5G: The Foundation for a Hyper-Connected World

A White Paper from Frost & Sullivan and Principal®
Foreword

Principal® is sparking an ongoing conversation on transformational technologies and their influence on our world. We are delighted to sponsor and collaborate with Frost & Sullivan on this paper—the first in a five-part series exploring the advent of 5G connectivity.

Frost & Sullivan is a uniquely qualified strategy consulting and research firm with deep expertise around innovative mega trends, including emerging technologies. These trends will define our future world with their far-reaching impact on business, markets, economies, and personal lives.

Why is a financial services firm deeply involved in asset management talking about 5G technology? While there may not be an obvious connection, technology is a critical factor influencing investments and the economy. 5G connectivity will be a positive disruption that goes beyond how people live, work, and communicate with one another. The implications will span industries and benefit a whole suite of other technological innovations including artificial intelligence, augmented reality, autonomous vehicles, smart cities, and the Internet of Things (IoT).

5G deployment will radically impact almost every industry sector. Through the expected increase of sales and millions of new jobs, the 5G value chain is projected to be a catalyst for productivity growth, which will strengthen real GDP. However, the 5G ecosystem will be complex, and the impacts rippling through the economy will be difficult to pinpoint. Successful long-term investment strategies will include those that are actively managed and that focus on industries, companies, and infrastructure that prominently position 5G and use sound business models to lessen risk.

We hope you find this paper valuable as the first discussion in our ongoing conversation on transformational technologies and their influence on our world.

Jim McCaughan,
CEO, Principal Global Investors
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Digital is proliferating in our world. Many of us can't go an hour, let alone a day, without our smartphones. We live parallel lives on social media sites like Facebook and Instagram. Our cars come equipped with infotainment systems, our homes with connected lights and thermostats. Intelligent personal assistants, like Amazon's Alexa or Apple's Siri, pay our bills and do our shopping. It's tempting to believe our digital age has peaked. But talk with anyone who's used Alexa or Siri, and you'll likely hear at least one humorous anecdote about misconstrued words or meaning. The reality is that the innovations we see today are only in their infancy. Digital transformation is just getting started. Technology is still poised to deliver dramatic disruption, and investors must be prepared.
What is 5G and what will it do?

As the next generation of mobile communications, 5G has the potential to radically change how we think about connectivity. Consider some of the advantages 5G will have over 4G networks: the ability to handle significantly more data at speeds up to 10 times faster than current standard rates, enough bandwidth to connect billions of people and trillions of “things,” greater than 99% service reliability, enhanced security, and greatly reduced energy demands.

With these features, 5G will enable tomorrow’s hyper-connected world, characterized by the global spread of smartphones and increasingly sophisticated applications for mobile technologies. It will be a world in which more and more objects are connected online, making our homes, cities, farms, and factories more efficient. Where adopted, 5G will be a critical enabler of innovation, bringing new products and services to market that will help people live better while also increasing productivity in sectors such as manufacturing and healthcare. Within this world, investment opportunities and threats will inevitably emerge, prompting critical questions around timing, location, and which industries stand to benefit the most.

A hyper-connected world

It may seem obvious to note that the world is becoming increasingly connected. However, the numbers really are staggering. By our estimation, over 2.9 billion smartphones will ship globally in 2022 alone. That's a projected 47% increase over 2018 forecasts and a 340% increase over 2012 figures. Price declines, even as phones are becoming more powerful, and the desire to access social networks are fueling this rapidly expanding market. Pay-as-you-go subscriptions are making smartphones more accessible to a growing global middle class in Latin America and Africa, as well as in markets like China and India. With the smartphone comes the ability to supplement learning, quickly locate jobs, access new forms of financial services, and complement entrepreneurial activities—all of which benefit local economies. But it also means that rising data traffic will continue crowding mobile networks, necessitating the move to 5G faster than we might think.

But beyond current device capabilities, 5G-enabled smartphones will support widespread adoption of emerging data-intensive technologies, such as mobile augmented reality (MAR). MAR, which overlays digital information onto the real world when viewed through a smartphone screen, will be a transformational technology, one that 57% of those under 34 said they are already using or would use in the future. Pokemon Go was an early, albeit simple, example. Far more sophisticated MAR applications are emerging, showing strong ROI potential. These include virtual grocery stores in China and Ikea Place, a furniture visualization app—both of which prefigure the new business models that will come about because of 5G connectivity.

