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LEGAL ASPECTS OF SPACE COMMUNICATIONS AND SPACE SURVEILLANCE

BY JEROME KRAUST†

MUCH of man's early activity in space deals with communications and surveillance, which are based on very similar technologies. The law relating to both of them has been overcast with the problem of sovereignty. Nevertheless, significant insights are obtainable by considering technical foundations before introducing the element of sovereignty.

The tendency of these two technologies to merge, suggests the possibility that the same legal principles may be applied to both. After an examination of intent, a principal factor tending to distinguish communications from surveillance, a tentative code for users of the electromagnetic spectrum is proposed and tested against both technical trends and legal viewpoints.

I. TECHNICAL DEVELOPMENTS

In the form of speech and observation, communications and surveillance are the primary tools of learning. Before the seventeenth century, communications and surveillance were limited in effectiveness substantially to how far a man could hear and see. But the invention of the telescope provided greatly increased efficiency of surveillance at a distance. Nineteenth and twentieth century development in electromagnetic wave propagation and modulation made possible communication at a distance for which many totally new and widespread forms were found.¹ The telegraph and telephone were developed in the nineteenth century, point-to-point radio in the first decade and entertainment broadcasting in the second and third decades of the twentieth century.

Surveillance at a distance failed to exhibit the remarkable development which communications experienced in the nineteenth century. The shape of the future became apparent, however, when eighteenth and nineteenth century man took his optical instruments aloft in balloons to gain longer lines of sight to distant objects on earth.² Not until World War I were new tools of surveillance—aerial photography and infrared detection—developed, and another generation was to elapse before radio techniques in the form of radar, radio astronomy, and direction finding were to be applied to surveillance. Since man has thrust into space, the technologists of communications and surveillance have been quick to reap the geometrical advantage of placing their equipments high above the earth's surface.

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¹ See Godding, *The International Telecommunications Union*, Leyden (1952), for bibliography on early communications.

² The first successful balloon was launched in France in 1783 and first used for military surveillance in 1794. See *Balloon*, *Encyclopedia Britannica*.

Basic techniques which will have far reaching effects on both these technologies continue to be developed. A most profound change in technology has occurred as a result of the discovery of coherent light generation in the form of the laser.³ As a result, the unity of the electromagnetic spectrum, first postulated by Maxwell in the 1870's, has become a functional reality. Surveillance, once dependent wholly on optics and the visible portion of the spectrum, and communications, once dependent upon the radio frequencies, are now seen to be based on the entire electromagnetic spectrum from the very low frequencies through infrared, visible light, ultraviolet, X-Rays, and gamma rays.

Whereas acoustic and seismic waves play important roles in communication and surveillance on the earth or in the atmosphere, in the airless regions of space, primarily the electromagnetic wave is useful. The law of space communications and space surveillance, therefore, in its simplest manifestation, deals with the effects and implications of using the electromagnetic spectrum.

Electromagnetic propagation in space tends to emphasize points easily forgotten on the earth's surface. Propagation in straight lines is the norm of the universe. Propagation on curvilinear or irregular paths, such as on the surface of the earth, are local aberrations dependent upon the composition of a planet and its atmosphere. Transmission in space over very long distances is likely to be carried on at frequencies well above the microwave limits commonly used on earth. Because it becomes increasingly more difficult to concentrate electromagnetic waves in narrow beams as the frequency of the wave decreases, the use of microwave or lower frequencies in space-to-space transmission may be limited. On the other hand, frequencies above the microwave are attenuated severely in the earth's atmosphere, thus making space-to-earth propagation or earth-to-space propagation using frequencies above microwave difficult.⁴ To achieve penetration of the earth's atmosphere with infrared, visible light, or higher frequencies, it is necessary to concentrate energy in a narrow beam or to use very high energy sources. The sun is an example of the latter.

II. MODES OF OPERATION

Four modes of space communications are: ground-to-ground via space relay, earth-to-space, space-to-earth and space-to-space.

