Allocation of the Radio Spectrum: Is the Sky the Limit?

I. Introduction

The radio spectrum, also called the electromagnetic spectrum, is a critical and scarce natural resource.[1] It has been compared to a river,[2] real estate,[3] and farmland.[4] Radio spectrum is instantly renewable at no cost; when a portion of the segment is unoccupied, it is freely available to other users.[5] Like other natural resources, it can be polluted,[6] it can be wasted via inefficient practices,[7] and it can be rendered almost useless by overcrowding and interference.[8] Given current technology, radio spectrum can also be defined as a limited natural resource,[9] since only a finite portion of the atmosphere above the Earth is amenable to present communications technology.

Because radio spectrum cannot be seen, heard, smelled, or touched, it has been taken for granted by the public at large in much the same

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1. Christian A. Herter, *The Electromagnetic Spectrum: A Critical Natural Resource*, 25 Nat. Resources J. 651 (1985).

2. *Id.* at 653.

3. Milton Mueller, *Technical Standards: The Market and Radio Frequency Allocation*, Telecomm. Policy, March 1988, at 42, 44. The author suggests that since the way to deal with scarcity in real estate is to build skyscrapers, a solution to the spectrum problem can be found by increasing technology so as to manipulate higher frequencies; to increase the ceiling on the maximum usable frequency. There are many ideas for changing technology to either move higher on the spectrum or increase existing spectrum efficiency. A compilation of these is provided in Electronics Division of the Institution of Electrical Engineers, *Second International Conference on Radio Spectrum Conservation Techniques, 6-8 September, 1983*, University of Birmingham, U.K., 1-159 (1983).

4. Jack Taylor, *Technology vs. Allocation: Dividing Up the Radio Spectrum*, Telephony, Oct. 8, 1990, at 24.

5. Herter, *supra* note 1, at 653.

6. *Id.*

7. Taylor, *supra* note 4, at 24. The author compares what has happened to the radio spectrum with the settlement of the American West. When poor farming practices exhausted the soil, people merely moved farther toward California. Eventually, the open frontier ran out, which forced farmers to use more efficient methods of farming to conserve soil. According to Taylor, the same thing has occurred with spectrum. Overcrowding and interference from inefficient use of spectrum has led to the manipulation of spectrum at higher and higher frequencies, until the ceiling of maximum usable frequency (MUF) was reached, resulting in the need to reconsider spectrum allocation practices.

8. Herter, *supra* note 1, at 655.

9. *Id.*

way as clean air and fresh water have been in the past. If radio spectrum is to continue to support such traditional technologies as radio and television broadcasting, air traffic control, and police and emergency communications, as well as accommodate newer communications like cellular telephones and satellite systems, it must be allocated equitably and efficiently, in a manner that takes advantage of the transmission characteristics of available frequencies.

Concern with the scarcity of radio spectrum is not new. In 1950, Harry Truman remarked:

> The most pressing communications problem at this particular time, however, is the scarcity of radio frequencies in relation to the steadily growing demand. Increasing difficulty is being experienced in meeting the demand for frequencies domestically and even greater difficulty is encountered internationally in attempting to agree upon the allocation of available frequencies among the nations of the world.[10]

Truman realized 40 years ago that the scarcity of the radio spectrum had international as well as domestic implications for the growth of communications technology.

The problem of radio spectrum allocation has emerged again as an issue of international importance for several reasons. First, a variety of new communications products are being developed. The companies representing technologies such as high definition television (HDTV),[11] personal communications services (PCS),[12] and digital audio broadcasting[13] do not want to expend resources on product development without some guarantee that they will be allocated the spectrum they need to support these new products. Providers of these technologies also assert that spectrum allocation methods in the United States are too slow, leaving them at a competitive disadvantage to Japan and Western Europe.[14] Second, the Federal Communications Commission

10. Harry S. Truman, quoted in OFFICE OF TECHNOLOGY ASSESSMENT, CONGRESS OF THE UNITED STATES, THE 1992 WORLD ADMINISTRATIVE RADIO CONFERENCE: ISSUES FOR U.S. INTERNATIONAL SPECTRUM POLICY 1 (1991) [hereinafter WARC-92].

11. Janine S. Natter, *Scarcity of the Airwaves: Allocating and Assigning the Spectrum for High Definition Television (HDTV)*, 13 HASTINGS COMM./ENT. L. J. 199, 201 (1991).

12. Carson E. Agnew, *Efficient Spectrum Allocation for Personal Communications Services*, IEEE COMMUN. MAG., Feb. 1991, at 52, 54.

13. Ernest A. Hakanen, *Digital Audio Broadcasting: Promises and Policy Issues in the USA*, 15 TELECOMM. POLICY 491-96 (1991).

14. Mike Mills, *Tight Squeeze on Spectrum Tunes Out Competition*, 48 CONG. Q. WEEKLY REP. 2823, 2824 (1990).

(FCC), the government agency responsible for spectrum allocation within the United States, has already notified one user group, electric utilities, that they will have to move off a segment of spectrum to make room for personal communications services (PCS) and personal communications networks (PCNs).[15] Third, another group of spectrum users, amateur radio operators, has had legislation introduced in both the House and Senate that would protect amateur radio allocations. S. 1372[16] and H.R. 73[17] would mandate the FCC to provide equivalent spectrum for amateur radio operators should any of their existing spectrum be reallocated for other purposes. Both bills reveal that amateur radio has already lost over 100 MHz of spectrum through reallocation by the FCC.[18] Such so-called first generation services may be faced with relinquishing portions of their spectrum in order to make room for new technologies.[19] In addition, those that are non-mobile in nature may be forced to switch from wireless to wireline technology,[20] which may involve expensive and extensive retrofitting for users of these services. Fourth, the World Administrative Radio Conference, the international body responsible for allocating radio spectrum for the entire world, met in Torremolinos, Spain, for a month, beginning February 3, 1992.[21] The ability of WARC-92 to provide a viable forum

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15. Steven R. Rivkin, *FCC to Electrics: Move, Use, or Lose!* PUB. UTIL. FORT., May 1, 1992, at 13.

16. S. 1372, 102nd Cong., 1st Sess., 137 CONG. REC. S8617 (1991). Text reads: "(2) The Federal Communications Commission shall not diminish existing allocations of spectrum to the Amateur Radio Service after January 1, 1991. The Federal Communications Commission shall provide equivalent replacement spectrum to the Amateur Radio Service for any frequency reallocation after January 1, 1991."

17. H.R. 73, 102nd Cong., 1st Sess., 137 CONG. REC. H56 (1991). As of this writing, neither bill has been passed and the FCC has rejected H.R. 73. *See FCC Rejects Amateur Spectrum Protection*, CQ, Dec. 1992, at 143 and *Congress Adjourns With No Action on Amateur Radio Bills*, QST, Dec. 1992, at 89.

18. *Id.* Text reads: "(5) the Federal Communications Commission has taken actions which resulted in the loss of over 100 MHz of spectrum to amateurs."

19. Ray Kowalski, *Currents*, CQ, Nov. 1992, at 11, 12. CQ is not an abbreviation, but is the name of an amateur radio journal. When amateur radio operators want to contact each other, they call CQ, then their callsigns, on the air.

20. *Id.* at 14. The transition between wireless and wireline transmission technology has been called the Negroponte Switch. *Id.* However, the switch is limited by whether the communications needed are mobile or non-mobile, since it is not practicable to use wireline technology for mobile applications.

21. David Sumner, *It Seems to Us . . . WARC-92*, QST, Feb. 1992, at 9. QST is not an abbreviation, but is the name of an amateur radio journal. Its name comes from the Q signals, a shortened way to communicate, and is a general call to all amateur radio operators.

for radio spectrum allocation is crucial in determining the role of WARCs in allocating spectrum in the future.

In addition to economic factors, geopolitical changes make a discussion of spectrum particularly appropriate. The last major World Administrative Radio Conference was held in 1979 (WARC-79). However,

> [t]he world today is a far different place from 1979. Western Europe is more unified, eastern Europe less so. Some countries, especially along the Pacific rim, have made startling economic progress while other economies have faltered and some have even collapsed. Former enemies have become allies; former outcasts have been welcomed back to the world community.[22]

Thus, there are international political shifts that will cause the United States to seek new alliances to achieve the spectrum allocation goals it desires. At the same time, developing countries or countries whose economies have been unprecedented growth may have greater demands for spectrum than they have had in the past. On the other hand, developing countries whose economies cannot yet support substantial communications technologies still want to preserve their allocation of radio spectrum for future communications needs.

Few outside the communications industry realize the magnitude of the problem of scarce spectrum and how it will impact the development and viability of communications technology in the future. New users and service providers are faced with nearly zero-sum growth because most of the technologically viable spectrum has already been allocated.

> [T]he commercial telecommunications world is engaged in a titanic struggle. At stake is telecommunications supremacy, or maybe even survival. Telecommunications users and service providers are battling telecommunications innovators who see their chance to gain a share of the multi-billion-dollar industry. Given the absence of vacant spectrum to support new technologies, the spectrum innovators can only prevail at the expense of the spectrum incumbents.[23]

In addition, a report by the Office of Technology Assessment to help United States delegates prepare for WARC-92 listed six major trends

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22. *Id.*
23. Kowalski, *supra* note 19, at 14.

that would shape communications policy at WARC-92 and in the future: the pace of technological change;[24] globalization;[25] the rising importance of regionalism;[26] liberalization and privatization;[27] telecommunications and economics;[28] and new players and alliances.[29]

This note will look at the allocation of spectrum from a historical perspective to see whether current mechanisms are appropriate for the future, given intense competition for spectrum and a changing geopolitical and economic landscape that will further increase the demand for spectrum. Auctions, user fees, and flexible use will then be examined to see whether they might apportion spectrum more fairly and efficiently than current allocation mechanisms.

II. WHAT IS SPECTRUM: A TECHNICAL OVERVIEW

The birth of modern radio communication, and hence the discovery of radio spectrum, is usually credited to Guglielmo Marconi.[30] On December 12, 1901, Marconi was able to transmit the letter "S" in Morse code from St. John's, Newfoundland, to Cornwall, England, with a kite sent 400 feet in the air, a transmission of over 2,000 miles.[31] Not only did this newly discovered ability to communicate over long distances excite the public, but it also fanned the flames of entrepreneurship in communications technology.[32] A combination of this entrepreneurship and the powerful communications possibilities of the radio spectrum has provided modern society with television, shortwave and amateur radio, microwave ovens, air traffic control, infant monitors,

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24. WARC-92, *supra* note 10, at 63.
25. *Id.*
26. *Id.* at 64.
27. *Id.* at 69.
28. *Id.* at 70.
29. *Id.* at 71.
30. CLINTON B. DESOTO, 200 METERS AND DOWN 10-15 (1936). However, other inventors also played a role in the discovery of the radio spectrum. Michael Faraday found a relationship between electromagnetism and light. James Clerk Maxwell theorized that electric phenomena could be reduced to motion in the form of waves, which traveled through a mysterious substance he called "aether." *Id.* at 10.
31. *Id.* at 15. Marconi's first wireless message was transmitted a total of two miles in 1896. On June 2, 1896, he applied for a patent from the British Patent Office. He used an oscillator as a transmitter, with a coherer as a receiver. He added a Loomis aerial to radiate the electromagnetic oscillations that made sound possible. *Id.* at 13.
32. *Id.* Some scientists considered Marconi a charlatan. He had not invented anything new, but had used familiar devices developed by others. *Id.* at 13.

and a host of other products and services which provide information, safety, entertainment, and communication. The entrepreneurial spirit is still evident today, with the introduction of such new products as cellular telephone and satellite communications, which depend on manipulation of the radio spectrum.

