

Everything You Need to Know About 5G

by Rebecca D. Costa

With all the buzz surrounding 5G, you might be wondering how to prepare for the coming “4th industrial revolution.” After all, economists claim 5G will add \$12 Trillion in new goods and services and 220 million jobs by 2035. And networking giants like Cisco Systems predict 12 percent of the world’s mobile data will run on 5G in the next 24 months.

If these forecasts sound impressive, they have cause to be. 5G is the next logical evolution in cellular networking technology. Without it, the true promise of machine-to-machine communications and IoT cannot be realized.

To appreciate how necessary 5G is, it’s helpful to step back and look at how we arrived at this important juncture. First came 1G, which brought about an overnight explosion of cellular phones. Then, 2G which made texting fast and abundant. 3G gave a plethora of new digital devices access to the internet anytime, anywhere. And 4G paved the way for faster, better quality video. Today, 4G networks which were designed to solve video buffering and resolution issues are trying do things they were never created for. As a result, we are quickly surpassing their limits.

FOUR WORDS

The advantages of 5G are too numerous to describe in a single article, but the benefits most often talked about can be summarized in four words: Speed, Latency, Connectivity and Power.

For starters, 5G is more than 100 times faster than 4G. Whereas 3G would have required 26 hours to download a Netflix 2-hour movie, the advent of 4G cut that time to 4-6 minutes. Using 5G, that same movie now requires 3-4 seconds to download. Today’s 4G networks operate at an average speed of 45 Megabytes per second. 5G averages 10 Gigabytes per second.

Next up, 5G provides near-zero latency - a feature that’s essential for applications where any delay between an instruction and implementation spells disaster. Think of thousands of autonomous cars traveling at 65 miles per hour. Or robotic surgery,

defense guidance systems, precision manufacturing and other uses where instantaneous, continuous data is needed.

As if an unprecedented leap in speed and latency weren't enough, 5G enables more digital devices to be connected to the network than ever before. Today's 4G networks accommodate roughly 100,000 devices per square kilometer. 5G has the ability to connect more than a million within that same area. With analysts anticipating over 80 Billion connected devices by 2025, users will soon begin experiencing drop-outs without 5G technology. Similar to freeway commuter traffic, 5G eliminates congestion by 1) raising the speed limit so cars get off the road faster, 2) adding more lanes to existing roads, and 3) building new roads. 5G is a multi-layered data highway offering multi-faceted benefits.

Lastly, while other 5G features often steal the spotlight, the substantial power savings 5G offers cannot be overlooked. Faster speed and near-zero latency allows apps to be continuously streamed from the cloud, so expensive, power-greedy chips are no longer needed to store or run apps on the devices themselves. What's more, users will never have to update software or upgrade their phones once they have a 5G compatible device. According to President of Qualcomm, smart phones will soon be reduced to glass screens with batteries - opening the door to an entirely new generation of inexpensive telecom products.

Whether we're talking speed, latency, connectivity or power, it turns out there are well-founded reasons 5G is generating so much excitement. 5G networks are destined to change the way we work and live.

Yet, for all the upside, many experts are beginning to wonder if 5G is more hype than reality.

The technology faces serious hurdles ranging from regulatory laws, spectrum licensing and infrastructure retrofitting, to how deployment will be financed and who will be responsible for network security. There are also formidable technical and geopolitical issues that must be addressed before the technology can go mainstream. As well as yet-to-be-answered questions regarding human health and the environment. These challenges and others suggest a slower, more incremental 5G roll-out than the fait accompli today's TV ads portray.

BREAKING FROM HISTORY

So, who's right? Is 5G likely to be an overnight disruption? A sudden tsunami that hits businesses and consumers everywhere all at once? Or will it be a gradual transition over a longer span of time? One we can comfortably ease into?

The verdict's out. Here's why:

For more than 1000 years, faster, more efficient communications have been associated with rapid economic expansion. From the first Egyptian postal systems, to the building of roads and passages by the Romans, to semaphore networks, clipper ships, the telegraph, telephone and internet, faster communication offered tremendous advantages in business and governance. It's a documented fact that cities which adopted the printing press in the 15th Century grew 60 percent faster in the 16th Century than those that did not. And had news the War of 1812 ended reached them 2 weeks sooner, the lives of 2000 soldiers would have been saved at the Battle of New Orleans.

While few would be foolish enough to claim that faster, better communications *cause* victories on the battlefield or economic booms, a thousand-year track record of consistent *correlation* is worth paying attention to. And this is precisely the reason why reality failed to match expectations as the world moved from 3G to 4G. For the first time in more than a millennium - the economic gains which historically accompany a major improvement in communications speed did *not* materialize. Even accounting for the global recession in 2008 and 2009, overall global economic growth slowed. And telecom carriers and device manufacturers who rushed ahead of 4G's availability - banking on the demand for faster, better video - were left wondering why 4G didn't translate to their bottom lines as forecasted.

