



# INVESTMENT STRATEGY UPDATE

September 28, 2018

## 5G WIRELESS

Companies that develop or benefit from wireless technology have had a place in BTR's portfolios for years. In the most advanced economies, smart phones are ubiquitous, and they are becoming ever more prevalent in developing economies, so the theme is maturing. As we embark upon the fifth generation of wireless technology, a.k.a. 5G, it behooves us to ask whether or not this changes the game. In the short-term, 5G is a marginal step in the evolution of wireless. Long-term, however, there are aspects of 5G technology that will revolutionize other industries. Research firm IHS Markit believes the deployment of 5G ultimately will elevate wireless communications into the realm of "General-Purpose Technologies." Other examples of such technologies include the steam engine, electricity, and the Internet, so it's a bold statement. With this *Investment Strategy Update* we intend to assess whether IHS's view is plausible, but more importantly, to see whether the 5G theme is investable in our normal one- to two-year timeframe.

### What's So Special About 5G?

The International Telecommunications Union, a U.N. organization that promotes the harmonization of global communications standards, has set a target of 2020 for a re-vamped wireless system that can do much more than any previous generation. The key services 5G is intended to enable are 1) Enhanced Mobile Broadband ("eMBB"), or an incremental improvement in the speed/capacity of wireless networks, 2) Ultra Reliable Low Latency Communications ("URLLC"), or the complete and nearly instantaneous delivery of critical data, and 3) Massive Machine Type Communications ("mMTC"), or what we might call the Internet of Things.

We've probably all read something about the kind of services such standards could enable. In the case of eMBB, our everyday experience with making calls, watching videos, or playing games while in transit will improve. More importantly, fixed wireless installations (i.e. local cell towers capable of delivering broadband video or Internet service) could be a boon to rural residents who are too remote to receive wired service.

With URLLC, the focus is less on how much data can be transmitted, but how quickly and reliably it can be transmitted. Highly sensitive applications that allow for neither interruption, delay, nor loss of data include remote surgery and autonomous vehicles. Such applications would be supported by computing power being pushed to the edge of the network or by machines communicating with each other directly without accessing a network. This would lower latency, or the time it takes to transmit a signal, from 50-100 milliseconds to just one millisecond.

Finally, in the case of mMTC, a 5G network can increase the number of devices capable of functioning per square mile from a few thousand to more than a million. This would not only allow large concentrations of people (such as those attending a football game or stadium concert) to receive good service on their smartphones but also allow for the proliferation of connected devices with sensors of all kinds. Smart homes and factories that can be managed remotely, utility or construction equipment that provides ongoing operational data to managers, and smart cities that are far more efficient will be possible.

When one considers what new services have been enabled by the Internet over the past two decades, compared to what was probably envisioned in the 1990s, it does seem fair to assume that applications even more extraordinary than remote surgery could be possible in a world of pervasive connectivity. So, perhaps wireless truly is a General-Purpose Technology. But how will all this, and more, be possible?

### **Wireless 101**

“Wireless” can be a confusing term because, generally, the data being transmitted is traveling wirelessly only over the “last mile”. The rest of the time, it is passing along high-speed optical fiber, coaxial cable, or copper wires to and from relatively distant computing and networking equipment. Of course, that wireless last mile—or last few feet if one happens to be near a cell tower or WiFi router—untethers our devices and allows us to roam freely while engaging in a phone call or watching a TV show. Therefore, it is the critical link in providing quality communication services to modern consumers, and, in the past decade, as smartphone use has spread, the radio frequency spectrum that allows all that data to be transmitted has become pretty crowded.

Fortunately, there is a lot more of this spectrum to be harnessed. Part of the reason 5G will provide more capacity is that it will transmit using relatively high-frequency microwaves. Microwaves fill the portion of the electromagnetic spectrum between long (1 meter), low-frequency (300 Megahertz) radio waves and shorter (1 millimeter), higher-frequency (300 Gigahertz) infrared radiation. For now, most of the wireless devices with which we’re familiar use frequencies that are crammed in the 1-4 Gigahertz range. This is because waves of that frequency provide a good balance between their inherent capacity, their ability to travel long distances, and their ability to pass through solid objects.

As we move toward 5G deployments, trade-offs will need to be made. A higher-frequency wave can carry more information, but as it tends to be absorbed by gases and moisture in the atmosphere, its range is limited. Instead of “macro” cell towers transmitting and receiving over several miles, substantially more “small cells” will be deployed on lamp-posts and telephone poles in densely populated areas. As the waves may not be able to penetrate buildings, arranging a line of sight connection would be ideal.

