"They used to rob trains in the Old West. Now we rob spectrum."
Senator John McCain,
Chairman, Senate Commerce Committee

The citizen's guide to the airwaves

A graphic depiction of the uses –and misuses– of the radio frequency spectrum

Sources and further reading are included in the separate report that accompanies this chart.

"The wireless spectrum belongs to the public, and thus should be made to serve the public."
Senator Ernest Hollings, former Chairman,
Senate Commerce Committee

NEW AMERICA FOUNDATION
SPECTRUM POLICY PROGRAM

The value of the airwaves (vertical scale) **varies with frequency** (horizontal scale)

Potential windfall if the spectrum is privatized ( )

Market value of current use ( )

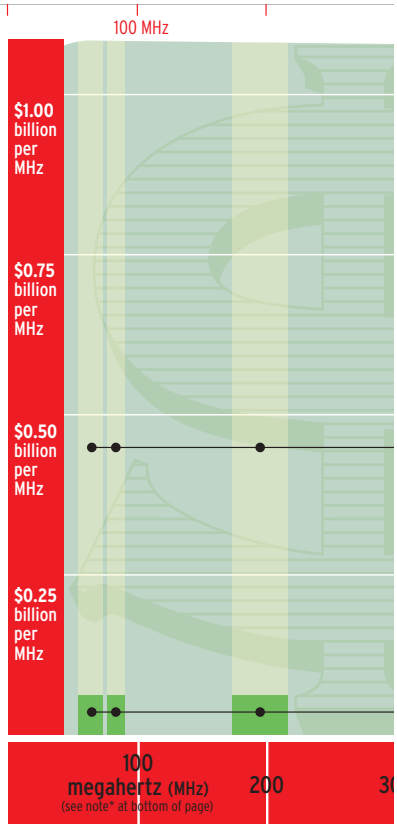
FREQUENCIES

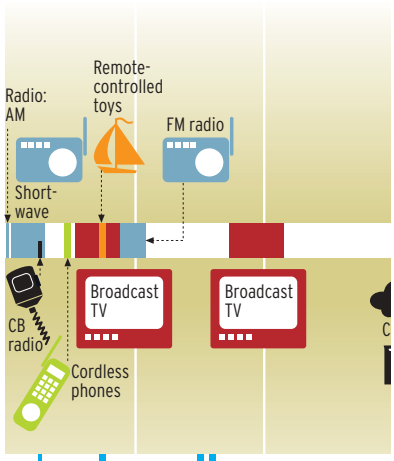
Frequency assignments used by everyday devices

Citizen's access spectrum (unlicensed, amateur, personal radio)

Obstacles frequencies can overcome (propagation characteristics)

