XCNETWORKS

SPECTRUM
THE VERTICAL LAND RUSH OF THE 21ST CENTURY

BY THOMAS J. SPACKMAN

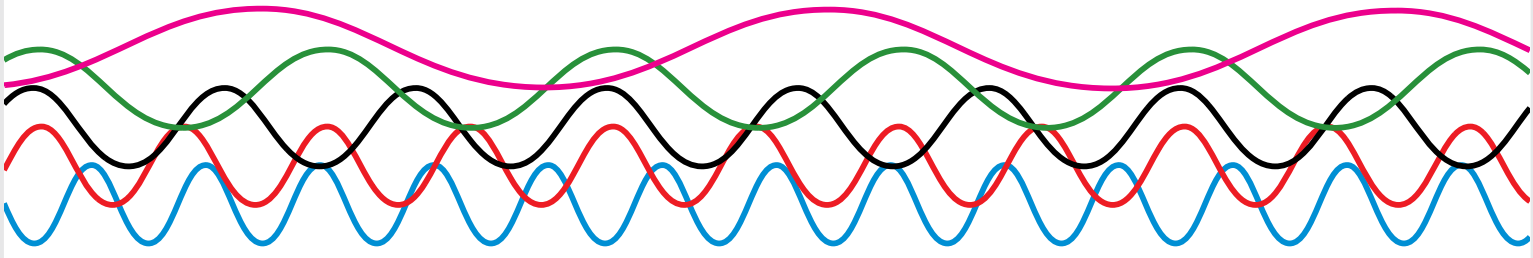
Just as the beginning of the 20th century saw a rush for land, the beginning of the 21st is seeing a rush for another valuable and limited physical resource, radio electric spectrum. Like real estate, radio spectrum can benefit from some of the same governing principles of planned usage.

In this paper, we will take a look at why privatization through sale of these spectra leads to their most efficient use. We will examine the concept of "zoning" for the spectrum and we'll briefly compare the regulation of spectrum by the federal governments of the United States and Mexico and find real world lessons from these markets.

Radio frequency, or RF, refers to that portion of the electromagnetic spectrum in which electromagnetic waves can be generated by alternating current fed to an antenna. Frequencies starting at 700 Megahertz (MHz) and continuing up to 38 Gigahertz (GHz), or 3800 MHz are used today in modern cellular and broadband communications networks. A certain block of radio frequency is often referred to as "spectrum" which refers to the compound signal itself. We are familiar with the "spectrum of visible light," those electromagnetic waves that are visible to the human eye or "cellular spectrum" a certain range of frequencies used by transmission equipment powering cellular networks. The image below is a graphical representation of five frequencies.

Another way to look at this is to think of spectrum as vertical real estate. Imagine the space that starts at the ground and extends vertically up into the atmosphere. Just like real estate, spectrum can be exactly located and measured. In real estate, we locate a specific tract of land through coordinates on a local map or a world globe. For example, XC Network's NOC in Dallas is located at N. Latitude 32-47-56.4 and W. Longitude 96-46-43.0. We can also measure the size of the tract in acres, square feet or square meters. The NOC sits on 36,000 sq. feet of land.

With spectrum, we identify the location by measuring the frequency in MHz in the lower frequencies and GHz in the higher frequencies. The amount, or channel size, of a specific block of frequency is also measured in megahertz. The channel size can also be measured by the speed at which data passes through the channel of frequency. An example is a 10 megabits per second (Mbps) wireless connection. This concept of transmission speed is analogous to measuring a volume of water passing through a water main at 10 gallons per second.



Graphical Representaion of Five Frequencies

Since it is possible to measure spectrum, it is possible to sell or rent specific channels and create businesses that profit from its use. Traditionally, the biggest seller of spectrum has been the sovereign governments of the world.

All lands were originally owned by the founding government, be it the reigning King or the indigenous people, and lands have been sold or granted to private interests for thousand of years. Spectrum has been distributed using a similar methodology with central governments taking the obvious position (after it was determined that spectrum had value) that they own *all* radio frequency spectrum and that it is their inherent right to create and implement policy for its sale and use. For the last 75 years, governments have either sold or rented spectrum to individuals or private entities. The most common buyers of this resource are communication companies providing services such as television, radio, cellular telephone and broadband transport.

Governments worldwide continue to auction blocks of spectrum that allow the purchasers to deploy equipment to deliver services to end users. Two everyday examples include radio stations and cellular phone companies. Governments also reserve certain blocks of spectrum for their own internal use or for future use. Examples of these include frequencies used for public safety and military communication systems.

