Michigan Journal of International Law

Volume 5 | Issue 1

1984

The Political Economy of Orbit Spectrum Leasing

Harvey Levin
Hofstra Universtiy

The Political Economy of Orbit Spectrum Leasing

Harvey Levin*

INTRODUCTION

This article[1] will propose several plans for allocating a common resource of the earth—the international orbit spectrum—among nations through mechanisms designed to introduce market incentives. The rights to orbital "parking places" are so defined as to permit their subdivision, recombination, and assignment in lease markets.[2] The lease market approach accommodates the interests of both developed countries (DCs), who have the technology and domestic demand to establish satellite systems today, and less-developed countries (LDCs), who seek long-range planning to guarantee them access to the orbit spectrum at a time in the future when they, too, possess the capability and need.[3] In the interim, this plan will provide LDCs with income as the lessors of orbital slots they cannot currently use.

To elaborate, those states (primarily LDCs) who choose not to use their orbit spectrum assignments can lease their rights to the highest bidder for a term of years. Conversely, states with many operational satellite systems (primarily DCs, with some East bloc participants) can lease any "extra" orbit spectrum rights they need, if their allotment is insufficient. As lessee, this state would pay an orbit spectrum rent, based, for example, on a percentage of the gross revenues generated by the satellite system placed in the leased orbital slot.

At present, the most significant hurdle to this plan is the current practice of defining rights to a portion of the orbital spectrum in such a way that they are usable by only a few states. For example, a satellite which transmits and receives signals between New York and Los Angeles must be

* Harvey Levin is Weller Professor of Economics and Director of the Public Policy Workshop, Hofstra University. He is Vice Chairman of the Economic Advisory Group of the FCC Space WARC Advisory Committee and has been a consultant on telecommunications to the Office of Technology Assessment of the U.S. Congress, the General Accounting Office, and the Committee of Economic Development. This article is part of a larger inquiry funded by Resources for the Future, whose support the author gratefully acknowledges.

visible from both cities. If RCA (a large, private satellite system operator) wishes to increase its transmission capacity between them, an unused orbital slot over the Indian Ocean (assigned, say, to India) will do it no good. Generally, a lease market operates more effectively when the leased good is homogeneous. If homogeneous, the challenge, then, is to define orbital spectrum rights in such a way that they are more readily transferable among potential uses and users.

The article first describes certain physical qualities of the orbit spectrum. As a scarce common resource, much like fisheries, the orbit spectrum is subject to overuse, congestion and pollution. By introducing market incentives, these undesirable external diseconomies will be optimized, or at least mitigated. Next, the objectives of orbit spectrum allocation are introduced to provide a yardstick from which to appraise the two competing approaches which have been proposed by DCs and LDCs, viz., first come, first served, and *a priori* planning. After proposing to generalize orbit spectrum rights so as to render them more exchangeable and hence improve the operation of lease markets, the article then evaluates certain imperfections caused by economic and technical constraints.

Recognizing that free markets are difficult to achieve, the article discusses certain modified market mechanisms which, while falling short of the efficiency inherent in lease markets, still offer advantages over the present nonmarket system. These mechanisms are analyzed from a one-country perspective.

International lease markets are analyzed in the remainder of the article. A basic rent system is proposed. To accommodate LDC concerns over future access, two arrangements are discussed which provide lessors with greater protection: a guaranteed accommodation procedure and a modified coordination procedure.

PHYSICAL QUALITIES OF THE ORBIT SPECTRUM

Scarcity

The orbit spectrum is a scarce resource for three reasons. First, any object placed in an orbit 22,300 miles above the surface of the earth rotates at the same speed as the earth and thus appears stationary when viewed from earth. Commonly referred to as the geostationary or geosychronous orbit, this is a preferred position in which to place satellites. Since satellites placed in that orbit do not move in relation to the transmitting or receiving points on earth, expensive tracking gear is not needed; it is much less costly to "bounce" signals off them than off a "moving" satellite. To occupy a position in this orbit, however, a satellite must be placed within a narrow corridor above the equator. The physical space to provide least cost orbits is thus limited.

Second, once a satellite is placed in orbit, its signals travel in straight lines. Earth stations must be in a direct line of sight to the satellite to receive or transmit the signals. Owing to the curvature of the earth, some orbits over oceans or sparsely populated areas which are out of the line of sight of current land users cannot be utilized. So as a practical matter, some orbit slots are not exploitable.

Finally, each satellite is limited in the range of radio frequencies it can carry. Given adequate separation between frequencies to avoid interference, each frequency can carry a different message. But if satellites are placed too close together, and they are transmitting to the same region of the earth, their signals will interfere with each other.[4] Thus, the limited amount of exploitable orbit space cannot be too congested.

A Common Resource

From an economic perspective, the orbit spectrum is a finite, common resource, similar to the air, a river, watershed, migratory fishery or an oil pool because, like them, the orbit spectrum is subject to pollution, congestion, and overuse.[5] Few common resources are owned by individual firms or countries; even when they are nominally owned by some entity, exclusive property rights are rarely enforced.[6] Thus, either all potential users own the resource (a "common heritage of mankind") or no one owns it; the consequences are the same. If the common resource is not owned, no one extracts a royalty for its use or regulated exploration, or prevents unauthorized use. Only through actual occupancy, use or harvesting can any rights be established. Unfortunately, rational users will tend to overpump, overfish or—in the case of orbit spectrum—overoccupy (by taking up more slots, more quickly, than is economically efficient).

By way of illustration, the first person to arrive at a rich fishing bank in international waters takes what he can, and is wise to do it as quickly and thoroughly as possible, before other potential users can discover the bank or begin fishing it too. But similarly, consider three contiguous plots of land owned by different persons over a sizable pool of oil. Generally speaking, without external intervention (*e.g.*, output quotas), no mechanism exists to divide up the pool among the three plots. Therefore if Driller A has purchased a lease on plot 1, it is in his interest to lift as much oil out of the ground as rapidly as possible, before other drillers arrive on the other parcels. Certainly the oil may have flowed partly from underneath plots 2 and 3, but since a pool cannot be divided, the owner of the other plots can do little to stop Driller A if he enjoys a lead in time (over his rivals). Even if the price of oil is low, Driller A has an incentive to pump and sell immediately since waiting for higher prices might mean that drillers B and C on the other plots will exploit the resource first. In the case of renewable resources such as fisheries, finally, the fact that no one owns the resource implies that no user has an incentive to moderate his fishing to allow regeneration. In the absence of outside institutional safeguards, excessive, premature investment and output often result.[7]

Additionally, latecomers are often reduced to exploiting economically less attractive regions, grades or qualities of the resource, at higher investment and operating costs. Finally, as users rush to be first, in order to establish position and pre-empt other users, exploitation costs rise for all the users. Nevertheless, technical innovation seems likely to help bring down per unit costs of satellite technology for all countries. Therefore, the developing countries may also enjoy certain compensatory free-rider benefits, although it is hard to determine if these exceed the higher cost of latecomer access.

OBJECTIVES OF ORBIT SPECTRUM ALLOCATION PLANS

There are five basic objectives which an orbit spectrum allocation plan should ideally achieve. The plan should lead to widespread availability of service—among regions and among uses.[8] The plan should directly reward technological advancement. The orbital spectrum should be available equitably to all nations. Finally, the plan should above all promote economic as well as technical efficiency.[9]

It is immediately clear that these goals may often conflict. For example, to guarantee equitable access by partitioning the orbital spectrum and assigning pieces to states far into the future might mean that many segments assigned to LDCs would remain unused for long periods, even if it were economical for other nations or private entities to use them. Sometimes a plan yielding the highest physical or technical level of signal transmission (and hence "availability") may be uneconomic.

METHODS OF ORBIT SPECTRUM ALLOCATION

First-come, First-served

Two basic models of allocation address these objectives in different ways. A first-come, first-served system gives priority to the first user who places a satellite in orbit over latecomers. In the case of satellites put up by an individual firm with limited resources, this approach might appear to be economically efficient because, presumably, a market study will justify the initial capital outlay.

Yet in the above mentioned common pool context, economic efficiency might be impaired because each satellite company may, in principle, tend to build more systems sooner than economically optimal, for fear that rival companies would otherwise launch their own in the face of dwindling orbit spectrum resources. While this might provide a high level of physical service, it would not in general yield maximum economic efficiency.

Nor are many LDCs currently able to raise the needed capital, and thus, the opportunity to use a satellite is not widely available.[10] Moreover, the best technical use of the orbit spectrum in practice means that only the most advanced technology is used, which is not necessarily the most economic use. The first-come, first-served approach may thus achieve technical efficiency but only at the cost of neglecting other objectives.[11]

A Priori Planning

On the other extreme, there is *a priori* planning.[12] Under such a regime, orbital slots are allocated to all states for a period extending far into the future, and the goal of equitable access is maximized.[13] However, *a priori* allocation may result in many spaces assigned to LDCs going unused for long periods while those slots given to DCs are overused and potential projects needing additional slots languish.

