An Investor's Guide TO THE 5G REVOLUTION HAPPENING TODAY

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5G has been a major topic in the investment world for several years now. The technology has been touted as the "next big thing" for everything from entertainment to transportation to energy.

So, what is all the hype about? Why are companies investing billions of dollars? Why are governments around the world debating how 5G will impact citizens, and how to regulate potential new industries it will create?

And, how can investors, who are laser focused on the new technology, figure out where to make a 5G investment to hit it big?

In this report I want to answer some of the questions I've been hearing from you about 5G. What is 5G? What are some of the projected uses for 5G, or, straight to the point, why all the hype? What are the challenges, and why is it taking so long to arrive? And finally, who are some of the major players in 5G that may offer sound investment opportunities?

History

In order to understand 5G, let's take a short trip back in time a few years to the birth of cellular wireless technology. First generation cellular wireless technology was initially put to widespread use in the 1980's.

This was the birth of the cell phone we use almost constantly today. But, those first cell phones could do little more than make mobile telephone calls. Ironically, that original feature, making calls, is probably one of the lesser used functions of our phones today, especially by younger cell phone users.

2G, or second generation technology (if you haven't figured it out yet, 5G just means "fifth generation") gave cell phone users the ability to send text messages (SMS), photographs, and even crude, by today's standards, multimedia messages between phones. One of the major advantages to 2G was that is greatly reduced the power necessary for a cell phone.

This meant phones could have smaller batteries, which meant the phone could be MUCH smaller. No more walking around with the "brick" cell phone of bad 80's movies.

3G was a major leap forward. With third generation technology cell phone users could reliably stream media for the first time. To give you an idea of the impact of 3G, the transition from 2G to 3G coincided with the dotcom boom of the late 1990's and early 2000's. 3G, and the capabilities it introduced, played a major role in the founding of entirely new applications and industries.

I won't go much into **4G LTE**, (LTE stands for Long Term Evolution and refers to the technology used to arrive at 4G speeds) because most likely you're using 4G LTE right now to read this report. I can tell you that 4G gave network users a 10X speed increase over 3G.

And 4G has enabled the founding of companies like **UBER (UBER)**, and almost all of the companies we think of as being part of the Gig, or Sharing, Economy. And, as you know, major components of the economy have, and will continue to be, disrupted by 4G even as 5G comes online.

The Promise of 5G Technology

With that background, let's now talk about 5G and how it is superior to 4G.

We can break this down into three very distinct capabilities:

1. **Greater speed**, which enables it to move more data. This means faster download and upload speeds than 4G,
2. **Lower latency**, which makes it more responsive. and
3. The ability to **connect more devices**, which enables more sensors and smart devices for the new era of Internet of Things (IOT).

Let's touch on each of these individually and highlight a few of the possible benefits they bring to network users.

Greater Speed of 5G

While 5G zealots rave about 5G being 100X faster than 4G, in reality we'll likely see speed increases of between 5X and 10X current 4G speeds. Don't get me wrong, that's still a huge speed increase. HD movies that take 5-10 minutes to download today will take only seconds using 5G.

While download speed increases will be noticeable, probably more noticeable will be the increase in upload speeds. If you've ever tried to upload a photo, or large business presentation, you'll find 5G will enable upload speeds that are greatly increased from the 4G network. In some instances they may be the same as download speeds.

Upload and download speed increases will certainly add to the convenience of network use by consumers, and may be a boon to companies like **Netflix (NFLX)**, as well as the other rapidly forming streaming businesses from the likes of **Apple (AAPL)** and **Disney (DIS)**. But, the real game changer for 5G may lie in the capability to deliver lower latency.

Lower Latency, Greater Responsiveness

Have you ever used Waze or Apple Maps and missed a turn because the app didn't update quickly enough? Maybe you've seen a stock price, entered a buy or sell order, and the price moves away from you before you can get an execution on your order. Or, maybe you're one of the apparently billions of people who play Fortnite, and a lag in the game has cost you a victory.

In each case there is a delay, or latency, in the communication between the input from your device and the server, which holds the relevant information…the directions, the stock price, or your character's relative position in the game.

The information provided by your device must be received, interpreted,acted upon, and then the next step in the process, e.g., the next turn you need to take to stay on course, must be provided to you.

Today, a delay in providing you directions may result in the inconvenience of you missing a turn and losing time while you have to backtrack. But, this same delay, or latency, when the device being given directions is your autonomous car, could easily result in death or serious injury.

Obviously this is unacceptable, and is one of the main reasons 5G, which promises almost no latency at all, is such a big deal.

5G is paramount to the safety and operation of devices such as autonomous automobiles, network connected traffic solutions, and any device requiring real time operation and feedback. Such as a doctor performing remote medical operations.

And, while not as important from a safety standpoint, the gaming and entertainment industries are excited about this capability as well. The goal is real time virtual gaming and entertainment.