A basic understanding of how radio spectrum works is essential to seeing why it is both a crucial and a scarce natural resource. Radio waves are the foundation of wireless communications.[33] A radio wave can transmit information either as audio, video, or data signals by varying such characteristics as phase, amplitude, or frequency.[34] Radio waves are distinguished either by their frequency or by their wavelength.[35] Frequency is defined as the number of cycles a radio wave can complete in one second and is measured by an international unit of frequency known as a hertz (Hz).[36] Radio waves can also be designated by length of their wave, with the longer wavelengths having the lowest frequencies.[37] For example, the wavelengths for commercial AM radio broadcasting are very long, while those for microwaves are very short.[38]

The radio spectrum is further classified into "bands" that group a series of radio frequencies together.[39] Bands are then described either by their wavelength or by name.[40] Hence, a band may be designated as high frequency (HF) or very high frequency (VHF), or it could be called the L-band, the S-band, or the K-band, a naming convention that was developed in World War II to keep actual frequencies secret.[41] The International Telecommunication Union (ITU) uses band numbers, for example, Band 1 or Band 2, to classify frequencies,[42] while bands

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33. WARC-92, *supra* note 10, at 27.

34. *Id.* 1 hertz is equal to one cycle per second. Amplitude and frequency are used in the familiar designations of AM and FM for radio stations. These refer to frequency modulation or amplitude modulation.

35. *Id.* at 28.

36. *Id.* The name of the international unit for frequency measurement was in honor of Heinrich Hertz, who discovered that a spark could be induced to jump across an air gap between two wires, when a another spark was created in a circuit using a spark gap and an induction coil. DESOTO, *supra* note 30, at 10.

37. *Id.*

38. *Id.*

39. *Id.* at 29.

40. *Id.*

41. *Id.* See Figure 1 for a graph of frequency band designations and their corresponding wavelengths. *Id.* at 31. The designations of VHF and UHF can be found on many television control panels.

42. *Id.* at 29.

may also be designated to reflect the communications service which uses it, such as the AM or FM radio bands.[43]

The ability of radio waves to transmit signals can be influenced by several factors.[44] The weakening of a signal as it travels through the atmosphere is called attenuation.[45] Attenuation happens when radio signals pass through rain, clouds, snow, or sleet, with radio signals at high frequencies being more affected by atmospheric conditions than those at lower frequencies.[46] This susceptibility to attenuation is one reason why communication over long distances is difficult at higher frequencies, especially those above 10 GHz.[47] Thus, the range of spectrum that can be economically manipulated by communications technology is currently limited by height restrictions.

Radio waves are both bent and reflected as they pass through the atmosphere.[48] Radio signals bend as they travel from one atmospheric layer to another, depending on the density of the atmosphere.[49] In addition, radio waves can also be reflected by the ionosphere, which is the top layer of the Earth's atmosphere.[50] The ionosphere is divided into D, E, F1, and F2, layers, with the D and E layers disappearing at night and the F layers combining into one,[51] leading to changes in the reflective properties that influence long-distance communication possibilities.[52] Reflection by the ionosphere makes it possible for radio signals to travel thousands of miles, enabling long-distance communications, particularly on the high frequencies (HF) between 3 and 30 MHz.[53] These same HF waves can catch shorter waves and channel them back to Earth using orbiting satellites.[54]

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43. *Id.* at 30.
44. *Id.* at 30-32.
45. *Id.* at 30.
46. *Id.*
47. *Id.*
48. *Id.*
49. *Id.* at 31.
50. *Id.*
51. LARRY D. WOLFGANG, THE AARL 1989-1992 TECHNICIAN CLASS LICENSE MANUAL FOR THE RADIO AMATEUR, 3-3 (1989).
52. *Id.* See Figure 2, which illustrates how the D, E, F1, and F2 bands encircle the earth, as well as their distance from the surface of the Earth, measured in miles. *Id.* at 3-3.
53. WARC-92, *supra* note 10, at 31.
54. Frederick O. Maia, *WARC-92 Could Impact Amateur Spectrum: 150 Nations to Meet February 3rd in Spain*, CQ, July 1991, at 82.

The amount of bending of a radio signal is related to its frequency, with less bending at higher frequencies.[55] At a certain frequency, atmospheric conditions prevent sufficient bending so that the radio signal cannot be reflected back to Earth.[56] This point on the radio spectrum is known as the maximum usable frequency (MUF),[57] a point which can be as high as 30 to 40 MHz or as low as 6 MHz. MUF may also be influenced by the time of day, the season, and atmospheric conditions.[58] MUF can also be affected by the sunspot cycle,[59] although no one is certain why this is so.

The behavior of frequencies above MUF indicates why these frequencies are not as good for long distance communications as those from 3 to 30 MHz. Above MUF, especially for frequencies above 1 GHz, radio signals travel in nearly straight lines from a transmitter to a receiver.[60] The distance of line-of-sight communications is generally limited to the horizon, but since the Earth is curved, this distance can also be affected by antenna height.[61] Using line-of-sight communications requires that no obstacles be between the transmitter and the receiver, such as tall buildings or hills.[62] However, some lower obstacles do not pose a problem if antennas are placed on top of towers or mountains.[63] Line-of-sight radio signals are also substantially affected by atmospheric conditions, such as temperature and the amount of water vapor in the air,[64] making it possible for radio signals to travel farther than normal.[65]

The unpredictability of the distance abilities of higher frequencies, especially those above 1 GHz, makes them difficult to rely on for

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55. WARC-92, *supra* note 10, at 31.

56. *Id.*

57. *Id.* See Figure 3 for a demonstration of how radio signals travel. Note that some bounce off the ionosphere at angles which make long distance communications possible. Others, particularly the signal on the left side of the diagram, head off into space, making them useless for communication. WOLFGANG, *supra* note 51, at 3-8.

58. *Id.*

59. JAMES P. DUX AND MORTON KEYSER, TALK TO THE WORLD: GETTING STARTED IN AMATEUR RADIO, 23 (1989). Some people theorize that the sunspots enrich the atmosphere with unusually high levels of ultraviolet radiation. This super-charged atmosphere is then more responsive to radio signals. *Id.*

60. WARC-92, *supra* note 10, at 31.

61. *Id.* "Line-of-sight propagation is accomplished by means of the space wave, a combination of a direct ray and one or more reflected rays." WOLFGANG, *supra* note 51, at 3-9.

62. *Id.*

63. *Id.* See Figure 4 for an illustration of the path of a groundwave from antenna to antenna. *Id.* at 32.

64. *Id.* at 31-32.

65. *Id.* at 32.

communications.[66] This lack of predictability means that international radio spectrum allocation is particularly challenging at these frequencies, since one of the basic functions of international spectrum management is to prevent or reduce interference.[67] Interference prevents the same frequency from being used again for many miles beyond the horizon because of the possibility that atmospheric conditions may carry a line-of-sight signal beyond its normal transmission limits, adversely affecting another country's communications.[68]

Many users of the radio spectrum can operate in the same geographical region at the same time as long as they are on different frequencies; however, only one user can operate without interference on any one frequency in a given area.[69] These constraints mean that governments or other organizations need to allocate spectrum among a variety of user groups within a country or geographic region. Since radio spectrum cannot be confused within national boundaries and cannot be measured to a point past a country's borders, like the 12-mile limit of the territorial sea,[70] allocation of the radio spectrum must be determined at an international level before it can be further divided within a particular nation. Because the transmissions of one nation can interfere with or even jam transmissions of another, it became apparent several decades ago that international control of the radio spectrum was essential.[71] Hence, a global organization was developed to set standards for international radio operation,[72] particularly in the area of spectrum allocation. This organization is the International Telecommunication Union (ITU).

III. ORGANIZATIONS RESPONSIBLE FOR ALLOCATING SPECTRUM

There are international and domestic organizations and government agencies that allocate radio spectrum. Those most important for worldwide allocation are the International Telecommunication Union (ITU) and World Administrative Radio Conference (WARCs). Within the United States, spectrum is allocated by the Federal Communications Commission (FCC) and the National Telecommunications and Information Administration (NTIA).

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66. *Id.*
67. *Id.*
68. *Id.*
69. Maia, *supra* note 54, at 82.
70. Herter, *supra* note 1, at 655.
71. Maia, *supra* note 54, at 82.
72. *Id.*

A. *The International Telecommunication Union (ITU)*

The International Telecommunication Union was established in 1865 by 20 European nations.[73] Originally called the International Telegraph Union, its responsibility was to facilitate the delivery of telegrams between member nations.[74] The system in place at the time was simple; messages were handed to other telegraph operators at the member nations' borders.[75] In 1885, telephone regulation was made part of the mission of ITU, with radio communication added in 1906.[76] That same year, the first of several telecommunications treaties was promulgated.[77,78,79] In spite of these treaties, ITU continued to be the