## **What's the Hold-Up?**

As non-technologists, we take it as given that perfecting any of this technology is difficult, and it can't even be done until there are standards to target and specifications to follow. The specifications for a standalone 5G network were only made final in June of this year, but one major U.S. wireless service provider announced that fixed wireless broadband would be offered in a few cities beginning October 1. In the context of what could come in the next 20 years, this is a baby step. In order to provide this and other 5G services more broadly, a lot of infrastructure needs to be built. That means a lot of permits for small cells from a lot of local governments. Also, because spectrum needs to be shared by a variety of interested parties, including the U.S. military, more of it needs to be licensed.

The federal government is doing its bit, exempting small-cell deployments from certain regulatory reviews as of March, auctioning 28 Gigahertz spectrum in November, and encouraging local governments to cut red tape. It is also attempting to address security concerns that inevitably come up when one considers a future society even more pervasively and irrevocably connected than it is already, since it would include not only people but many more of the devices that impact peoples' lives. A major cause of the trade spat between the U.S. and China in the past year is the battle to maintain or improve relative technological capability. While the U.S. is still the leading technological power overall, the Chinese are viewed as being further along the path to 5G. One manifestation of the battle has been the banning of Chinese communications equipment companies from selling their products in this country, out of concern that such equipment could identify sensitive data passing through it and report to the foreign government. As a result, two cross-border mergers have been nixed in the past year, one by each country.

As wireless consequences to health are considered, alarms may be raised and slow down 5G development. People have been concerned about the impact of microwave radiation for years. On the one hand, microwaves clearly fall in the portion of the spectrum known as non-ionizing radiation (i.e. that which does not cause a chemical change) whereas cancer is usually associated with exposure to much higher frequency waves, such as ultraviolet, x-rays, or gamma rays. To date, the consensus seems to be that moderate exposure to the types of radiation generated by our cell phones and WiFi routers is not a health risk, but we know that people will be watching as the amount and frequency of such radiation increases.

## **Investment Implications**

A fixed wireless broadband offering could be viewed as a threat to cable companies, but we believe that current and projected speeds are not enough to replace coaxial cable. With at least three or four well-funded wireless providers in a mature market, we are also uncertain how much the carriers will be able to charge for faster speeds. However, as the economic cycle matures and interest rates rise, we may develop more interest in the service providers as relatively stable, high-yield investments.

Even under 4G, more and faster mobile data delivery has been enabled through a steady, strategic build-out of small cell infrastructure, either by the service providers or their cell

tower partners. For now, we prefer to focus investment on the towers, based on both traffic growth and pricing power.

As noted, the domestic smartphone market is quite well penetrated, and the U.S. is by no means the global leader in this regard. As such, until a 5G-related “killer app” becomes apparent, we wonder about the future growth rate of smartphone manufacturers.

It remains unclear who will be the biggest intellectual property winners amongst the suppliers of telecom semiconductors, sensors, and equipment. We will continue to watch company-specific news flow to get a better idea of who, if anyone, will hold the whip hand when it comes to licensing revenue under 5G.

Two quarters ago, our *Investment Strategy Update* focused on autonomous vehicles, which are considered a significant application of the URLLC aspect of 5G. However, evidence to date indicates that driverless cars can be safe even without the one millisecond latency 5G can bring. The more capabilities such cars have, the better, but we believe certain parts of the country may see driverless cars become prevalent before 5G service itself, and we are open to a position in a pure-play driverless car service.

Two aspects of future networks that make them both capable and potentially vulnerable are that they will be much more software-based, and that they will surely be targeted by bad actors. As such, we expect cyber-security to remain at least as mission critical in the 5G era as it is now.

The irony of the 5G wireless theme is that if it is truly a General-Purpose Technology, there are likely to be applications that will eventually be deemed “indispensable” of which we can’t yet conceive, but in the short-term, we may find that we want our clients’ portfolios to have less exposure to some of the enabling companies.

## **Market Outlook**

The U.S. economy and corporate earnings are growing nicely for now, aided by recent tax cuts, and along with them goes the stock market. Interest rates continue to increase gradually, in line with the Federal Reserve’s plan to “normalize” the interest rate environment without precipitating an economic contraction. The likelihood of further trade battles, especially between the U.S. and China, remains a risk to the economic picture, and stock market volatility is possible around this issue between now and year-end. For now, we continue to see the bull market for stocks as intact, with a good chance of further new highs this year and, at some point, next year. However, with stock valuations getting stretched, we have one eye on the exit, and believe starting to pull back on risk-taking within equity investments is prudent.

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