Sky of Plenty

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Introduction

I was watching The CBS Evening News last week, which was a rarity. By the commercials I can tell it is only watched by men over 60 with a high risk of prostate and erectile dysfunction issues.

Anyway, they were interviewing one of the President-Elect's supporters from rural Georgia and when asked what he thought of the final Electoral Map, he said, "Trump had better coverage than Verizon."

That seems a nice pivot from politics to my subject tonight.

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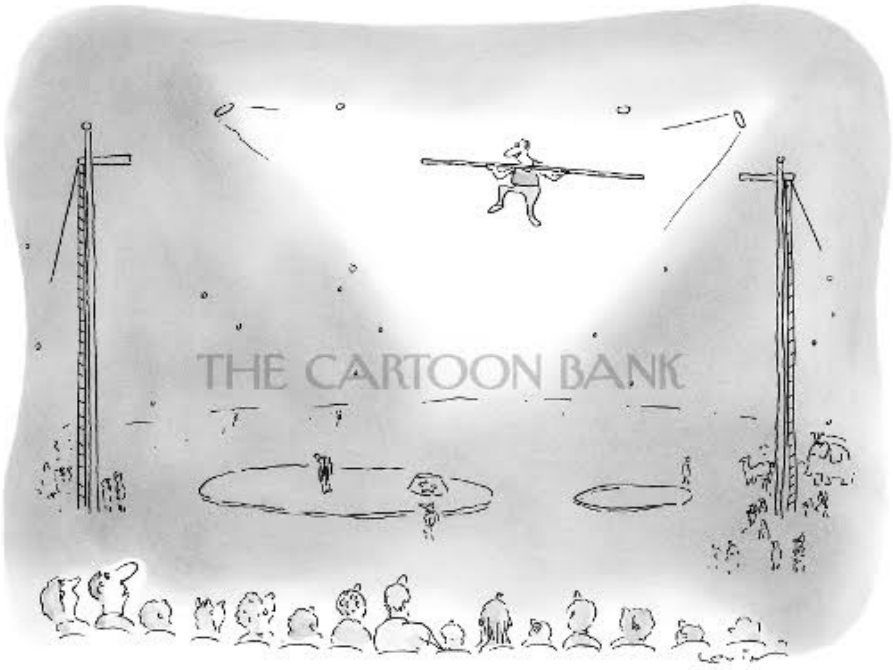
Though he has no culpability for this essay, I must mention that this topic was inspired by the March 15, 2016 Kit Kat presentation by Warren Tyler called: GOT ALMONDS?

If you recall, it was an eye-opening essay about the serious challenges ahead to sustain a safe and ample water supply. Thank you - Warren.



"It appears to be some kind of wireless technology."

SKY OF PLENTY

A Natural Resource

Water, of course, is a key natural resource, as are forests, minerals, and fisheries -- physical resources – we can touch, we can see.

That is not the case with the air around us, which is filled with invisible electromagnetic waves. This too is a limited natural resource – some call these waves beachfront property. They are subject to pollution, overuse, and misuse. But the primary issue today is who has the right to use these waves?

You might think the sky is full of data capacity for your smartphones, for local radio and television stations, for wireless microphones, GPS devices, Bluetooth devices, and even garage door openers.

But there is no Sky of Plenty.

There is instead an intense competition among many players for how these waves are to be used in the future.

Full disclosure. I've been in the broadcasting business for nearly 40 years, but just as you drink water and may not understand a pending water crisis, I've been a manager of radio and television stations, but largely ignorant of this war for our airwaves.

Only Kit Kat could make me delve into the world of physics in a likely a vain attempt to understand the electromagnetic spectrum.

Birth of Radio

I live right inside radio when I listen. Marshall McLuhan

Let's start at the beginning.

The communications portion of the spectrum was revealed in 1895 through extensive experimentation by a 21-year old Italian – Guglielmo Marconi.

Building on the work of German Physicist Heinrich Hertz, Marconi proved you could transmit Morse code almost magically through the air to be received by an antenna and receiver.

