The citizen's guide to the airwaves

Each economic era has had a resource that drove wealth creation. In the agricultural era it was **land**; in the industrial era it was **energy**; and now, in the information age, it is **spectrum**, popularly known as the "airwaves."

This **citizen's guide** explains salient spectrum policy issues and emphasizes these important points:

1. **The public airwaves are immensely valuable.**
2. **Government uses and licenses spectrum with gross inefficiency.**
3. **The government is granting free, exclusive licenses to prime frequencies in what is perhaps the largest corporate welfare giveaway in U.S. history.**
4. **Opening more of the spectrum to unlicensed sharing by individual citizens can reduce spectrum scarcity and promote high-speed Internet access.**

"The bottom line is that spectrum is just as much a national resource as our Nation's forests. That means it belongs to every American equally. No more, no less. If someone wants to use our resources, then we should be fairly compensated." –Senator Bob Dole

The government's confusing 'Official Chart of Frequency Allocations' disenfranchises the public from the spectrum policy debate.

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Who owns the airwaves?

The Communications Act of 1934 states:

"It is the purpose of this Act, among other things, to maintain the control of the United States over all the channels of interstate and foreign radio transmission; and **to provide for the use of such channels, but not the ownership thereof, by persons for limited periods of time,** under licenses granted by Federal authority, and **no such license shall be construed to create any right, beyond the terms, conditions, and periods of the license."** –THE COMMUNICATIONS ACT OF 1934 TITLE III, SECTION 301

Number of times the government has terminated an industry's spectrum allocation without compensation..... **0**

Who manages **access** to the airwaves?

CONGRESS

Role of Congress Our elected representatives (Congress and the President) are responsible for setting spectrum management policy and overseeing the FCC and NTIA. By amending the Communications Act, Congress sets basic policies such as whether spectrum licenses are auctioned or given away free to private companies.

"It's like giving Yellowstone National Park to timber companies." William Safire, *New York Times*

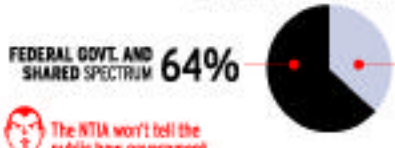
FEDERAL COMMUNICATIONS COMMISSION

Role of the FCC An independent regulatory agency, the FCC manages all frequencies not reserved for military and other federal government purposes. For 75 years the FCC has regulated the airwaves in two key respects: it *allocates* frequencies for specific purposes (radio, TV, cell phones) and then *assigns* licenses to particular companies and other users (by regulatory fiat and at no charge prior to 1994, more recently by auction). Remarkably, the FCC does not measure the utilization of the spectrum it licenses.

NATIONAL TELECOMMUNICATIONS AND INFORMATION ADMINISTRATION

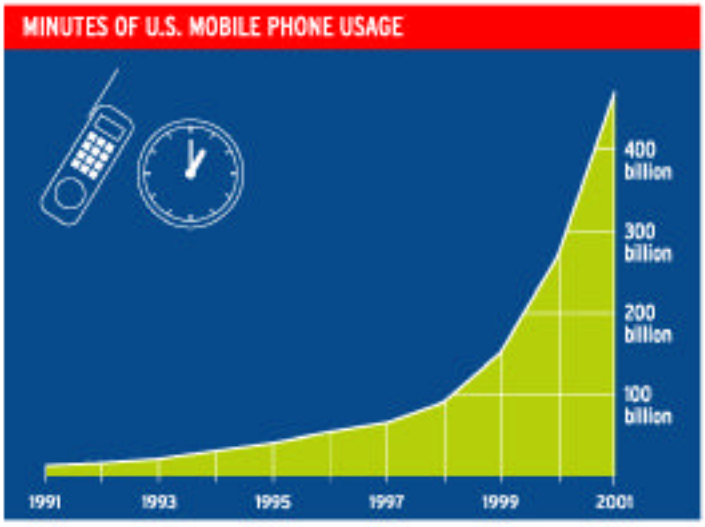
Role of the NTIA An agency of the U.S. Commerce Department, NTIA manages large tracts of spectrum reserved for military and other federal users. NTIA faces virtually no public oversight and keeps the use of particular frequencies secret, on grounds of national security. For example the NTIA won't say what frequencies the Department of the Interior uses for fear that, through a process of elimination, enemies could figure out which frequencies the CIA uses.