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73. *Id.*
74. *Id.*
75. *Id.*
76. *Id.*
77. Telecommunication (Wireless Telegraph), November 3, 1906, 37 Stat. 1565, Treaty Series 568, p. 556. Countries participating included Germany, the United States, Argentina, Austria, Hungary, Belgium, Brazil, Bulgaria, Chile, Denmark, Spain, France, Great Britain, Greece, Italy, Japan, Mexico, Monaco, Norway, the Netherlands, Persia, Portugal, Roumania, Russia, Sweden, Turkey, and Uruguay.
78. Telecommunication (Radiotelegraph), July 5, 1912, 38 Stat. 1672, Treaty Series 581, p. 883, 1 L.T.S. 135. Countries participating included Germany and the German Protectorates, the United States and its possessions, the Argentine Republic, Austria, Hungary, Bosnia-Herzogovina, Belgium, the Belgian Congo, Brazil, Bulgaria, Chile, Denmark, Egypt, Spain and the Spanish Colonies, France and Algeria, French West Africa, French Equitorial Africa, Indo-China, Madagascar, Tunis, Great Britain and the British Colonies and Protectorates, the Union of South Africa, the Australian Federation, Canada, British India, New Zealand, Greece, Italy and the Italian Colonies, Japan and Chosen, Formosa, Japanese Sakhalin and the leased territory of Kwantung, Morocco, Monaco, Norway, the Netherlands, the Dutch Indies and the Colony of Curaçao, Persia, Portugal and the Portuguese Colonies, Roumania, Russia and the Russian Possessions and Protectorates, the Republic of San Marino, Siam, Sweden, Turkey, and Uruguay.
79. Telecommunications: Radiotelegraph, November 25, 1927, 45 Stat. 2760, Treaty Series 767, p. 683, 84 L.T.S. 97. Countries included the Union of South Africa, French Equitorial Africa and other colonies, French West Africa, Portuguese West Africa and the Portuguese Asiatic possessions, Germany, Argentine Republic, Commonwealth of Australia, Austria, Belgium, Bolivia, Brazil, Bulgaria, Canada, Chile, China, Republic of Colombia, Spanish Colony of the Gulf of Guinea, Belgian Congo, Costa Rica, Cuba, Curaçao, Cyrenaica, Denmark, Dominican Republic, Egypt, Republic of El Salvador, Eritrea, Spain, Estonia, the United States, Finland, France, Great Britain, Greece, Guatemala, Republic of Haiti, Republic of Honduras, Hungary, British India, Dutch East Indies, French Indo-China, Irish Free State, Italy, Japan, Chosen, Taiwan, Japanese Sakhalin, the Leased Territory of Kwantung and the South Sea Islands under Japanese Mandate, Republic of Liberia, Madagascar, Morocco (with the exception of the Spanish Zone), Mexico, Monaco, Nicaragua, Norway, New

international body responsible for radio regulation. ITU made its first radio frequency allocation in 1927.[80]

In 1932, ITU adopted its current name, the International Telecommunication Union, to reflect its responsibility for total oversight of communications on a global basis.[81] ITU became a specialized agency of the United Nations (U.N.) in 1947,[82] even though it is older than the U.N.,[83] pre-dating it by 80 years.[84] Its headquarters are in Geneva, Switzerland,[85] and 162 nations are currently members.[86] Almost every country in the world is a member of ITU, even though some are not members of the U.N.[87] These statistics suggest that most countries throughout the world recognize how vital radio spectrum is to efficient communication systems.

The most far-reaching responsibility of ITU is the allocation of radio frequencies to prevent interference between its member nations.[88] Member nations must then conform their own radio regulations to the international framework of radio agreements developed under the auspices of the ITU.[89] It is important to realize that the ITU has no power to prevent unauthorized use of a particular frequency.[90] However, the ITU can deny legal protection under the Radio Regulations to any user who engages in prohibited "harmful interference" to another radio service.[91] Each member nation of ITU typically has its own organizations

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Zealand, Republic of Panama, Paraguay, the Netherlands, Peru, Poland, Portugal, Rumania, Kingdom of the Serbs, Croats, and Slovenes, Siam, Italian Somaliland, Sweden, Switzerland, Surinam, Syro-Lebanese Territories, Republic of San Marino, Czechoslovakia, Tripolitania, Tunis, Turkey, Uruguay, and Venezuela.

80. Maia, *supra* note 54, at 82.

81. *Id.*

82. *Id.*

83. David Sumner, *WARC-92 Finds Room for New Radio Services*, QST, May 1992, at 25.

84. THE WORLD ALMANAC AND BOOK OF FACTS, 828 (1992). The charter for the United Nations became effective on October 24, 1945, upon ratification by the permanent members of the Security Council, along with a majority of other signatories.

85. Maia, *supra* note 54, at 82.

86. Kirk Kleinschmidt and Paul Rinaldo, *WARC-92: What it Means to You*, QST, June 1991, at 16.

87. Sumner, *supra* note 83, at 25. According to the World Almanac, the U.N. has 150 member countries. WORLD ALMANAC AND BOOK OF FACTS, *supra* note 84, at 828.

88. Maia, *supra* note 54, at 82.

89. Kleinschmidt and Rinaldo, *supra* note 86, at 16.

90. Herter, *supra* note 1, at 658.

91. *Id.*

and government agencies that are responsible for domestic radio regulation.

B. *United States Spectrum Agencies*

Two agencies are responsible for allocating radio spectrum within the United States per regulations provided by ITU. These two agencies are the Federal Communications Commission (FCC) and the National Telecommunications and Information Administration (NTIA). The NTIA represents government and military radio users, while the FCC is responsible for other radio users, such as commercial, amateur, and local government.[92] The FCC is the most important organization for spectrum allocation in the United States in that it has control over the bulk of current and potential radio spectrum users, including those in the communications industry whose new products will be vying for spectrum space in which to operate.

Allocation of radio spectrum in the United States began with the enactment of the Radio Act of 1912.[93] This legislation was in response to technical interference problems from government, commercial, and amateur spectrum users.[94] However, as commercial radio broadcasting expanded, the demand for radio frequencies soon exceeded the supply, and current legislation did not give the Secretary of Commerce the power to deny an application to use a particular frequency.[95]

The Radio Act of 1927 was an attempt by Congress to cope with widespread interferences caused by an increasing number of radio broadcasters.[96] This Act created a Federal Radio Commission (FRC) that was given responsibilities for assigning frequencies and reducing interference.[97] To expand this type of regulation to all forms of communication, Congress enacted the Communications Act of 1934.[98] This Act incorporated the regulatory scheme adopted in the Radio Act of 1927[99] and is still used today to control telecommunications in the

92. Kleinschmidt and Rinaldo, *supra* note 86, at 16.

93. Michael C. Rau, *Allocating the Spectrum by Market Forces: The FCC Ultra Vires?* 37 CATH. U. L. REV. 149, 153 (1987).

94. *Id.*

95. *Id.* at 154.

96. *Id.* For a comprehensive discussion of early radio broadcasting, *see* TOM LEWIS, EMPIRE OF THE AIR: THE MEN WHO MADE RADIO, 1-142 (1991).

97. *Id.* The FRC was to exercise these powers according to the "public convenience, interest, or necessity." *Id.*

98. *Id.*

99. *Id.* at 155.

U.S.[100] The Act also resulted in the establishment of the Federal Communications Commission (FCC) as an independent government agency that would oversee and regulate wire and radio communication.[101]

The FCC must exercise its authority within the scope and spirit of international telecommunications agreements, including the ITU.[102] Its primary functions are to allocate radio frequencies, determine which frequencies will be used by individual stations, and provide licensing to individual stations.[103] Operation of the FCC is conducted according to the Communications Act of 1934, the Administrative Procedures Act, and other laws of Congress. It is managed by five Commissioners who are appointed by the President, but who also must be approved by the Senate.[104] Commissioners serve for a term of five years, and no more than three can be from the same political party.[105] The President designates one of the Commissioners as FCC Chairman.[106] The FCC staff is further organized into different administrative bureaus.[107] In addition to their domestic responsibilities, both the FCC and the NTIA have a role to play in representing the United States in international radio spectrum allocation. This role becomes particularly important for World Administrative Radio Conferences (WARCs).

C. *World Administrative Radio Conferences (WARCs)*

World Administrative Radio Conferences (WARCs) are responsible for making changes to international radio regulations.[108] Deriving their authority from the ITU, they are international meetings of government and private industry representatives.[109] Radio regulations that are promulgated by a WARC are equivalent to treaties among ITU member nations, and must be adhered to when these nations formulate their own domestic communications regulations and policies.[110] In the United States, the Senate must ratify the Final Acts of a WARC before they are binding on this country.[111]

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100. Maia, *supra* note 54, at 82.
101. *Id.*
102. *Id.*
103. *Id.*
104. *Id.*
105. *Id.*
106. *Id.*
107. *Id. See also* WARC-92, *supra* note 10, at 76-80.
108. Kleinschmidt and Rinaldo, *supra* note 86, at 16.
109. *Id.*
110. *Id.*
111. *Id.*

There have been many WARCs throughout the 20th century. Most of these WARCs were specialized, covering a single spectrum user group, a particular geographic area, or a limited portion of the spectrum.[112] Examples of specialized WARCs were ORB-85[113] and ORB-88,[114] which dealt primarily with regulation of the geostationary orbit. However, several WARCs in the past century have been considered "general." The first general WARC was held in 1903, with several significant WARCs held since then.[115] Of these, perhaps the WARC of 1927, held in Washington, D.C., has been the most important.[116] At this conference, the radio spectrum was first divided into segments, resulting in a Table of Frequency Allocations that countries later agreed to as a guide for domestic spectrum assignments at the 1932 WARC in Madrid.[117] The last large WARC was held in 1979.[118] WARC-92 is not a "general" WARC, but has been called to handle specific questions and issues identified at WARC-79 and subsequent specialized radio conferences.[119]

A WARC only has authority over specific issues that are on its agenda, which may be formulated as early as two years before the conference.[120] Each member nation of ITU is responsible for selecting its own delegates to a WARC.[121] The United States team may contain dozens of delegates, representing the Department of State, which has overall responsibility for United States participation in WARCs, the NTIA, the FCC, and selected spokespersons from the communications

112. *Id.*

113. Milton L. Smith, *Space WARC 1985: The Quest for Equitable Access*, 3 BOSTON UNIV. INTL. L. J. 229-55 (1985); Barbara L. Waite and Ford Rowan, *International Communications Law, part II: Satellite Regulation and the Space WARC*, 20 INT. LAWYER *341-365 (1986); Gregory C. Staple, The New World Satellite Order: A Report from Geneva*, 80 AM. J. INT. L. 699-720 (1986).

114. Stephen E. Doyle, *Space Law and the Geostationary Orbit: The ITU's WARC-ORB 85-88 Concluded*, 17 J. SPACE L. 13-21 (1989); Stephen E. Doyle, *Regulating the Geostationary Orbit: ITU's WARC-ORB '85-'88*, 15 J. SPACE L. 1-23 (1987).

115. Kleinschmidt and Rinaldo, *supra* note 86, at 18. The following were major WARCs that have been held in the last century: Berlin, 1903; Berlin, 1906; London, 1912; Washington, 1927; Madrid, 1932; Cairo, 1938; Atlantic City, 1947; Geneva, 1959; Geneva, 1971; and Geneva, 1979.

116. *Id.*

117. *Id.*

118. *Id.* at 16.

119. *Id.*

120. Sumner, *supra* note 83, at 25.

121. Kleinschmidt and Rinaldo, *supra* note 86, at 16.

industry.[122] However, the representation of smaller countries may be handled entirely by officials from particular government agency, such as the Ministry of Post, Telephone and Telegraph, in lieu of broad-based representation from a wide variety of groups that is typical of larger countries.[123] In addition, a number of recognized international organizations, such as the International Amateur Radio Union (IARU), may be permitted to attend a WARC on behalf of its members.[124] Extensive preparation goes into a WARC, which is evident from documentation produced before and after WARC-92.[125,126]

IV. WARC-92 AND SPECTRUM ALLOCATION

Since WARC-92 happened so recently, very little substantive information has been published to date. The most comprehensive sources are two articles that appeared in QST, the official journal of the American Radio Relay League,[127] and the United States Delegation Report,[128] submitted to the Secretary of State by Ambassador Jan Witold Baran, Chairman of the United States Delegation. These sources provide details on the purpose of WARC-92, preparations by the United

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122. *Id.*

123. *Id.* at 17.