In the next decade, much attention will be devoted to ground-to-ground communication via satellites. The success of Echo, Telstar, and Relay satellites has been notable, although the West Ford orbiting needles concept is yet to be proven. The techniques used are straight-forward and well known. The satellite receives microwave signals from the earth and reflects or retransmits them back to the earth, thus permitting communication of high quality without wires between two points on earth

³ First suggested by Schawlow and Townes, *Infrared and Optical Masers*, 112 *Physical Review* 1940 (1958); the laser has developed very rapidly. Yariv and Gordon, *The Laser*, 51 *Proceedings IEEE* 4 (1963), summarizes theory and applications. The great bandwidths potentially available in the portion of the spectrum opened up by the laser will make spectrum conservation of less concern than at microwave and lower frequencies.

⁴ Kerr, *Propagation of Short Radio Waves*, 13 *M.I.T. Radiation Laboratory Series* 663 (1951). See also Neuringer, *Infrared Fundamentals and Techniques*, 65 *Electrical Manufacturing* 111 (1960).

well beyond the 500 mile limit of troposcatter communication systems.⁵ Some of the discussions of this mode of space communications seem to ignore the point that such communication is carried on between two complex ground terminals and does not enable the ground transmitting station to broadcast to millions of home radio receivers.

The second mode of space communications is one in which a station on earth has established a communications link to a vehicle, a sounding-rocket, a probe, or celestial body in space. In the link from ground to orbiting vehicle, the need is one of directivity to enable reception of the command or information signals. As probes or manned vehicles move farther out into space, the problem of directivity will become an increasingly more severe one if the station on earth is to retain its ability to communicate reliably.

In the third mode of space communications, the space probe, vehicle, or satellite will be communicating with an earth-based station. Because of weight considerations the space-borne transmitter will tend to be as simple as possible, and the complexities will be built into the ground-based equipment. As the spacecraft moves farther out into space, only one or, at the most, a few extremely large, sensitive receiver installations on earth will be capable of receiving their emissions, such as the NASA/Jet Propulsion Laboratory Deep Space Instrumentation Facility.⁶ Transmitters in unmanned vehicles cannot be turned off except by command from a remote point or component failure. Thus, there exists the possibility of generating interference from satellites whose useful life is ended, but whose transmitters still operate.

Broadcasting from space requires placement of a relay station in a satellite. The frequency required would probably be below 10 gc. in the microwave or very-high-frequency region of the spectrum.⁷ Above about 10-15 gc., the attenuation in the earth's atmosphere becomes sufficiently high to make a space-borne broadcast transmitter uneconomic.

In the fourth mode, space-to-space communications, the emphasis at least until bases are established on the moon and other planets will be on lightweight transmitting and receiving equipment. To achieve very long range communications, frequencies beyond microwave will be required. Highly directional beams will be used, and the transmission for the most part will be incapable of penetrating the earth's atmosphere. Ultimately, relay stations on the moon or on lunar or terrestrial satellites will be required to convert the microwave signals used for penetrating the earth's atmosphere to the optical and higher frequency signals used in long distance space communications.

Turning now to surveillance, major distinctions can be made between passive systems and active systems. The traditional passive systems, such as telescopes, binoculars, and cameras, are sensitive to visible light, but a host of passive systems using other portions of the electromagnetic spectrum are also available. Among these are the radio telescope, the infrared horizon sensor, and the ultraviolet detector. The most widely used

⁵ Parry, *Equipment Configuration and Performance Criteria for Fully Optimized Tropospheric Scatter System*, CS-9 IRE Transactions on Communications Systems 427 (1961).

⁶ NASA/*Lunar and Planetary*, 11 Missiles and Rockets 122 (1962).