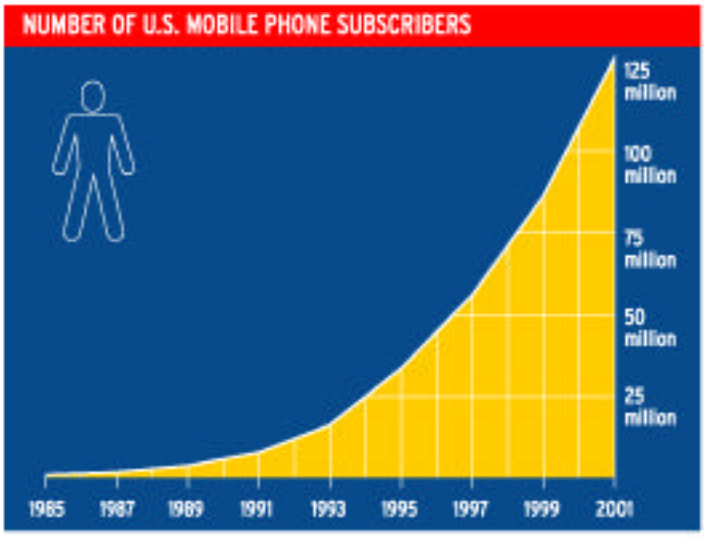
SPECTRUM ALLOCATIONS **UNDER 3.1 GHz**



The NTIA won't tell the public how government bands are used.

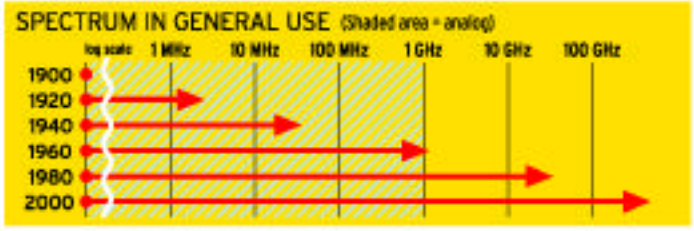
Demand for spectrum is surging





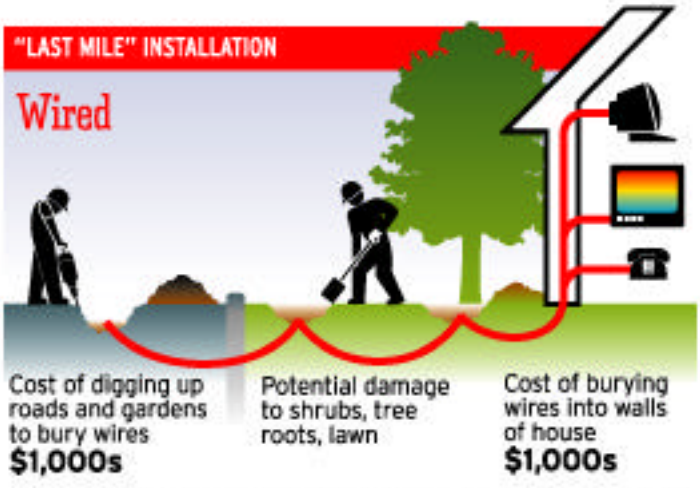
Have we reached the **spectrum frontier?**

As Americans needed more space, pioneers tore down trees and pushed West. Eventually, however, the frontier was settled and existing lands had to be used more efficiently. Today, we are in a similar situation with spectrum: the 'beachfront' spectrum that passes easily through walls, trees and weather has already been allocated, so we need to use it more efficiently.

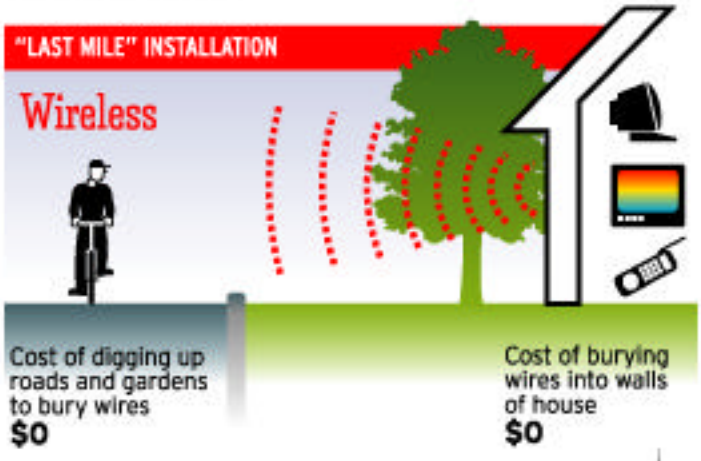


New digital technologies foster efficient spectrum use. Allowing early allocations to remain analog is like letting downtown waterfront property deteriorate into a slum, while forcing new homes and businesses to be built in the landlocked suburbs.