By World War I, the ability to send voice and music over wireless had been achieved, but it wasn't until 1921 that radio stations became the rage.

Radio was magic.

And the government was caught off guard by the instant popularity. They had predicted that one radio station and one frequency could cover each community in America. When two or three radio stations went on the air in a city, they were required to timeshare that single frequency. Some of the stronger stations interfered with less powerful stations and basically used their transmitting power to shut them down.

There was chaos.

The Federal Radio Commission was soon created to approve licenses, create more radio frequencies and manage spectrum. This was the forerunner to the Federal Communications Commission, established as an independent governmental agency, with five political appointees to regulate communications and manage the radio spectrum.

The Spectrum

I will use the terms radio spectrum or radio waves because they typically refer to the full frequency range for all of wireless communication – from shortwave to radio to television to cell phones.

All waves in the ether are called electromagnetic, but there is only a relatively small part of the spectrum optimized for communications.

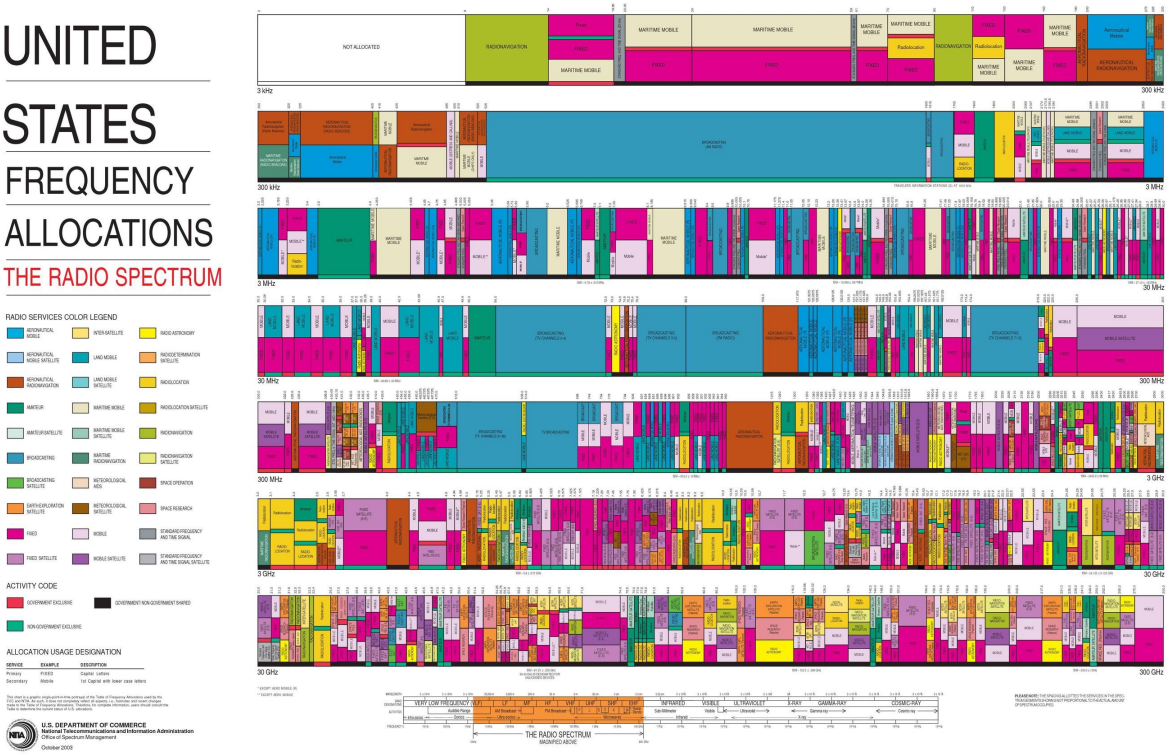
Radio Waves are at the lower end of the spectrum because they have the lowest frequencies and longest wavelengths. A simple way to think of radio waves is to imagine dropping a stone into a still pond of water. Those waves created in the pond are like those waves in the air. They can be classified by length between a crest and adjacent crest… and frequency – the number of waves passing through a given point every second.

