



Wireless Spectrum for Dummies

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Spectrum

THE ELECTROMAGNETIC SPECTRUM HAS been around for as long as the universe, but from all the attention heaped on it recently, you'd think it had just surfaced yesterday. New digital and wireless technologies—from cell phones to satellites to high-definition television—are dramatically changing how we use the airwaves and presenting enormous new

business opportunities. The U.S. government and the Federal Communications Commission have responded by reallocating huge swaths of spectrum for new uses and auctioning slices to the highest bidders for prices expected to reach well into the billions.

The future of many giant communications companies rests on the outcome of those auctions. It's tricky business and complex science. Here's a primer.

Major Commercial Wireless Services*

Broadcast TV

Channels 2-4 (VHF) **54 to 72 MHz**
 Channels 5-6 (VHF) **76 to 88 MHz**
 Channels 7-13 (VHF) **174 to 216 MHz**
 Channels 14-20 (UHF) **470 to 512 MHz**
 Channels 21-36 (UHF) **512 to 608 MHz**
 Channels 38-69 (UHF) **614 to 806 MHz**
 See also 3G Broadband Wireless below

3G Broadband Wireless

746 to 764 MHz; 776 to 794 MHz
 To be used for "third-generation" advanced wireless services. Now houses TV channels 60-69 but is scheduled for auction in March 2001. 3G services may not launch for years, though, because broadcasters don't have to leave the band until 2006 at the earliest.

3G Broadband Wireless (proposed)

1,710 to 1,855 MHz
2,500 to 2,690 MHz
 The Clinton administration has proposed auctioning this spectrum for 3G broadband wireless services.

Wireless Communications Service (WCS)

2,305 to 2,320 MHz; 2,345 to 2,360 MHz
 Intended for wireless data services; proximity to the satellite radio band could make it a good addition to digital radio services in the future.

Direct Broadcast Satellite (DBS)

12.2 to 12.7 GHz
 EchoStar and DirecTV now dominate this fast-growing business, offering hundreds of TV channels via satellite. They have become major competitors to cable TV companies. Both DBS firms are adding interactivity using wire-line and satellite back channels.

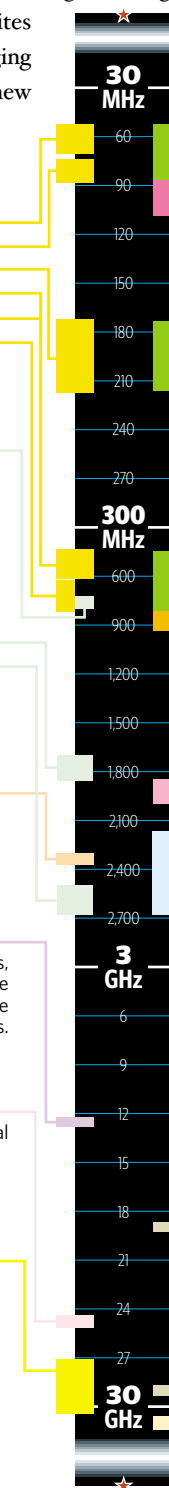
Digital Electronic Message Service (DEMS)

24.25 to 24.45 GHz; 25.05 to 25.25 GHz
 This high-capacity allocation carries a lot of data but the signal can't travel far. Teligent owns most of the licenses and offers broadband data services to businesses in dense, urban areas.

Local Multipoint Distribution Service (LMDS)

27.5 to 29.5 GHz; 31.0 to 31.3 GHz
 XO Communications (the merger of NextLink and Concentric), a venture founded by Craig McCaw, dominates this band, with 95 percent coverage in the top 30 markets. Winstar also holds some licenses here. Both are building fixed wireless systems.

*This diagram shows only a select number of U.S. commercial services. Not represented are hundreds of more minor commercial and noncommercial services. The government is the single largest user of U.S. airwaves. It runs services ranging from law enforcement radio to satellite space research and top-secret military communications.



★ The radio spectrum starts at 3 KHz

AM/FM Radio

535 to 1,605 KHz
88 to 108 MHz

Digital TV

54 to 88 MHz
174 to 216 MHz
470 to 806 MHz

Broadcasters have started transmitting digital signals, but rollout is slow due to sluggish sales of digital TV sets and reluctance by cable operators to carry HDTV. By 2006, all broadcasters are expected to switch over to digital TV, although that deadline may not hold. Broadcasters' analog spectrum will be reaucted for new wireless services.