⁷ Wiesner, *Communications Using Earth Satellites*, Lectures on Communications Systems 592 (E. J. Baghdady ed. 1961). See also Martin and Jacobs, *Direct Broadcasting from Earth Satellites*, 30 *Telecommunication J.* 11 (1963).

active surveillance system is radar, which is now breaking out of its microwave bonds and moving into the infrared and visible light region by taking advantage of the capabilities of the laser.

The modes of space surveillance are earth-space, space-earth, and space-space. The earth-space mode includes most of the astronomical activities⁸ as well as missile, satellite, probe, and space vehicle detection and tracking. Both active (radar) and passive (radiometer, telescope, camera) equipments are used. Active systems will tend to be restricted to the portion of the spectrum below 10 gc., because of atmospheric attenuation, but passive systems are reliable up to ultraviolet frequencies. In the space-earth mode of surveillance, passive equipments, chiefly cameras and radio frequency radiometers, are much more popular than active equipments, although the latter (radar) are used to some extent. Cameras have figured prominently in the U-2 incident, recent U.S.-U.S.S.R. encounters in Cuba, and discussions of photographic satellites.

A very important consideration in image-producing space-to-earth systems is resolution of the image obtained. The greater the distance of the sensor from the surface of the earth, the more difficult it is to achieve fine resolution. Many conjectures have appeared in the open literature concerning the minimum size object which could be photographed on the ground from satellite heights.⁹ Whatever the answer may be, useful information undoubtedly can be obtained from satellites. As coherent light and, perhaps, gamma-ray radar becomes available, the limitations of resolution of microwave radar will be overcome and such radar may achieve limited usefulness in surveillance of the earth.

In the space-to-space mode, the same equipments are useful as in the earth-space mode. The lack of atmosphere, however, makes passive surveillance systems using frequencies beyond visible light (ultraviolet, X-Ray, and gamma ray) feasible. For the same reason, active systems above microwave frequencies become much more useful. Also, the need for long-range, lightweight radar makes the frequencies above microwave very attractive. Some of the manifestations of space-to-space surveillance are meteorological satellites, vehicle rendezvous radar, and satellite inspection. Significantly, sensors used for detecting cloud formations above the earth also provide photographs of the earth's surface.¹⁰

In summary, the technical aspects of space communications and space surveillance reveal the following points potentially significant for legal development:

1. Communications and surveillance technologies tend to merge as the entire range of the electromagnetic spectrum has been opened to both technologies by the development of the laser.
2. The use of coherent waves at frequencies above microwave (infrared, ultraviolet, etc.) permits the use of higher and higher concentrations of energy in communications and surveillance.

⁸ See Wenk, Jr., *Radio Frequency Control in Space Telecommunication*, ch. IX, in which the spectrum needs of radio astronomy is reviewed.

⁹ Levison, *Capabilities and Limitations of Aerial Inspection*, Inspection for Disarmament 59 (S. Melman ed. 1958) indicates some of the limitations of photoreconnaissance, particularly from aircraft. Stewart, *The New Optics*, 4 International Science and Technology 23 (1962) proposes that objects three inches apart might be resolvable from altitudes of 125 miles.

¹⁰ *Tiros 6 Sends Excellent Photos; Surveys MA-8 Path, Storm Area*, Aviation Week, Sept. 24, 1962, p. 41.

3. The atmosphere of the earth severely attenuates frequencies above about 10 gc.

4. The development of coherent light generation potentially makes available millions of new communication channels and much higher resolution active surveillance systems.

III. A TENTATIVE CODE

Although a natural consequence of point 1 of the technical summary above is to attempt to combine the law of space communications and space surveillance into a single set of principles, there is insufficient assurance that human activities flowing from these two technologies are sufficiently similar to warrant such treatment. Not only have their historical developments differed, but they may be distinguishable on the basis of intent.