Many users of the radio spectrum can operate in the same geographical area at the same time, but they must be on different frequencies or there is interference. So the FCC's main job is to allocate spectrum among many user groups and regions and prevent interference.

All waves are not created equal.

Scientists have created a sort of piano keyboard to create a spectrum range. The low notes have a low frequency and long wavelength and high notes have a high frequency and a short wavelength.

(Reveal Radio Spectrum chart below on poster board)



This is a government chart showing just the portion of the Spectrum involving radio waves primarily used for communications.

The thing that's instantly notable here is that every part of the spectrum is taken and much of it shared. The colors designate whether it's used by the government, mobile wireless, navigation, maritime communications and more.

Let me point out the blue section at the top, which is used for AM radio. That's quite a lot of spectrum, but it's also subject to a great deal of noise from other stray radio waves and unusable for many reasons by the wireless industry. The VHF TV spectrum is also not ideal for wireless. VHF transmission requires large outdoor antennas for reception and are subject to interference.

The sweet spot is higher in the frequency band. It's right here in the 600 Megahertz part of the UHF band. This part of the spectrum works reliably indoors with very small antennas and across great distances, and it can help the carriers keep up with customer demands for coverage.

The Digital Explosion

> Having extended or translated our central nervous system into the electromagnetic technology, it is but a further stage to transfer our consciousness to the computer world as well.
> Marshall McLuhan

Since the digital transition of television about a decade ago, the vast majority of the 1,700 TV stations in the U.S. have resided on the UHF Band. All seven of the Columbus TV stations transmit on UHF, which originally included channels 14 to 83 for TV broadcasting.

Starting with the days of bulky bags of mobile cell phones connected to your car, the wireless industry and the FCC has targeted the UHF TV spectrum as the best place to expand wireless phone and data signals.

Again, the UHF band has a mix of benefits including short practical antennas, good transmission range, and the ability to handle high data rates.

In the 1980s, the FCC sliced a portion of the UHF band – channels 69 to 83 – for cellular phone use.

A decade ago, the agency auctioned off TV spectrum from channels 52 to 69 vacated by TV stations during the digital transition.

Now, the explosion in data use by smartphones has accelerated the need for even more spectrum. You likely know some of the stats:

- Smartphone penetration was next to nothing in 2006…its up to over 80 percent of the U.S. Population today.

- There were over 1.9 trillion text messages sent last year, and mobile data use exploded with people watching videos and accessing social media sites.

- Business related cloud computing is now a $110-billion dollar business and is growing over 25 percent annually. Amazon has net sales last year of $8

billion dollars for its cloud infrastructure.

- When you open an app on your smartphone, you connect to the wireless data network via spectrum. You become part of the what's called the App economy, which has grown to employ over 2.3 million people in this country since the iPhone was introduced.

Wireless is simply a huge economic driver.

In 2010, with a spectrum crunch on the horizon, President Obama signed an executive order directing the FCC to make available at least 500 Megahertz of spectrum by 2020 for use by companies to expand wireless use. The FCC has a long way to reach that goal.

The problem is much of the communications spectrum is already designated. For instance --

- Major portions of the spectrum are owned by the government.

  This spectrum is held by over 30 government agencies, most notably the military, and used infrequently. The agencies don't want to give up their slice of spectrum or share it with commercial enterprises for security and other reasons. And so far, there has been little pressure for them to do so.

- Then we have an analysis of wireless use that found some players like Clearwire and Dish Network owning spectrum from past auctions, but holding back deployment because of financial issues.

- And the television broadcasters –they may have lost portions of their UHF spectrum in the past, but they still have a grip on valuable wireless spectrum. So this year, the FCC will once again target the radio waves in the UHF band, right where broadcasters are transmitting their channels.

