to the northern hemisphere and another satellite communicating to a completely different location, perhaps in the southern hemisphere.

It was also proposed that the following sentence be added at the end of the paragraph:

"However, such a reduction in spacing would require technology which may be beyond the capacity of developing countries."

Paragraph 81

It was proposed that for purposes of clarification, the second sentence be revised to read as follows:

"For satellites operated by different countries, such co-ordination, while administratively more difficult, is possible and has been carried out for many existing systems."

It was also proposed that the last sentence be revised to read as follows:

"Since it is difficult or impossible to modify a satellite's characteristics after it is in orbit, the distribution of transponder traffic can be changed to help reduce potential interference and minimize possible satellite relocation."

Paragraph 85

It was proposed that the following sentence be added at the end of the paragraph:

"Implementation of this technology would have implications for developing countries in terms of technology available and economics of the system."

Paragraph 99

It was proposed that the penultimate sentence be revised to read as follows:

"A general reduction in spacing would require changing the assigned positions of some satellites, but not necessarily every satellite, in the orbital segment. This would require multilateral co-ordination involving all administrations with satellites in the segment."

Paragraph 105

It was proposed that the second and third sentences be revised to read as follows:

"The realization of this potential minimum spacing would require co-ordination and planning followed by adjustments in the positions of satellites and/or distribution of signals within the individual transponders. In principle, the entry of any new satellite could result in movement of all satellites in that part of the orbit, but this would be the extreme case."

Paragraph 107

It was proposed that the following sentence be added at the end of the paragraph:

"The impact of this approach on developing countries from the viewpoint of both system economics and indigenous production should be recognized."

Paragraph 111

The view was expressed that the last sentence implied that satellite costs decreased linearly with capacity, an implication which was not warranted. Cost-effectiveness would depend upon current and projected future requirements. It was therefore proposed that the last sentence be revised to read as follows:

"Deployment of standardized low-capacity satellites for the majority of developing countries may provide a more cost-effective approach to the establishment of an initial, nationally dedicated satellite system."

It was also proposed that the following sentences be added at the end of the paragraph:

"There is a need for caution in considering such an international space segment in view of the complexities of its organization. In addition, since the question is not one of physical crowding, but of radio-frequency crowding, many spacecraft can be stationed at the same nominal orbital location through frequency band segmentation and still reach the same utilization efficiencies as a single large satellite. For gradual system growth and risk management, multiple co-located satellites, with segmented radio-frequency bands, could be equally attractive."

Paragraph 118

The view was expressed that the last sentence appeared to be out of context and should therefore be deleted.

Paragraph 122

The view was expressed that while no country had been denied access so far to the geostationary orbit for any satellites, unsuitable slots/locations may have an impact, especially for developing countries. It was therefore proposed that the first three sentences be revised to read as follows:

> "Under the present co-ordination procedures, although there have been some cases in which countries have had difficulties adapting their proposed satellites to the existing assignments, no country has, so far, been denied access to the geostationary orbit for any satellite. For the future, there is a possibility of congestion which can to some extent be overcome. Furthermore, some problems due to radio frequency interference between satellite systems might occur in particular arcs of the geostationary orbit, particularly in the 6/4 GHz band, which is the most heavily used."

Paragraph 124

The view was expressed that the last sentence was unacceptable since the orbital arcs were being used by 283 satellites of which only four belonged to developing countries. It was considered that if anyone should be educated, it should be the technological powers which exploited the orbit.

Paragraph 126

The view was expressed that the wording of this paragraph should be changed as it did not accurately reflect the existing relation between the United Nations and ITU and the obligation of the latter to take into account the recommendations of the General Assembly and the provisions of the Charter.

UNITED STATES SPACE LAW

National & International Regulation

Compiled and edited by

STEPHEN GOROVE

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