Proper and Efficient Use of Spectrum

Over the years, certain guidelines have been established for the efficient use of land for the common good, often referred to as "zoning laws". Some lands are used for residential housing, others for industrial and commercial use, and still others are set aside for recreation and public use. And, because land has different physical characteristics and its desirability varies with location, the demand and value varies greatly: Obviously, an acre of swamp land in Louisiana costs much less than an acre of land in Beverly Hills. And, these guidelines and economic rules affect the behavior of people. A real estate developer would be foolish to build a high end residential development in the middle of an industrial park. The public would never permit an oil company to build a refinery in the middle of Grand Canyon National Park.

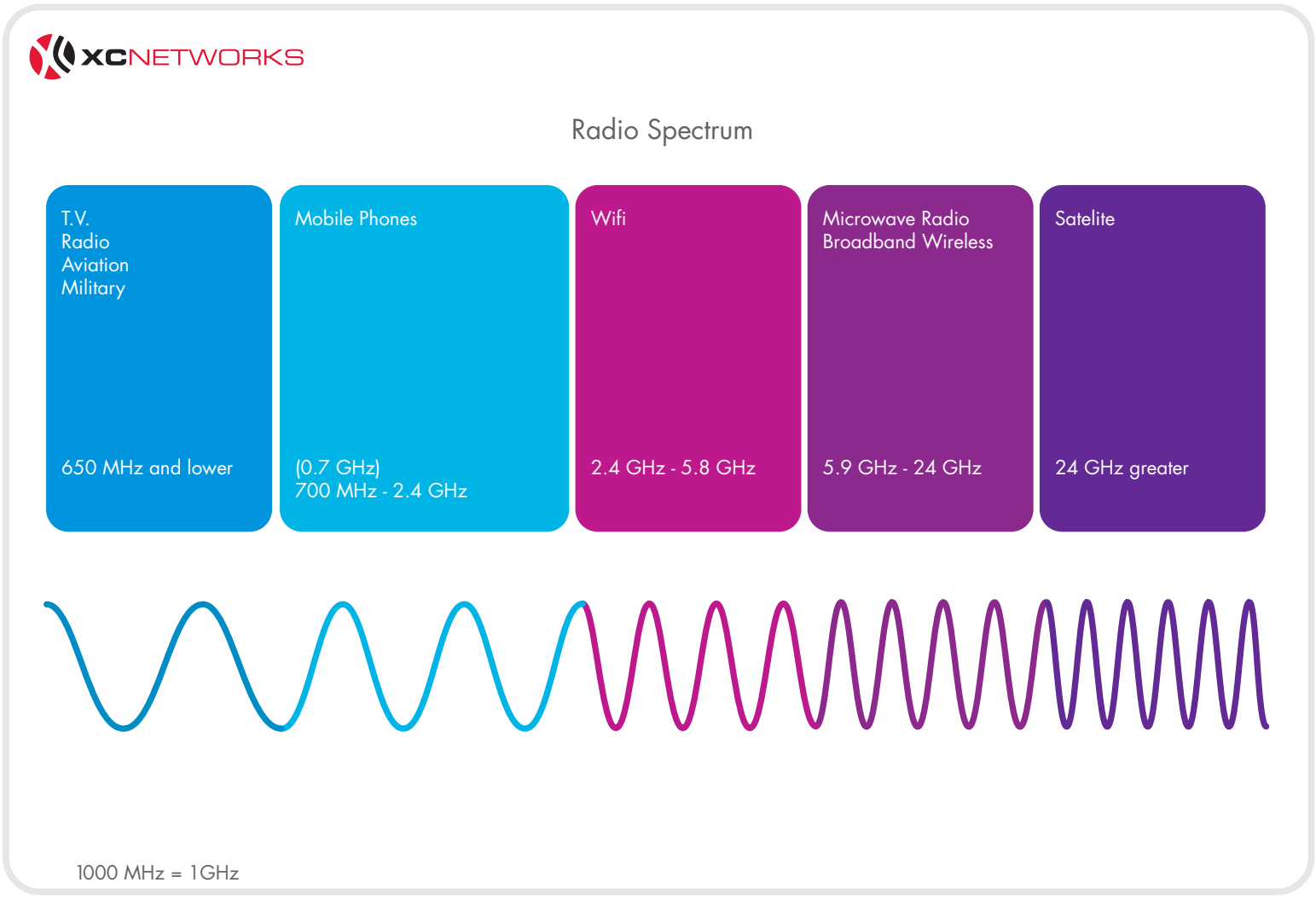
The same is true for the efficient use of the vertical real estate of spectrum. Frequencies are divided up and assigned for different uses. For example, radio and television stations are assigned specific universal frequencies in specific geographic locations. In the period following World War II, the United States Federal Communication Commission assigned the FM band, 87 MHz to 108 MHz with a 0.2 MHz channel, to radio stations. Entrepreneurs bought this spectrum, deployed transmission equipment, started broadcasting easy listening music, then found rock and roll, and started to sell commercials to local car dealerships and fast food restaurants. Thus a very profitable industry was born.