From connecting billions of people to connecting trillions of things

Indeed, 5G will spur innovation outside of smartphones, as well. One of the key differentiators between 5G and earlier generations of cellular technology is its ability to scale the Internet of Things (IoT) — an umbrella term for many of the buzzed-about paradigms futurists envision, including:

**Smart Cities**—In a smart city everything is connected, from water pipes to street lights, cameras, public transport, and ambulances. 5G is the lauded technology that will allow all of these “things” to talk to each other, improving urban experiences and allowing cities to allocate resources more efficiently. We anticipate that this market will reach over $1.56 trillion by 2020, with widespread rollout of robust connectivity networks clearing the path for growth.

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5G in a nutshell
Overview of 5G Capabilities

<table>
<thead>
<tr>
<th>5G expectations</th>
<th>Enhanced Mobile Broadband</th>
<th>Massive IoT</th>
<th>Mission-Critical Control</th>
</tr>
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<tbody>
<tr>
<td>Increasing wireless capacity 1,000 times</td>
<td>Provides faster connectivity speeds and the ability to transfer more data</td>
<td>Supports trillions of connections globally and millions of connections within a relatively small geographic space</td>
<td>Enables applications for which failure or slow data transfer rates is not an option</td>
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<tr>
<td>Connecting 7 billion people</td>
<td>Application: Augmented reality and high-definition video streaming</td>
<td>Application: Smart Cities</td>
<td>Application: Autonomous Vehicles</td>
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<tr>
<td>Connecting up to 1 trillion “things”</td>
<td>Saving 90% energy</td>
<td>Ensuring 99% reliability</td>
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5G timeline
- **2020**: Initial rollout
- **2021**: Expansion into IoT
- **2025**: Expansion into mission critical applications

5G Tests, Trials, and Demonstrations Around the World

5G networks will drive three levels of connectivity: enhanced mobile broadband, massive Internet of Things (IoT), and mission critical applications—all of which will enable a range of technological innovations. However, the transition to 5G will require expanding the cellular communications spectrum into millimeter waves and integrating a number of new technologies into current networks. In addition to cell towers, networks will include thousands of small cell nodes scattered throughout a service area, allowing for significantly faster speeds and the ability to support a massive number of connections. Mobile network operators and mobile technology vendors are currently developing and testing 5G technology in a number of countries throughout the world.
Autonomous Vehicles—For a truly driverless future, hundreds of millions of vehicles will have to connect to each other as well as to road infrastructure through highly secure, ultra-reliable networks. 5G is already driving early government funding and regulatory approvals for autonomous vehicles in countries such as Japan, South Korea, and the United Kingdom. By 2025, 59.7% of automotive connectivity will be achieved through 5G and/or satellite networks, while phasing out connections using 4G and below will have already begun.⁴

Robotics and the Internet of Industrial Things—In the manufacturing sector, smart digital factories aim to integrate collaborative machines and robots that dynamically interact with each other in real time. Several technology vendors are partnering to mature this concept using 5G connectivity.

These are just a few of the connected scenarios representing the vast number of connected things that are expected to come online in the next decade because of 5G networks. These scenarios will radically change how goods are produced, supply chains are constructed, and space is made productive, among countless other outcomes we cannot yet imagine.

When we look at the global trajectory of smartphone adoption and innovation, as well as the growing Internet of Things, it's safe to say that industry sectors as diverse as manufacturing, healthcare, transportation and logistics, entertainment, and real estate (to name only a few) will be transformed, impacting allocations within current investment portfolios.

