# In Search of Common Pool Behavior--The Case of Redundant Satellite Capacity

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# IN SEARCH OF COMMON POOL BEHAVIOR-- THE CASE OF REDUNDANT SATELLITE CAPACITY

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For all practical purposes, the geostationary orbit above the earth, and related frequencies for communications satellites, are a finite common pool resource akin to the oil pool, the watershed, and perhaps the migratory fishery. Like these other resources, orbit spectrum is potentially subject to pollution, congestion, and overutilization. But unlike the oil pool or seabed nodule at least, orbit spectrum is not depletable upon use.

In fact, none of these alleged common property resources is owned by individual firms or countries, or if so owned, no exclusive property rights are enforced. That is, the resource is either owned by <u>all</u> potential users (the common heritage of mankind), or owned by none.[2]

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[2]More explicitly, common property resources may be viewed as the property of no one, where there are no property rights at all (<u>res nullius</u>, where users will carve out <u>de facto</u> rights on a first come, first served basis. Or they may be viewed as the property of all (<u>res communis</u>), where the resource is open to common usage by all exploiters, but where governments or nations may carve out exclusive rights for themselves while preventing private parties from doing so. Or they may be viewed as the "common heritage of mankind" (<u>res communis</u>

(Some expert observers contend that this need _not_ be the case with seabed mineral nodules where an enclosure movement by coastal states is already under way and, for purposes of economic efficiency, quite properly so).

In the common pool cases, _cet_. _par_., users are deemed to be motivated to overdrill, overpump, or overfish, or, in orbit spectrum, to overoccupy and overuse the resource from an economic viewpoint. This is because only through actual occupancy and use (i.e., through squatters rights or the rule of capture) can de facto property rights be established, albeit on a first come, first served basis. Without special institutional arrangements or safeguards, therefore, there may result "excessive" or "premature" investment and output, or "economic waste".[3]

Firstcomer firms (or nations) may enter and use the resource to establish use rights before rival users do, whereas latecomers normally suffer the handicap of having to exploit economically less attractive regions, grades, or qualities of the resource at higher capital and operating costs. However, technical innovation based on experience

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_humanitatus_ or _res publicae_ -- _in patrimonio populi_) where, while open to common usage, such usage must be geared to the widest diffusion of benefits, for all mankind. See Carl Q. Christol, "International Satellite Activity: The Search for a Stable Regulatory Framework," presented at the conference on TRACING NEW ORBITS: COMPETITION AND COOPERATION IN SATELLITE DEVELOPMENT, Nov. 30, 1984, Columbia University.

[3]On the economic characteristics of the radio spectrum as an alleged common property or 'fugitive' resource, see generally, Levin, "Externalities, Common Property Pricing, and the Management of TV Broadcast Rents," in H. Trebing (ed.), _New Dimensions in Public Utility Pricing_ (MSU Press, 1976), especially at 83-92. On space satellite spectrum as a global commons, see also Levin, "The Political Economy of Orbit Spectrum Leasing," 1984 Michigan Yearbook of International Legal Studies, _Regulation of Transnational Communications_, at 43-44, and footnotes 2, 5-7.

seems likely to bring down per unit costs of satellite technology for all countries, and thus to generate some measure of compensatory free rider benefits for the developing countries. The question is whether these benefits do or do not offset the full cost handicaps of latecomer access, no easy matter to determine.

Typically, in any case, as users engage in strategies of preemptive entry and use, costs are in some sense bid up for all users, firstcomer DCs or firms, and latecomer LDCs alike. This is a kind of "pure externalities" effect, which penalizes all entrants comparably, firstcomers and latecomers alike. An overcrowded roadway slows down all users to a like degree, e.g., whether any single car enters the road early or late. In effect, any given car creates an incremental slowing effect the bulk of whose wasted time cost falls on others, while the incremental effect on itself is entirely negligible. The upshot, of course, is that without explicit congestion charges, say, through a metering of road space, or a time-of-day toll structure, no individual driver is fully aware of all the external effects of his or her entry and use of the roadway.

Accordingly, latecomers continue to join the queue until it is no longer worth it to the last entrant to sit in a queue that long, so he decides not to use the road at all. For him at least, the traffic flow comes to a grinding halt. In this way, where latecomer demand for access just exceeds roadway capacity (and marginal user cost becomes infinite), the resultant congestion and expected delay act to reduce demand to capacity.

