

The Fifth Generation

Mobile technology has changed quite significantly since the introduction of the first cell phones in the 1980s. The first mobile phone commercially introduced was the Motorola DynaTAC 8000X; it offered 30 minutes of talk-time between charges and weighed around 800 grams (or 1.76 lbs). Not only do cell phones weigh much less today, but the wireless technology that powers them is much faster and made their adoption ubiquitous around the world.

5G Versus 4G

Features of 5G versus 4G	Benefits
10-100x Faster Download Speeds	Performance improvements for high bandwidth applications such as high-res video
5-10x Lower Latency	For time-sensitive critical applications
3x Spectral Efficiency	Expands capacity of existing spectrum bands, lowering carriers' transmission costs
300x Max Simultaneous Connections per Cell	Ideal for densely packed IoT connections

Source: American Tower Company Filings

Next Generation

We may all be familiar with 4G, the acronym that pops up at the top of our phones when using mobile data. The “G” stands for generation and simply showcases how mobile networks have evolved over the years – so today we are using the fourth generation of wireless technology. Just as we look back and reminisce about how much technology has evolved over the past 40 years, the next generation of mobile connectivity will bring even greater change to our digital activity as we know it today. 5G is expected to provide significantly higher download speeds, improved signal coverage, reduced lag, and increased number of connected device to the internet at the same time without impacting performance. Data rates are expected to be 10-100x faster than 4G, bringing about enhanced video quality (i.e 8K ultra-HD TV) and increased augmented and virtual reality (AR/VR) applications. Connection density, or the number of wireless devices within a specific coverage area will allow more advances in Internet of Things (IoT), which essentially refers to a series of sensors or appliances connected through a

network. Network slicing also furthers IoT as users and operators can allocate sections of their networks for specific devices or customers. Lower latency, or the speed at which networks respond, will also be essential for gaming applications (meaning less lag) and autonomous cars among other possibilities. For instance, autonomous car networks require rapid response times and high-capacity computing as driverless cars generate anywhere between 10 to 30 gigabytes (GB) of data per day compared to the 10 GB/month consumers would normally go through on a personal device. Thus, fast speeds and less lagging will be essential for the smooth operation of a driverless car. 5G is also more flexible and programmable than 4G as providers can open up their networks to third-party developers to create new applications. As such, the transition to 5G brings only upside to consumers with a better mobile experience and the possibility of many more applications that can revolutionize society.

Benefits From 5G

Beneficiaries of 5G			
Parties	Service	Benefits	Companies
Carriers	Deploy 5G	Renewed pricing Power greater Network control	Bell, Rogers, TELUS, Verizon, AT&T
Handset Manufacturers	Manufacture 5G smartphones	New 5G smartphones	Apple, Samsung, Huawei
Tower Companies	Provide backbone for 5G	Fiber and small cell infrastructure	Crown Castle, American Tower, SBA Comm.
Equipment Companies	Supply 5G radio gear	Renewed equipment demand	Ericsson, Samsung, Nokia, Huawei, Cisco
5G Users	Benefit from 5G use	IoT, VR, AR, Autonomous cars	Global economy

Source: Bloomberg Intelligence, Raymond James Ltd.

Applications Powered by 5G

While specific 5G-powered applications have not been pin pointed out just yet, time will tell what will emerge depending on the demand. As such, the actual market size is not yet known, but the 5G subscriber base is expected to grow rapidly over the next few years to represent 19% of wireless subscriptions in North America by 2022. Forecasters expect most of the initial users to be industrial/business customers followed later by retail consumers since current 4G LTE speeds are adequate for today's applications. Some have indicated that IoT may be the likeliest commercial application since IoT networks require a high level of software control, something suitable for 5G's cloud-based architecture. We wrote about IoT in a past *Trends & Ideas*

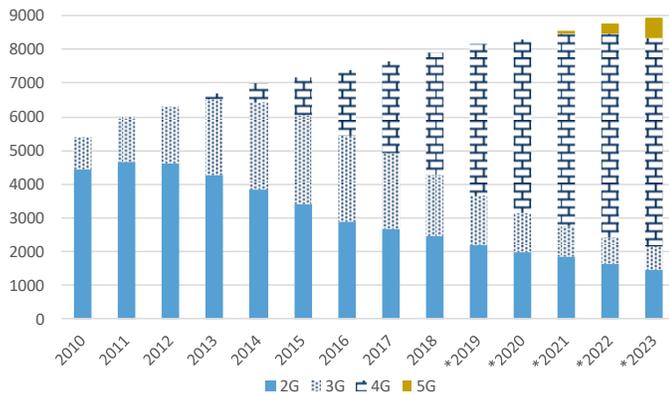
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dated February 2, 2018 titled *A Connected World*. These devices can reside anywhere from homes, schools, cities, cars and many more and sometimes have the word “smart” preceding the name like smart factories, smart utilities or smart clothes.