124. *Id.* at 16. The IARU is one of many organizations that has participated successfully in WARCs, protecting the spectrum interests of its members. Sumner, *supra* note 83, at 27.

125. WARC-92, *supra* note 10, 1-131. This is the most complete source the author has found on what spectrum is, the technological, economic, and geopolitical problems associated with it, an overview of international and national bodies dealing with spectrum, and future projections on spectrum allocation.

126. Jan Witold Baran, World Administrative Radio Conference for Dealing with Frequency Allocations in Certain Parts of the Spectrum (WARC-92) 1-79 (July 10, 1992), a substantive, but as yet unpublished, report on the purpose, preparations, and outcomes of WARC-92.

127. Sumner, *supra* note 83, 25-28; Paul L. Rinaldo, *WARC-92: Inside the United States Delegation*, QST, May 1992, at 28-30, 52. David Sumner is the Executive Vice President of the American Radio Relay League (ARRL), the U.S. organization for amateur radio operators. Paul L. Rinaldo is the Editor of QST, the official journal of the ARRL.

128. Baran, *supra* note 126, 1-79. Baran's report also features tables showing present and future spectrum allocations as a result of WARC-92, as well as detailed information on each of the committees, the attendees of WARC-92, and the number of representatives sent by ITU member nations. This report was obtained from the headquarters of the American Radio Relay League. It is not clear whether it will be published in an official form.

States delegation, and the important outcomes that were achieved on an international, as well as a national, level.

A. *Purpose of WARC-92*

The official title for WARC-92 was the World Administrative Radio Conference for the Allocation of Frequencies in Certain Parts of the Spectrum.[129] Its primary purposes were to revise radio frequency allocations for new and existing services and to specify conditions governing the use of these frequencies.[130] Although not a "general" WARC per se, WARC-92 was important because it had the broadest responsibilities for allocating radio spectrum since WARC-79. According to Ambassador Baran, "WARC-92 will play an important role in determining the economic competitiveness of the U.S. in international communications technologies and the ability of the U.S. to achieve its own domestic telecommunications goals."[131] WARC-92 was also held to deal with issues that had been raised at specialized conferences on mobile communications, space, and broadcasting.[132] The need for the conference became evident with new advances in communications technology making increasing demands on spectrum that had already been allocated to other uses.[133]

Fifty-three delegates from the United States attended WARC-92, joining a total of 1400 delegates representing 127 ITU member nations and observers from 32 international and regional organizations.[134] WARC-92 was preceded by 18 months of preparation on behalf of the United States delegation, setting United States requirements for spectrum, submitting positions to be used in negotiation with other ITU member nations, participation in bilateral and multilateral negotiation sessions, and coordinating spectrum requests between established United States government and industry groups.[135]

B. *Preparations for WARC-92*

Extensive preparations were made before WARC-92, from the distribution of a technical report that was agreed to in advance of the

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129. *Id.* at 1.
130. *Id.*
131. *Id.*
132. *Id.*
133. *Id.*
134. *Id.*
135. *Id.* at 2.

conference to the setting of an agenda at an international level.[136] Member nations of ITU then prepared proposals that were due in Geneva eight months before WARC-92 was actually held.[137] These proposals were prepared in English, Spanish, and French.[138] Representatives of member nations then carefully read all proposals to identify positions that they could support or areas of potential compromise.[139]

United States preparations for WARC-92 were initially handled by the NTIA and the FCC.[140] NTIA was responsible for developinig government proposals, which it did in conjunction with the Interdepartmental Radio Advisory Committee (IRAC), which is chaired by the NTIA.[141] This led to the formation of an ad hoc committee from IRAC, Ad Hoc 206, in August 1989, which then broke into four subcommittees: allocations to the high frequency broadcasting (HFBC) services; allocations to the bands 1-3 GHz; allocations at frequencies greater than 10 GHz; and regulatory matters.[142] By April 1991, Ad Hoc 206 sent its positions on WARC-92 to the United States Department of State.[143]

On the non-government side, the FCC formed an Industry Advisory Committee (IAC) to help collect information and develop proposals for WARC-92.[144] While IAC also divided into four subcommittees, it included public input through two Notices of Inquiry and one Supplemental Notice of Inquiry (NOI).[145] The FCC adopted its proposals on June 13, 1991.[146]

The proposals from both the NTIA and the FCC were nearly identical, so only minimal coordination was needed.[147] The Department of State then forwarded these proposals to the ITU in July 1991.[148]

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136. Sumner, *supra* note 83, at 26.
137. *Id.*
138. *Id.*
139. *Id.*
140. Baran, *supra* note 126, at 7.
141. *Id.*
142. *Id.*
143. *Id.*
144. *Id.*
145. *Id.*
146. *Id.*
147. *Id.*
148. *Id.* Principle objectives of the United States at WARC-92 were:
a) to obtain spectrum allocations needed to support a host of new mobile-satellite applications including those provided by low Earth orbiting satellites;
b) to obtain frequency allocations to provide for new and improved terrestrial

Since these proposals lacked positions on satellite sound broadcasting and terrestrial digital audio broadcasting, an additional proposal was sent to the ITU in November 1991.[149]

After United States proposals were sent, delegates from the United States conducted intensive preconference bilateral and multilateral consultations with individual countries, groups of countries, and international organizations.[150] These meetings included representatives from the Conference of European Posts and Telecommunications (CEPT), the Region 2 countries of the Inter-American Telecommunications Conference (CITEL), the frequency management arm of the North Atlantic Treaty Organization (NATO), and the Satellite Organizations and Notifying Administrations (SONA), which includes the International Telecommunications Satellite Organization (Intelsat), the International Maritime Satellite Organization (Inmarsat), and the European Telecommunications Satellite Organization (Eutelsat).[151] In addition, joint industry-government trips were taken to Senegal, Côte d'Ivoire, Nigeria, Cameroon, Benin, Japan, Australia, and India.[152] Other bilateral meetings included representatives from Hungary, Korea, Tanzania, Nicaragua, New Zealand, and Switzerland.[153] Such comprehensive diplomacy may become increasingly necessary if the United States is to achieve its spectrum allocation goals, particularly as new alliances are formed and the economies of both developed and developing countries improve or decline.

In addition to United States preparatory efforts, planning for WARC-92 continued on several fronts. Organizations included in this planning were ITU's International Radio Consultative Committee

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and satellite-based broadcasting services;

c) to obtain frequency allocations needed to support the National space program;

d) to protect vital U.S. national security interests;

e) to gain acceptance of new and revised radio service definitions into the Radio Regulations; and

f) to ensure adoption of new procedures to coordinate the operation of non-goestationary satellite networks with other services operating in the same bands.

Id. at 6.

149. *Id.* at 7.

150. *Id.* at 10.

151. *Id.* at 10-11.

152. *Id.* at 11.

153. *Id.*

(CCIR),[154] the International Frequency Registration Board (IFRB),[155] the Plenipotentiary Conference,[156] and the Administrative Council.[157]

Authority over a WARC rests with a body called the Plenary, which then establishes committees to work in certain areas.[158] Once WARC-92 was convened, delegates were divided into six committees.[159] Committee 4 (Frequency Allocation), Committee 5 (Regulatory), and the Working Group to the Plenary (a Technical Committee) had the most significant input into the substantive matters of WARC-92.[160] Committee 4 divided itself into three groups, dealing with frequencies below 137 MHz, frequencies between 137 MHz and 3 GHz, and frequencies above 3 GHz.[161]

C. *Results of WARC-92*

WARC-92 proved to be a workable venue for allocating spectrum on a worldwide basis, with the United States able to achieve its goals for communications development without these goals being at the expense of other WARC participants and, according to Ambassador Baran,

> [t]he United States delegation's broad objectives were to improve the efficiency of spectrum use and increase the availability of modern telecommunication services at competitive prices. Worldwide interest in liberalizing telecommunications regulations, coupled with the sweeping geopolitical changes in the years immediately preceding the WARC, created a climate favorable to reducing technical and operational barriers in international regulations.[162]

The positive outcomes of WARC, especially the reallocation of spectrum for new technologies, show that it continues to be a significant mechanism in the international allocation of spectrum. However, as the speed of technological development increases, it may be that WARCs, or at least specialized WARCs dealing with a specific communications

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154. *Id.* at 8.
155. *Id.*
156. *Id.* at 9.
157. *Id.*
158. Sumner, *supra* note 83, at 26.
159. Baran, *supra* note 126, at i-ii, Table of Contents.
160. Sumner, *supra* note 83, at 26.
161. *Id.*
162. Baran, *supra* note 126, at 2.

technology, will need to be held more often. This idea has been proposed,[163] as have changes in the structure of ITU and its related organizations,[164] so that they can more quickly respond to ongoing spectrum allocation demands and communications regulation in general.

Committee 4, the frequency allocation committee for WARC-92, considered 22 different requests for spectrum.[165] However, the most important of these frequency requests concerned shortwave radio,[166] satellite sound broadcasting,[167] mobile satellite services,[168] high definition television,[169] and space services.[170] Increased allocation for shortwave radio was considered essential, since such broadcasting is a vital part of promoting United States foreign policy goals.[171] Shortwave radio saw a surge in popularity during the Gulf War of 1991. An additional 790 kHz was allocated for shortwave radio during WARC-92, including 200 kHz on the most optimal segment of the shortwave spectrum.[172] Satellite sound broadcasting, which would provide digital audio broad-

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163. Kleinschmidt and Rinaldo, *supra* note 86, at 17.

164. WARC-92, *supra* note 10, at 49-62. Some of the proposed changes have already been made to the structure of ITU.

> The "new" ITU is organized into three sectors: Development, standardization and radiocommunication. Of the most interest to us is the Radiocommunication Sector, which includes the activities (other than standards-setting) of the CCIR. The work of the sector will be conducted through World and Regional Radiocommunication Conferences and Radiocommunications Assemblies, held every two years. Thus, "World Administrative Radio Conference" and "WARC" disappear from our lexicon.

Michael Owen and David Sumner, *The ITU Restructures*, QST, March 1993, at 103.

165. Baran, *supra* note 126, i-ii, Table of Contents. The Committee's 22 requests for spectrum allocation were: high frequency broadcasting; low earth orbit mobile-satellite service below 1 Ghz; manned space communications near 400 MHz; aeronautical public correspondence; terrestrial mobile service; existing mobile-satellite service allocations; radio astronomy services; low earth orbit mobile-satellite services above 1 GHz; radiodetermination-satellite service; future public land mobile telecommunication systems; space services near 2 GHz; new mobile-satellite service allocations; broadcasting-satellite service (sound); wide RF-band high definition television; fixed-satellite service at 14.5 - 14.8 GHz; general-satellite service; inter-satellite service for LEOs; radiolocation-satellite service; inter-satellite service for data relay satellites; uplink power control beacons; deep space research; and new space research service allocations near 37/40 GHz.