Within this context, sec. A considers the degree to which investment in space satellite facilities can be explained by a desire to carve out _de facto_ rights to occupy and use positions, or 'parking places' in the geostationary orbit and in associated space satellite frequencies. This "excessive" investment is reputedly aimed to establish such rights before rival nations or firms do. Thus a recent public document states:

"The LDCs are very disturbed about U.S. practices concerning the underutilization of spacecraft because it appears that the U.S. plans to continue these practices despite the increasing congestion of the orbital arc. The (FCC) has publicly stated that it will endeavor to grant every domestic satellite application presently on file. Applications for approximately 60-70 new spacecraft are presently pending before the Commission. Yet reputable studies submitted by U.S. companies to the Commission have demonstrated that the demand does not exist for such an enormous (increase in) ... spacecraft.

"(...Clearly), ... _the primary motive of the U.S. is the annexation of additional orbital positions to the detriment of the LDCs rather than the efficient use of the orbital spectrum for the good of the people of the U.S. and the world_. (italics added) Thus, the LDCs cannot accept the U.S. position."[4]

Then, in sec. B, I further consider the degree to which such

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[4]See "devil's advocate" statement on LDC perspectives in FCC Space WARC85 Advisory Committee, Interim Report of Proposal and Evaluation Test Group, Nov. 20, 1984, SWAC DOC PEG #8, sec. III C.2. In contrast, "... when faced with a situation where existing satellites are underutilized, (other countries) have decided not to launch additional spacecraft. (For example, Canada recently announced that it would sell some of its ANIK spacecraft because its existing in-orbit satellites are not filled to capacity.)" Id. Nevertheless, in the U.S., too, there might well be far less underutilization if assignments were bought and sold in lease markets, freely. For in that case, with spectrum no longer a free good, the opportunity costs of redundant capacity would presumably reduce its attraction as a means to claim-stake.

uneconomic investment may be geared rather to avoid latecomer cost handicap, as the origins and incidence of that phenomenon is spelled out in that section.

As to the former issue -- excessive investment in satellite capacity -- to what extent does such investment reflect an attempt to wrest positional advantage in a common pool resource? That is, to what extent is this investment behavior analogous to overpumping in an oil pool, or overcatching in a migratory ocean fishery?

On my first issue, then, sec. A will identify major factors contributing to redundant or unused (if not necessarily "excessive") transponder capacity. Account must be taken of such elements to isolate out the unique impact of the pursuit of positional advantage in all this. Illustrative factors here, as in analogous fields, must include: (1) lumpy factors of production, (2) imperfect demand projections, (3) stockpiling of idle orbit spectrum assignments, (4) planned redundancy for reliability and safety, etc., (5) redundancy due to attempted intermodal preemption, (6) strategic preemption geared to keep potential rivals out, (7) time slippage in building the earth segment, and, most important, (8) the avoidance of latecomer cost handicap (which I reserve for detailed treatment later).

A. <u>Underutilized Satellite Transponder Capacity -- Key Determinants</u>

Let's next consider seven of the above determinants, leaving latecomer cost for separate review afterwards. Throughout, we must bear in mind, of course, that idle capacity need not necessarily be "excessive," but sometimes rather provides just what economic efficiency requires, as certainly the case with planned redundancy for safety and reliability, and possibly also with lumpiness of inputs.

1. Lumpy Factors of Production

Redundant capacity may simply reflect lumpy investments and very long time horizons in regard to projected demand. Before the AT&T break-up, e.g., that company was often said to initiate its terrestrial investments within a 100-year planning period. At the outset, therefore, its presumably underutilized telecommunications capacity may have appeared excessive, wasteful, or otherwise uneconomic. However, in retrospect, this may just have been a transitional phase, and no evidence of claim-staking. Yet in orbit spectrum, design life for the space segment is only ten years (even for the earth segment, only twice that), in contrast with 30 years for an L-5 terrestrial cable. Therefore, the space segment is at best a lumpy factor which must be filled quickly and, on that score at least, lumpiness may figure less significantly in explaining unused transponder capacity than in the case of coaxial cable. Mention must in any case be made here of the regulated firms' well-known incentives to expand their capital-intensive investments under rate base regulation, and to engage in short-run predatory pricing towards that end, with little reason to keep cost expenditures down insofar as they can recover any cost increment by charging more for services they sell to users with low elasticity demands, and have non-profit goals which can be furthered by "unprofitable" cost-increasing outlays.[5]

