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# Artificial Intelligence and 5G Mobile Technology Can Drive Investment Opportunities in Emerging Markets

**By Peter Mockel and Baloko Makala**

The intersection of artificial intelligence and 5G mobile technology has enormous potential to deliver dramatic improvements in productivity, efficiency, and cost across business sectors and broader society, delivering innovative products and services not previously possible. Though mainstream applications that combine AI and 5G have yet to emerge, key emerging markets sectors such as agribusiness, healthcare and education will be transformed by the combination of AI and 5G. While many mobile operators remain focused on recouping their investments in previous network standards, there is a growing interest in 5G networks globally.

Artificial Intelligence (AI) refers to a growing body of computational techniques relating to computer systems capable of performing tasks that would otherwise require human intelligence. Examples include the diagnosis of diseases, solving complex mathematical equations, and analyzing electronic circuits.[1]

For the purpose of this note, we follow the definition and description of basic, advanced, and autonomous artificial intelligence put forward in previous EM Compass Notes.[2] Essentially, AI is the science and engineering of making machines intelligent, especially intelligent computer programs.[3] This also means that AI is not one type of machine or robot, but a series of approaches, methods, and technologies that display intelligent behavior by analyzing their environments and taking actions—with some degree of autonomy—to achieve specific objectives.

While AI alone offers innovations, it is the combination of AI and other technologies such as 5G that has the potential to profoundly transform society as we know it. Although a majority of emerging markets have not yet rolled out 5G networks, they can still reap some of the benefits of AI and cellular communication technology. Even with a 2G cellular network, various successful business models have emerged across emerging markets.[4]

## What is 5G Cellular Technology?

**The mobile communication industry is on the verge of yet another technological revolution: the fifth cellular technology generation, commonly referred to as 5G.** Unlike previous generations, 5G is expected to provide optimized support for a variety of different services, different traffic loads, and different end-user communities. 5G networks are anticipated to impact virtually all processes of everyday life and will be treated as critical national infrastructure.[5]

Higher spectral efficiency means that 5G networks can transmit more bits of data per second and per hertz of spectrum than previous cellular generations. This is

**About the Authors**

Peter Mockel, Principal Industry Specialist, Climate Strategy & Business Development, Economics and Private Sector Development, IFC. His email is pmockel@ifc.org.

Baloko Makala, Consultant, Thought Leadership, Economics and Private Sector Development, IFC. Her email is bmakala@worldbank.org.

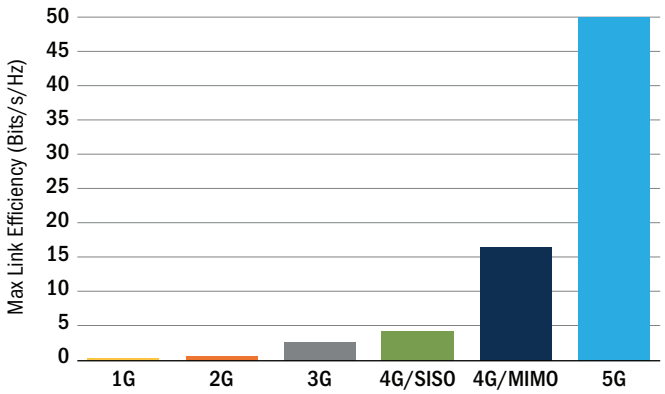


**FIGURE 1** Spectral Efficiency of Mobile Systems

*Source: Ortenga; Ortenga Blog at ortenga.com/2016-2/.*
*Note: SISO = single-input and single-output; MIMO = multiple-input and multiple-output.*

significant because spectrum is both scarce and expensive. Higher spectral efficiency means more concurrent users can be served at lower cost.

**Another key difference between 5G and earlier mobile network generations is the higher priority of Internet of Things, or IoT, applications.** Earlier generations served the IoT market through mobile modems that provided full-service access for machine-to-machine applications. That provided an adequate but expensive solution for high-value use cases, for example home alarms or industrial machinery monitoring. 5G introduces new network services dedicated to IoT that can be tailored to lower-cost and lower-bandwidth IoT applications, allowing efficient and low-cost blanket coverage of large fleets of IoT objects.