A timeline with challenges
To be sure, 5G development faces headwinds. Global standards needed for network interoperability will not be finalized until 2019. Large capital investments for network hardware will slow deployment. In developed countries, regulatory wrangling will almost certainly delay implementation in some areas, requiring governments and private entities to work closely together during rollout. In developing countries with extensive 4G network growth plans, like those in Latin America, mobile network operators will prioritize returns on their existing infrastructure investment over 5G upgrades. In developing countries that still face significant telecommunication infrastructure challenges, like many in Africa, the cost of 5G services will have to be made affordable to average citizens to justify implementation, even though the opportunities

Our Connected World

Over 2.9 billion new smartphones will be shipped in 2022 alone—that's a new smartphone for every 2 out of 5 people globally. Considering that the typical length of smartphone ownership before replacement is two years, total ownership numbers will be significantly higher.⁵

Our forecasts show that by 2022, there will be over 40 billion connected devices, doubling 2018 estimates in only 5 years.⁶ This means there will be an average of 5 devices for every person on earth (not including smartphones, tablets, or personal computers).

Source: Frost & Sullivan
to leapfrog to a 5G or 5G-ready 4G network are great. Further, no one is completely certain which business models will be successful for 5G—a question that only the future market will be able to answer.

Yet despite uncertainties, promising 5G pilots and trials are underway, with widespread commercialization due in 2020 in select cities and countries, such as South Korea, Japan, and the United States. China also has strong economic motivations to match the 2020 timeframe. However, full-scale, global rollouts will not occur quickly. Like previous cellular generations, networks will likely take a decade or more for full expansion: 4G launched around 2009 and, years later, only 17 countries have consistent network availability greater than 80% of the time.⁷

Implications for how we live

By 2020, there will be close to 5.7 billion mobile subscribers globally, many of whom will only have Internet access via their smartphones.⁸ This is important because both mobile technology and broadband have been linked to increases in per capita GDP, particularly for developing economies.⁹ Further, mobile communications is already playing a central role in ensuring financial security. In the U.S., money management apps have made budgeting fashionable. Financial technology (fintech) aimed at developing countries has produced innovative solutions for the unbanked. One such company is Branch, which offers loans to applicants in Africa based on mobile data-generated credit scores. Faster, more robust, and more secure connections from 5G would advance the delivery of these mobile financial services by integrating additional features, such as remote video interactions with financial advisors, allowing for a higher degree of personalization at a relatively low implementation cost. Overall stronger consumer money management will, in turn, help drive wealth creation for all levels of economic stratification.

5G will improve people’s quality of life in other ways as well. Some of the most compelling examples put forth are in healthcare. For instance, the U.S.-based

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startup Zipline is delivering medical supplies to Rwanda using drones that navigate with GPS and cellular services. 5G will enable expansion of this service by offering dedicated slices of a network for drone data transmission, ensuring that no interference compromises deliveries. The World Health Organization estimates that by 2030, the global shortage in healthcare professionals will exceed 14 million. 5G would take virtual healthcare solutions a step further. For example, long-distance telesurgery could become a lifesaving option in underserved communities. This is because 5G’s ultra-low latency will support what’s known as the Tactile Internet, so that a surgeon realizes no delay between actions performed in one location and video streaming from the patient’s location. Another example: Swansea University in the U.K. is preparing to test the use of 5G in smart bandages, which can alert doctors to the status of a wound as it heals, reducing hospital visits and unnecessary treatments. The point is that, with 5G on the horizon, these concepts are no longer the stuff of science fiction; they are real solutions being tried and tested in universities and R&D centers around the world.

**Economic implications**

Thus it's not an overstatement to say that 5G will enable digital disruption in the coming decades. We see this disruption converging with questions around productivity gains that have abounded since the global financial crisis. In the U.S., productivity slowdown has accompanied a slowdown in the accumulation of productive IT and software capital stock. As a result, the contribution of information technologies to economic growth has declined. In other words, slowed IT investment can be seen as one factor holding back the economy.

One explanation of this slowdown is that some economic sectors have not been pressed enough to invest in emerging IT technologies. In other words, the digital economy has yet to be fully unleashed. 5G will change this by becoming the catalyst for uptake in a range of transformational technologies already discussed (e.g., smart cities, autonomous vehicles, the IoT, smart manufacturing, and augmented reality), as well as other technologies that will benefit from hyper-connected, high-speed infrastructure for further evolution, such as artificial intelligence, big data, predictive analytics, and the blockchain. All it will take is the success of a few disrupters with 5G-based business models to prod incumbents to adapt, much in the same way that Amazon has forced Walmart to spend billions on eCommerce.