Worldwide Wireless Subscribers by Gen. (mlns)

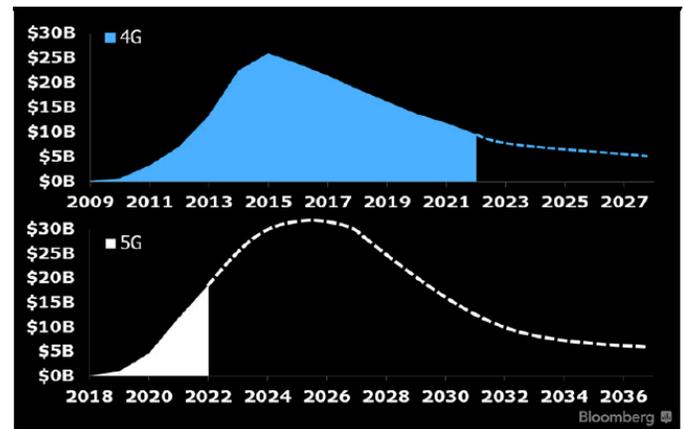


Source: Statista 2019, Raymond James Ltd.

Investing in 5G

The wireless industry is crucial to economies around the world as it supports jobs and contributes enormously to global growth. The industry allows services that are becoming mainstream such as ride-hailing, door-to-door delivery and content creation among many others. With the advent of 5G, we expect many more jobs to be created in the AR/VR, autonomous car and IoT spaces to name a few industries. As such, countries around the world have started making 5G a priority. China has outspent the US by \$24 bln in 5G investment since 2015, according to Deloitte, and its five-year economic plan indicates \$400 bln in total investment in the space. Recently, the White House has made 5G a national security priority with the US National Security Council warning that China “will win economically and militarily” if it is the first in 5G, somewhat indicating why the US along with Australia and New Zealand have banned Huawei’s 5G equipment. Some anticipate the complete 5G infrastructure buildout to take quite some time, even longer than the 4G investment cycle. While 4G investment took six years to reach its peak since it began in 2009, Nokia’s CEO Rajeev Suri predicts 5G to peak 7-10 years from now. That said, investors looking to gain exposure to 5G could be interested in a variety of players in this space that may benefit at different points of the investment cycle, mainly carriers deploying 5G services, handset manufacturers building smartphones, equipment vendors supplying 5G gear and tower companies providing the infrastructure.

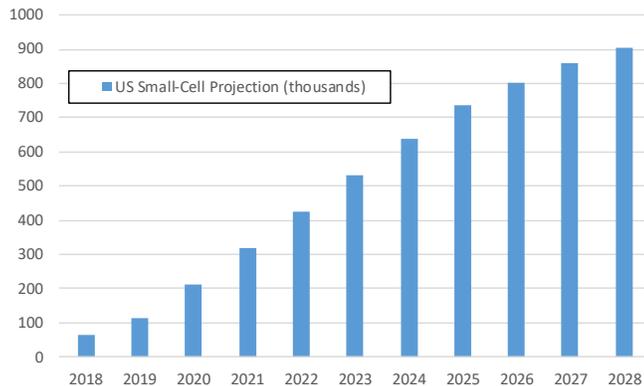
Wireless Equipment Revenue Forecast



Source: IHS, Bloomberg Intelligence

- Equipment Vendors:** Since the investment cycle will be longer for 5G compared to 4G, we believe the earliest beneficiaries of the 5G trend may be the equipment vendors such as **Telefonaktiebolaget LM Ericsson (ERIC-US)**, **Samsung**, **Nokia Oyj (NOK-US)**, **Huawei** and **Cisco Systems (CSCO-US)**, which are all placing the necessary infrastructure to bring 5G to life. Given the security concerns surrounding Huawei’s equipment, some expect Nokia and Ericsson to capture the Chinese company’s lost market share. Equipment spending by carriers is expected to accelerate to \$3.2 bln in 2019 from around \$750 mln in 2018, growing to \$19.3 bln in 2022.
- Tower Companies:** Tower companies, those that own and operate cell towers in the US and lease antenna space to carriers, are also set to be early beneficiaries as carriers upgrade their network coverage to get ready for 5G. Companies like **American Tower (AMT-US)**, **Crown Castle International (CCI-US)** and **SBA Communications (SBAC-US)** are the main players in the tower space. Small-cells and fiber will play a crucial role to allow network operators to deliver on 5G’s key features of high-speed low-latency. Fiber cables will be connected to small-cells, which are small portable base stations that allow short-range wireless transmission systems that help cover a small area either indoor or outdoor. These small cells can be placed throughout cities, preferably closer to customers, to create a dense network, allowing carriers to blanket an entire city. With carriers ramping up their 5G deployments, Bloomberg estimates the small-cell market to grow to 903,000 nodes by 2028 from 65,000 as at end of 2018. Of the three tower companies, CCI has the most exposure to small cells and fiber, according to Bloomberg.