Communications, developed primarily from civilian endeavors, is a widely used and accepted technology which has been regulated by the International Telecommunications Union and its predecessors for a century. Surveillance, on the other hand, with a larger military component in its twentieth century development, has been considered somewhat sporadically by several international bodies having interest in only a small part of surveillance technology. Although the aircraft conventions have peripherally affected surveillance by establishing rights in the airspace, and organizations such as the World Meteorological Organization and the International Astronomical Union are concerned with specific subject matter, no counterpart to the International Telecommunications Union exists.

Within recent years the equipments used for space applications have tended to be interchangeable. Many radar transmitters with little modification can be used as communications transmitters. Radio telescopes are useful not only in searching out the secrets of the cosmos, but also in receiving signals from communications transmitters millions of miles from earth. The visible light telescope, too, will be increasingly useful as a communications as well as a surveillance receiver.

A theory of dissimilarity in historical background as a reason for separate consideration of the law of surveillance and communications is difficult to maintain because the magnitude of technical change inevitably will cause convergence of their lines of development.

Superficially, the intent of users of space communications is identical to that of users of space surveillance systems: to employ the information-carrying properties of the electromagnetic spectrum. Traditionally, the intent of the transmitting instrumentality of a communications system could be distinguished from that of a surveillance system. Usually, in communications systems, the transmitter intended that a specific receiver or specific class of receivers should have access to the information sent, whereas the transmitting (or modulating) instrumentality in the surveillance system had no such intent. Conversely, the surveillance system receiver intended to find out what the surveillance transmitter system had no intent to reveal. With modern developments, particularly in active surveillance systems, this distinction is no longer valid.

To illustrate the growing ambiguity of intent as a distinguishing feature

between communications and surveillance, four systems are considered. These are: (1) point-to-point military communications system, (2) broadcast communication system, (3) active surveillance system and (4) passive surveillance system.

In a point-to-point military system the transmitting instrumentality intends the information sent to be restricted to a limited class of receivers. This intent is often manifested by transmitting encrypted messages, controlling the directivity of transmission, or limiting severely the time of transmission.

In a broadcast communication system the transmitting instrumentality using a high power transmitter usually has the intent to present its message to as large a number of receivers as possible, but there may exist certain qualifications on this intent. For example, broadcasting may be done in a language known to a select group, or a secret code may be used. The receiving instrumentalities in this system may be a very large number of individuals operating home receivers.

The transmitting instrumentality of an active surveillance system intends to have the transmitted beam modulated with information about an object or unknown mass and have the modulated beam transmitted to a receiver. Although the transmitting instrumentality intends its transmission for one or a very few selected receivers, it may be indifferent to the numbers of unauthorized receivers picking up signals. Several types of intent may be illustrated by the modulating instrumentality. For example, a crater on the moon is incapable of formulating any intent regarding its modulating radar signals. The instrumentality controlling a classified military vehicle, on the other hand, may be assumed to intend concealing it from the radar beam. In still other instances the modulating instrumentality may intend actively to aid the radar beam in illuminating an object by providing an augmentor to enhance the return signal. In the latter application, the resulting system, although it uses the techniques of surveillance, is on a poorly defined borderline between surveillance and communications.

In passive surveillance systems variations in intent are also conceivable on the part of the modulating instrumentality, although in many instances the transmitting instrumentality is indifferent to the requirements of the receiver. For example, in lunar photography systems, the transmitting instrumentality is the sun which illuminates the moon, the modulating instrumentality. Neither of these are capable of formulating an intent regarding transmission of information to the receiving photographic system. The sun also illuminates ballistic missile emplacements, but the modulating instrumentality, the deployer of such weapons, may employ all the methods of concealment available to him to prevent the modulation of sunlight in such a way as to permit the user of the surveillance system to gain information. Sometimes systems are used in which the transmitting instrumentality actively seeks to cooperate with the receiver. For example, the illumination of satellites or balloons with flares enables optical tracking systems on earth to follow them easily. Again, such surveillance systems as these are hardly distinguishable from communications systems.