The Industrial IoT in particular will be an important factor in industrial competitiveness. There will be a direct link between the availability of 5G network services and economic development. Economies that lack 5G technology will find themselves at a clear disadvantage. With the expansion of 5G in urban core networks around the world, consumers are already experiencing a significant increase in their data rates as high as 1 Gigabit per second (Gbps) over the air. Below is a map of the roll-outs of 5G networks in cities around the world. Nonetheless, it is important to mention that in real-world transformation, 5G will continue to coexist with previous technologies for many years.[6]

**The transition between network generations is less sharp than it seems. As existing 4th generation networks are pushed to their limit in what is referred to as 4G LTE-A (Long Term Evolution – Advanced), the step change to the first 5G networks is more gradual.**

Indeed, the adoption of 5G in emerging markets will take time. In Sub-Saharan Africa, for example, 5G adoption

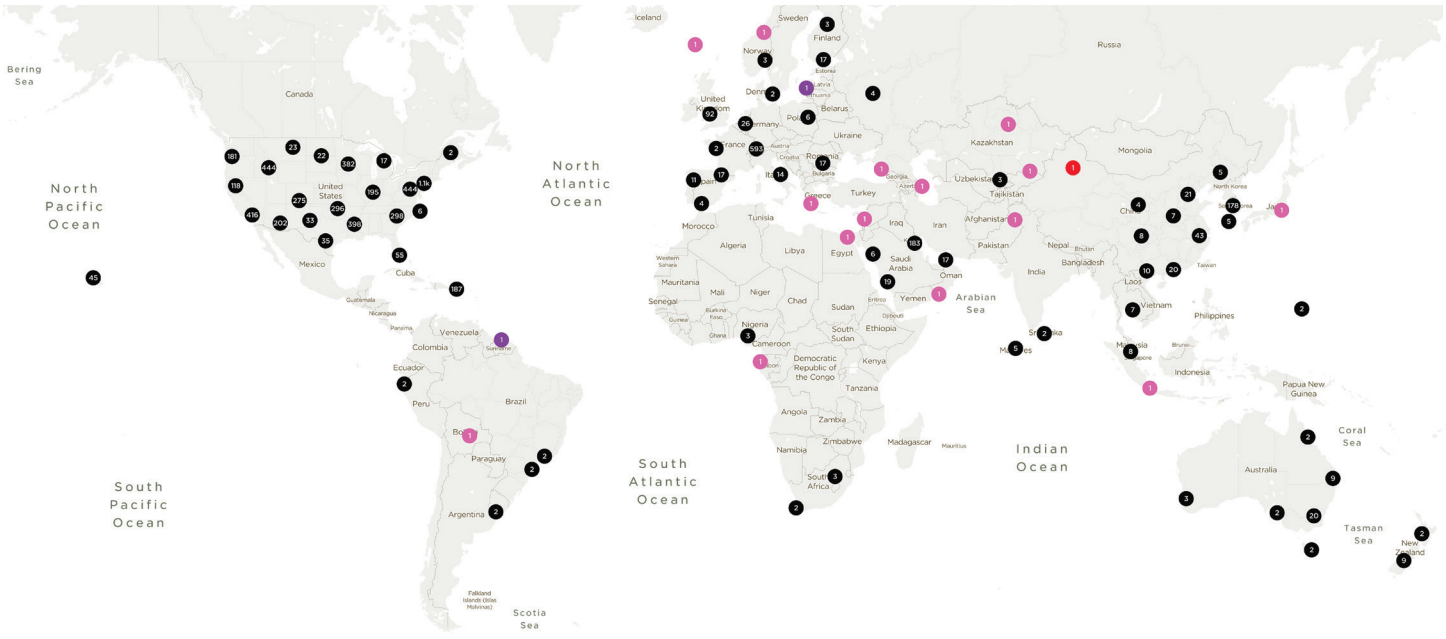


**FIGURE 2** 5G Roll-out in Cities Around the World

*Source: Ookla Interactive 5G Map. www.ookla.com. Note: Red indicates commercial availability, i.e. a 5G network is present and devices are available for consumers to purchase and use; purple indicates limited availability, i.e. a 5G network is present but devices are limited to select consumers; pink indicates pre-release, i.e. 5G network hardware is in place but is currently in testing and/or not yet accessible to consumers; dark blue dots indicate the number of multiple networks of any combination of red, purple, or pink that are revealed when zooming in in the interactive map showing, for example, the high number of such networks in Kuwait and in and around Kuwait City.*

| GENERATION | 2G EDGE | 3G HSPA | 3G HPSA+ | 4G LTE Cat 4 | 4G+ LTE-A Cat 6–16 | 5G |
|---|---|---|---|---|---|---|
| MAXIMAL SPEED | 0.3 Mbps | 7.2 Mbps | 41 Mbps | 150 Mbps | 300 Mbps–1 Gbps | 1–10 Gbps |
| AVERAGE SPEED | 0.1 Mbps | 1.5 Mbps | 4 Mbps | 15 Mbps | 30–90 Mbps | 150–200 Mbps |
| LATENCY IN SECONDS | 0.5 | 0.1 | | 0.05 | | 0.001 |