2. Faulty Demand Projections

Redundant capacity may further reflect forecasting errors which leave us with more excess capacity than planned, for longer periods than initially anticipated, and once again, signify no behavior aimed at gaining a larger share in a common pool. But here regulatory constraints are crucial, private carriers being more seriously hurt by poor forecasts than regulated firms which can presumably pass through the cost of forecasting errors onto their end users under rate base regulation. On that count, at least, unregulated private carriers would seem less willing than regulated firms, cet. par., to run the risk of being left with unused capacity due to faulty predictions, and one would accordingly expect to find more such underused capacity in private carriers due to claim-staking than to forecasting errors.

3. Inventory Management

Redundant capacity may additionally reflect a kind of "inventory management strategy" which leaves us with some interim underutilization of transponders today, the better to enhance their subsequent value whether in outright re-sale, or more time-limited sub-leasing to interested users, all wholly aside from the pursuit of positional advantage.

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[5] See generally, Harvey Averch and Leland Johnson, "Behavior of the Firm Under Regulatory Constraint," American Economic Review, Dec. 1962, pp. 1052-68. These and related aspects of the Averch-Johnson formulation are nicely laid out in William Baumol, "Reasonable Rules for Rate Regulation: Plausible Policies for an Imperfect World," paper presented at Brookings Rate Base Symposium, June 7, 1968, pp. 3-6, and in Harry Trebing (ed.), Performance Under Regulation, MSU Public Utilities Studies (Michigan State University Press, 1968), pp. 42-47, 74-78. On the possible manifestations of these alleged predispositions of regulated carriers, see further discussion and citations in Levin, #9, at pp. 292-94.

4. Planned Redundancy for Safety, Reliability, and Convenience

Excess capacity may also reflect a deliberate strategy to build redundancy so as to insure reliability for safety, security, convenience, etc., the central issue being whether the margin of planned redundancy is imposed by the supplier of circuits, or is user-responsive, in giving users something they really want enough to pay extra for. If redundancy is not imposed beyond what users really want, it does seem less likely that suppliers are exercising their discretion to gain positional advantage.[6] But here, too, regulated firms (like AT&T's Comstar) can pass through the costs of redundancy onto their end users, far better than unregulated private carriers, the main issue being how to classify INTELSAT, which some observers deem to have the benefits of de facto rate base regulation, without the regulation. It follows, also, that on that count at least, redundant capacity is less likely to reflect claim-staking behavior in regulated than unregulated carriers.

5. Intermodal Preemption

Redundancy may also be created by institutionally-grounded intermodal preemption where the PTTs overinvest in one transmission

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[6]Clearly related issues are examined in A.S. De Vany and T.R. Saving, "Product Quality, Uncertainty, and Regulation: The Trucking Industry," Amer. Econ. Rev., Vol. 67 No. 4 (Sept. 1977), 583-94. See also De Vany, "Uncertainty, Waiting Time and Capacity Utilization: A Stochastic Theory of Product Quality," Journ. of Pol. Econ., Vol. 84 No. 3 (1976), 523-40. There De Vany demonstrates that, with waiting time as a form of product quality, excess capacity can exist in a market equilibrium. See, finally, Walter Y. Oi, "Slack Capacity: Productive or Wasteful?", Amer. Econ. Assoc. Papers & Proceedings (May 1981), 64-69. Oi cites Hutt's eight categories of idleness "of which five can properly be classified as wasteful." (68) "Productive slack" is illustrated by a concept of "pseudo idleness", where resources are held intact (and not scrapped), because their capital value exceeds their "net positive scrap value." (68)

mode (say, satellites) over a rival mode such as fibre optic cable, and do so even though the latter mode may be more cost-effective. The objective is to get one's ministry of communications or other regulatory authority committed, say, to satellites over cable for the long-haul, and to do so even at the expense of interim redundancy. But here, different incentives and implications appear to operate in DCs and LDCs. In LDCs, e.g., investment decisions are fixed for long planning periods -- even if uneconomic -- and we are more likely to find redundancy due to intermodal pre-emption here, than in DCs like the U.S. where planning decisions are more flexible and alterable; and where claim-staking behavior is therefore less likely to explain redundant capacity than in LDCs generally. However, this is still no necessary evidence of common pool-type pursuit of positional advantage, or claim-staking as such.