166. *Id.* at 2.

167. *Id.*

168. *Id.* at 3.

169. *Id.* at 4.

170. *Id.*

171. *Id.* at 2. *See also Id.* at 17-19.

172. *Id.*

casting from satellites directly to individual receivers, was agreed on as a vital need by all ITU delegations.[173] Most ITU member nations chose 1452-1492 MHz as their frequencies.[174] However, the United States, China, India, Japan, and Russia decided upon the S-band for satellite sound broadcasting.[175] The use of satellite sound may have an additional benefit; it may reduce interference on the shortwave bands, because it will provide another method of offering audio communication outside of already overcrowded HF spectrum.[176] Similar allocations were made for terrestrial-based digital audio broadcasting.[177]

One of the most significant allocation agreements was for mobile satellite services, including low earth orbit satellite systems, referred to as LEOS.[178] "Little" LEOS would provide data services at frequencies below 1 GHz,[179] and "Big" LEOS would support a wide range of communications services, including both data and voice.[180] Additional allocations were made for mobile satellite services (MSS) and geostationary orbit (GEO) satellite systems, so that spectrum will be available for these technologies in the future, since it is estimated that there will be tremendous demand for a wide variety of services that can be provided via mobile satellite systems.[181] This technology could potentially

173. *Id. See also Id.* at 28-29.

174. *Id.* at 3.

175. *Id.* Source uses Russia. *See also* Rinaldo, *supra* note 127, at 52. Author uses Russian Federation.

176. *Id.*

177. *Id.*

178. *Id. See also Id.* at 19-21 and 24-25.

179. *Id.* These data-only systems require very little spectrum and can be operated with inexpensive mobile equipment. They are especially practical where population density is too low to consider investing in a communications infrastructure built on wire or optical fiber cabling. Developing countries are especially intrigued by this technology as a way to economically reach unserved segments of their populations without extensive investment in infrastructure. It is estimated that there may be a $1-2 billion dollar market potential of LEOS, half from domestic sales and the other half being sold internationally. *Id.*

180. *Id.* "Big" LEOS will provide real time communications directly between two points any place in the world. They will also be able to interface with wireline systems or provide a direct connection between mobile terminals and satellites. Several U.S. companies are interested in these systems and counted on WARC-92 to ensure them the spectrum they will need before they are willing to make further investments in developing "big" LEOS. Estimates have suggested that by 21st century, there may be as many as 2 million subscribers to "big" LEOS. *Id. See also* Bruce S. Hale, *Big LEOS*, QST, April 1993, at 40-41.

181. *Id. See also Id.* at 23-24 and 27-28.

involve complex arrangements with terrestrial mobile systems and cellular and public correspondence networks.[182]

The public at large might be most intrigued by the WARC-92 allocations for high definition television (HDTV) and space services. Committee 4 was able to allocate spectrum for wide-band HDTV, which will become available in 2007.[183] Frequencies were also allocated for several of NASA's projects, such as communications to support a space station, a moon colony, and a manned mission to Mars.[184] There was also an allocation for extra vehicular activity (EVA), which is needed when astronauts work outside of their space vehicles.[185] An additional allocation in support of the United States space program was the proposed data relay satellite system.[186] This will be instrumental in the multinational mission to planet Earth, a project which will provide extensive information for researchers in climatology and meteorology.[187]

The United States was not the only ITU member nation to achieve its spectrum goals. Other countries were equally successful, with allocations made for Future Public Land Mobile Telecommunications Systems (FPLMTS),[188] aeronautical public correspondence,[189] general satellite services,[190] and very-long-baseline radiointerferometry (VLBI).[191] In addition, the Working Group of the Plenary discussed wind profiler radars and decided to commission a study on this technology, as well as to slate a future conference to determine its spectrum requirements.[192]

The question of political alliances was expected to be most evident in the deliberations of Committee 4. The traditional split between developed and developing countries was present, as delegates attempted to provide room on the spectrum for new technologies being contemplated by the developed countries without disenfranchising the more modest communication goals of developing countries.

> It became evident that there were two camps; one advocating allocation for new technologies; the other willing to

182. *Id.*
183. *Id.* at 4. *See also Id.* at 29-30.
184. *Id. See also Id.* at 21, 27, and 33-34.
185. *Id.*
186. *Id. See also Id.* at 32-33.
187. *Id.*
188. Rinaldo, *supra* note 127, at 52. *See also* Baran, *supra* note 126, at 26.
189. *Id. See also* Baran, *supra* note 126, at 21-22.
190. *Id. See also* Baran, *supra* note 126, at 31.
191. *Id. See also* Baran, *supra* note 126, at 34.
192. *Id. See also* Baran, *supra* note 126, at 39.

> benefit from new technologies so long as there was no change. Allocations for new technologies would have to come mostly from the fixed service. In the developed world, while there are fixed service operations at UHF, many of these operations have been or could be moved to frequencies above 3 GHz. Optical fiber is also increasing in use, which can free up some radio frequencies. In the developing world, the picture is entirely different. Frequencies all the way from HF through VHF and UHF are extensively used for fixed service operations, in many cases simply to provide basic telephone service to rural areas. Developing countries would like to take advantage of new technologies, which may involve satellites, but want to retain their terrestrial fixed services to provide basic domestic communications services.[193]

More unusual was a rift between the United States and European countries, which had traditionally allied themselves to achieve common spectrum allocation purposes.

> [A] split in the industrialized world was also evident. The United States came to WARC with numerous allocation proposals for mobile satellites, mainly targeted toward serving parts of the US and other countries with low population densities. Europe, on the other hand, was pushing terrestrial mobile service allocations, particularly the much heralded Future Public Land Mobile Telecommunications Systems (FPLMTS). These two giants were on a collision course.[194]

These changes in alliances, particularly the new regionalism, had been predicted in WARC-92 preparation documents.[195]

Based on the frequency allocations made, WARC-92 provided a basis for emerging technologies that could become essential parts of communication systems in the 21st century.[196] WARC-92 was also significant in that it showed that a public/private partnership and extensive diplomacy between both developed and developing ITU member nations can have a positive and lasting impact on spectrum allocation in the future.[197]

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193. *Id.* at 29.

194. *Id.*

195. WARC-92, *supra* note 10, at 64-69 and 71-73.

196. Rinaldo, *supra* note 127, at 52.

197. Letter from Jan Witold Baran, Ambassador and Chairman, United States Delegation, to James E. Baker, Secretary of State, 2 (July 10, 1992).

V. OTHER ALLOCATION PROPOSALS

A variety of authors have proposed alternative ways to allocate the radio spectrum. These proposals focus more on allocations at the national level. A discussion of each reveals strengths and weaknesses that may help determine whether they could successfully be implemented either domestically or internationally. It is first useful to review how spectrum is currently allocated, then to look at three of the most commonly proposed alternatives: auctions, user fees, and flexible use. Finally, the legal and economic implications of these three alternatives must be considered from both a national and an international view.

A. *Current Allocation Mechanisms*

Radio spectrum is currently allocated first at the international level. WARC-92 is a good illustration of how ITU member nations come to a WARC with extensive preparation and negotiation already completed. Within a WARC, delegates from member nations reach agreement on how the spectrum will be allocated on a worldwide basis. Typically, agreements can be reached that are satisfactory to the majority of member nations. Member nations that are unhappy with allocation decisions can request secondary allocations,[198] ask for footnotes to protect their desired frequencies,[199] or split the service into different frequencies among ITU regions.[200]

WARC-92 was successful in that it made great strides in finding spectrum for new technologies without hampering existing spectrum users. The strength of a WARC-type system of spectrum allocation is evident in that international cooperation is fostered, which hopefully will result in compliance with allocation decisions. On the other hand, when WARCs are held sporadically, new technologies needing spectrum may have to wait several years before a commitment is made to allocate spectrum to them. With rapid developments in communications technology, pressure will build for spectrum allocation long before a WARC can be prepared and held. In addition, many of the WARC-92 decisions will not be implemented for 10-15 years.[201] While it is only fair to give

198. Rinaldo, *supra* note 127, at 52. Secondary allocations were made for very-long-baseline radiointerferotomy (VLBI).

199. *Id.* at 30. Footnotes were requested by the U.S. for "Little" LEOS to protect existing services.

200. *Id.* at 52. This was used to satisfy spectrum needs for HDTV among a number of ITU member nations who wanted to use different segments of the spectrum.

201. Baran, *supra* note 126, at 1.

existing spectrum users sufficient time to move onto alternate spectrum, waiting periods of a decade or more slow down the product development process in a global economy where companies must innovate to remain competitive.

At the domestic level, the FCC is primarily responsible for spectrum once allocations have been made at a WARC. The FCC traditionally has followed a licensing scheme where companies and individuals make direct application.[202] Often cumbersome and time-consuming, "[t]he process by which the Federal Communications Commission allocates the nongovernment portion of the spectrum is in essence a complex series of coordinating activities. It includes negotiations with numerous other parties, both public and private."[203] Over time, the FCC has adopted several principles to help it decide whether to grant a license,[204] which have been published in some form since 1935.[205] Looking at past decisions, the FCC seems to give the most weight to safety of life and property, the number of people served, and the amount of capital investment involved.[206]

Currently, the FCC relies on a "block allocation" system, where the FCC estimates what a communications service will need and then

202. For example, once an amateur radio operator has passed the necessary examinations and Morse code requirements, a short application is filled out by a Volunteer Examination Coordinator (VEC). This application is forwarded directly to the FCC. Within 4-8 weeks, a license with callsign is sent directly to the applicant. The only charge is a $4.95 fee for Technician and higher license classes, which subsidizes the administration of the examination process.

203. John O. Robinson, *Spectrum Allocation and Economic Factors in FCC Spectrum Management*, 19 IEEE TRANS. ELECTROMAGNETIC COMPAT. 182, 183 (1977).

204. *Id.* at 185. These principles are:

a) whether the service in question really requires the use of radio or whether wireline is a practical substitute;

b) radio services which are necessary for safety of life and property deserve more consideration than those which are more in the nature of conveniences or luxuries;

c) where other factors are equal, the Commission attempts to meet the request of those services which will render benefits to the largest segment of the population;

d) whether the service meets a substantial public need and has a reasonable probability of being established on a viable basis;

e) consideration of the most suitable place in the spectrum to satisfy the requirements of each particular service;

f) consideration of industry and public investment already committed to a particular frequency band.

205. *Id.* at 184.