The advantages of **wireless vs. wired** communications



The current wired last mile cannot provide high fidelity (e.g., HDTV quality) Internet service. Hence a high fidelity wired last mile would require the costly excavation of roads, lawns, and walls.

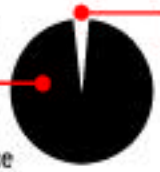


Where has **U.S. telecommunications policy** failed?

The rate of innovation in the telecommunications backbone far exceeds the rate of innovation in the "last mile." As a result, last mile connections are characterized by high prices and slow speeds. A single strand of fiber optic cable carries tens of billions of bits/second, but residential Internet connections over copper phone or cable wires rarely exceed 1 million bits/second downstream and 100 thousand bits/second upstream. A major cause of this last mile problem is the government's failure to manage spectrum efficiently. For example, more than 90% or more of the most valuable spectrum lies fallow at any given time. This spectrum could be used to provide affordable, high-speed Internet access from neighborhood or curbside fiber access points to nearby homes and small businesses.

Licensed and unlicensed spectrum: what's the difference?

On **licensed bands** (>98% of assigned spectrum) a user is given **exclusive** rights to use a frequency either to provide a consumer service (e.g., broadcasting) or as an input to production (e.g., freight trains).



On **unlicensed bands** (<2%) any individual or company can use frequencies, but on a **shared** basis and with no guarantee against interference.

SOME DEVICES OPERATING ON LICENSED FREQUENCIES TODAY...

3G & 4G Third (3G) and Fourth (4G) generation cellular systems upgrade existing mobile telephone networks to make more efficient use of spectrum and offer higher speed Internet service.

... AND SOME DEVICES OPERATING ON UNLICENSED BANDS

Whereas licenses grant exclusive rights to wireless service providers, unlicensed spectrum is shared, allowing a virtually unlimited number of consumer devices to use the band at no charge. Unlicensed spectrum is managed like a public highway: as long as citizens obey the "rules of the road," access is open, free and shared.

Wi-Fi (Wireless Fidelity) uses **unlicensed** frequencies to create wireless local area networks (WLANS). College campuses, airports and other "hot spots" share high-speed Internet connections with many users on a wireless basis.

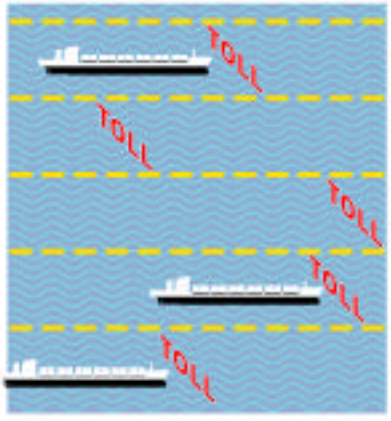
The lack of licensing procedure ensures...

- ...that wireless network deployment can be rapid and inexpensive, making mass market systems affordable.
- ...that there is freedom from content constraints. Like the unfiltered communication of the Internet, information can be disseminated freely, available to all and without restriction.

Although the FCC has restricted unlicensed consumer devices to a tiny portion of the useable spectrum, the explosive growth of Wi-Fi and other wireless networking technologies led the FCC's Spectrum Policy Task Force in 2002 to recommend expanded unlicensed allocations and band sharing in the future.

In addition to the well-known uses of unlicensed spectrum shown here, there are also industrial uses, such as hospitals that link patients to external monitoring equipment and retail stores using unlicensed spectrum to track inventory.

Open spectrum: an unlicensed commons



Like the atmosphere and oceans, in every nation, spectrum is a natural system owned equally by every citizen. Yet the FCC's approach to licensing the airwaves is like dividing the ocean into shipping lanes, selling exclusive licenses to those lanes, and allowing licensees to impose toll charges on individual ships that need to cross.

