

Micro Economics



The Revolution in Spectrum Allocation

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.....Some aspects of the wireless telephone revolution are obvious. Long elevator rides no longer involve the car's inhabitants awkwardly staring at the floor numbers over the door. Today everyone looks down at their phones, texts a friend, reads their email, or twitters.

At the end of 2007 (the latest data) the US Federal Communications Commission estimates there were 263 million wireless subscribers (almost 2.3 subscriptions per household in the US). Subscribers used an average of 769 minutes per month, generating US\$0.06 average revenue per minute for all traffic (\$0.05 for voice traffic). The FCC also estimates that 14.5 percent of US households received their primary service exclusively through a wireless phone.

A related revolution has largely gone unnoticed. Since 1994, the US has assigned spectrum for mobile telephony through auctions instead of the traditional regulatory mechanisms. The transition from analog to digital television freed up additional spectrum, giving the FCC the opportunity to set up an auction in the 700-MHz range. That spectrum auction ended in March 2008. The spectrum will go into use in June 2009, after analog television retires.

An inauspicious start

In 1982, the FCC began issuing licenses for cellular telephony. It took a big step toward spectrum auctions by initially taking a step backward.

At first, the FCC decided to issue one license to the local incumbent fixed-line telephone company—that is, the regional Bell operating company or another local incumbent such as GTE (which is now part of Verizon). It also decided to issue a second license to a nonwireline provider, awarded on the basis of comparative hearings. That process led to many absurdities in practice. For example, in *Wireless Nation* (Perseus, 2002), James Murray tells how the Los Angeles license was awarded. Two applicants could not agree, so they had a hearing, and it went to a judge. The winning applicant had included 24 cell sites instead of 23, with the additional site on Santa Catalina Island. This made no sense. The island lies 22 miles off the coast of Los Angeles. Vacationers and sailors far outnumber the island's permanent population of several thousand people. Why should coverage of such a small area matter to Los Angeles?

The comparative hearing process's delays, expense, and arbitrariness led the FCC to introduce lotteries for cellular licenses. This also became a debacle. The technical barriers to submitting a qualifying application were low. For example, many applicants used exactly the same technical proposal, changing only the name on the cover. As a result, the number of applications grew from six per market for the top 30 (and most valuable) markets to almost 600 per market for some markets.

Most applicants never wanted to operate systems at all; they wanted to win a cash lottery. Winners won the right to sell their interest for a large profit to the highest bidder. In time, interested operators bought the licenses and consolidated them, but only after going through a time-consuming and inefficient series of negotiations.

That embarrassing and potent example of how not to allocate spectrum convinced many in Congress to try an alternative: auction off spectrum rights, as with any other asset in fixed supply, such as land. After many hearings, Congress passed the Omnibus Budget Reconciliation Act of 1993 (OBRA 93), which gave the FCC the relevant authority.

Market structure

The first spectrum auctions, held in 1994, were a stunning success. Some controversy accompanied this success, however. For example, the FCC tilted the auction in favor of new firms. Auction rules guaranteed that there would be room for at least five providers, with 30 MHz of spectrum in every geographic area of the country. The FCC also excluded the two existing incumbents from the bidding, virtually guaranteeing the presence of three new firms in every urban area.

The 1994 rules led to another novel policy experiment. The FCC let private firms decide which areas to cover. As a result, many low-density areas did not

receive service from all five providers because in most cases having all firms serving every small town and highway did not make business sense. So, for a long time, many isolated locations did not have competitive supply. As of 2007, that spottiness is largely gone. According to the 2007 data, approximately 95 percent of the US population lives in census blocks with three or more providers, and approximately 60 percent lives in blocks with five. Approximately three quarters of the US land area is covered by one or more providers.

The recent 700 MHz auction included no provisions favoring new bidders. Indeed, that auction's two major winners were the two largest wireless incumbents: Verizon and AT&T. Verizon won its position by outbidding Google for one large national block of the 700-MHz spectrum, whereas AT&T outbid many rivals in numerous locations for other blocks. Offsetting this domination by large incumbents to some extent, in many areas at least one block of licenses went to a rural telephone company, smaller entrant, or new bidder.

Today there are four major national wireless telephone providers: AT&T, Verizon, Sprint/Nextel, and T-Mobile. There are also smaller regional providers such as MetroPCS, Leap Wireless, and many small rural telephone companies. The latter do not provide service across the country, but rely on roaming agreements to ensure coverage for their customers.

The recent auction also experimented with openness requirements. The FCC mandated four openness provisions for one of the license blocks. It announced that it would impose those requirements only if the sum of the bids on the block exceeded \$4.64 billion. Why that number? The FCC picked it in part because Google's CEO, Eric Schmidt, sent a letter to the commission stating that Google would be willing to pay that amount for the block if its list of openness provisions were made part of the licenses.

As it happened, Google did bid up to that level and triggered the provisions early in the auction. Verizon eventually outbid Google and won the spectrum, open requirements and all.

Interference

Another issue reared its head during the 2008 auction: interference.

There are several ways to deal with interfering signals. One way is to establish a system of quasiproperty rights that assures licensees that they can transmit on a particular frequency in a geographic area. The use of spectrum licensing approximates this system. If two transmitting licensees are separated by frequency, geography, distance, or time, receivers will not hear both signals at the same time.

Another way to deal with interference is to set transmit and receive standards for equipment so it operates under protocols to deal with the interference issues. The FCC essentially did this when it released spectrum for unlicensed use in the 900-MHz, 2.4-GHz, and 5.3-GHz bands, which are used for garage door openers and WiFi systems. Reduced power requirements have reduced the contention for spectrum. Local participants work out interference for themselves if it arises.

The so-called "white spaces" debate introduced a new snag in dealing with interference. White spaces are bits of spectrum between television channels—buffers to prevent interference. With the retirement of analog television, these white spaces no longer need to be empty.

Or so it seemed.

As it turned out, during the analog television era, several wireless microphone manufacturers used white spaces for their products. Users of these products are all across the US—in sports leagues, Broadway shows, megachurches, and at rock concerts. In many of these uses, the equipment has low tolerance for interference.

Manufacturers could easily alter their equipment designs to accommodate new FCC rules for white spaces, but then users would have had to spend money on new equipment, not to mention testing it and refining it until it worked perfectly. These users (which included entertainers such as Dolly Parton and the Dixie Chicks and the National Football League) formed a formidable coalition of reluctant investors. They organized and lobbied. The debate took a surprising twist when some manufacturers of equipment and potential products for white spaces—Microsoft, Intel, Google, and others—could not agree with the wireless microphone providers about how to detect interference. Amazingly, tests showed that equipment designed to detect interference in real time could not reliably detect interference within white spaces.

In November 2008 the FCC issued orders that let users continue to occupy some of the white spaces, while signaling a transition away from other white spaces. Some issues in this decision remain unsettled, and many FCC watchers expect the new administration to take the issue up again. I am not sure how it will end.

What to make of all this sturm and drang? Seen in a broader context, the white space issues are just another bump in a revolutionary road. In 15 years, the FCC has raised about \$50 billion from auctioning spectrum, including \$19 billion in the 700 MHz auction. Although the mobile revolution has received the headlines, changes in spectrum assignment were also revolutionary, reducing allocation delays and ultimately helping to build out new services.

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