Examples such as the four above can be multiplied, but they will only

serve to point out that intent, which gave promise of distinguishing communications from surveillance systems, is incapable of doing so.¹¹

The following four principles are presented as a tentative code of the law of space communications and space surveillance. An attempt has been made to restrict the principles only to aspects of space law specifically pertinent to communications and surveillance, thus eliminating consideration of subject matter, such as damages, which have broader application. All of the principles are implicit in the literature of space law. The first three summarize the rights and duties of a State operating electromagnetic equipment in regions under its own jurisdiction, in regions under the jurisdiction of other States, and in regions not subject to national appropriation. The fourth principle imposes a qualification on the first three principles and further restricts the rights of States.

1. From regions within its own jurisdiction a State has a right to propagate electromagnetic radiation in any manner and at any frequency not contrary to international law and may use electromagnetic receivers, detectors, or sensors of any frequency to collect information.

2. From regions under the jurisdiction of another State, a State without authorization has no right either to propagate electromagnetic radiation or to collect electromagnetic radiation, except as permitted under international law.

3. From regions not subject to national appropriation, a State has a right to cause electromagnetic radiation to impinge on the territory or airspace of another State, except that broadcasting is prohibited. In such regions as State may receive electromagnetic radiation emanating from any region of the universe, but has no right to use or to interfere with operation of electromagnetic equipment not its own, except as permitted by international law.

4. At all times, a State has a duty to refrain from radiating any region of the universe in such a manner as to be physically harmful, or potentially physically harmful, to inhabitants of that region or their works and to refrain from emitting radiation in such a manner as to be wasteful of bandwidth in the electromagnetic spectrum.

The principles above are graded so that the State has the greatest freedom of action in operating from its own territory and airspace and the least freedom of action when operating from the territory or airspace of a non-cooperating nation. Under all circumstances, the State must utilize care to avoid physical harm to inhabitants or material goods of regions it radiates.

As is implied in the first principle, there is little restriction on activities which a State can conduct on its own territory. A State may use

¹¹ The above discussion suggests, however, that a distinction might be made in the law, not in accordance with the user's desire to employ electromagnetic spectrum for surveillance purposes or for communication purposes, but in accordance with the transmitting or modulating instrumentality's intent or lack of intent to withhold information from unauthorized receivers. Analysis of this proposition, which is outside the scope of this paper, leads to results which would require great change in existing customary international law. See Beresford, *Surveillance Aircraft and Satellites: A Problem of International Law*, 27 J. Air L. & Com. 112 (1960). A similar proposition applied to the intent of the receiving instrumentality is implied in the 1962 U.S.S.R. *Draft Declaration of the Basic Principles Governing the Activities of States Pertaining to the Exploration and Use of Outer Space*, wherein it is provided: "8. The use of artificial satellites for the collection of intelligence information in the territory of foreign States is incompatible with the objectives of mankind in its conquest of outer space." (U.N. Doc. No. A/Ac. 105/L2).

transmitters and receivers most freely. It may use such devices as telescopes to collect information from its neighbors and even direct radar beams into the territory of unfriendly nations. As Beresford has stated in commenting on the U-2 incident, ". . . it has been long possible to peer across the frontiers of another country by means of radar. Although it might well be considered a penetration of territorial integrity, radar scrutiny is apparently accepted by all nations."¹²

Although the use of transmitters by a State within its own territory is limited by ITU regulations, the State receiving the foreign transmission has the right to jam under two theories. Under the first, the State can jam because it has sovereignty over the airspace; under the second, it can jam because it has the right to protect the security of the State. Jamming of point-to-point radio not intended for reception in the jamming country obviously can be sustained more easily under the sovereignty theory, because the security of the State is unlikely to be involved in most point-to-point transmissions.¹³ Jamming of broadcast transmissions is conceivable under either theory.