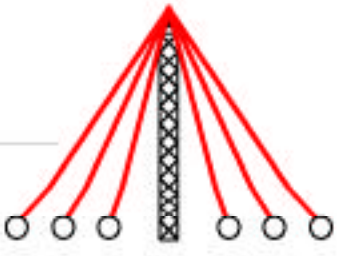
The oceans and other navigable waterways are "commons"– meaning acccess is open and shared, provided individuals use appropriate equipment and observe basic rules of etiquette. As with waterways and public highways, **Open Spectrum** would allow consumers using "smart radio" technology to dynamically share not only designated bands of unlicensed spectrum, but also underutilized spectrum within licensed bands (such as empty frequencies between television stations), subject to rules against harmful interference.

"The unlicensed bands employ a commons model and have enjoyed tremendous success as hotbeds of innovation."
FCC Chairman Michael Powell

CELLULAR SYSTEMS VS. WI-FI VS. OPEN SPECTRUM

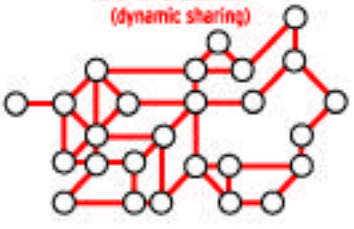
The engineers and Internet pioneers who advocate Open Spectrum argue that sharing can greatly increase efficient spectrum use. Whereas cellular systems widely disperse towers, thus limiting frequency re-use, unlicensed networking devices (both Wi-Fi and meshed networks) transmit at low power over short distances. In the future, meshed networks of software-defined ("smart") radios will be, in turn, far more efficient than Wi-Fi. First, they can be programmed to utilize the "white space" in underutilized bands across large ranges of both licensed and unlicensed frequencies; second, wireless networks can be configured like the Internet, with additional users actually adding capacity by passing along (repeating) messages to and from nearby users.

● LICENSED CELLULAR SYSTEMS



● "COFFEE SHOP" WI-FI (wireless Internet access)

● OPEN SPECTRUM (dynamic sharing)



What is **smart radio?**

Smart radio is software defined. A single smart radio has the flexibility to provide all the wireless services of hundreds of dumb radios, including FM radio, broadcast television, cellular telephone, cordless phone and remote control.

TIMELINE OF INNOVATIONS

Dates indicate approximate commercial use

- 1900 — Radio Morse Code (telegraphy)
- 1920s — AM radio
- 1930s — Television
- 1940s — FM radio
- 1950s — Color television
- 1960s — Radio dispatch
- 1970s — Citizens Band radio (CB)
- 1980s — Mobile telephones
- 1990s — Satellite TV, global positioning systems
- 2000s — Wi-Fi (wireless Internet)
- Future — Smart radio

Economic Advantages of Smart Radio

Smart radios can create an "open network" and allow the dynamic sharing of frequencies. Consumers and vendors can easily switch frequencies, thus diminishing the monopoly power of license holders. They can also spread their equipment costs across many services and frequency bands, thus reducing the total cost of spectrum equipment.

Policy Implications of Smart Radio

Smart radio fundamentally changes the economics of licensing. Today, there are substantial efficiences gained from granting long-term licenses of as much as a decade or more. This is because license holders need to recoup substantial investments in specialized (i.e., dumb) spectrum equipment. In the future, if both transmitters and receivers can easily be reprogrammed to use a variety of frequencies, the efficient term of a license may drop to microseconds.

Politics of Smart Radio

Incumbent license holders will strongly oppose any use of smart radio that reduces their monopoly power over both consumers and vendors—or that undermines their rationale for long-term licenses with property rights.

The U.S. military has invested substantial sums in smart radio so that personnel can go anywhere in the world and communicate over any frequency.

Is spectrum used **efficiently?**

TELEVISION EFFICIENCY

TV broadcasters are allocated 402 MHz of consumer spectrum.

Analog broadcasts produce **.03** channels per MHz...

...but after digital TV transition, broadcasters can get **.18** channels per MHz.

So, if broadcasters used efficient digital technology, they could transmit the same number of channels using far less spectrum space, **meaning that they could give back hundreds of MHz of their allocated 402 MHz while still providing the same service.**

Meanwhile, **digital satellite TV,** (which uses the far less valuable higher frequencies) gets up to **.43** channels per MHz. With 900 MHz to use, this allows as many as 384 TV channels.