6. <u>Strategic Preemption</u>

Here excess capacity is said to be part of a competitive effort to keep potential satellite rivals out, by making them fearful of predatory pricing if they attempt to enter. Most economists discount this hypothesis, however, unless the carrier is a monopolist, for otherwise, inhibition of entry by one oligopolist benefits others too, so that <u>among oligopolists</u> this makes for a <u>public good</u> of sorts, but not for the public as a whole. The point is that a carrier's potential satellite rivals would <u>also</u> benefit, if, e.g., it tried to deter (say) AT&T from laying a fibre optic cable.[7] In telecommunications,

[7]Some interesting analogies appear in the literature on preemptive invention, where firms may try to maintain monopoly power by patenting new technology before their potential rivals, though the patents remain unused by the patentholder, and unlicensed to others. The unused patent, in short, figures in precluding or inhibiting entry by rival

moreover, monopolistic common carriers are most likely regulated firms. In the case of INTELSAT, redundant capacity would be evidence of strategic preemption (claim-staking) only if she alone stood to gain from such pre-emption.

7. Time Slippage

Time slippage in completing a system's ground station may also contribute to redundant transponder capacity in its space segment. This slippage may be due to engineering delays, financing problems, strikes, regulatory procedures, etc., but, once again, the resulting unused capacity need not be evidence of the pursuit of positional advantage.

Bearing in mind these seven major determinants of redundant satellite capacity, we may turn next (and last) to a word on late-comer cost handicaps to avoid which nations are further impelled to stake out claims on orbit spectrum assignments, by means of premature, excessive investment.

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B. The Origins and Incidence of Latecomer Cost Handicap in Orbit Spectrum Utilization[8]

Latecomer nations, firms, or nonprofit entities, are often compelled to operate in higher spectral regions, at higher capital and

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firms, and, in that sense would contribute to positional advantage. Richard J. Gilbert and David M.G. Newbery, "Preemptive Patenting and the Persistence of Monopoly," Amer. Econ. Rev., Vol. 72 No. 3 (June 1982), pp. 514-26.

[8]For fuller development and documentation see Levin, "Latecomer Cost Handicap -- Origins, Measurement, and Opportunities for United States Initiatives at Space WARC85," presented at the conference on TRACING NEW ORBITS--COMPETITION AND COOPERATION IN SATELLITE DEVELOPMENT, November 30, 1984, Columbia University. See especially secs. 2-5.

operating costs, incurred due to a variety of physical, technical, economic, and legal constraints. Let us now consider a number of these factors.

1. Latecomer Cost Handicaps Due to Harsher Propagation Characteristics

As we move up in frequency from C to KU, and again to KA, rain attenuation impairs reliable, long distance communication. As a consequence, more and more signal power is needed to sustain the same signal quality and area coverage as in a lower band. In going from C to KU, e.g., there could in principle be a six-to-one power increase to preserve the same communication capacity as before. Other things equal, this implies a six-fold increase in the dollar cost of transmission power, albeit reducible to only a three-fold cost increase for power with a maximum improvement of technical modulation.[9] Finally, high non-recurring R&D and engineering costs are necessarily incurred to open up the newest spectral regions, still higher up.

2. Spectral Location and Scale Economies in Equipment Manufacturing

Some of the cost handicap that latecomers incur may actually reflect the relatively greater scale economies that equipment manufacturers for the lower C-band region now enjoy; the relatively

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[9] If we accept a lower degree of reliability -- say, 99.7% instead of 99.9% -- we could further reduce cost increases in the move from C to KU to a doubling only. But how much reliability will LDCs at most be willing to give up? The issue is a delicate psychological-political one in part because those countries already resent what they view as second-class service in KU, subject as that is, to loss of coverage due to heavy rainfall in the tropics where many of the LDCs are located. The issue is also delicate because the latter further resent being relegated to lower cost but preemptible INTELSAT transponders in the domestic leases they hold; and because they have long sought access to satellites anyhow to escape sunspot-induced distortions in their use of HF broadcast spectrum. These LDC demands are no less intense though preemptible but lower-cost INTELSAT circuits may well be "all they need" today, and even though the aberrations of HF radio may also be cost-effective though seemingly unreliable and of poor quality.

smaller scale economies at KU, where the demand for equipment is also still small; and the much larger nonrecurring R&D and engineering costs incurred in developing new bands like KA. Once again, this leaves the LDCs no less sensitive to their status as latecomers. For on these counts, too, latecomer entrants will suffer still another relative cost disadvantage, and therefore want to impose detailed long-term a priori allotment plans which in turn act to force DCs to undertake costly design changes to narrow their orbital spacing requirements.