Jamming or conducting countermeasures against radar transmissions is another right of the State against which radar surveillance is directed. Since the transmission carries no intelligence per se, it cannot be a threat to security in the same sense that broadcast information can be. Nevertheless, radar surveillance is a type of espionage and, although espionage is not prohibited by international law,¹⁴ such surveillance can be countered as a threat to security.

A growing field of endeavor is related to ground-based surveillance systems. Although the passive systems such as the radio telescopes and optical tracking systems used to detect radiation either from distant celestial objects or from man-made objects launched from earth raise few legal problems, the active systems cannot be expected to respect arbitrarily drawn boundary lines on earth or in the airspace.

The second principle is a broadly prohibitive one which recognizes the sovereignty of a State within its own boundaries and in the airspace above it. The perhaps unnecessary clause at the end of the sentence "except as permitted under international law" is inserted to emphasize the hope that arms control agreements can ultimately be reached which provide for some abrogation of the unlimited right of sovereignty. This principle would prohibit unauthorized incursions into the territory of airspace of another nation for the purpose of using space surveillance or communications devices.

Under the third principle, where equipment is being operated from regions not subject to national appropriation, there is no limitation on emplacement of receivers or passive trackers of any kind. The right to radiate electromagnetic waves, however, may be restricted by extension of a rule of the International Telecommunication Union adopted May 1, 1961. This rule states that: "The establishment and use of broadcasting

¹² Beresford, *supra* note 11, at 114.

¹³ Estep and Kears, *Space Communications and the Law*, 60 Mich. L. Rev. 873 (1962). The essential problem is defined as the impact of the radio transmission on the receiving State. States should be forbidden to jam by disabling a satellite transmitter.

¹⁴ See *Reconnaissance in Air and Outer Space*, 61 Colum. L. Rev. 1074 (1961).

stations on board ships, aircraft, or any other floating or airborne objects outside national territories is prohibited."¹⁵

Since space and celestial bodies, according to the U.N. resolution of December 20, 1961,¹⁶ are not capable of national appropriation, any transmitter operated in space must be operated outside a national territory, therefore: "It is not clear how one could continue to prohibit broadcasting . . . from ships or aircraft situated outside national territories . . . and not impose the slightest restriction on broadcasting from satellites."¹⁷

Can such restriction on electromagnetic emission be extended to cover any electromagnetic radiation from a vehicle or satellite in space? To impose such a restriction would make impossible the exploration of space by man, since he is dependent upon receiving from earth instructions and vehicle guidance and must be able to communicate status information back to earth. Nor can unmanned exploration of the universe proceed because such a restriction would make necessary the return of a vehicle or a probe launched into space back to the earth or at least into a national airspace before it would be permitted to divulge the information collected. To prevent chaos in transmission through the earth's atmosphere, frequency control at least as effective as exists on the earth's surface and airspace will be required in outer space. Fortunately, the International Telecommunications Union will hold an Extraordinary Administrative Radio conference in Geneva, Switzerland, in October, 1963, for the purpose of considering frequency requirements and allocations for operating communications.¹⁸ Significantly, radio astronomy, which is a surveillance rather than a communications function, will be an agenda item.

Under the proposed third principle, radar could be used freely in outer space as a surveillance means. Currently, the right to use radar in a satellite as an earth surveillance sensor is somewhat academic, since microwave radar seems to have insufficient resolution capability to be worth the effort of putting it in orbit. Nevertheless, the developing higher frequency systems using infrared or visible light do not suffer from the resolution limitations of microwave radar. On the other hand, the severe attenuation experienced by these waves in going through the atmosphere may make the use of surveillance radar infeasible at these frequencies also.

The passive systems have far more interesting surveillance capabilities, and principle three would permit unlimited use of passive systems in space. These systems include meteorological sensors, usually infrared or visible light sensitive devices for photographing cloud and storm formations in the earth's atmosphere, photographic and TV sensors for earth surveillance, telescopes and radiometers for astrophysical parameter determinations, and many other systems. The sensors directed away from the earth toward the sun or toward other celestial objects and even man-made objects in space will cause less controversy than those sensors directed toward the earth.