Spectrum Auction 2016

In the most ambitious and complex auction ever held by a government agency, the FCC started in May 2016 an attempt to auction to wireless companies UHF TV Channels 30 through 51.

This means moving hundreds of television stations across the country to either a lower part of the UHF band or onto the much less desirable VHF band or putting enough money on the table to convince a number of broadcast owners to go out of business.

The FCC will price the spectrum through a reverse auction and seek broadcasters who might give up their spectrum for a certain price. Then the wireless industry would bid in a forward auction on the open spectrum to cover the costs of moving some broadcasters to another part of the spectrum and buying out others. The auction could raise in the range of $30 to $50 billion from the wireless industry for this new UHF spectrum.

The goal is to free some 120 megahertz, which would increase the overall amount of wireless spectrum available by 22 percent. We won't know until next year the results of the auction, but it's predicted some 300 TV stations may take the buyout. And many of the thousands of Low Power TV stations will have to go off the air because they could interfere with the remaining full power stations.

The ripples of this auction have many worried. For instance, unlicensed UHF spectrum is typically used for wireless microphones and intercoms. Studies show less access to UHF will mean more much interference of wireless gear at major live sporting events, but also theatre productions and any project that requires quality wireless microphones.

Impacting TV's Future

The bottom line is the digital disruption of the U.S. television industry is at hand. I did not expect to find the need for more wireless spectrum for mobile devices so connected to the future of the television industry.

But the neat and structured relationships of the past related to broadcast and pay cable networks are no longer relevant.

Let's continue talking about the traditional broadcast industry for a moment.

Overall, given the history of the FCC, it seems obvious is that the agency sees broadcasting as archaic. It's the grand old medium in the rocking chair on the porch.

The National Association of Broadcasters was once one of the most powerful political forces across the country. The wireless industry headed by Verizon, AT&T, T Mobile and others have taken up that role.

It's now believed by some in government and within the new media world that the entire broadcast spectrum could eventually be eliminated to benefit great expansion of needed wireless spectrum.

To quote Netflix CEO Reed Hastings – "broadcast television is like a horse…the horse was good until we had a car." Hastings predicts broadcast TV will be dead by 2030.

And in fact, the traditional broadcast networks are concerned about the many disruptive forces at work.

There are rumors that Disney may consider selling the ABC network as it pulls down their performance.

At Comcast, top executives are rethinking the future of NBC with its diminishing advertising returns.

It's actually the major cable companies that are propping up the commercial networks. High retransmission fees collected from cable have offset declines in advertising revenues at ABC, NBC, CBS and Fox. Those extra fees paid by cable to carry the broadcast networks drive up cable bills, but go straight to building a healthy bottom line for broadcast networks.

So, let's talk about the future of Pay TV.

83 percent of U.S. Households pay for satellite or cable television, but there are some troubling trends. The pay TV subscriber base is down 2 million households from three years ago.

We all have had bad cable experiences and frustration of paying 80 bucks or much more a month for channels we never watch…and now there are alternatives – driven by access to spectrum by wireless to deliver the Internet to any screen.

- We live in a world of Smart TVs that can now access the Internet directly transforming your set into a very large tablet computer. Over half of U.S.

households now subscribe to Netflix through what is called Over the Top television. And Amazon, Hulu and others are also big players in this growing field.

- Skinny bundles of cable channels delivered through the Internet to your television and your smartphone are now available through companies like Sling TV. Pay much less and get some of the channels you actually watch.

- And you can always find easy access to a massive amount of video programming online at YouTube and other sites…bypassing expensive cable channels.

All these options have led to a trend called cord-cutting. More consumers are dropping pay TV in larger numbers than ever before – 1.3 million over the past two years. As cable bills continue to increase, in part to pay those high retransmission fees charged by the major networks, the number of cord cutters is expected to increase.

Given the massive changes in how people access and use media, there is reason to think the entire cable TV model may be at risk.

A Future of 5G

> If an age of brain transplants lies ahead, it may become possible to supply each new generation with "brain prints" taken live and directly from the intellects of the age. Marshall McLuhan 1970

So, let's talk a bit about the future of mobile wireless.