Thus, the challenge is to create an allocation system that maximizes all five goals—widespread service availability, encouragement of technical progress, equitable access, and economic as well as technical efficiency—while retaining flexibility to change as plans and objectives or participants change. A lease market may be such a system to help provide "a practical compromise . . . between the evolutionary approach [first-come, first-served] and a rigid *a priori* plan for use of the geostationary orbit."[14]

LEASE MARKETS: BASIC PRECONDITIONS[15]

Distinct Markets for Orbital Slots and Satellite Services

A pure market allocation system allows any holder of orbital spectrum rights the untrammeled freedom to acquire, sell or lease any quantity or type of rights it chooses. From virtually any initial allocation of the resource[16] to the participants, each actor could undertake any transaction it wished, provided it had the required legal rights to do so. In the case of the orbit spectrum, the trading could be in either the undivided rights to a "parking place" in space, or to a portion of the transmitting and receiving capacity of a satellite for specified time periods.

The orbit slots or "parking places" themselves, are intermediate factors which are marketable among only a limited number of participants because only a few economic or political organizations would find it within their means and worth their while to finance the occupancy of a slot. The telecommunications services made available as a consequence of orbit slot occupancy are much more marketable since more people are in a position to demand, purchase, and use them.[17] Thus, the more active market would be not for slots but for the twenty-four transponders available on each satellite.

An illustrative analogy is provided by the market for urban real estate. Plots of land in a large city are finite and, to be useful, require significant capital improvements (*e.g.*, to erect an office tower). This is one market. Another, more active market exists for the *space* in those office towers. The market for individual offices is preferred by those users who are unable to finance an entire building. The office market builds upon the land and building markets: the number of direct players in the latter markets is small when compared to the secondary market for office space.

Just as a real estate developer may lease or purchase a plot of land, erect a building, and then dispose of the space therein;[18] so, too, states and large firms may bid for orbital slots, launch geostationary satellites, and then dispose of the transponders. Orbit slots and transponder sub-units can both be traded in competitive markets, just as office buildings as well as office space are traded.

Societal Rules

Certain societal rules must exist for these markets to function, however. In our urban real estate example they are found in domestic laws of property and contract. Generally, rules are necessary first to limit permitted uses of the resource so as to avoid impinging on a neighboring resource holder's ability to exercise its preferred uses for the property.[19] Second, to protect the value of one's investment from outsiders, one must be able to bar admission to one's property and to eject unauthorized trespassers. Third, the user needs some freedom to bring together those inputs which are necessary to accomplish its objective, consistent with any neighbor's rights. Fourth, so as to recoup its initial investment (and thus encourage others), the users should be free to sell or sublease a portion of the resource.

In the case of the orbit spectrum, the basic rules consist of: (1) emission rights to transmit signals, using designated frequency bandwidth, time, three-dimensional space, and maximum permissible power; (2) rights to exclude harmful interference; (3) freedom to combine or subdivide various rights; and (4) freedom to transfer such rights on terms mutually agreeable to the parties.

MODIFYING THE IDEAL: ACCOMMODATING ECONOMIC AND TECHNICAL IMPERFECTIONS

The "ideal" economist's model must be modified to accommodate major economic and technical imperfections which impede the creation of ideal spectrum markets. The imperfections partly stem from the manner in which electronic signals interact physically. These interactions are so varied that the task of defining who may transmit what signal at what frequency to which place on earth requires enormously detailed specifications of inputs before rights can become easily transferable.[20]

Even with this initial hurdle, lease markets still can operate. Consider an analogy to the real estate market of a large city. The amount of available ground space is limited, just as the number of spaces in the geostationary orbit. If space is too expensive in the city, a potential real estate investor can buy land in the outlying suburbs, just as a potential user of satellite communications can opt for terrestrial systems.

In an active real estate market, land will move toward its most highly valued use (*e.g.*, tearing down a brownstone to erect an office tower); by analogy, imagine an underutilized orbit slot being leased to a more active user who is willing to pay a higher price than it is worth to the present user. Market participants cope with the problem of interference (*e.g.*, in real estate: overcrowding, obstruction of view) by regulations (zoning) and through market adaptation (*e.g.*, moving one's offices from a crowded inner city section to outlying areas). They are also encouraged to invest in technological advancement (*e.g.*, designing satellites to handle more signals).

In short, free market trading will ideally yield an optimal level of interference and congestion: A sensitive user will acquire a slot with less interference and transfer his slot to a user who is more tolerant of interference. Such trading will also distribute the spectrum to its highest valued uses. The value of a piece of the spectrum to any user will eventually equal the value in any best alternative use, and the net economic value of authorized levels of signal output is maximized.[21]

The functioning of an efficient market may also be hindered by "hold outs": Right holders in adjacent slots of the spectrum are in a position to hold out against each other and so prevent otherwise economical combinations of rights. The right to use contiguous pieces of the resource is needed. In our real estate analogy, to make building a large office tower feasible, three small adjacent plots might be needed. Similarly, to accommodate a new TV station in the UHF band might in principle require spectrum which could otherwise have accommodated hundreds of mobile radio transmitters. The "hold out" attempts to obtain more than the normal market price for the orbital slot (*i.e.*, the price paid by buyers who do not need that *particular* parcel). An arbitral tribunal run by the ITU could, however, resolve this problem by setting a fair value for the hold out's share of the orbit spectrum.

A final limit on the free operation of markets is posed by transfer costs, including the enormous capital commitment, of moving from one use of rights to another. For example, an orbit spectrum user must terminate the old satellite, launch a new one and upgrade all its ground equipment. Transfer costs can hinder shifts from lower to higher valued uses. The burden of committing a large amount of capital can thus lead to operating inefficiencies.

In spite of these difficulties, real estate markets in cities the world over are vigorous; methods are devised to resolve the tension between political policies and economic demand. Lease markets for orbital spectrum spaces should similarly be able to juggle political objectives (equitable access, technological sophistication, wide dispersion of signals) and economic forces (demand for new slots by LDCs) so as to improve the efficiency of the outcome.

DOMESTIC UNITED STATES ALTERNATIVES TO FREELY TRANSFERABLE RIGHTS

The efficient allocation of satellite transmission rights in domestic service can be achieved by market-type mechanisms.[22] In broadcasting services,[23] a set of federally-designed rights, pre-planned to forestall third party signal interference, can be auctioned off to the highest qualified government or private company bidder, much like continental-shelf oil leases are sold. Such auctions compare favorably with the current cumbersome, expensive administrative practice of evaluating the applications of almost indistinguishable candidates. Bidder qualifications could be carefully specified and screened to safeguard against bidder collusion. The goal here is to reconcile market and administrative criteria in the allocation and licensing of the orbit spectrum.

Another domestic modified market-type mechanism would permit rightholders occasionally to trade rights without the prior permission of the Federal Communications Commission (FCC), provided they are within designated parameters. For example, rights assigned to many classes of safety and special radio services could be freely transferred (by organs competent to trade for whole groups of users) from the now over-detailed spectrum allocation to some thirty odd services: remaining regulations would then merely require that technical signal standards common to all private radio services be met.

A third mechanism would entail the derivation of so-called "shadow prices"[24] of spectrum bandwidth between two competing, heterogeneous services. For example, estimating the marginal value of a little more or a little less spectrum to the TV service as compared with the land mobile service could help allocate the spectrum between these two uses. Of course, regulatory and administrative considerations could still override an economic decision based on the shadow price. But administrative regulatory decision makers would no longer proceed in total disregard of such economic measures.[25]

A final modified market mechanism would involve user charges varying with the degree of utilization of the several dimensions of the spectrum resource, *i.e.*, bandwidth, frequency, time, polarization, intensity, and three-dimensional space. Although deriving such a user fee schedule might be extremely difficult, spectrum charges could be set through trial and error. User fees based, *e.g.*, on differences arising from marginal changes in available bandwidth, operate to enhance economic efficiency because they may induce least-cost factor input mixes more reflective of the true social opportunity costs of spectrum use than when spectrum is used at a zero price.

These modified market-type mechanisms are a more palatable way—politically—to inject economic incentives into spectrum allocation than a completely free spectrum market would be. Some form of market mechanism is needed, however, because there are always substitutes for spectrum. Yet, without price signals there is no incentive to seek them or assess their relative economic utility. Such modified market-type mechanisms are not so inconsistent with the current legal-institutional framework as to preclude their adoption. Their economic merits are, in fact, enough to make them important potential steps to inject economic factors into decision making about spectrum allocations. They also seem amenable to being phased in gradually so as to mitigate the degree of opposition by officials with real-world "line responsibilities." Finally, while it is by no means self-evident that the use of auctions in domestic markets can be readily extended to international uses of orbit spectrum, such an application has from time to time been proposed.

LEASE MARKETS IN THE INTERNATIONAL SETTING

This article next explores how certain international schemes have the potential—when combined with our observations in the general discussion of the basic preconditions of lease markets—to (1) move orbit spectrum rights from lower to higher valued uses among and within nations; (2) reconcile Third World demands for equitable access to orbit spectrum resources with developed countries' concerns for economic efficiency, technological progress and continued access; and (3) reduce the relative transaction costs[26] of multilateral exchanges compared to those now incurred at international conferences where allocations are made without prices.