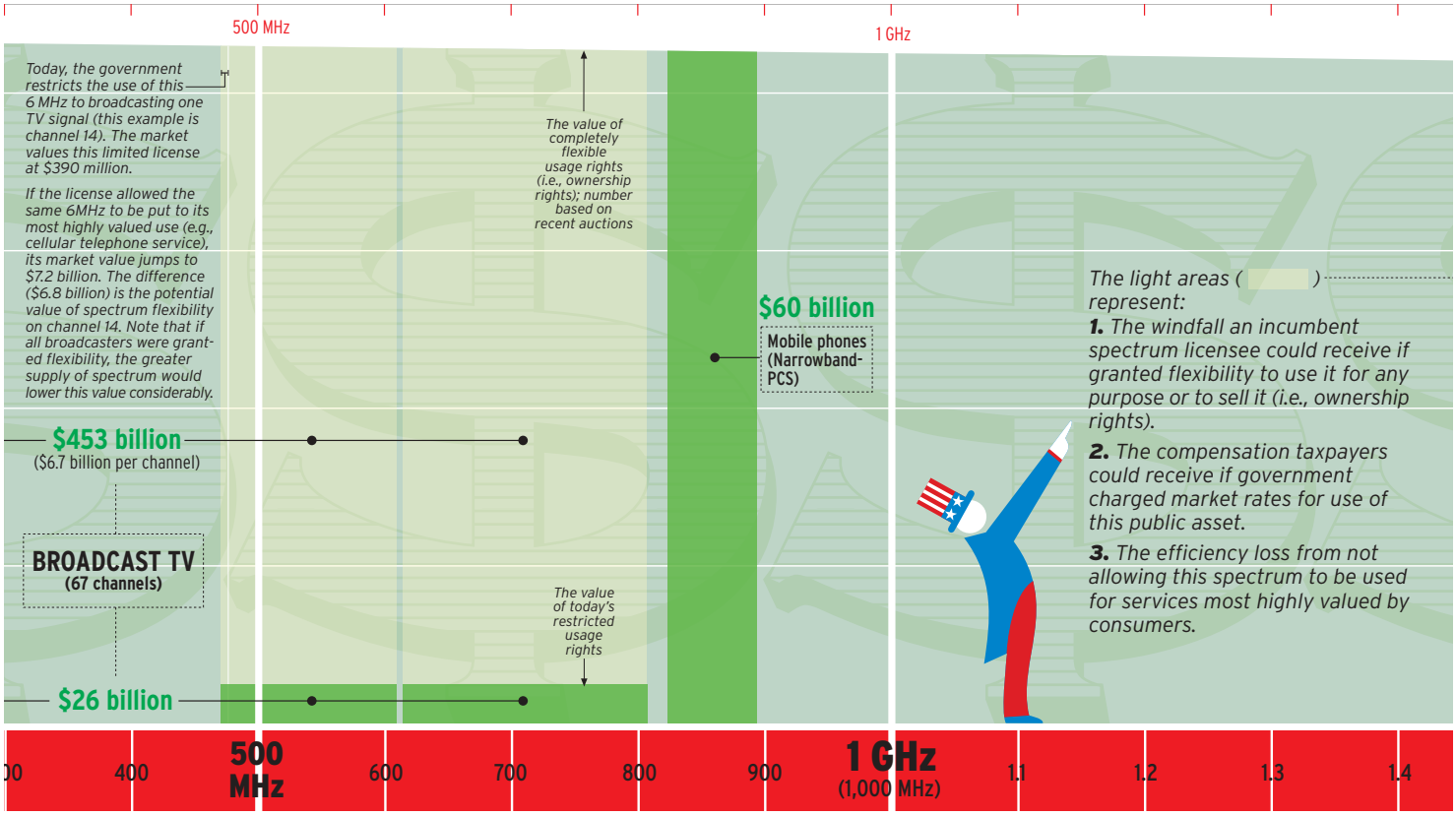
The value of the spectrum if it were thought of as real estate

