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**Full Text** (1194 words)

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The explosion in wireless usages - from mobile phones to satellite television, taxis to air traffic control, tanks to garage door openers - is making the allocation of the airwaves ever more contentious. Around the world, governments have traditionally exercised tight control over the electromagnetic spectrum, and for a long time generally granted licences to those with political influence and effective lawyers. More recently, the system of spectrum auctions emerged, under which licences were auctioned off to the highest bidders. This system, advocated half a century ago by Nobel winner Ronald Coase, refined by game theorists and eagerly adopted by governments in their eternal quest for new revenue sources, became the new policy orthodoxy.

Though the problems that emerged from the auctions were entirely predictable\*, they have brought much of the telecommunications industry to the brink of financial ruin. The systems advocates seek solace in the notion that the auctions were insufficiently pure, or blame the companies for bidding too high. Yet when companies - often profitably advised by the same auction experts - miscalculate almost everywhere, it is fair to ask whether the auction system itself is at fault.

Auctions inevitably degenerate into revenue tools for government, and their winners can survive their winners curse only by establishing retail price cartels that keep consumer prices higher than the competitive levels - which are very low indeed. Maybe the problem was that auction advocates knew a lot about game theory but very little about telecommunications reality.

More recently, another wave of innovation took place in which computers were unhitched from wire lines and connected via wireless modems to nearby base stations, or hotspots. This system is known as Wi-Fi (for Wireless Fibre, an oxymoron), or, less colloquially, as 802.11 or wireless local area networks (W-Lans). It permits connections at data speeds far greater than those of the instantly-clunky third generation of mobile phones, and already has millions of users.

One of the present characteristics of Wi-Fi is that it occupies a narrow slice of frequencies for which licences are not needed, similar to cordless phones. Yet there are not enough of such frequencies available. This has led to the advocacy of a larger allocation by a burgeoning open spectrum movement. Following arguments made almost a decade ago by George Gilder, Paul Baran and myself, this movement now spans the political spectrum, recognising correctly that the notion of a single user needing to control a slice of a frequency band is technologically obsolete. Increasingly, packets of information can be transmitted on whatever sliver of spectrum is available that instant and reassembled at the recipient into coherent messages.

Yet the advocates of hotspots have their blind spots, too. Whereas the auction orthodoxy ignored technology in favour of economics, the open spectrum advocates, sometimes similarly doctrinaire, err in the opposite direction. Many still believe the Negroponte mantra that the bit economy is governed by different economic principles than the carbon economy, that technology has overcome scarcity and that to charge money violates the vision of an electronic commons. Of course, much more usage can be crammed into the existing and expanding usable spectrum. But this can go only so far. Eventually, any resource whose utilisation is of value, yet whose use is without a charge, will be over-utilised. Just as in an earlier generation Citizens Band radio became an intolerably congested airwave Babel, so will the open spectrum also become used by anybody who wants to broadcast TV pictures to their neighbourhood, video-cam the front door of their shop, or bounce signals from large amplifiers known as repeaters. This is the classic problem of the tragedy of the commons, in which the open pasture became overgrazed. Inevitably, the open spectrum will be squeezed into a few overgrazed frequency patches while the real applications take place on more orderly bands.

Property rights are one solution, but they are not practical for a situation in which information packets will travel over numerous frequencies, each with different owners. It would be as if an airline had to negotiate overflight rights with each landowner whose property it crossed. Technical limitations on transmission power, length of transmission time or type of application - no video before midnight, for example - are another way to keep congestion at bay, but they will by necessity become highly complex and inefficient once one goes beyond low-powered stationary uses at home or in the office.

Yet there is a market solution other than the property right regime: dynamic user fees, in which users pay a charge for using certain frequency bands that varies with congestion. When many users want to use a particular band, such as during the morning rush hour, the band access price goes up, and smart software-defined radios migrate to cheaper bands or lower-quality transmission. The same smart technology also keeps a tab on the accumulated charges, most conveniently at the locations of bulk users such as cellular companies and taxi dispatchers. Those users who need to assure certain frequencies at certain prices can do so through forward markets.

Such a system of dynamic user charges would lower entry barriers, because no costly up-front acquisition of licences is necessary. It would therefore prevent the emergence of retail price cartels. It would raise some revenues for government, but on a pay-as-you-go basis. It would eliminate the present

system in which the state sells off assets to pay for current consumption. And it would prevent the certain over-use of frequencies.

Dynamic user charges combine the unfettered access of open spectrum with the efficiency and conservation benefits of property rights. But they are not the pure solution envisioned by each camp, and are thus rejected by both. Property rights advocates want a system that is closed like privately held land, and not free of charge; open access advocates want the opposite, access that is free in both senses of the word.

New technology is creating the tools for a new spectrum system. A non-exclusive sharing of frequencies becomes possible. And in such an environment, the role of government as the exclusive licensor becomes not only inefficient economically and technically but also restrictive of information-age liberties. The spectrum is not the governments to sell, no more than the colour green, the note C flat or the right to raise ones voice. All are part of the same frequency rainbow. Nor is the government the trustee of some ill-defined public airwaves. Rather, its role is to act as traffic cop and prevent the collision of users. In the past, the state of separation technology required frequency exclusivity. But if a more advanced technology coupled with a pricing mechanism can keep users apart, then the authority of the state to create intrusive mechanisms is much diminished.

It is unfortunate that governments are hurriedly selling off chunks of spectrum just as the concept of spectrum exclusivity becomes anachronistic. Spectrum should be free to access but not free of charge.

\* "Taking the Next Step Beyond Spectrum Auctions: Open Spectrum Access," IEEE Communications Magazine, (December 1995), pp. 66-73.  
[http://www.citi.columbia.edu/elinoam/articles/beyond\\_auctions.htm](http://www.citi.columbia.edu/elinoam/articles/beyond_auctions.htm)

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