You could play an opponent from around the world with no lag, or virtually sit courtside at a sporting event without fear your friend will text you the results before you see them for yourself. The promise of 5G is highly anticipated in both the live sports/entertainment industry and the rapidly growing eSports world.

Increasing Connectivity and User Satisfaction

While we've all seen adds for the "connected" refrigerator that lets you know when you're out of milk, we also know that when the kids get home from school and get on their phones, tablet, or Xbox, our internet connection can slow to a crawl.

5G will take care of this. It's predicted that 5G will provide up to 100X greater "traffic capacity" than 4G. This is largely due to the bandwidth used by 5G as opposed to 4G. Without getting too technical, 5G uses a much higher frequency than 4G, and as a result the bandwidth - and the amount of traffic that can flow through the network - is much higher.

This means being able to send a text or video when you're at your favorite team's stadium or at a concert. The high bandwidth, combined with technology that allows users to efficiently take advantage of that bandwidth, should mean a lot less spinning icons on your phone when trying to call that Uber, or tell your family you're near home.

And, this means we can all have a connected refrigerator, alarm system, Alexa, streaming video, gaming, and any other of a huge host of devices connected to the network without causing any slowdown. This is a major hurdle for IOT related companies that want to place a communications chip in every device we come near on a daily basis.

Now that we know what 5G is and how it will impact our everyday lives, let's talk for a minute about why it's not here yet.

Challenges

Three of the challenges facing the build out of 5G are cost, coverage, and cost. Did I mention cost?

First, there is the cost to build out the network. 5G is not a layer of technology built on top of 4G. While the two will interact with each other as 5G is built out, the infrastructure for 5G is an entirely new technology requiring new hardware.

5G hardware, such as antennas and repeaters, provide more capacity, but with a shorter range. While the antennas are smaller, think the size of a pizza box (or even smaller) than those required by 4G, there must be more of them. The cost to build the 5G network range from the hundreds of billions in the U.S. to several trillion dollars globally.

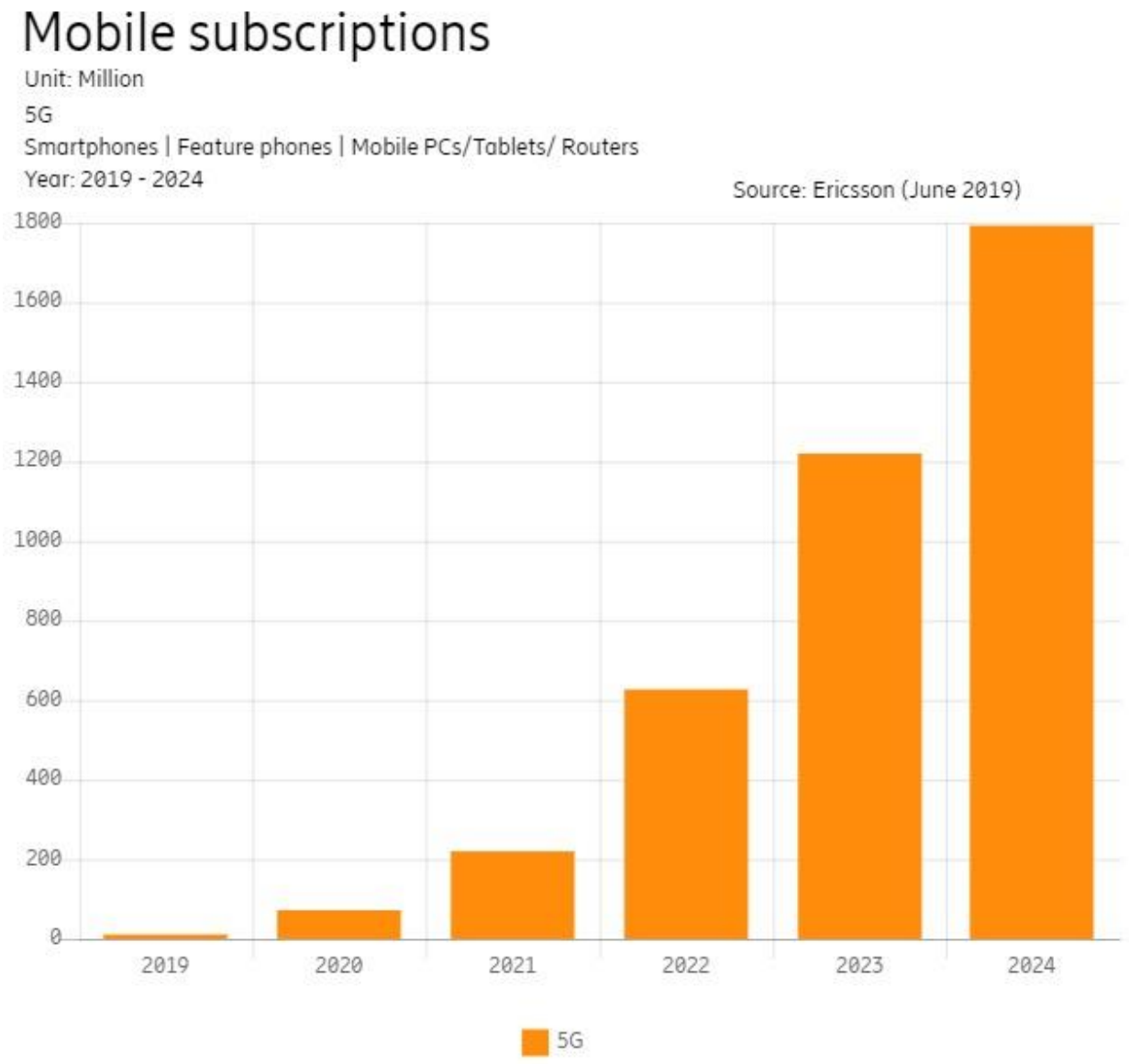
Second, as with any new technology, the living in the most concentrated population centers, who are willing to pay for the service, will benefit first. These first adopters will also bear higher costs as the service is rolled out. This means larger cities will likely see 5G coverage before less populated areas.