206. *Id.* at 185.

allocates a range of spectrum.[207] Criticisms of the block allocation method are that the public interest standard is too subjective, the quantity of spectrum made available by the FCC has a direct correlation with the profitability of a particular communications service, and traditional spectrum users such as radio and television broadcasters view allocation as potentially harmful either in terms of interference or economic competition.[208] Other problems with the block allocation system are that it is not an efficient method of allocating spectrum, it is not flexible enough to adapt to changing technology, it is detrimental to research and development of products that would conserve spectrum, and that the inadequate resources of the FCC limit the quality of decisions that are made on complex spectrum issues.[209] In addition, the public interest standard is considered too vague to be so heavily weighed in spectrum decision-making and the block allocation system limits opportunities to do long-range planning on spectrum issues.[210]

Should the FCC decide not to grant a license, or when more than one entity is vying for the same portion of spectrum, a hearing must be conducted.[211] These hearings can be long, costly to applicants, the government, and the public, and are also subjective, since they rely primarily on information supplied by license applicants.[212] Given problems with the allocation procedures used by the FCC, along with difficulties and delays associated with WARC decisions at the international level, it seems prudent to consider proposals for other methods of spectrum allocation.

B. *Auctions*

New Zealand and the United Kingdom have already instituted auctions for spectrum allocation.[213,214] In the United States, the Pres-

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207. Rau, *supra* note 93, at 158. *See also* Roy Kowalski, *Currents: A Look at Communications: Where We've Been, Where We Are, and Where We're Likely to Go*, CQ, Jan. 1993, at 26-28.

208. *Id.* at 159.

209. *Id.* at 159-60.

210. *Id.*

211. Robinson, *supra* note 203, at 189.

212. *Id.*

213. CONGRESSIONAL BUDGET OFFICE, AUCTIONING RADIO SPECTRUM LICENSES, 12-3 (1992) [hereinafter CBO]. The New Zealand plan included holding auctions to distribute rights for the "A" block American Mobile Phone Standard (AMPS) and both the "A" and "B" blocks for the Total Access Communications Standard (TACS). The bidding process provided $20 million in NZ dollars, equivalent at the time to

ident's budget request includes a proposal that would require the FCC to use auctioning or competitive bidding for assigning licenses to private users of the radio spectrum, as part of the Emerging Telecommunications Technology Act of 1992.[215] This Act transfers 200 MHz currently assigned to government use to the private sector, a segment that falls under 6 GHz, that would be made available over a 15-year period.[216] The proposal requires a first-stage application and a second-stage screening, but does not specify what the spectrum can be used for or how charges will be assessed.[217]

There are a variety of arguments for and against the use of auctions for allocating spectrum. Auctions could be especially helpful in the assignment of frequencies within spectrum already allocated for a particular purpose.[218] A primary advantage of an auction would be that it could replace the time-consuming hearing process that is now held when more than one entity applies for the same segment of spectrum.[219] Since the amount of the bid would approximate the value of that segment of the spectrum, this bid could also be used as a shadow price for other parts of the spectrum which are not currently assigned a cost.[220] In addition, an auction could help determine the applicant who

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$11.9 million in U.S. dollars. The funds generated by the auction went to the New Zealand Government. Terrence J. Schroepfer, *Allocating Spectrum Through the Use of Auctions*, 14 HASTINGS COMM./ENT. L. J. 35, 38-39 (1991).

214. *Id.* at 13-15. The U.K. auctioned the rights to offer programming on Independent Television Channel 3 in February 1991. The auction, which involved 40 production companies vying for 16 franchises, participated in a sealed bidding process, with the rights to the franchises awarded to the highest bidders. The entire bidding process took only six months, with an opportunity for public comment in the interim. The bidders were also evaluated on their capacity to fulfill the public interest standards that are the law in the U.K. as well as in the U.S. Countries such as Canada, Australia, and Italy, along with the countries of the European Community as a whole, are considering auctions as a way to grant spectrum licenses. *Id.* at 12.

215. *Id.* at 16.

216. *Id. See also* David Sumner, *It Seems to Us . . . Spectrum for the 21st Century*, QST, Jan. 1993, at 9.

217. *Id.*

218. Robinson, *supra* note 203, at 189.

219. *Id.*

220. *Id.*

> Shadow prices would exhibit their greatest effect in the spectrum management function of allocation. Since they would provide a measure of spectrum value, shadow prices would also be extremely useful in establishing user charges. However, their primary importance lies in that [sic] fact that the knowledge of spectrum value provided by these shadow prices would enable the Commission to examine the economic cost of allocation decisions,

would most likely use the spectrum to its optimum efficiency, comparing applicants by their willingness to commit financial resources.[221] It is also probable that an auction, as a single event with an established format, would be less expensive and less time-consuming than the open-ended hearing, which can last for many months.[222]

Although there may be economic efficiency if an auction is properly designed and administered,[223] the disadvantages of this mechanism are the need for regulation of the public trust,[224] the danger that the ability of auctions to raise funds for the government will lead to sacrificing other objectives of spectrum management,[225] and the potential for market failure within the communications industry.[226] The so-called "deep pockets" argument has also been made, with the premise that a comparative hearing offsets the advantages the large firms with vast financial resources have over smaller firms that would be out-bid in an auction format.[227] In addition, there is a concern that the public interest standard that underlies assigning radio spectrum will be lost if a monetary measurement of spectrum value is adopted.[228]

Other factors against the use of auctions for allocating spectrum are the administrative burdens,[229] the fact that an auction might not bring in the level of funding anticipated,[230] and that applying economic concepts to spectrum allocation would be a radical departure from the

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> including the cost of holding spectrum in reserve for anticipated radio service development and growth.

Id.

221. *Id.*

222. *Id.*

223. CBO, *supra* note 213, at 18-20.

224. *Id.* at 20.

225. *Id.* at 21-22.

226. *Id.* at 22.

227. Schroepfer, *supra* note 213, at 45-46. *See also* CBO, *supra* note 213, at 22.

228. CBO, *supra* note 213, at 21.

229. *Id.* at 19. However, the CBO report did state that "[a]uctions may be superior to either comparative hearings or lotteries in the areas of administrative ease, transaction costs, and timeliness." *Id.* The same study also notes that "[c]omparative hearings are time-consuming and costly. Lotteries are fast, but take longer than auctions and increase the cost to society of spectrum management because they encourage speculative entries." *Id.*

230. *Id.* at 23-38. Estimates the amount of revenue that could be generated from auctioning land-mobile communications licenses, looking at such factors as costs, revenues, and profits, consolidation in the industry, market projections, private investors, acquisition values, stock values, Office of Management and Budget forecasts, and foreign experiences.

tradition of viewing spectrum as a free, public good.[231] On the other hand, an auction is said to cost only fifteen percent of either a lottery or a hearing,[232] with the processing time for an auction being three months, as opposed to twelve for a lottery and eighteen for a comparative hearing.[233] What is particularly troublesome about an auction is that it could become purely a revenue-raising scheme for the government.[234]

A specific auction format has been proposed which would purportedly reduce the disadvantages of this method of spectrum allocation.[235] An auction is needed that would require a minimum amount of bidder preparation, would prevent collusion between bidders, and would have an outcome that would maximize the efficiency of spectrum use.[236] The type of auction proposed is a Vickrey auction, also known as second-sealed bid.[237] In a Vickrey auction, the bidder submits one bid, without knowing the content of other bids.[238] When the bids are opened, the winner pays the amount of the second highest bid.[239] This type of auction allows a bidder to value the item on his own, rather than trying to strategize according to what other bidders might offer.[240] The Vickrey auction is thought to be a way to protect consumers, minimize price inflation, and ensure that prices will match the value of the item being auctioned.[241]

C. *User Fees*

Charging for spectrum use is not a new concept. In 1969, the TAS method of selling spectrum to potential users was proposed.[242] Under this proposal, spectrum would be sold according to measures of time, area, and spectrum, hence the designation of TAS, and would permit TAS spectrum owners to negotiate for alterations in the specifications of their allocations.[243] It was theorized that such a system

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231. Robinson, *supra* note 203, at 190.

232. Evan Kwerel and Alex D. Felker, *Using Auctions to Select FCC Licenses*, OPP WORKING PAPER No. 16, 1985, at 20.

233. *Id.* at 17.

234. Schroepfer, *supra* note 213, at 44.

235. *Id.* at 45.

236. *Id.*

237. *Id.* at 41-42.

238. *Id.*

239. *Id.*

240. *Id.*

241. *Id.* at 46.

242. *Id.* at 38.

243. *Id.*

would result in efficient use of the spectrum, as users traded with each other to maximize their spectrum needs.[244] Under TAS, once spectrum had been initially allocated, the FCC would have a very limited role, with market forces rather than formalized applications and hearings determining how spectrum would be used.[245]

There are arguments for and against the implementation of user fees in apportioning radio spectrum.[246] If spectrum users were charged a fee related to measures of bandwidth, area of operations, or type of technology, there would then be financial incentives to use more efficient technology or reduce operating power in order to lower costs.[247] In addition, charging spectrum users seems to be a fairer system than letting the general population subsidize spectrum use via taxes and government-supported agencies.[248] Such a fee would not only prevent excess demand, but could also generate resources that might help pay for spectrum maintenance and regulation.[249] In addition, it may be that imposing user charges would have the immediate result of re-educating the public, as well as spectrum users, that there is a cost for using this resource.[250] It could also encourage the use of non-spectrum based communications, particularly when wireline, cable, or other alternatives might be available.[251]

There may be difficulties associated with implementing user fees for the allocation of radio spectrum. First, courts have often concluded that a user fee charged for a particular government service cannot exceed the benefits received from the use of that service.[252] In *National Cable Television Assn., Inc. v. United States*[253] and *Federal Power Commission*

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244. *Id.*

245. *Id.*

246. Terrance J. Schroepfer, *Fee-Based Incentives and the Efficient Use of Spectrum*, 44 FED. COMM. L. J. 411-33 (1992).

247. *Id.* at 411.

248. *Id.* at 413. He compares spectrum with a public park, to show how the imposition of a user fee can prevent non-users from subsidizing users and that fees generated can go towards maintenance of the park. In addition, charging a fee may reduce excess demand on park resources.

249. *Id.*

250. Robinson, *supra* note 203, at 189.

251. *Id.*

252. Schroepfer, *supra* note 246, at 419-28.

253. National Cable Television Assn., Inc. v. United States, 415 U.S. 336 (1974). Ruling on the interpretation of the Independent Offices Appropriation Act of 1952, the court held:

While those who operate CATV's may receive special benefits, we cannot *v. New England Power Co.*,[254] administrative agencies were limited by the Supreme Court in the amount they could charge for their services. These cases would be relevant for radio spectrum, since it is the FCC, a government agency, with the responsibility for regulating it. In addition, *Federal Power Commission* also held that user fees could only be charged to entities that actually use the service.[255] This would imply that spectrum users had "purchased" the spectrum, causing potential difficulty with the reading of the Communications Act of 1934.[256] However, cases such as *Skinner, Secretary of Transportation v. Mid-America Pipeline Co.*[257] and *Florida Power & Light Company v. United States*[258] seem

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> be sure that the Commission used the correct standard in setting the fee. It is not enough to figure the total cost (direct and indirect) to the Commission for operating a CATV unit of supervision and then to contrive a formula that reimburses the Commission for that amount. Certainly some of the costs inured to the benefit of the public, unless the entire regulatory scheme is a failure, which we refuse to assume.