XC Networks, the organization that I run, acquired spectrum in Mexico in 1998. Since acquiring this asset, XC has evolved into a "carrier's carrier" and a leading provider of broadband, operating over 2600 high capacity links throughout North America.

As in land use, there are "zoning laws" for frequency. This makes sense because communication traffic should not overlap between, for instance, cell phones and military or other transmissions. In addition to public policy and market forces, there are distinct technical reasons for subdividing spectrum pursuant to a central or global plan.

Certain transmission equipment requires specific frequencies to address technical limitations such as coverage, fade, interference and capacity.

The greatest value in the radio frequency spectrum is located in the range that lies between 650 Mhz and 4 GHz is often referred to as the "Golden Spectrum Band". It is used for cellular networks and will be used for future wireless broadband services that will un-tether the Internet. The reasons this spectrum is in high demand are technically complex; however, it is largely because it has the capacity to transmit data at high speeds while also having the ability to penetrate solid objects such as the walls of a building. This is technically referred to as "Non Line of Site" capability. The Bits per Hertz for radio signals will continue to increase as new technologies are invented, but at a lesser rate than dictated by Moore's law on computing power. There is a saying about real estate that it will always be a good investment because God stopped making it long ago. God has also ceased production of radio spectrum and this creates scarcity in the marketplace for desirable locations and scarcity means high value.



Methods for Distributing Spectrum

Governments use the same methods to distribute spectrum as are used to distribute land. It sells, rents or designates for public or official use pursuant to a central or global plan. When governments sell spectrum, they employ the legal concept of license, which is the right of an individual to enter upon and use the frequency as an owner. Essentially, it is ownership with limitations defined in the granting document or by law. This license right may be granted for an indefinite or specific period of time. Governments also rent spectrum in return for the payment of a fee by the commercial operator or on a revenue sharing basis. And governments designate certain frequencies for public use: for example, a WiFi enabled wireless laptop operates between 2.4 GHz and 2.5 GHz with a 5 GHz channel, part of the "Golden Spectrum Band".

In my opinion, the best way for governments to distribute spectrum is through the outright sale to private industry. My evidence is primarily anecdotal, but I contend that market forces will cause private, profit-oriented organizations to use spectrum most efficiently through the development of the technology and services that maximize the value of this resource.

Cellular Markets in the United States and Mexico

Since the early 1990's, the most successful business models for the use of spectrum are cellular systems. Both in the United State and Mexico, these successful businesses were spun off from the historical incumbent telephone monopolies. Telcel (the sister company to Telmex) and ATT are two of the largest and most profitable companies in the World. Telcel and ATT bought spectrum to operate their systems primarily through an auction process run by their respective governments. The ownership control of the spectrum allowed these companies to develop extremely complex networks costing billions of dollars and requiring tens of thousands of highly trained engineers and technicians. I do not believe these resources would have been deployed if the carriers rented, rather than owned, their spectrum. They controlled the key asset and they made it work.

Fixed Wireless and Broadband Wireless

Finally, turning to an area in which I have personal experience, fixed wireless, or microwave communications. This first began to be commercialized in the United States in the early 1970s. These systems utilize frequencies between 2.4 GHz to 24 GHz and are rented from the FCC for a specific geographic location. They are available to anyone who submits an application, pays the fee and proves that the operation of such a system will not interfere with the operation of any similar existing system. Microwave networks are abundant in the United States; however, they are utilized more extensively in other countries.

Mexico has a more interesting history as it relates to microwave communication. Because the Mexican government owned Telmex prior to 1994, the government adopted self serving regulations to limit competition with Telmex. If someone wanted to install a link, they were required to submit a petition to the Secretary of Communication and Transportation. Needless to say, only a limited number of links were granted to competitors of Telmex. In 1996, the system was completely overhauled and an oligopoly marketplace was established through the sale of microwave spectrum to 14 companies. Since that time there has been an explosion of new links. I believe this new-found efficient use is directly related to the privatization of the spectrum. An interesting secondary consequence of this process has been the establishment

of networks that "bypass" the incumbent monopoly's stranglehold on network access. This means that an end user of connectivity can access the world's communication networks without paying Telmex. This in turn has caused a reduction in prices and an increase in the quality of service for consumers.

Conclusion

Privatization though the sale of radio electric spectrum leads to the most efficient use of this resource. Wireless technology is a relatively new technology and as this technology advances, the requirements for access to more and more spectrum will create opportunities in the marketplace for the governments who control spectrum and entrepreneurs who can figure out how to efficiently use it.

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