Several possible approaches incorporate economic incentives for the efficient use of the orbit spectrum: (1) a pure lease model;[27] (2) real-world leasing arrangements for unused orbit spectrum assignments; (3) a guaranteed accommodation procedure where DCs using LDC slots post large bonds to guarantee that DCs will vacate when LDC rightholders are ready to enter; and (4) a modified coordination procedure with rules to help equalize the standing of latecomers and incumbents in their use of spectrum and orbital arc.

This article will now sketch how the last three schemes might work.[28] But first, note that the key to each is largely the same: we must choose an appropriate actor for the international setting and define spectrum rights so they are more readily transferable.

Choosing an Appropriate Actor

When considering which actor is best suited to act in the international setting, three factors are important. First, to manage and reduce the negative side effects of orbit and spectrum utilization without imposing costs on neighbors (*e.g.*, in the form of electronic noise) requires that participants be large groupings of users; either regional consortia of governments, consortia of users, governments or firms which are in widely scattered areas around the world, or interfirm consortia within large states.

Second, to finance development of the necessary infrastructure requires regional consortia and arrangements for joint collaboration between multinational corporations (MNCs) and LDCs. For example, the MNCs would donate capital facilities in exchange for the exclusive right to sell earth terminals and TV receivers. Alternatively, they could return a portion of the revenues as a royalty to the host government, or they might simply use their greater access to cheap capital to "donate" facilities, the cost of which they would later recoup by raising their prices on compatible equipment over as long a period as needed, assuming, of course, that they have enough monopoly power to do this. These institutional arrangements to fund telecommunication infrastructure development rely on entrepreneurial acumen and initiative rather than outright government grants.[29]

Third, the danger that political rivalries might impede the formation of consortia of governments, or destroy existing consortia, could justify the formation and management of a consortium by an outsider. For example, a Western firm might line up several countries to participate in a leased service.

Leasing Arrangements for Unused Orbit Spectrum Assignments

A properly conceived leasing mechanism [30] might induce those LDCs currently unable to use their orbit spectrum assignments to rent them to advanced countries for designated time periods. [31] By the same token, the DCs could better secure the *extra* orbit spectrum rights needed to develop new systems when their own slots and frequencies are fully occupied. DCs would secure these rights by paying sums to LDC rightholders tantamount to rent. [32]

Lease markets could, in fact, be based on one of two assumptions. First, orbital slots and radio frequencies are all distributed by the ITU and owned outright by LDCs and DCs, thereafter with LDCs leasing their unused slots to HDCs. Second, the IFRB records assignments, as today, for limited renewable periods, with LDCs free, within those periods, to sublease, or lend, unused assignments to DCs which want more than they currently have.

The major obstacle to instituting any viable leasing system is the continued practice of overspecifying spectrum rights, i.e., of defining them in such detail as to make them virtually unusable by any country except the one to which they were assigned. [33] The power, orbit location, frequency bandwidth, antenna beam, and directivity that each nation is authorized to use are specified so narrowly that there are few alternative uses or users for which they are suitable. To facilitate the prospects for leasing, therefore, we must define orbit spectrum rights so as to make them far more transferable than is the case today. [34]

To increase the transferability of these rights in an economically efficient manner, a "loosely" packed orbit spectrum allocation plan is required. Rights must be vested not in unique points in any segment of the orbital arc, [35] but in a whole range of such points within a designated segment of the arc. By generalizing the rights, any initial assignment holder could locate its satellite at any point within the orbital arc assigned to it. If an assignment were to remain unused because its holder did not have the need or resources to exploit it, a potential lessee would not have to use a *specific* "parking place," which was originally designed to meet the needs of the lessor were the lessor to use it. Instead the lessee could use any one of several "parking places," depending upon which suited its needs. [36] The possibility of trading to a third party would be significantly increased because points located at different places in the assigned segment would be suitable for a number of potential users, even though a *particular* point might not be. [37]

Assigning rights in whole segments of orbital arc necessarily entails loosely packed allocational plans in which vacancies more readily permit a move from lower to higher valued uses. Full occupancy might, however, be impossible to attain.[38] In addition, even though frequencies or orbital slots are currently defined chiefly to benefit original rightholders, subleasing and recombination would create new arrangements useful to others. Services and uses which are quite different from those currently envisioned may result.[39] International spectrum brokers could conceivably facilitate the packaging and repackaging of spectrum rights.

Another way to conceptualize the generalizing of orbit spectrum rights is as follows. Assume that only one compatible set of satellite services can be accommodated; let A,B,C, . . .,Z represent individual states. Suppose that each slot can accommodate four satellites, each aimed at a different country and service area. Assume further that more than one service configuration is possible, so that service areas ABCD (each served by a separate satellite) is one configuration; AEFG being an alternate configuration; and AHIJ still another, each with no unacceptable interference. (Other configurations may not, however, be compatible with all satellite uses of the slot in question, so that satellites serving EFGH would interfere with one another, as may those aimed at IJKL.) Assume, finally, that the orbit spectrum needed to reach service areas BCD, while usable technically, is not economically viable and is hence left unused, whereas the orbit spectrum needed to reach service areas EFG is deemed usable economically as well as technically. It might then be worthwhile for countries EFG to buy out orbit spectrum assignments from BCD, and use them at the same time as A.

Furthermore; if country A held slot rights in generalized form, it could sublease orbit spectrum to EFG, rather than to countries BCD for which its rights are not economically useful. It would therefore be best for EFG to form a joint venture and reach a collective agreement to sublease from A, where A holds full generalized rights which could be aimed in any and all directions (to AEFG, to AHIJ, etc.). The joint venture would then select the configuration that is most economically attractive.[40]

Were this not the case, and if A did not hold all slot rights, but only its own (and if each of countries BCD owns only its own), then a far more complex and costly transaction would be needed to bring about the above result. EFG would have to coordinate their several strategies to buy out BCD, since unless E, F, and G act collectively, they could not be sure that each could operate in a compatible manner.

There are no over-simplified WARC 77-type assignments here (ABCD alone). If we assume that only A (and not BCD) would be used, and that EFG also stand ready to operate, then EFG are higher valued users than BCD. Instead of specifying BCD as assignment holders, the ITU conference would place all assignment possibilities of the slot (i.e., generalized rights) with country A, leaving A free to sublease to the combination of highest bidders. Economic efficiency would be enhanced.[41]

Methods of Payment

The scheme would allow participants to experiment with the method of payment for their use of the assignment. An occupant-lessee (say, the United States) of the lessor's unused assignment could "pay" by providing the latter (say, Mexico) with reduced rate domestic circuits. It could do so at little incremental cost once its satellite is in place. Such payment in kind might circumvent the ITU's resistance to spectrum pricing and at the same time facilitate market-type exchanges of slots and spectrum.

Another option would be for LDCs simply to receive free stock in an incorporated consortium, and share in the economic value generated by the DC's satellite system that used the LDC's unused assignment. Or, the LDCs could be granted stock ownership rights *gratis* in *all* satellites launched into the geostationary orbit, as payment for the use of a global resource which is "the common heritage of all mankind." This free stock would constitute the kind of "payment in kind" illustrated by the United States-Mexico example above. In all such schemes, we would attempt to allocate satellite system stock shares rather than rights in the orbit spectrum resource itself.

Finally, the lessee could post bonds through a third-party insurer to guarantee its pledge to vacate an LDC's unused assignment at some agreed-upon time. The face value of such bonds would not be market-determined by the expected value of the orbit spectrum assignment being "borrowed." Rather, it would be set by the cost of the assignment's next best terrestrial alternative. Nevertheless, failure to withdraw and the consequent forfeiture of the bond should constitute a lump-sum payment of rents equal to the *minimum* any orbit spectrum assignment holder would require to release its assignment,[42] even though the assignment might be worth much more than this to the DC-borrower.

One criticism LDCs have against any of these methods is that they would be passive recipients of rents or dividends. Many LDCs instead want to be actively involved in developing their own communications systems.

MECHANISMS TO SATISFY DEMANDS FOR EQUITABLE ACCESS

Outlines of two mechanisms follow which would—consistent with a lease proposal incorporating incentives for economic efficiency—meet Third World demands for equitable access to the orbit spectrum.[43] First, a "guaranteed accommodation procedure" assumes that nations unable to use orbit spectrum could be awarded rights which they could assign to groups with the capital and expertise necessary to exploit them. Second, a "modified coordination procedure" presumes that both LDC latecomers and DC incumbents are ready to exploit.

A Guaranteed Accommodation Procedure Through Sureties

A "guaranteed accommodation procedure" would be closest to the current spectrum management system. The world's leading spectrum users would essentially agree to make room in orbit spectrum for latecomers when their technology and domestic needs had advanced to the point where they wanted to establish their own satellite systems.

LDCs would have to agree to forego immediate claims on orbit spectrum because their current technology does not permit effective usage. The guaranteeing nations, in turn, would pledge to phase out or relocate satellite operations upon LDC request within a predetermined time period, provided the LDC demonstrated technical and economic competence for utilization. Other rules would limit the useful life of satellite equipment to a period not later than an agreed upon date when an LDC would be ready and willing to enter.[44]

Although this option is clearly preferred by DCs to *a priori* planning, the question is whether credible safeguards for latecomer access can be devised (*e.g.*, stiff penalties for late withdrawal). The suspicion with which the LDCs often view DC actions, exacerbated by LDC technical inability to monitor compliance, would hinder the ability of DCs to convince LDCs to forego use of their assignments for some period in favor of leasing them to DCs.