US Small Cell Projection (Thousands)

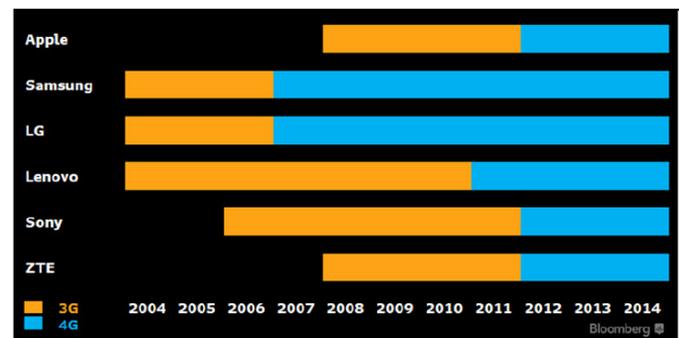


Source: Bloomberg Intelligence, Raymond James Ltd.

- Telcos/Carriers:** Telecom companies such as **BCE (BCE-T)**, **Rogers Communications (RCI.B-T)** and **TELUS (T-T)** in Canada and carriers including **Verizon Communications (VZ-US)**, **AT&T (T-US)**, **T-Mobile US (TM-US)** and **Sprint (S-US)** in the US have either announced or plan to announce 5G deployments. Given the flexibility and programmability of 5G compared to 4G, carriers will be able to create premium services for commercial and retail users looking for a performance boost to power new applications. Some expect the renewed pricing power for carriers and operators to help increase wireless revenue, more so than from subscriber growth given that the existing 4G customers are expected to convert to 5G. Rogers, partnered with Ericsson, has made plans for a 2020 rollout and has launched a partnership with the University of British Columbia (UBC) to create a 5G R&D hub on UBC's campus for 5G applications. Telus, partnered with Huawei, aims to bring 5G to the country by 2020 with an early roll out expected in Vancouver. However, the timing of the rollout may be impacted depending on whether Canada bans Huawei equipment. Bell has yet to announce a 5G equipment vendor or rollout of 5G services. In the US, Verizon made an initial launch in October of its 5G fixed-wireless broadband services in Los Angeles, Houston, Indianapolis, and Sacramento. AT&T launched mobile 5G services in 12 cities in December and plans larger scale deployment in 2020. T-Mobile also plans to launch broad scale 5G by 2020, but anticipates an initial launch in three cities in the US in 2019. As for Sprint, the company has also planned an initial launch in 2019 with a broader scale launch in 2020.
- Handset Manufacturers:** As carriers introduce commercial services, 5G phones should become more popular. As such, many handset manufacturers will also be introducing phones (some as early as 2019) including

LG Display (LPL-US), **Samsung**, **Huawei**, **Lenovo (LNVGY-US)** (Motorola's parent company) and **OnePlus**. Features here could include foldable screens or the ability to manage IoT devices linked to one's car, clothing or home, making these phones candidates to also being priced at a premium. Companies such as **Apple (AAPL-US)**, which holds over half of the premium-priced phone market, and Samsung, holding around a quarter, could be major participants in the 5G smartphone game. While LG and Samsung could be one of the earlier players to launch a 5G smartphone, Apple may make an entrance into the new segment by 2020 as the company is rarely among the first to make initial launches in recently introduced segments.

Handset Launches



Source: IDC, Bloomberg Intelligence

- Basket Approach:** Given the wide variety of companies to pick from, clients may be interested in playing the 5G space from a basket approach. Those searching for an ETF can look at the **Defiance Next Gen Connectivity ETF (FIVG-US)**, which tracks The BlueStar 5G Communications Index. Their top 10 holdings are in the table below, which include NOK and ERIC.

FIVG Top Ten Holdings

Name	Ticker
XILINX INC	XLNX
COMMSCOPE HLDG CO INC	COMM
SKYWORKS SOLUTIONS INC	SWKS
ERICSSON	ERIC
NOKIA CORP	NOK
FINISAR CORP	FNSR
UBIQUITI NETWORKS INC	UBNT
KEYSIGHT TECHNOLOGIES INC	KEYS
BROADCOM INC	AVGO
CISCO SYS INC	CSCO

Source: Defiance ETFs Website

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