Id. at 343. *See also* Schroepfer, *supra* note 246, at 420-23.

254. Federal Power Commission v. New England Power Co., 415 U.S. 345 (1974). Again applying the Independent Offices Appropriation Act of 1952, the court ruled on whether the Federal Power Commission could impose an assessment on electric utilities and natural gas companies in proportion to sales and deliveries. "The Court of Appeals held that whole industries are not in the category of those who may be assessed, the thrust of the Act reaching only specific charges for specific services to specific individuals or companies. We agree with the Court of Appeals." *Id.* at 349.

255. *Id.* at 351. "But each member of the industry which is required to adopt the new accounting system is an 'identifiable recipient' of the service and could be charged a fee, if the new system was indeed beneficial to the members of the industry. . . . But what was done here is not within the scope of the Act."

256. *See infra*, this Note, Section E: Legal and Economic Implications.

257. Skinner, Secretary of Transportation v. Mid-America Pipeline Co., 490 U.S. 212 (1989). The Secretary of Transportation was directed to develop a schedule of pipeline safety user fees under Section 7005 of the Consolidated Omnibus Budget Reconciliation Act of 1985 (COBRA) and to collect these fees from facilities covered by the Hazardous Liquid Pipeline Safety Act of 1979 (HLPSA) and the Natural Gas Pipeline Safety Act of 1968 (NGPSA). "As we have indicated, § 7005 explicitly reflects Congress' intention that the total costs of administering the HLPSA and the NGPSA by recovered through the assessment of charges on those regulated by the Acts and provides intelligible guidelines for these assessments." *Id.* at 224.

258. Florida Power & Light Company v. United States, 846 F.2d 765 (D.C. Cir. 1988), *cert. denied*, 490 U.S. 1045 (1989). This case was also decided under COBRA, wherein licensees of nuclear power reactors sought to avoid uniform annual fees imposed by the Nuclear Regulatory Commission.

> Without defining the limits of the COBRA delegation to the NRC, we conclude that the NRC has exercised its authority within congressional guidelines that provide sufficient standards. The NRC has reasonably lim-

to allow the collection of fees regardless of the benefit obtained by the user. This is fortunate for those who would charge user fees for spectrum, since it would be hard to place a value on the benefit gained by access to the radio spectrum. Indeed, given the wide variety of concerns which use spectrum, from individual amateur radio operators to vast broadcasting conglomerates, different values would probably be needed.

Another difficulty that would arise with the introduction of user fees for spectrum allocation would be the additional administrative burdens imposed on the FCC.[259] While a flat fee may be appropriate for some activities, it would not be such a simple arrangement when applied to spectrum allocation.[260] First, the characteristics of spectrum vary greatly depending on power, bandwidth, time of day, and frequency level.[261] In addition, the value of a segment of spectrum may depend on the particular user group involved and the services to be offered.[262]

A variety of pricing mechanisms have been proposed, based on gross revenues, cost recovery, and opportunity costs.[263] However, the difficulty of some of these pricing mechanisms is that many services provided by spectrum are not sold, but are available to society as a public good.[264] In addition, many entities use spectrum for only part of their services, leading to the difficult task of determining what percentage of a company's profits were dependent on spectrum.[265] Equally complex would be the FCC constructing a fee structure which provides an incentive to move to alternative or more efficient technology, as well as the need for the FCC to speculate as to which technologies would be most suitable for given segments of the spectrum, a particularly

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> ited regulatory services to programs which it concluded, with sufficient explanation, were clearly applicable to all operating licensees. Further, it reasonably limited the charges to those licensees only. We are unpersuaded of error or impermissible arbitrariness in the NRC's implementation of the statutory directive.

Id. at 776.

259. Schroepfer, *supra* note 246, at 423-28.

260. *Id.* at 424.

261. *Id.*

262. *Id.*

263. *Id.* at 426-28.

264. *Id.* at 428. The value of spectrum can now only be estimated from other sources. If some portion is allocated via market mechanisms, it may provide shadow pricing that can be used to value segments of the spectrum that will not be sold.

265. *Id.*

subjective task when considering future communications services.[266]

Instead of user fees, granting property rights over a segment of radio spectrum is advocated as being easier to administer and more likely to result in the conservation of spectrum.[267] Spectrum saved via more efficient technology could then be offered to other users.[268] Such a plan has been proposed in Australia.[269] Under this scheme, spectrum access rights (SARs) could be sold, with the owner of a SAR being granted certain rights over a frequency allocation, the time it could be used, the geographic region that could be covered, and the maximum power level that would be allowed.[270] This is the most radical of the proposals for spectrum allocation and may not currently be permitted under the statutory language of the Communications Act of 1934.[271]

D. *Flexible Use*

A third method suggested for allocation of the radio spectrum is flexible use, also called flexible radio allocation. The idea for this method was proposed through the FCC's Office of Plans and Policy (OPP) in October 1983.[272] The study advanced defining segments of radio spectrum without specifying a particular technology that would be used.[273] In response to this, the FCC set aside 2 MHz, a very small segment of spectrum, to be reserved for General Purpose Radio Service.[274] Advantages of flexible use were identified as allowing more diversified ownership of the spectrum, providing greater ease of market entry, and permitting small scale innovation,[275] since companies wanting to introduce a new communications service could piggyback onto spectrum already held by a compatible technology without having to go through the lengthy process of license application and hearing. In addition, product innovation could go forward on a limited scale at first, with the opportunity for additional spectrum in the future.

On the other hand, there are some dangers associated with flexible use of the spectrum. The first of these is that the flexible use licensee

266. *Id.* at 429.
267. *Id.* at 429-30.
268. *Id.*
269. *Id.* at 431.
270. *Id.*
271. *See infra*, this Note, Section E: Legal and Economic Implications.
272. Mueller, *supra* note 3, at 45.
273. *Id.*
274. *Id.* at 48. *See also Senate Bill Includes Protection for Amateur Radio Operators*, QST, April 1993, at 78-79.
275. *Id.* at 56.

would in a sense "own" his portion of the spectrum,[276] which seems contrary to the Communications Act of 1934. The freedom for a spectrum user to determine what services would be offered through his spectrum is thought to usurp the statutory role of the FCC in overseeing spectrum for the public interest.[277] Even more unusual would be the ability to allow the granting of sublicenses outside of the primary purpose for which spectrum was allocated in the first place.[278] In addition, a spectrum "owner" would be allowed to stop a current service in favor of a new one without permission from the FCC.[279]

There are several obstacles that would have to be overcome before flexible use could be implemented: the current mandate by the Communications Act of 1934 for periodic license renewal,[280] the requirement that a hearing be held,[281] the protection of the public interest standard,[282] and administrative problems associated with trying to maintain control over licensees when the FCC would no longer be involved in determining the type of spectrum services to be provided.[283] Instead, the FCC's responsibility would merely be to issue "flexible" licenses, rather than those that specifically indicate what the spectrum can be used for.[284] Additional problems concern the extent to which flexible use would still preserve the status quo of current spectrum users[285] and the difficulty of recombining small segments of spectrum that have been licensed away in the past to form a large enough block to divide between flexible spectrum users.[286]

E. *Legal and Economic Implications*

There could be difficulties at both the international and national level in implementing any of these allocation methods. The Commu-

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276. Rau, *supra* note 93, at 178. Section 301 provides that the purpose of the Act is "to provide for the use of such channels [of radio transmission] but not the ownership thereof, by persons for limited periods of time, . . . and no such license shall be construed to create any right, beyond the terms, conditions, and periods of the license." 47 U.S.C. § 301 (1988).

277. *Id.*

278. *Id.* at 179.

279. *Id.*

280. *Id.* at 180-82.

281. *Id.* at 182-84.

282. *Id.* at 184-85.

283. *Id.* at 186-87.

284. *Id.* at 186.

285. *Id.*

286. *Id.* at 187.

nications Act of 1934, through which the FCC derives its authority to allocate the non-government portion of the spectrum, is not clear on whether market-based allocation methods can be used.[287] There is a general belief that legislation would have to be adopted to permit either auctions or user charges for several reasons.[288] First, the Communications Act of 1934 prohibits private ownership of the radio spectrum,[289] primarily out of concern that spectrum would be monopolized as it was back in the early days of spectrum-based communications.[290] However, granting spectrum via an auction or by the payment of user fees implies that it is "owned," even if only temporarily.[291] Instead, the Act contemplates a "trusteeship" model, where licensees serve the public interest in exchange for permission to use the radio spectrum.[292] The spectrum is considered to be publicly owned[293] and spectrum users

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287. Robinson, *supra* note 203, at 190.

> The FCC spectrum management goals have not been explicitly defined in any one document. However, a review of FCC Reports, Orders, and Notices of Inquiry makes clear that its management goals are to satisfy the objectives contained in the Communications Act, within the authority bestowed by Congress. The overall guiding principle is stated at the outset of Section 303, wherein Congress charged the Commission with management of the spectrum "as public convenience, interest, or necessity requires." In addition, the FCC has paid special attention to:
>
> 1) the congressional objective stated in Section 1 of the Act: "to make available, so far as possible, to all people of the United States a rapid, efficient, nation-wide, and world-wide wire and radio communication service with adequate facilities at reasonable charges."
>
> 2) the Congressional mandate to
>
> a) Section 303(c), Assign bands of frequencies to the various classes of stations;
>
> b) Section 303(f), Make regulations not inconsistent with law as it may deem necessary to prevent interference between stations;
>
> c) Section 303(g), Study new uses for radio, provide for experimiental uses of frequencies, and generally encourage the larger and more effective use of radio in the public interest.

Id. at 184.

288. *Id.*

289. *Id.*

290. Herter, *supra* note 1, at 657. The earliest efforts towards international cooperation in spectrum allocation stemmed from the need to provide safety at sea. At that time, Marconi had a monopoly on the equipment and personnel that were used by the fleets of Canada and Great Britain. The only way to communicate with them or to stations on shore was through his equipment.

291. Robinson, *supra* note 203, at 190.

292. Rau, *supra* note 93, at 149-50.

293. *Id.*

cannot alter their communications services without approval from the FCC.[294] Second, the Act requires the FCC to license spectrum for a limited period of time.[295] Without a modification in legislation, this could mean routinely holding auctions for segments of spectrum, perhaps as often as every ten years. Companies responsible for developing new communications technologies would need to consider carefully before committing resources to a new product when the necessary spectrum could be lost to a higher bidder within the next decade.