One method to ensure that the DC vacates on schedule[45] would require a DC or its concessionaire to post a bond which would be forfeited if the DC does *not* vacate on time. In that case, the forfeited bond would be tantamount to a lump-sum rental payment for occupancy of the borrowed assignment during the time period in which the LDC-lessor would otherwise have entered. The posted bond would equal the cost of the LDC's next best terrestrial alternative, less the cost of the new LDC satellite service if the DC *did* vacate on time.

The promise of the LDC to stay out for a term of years is worth enormous cost savings to the DC (*i.e.*, what it would have had to pay had the slot not been available). The DC's promise to vacate on schedule, guaranteed by the bond, is also worth cost savings to the LDC. The two promises become a contract between the LDC and DC. The LDC's own orbit spectrum assignment effectively is "loaned" or "leased" to the DC for a bond forfeited if the DC does not vacate on time.[46]

The bond-posting method is at least similar to a lease from an LDC to a DC company. The premium on the DC bond, reflective of the actuarial risk that the DC will not vacate on schedule, is bounded by the expected difference between the cost of a given system in a particular orbit slot (for DC or LDC), *and* the cost of the next best terrestrial alternative for the LDC. This arrangement guarantees either that the LDC can enter when it wants (the DC will vacate), or that the LDC will have funds for its next-best alternative. The differences in the cost of the two options are the lease value to the DC *and* to the LDC.[47] However, the premium on the bond, paid to a surety company, is all the DC would have to pay.

It is important to distinguish bond and lease plans, however. In the bond context no direct benefits would normally flow to LDCs, whereas in the lease context they would (rent payments). Since the task is to establish a subsidy system which is acceptable to LDCs and DCs, the plan must show benefits to both sides. We must consider who pays how much, to whom, for what, to secure the assignment. Common resources can reasonably be expected to give the LDCs some rents; yet we do not want the "haves" to pay exorbitant sums to the "have-nots."

Another basic issue here is how committed the LDCs are in their opposition to first-come, first-served, and how firm their opposition is to formal leasing. If the LDCs prevail in imposing *a priori* plans, and in blocking formal leasing, the bond-posting plan merits special consideration as a possible "back door" alternative.

Who ultimately bears the risk that a DC will not vacate on time? Would any DC ever vacate once it was operating? Would the premium on the bond become bigger and bigger at each renewal? Since sureties do not typically insure for more than three year periods, and the typical satellite life is nine years, will the risk of DC default increase as each maturity date approaches? How reliable and secure are long-term bonds anyway? Why should the LDCs accept the proposed long-term bond, rather than insist on annual lease charges? Presumably LDCs would prefer to be paid *something* each year during the ten or twenty-year period, and not wait until the end with risks that the DC would renege.[48]

A Modified Coordination Procedure With Economic Incentives

The next and final approach would create new mechanisms to strike a better balance between latecomers and incumbents in their use of the orbit spectrum. These might reduce the likelihood of conflicts and tensions between newcomers who seek slots and frequencies which incumbents already occupy (rather than incur much higher capital and operating costs without them), and incumbents unwilling to adjust orbital positions or to undertake costly retrofits and equipment design modifications. The basic issue is the extent to which incumbents should be forced to accommodate latecomers regardless of the adjustment costs the incumbents would face.

In considering how to design ITU arrangements which would help to avoid such conflicts in the future, the following possible scheme should be considered:

(1) Every new satellite applicant must not only identify a preferred orbital location but also two or three alternate points from which it could be serviced;
(2) Any latecomer (LDC) could request an incumbent (DC) to reposition its satellite (or to adjust its ground equipment) so that the latecomer could occupy its preferred position, provided that the latecomer reimbursed the incumbent for any extra (adjustment) costs thereby incurred;
(3) Where the incumbent refuses to adjust any ground equipment, or to move to a previously agreed upon alternate orbital location, it must reimburse the latecomer for extra costs the latecomer would incur to reach its proposed service area, were it compelled to operate at any second-best position. (This reimbursement will be called "penalty costs.")

The purpose of such analysis would be to formulate specific rules under which:[49]

(1) An incumbent would have the right to refuse to reposition its satellite (or to adjust its ground equipment), provided it paid the above penalty costs, but
(2) If the incumbent *did* adjust, the latecomer must itself pay those necessary adjustment costs.

Part of the analysis must also focus on whether:

(1) The incumbent would prefer to stay put and reimburse the latecomer where the extra value to the incumbent of operating from its preferred location would exceed the extra costs the latecomer would incur by being forced to a less preferred location; and
(2) The latecomer would find it worthwhile to seek the change unless the value to it of operating from a preferred position fell short of the costs the incumbent would incur in shifting positions, and which latecomers must pay.

Before proceeding, let us define these cost concepts in greater detail. On the one hand, adjustment costs are defined as hardware costs only, estimated arbitrarily at one-half the total change in value when incumbent moves from one orbital position to another. This is analogous to a highway builder who, as a latecomer, will compensate a building owner for his building but not for the discounted value of future earnings that the road will eliminate, *i.e.*, for the foregone future income.

This implies, first, that even if building owner owned his building and land outright, as a property right, under eminent domain the state could condemn land and evict occupant to accommodate the latecomer (road builder), but not pay the incumbent full compensation for the loss. In orbit spectrum, a weak analogy exists, but does not fit tightly since, strictly speaking, only *de facto* rights exist, not formal legal rights under international law. Yet even if slots are a common resource of all mankind, and even if incumbent has no permanent rights to use them, still, before incumbent's investment is fully amortized, it must be compensated to move, though again not for the slot's full value, only for extra equipment costs incurred.

Penalty costs, on the other hand, are most analogous to environmental pollution costs. If the incumbent will not move on request, it must compensate the latecomer for extra costs (losses) imposed. In environmental pollution, with pollution charges, if a polluter will not clean up via investment to control pollution to accommodate latecomer users of atmosphere or water, it must pay pollution charges instead, for the pollution imposed on these latecomers. Before latecomers appear as second-best users of atmosphere, that is, no harm is imposed and the atmosphere is a free good. But when latecomers do appear, there is no more free good, and incumbent polluters must either control pollution under law, or pay for the pollution costs imposed upon the latecomers. Indeed, without pollution charges, users of air, water, or the amenities, will not be even crudely aware of the opportunity costs of their use.

Bear in mind, finally, that this whole process entails hypothetical presentations before a new international arbitral authority. Incumbents and latecomers must both estimate (a) penalty costs, and (b) adjustment costs, with assessment by the new arbitral authority—subject to empirical, conceptual, and political imperfections.

How might such principles and analysis operate in practice? Several years ago, India and Indonesia both sought access to orbital positions for proposed domestic satellites close to those then occupied by INTELSAT and the Soviet Union's STATIONAR system. The applicants in each case did not foresee the likelihood of serious interference with the incumbent systems, if only the incumbents would adjust their antenna beams and earth station equipment appropriately. The incumbents refused to adjust, however. INTELSAT was unwilling to lose its ability to connect London and Sydney in one hop, and the Russians did not want to relinquish their one-hop connect between Vladivostok and the Czech border. As a consequence, India (INSAT) and Indonesia (PALAPA) each had to make costly design adjustments of their own.[50]

India is said to have lost about 20 percent of its initially proposed satellite capacity. In addition, India's problems led it to advocate detailed longterm *a priori* allotments at future space conferences, as at WARC-77. Indonesia's brusque treatment by the Soviets and the adjustment costs it faced also encouraged it to pursue a direct planning approach.

Designing ITU arrangements to avoid such conflict in the future would serve DC interests. Under the guiding principles here proposed, any incumbent would have the right to refuse to reposition its satellite or adjust its ground equipment, provided it reimbursed the latecomer for the extra costs it would incur if compelled to operate at its second-best position. If the incumbent did adjust, on the other hand, the latecomer would pay its necessary adjustment costs.

It could of course be argued that INTELSAT in the above case represents 107 countries, whereas India is only one, so that the two users are not of equal importance and, therefore, cannot be treated the same. Superficially, one might even contend that a hierarchy of users might justify a lower penalty charge for a global consortium (with 107 co-owners), than for a single country incumbent which chose not to accommodate a latecomer as described.[51]

Yet such reasoning is seriously flawed. Even multi-firm domestic joint ventures in the United States, or in foreign trade, must bid in the market against competing users for non-spectrum resources. Then why should INTELSAT, or INMARSAT, not also be expected to compete for orbit spectrum, say, against India, Indonesia, or Chad? In this paper, the incumbent's demand price for access to orbit spectrum is crudely reflected in the penalty costs it agrees to pay to hold its preferred slot. A latecomer's demand price is also (crudely) reflected in the adjustment costs it would pay to dislodge an incumbent from an assignment the latecomer wants. Indeed, earlier we saw demand price more directly reflected in lease payments by LDCs, or DCs, to secure access to unused assignments in a comprehensive, long-term, pre-engineered allocation plan.