RADIO EFFICIENCY

FM radio broadcasters are allocated 20 MHz of spectrum.

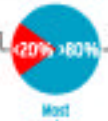
Satellite radio broadcasters have 25 MHz.

"[Spectrum] sits paralyzed, consigned to uses that time and technology have long since passed by. Old technologies are swamped with excess airwaves they don't use; newer technologies grasp for airwaves they desperately need, and promising industries of the future are asphyxiated."

Forbes Magazine Cover story, November 2002

Retail and **industrial** spectrum: what's the difference?

Retail spectrum
Outputs of production—spectrum used to deliver consumer services, such as mobile telephone service.

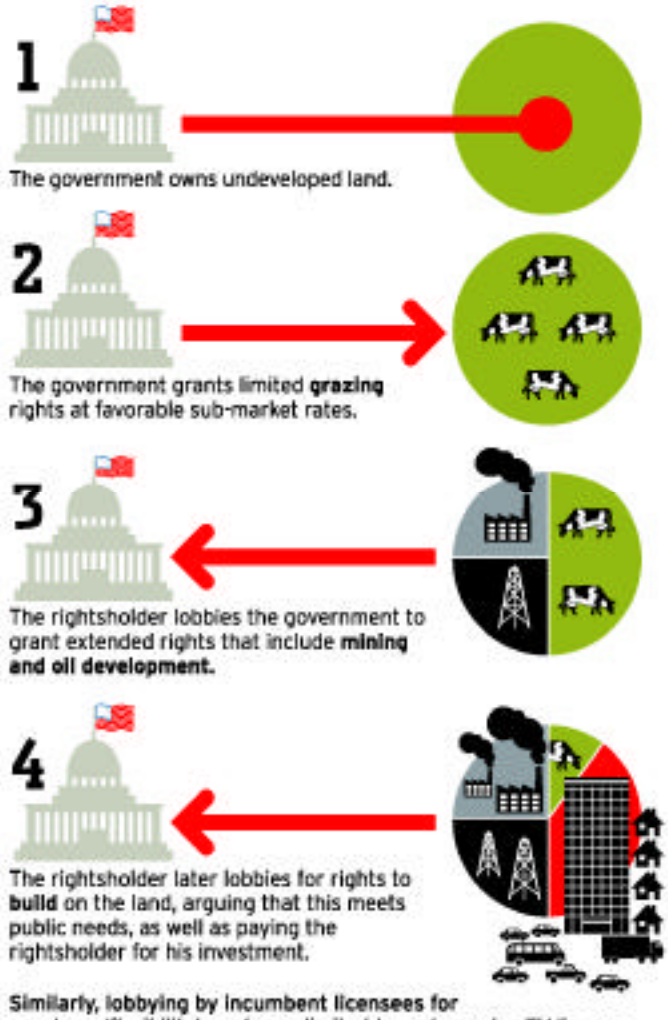


Industrial spectrum
Inputs of production—spectrum used for the internal use of corporations, such as connecting a TV field crew to a TV station. Giving industrial users free spectrum is like giving them a tax break or an explicit subsidy for the energy they need to produce a consumer product.

SOME SPECTRUM ALLOCATIONS COMPARED

The **politics** of spectrum

To help understand **how spectrum lobbying works,** here's an analogy with federal land grants:



Similarly, lobbying by incumbent licensees for spectrum 'flexibility' can turn a limited-term, low-value TV license into a permanent and far more valuable mobile Internet service.

Actual vs. potential market values

Under the FCC's 75-year-old zoning–and giveaway–allocation process, most licenses specify the service that must be operated at that frequency. Most licensees do not have the flexibility to change the service provided, or to sell or sublease the license, without permission. This is analogous to a vendor who obtains a license to operate a hot dog stand in New York's Central Park. The right to sell hot dogs is a lot less valuable than the right to operate a retail store in the same area.

Similarly, a license to operate a TV station is much less valuable than a license to provide cell phone or wireless Internet services on the same spectrum–licenses that have sold at auction for billions of dollars. As a result, broadcasters and some other incumbent licensees are lobbying for spectrum "flexibility"–new, more valuable license rights that they could even sell or sublease to other companies. Cell phone companies that paid billions at auction for spectrum licenses are among those arguing that such enhanced license rights should be auctioned, not given away.