Cellular Phone Service

806 to 902 MHz
 Waning in popularity as PCS takes off.

Personal Communications Service (PCS)

1,850 to 1,990 MHz
 This band is used for digital cellular phone service. Considered a 2G (second-generation) cellular service. Dominated by big carriers such as AT&T, Cingular Wireless (a joint venture of SBC and BellSouth), and Sprint.

Satellite-Delivered Digital Radio

2,320 to 2,325 MHz
 Sirius Satellite Radio and XM Satellite Radio paid a combined \$173.2 million for licenses in 1997. They plan to launch services in spring 2001.

Multichannel Multipoint Distribution Service (MMDS)

2,150 to 2,680 MHz
 Sprint and WorldCom bought several of the failing "wireless cable" companies with MMDS spectrum and are converting them from TV service to two-way digital data services.

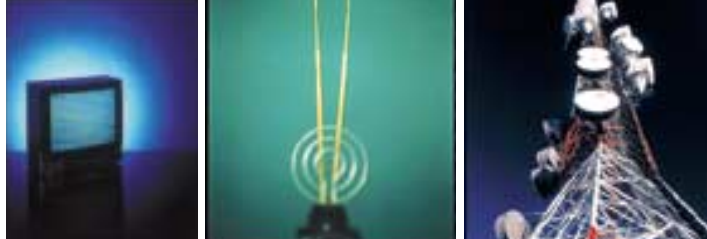
Teledesic

18.8 to 19.3 GHz
28.6 to 29.1 GHz
 Teledesic, the two-way digital satellite service scheduled for full deployment by 2005, plans to use the 18-GHz band for downstream transmissions and the 28-GHz band for upstream. Teledesic's investors include wireless pioneer Craig McCaw, Bill Gates, and Saudi prince Al-Waleed bin Talal.

39 GHz Fixed Wireless Service

38.6 GHz to 40 GHz
 Winstar was the top bidder at the May auction of this spectrum, paying \$161 million for 931 licenses. It plans to offer fixed wireless services in combination with its LMDS capacity at 28 GHz.

The radio spectrum ends at 300 GHz



Spectrum—What Is It?

Spectrum is the range of electromagnetic radiation, from the highest frequency to the lowest. It encompasses everything from X-rays and gamma rays to visible light and radio waves. The part of the spectrum used for cell phones, broadcasting, satellite, and other wireless communications falls in the range of fairly low radio frequencies—from 3 KHz up to about 300 GHz. Most of the major commercial activity takes place from 30 MHz to 30 GHz. Higher than 300 GHz, you hit infrared, visible light, ultraviolet light, X-rays, and gamma rays.



Coming Soon: 3G Broadband Wireless

3G, or third generation, describes upcoming broadband wireless services, which could include everything from high-speed mobile Internet access to, perhaps someday, wireless videoconferencing. It's uncertain when 3G services will launch in the United States—but no sooner than 2002. After months of confusion over what parts of the spectrum would be made available for 3G, the Clinton administration in October proposed freeing up blocks (1,710 to 1,885 MHz and 2,500 to 2,690 MHz) for the auctions. Why the presidential push? Well, the United States lags far behind Europe and Asia in the race to 3G. Japan is in the lead; its 3G services are expected to launch by May. Germany and the United Kingdom will follow in 2002. Those German and U.K. licenses, by the way, sold for \$45 billion and \$33 billion, respectively. That's more than the United States has collected so far on all of its auctions combined.