In all three cases, the payments in question virtually constitute the price to use orbit spectrum under the hypothesized conditions. There seems no less reason for INTELSAT, EUTELSAT, ARABSAT, or INMARSAT to pay for this resource, then, than to compete, as they necessarily do, for administrative or engineering personnel in the labor market, or for capital in the capital market.[52]

By way of an illustrative starting point for further analysis, and in no way any definitive proposal, consider next the hypothetical facts summarized in Tables I and II which follow.

TABLE I: Estimation of Hypothetical Charges

	I	II	III	IV
Value of A to INTELSAT	12	10	10	10
Value of B to INTELSAT	11.5	8	8	8
Value of A to India	13	7	7	7
Value of B to India	11	4	6	6.5
Penalty Costs on Intelsat for staying	13 − 11 = 2	7 − 4 = 3	7 − 6 = 1	7 − 6.5 = .5
Adjustment Costs on India if INTELSAT moves	12 − 11.5 = .5/2 = .25	10 − 8 = 2/2 = 1.0	10 − 8 = 2/2 = 1.0	10 − 8 = 2/2 = 1.0

In scenario I, INTELSAT will move from slot A to slot B (though value to it falls from 12 to 11.5), since it thereby avoids (a) penalty costs of 2, (b) net loss in value of A of 1.5, and receives (c) hardware adjustment costs

TABLE II: Summary of Hypothetical Outcomes

Scenario	Value of A	Latecomer (India)	Incumbent (INTELSAT)	Ecomonic Efficiency	Equity
I	rises	pays adjustment costs & gets A	moves to B	rises	rises
II	falls (but India's relative gain exceeds INT's relative loss)	pays adjustment costs & gets A	moves to B	rises	rises
III	stable (India's relative loss less than what INT's relative loss would have been)	must take B gets penalty costs	keeps A and pays penalty costs	rises	falls
IV	stable (same as in II)	takes B but gets penalty costs	keeps A and pays penalty costs	rises	falls

of .25 from latecomer, equal to one-half of loss in incumbent's slot value of 2−1.5=.5/2= .25. Hence by moving from A to B, incumbent loses, net, only .25 in value, whereas if she stays put she loses penalty cost, 13−11=2+foregone adjustment costs of .25, or 2.25. Note also that in this scenario, value of A rises from 12 (for incumbent) to 13 (for India), with India risking only .25 in adjustment costs if INTELSAT moves, but in that case improving its own position from 11 to 13, or by 2. Finally, note that economic efficiency rises insofar as total value after the reassignments will be 13+11.5=24.5, compared to 12+11=23 beforehand. In addition, equity increases insofar as latecomer's relative gains (2/11=18%) exceed incumbent's loss (.5/12=4%).

In scenario II, on the other hand, once again INTELSAT would lose only 2 by moving from A to B, but avoid payment of 3 in penalty costs to India, and receive 1 in adjustment costs, and hence suffer a net loss of only 1. By the same token, India risks only 1 in adjustment costs by making the request, but receives 3 in penalty costs if INTELSAT refuses. Here, because INTELSAT does move from A to B, India does pay 1 in adjustment costs, but raises its expected slot value from 4 (B) to 7 (A), triple those adjustment costs.

By the same token, though the value of A falls from 10 to 7 in scenario II, total value of A plus B rises from 14 to 15, India's relative gain (¾ =75%) far exceeds INTELSAT's loss 2/10=20%, or more precisely, from 10 to 8 plus adjustment costs of 1, or 10−9=1/10=10%). On all counts then, economic efficiency has increased, and so, too, has the equity in latecomer gains.

Yet in scenario III, INTELSAT would opt to stay put to avoid loss of 2 which would be twice the penalty costs of 1 she would otherwise incur. Even with adjustment costs in moving to B added, INTELSAT would receive only 8 (at B) plus 1 (adjustment costs), or 9, just equal to her net value in staying put, viz., 10-1 penalty costs, or 9. So why move?

If, as in scenario IV, value of A and B to India were closer still, say, at 7 and 6.5, then there would be even less reason for INTELSAT to move. Again, in scenario IV as in III, incumbent would in fact pay the opportunity costs of its incumbency as reflected in penalty costs of 1.

So much for the tables. A further word is in order on penalty costs and their rationale. These do, indeed, appear to rise over time; as with pollution costs, recall that what was seemingly a free good at the outset (air, water, land) becomes congested, polluted, and scarce with growing numbers of next-best users. In that case, economic efficiency requires that the opportunity cost of continued occupancy and use by firstcomers be identified and paid for. This is also true of orbit spectrums.

As for adjustment costs, on the other hand, recall that these comprise not the full difference in value between A and B when incumbent moves to B, but are set arbitrarily at one-half this, viz., at hardware costs net of future income stream. Granted, however, that with enough increase in power, incumbent could conceivably restore the original service of A in slot B. But this might cost a lot, indeed be equal to or greater than the original loss of moving from A to B. If so, with adjustment costs that big, why would an incumbent ever stay put and pay opportunity costs?

There are indeed four reasons. First, expanded hardware costs would have to be at least double the size of the loss for adjustment costs (at one-half) to leave the incumbent without incentive to move—at best a very large sum. This alone reduces the likelihood of any such eventuality. Second, to pay for the hardware move from A to B is one thing. But would an incumbent in any case be willing to risk being permanently saddled with these excessive hardware costs by designing a system mainly to keep latecomers out of A? Third, the governing rule might specify that hardware adjustment costs must be limited to parameters initially set by the incumbent in applying for A and B, and these would necessarily be limited by potential signal interference effects from A and B. Fourth, and last, if penalty costs actually went to a third party, say the United Nations or the ITU (for infrastructure development), there is no incentive for latecomers to make frivolous claims to exact penalty costs from the incumbent. Therefore, adjustment costs *could be scrapped entirely without running that risk.* True, the latecomer responsibility for the incumbent's adjustment costs symbolically recognizes the incumbent's business equities in a slot. However, eliminating that responsibility implicitly favors the latecomer's equities instead.

So much for the proposed modification of existing coordination procedures. Needless to say, there are shortcomings in any such scheme in the present institutional and real-world setting. There may be intractable disputes over international assessment of relative adjustment and penalty costs as separately estimated by incumbents and latecomers. Could the ITU, as presently constituted, readily administer any such mechanism? As a consensus standards organization, is it the appropriate forum for such decisions? Or does its longstanding animus against economic incentive mechanisms to resolve what are still widely viewed as technical or engineering problems, really rule out such a role? If so, could the International Court of Justice effectively figure in such assessments, or may it in turn be too cumbersome a mechanism for that purpose? In that case, might a new international arbitral organ really have to be established, with all the political, legal and institutional problems this would pose?

However serious these shortcomings may be, the alternatives to any such modified coordination procedure are by no means without their own limitations. Thus, the status quo would at best continue to deprive latecomers of equitable access, whereas instituting an economically ideal auction scheme faces far reaching administrative, political, and technical obstacles well beyond our scope here to review.[53] To improve the economic efficiency of orbit spectrum allocations, then, some hard decisions must be made between second-best solutions which are closer to the current administrative-institutional framework, and economically more ideal mechanisms even less likely to win international acceptance.

Why not allow a private transaction between LDC and DC rather than one which entails the administrative and computational complexity of penalty costs and adjustment costs? A private transaction would work only where (1) the value of an orbital position to incumbent and newcomer differ substantially, and where (2) both parties have comparable access to the capital market. Given the different wealth of DCs and LDCs, and their different access to capital markets, a bald market contest would clearly work to the LDC's disadvantage. Imposing penalty costs as conceived here on incumbent DCs would at least operate to help the less affluent LDCs (by forcing the incumbent to pay the opportunity costs of its occupancy). At the same time, as noted earlier, a latecomer, faced with having to pay for an incumbent's adjustment costs, would thereby be restrained from making frivolous requests.

Ultimately, we want the preferred position to go to the party for whom it has the greatest relative value, each party being reimbursed for the extra cost of being compelled to use its next best alternative. However, the rules outlined here would at best facilitate only a very crude approximation of that result. What we really need is a procedure which clearly reveals demand, such as a grand auction of perpetual rights at the outset,[54] something this article will not examine.

The mechanism outlined above would help equalize the standing of latecomers and incumbents and hence reduce the former's resentment and resulting North-South confrontations. Without by any means approaching a complete market for orbit spectrum, these procedures might usefully introduce controlled economic incentives into the process of coordination and planning.

CONCLUSION

The current legal debate concerning the allocation of the orbit spectrum threatens to reach an impasse because of irreconcilable differences between the DCs and LDCs. If this should happen, the allocation of this scarce common resource might degenerate into unregulated national behavior, as each state pursues its own interests. This will have grave consequences for the quality of the orbit spectrum as a natural resource; inevitably congestion, misuse and economic inefficiency will result.