A modification in legislation would also be needed to replace the hearing process required under Section 309(e) of the Communications Act.[296] Interpreting current statutory language suggests that there is currently no authority for the FCC to substitute an auction for the hearing process.[297]

The Communications Act of 1934 may or may not allow flexible use as a method of allocating spectrum.[298] Section 303(b) of the Act mandates that the FCC must "[p]rescribe the nature of the service to be rendered by each class of licensed stations and each station within any class."[299] If this section of the statute is construed broadly, it may permit spectrum to be classified for flexible use.[300] On the other hand, if the statute is read more narrowly, it would forbid the flexible use as an allocation mechanism.[301] The Act seems to charge the FCC with determining how a segment of the spectrum will be used by a particular communications service.[302] However, the premise of flexible use is that once a communications provider is granted a portion of the spectrum, the provider would determine how the spectrum would be used and would have the ability to "sell" or "rent" that spectrum to other users.[303] The narrow view of 303(b) suggests that it is the FCC which must determine the nature of the service that can be offered in a segment of spectrum.[304] To find otherwise implies that the FCC can

294. *Id.* at 150.

295. *Id.* at 155. Citing to 97 U.S.C. § 307(c) of the Communications Act of 1934.

296. Robinson, *supra* note 203, at 190.

297. *Id.*

298. Rau, *supra* note 93, at 177.

299. Special Provisions Relating to Radio; Powers and Duties of the Commission, 47 U.S.C. § 303(b) (1988).

300. Rau, *supra* note 93, at 177.

301. *Id.*

302. *Id.*

303. *Id.* at 178.

304. *Id.* at 177.

delegate its responsibility for spectrum determination to a private party.[305]

Flexible uses seems to fly in the face of the trusteeship model of spectrum allocation envisioned by the Communications Act of 1934. In order to allow the implementation of flexible use, the Act would have to remove such requirements as periodic renewal, promote minimal FCC supervision, ensure that the holding of a flexible license does not constitute "ownership," and recognize that local markets may influence what types of spectrum-based communications services will be offered.[306]

Experiments are underway in the United States, as well as in other countries, to see whether auctions, user fees, or flexible use can be implemented as alternatives to existing spectrum allocation mechanisms. While there may need to be changes in the Communications Act of 1934, as well as a realignment of the view of spectrum as a public good in the United States in order to allow devices such as auctions and user fees to be implemented in the United States, the introduction of these methods on an international scale seems more problematic. It is one thing for the FCC to collect monies from auctions or user fees. It is quite another for collection to be done among the nations of the world. Supposedly, the responsibility for this would fall to the ITU, an organization which has not traditionally had a monetary purpose behind its formation. It is also not clear where the proceeds from auctions or user fees would go once they were paid to the ITU. Instituting these methods could result in adversarial relationships, with the larger, richer countries possibly being able to "buy" spectrum from poorer countries willing to subordinate their future communications goals for funds needed currently for other social problems.

Of the three proposed allocations methods, flexible use seems most compelling for experimentation on an international level. ITU member nations already accept primary and secondary use arrangements, the footnoting of spectrum plans to reserve spectrum, and a deviation from spectrum allocations within regions where no harmful interference will occur. Allowing spectrum to be defined for multiple uses could be tried on an international level without destroying the relationships between ITU member nations which were manifested at WARC-92. Flexible use could be blended into the allocation proposals submitted at several specialized radio conferences coming up in the future.

VI. CONCLUSIONS

Characteristics of the radio spectrum and the economic constraints of current technology mean that, at least for now, the sky *is* the limit

305. *Id.*
306. *Id.* at 188.

in terms of the radio spectrum that can be allocated for current and new communications technologies. Given these limitations, it is important that the available spectrum be apportioned not only among a variety of commercial and public concerns, but also between countries, whether they are ready to exploit it at present or not. The ITU has a rich history of being able to fairly allocate spectrum and the nations of the world have been willing to participate in this organization. The success of WARC-92 in allocating the spectrum to both the new technologies that wanted it and the ITU member nations that requested it proves that WARCs, or their successors, can continue to be the primary method of allocating spectrum at an international level. Some experimentation should be done with flexible use at the international level. This can be done with minimal disruption to existing allocation relationships.

At the national level, the FCC should continue to explore auctions, user fees, and flexible use for limited allocations of spectrum. Of these three mechanisms, flexible use seems to be the most workable, because it provides greater efficiency of spectrum without the administrative and spectrum-valuing complications of auctions and user fees. The proposed auctioning of a segment of previously government-owned spectrum is an appropriate way to test the effects of market mechanisms on a traditionally free public good. However, any type of market-based allocation method must consider the public, non-profit users of spectrum, who would potentially be deprived of spectrum if fees were charged for it. Society benefits from such free services that rely on spectrum as public broadcasting, amateur radio, and emergency communications systems. These services must be protected in the event that market-based approach is taken to allocating spectrum in the future.

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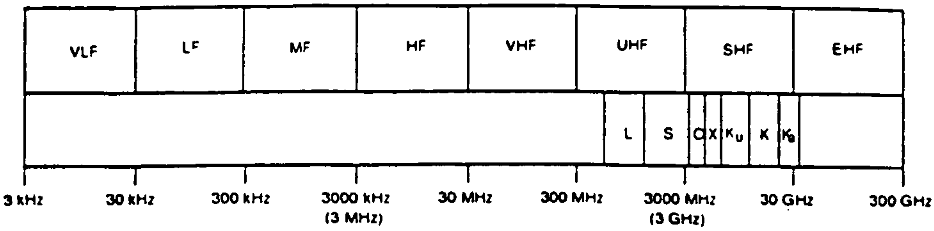
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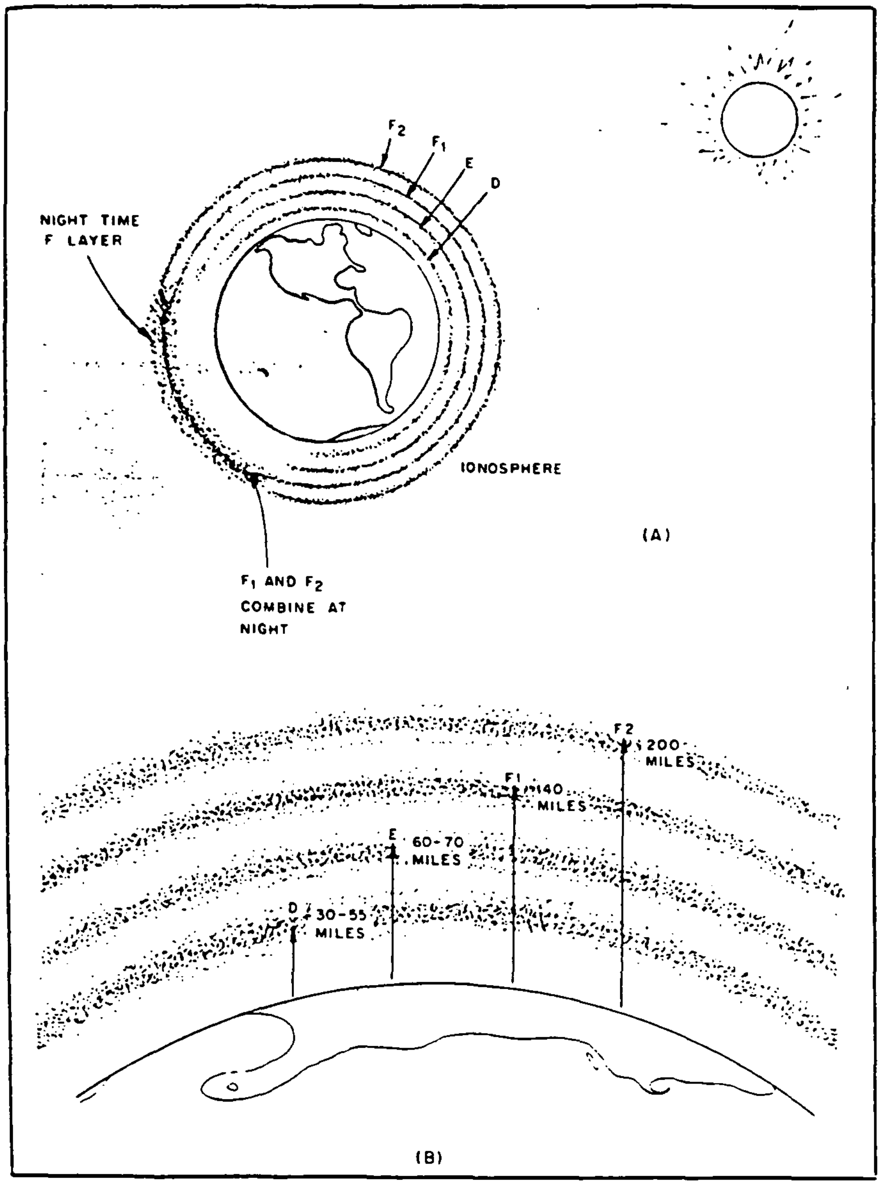

Figure 2

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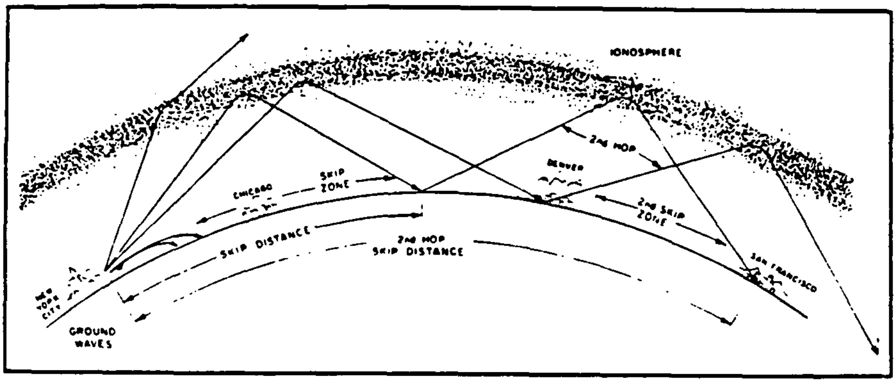

Figure 3

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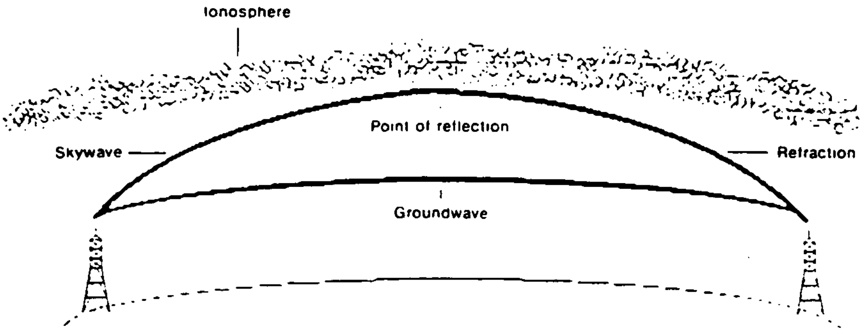
Ionosphere
Point of reflection
Skywave
Refraction
Groundwave

Figure 4