**FIGURE 3** Comparing Speeds of Different Generations From 2G to 5G

*Source: Authors.*
*Note: Mbps = Megabit per second; Gbps = Gigabit per second; HPSA = high speed packet access; LTE-A = Long Term Evolution - Advanced; Cat = Category. For detailed and accessible explanations see: https://kenstechtips.com/index.php/download-speeds-2g-3g-and-4g-actual-meaning.*

is not imminent.[7] Mobile operators are still recouping their investment in previous technology standards. Thus, it is expected that there will not be any large-scale 5G deployment before 2025, although 5G pilot testing is already underway in many markets.[8] In Egypt, it was reported that 5G would be used during the African Cup of Nations.[9] Cellular provider Rain South Africa launched the country's first 5G network in September 2019.[10]

Across the Latin America region, 18 5G trials were identified across the region as of August 2019.[11] However, it is anticipated that Latin America will trail the rest of the world in terms of 5G adoption with an 8 percent adoption rate by 2025. The future of 5G in the region is dependent on macroeconomic stability, government policies, and the use of 4G.[12]

In the Asia-Pacific region, on the other hand, the lack of clear business cases and lack of demand were identified as the main impediments to 5G adoption.[13] To illustrate this,

**BOX 1** 5G and Latency

In networks, latency describes the time it takes for a corresponding server to reply when a packet of data is sent. It is therefore different from the speed of downloading data packets. Why does reduced latency matter? Take an example of an automobile travelling at a speed of 50 mph using 4G LTE Cat 4 with a latency of 0.05 seconds. At this speed the vehicle would travel another 1 meter before the corresponding server would respond (the distance traveled in 0.05 seconds). With 5G, that latency would be reduced by 98 percent, to just one millisecond (0.001 seconds). During this reduced time the car would only travel 2 centimeters before the server responds. It can be argued that the reduced latency is at least as powerful as the increased speed of downloading in opening up new applications, as counterparts are reached faster and can reply faster.

multi-party video calls are just about practical with the current 4G networks, and they will also be one of the initial key applications for 5G, albeit with improved quality.

Beyond that, the first set of applications that are firmly outside the performance envelope of even the best 4G networks, and therefore require 5G, include autonomous driving, augmented reality, and online gaming with low latency.

## Potential of AI and 5G in Emerging Markets:

**The world is embracing a new era characterized by breakthroughs in emerging technologies,** the rise of artificial intelligence, and faster data rates, the combination of which is set to transform virtually all facets of everyday life through automation and machine-enabled decision making.

Undoubtedly, AI and 5G are set to become the engines of this new technological revolution. However, the majority of use cases that have been proposed for 5G involving AI cannot be considered true 5G use cases as they do not necessarily require a generational change. What will truly make the difference are applications that would leverage an improvement in latency reduction, that is, response time less than 1 millisecond.

The AI and 5G journey in emerging markets will most likely involve enhancing existing use cases[14] and the development of new ones that are yet to be addressed by current technologies. There are many applications that can be made possible as a result of the combination of AI and faster data rates supported by 5G networks. These include:

***Enhanced Mobile Communication Network and Services.*** **The provision of mobile communication services is becoming increasingly complex.** The roll-out of 5G networks is much more challenging than previous generations as it requires upgrades in radio, edge, transport, core, and cloud infrastructure that would ideally be optimally managed with AI to address the complexity associated with 5G networks and the billions of IoT devices these networks can support.

In addition, the combination of 5G and AI will bring about a host of new or improved technology applications and services. Entertainment is expected to become richer and more social thanks to high-speed connectivity capable of delivering holograms, augmented reality, and other virtual applications.

**AI and 5G represent a symbiotic combination and enable each other.** 5G relies on automated optimization based on AI algorithms. 5G is too complex to work with the static, manual planning optimization of earlier mobile network generations. 5G networks change their topology dynamically, responding to changes in traffic. The better the optimization works, the more efficiently the network will perform in terms of spectrum and energy use. For example, 5G relies on Self-Organizing Network (SON) technology. SON measures radio parameters such as path loss and throughput constantly for different frequencies, drawing conclusions about optimal performance and automatically adapting network settings.