This article proposes that market incentives be allowed to operate in the allocation of the orbit spectrum. These incentives may be introduced by means of leasing arrangements for unused assignments (with payment in kind, by stock ownership, cash or by bonds), or by means of an accommodation procedure. Under the latter, DCs using vacant LDC slots would post large bonds to guarantee that they (the DCs) will vacate when LDCs are ready to enter, or else forfeit such bonds as lump-sum payments of rents equal to the minimum any LDC will require to release its assignment, viz., the cost of its next best terrestrial alternative. The last alternative proposed was a modified coordination procedure which requires incumbents to pay third parties the opportunity costs of continued occupancy when latecomers seek entry, under rules which operate to equalize the standing of both parties in gaining access to scarce orbit spectrum resources.

Although such procedures and lease market mechanisms are at best imperfect arrangements for efficient orbit spectrum allocations, important advantages may still accrue. Not only will a more optimal use of the common resource result, but the tension between technological demand and equitable access can be mitigated.

NOTES

1 Special thanks are due to William S. Vickrey of Columbia University for invaluable comments and criticisms of successive drafts, and for numerous helpful discussions with John Barton, Stanford Law School, Charles Firestone, UCLA Law School, and Martin Rothblatt, George Washington University. I am also grateful for specific suggestions during the long research period from colleagues in government (C. Block, R. Crowell, H. Hupe, S. Probst, R. Shrum, F. Urbany), industry (P. Ackerman, W. Ehrhart, E. Martin, E. Parker, J. Pelton, E. Reinhart), academia (C. Agnew, C. Christol, D. Dunn, B. Lusignan, R. Noll, I. Pool), and research organizations (H. Geller, L. Johnson, M. Jussawalla, B. Mitchell, E. Park). However, the views expressed here are the author's only and not necessarily shared by any of these individuals or organizations.

2 Orbit spectrum use, like the use of oil pools or ground water, could in principle be based on "unitized management," or sole ownership over a microeconomically useful portion of the resource. Sole ownership of the orbit spectrum can be achieved by the creation of regional or global consortia of largely governmental users. However, this approach would assume that the sole owner only controls a small portion of the global supply, there being many economically exploitable units of the resource. Thus, though the sole owner possesses a property owner's right of control, it cannot influence the price of the resource. Competitive market supply questions aside, if the sole owner is a public entity, we must add the dubious assumption that it seek to optimize economic efficiency. The public sector is notoriously impervious to market constraints. *See* Levin, *Externalities, Common Property Pricing, and the Manage-*

ment of TV Broadcast Rents, in NEW DIMENSIONS IN PUBLIC UTILITY PRICING 83, 83-87, 99-105 (H. Trebing ed. 1976); *see also* Baxter & Altree, *Legal Aspects of Airport Noise,* 15 J. L. & ECON. 1, 69 (1972) (proposes "expanded firm" to internalize airport noise externalities); Freeman & Haveman, *Water Pollution Control, River Basin Authorities, and Economic Incentives: Some Current Policy Issues,* 19 PUB. POL'Y 53 (1974); Roberts, *Organizing Water Pollution Control: The Scope and Structure of River Basin Authorities,* 19 PUB. POL'Y 75 (1971); Roberts, *River Basin Authorities: A National Solution to Water Pollution,* 83 HARV. L. REV. 1527, 1544-54 (1970); Rothenberg, *Evaluation of Alternative Public Policy Approaches to Environmental Control,* in THE ECONOMICS OF ENVIRONMENTAL PROBLEMS 71 (F. Emerson ed. 1973) (discusses common property management and pricing policies).

3 *See* OFFICE OF TECHNOLOGY ASSESSMENT, RADIOFREQUENCY USE AND MANAGEMENT: IMPACTS FROM THE WORLD ADMINISTRATIVE RADIO CONFERENCE 1979 50-52 (1982)[hereinafter cited as OTA REPORT]. *See generally* Butler, *World Administrative Radio Conference for Planning Broadcasting Satellite Service,* 5 J. SPACE L. 93, 98 (1977); Rothblatt, *A Jurimetric Framework for the International Allocation and Economic Development of the Orbit/Spectrum Resource,* in PROCEEDINGS OF THE TWENTY-FOURTH COLLOQUIUM ON THE LAW OF OUTER SPACE 79, 80-81 (1981)[hereinafter cited as *A Jurimetric Framework*]; Rothblatt, *Satellite Communication and Spectrum Allocation,* 76 AM. J. INT'L L. 56, 69-70 (1982). For a discussion of the Third World perspective, see T. Srirangan, *Some Thoughts on Techno-Economic Considerations and Potentials of Orbit/Spectrum Planning for Developing Countries,* delivered at the Inaugural Session of International Training Courses on Orbit Frequency Planning ¶¶ 1.6, 9.1 & 10.1 (Mar. 6, 1981).

4 *See generally* D. SMITH, SPACE STATIONS: INTERNATIONAL LAW AND POLICY (1979) (treatment of the technology of satellites in the orbital spectrum).

5 However, a significant difference between the orbit spectrum and other common resources is that the spectrum is *not depletable.* It is a constant source which can never be diminished, replenished, or—ultimately—depleted. This important difference has no bearing on the short-run use of the spectrum, however, and so we can fruitfully analogize to other common resources.

6 *E.g.,* under American law, the owner of lake front property "owns" the lake bed out to the middle of lake. Yet such ownership coexists with the passage and anchoring of boats, swimming, etc.

7 *See, e.g.,* MANAGING THE COMMONS (G. Hardin & J. Baden eds. 1977); THE GOVERNANCE OF COMMON PROPERTY RESOURCES (E. Haefele ed. 1974); Goodwin & Shephard, *Forcing Squares, Triangles and Ellipses into a Circular Paradigm: The Use of the Commons Dilemma in Examining the Allocation of Common Resources,* 32 W. POLI. Q. 265 (1979).

8 From a contemporary international legal perspective, the basic goal of orbit spectrum management appears to be maximum diffusion of the technical-physical-engineering benefits of orbit spectrum usage, and not necessarily the economic benefits. Thus, international pronouncements speak of maximizing the wide physical diffusion of information across nations, called value dispersion.

Value dispersion depends on channel depth and channel distribution. Channel depth refers to the potential technical capacity of spectrum bandwidth to carry messages per unit of time, i.e., to accommodate some maximum predictable number of radio channels with some acceptable level of signal quality. Channel distribution, on the other hand, denotes the number of different places to which a channel can convey a message, i.e., the geographic incidence or "footprint" of information pathways.

Channel depth can presumably be increased by more efficient hardware design. The problem is to promote technical advances more expeditiously than at present, where orbit/spectrum congestion, interference and delays produce poor economic efficiency.

Pricing arrangements in orbit spectrum lease markets may offer the necessary incentives for technical development. *See* International Telecommunications Convention, Oct. 25, 1973, arts. 10, 13, 28 U.S.T. 2497, T.I.A.S. No. 8572; *Jurimetric Framework*, *supra* note 3; Rothblatt, 76 AM. J. INT'L L. at 61.

9 If these five objectives were achieved, then the successful plan would probably offer two added virtues: open access and flexibility. Open access is arguably part of the larger goal of economic efficiency because if a state has sufficient demand for satellite service (or for additional service), it should be able to obtain a slot, the sole constraint being its willingness to pay. Flexibility—the capacity to effectively respond to changing technology and shifting demand—is obviously a *sine qua non* for the operation of markets and economic efficiency.

10 First-served DCs not only occupy slots, but also utilize some of the least expensive technologies and frequencies, forcing late-arriving LDCs to use more expensive ones. Some LDCs are sensitive to such cost handicaps: they urge that "the newer and more expensive technologies that lead to better utilization . . . should be adopted by the developed countries and by international systems, so that the comparatively simple and cheap technologies (*e.g.*, lower frequency bands 4 and 6 GHz) are freed for use by developing countries." Draft Report of the Second United Nations on the Exploration and Peaceful Uses of Outer Space, U.N. Doc. A/Conf. 101/10/PC/L.20/Add. 1, 2, at ¶ 275 (1982) (commonly referred to as the Second Unispace Report). In a discussion of flux density limitations in the 6 and 4 GHz bands, language later removed from the Report commented on the desirability that "developed countries shift their satellite . . . systems to a different frequency band (e.g., 11/14GHz,) leaving the 4/6 GHz band basically for use by developing countries." This change, combined with relaxed limitations on flux density, would facilitate significant cost reductions for developing nations. *Id.* at ¶ 150.

11 Recall that the LDCs come in late, often at higher cost, and therefore start with a far smaller share of orbit spectrum resources than the DCs, which have greater capacity to stake out claims sooner, and more extensively. For a discussion of the cost handicap of latecomer LDCs, see Srirangan, *supra* note 3, at paras. 13.1, 13.2.

12 This is a term of art for orbit spectrum allocation based on a comprehensive, long-term plan of pre-engineered assignments.

13 Several commentators have questioned the legality of a priori planning under current international law. Professor Gorove contends that under Resolution No. 3 of WARC '79, "states must be able to use the geostationary orbit 'in practice' and not just merely assert a claim in order to avail themselves of the guarantee of equitable access." He further notes that Article 33 of the 1970 ITU Convention

> stipulates access according to the Radio Regulations and the countries' "needs and technical facilities at their disposal" and not unequivocally without reference to the two vital criteria "needs" and "technical facilities." Thus, a country is not assured equitable access, in fact, unless it has the need for it and possesses the relevant technical facilities. Both of these criteria . . . point in the direction of use or ability to use. The "need" is presumably for "use" and without "the technical facilities" there is no ability "to use."