Spectrum Caps

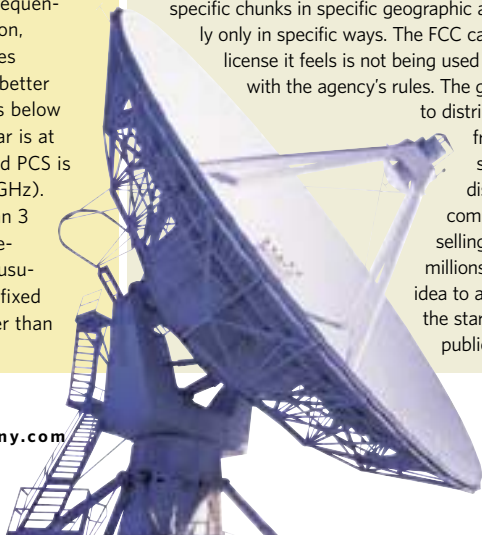
The government limits companies to 45 MHz of mobile wireless spectrum capacity in any market (55 MHz in some rural areas). That means that in any single locality, one wireless carrier could own, say, a 30-MHz slot and a 15-MHz slot, or three 15-MHz slots. The cap applies market-to-market (the FCC divides markets into basic trading areas, or BTAs), so a carrier could license different amounts of spectrum in



each market but never more than 45 MHz in any one place. The government instituted caps to discourage local wireless monopolies. After years of building up their systems, of course, most of the major players are close to the statutory limit. Carriers are pressuring the FCC and Congress to abolish the caps. They claim that the current cap, which was created when less spectrum was available for commercial services, is outdated.

Who Owns the Airwaves?

Technically, U.S. airwaves are a publicly owned natural resource. In practice, they are controlled by the federal government. The FCC grants licenses for companies to use specific chunks in specific geographic areas, and usually only in specific ways. The FCC can revoke a license it feels is not being used in accordance with the agency's rules. The government used to distribute licenses for free in a lottery system but then discovered that companies were later selling the licenses for millions—hence, the idea to auction them at the start to benefit the public trough.



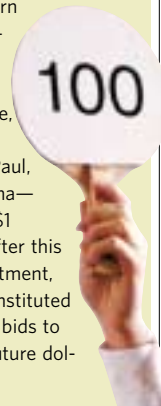
Auctions

In 1993, Congress authorized the FCC to sell parts of the radio spectrum at auction. As of October, those auctions had raised about \$25 billion.

RECORD BIDS

Highest: A license in New York City garnered the highest all-time bid—\$994 million, during the frenzied 1995-96 auction of the digital wireless PCS spectrum. However, the winner, NextWave Telecom, ended up defaulting on its bid. The spectrum is slated for re-auction on Dec. 12.

Lowest: Not every auction is a billion-dollar windfall for the U.S. Treasury. In the 1997 auction of Wireless Communications Service (WCS), licenses in four Midwestern markets—Des Moines, Milwaukee, Minneapolis-St. Paul, and Omaha—went for \$1 apiece. After this disappointment, the feds instituted minimum bids to prevent future dollar days.



AUCTIONS TO WATCH

UNITED STATES

3G BROADBAND WIRELESS (700 MHz)

When: March 6, 2001
Up for grabs: 12 licenses
Expected bidders: Cingular Wireless, Nextel, Qwest, Verizon Wireless

FIXED WIRELESS (4.94 GHz to 4.99 GHz)

When: Unannounced.
 Recently switched from the feds to private-sector use.
FIXED WIRELESS (24.25 to 24.45 GHz; 25.05 to 25.25 GHz)
When: Unannounced.
 Teligent dominates this band, but new players plan to bid aggressively.

FOREIGN

3G BROADBAND WIRELESS

- **Belgium**
When: Early 2001
Up for grabs: 4 licenses
- **Denmark**
When: Mid-2001
Up for grabs: 4 licenses
- **Venezuela**
When: August 2001
Up for grabs: 4 licenses

DIGITAL WIRELESS

- **Brazil**
When: Early 2001, 3 auctions
Up for grabs: 9 licenses
Expected bidders: British Telecom, Deutsche Telekom, Telecom Italia, Telefonica, Vodafone

Top 10 U.S. Mobile Wireless Firms

CARRIER	SUBSCRIBERS (second quarter 2000)
Verizon Wireless	25.6 million
Cingular Wireless*	18 million
AT&T Wireless	12.5 million
Sprint PCS	7.4 million
Nextel Communications	6.2 million
Alltel	5.9 million
VoiceStream Wireless	2.6 million
Western Wireless	930,500
Dobson Communications	800,900
Powertel	727,000
*A joint venture of SBC and BellSouth	

Source: Kelsey Group