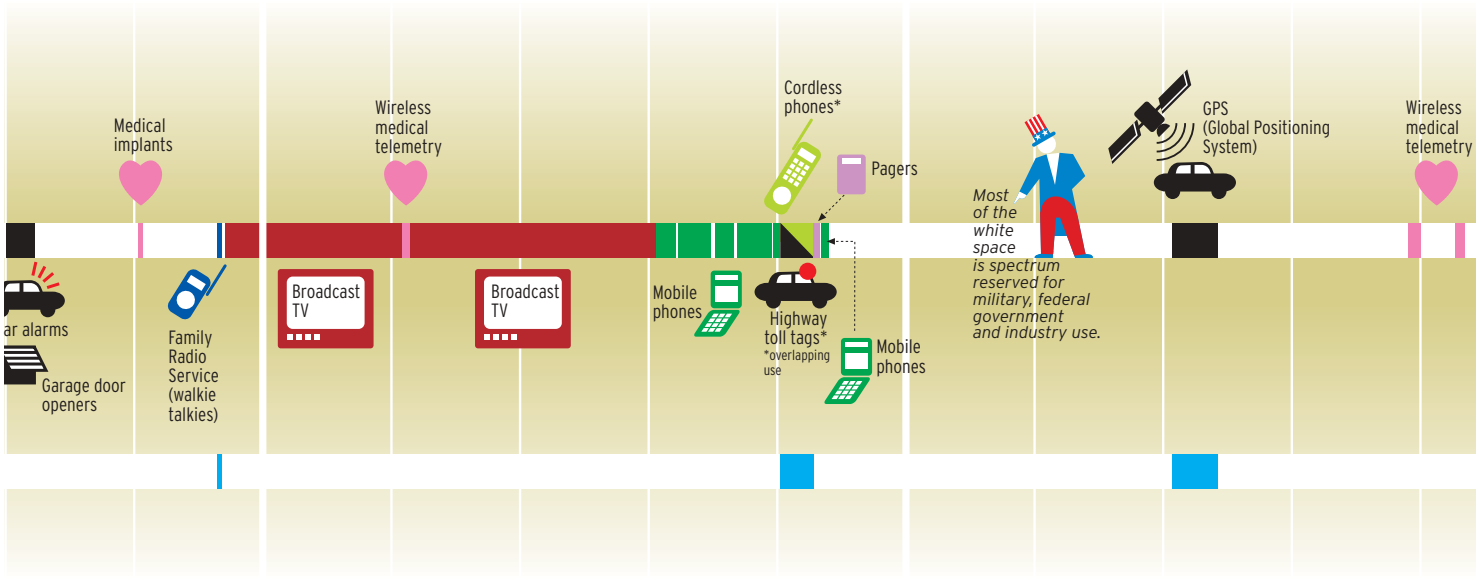




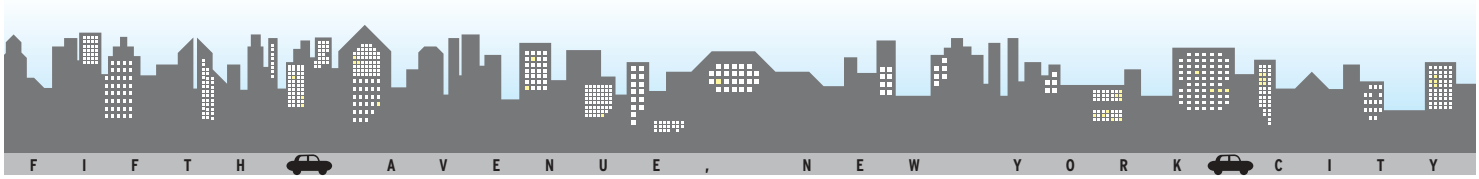
Notes and definitions

* Radio waves are transmitted at different frequencies measured in **hertz (Hz)**. A slice of spectrum contains a band of frequencies. The wider the band, the more information carrying capacity it has. (It has more "bandwidth").





Permeable zone: signals, which carry information, can easily traverse through dense objects such as buildings, mountains, forests, and storms.



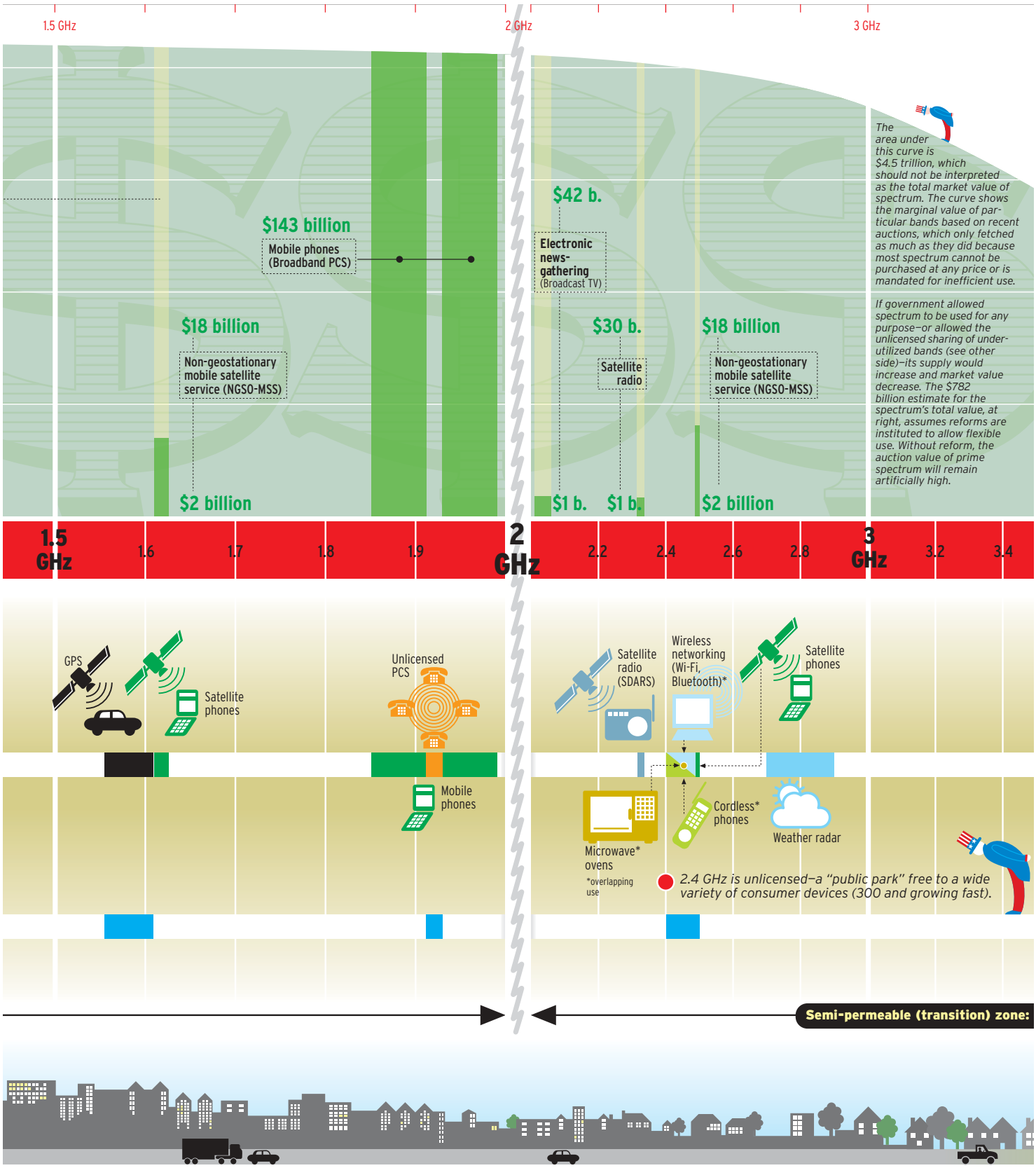
Wireless bandwidth is generally counted in megahertz.