Which begs the question. Was 4G just a historic anomaly? A mere blip in an otherwise 1000-year old pattern? Or did it represent some milestone break from the past? Did we cross some threshold wherein more, faster, better communication no longer packs the economic punch it once did?

According to researcher Jonathan Spira, there's a simple explanation. Over one trillion dollars of economic output is now lost every year in the U.S. owing to "data distraction." And the body of evidence that suggests more information doesn't necessarily equate to greater productivity, efficiency or even better decision-making is growing. It turns out, all that time spent reading and answering emails, posting on social media, catching up on the latest news and videos, isn't paying off the way we thought it would . . .

Adding credence to the idea that more, faster data may be backfiring are anecdotal stories like Atos Origin. Not long ago, the CEO of the company became convinced that productivity lost from reading and answering emails was having a negative effect on output. So, he challenged his employees to reduce their emails to as close to zero as possible. The employees quickly embraced the experiment and within 3 years a whopping two-thirds of the company's use of email had been eliminated. Interestingly, during this same period, the company's operating margins grew 1 percent to 7.5 percent and their stock price increased 50 percent.

Similar stories abound in other industries. As more organizations begin monitoring and restricting employee access to video, entertainment, retail and other sites, measurable gains in productivity have been reported. Of course, “data distraction” is only one of a number of possible explanations as to why the leap from 3G to 4G did not produce the economic upside it was predicted to. But the disappointment was profound enough to teach telecom carriers an important lesson. This time around they’re not going to get too far out ahead of device makers or consumer demand. They’re approaching 5G more cautiously.

THE REAL PRICE TAG

Carrier caution is one reason 5G service won’t replace 4G overnight. The ginormous costs associated with building 5G networks is another. It’s no coincidence the countries which are farthest ahead in 5G deployment are those where the government is footing all or most of the bill: China, South Korea, Qatar, Switzerland, etc. Countries banking on for-profit carriers like Verizon and AT&T to shoulder the full financial burden are places where 5G is moving more slowly. These are places where 5G service is available in a few contained spaces such as sports arenas or the stock exchange.

The reason 5G cellular networks are expensive to build has to do with how the technology works. *True* 5G utilizes millimeter waves on the high-end of the radio spectrum - waves which can only transmit over very short distances. Making matters more challenging, these millimeter waves have trouble passing through walls, trees, humans, even rain. So, in order for 5G networks to function the way they are designed to, small antennas must be placed every 200-1000 feet. The antennas work together as coordinated phased arrays to deliver continuous, instantaneous service.

If installing antennas every 200-1000 feet doesn’t sound very practical consider this: There are approximately 13 Million utility poles in the U.S. If every utility pole were fitted with a 5G antenna the estimated cost would be somewhere in the neighborhood of \$400 Billion. That \$400 Billion would deliver 5G service to only half of all U.S. citizens - those living in the most densely populated urban areas. Because of short transmission distances, people living in rural areas will not enjoy the benefits of 5G anytime soon, or perhaps ever - causing the digital divide between urban and rural communities to grow larger with time.

When it comes to the full price tag of 5G, installing millions of antennas is the tip of the iceberg. Experts estimate that 8 miles of fiber cable for every square mile of 5G cells are also needed. As well as significant investment dollars to develop 5G compatible devices, new security and troubleshooting systems and so on. Which brings us to another reason that countries which lead the world in 5G are also countries where the government has an active hand in building the new infrastructure: security.

5G has the ability to connect 10x more devices within a square kilometer than 4G, which, regrettably, also means bad actors have 10x more access points to the network. Compounding the exposure is the fact that there are millions of interconnected antennas and many more miles of cable to protect. Let us not forget that 5G networks are also software dependent - making them more vulnerable to security breaches than 4G. Given these considerations and others, is it realistic for a government to expect for-profit telecom companies to be responsible for securing an infrastructure on which an entire nation depends? Probably not.

COMPLICATIONS AND SETBACKS

Funding and protecting 5G networks are not the only concerns which have forced many governments to play a more active role in building a 5G infrastructure. Or why 5G is taking longer to implement in some places. In the last decade, 5G has stirred up troublesome geopolitical issues - issues which are certain to determine the future of global data and communications.

By all accounts (market share, price/performance, technology, etc.), the leading 5G equipment maker today is Chinese state-sponsored, Huawei Technologies. If that name sounds familiar it should. In 2012, the U.S. government banned the use of Huawei products over concerns the equipment could be used by the Chinese government to spy on sensitive commercial and government communication. It turns out, those concerns were justified. Since the time of the ban, the U.S. Justice Department has unsealed 23 comprehensive indictments against Huawei pertaining to fraud, theft of intellectual property and obstruction of justice. In addition, Huawei was caught red-handed downloading sensitive government data back to mainland China from the headquarters of The African Union. Charges of similar breaches elsewhere have caused security experts to describe Huawei as a digital *Trojan Horse* - a dangerous technology designed to give China unlimited access to proprietary communications, power grids, defense systems, etc.