Legal Implications, FCC Space WARC Advisory Comm., FCC Doc. No. B1-12 (1982) (statement of Stephen Gorove).

> In Professor Christol's view, certain language in article 2 of the Outer Space Treaty imposes restraints on the rights of international organizations to assert claims to make dispositions of the areas of space and their resources. It is possible to contend that since States could not create exclusive rights for themselves, they do not have the power to give exclusive rights to international organizations, which, as agents of States would give to States by way of an international edict some or all of the rights prohibited by the terms of Article 2.

The same language in Article 2 is also alleged "[i]n practical terms . . . to deprive the ITU or WARCs of the power to grant sovereign and exclusive rights to the orbit/spectrum resource by way of making allotments. . . ." Legal Implications, FCC Space WARC Advisory Comm., FCC Doc. No. B1-15 (1982) (statement of Carl Christol).

Nevertheless, numerous precedents in domestic U.S. regulatory law allow regulatory authority to delineate spectrum rights and hold them open for future use by latecomers unable presently to use them. Other laws and regulations deliberately override or qualify the rule of capture, to safeguard educational, social or other non-market goals. *See* Levin, *Foreign and Domestic U.S. Policies—Spectrum Reservations and Media Balance,* 6 TELECOM. POL'Y 123 (1982); *see also* Legal Implications, FCC Space WARC Advisory Comm., FCC Doc. No. B1-21 (1982) (statement of Donna Demac).

14 OTA REPORT, *supra* note 3, at 126, 132-33. Curiously, there is virtually no discussion of such mechanisms in the otherwise far-ranging OTA REPORT—none in the six policy options it outlines, *id.* at 114-26, and only one vague reference to "economic techniques" in its final findings, observations and conclusions. *Id.* at 135

Nevertheless, the OTA Report underscores the necessity of reaching a compromise in spectrum allocation. Not only does U.S. influence in the International Telecommunication Union (ITU) appear to have declined over time, while that of the Third World has increased, *id.* at 53-54, but finding a "practical compromise" is widely recognized as both "possible and desirable." *Id.* at 72.

For a discussion of the origins of *a priori* planning as the Third World response to the ITU's traditional evolutionary approach, see Christol, *Telecommunications, Outer Space and the New International Information Order (NIIO),* 8 SYRACUSE J. INT'L L. OF COM. 343, 354-59 (1981); see also Christol, *National Claims for the Using/Sharing of the Orbit/Spectrum Resource,* in PROCEEDINGS OF THE TWENTY-FOURTH COLLOQUIUM ON THE LAW OF OUTER SPACE 116 (1982) (review and appraisal of both approaches) [hereinafter cited as *National Claims*].

15 The next task of this article will be to explore the theory behind, and basic benefits of, a market allocation system. For methodological purposes, it will assume that the basic problem is confined to one state's allocation of orbital slots among competing domestic users. But most of the observations and conclusions are applicable in the international arena.

16 Either from a first-come, first-served system (*e.g.*, early American settlers who simply fenced in what they wanted), or through a political decision (all citizens who meet certain prerequisites get the resource, along the lines of the U.S. Homestead Act).

17 Placing a satellite in orbit is a costly proposition. However, many satellites are designed for multiple uses. This seems implicit in the emerging market for transponders. (A "transponder" is the device on a communications satellite which amplifies and relays transmissions between "transmit" and "receive" earth stations.)

In the domestic U.S. setting, the FCC is trying to regulate this burgeoning market for multi-use satellite services. *See, e.g., FCC Vetoes Transponder Auction,* BROADCASTING, Feb. 1, 1982, at 31. But the policy was liberalized in a more recent FCC Memorandum Opinion. *See In re* Domestic Fixed-Satellite Transponder Sales, Docket No. 82-45 (F.C.C. Aug. 17, 1982).

18 *See* H. LEVIN, THE INVISIBLE RESOURCE 149-50 (1971) [hereinafter cited as INVISIBLE RESOURCE].

19 *E.g.*, in the case of real estate, in addition to the nuisance cause of action, restrictive covenants and zoning laws serve this function. *See* O. BROWDER, R. CUNNINGHAM, J. JULIN & A. SMITH, BASIC PROPERTY LAW 111-33, 612-706, 1104-1436 (3d ed. 1979).

20 *See* Levin, *Spectrum Allocation Without Market,* AM. ECON. REV., May 1970, at 209, 210-11.

21 *See* INVISIBLE RESOURCE, *supra* note 18, at 85-91.

22 *See* Levin, *supra* note 20, at 213-18.

23 *E.g.*, the Multipoint Distribution Service (MDS), a common carrier service in the microwave band geared to broadcast the same material to different fixed receivers.

24 *See* INVISIBLE RESOURCE, *supra* note 18, at 118 ("The maximum sums that users of spectrum

would be willing to pay rather than do without some marginal amount of bandwidth . . .").

25 One must distinguish between the consequences of being deprived of *all* one's spectrum, and being deprived of some smaller amount. The problem of finding substitutes for an entire block of spectrum to, *e.g.*, a mobile service, is one thing; substitution at the margin of one use is something quite different. Small decrements or increments of spectrum impose different constraints on systems choices and hardware design. This is as true for communications satellite systems and for the aeronautical-maritime or land mobile services as it is for point-to-point microwave.

The central issue here is whether to allot a little more, or a little less, spectrum to any group of users. What are the implications of marginal adjustments in spectrum availability on systems design, systems choices, and hardware costs? Holding constant the desired degree of reliability, what are the dollar trade-offs in building any system, between varying the amounts of spectrum and such nonspectrum factors as vehicles, personnel, storage, and a variety of electronic components?

26 Lease market transaction costs working through its home government and the ITU, however, might still be greater than if a transnational corporation deals directly with a foreign administration. The latter bypasses bureaucratic delays and skirts the ITU's hostility to rental or lease payments.

27 *See supra* note 21 and accompanying text.

28 An international scheme might also apply to orbit and spectrum assignments the principle of stratified bidding which is used in the allocation of highway concessionaire rights, timber sales, grazing rights and offshore oil rights. The best example of "stratified bidding" is that of "set asides" in timber sales, where some auctions are limited to small businesses.

29 *See* Statement by Harvey Levin, U.S. Orbit Spectrum Strategies—Is There a Role for Satellite Hardware Companies?, Conference of the International Association of Satellite Users 4-8 (Apr. 1981).

30 For a discussion of orbit spectrum assignments which differs from this article, see Jackson, *The Orbit Spectrum Resource: Market Allocation of International Property*, 2 TELECOM. POL'Y 179, 179-90 (1978); *see also* Agnew, Gould, Dunn, & Stibolt, ECONOMIC TECHNIQUES FOR SPECTRUM MANAGEMENT chs. 12, 13 (1979). *See generally* General Electric Co., *Electromagnetic Spectrum Management: Alternatives and Experiments* at §§ 4 (lease/sale market system) and 7 (spectrum leasing), in STAFF PAPER NO. 7 OF THE PRESIDENT'S TASK FORCE ON COMMUNICATIONS POLICY at app. A (1969).

31 Even Third World spokespersons recognize the dangers of "padded" claims on spectrum under *a priori* assignment plans, at least without "a method to guarantee without unfair penalty access to the resource." Srirangan, *supra* note 3, at para. 14.4.1. He goes on to note that "[o]nce this lacuna is removed, the tendency to exaggerate needs would be moderated."

32 Proposals by equatorial nations (among the poorest on many counts) to charge rent for DC access to their unique resource, the equatorial orbit spectrum needed for geosynchronous satellites, have generated discussions related in some ways to the leasing ideas contained in this article. These proposals would distribute the rents generated: first, to equatorial nations themselves; second, to the LDCs more generally; and third, to developed countries at large. *See* Christol, *International Space Law and the Use of Space Resources: Solar Energy*, 15 REVUE BELGE DE DROIT INT'L 38 (1980); Christol, *The Geostationary Orbital Position as a Natural Resource of the Space Environment*, 26 NETH. INT'L L. REV. 5, 15-22 (1979); *see also* Pool, *The Problems of WARC*, J. COMM., Winter 1979, at 187, 189 (related discussion pertaining to the possible imposition of an excise tax on international activities such as transportation, communications and commerce; or a tax on the use of orbital slots of frequency spectrum); Robinson, *Regulation of International Airwaves: The 1979 WARC*, 21 VA. J. INT'L L. 1, 43, 47-52 (1980) (discussing technical and development

assistance with—as a distribution of wealth issue—LDCs selling or subleasing their usage or access rights to more affluent countries; also discussing allocation by market).

33 *See* Levin, *Orbit and Spectrum Resource Strategies – Third World Demands*, 5 TELECOM. POL'Y 102, 105-06 (1981).