The Soviet Union has objected to the use of photographic and other "intelligence gathering satellites." Nevertheless, it would be difficult to reconcile such a viewpoint with established practice of gathering recon-

¹⁵ International Radio Regulations, art. 7, par. 1(1).

¹⁶ U.N. Gen. Ass. Res. 1721 (XVI) (A/5100).

¹⁷ Persin, *Will Space be Open to Piracy*, 30 *Telecommunication J.* 14 (1963).

¹⁸ 29 *Telecommunications Rep.* 13 (1963).

naissance data over international waters. To quote Beresford: "High-altitude aircraft flying over friendly lands or international waters can use air sampling techniques to detect nuclear explosion on foreign soil and can make recording of foreign radio and radar transmission."¹⁹ High and low level photography from aircraft flying over international waters or friendly lands is a practice long engaged in by many nations. Under these conditions application of a different rule to outer space where national sovereignty does not exist is unwarranted. Successful use of communications satellites will depend upon agreements between the State controlling the satellite and other using States. Without such agreement, mutual interference between would-be satellite users is almost inevitable.

The practical consequences of the fourth principle regarding harmful electromagnetic radiation applies on earth primarily to frequencies above the microwave region. As frequencies increase toward the X-Ray and gamma-ray region of the spectrum, higher and higher energy particles are produced. With the production of coherent infrared and visible frequencies, concentration of energy in the form of heat may also be dangerous to human beings. As more effective use is made of these higher frequencies, greater care must be exercised to avoid the dangers inherent in intense heat and high energy. Such effects may be noted in high power radar and communications transmitters for earth-space service. Because of the protection of the earth's atmosphere, there is little danger of harm resulting on earth as a result of transmissions from space.

It is in space-to-space communications and surveillance that this problem may become severe. The beam of a high power transmitter emitting at infrared or X-Ray frequencies could probably destroy a human being, a satellite, or a probe at considerable distance. The affects of even lower frequencies or other types of life and societies we may encounter in the universe cannot be forecast.²⁰

Caution must be exercised not only to avoid causing physical harm but also to avoid wasteful use of the electromagnetic spectrum. Such wasteful use may occur either through failure to observe rules of the ITU or other regulatory bodies, or through failure to provide means for turning off solar-powered space transmitters after they have served their intended purposes.²¹

With the increasing availability of higher frequencies and the desirability of using them in space, the problem of frequency control may have been overcome because of the potentially millions of channels available for use and because of the development of modulation schemes which may make specific channel assignments unnecessary. In place of frequency control, however, there will arise a new and very formidable problem of energy control.

IV. CONCLUSIONS

Four tentative principles of space law are proposed to cover both space communications and space surveillance. Damages, violation of airspace,

¹⁹ Beresford, *supra* note 11, at 114.

²⁰ See Haley, *Recent Developments in Space Law and Metalaw*, 24 Harv. L. Rec. (Feb. 7, 1957); reprinted in Doc. No. 26, 87th Cong., 1st Sess. 93 (1961).

²¹ U.N. Gen. Ass. Doc. No. A/4141, pt. II, para. 72 (1959).

and other problems have been deliberately avoided as not specifically related to communications and surveillance, but to a broader field of space law. The list of principles is neither authoritative nor exhaustive. Yet, the formulation of tentative codes or sets of principles may serve a useful function in crystallizing thought and defining issues.

A natural consequence of the joint consideration of communications and surveillance would be broadened regulatory action by the United Nations Specialized Agencies. The ITU has already moved in this direction by considering a major space surveillance function—radio astronomy.

As technology grows, the bitterly contested points of yesteryear may well prove to be irrelevant. Thus, any proposed principles need constant review and revision. Eventually, some of them may withstand the corrosive effects of time.