As a result, mobile network operators are currently testing AI due to increased network complexity that requires an intelligent and automated approach.[15] It is expected that more than half of mobile operators will incorporate AI into their networks by the end of 2020.[16] According to the key findings of a study conducted by Ericsson, with 132 service providers globally as respondents,[17] AI is already being incorporated into cellular networks primarily because of a potential reduction in capital expenditures. Service providers testing AI are focused on several areas for potential improvements. These include cost reductions, network optimization, and increased revenue streams, which stand at 48 percent, 35 percent, and 41 percent improvement, respectively.[18]

Sub-Saharan Africa is the region with the highest mobile subscription growth rate globally. Subscription rates in the region are expected to grow at a compound annual growth rate (CAGR) of 5 percent, to over 900 million subscriptions between 2017 and 2023. That will lead to a penetration rate of 105 percent,[19] which indicates availability on average of more than one mobile phone per user. Digitalization is rising across the region and represents $10.5 billion in potential revenue by 2026 across key industries in Africa.[20] Affordability remains an important factor in the adoption of AI and 5G-enabled services in emerging markets. Most of the potential applications for these technologies in emerging markets hinge on the development of affordable network technologies in industries such as agriculture, education, health, mining, and others.[21]

Other examples for the pivotal role of AI in 5G network operations include:[22]

- Support Vector Machines (SVM) for path loss prediction models in urban environments.
- Machine learning for dynamic frequency and bandwidth allocation in self-organizing dense small cell deployments.
- Unsupervised learning for cooperative spectrum sensing.

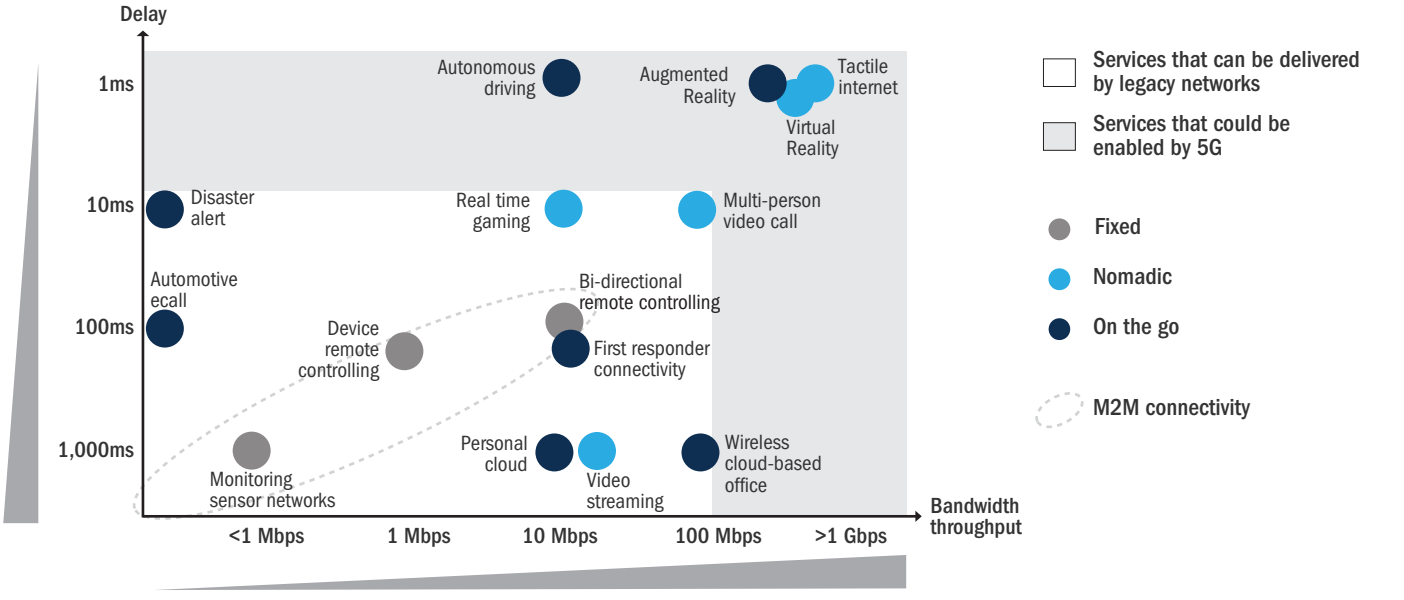


**FIGURE 4** Bandwidth and Latency Requirements of Potential 5G Use Cases

*Source: GSMA*

And AI applications are also dependent on 5G technology, requiring its ubiquitous, high-bandwidth, low-latency connectivity. While 5G improves on bandwidth, the technology's ability to cut response times represents a qualitative improvement for AI applications: Lower latency is not just a qualitative improvement for AI applications but a qualitative step change. In addition to radically reducing latency, 5G makes latency definable as a Quality of Service (QoS) parameter. That is, the network can guarantee response times, whereas earlier network generations delivered on a best-effort basis.