Abbreviations: **kilohertz** (1,000 hertz) is written as **kHz**,
megahertz (1 million hertz) is written as **MHz**, and
gigahertz (1 billion hertz, or 1,000 megahertz) is written as **GHz**.

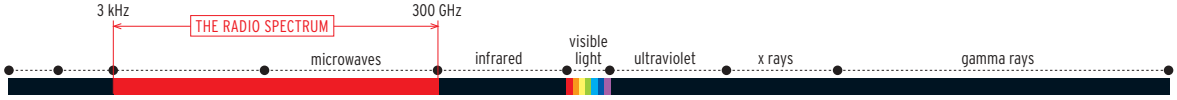
A **wavelength** is the distance between the recurring peaks of a wave.

The **electromagnetic spectrum** has long wavelengths (low frequency) at one end and short wavelengths (high frequency) at the other end.

The size of the wavelength influences the ability of a wave to pass through objects. Generally, as a wavelength decreases in size, its value also decreases.



The **radio spectrum** (enlarged in the charts above) is the portion of the total electromagnetic spectrum distinguished by its value for communication.



In order to emphasize the most valuable parts of the spectrum, this scale gives the lower frequencies disproportionate space.

3kHz — 2GHz — 5GHz — 50GHz — 300 GHz

Using an unadjusted linear scale, the values part of the chart would appear like this:

3kHz — 100 GHz — 200 GHz — 300 GHz

Higher frequencies are less valuable than lower ones because popular consumer services (broadcasting and cell phones) need to penetrate buildings, and this gets harder as you move up the spectrum.

Note: Spectrum valuations, which are notoriously volatile, are as of December 31, 2001.

The spectrum's worth compared to other things

each ■ = $1 billion

"[Spectrum is] the most valuable natural resource of the information age."
William Safire,
New York Times

- Empire State Building $1 billion
- Bill Gates $52.8 billion
- Temporary assistance for needy families (TANF) $24 billion annually
- Government Medicaid spending $147 billion annually
- McDonalds $31.2 billion
- All the gold stored in Fort Knox $45.5 billion

3.6 — 3.8 — 4 GHz — 4.2 — 4.4 — 4.6 — 4.8 — 5 GHz — 10 — 15 — 20 — 25 — 30 — 35 — 40 — 45 — 5(GHz)

Fixed satellite communications (cable TV networks are carried on these bands)

Wi-Fi
Satellite TV
Security alarms
Security alarms
20 GHz
30 GHz
40 GHz
Police speed radar
Police speed radar
Highway toll tags
Driver safety warning

signals have difficulty traversing dense objects.

Long line-of-sight zone: signals cannot traverse dense objects but can be sent long distances through the atmosphere.

The amount of spectrum required for everyday communications

Today, most wireless communication is low fidelity audio. In the future, high fidelity video could require up to 5,000 times as much bandwidth.