- I can use a bit of short-range wireless spectrum called Bluetooth to connect my iPhone to Bluetooth speakers throughout my house and listen to Pandora or my NPR App.

- I can spy on my two daughters living in New York City, calling up an App and locating exactly where they are or at least where their iPhone resides.

- I can use Facebook Live to stream video of a Columbus Jazz Orchestra concert and get comments from throughout the world, instantly.

- With some configuring, I can watch most everything the broadcast networks air and many cable programs on my iPhone.

There are dozens of other examples of what mobile access to spectrum to connect to the Internet quickly and with high capacity means to me.

How do you use mobile technology? How important is it to your life?

It's a mistake to think of any pending crisis over spectrum as just a Verizon or AT&T issue and just an issue related to my and your use of the spectrum.

There is a vast technical ecosystem of innovative companies that depend on swift and reliable wireless connections to survive and the numbers are growing.

So what's next? You might have the latest 4G or 4th Generation of wireless technology in your pocket, but its 5G that really excites the industry – you might say the industry is orgasmic over 5G's potential.

5G is being touted as the key to smart cities like Columbus -- providing the ability for autonomous cars to travel using an artificial intelligence traffic management system.

A Nokia engineer describes a scenario where you might be cruising in your driverless car when, unbeknownst to you, a crash has just occurred up the road. With 5G, sensors placed along the road would be able to instantly relay that information back to your car, so it could brake earlier and avoid another accident.

5G's wireless speed would enable you to download an HD quality movie to your phone in six seconds, and more than that provide the network for the Internet of Things -- smart home appliances, wearable Internet devices, smart glasses and much more.

What is needed for 5G to become reality over the next decade is new infrastructure, new antenna technology, and more spectrum. 5G developers are not targeting the UHF waves, but higher frequencies in what is called the millimeter wave range.

These higher frequencies offer lots of bandwidth for 5G, but the range of is much more limited, which will mean many more small antennas and transmitters throughout a community.

And there is competition for this portion of the spectrum – communications satellites are already using this space and that will be another issue faced by the FCC in the future.

5G technology will be a feature you will hear about at the 2018 Winter Olympics in South Korea as they will experiment with live holograms of athletes and 5G linked drones equipped with the latest 4K cameras and more. Developers hope it begins to roll out in the States by 2020.

The Risk

Wireless technology on the horizon will move us into a new technological era, but the risks will be high.

On September 22nd of this year, the Internet firm Yahoo confirmed a breach that is believed to have affected at least 500 million user accounts – one of the largest cyber security breaches ever.

And less than a month ago, on October 21st, major websites were inaccessible to people across the U.S. after a company that manages crucial parts of the Internet's infrastructure said it was under attack.

Security experts call this a distributed denial-of-service attack. The attack relied on hundreds of thousands of internet-connected devices like baby monitors and home routers that have been infected with software that allows hackers to command them to flood a target with overwhelming traffic.

The number and types of attacks, the duration of attacks and the complexity of these attacks on the Internet are all on the rise. The explosion of devices being

hooked up to the Internet presents an enormous security issue and threatens the future of the wireless world.

That could be a very interesting essay for the future.

For now and to summarize --

- The FCC is at the beck and call of the wireless industry and that will continue. They will need to clear more spectrum and be pressured to start tapping the unused government spectrum and even expanding their auctions to tap into more broadcast UHF spectrum.

- We love instant access. When it comes to watching video, our allegiance is to the program and not the network or channel providing it. The Internet has disrupted traditional broadcasting and pay TV and both must evolve.

- And 5G sounds revolutionary, but do you really want to be sitting in a driverless car when someone hacks into the data stream and takes over control? Assuring cyber security could be the most difficult challenge forward.

Thank you for listening.

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Note: There is no definitive book about the history and current use of the Electromagnetic Spectrum. Most of my research depended on recent coverage and opinion from a variety of online and print sources and from my own experience in the media industry.