Our hypothesis suggests that 5G will help individuals and industries realize the value of emerging technologies. On the one hand, this value should be a positive factor influencing GDP. Countries and cities that are quicker to adopt 5G technology will benefit from larger gains in productivity output through higher utilization of assets. On the other hand, disruptions that have already emerged with the digital economy will likely accelerate: new business models will upend many industries; some workers will be displaced even as new jobs are produced; and greater productivity will lower consumer costs, creating disinflationary pressures. Importantly, despite anticipated investments in 5G and 5G-enabled IT, capital investments on the whole are likely to decline due to new efficiencies gained. When 5G comes online, we should brace for economic adjustments and realignment across industries. Transformation will bring both possibilities and challenges.

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The Internet revolution took over in the 1990s, accelerating business investments in IT-related capital from 1996 through the early 2000s. As a result, IT capital contributed both directly and indirectly to economic growth, as can be seen in higher pre-financial crisis multifactor productivity—a measure of efficiency partially tied to technological innovation. IT investments have remained slow in the wake of the global financial crisis, but 5G is primed to be the catalyst for renewed growth because it will provide the connectivity needed to take full advantage of other emerging technologies, such as big data, artificial intelligence, and augmented reality.

*Other capital includes R&D, entertainment originals, and other capital such as equipment, structures, intellectual property products, rental residential capital, inventories, and land.

*Source: Bureau of Labor Statistics; Bureau of Economic Analysis*
Implications for the investment community

Disruption brings with it the potential to find strong growth prospects. However, with 5G, as with any new technology, investors must remain realistic. While 5G will improve people’s lives and strengthen productivity, rollout will take time. It will likely be a decade or more until the widespread economic impacts of this technology are measurable on a global level. Further complicating the picture, like all previous mobile generations, rollout periods will be unique to each country and impacts will vary according to industry. Finding opportunities, then, becomes an issue of ongoing, active monitoring of regional, government, and industry landscapes. This applies to the telecommunications industry, as well as to industries that are poised for greater investment in 5G-enabled solutions. Successful long-term investment strategies will place a premium on those industries, companies, and countries that establish clear use cases for 5G early on and that position this technology as a strategic complement to additional technological pursuits, such as in artificial intelligence, big data, and predictive analytics.

As touched on earlier, 5G rollout will require significant network infrastructure investments. No one knows for certain what the total costs will be, but they are estimated to top over a trillion dollars globally. China alone is set to spend over $411 billion on 5G networks through 2030. Financing strategies will impact both mobile network operators and the network vendors that supply 5G technology. Thus, the issuance of corporate bonds to support 5G investments is highly probable. Given that use cases will be cemented as 5G rolls out, investors must remain attuned to sound business models to mitigate risk. Investors must also maintain a distinction between capital invested for 5G networks and ensuing technology, and capital invested elsewhere. The next wave of the digital economy will make what is already owned more productive and future investments more efficient, depressing growth in capital expenditure for both consumers and businesses alike.

Tracking the progress of 5G in developing countries will also be critical. Ensuring equitable deployment will be necessary to advance standards of living in these countries. It will also prevent the global digital divide from widening while supporting long-term sustainability and competitiveness. In turn, overall global economic health will be buoyed if 5G is rolled out universally. While issues around Internet censorship and corruption continue to slow progress, governments in developing countries are realizing the economic benefits of connectivity, which should lead to more public-private partnerships and bonds related to telecommunications infrastructure investment.

Successful long-term investment strategies will place a premium on those industries, companies, and countries that establish clear use cases for 5G early on and that position this technology as a strategic complement to additional technological pursuits.
In the Internet’s early days, we could not have envisioned the success of companies like Facebook or Amazon. When mobile networks were first being built, we could not have anticipated Uber or Airbnb nor could we have imagined the pivotal role smartphones would play in our daily lives. We are now on the brink of the next evolution in connectivity, and it will be foundational for a whole suite of emerging technologies. While it is impossible to predict all the implications this will have on our future, we do know that transformation will follow. We should prepare for the next wave of digital disruption.
End Notes


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