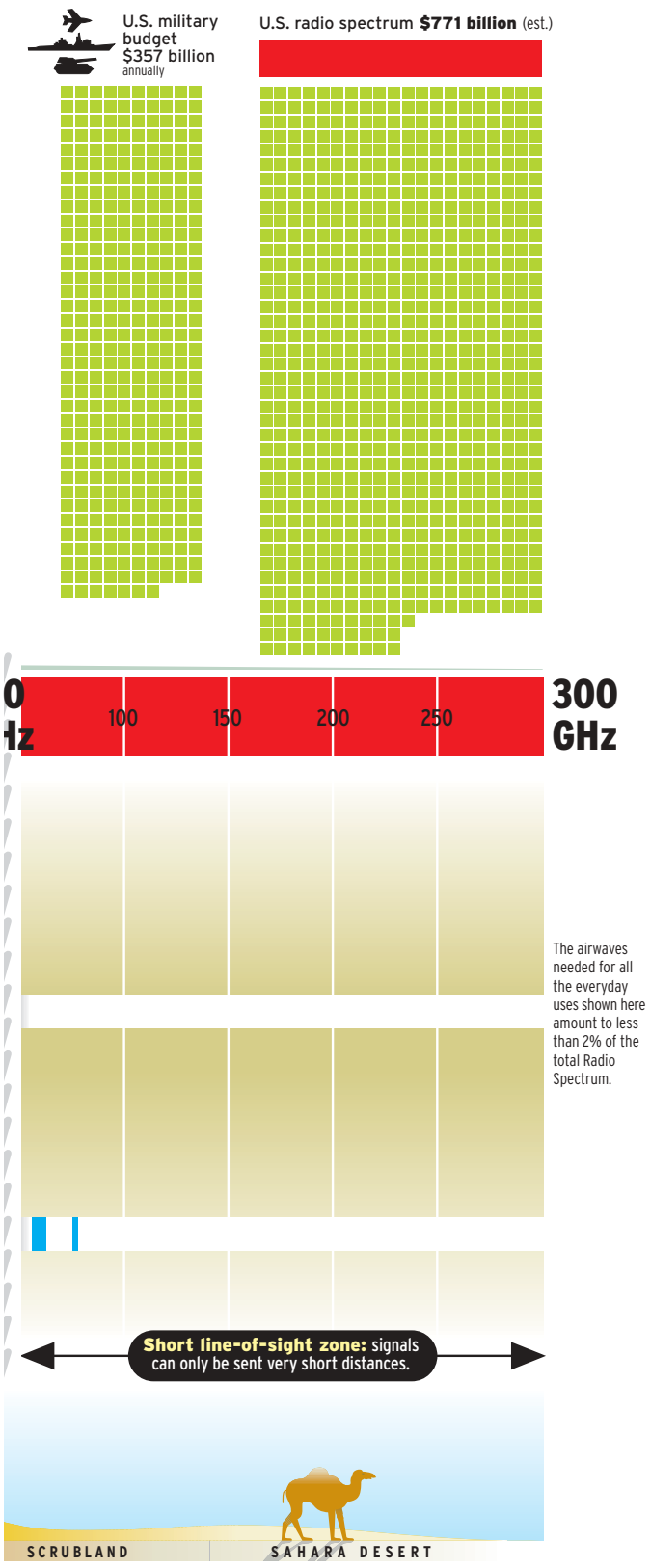
LOW FIDELITY COMMUNICATIONS ↕ HIGH FIDELITY COMMUNICATIONS

APPROXIMATELY

- **10 kHz** ..... **Voice** (e.g., telephone quality)
- **100 kHz** ..... **Music** (e.g., CD quality)
- **1,000 kHz** (=1 MHz)..... **Standard definition TV** (e.g., VCR quality)
- **5,000 kHz** (=5 MHz)..... **High definition TV** (e.g., movie theater quality)
- **50,000 kHz** (=50 MHz)..... **Super high definition TV*** (e.g., glossy magazine quality)

*Super high definition video in 3D or holography would require additional bandwidth.

"The basic problem is that demand for spectrum is outstripping the supply."
U.S. General Accounting Office Report, September 2002



The airwaves needed for all the everyday uses shown here amount to less than 2% of the total Radio Spectrum.

"[The spectrum allocation] system is inefficient, unresponsive to consumer demand, and a huge barrier to entry for new technologies anxious to compete in the marketplace."
Thomas Hazlett, Former Chief Economist, FCC

The spectrum's **worth** compared to other things

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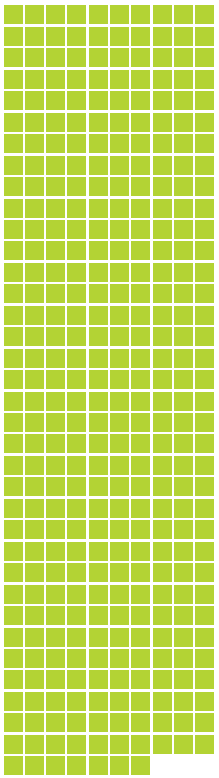
Bill Gates
$52.8 billion

Government Medicaid spending
$147 billion
annually

U.S. military budget
$357 billion
annually



U.S. radio spectrum **$771 billion** (est.)