3. Narrower Orbital Spacing

There is, moreover, greater likelihood of narrower orbital spacing, which is more likely to occur, too, in response to growing congestion and competing applications for entry (by DCs at least). On that score as well, then, higher design costs are likely to result. Indeed even if a latecomer preferred less refined, poorer quality equipment (say, geared to 4 or even 5 degree spacing), it would now be available only on a hand-tailored, and hence far more expensive basis. Some things are in any case no longer available because they are essentially superceded. The fact here is that U.S. equipment demand leads the world market. Accordingly, changes in U.S. orbit spacing regulations will operate to deprive latecomer nations of certain earlier cost-savings in lower spectral regions, even if entry in the lower frequency bands there were still possible, around the 120 degree East longitude position at least. However, the cost dissavings in question should not be overemphasized.

4. Coordination Costs as a Factor in Latecomer Handicap

Under present rules latecomers must pay the cost of coordinating any system they install with the existing prior operations of incumbents, much as India and Indonesia had to bear extra costs in their coordination with INTELSAT and the Soviet Union's STATIONAR system. Coordination costs involve the locational and power costs incurred by a latecomer to avoid interfering with an incumbent user. But they could also refer to the incumbent's extra costs in accommodating latecomers with minimal extra costs imposed upon them and strictly speaking, coordination should entail the smaller of these two estimated costs. Basically, coordination costs are a function of orbit and spectrum congestion, and current administrative-legal-regulatory practice. Thus even in lower spectral regions like C-band, as they fill up and become congested, latecomers are disadvantaged.

In sum, the origin of latecomer cost handicap lies in (a) the harsher propagation characteristics of higher spectral bands, and (b) the far smaller scale economies in producing new equipment for the newer, less fully utilized higher spectral bands. But these cost handicaps may in part be offset by lower coordination costs in the less congested higher bands, than in the more congested lower bands.

5. Summation

Any sound estimate of latecomer handicap could well reveal (a) costs that rise as increased power is needed to offset poor propagation conditions, while holding constant (b) scale economies in equipment manufacturing, (c) nonrecurring engineering plus R&D costs, and (d) the incidence of coordination costs as between latecomers and incumbents, across the several spectral bands, reflective of their relative congestion. At some point, moreover, latecomers will doubtless have to choose between (a) higher coordination costs in the lower congested bands (though with lower equipment costs due to better propagation conditions and larger scale economies); and (b) lower coordination expenses but higher non-recurring engineering costs in the higher newer bands.

CONCLUSION

As for claim-staking incentives, DCs will presumably want to recover orbit spectrum value as Ricardian rents which, as firstcomers, they can better capture at C-band, rather than at KU or KA. And here the analysis of latecomer cost handicap could help us estimate that orbit spectrum value. When faced, say, with a 3 to 1 power cost increment in operating space satellites at KU rather than C, and another such increment going to KA, the hypothetical latecomer should rationally be willing to pay something just short of this cost differential for access to the lower band. In principle, that is, latecomers should pay a sum just short of the cost savings C-band would have facilitated relative to KU, or KU relative to KA.

The main point, then, is that if costs at C-band are decisively lower than at KU, and KU lower than KA, all spectrum users, whether in DCs or LDCs, will want to secure assignments, and hence tacit rights, in the lower cost bands <u>long before they are ready to use them</u>. Hence the expected cost savings at, say, C or KU, can be viewed as the orbit spectrum rents firstcomers will gain by early application, construction, and operation of satellite facilities, <u>even if the transponder capacity is thereby left underutilized</u> for an interim period.

Stated otherwise, the greater the expected orbit spectrum rents, the more likely that the unused transponder capacity reflects the pursuit of positional advantage (i.e., claim-staking) rather than factors like lumpiness, faulty demand projections, inventory management, time slippage in completing the ground segment, or planned redundancy for security, reliability and convenience.