That said, there's no argument as to whether countries which are furthest along in their deployment of 5G are currently leveraging Huawei's technological lead. Or the lead of ZTE, the other Chinese state-sponsored leader in 5G. Since Huawei and ZTE's closest competitors, Ericsson and Nokia, don't come close in performance, this presents a real dilemma for the U.S. and other nations, such as Australia, which have banned the Chinese makers. These nations have been backed into a corner where their only choice is to buy 5G technology which is inferior.

This stand-off has caused experts in the know to warn of a coming *Cold War*. At one time a country's allegiance could be determined by who they purchased weapons or sought security from. But today, the world may be dividing along the lines of those

willing to be beholden to the Chinese for 5G technology despite the known security risks, and those who choose to fall behind rather than take that risk.

In the long run, the embargo by the U.S. may be necessary, but there is no question as to whether this has caused the U.S. to lose ground in the global 5G race every year since the 2012 ban. And no question as to whether U.S. tech leaders like Amazon, Apple, Google, and Microsoft are being negatively impacted. Whether 5G marks the beginning of global Chinese technology dominance remains to be seen, but one thing is certain: doing business with a country which does not share compatible values or interests is tricky, and this will only get trickier as the 5G race heats up.

The political challenges 5G faces are by no means limited to strained US-China relations. There are equally daunting local, regional, state and federal legal issues which must be addressed before 5G is available to consumers everywhere. For example, the City of San Jose, California - located in the heart of Silicon Valley - is currently in the midst of a court case which has made them unable to activate thousands of installed 5G antennas. In order to offset the costs of building expensive 5G networks the city struck an agreement with a commercial carrier to allow antennas to be installed on existing utility poles. Shortly after the antennas were up and running, the city learned the poles were the property of the public utility and therefore, paid for and owned by taxpayers. By law, any equipment added to taxpayer-paid utility poles must necessarily benefit *all* taxpayers. Since the for-profit carrier charges a fee for use of their cellular service, 5G would only be available to paid subscribers, not *all* taxpayers. So, in spite of having thousands of antennas ready to deploy, the City of San Jose has been prohibited from activating the majority of them pending the court's ruling. It remains to be seen whether the city can prove taxpayers benefit from things other than free service - benefits such as the ability to attract new businesses, conferences, added tourism, etc. And whether the court ruling will permit San Jose's cost and risk sharing model to be replicated elsewhere.

In addition to funding, and political, legal and security concerns, there's another reason 5G deployment has been slower than anticipated and why governments have become unwitting players. Here, I tread gently. Anytime a person states that there have been no studies on the impact massive volumes of millimeter waves *could* have on human health and the environment, they're immediately pegged as a member of the lunatic fringe. Worse yet, they're dismissed as ignorant and incompetent. After all, radio waves of all types pass through humans and the planet all day, every day. Since millimeter waves emit a significantly smaller amount of radiation in comparison to other waves, theoretically, they present no danger.

Yet, dare to point out that science makes a clear distinction between *theoretical* and *proven*, and be prepared to be attacked on all fronts: by chip makers, carriers, physicists, engineers, government agencies and self-proclaimed experts. Similar to discussions on

climate change and gun control, any hope of rational discourse gives way to zealotry. The conversation quickly descends into adjectives aimed at discrediting those who favor caution.

As a point of fact, there have been zero studies commissioned on the impact millimeter waves, in large numbers, could have on human health and the environment. Though it's early to gauge the extent of the public's concerns or whether those concerns will slow progress, it should be noted that Brussels, along with a handful of other cities have stopped building 5G networks until further research can be conducted. And recently, 180 scientists and doctors from 36 countries signed a petition appealing to the EU to put a temporary moratorium on 5G until research proves or disproves the technology is safe.

SLOW BUT CERTAIN

To sum up, 5G networks are both essential and inevitable. As we approach the limits of 4G cellular technology, every industrialized nation in the world is embracing the advantages 5G offers: speed, near-zero latency, connectivity and lower power usage. That said, we should be careful not to allow the momentum to sweep challenges which lie ahead under the rug. From funding, regulations, health, security and geopolitical concerns to technical hurdles regarding short transmission distances and easy interference, the road to full 5G deployment is far from paved. Neither should we treat the economic anomaly which occurred in the transition from 3G to 4G as if it were some spoiler. If 1000 years of history is proven right, 5G networks will usher in an economic boom like no other. On the other hand, if, as some have suggested, we've crossed a threshold wherein more, faster data no longer translates to an economic upside, the impact in terms of revenue, jobs, etc., may be minimal. With so many factors at play, the future favors those who anticipate a long-term transition wherein, one-by-one, the obstacles to full deployment can be removed along the way.

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