34 The difficulty of this task is widely recognized. *See, e.g.*, Robinson, *supra* note 32, at 43-44, 47-52.

35 Orbital arc here refers to the curved path described by a satellite around the earth.

36 For a recent discussion of the related concept of "super-service" areas (SSA), in which neighboring nations retain disretion to "defer their choice of channel bandwidth and channel spacing until . . . ready to design [their] systems," see Gould, Hupe & Reinhart, *Domestic Broadcast Satellite System: The Need for a Common Standard and the Case for Block Allotment Planning*, in INTERNATIONAL CONFERENCE ON COMMUNICATIONS sec. 4 (1982). Block frequency allotment planning has considerable flexibility in polarization, antenna sidelobe control, bandwidth reduction, and other attributes of system design, all "without seeking the agreement of countries that lie in other super service areas." *Id.* The key mechanism is the agreements several nations strike within any given SSA on each other's technical requirements. *See* Panel of Experts Preparing for the 1983 Regional Administrative Radio Conference, Block Allocation Planning, Ad Hoc 177-133 (Rev.) (Nov. 18, 1981).

37 Although a lease market approach is normally ignored in current Third World commentary, it does seem to provide "a method of negotiation and coordination" to enable "assigned slot[s] . . . unused for any reason and [which] can usefully meet someone else's needs . . . [to be so used.]" Srirangan, *supra* note 3, at para. 14.4.2. Lease markets and orbit spectrum pricing also appear to be responsive to Resolution BP of WARC-79, *see* ITU, FINAL ACTS OF THE WORLD ADMINISTRATIVE RADIO CONFERENCE (1979), and to article 33 of the International Telecommunications Convention, *supra* note 8. The resolution considers the orbit/spectrum as "limited natural resources, suitable for allocation by relative pricing." *See* National Claims, *supra* note 14, at 3-4. Article 33 prescribes that the orbit/spectrum resource "must be used efficiently and economically so that countries . . . may have equitable access to both . . . according to their needs and the technical facilities at their disposal." *Id.* Again, lease markets and orbit/spectrum pricing appear suitable implementing mechanisms.

38 Must the benefits foregone due to some of the orbital arc being unused (under a loosely-packed plan) impose net economic losses? Not necessarily, if the greater transferability of rights arising from the loosely-packed plan generates sufficient extra economic outputs from the higher valued uses to which the assignments are moved. The vigor of the American urban real estate market, where a 5-10 percent vacancy rate is considered optimal, suggests that technical underutilization may actually result in net economic gains.

39 *See* De Vany, Eckert, Meyers, O'Hara & Scott, *A Property System for Market Allocation of the Electromagnetic Spectrum: A Legal-Economic-Engineering Study*, 21 STAN. L. REV. 1499, 1505-18 (1969).

40 Recall the hold-out problem discussion, *supra* text after note 21.

41 Recall the user maximization discussion, *supra* text accompanying note 21.

42 The bond method thus addresses the issue of access, timely surrender and guarantees. These problems will be discussed in the next section from two perspectives.

43 *See* Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space [Second UNISPACE Conference], Declaration of the Group of 77, U.N. Doc. A/CONF.101/5/PC/L.22 (1982).

44 *See, e.g.*, ACADEMY FOR EDUCATIONAL DEVELOPMENT, WARC-79: DEVELOPMENT COMMUNICATIONS STRATEGY—A REPORT TO USAID 29-31 (1979). The guarantor concept continues to generate interest. *See* CCIR, Provisional Technical Report for WARC 84, Doc. No. 4/286-E, at 100-02 (1981) (section on equitable access); *see also* Levin, *supra* note 33, at 105.

45 Actuarial risk that an HDC will not vacate on time really depends on two factors: the rate of obsolescence (the wearing out of satellite equipment), and the probability of renewal

in a market that has been attractively developed. On the former, if the satellite equipment does wear out within the agreed period, e.g., 10 years, then it is more likely that the DC will withdraw on schedule, and hence "redeem" the bond. But if the equipment does not wear out that rapidly, DCs are less likely to vacate on time, and the actuarial risk of bond forfeiture and consequent premium to third party insurers will be much higher. Second, timely withdrawal is also less likely if the incumbent opts to replace equipment, even if it wears out during the term of the lease. The incumbent would have some incentive to remain in the orbital position because its markets would develop over time.

However, new technology could induce it to alter its orbit slot utilization.

[46] Depending on the contracting states' agreement, the promises would be enforceable before the International Court of Justice. The parties could also agree to arbitrate.

Even if the DC were in fact a private company, there is some authority that it could invoke principles of international law before an arbitral panel to enforce its contract, provided the contract was "internationalized." *See* Texaco Overseas Petroleum Co./California Asiatic Oil Co. v. Libyan Arab Republic, 17 I.L.M. 1 (1978).

[47] *E.g.*, Let a satellite service cost $50 million and a next-best terrestrial alternative $250 million for either an LDC or a DC. (The cost of the land alternative is likely to differ between DC and LDC, but we assume comparability here for convenience.) The DC would save $200 million if it could borrow an LDC's unused assignment and install a satellite. The LDC would redeem the $250 million bond if the DC refused to vacate on time (less the $50 million it would have paid for satellite service). It would net $200 million.

Hence, the bond posting constitutes a guarantee that the DC will vacate on schedule or pay for the extra cost of an LDC's next-best alternative. It also represents a guarantee to the DC that it may use an unused LDC assignment for a specified period, at a cost of covering the actuarial risk that it will fail to vacate on time. For both parties, in this scenario at least, the value of the "lease" is $200 million.

[48] Another approach, avoiding the risks for the LDC described above, would be for the DC to offer to install the satellite gratis (for 10-15 years) in exchange for a rent-free lease for, say, five years, but on the explicit understanding that the satellite would revert to the LDC afterward. Here, the longer the satellite lifetime, the more things the LDC could do with it when the DC's rent-free period is over.

For an excellent early statement documenting still other DC-LDC joint arrangements in space, see Christol, *Space Joint Ventures: The United States and Developing Nations*, 8 AKRON L. REV. 398 (1975). Professor Christol reviews the history of such bilateral space environment joint ventures, which include arrangements with Argentina, Bolivia, Columbia, The Dominican Republic, Ecuador, Guatemala, Guyana, Haiti, India, Mexico, Paraguay, Peru, Uruguay, and Venezuela.

[49] For a similar formulation, see INVISIBLE RESOURCE, *supra* note 17, at 228-30 app. D; Levin, *New Technology and the Old Regulation in Radio Spectrum Management*, AMERICAN ECONOMIC REV., May 1966, 346-49.

[50] The episode described in this paragraph and the next appears to illustrate very nicely the kind of latecomer handicap increasingly attributed to present coordination procedures. *See* Srirangan, *supra* note 3, at paras. 13.1, 13.2.

[51] More specifically, one might ask: "Why should Chad, Zimbabwe, Libya, or Paraguay and Uruguay, as INTELSAT members with limited resources, and no Indian Ocean service be expected to help reimburse India for the extra costs allegedly imposed on it by INTELSAT's refusal to move?" The simple answer is that *all* INTELSAT members in this scenario—including Chad, Zimbabwe, etc.—receive 14% on their investment shares, and hence benefit at least indirectly from INTELSAT's Indian Ocean service. Therefore, the fact that they themselves have no Indian Ocean service is irrelevant. To raise the question at all in the above form reveals a basic misunderstanding of the economics of orbit spectrum management in

particular, and of multi-party consortia in general. Furthermore, though procedures now exist for a technical resolution of potential interference problems before any satellite is placed, this by no means precludes the imposition of cost disadvantages on latecomer nations—India in our hypothetical example—or on firstcomer incumbents (INTELSAT). Quite the contrary: the very technical resolutions undertaken could well raise the cost of satellite design (for LDC or DC), or of comparable geographic coverage, above those design costs if such potential interference had not arisen.

52 Nor is there any reason why mere existence of numerous separate consortium members need preclude the assessment of penalties on, and payments by, the INTELSAT organization. After all, signatories exercise voting rights and share in INTELSAT revenues according to their respective investment shares—and do so whatever the source of INTELSAT revenues. One equitable formula might therefore be to distribute penalty costs among signatories according to those investment shares. This would have the dual advantage of making all signatories (a) more aware of, and sensitive to, the external cost ramifications of INTELSAT behavior (on proposed domestic or regional systems of particular members); and (b) more involved in creating or joining internal voting coalitions on decisions which not only bear directly on voting members, but also more generally on total INTELSAT revenues.

53 *See* INVISIBLE RESOURCE, *supra* note 18, at 147-57; Robinson, *supra* note 32, at 47-52.

54 My colleague, Professor William S. Vickrey of Columbia University, has described such an auction scheme to me as follows. "[The spectrum would be allocated] on the basis of a demand-revealing procedure. Every interested party would be asked to state in a set of bids the value it places on various possible combinations of spectrum pieces it might be interested in. An allocation is determined to maximize the aggregate value. A set of alternate allocations is also determined, by optimizing with each party in turn excluded; and each party charges an amount equal to the difference between the value of the allocations received in the corresponding alternate allocation and the (smaller) value of the allocations to the n-1 parties in the actual allocation. The proceeds can be used to help finance the U.N.; or alternatively the process can be carried out separately for the eastern and western hemispheres, with the payments for western slots distributed to countries in the east and vice versa, on some suitable basis that will give the LDCs an adequately large share."