The problem will be where you have a 5G device that must travel from a place where there is coverage to a place where there is not. While smaller devices, such as phones and tablets may be able to use either 4G or 5G, autonomous automobiles will not have this luxury.

And third, device and IOT adoption will be hampered by, what else, cost. The cost of 5G devices will come down as more and more people gain access to the network and purchase 5G enabled devices.

But, initial adopters will pay a higher cost for both devices and access to the network.

The higher device and subscription costs will definitely hamper 5G rollout and adoption, especially in locations more economically sensitive to higher cost services. It is likely we'll see a very uneven rollout of 5G both within nations as well as across the globe.



5G Will Be a Major Boost to These Companies

Now that we know what 5G is, what it's impact will be, and what some of the challenges are to its rollout, let's look at a few companies that will benefit from the technology.

While there will be companies that aren't in existence yet that will arise out of the 5G capabilities, as Uber did with 4G, I believe we can separate the currently known beneficiaries into three large buckets. There is definitely overlap in what some of the companies do, but this is a good way to begin thinking about the players.

1. The carriers,
2. The hardware suppliers, and
3. The application or software companies

Key Carriers Will See User and Revenue Bumps

Verizon Communications (VZ) is one of the top carriers to lock down 5G spectrum. In the top 50 key U.S. markets Verizon controls over 75% of one key 5G spectrum and almost 50% of another.

Having access to both 5G spectrum and a ready made customer base should make Verizon a winner in the 5G game.

T-Mobile (TMUS) and **Sprint (S)** appear to be on the verge of completing a major merger that will make the combined company a major player in 5G. T-Mobile is adding customers at a rapid clip, and has a track record, in 4G, for rapidly deploying new tech. If the combined company remains as aggressive in the 5G space as it has been in 4G it will be a leader in 5G in very short order.

Hardware Suppliers are Already Benefiting from 5G Build

There are a number of hardware suppliers that will benefit from 5G deployment, but one of the leading candidates is **Xilinx (XLNX)**. Xilinx is heavily concentrated on future 5G deployment and is already seeing revenue growth well over 70% in its 5G related chipsets.

Qualcomm (QCOM) should be another large beneficiary of 5G deployment. After settling a major intellectual property suit with Apple, the company is poised to provide 5G chipsets for Apple 5G phones for the next several years, with the opportunity to prove itself for continued future chipset offerings. Qualcomm has an impressive IP (intellectual properties) portfolio of 5G offerings, and will be a major provider of the "picks and shovels" for the 5G build out.

Applications and Software May Be the Biggest Winners

Application and software companies may be the greatest disruptors born out of 5G implementation. But one company which is already benefiting from its software position in the 5G build out is **VMWare (VMW)**.

VMWare provides carriers with software that allows them to run multiple 5G networks on the same hardware. In other words, VMWare is making money by making 5G networks more efficient. Revenues have tripled in the past five years, and should continue on a steep upward trajectory.

Finally, take a look at **Aptiv (APTV)**. The company was spun off from **Delphi Automotive (DLPH)**, and many view it as a hardware company for autonomous vehicles. But, Aptiv is actually a software company hiding in a hardware body. The company is producing cutting edge software to guarantee your ride in an autonomous vehicle is uneventful.

Being embedded with a number of autonomous vehicle manufacturers, the company also makes connectivity software to ensure the myriad sensors on an autonomous vehicle can communicate at lightning speed over the 5G network. As autonomous vehicles mature and thrive on 5G, Aptiv stands to reward patient investors in a big way.

5G is Coming

The potential of 5G to improve the 4G network and bring major new capabilities to both current and future industries is real. Just as the move from 2G to 3G birthed some of the tech goliaths of today, 5G is already impacting the revenues of network builders and will be a major driver of growth for companies that can harness the power of the new network.

Opportunities abound for those investors willing to bet on the coming wave of innovation 5G will usher in over the next several years.

Best Regards,

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