Taken together, higher bandwidth, ubiquitous availability, and guaranteed latency performance make it possible to run critical AI applications in real time. For example, vehicle-to-vehicle communication (V2V) for accident avoidance requires communication between fast-moving cars at guaranteed maximum latency.

If one car warns another car of an obstacle on the road, the system needs to rely on the message not being delayed by the network. In general, any application that requires acquisition of continuous high-volume data (for example, video) and the real-time control of assets based on their analysis will require a 5G network.

**Furthermore, AI is deemed to be vital for improved customer service and enhanced customer experience.** Because of AI, service providers anticipate recouping their investments in 5G.

## Potential 5G and AI Uses

From crisis-related challenges such as responses to natural or man-made catastrophes, or using drone capability for economic empowerment through use of low-altitude sensors to improve farming yields, AI-powered applications could leverage 5G networks and by doing so deliver real societal benefits and impact.[23]

Other potential and impactful uses include:

**The automotive industry, which is betting big on 5G connectivity and its potential when combined with AI.** Today, virtually every major car manufacturer has developed its own autonomous vehicle. Manufacturers such as Tesla and Toyota are testing self-driving vehicles. These vehicles rely on sensors to continuously detect their surroundings, first by identifying and classifying the information (perception), followed by acting on the information through autonomous control of the vehicle. The success of this new transportation business model will depend on the availability of network coverage, low latency, and fast connection speeds.

However, one of the most promising aspects of 5G is when it is used in combination with industrial IoT. That is, IoT used in a non-manufacturing environment, for example from windows and doors to air conditioning control hub units, and almost all objects and tools we use on a daily basis. Although 4G LTE could deliver on some of these requirements, only 5G can offer them all.

**Drones are another important application.** They represent a $100 billion market and have multiple applications, in particular public safety through information gathering and inspection in remote regions.[24] Drones also have been used across emerging markets to address different transport and logistical challenges.

In Argentina, for example, drones have been used in forest management to offer cost-effective, high-resolution imagery.[25] The World Economic Forum highlighted how Africa helped the drone industry get off the ground as the continent is experiencing a drone revolution with pioneers using drones to address various challenges.[26] For example, the U.S. startup Zipline, in partnership with the Rwandan government, made headlines with the first delivery of blood supplies to remote medical facilities.

Drones require high-speed connectivity in order to perform command and control, media sharing, and autonomous flying. 5G networks are well placed to provide machine-to-machine connectivity while meeting stringent requirements of latency, throughput, capacity, and availability.[27]

HAWK 30 drone, an Alphabet-backed project developed at the University of Hawaii, is a solar-powered drone beaming a 5G signal that can fly non-stop for six months at a time. The project is currently in testing phase.[28]

In South Korea, drone manufacturer Percepto developed drone-in-a-box systems that are designed for industrial and enterprise applications in areas such as security optimization or business operations using aerial visual insights while reducing risk and operational costs. Percepto recently demonstrated autonomous drones using SK Telecom's 5G trial network.[29]

**Public safety and security** will benefit from the proliferation of IoT devices. The main impediments to the emergence of a "smart city" have been speed and bandwidth. The combination of IoT devices and 5G through advances in analytics and AI could enable applications around public transit law enforcement. In 2017, U.S. fire and police agencies acquired drones for proactive policing. In China, at the 2019 "5G is ON" summit, the China Mobile Industrial Research Institute project, in which 5G drones provide firefighting support, was bestowed a Mobile Internet Innovation Pioneer award.

**Utilities and Energy.** Smart meters are already commonplace in many households around the world. The modernization of smart grids is becoming an imperative in order to reduce hydropower generation inefficiencies, fault prediction, decision making, theft prevention, and load balancing. Data communication has been critical to efficient power generation and consumption. AI is expected to be an important component in this effort, as the increasing use of sensors means a constant demand for faster data speeds. This could be a possible application for AI and 5G, although the energy sector appears to be following a modest adoption of 5G because of the reluctance of utilities to test new technologies.[30]

In **agriculture**, smart farming is not an option but a necessity if the industry is to keep pace with a growing world population, particularly at a time when crop yields are being affected by climate change. Sensor technology is already being used in agriculture through IoT devices that allow farmers to better measure critical factors such as moisture, fertilization, and weather patterns. Global technology company XAG develops drones, IoT, AI, and other digital tools to help farmers effectively grow high-quality produce without excessive pressure on the environment.[31] High speed connectivity in rural areas remains a challenge, however, which is an obstacle for 5G to address.

AI in **healthcare** offers new avenues to solve health challenges. For example, Ada Health has developed a chatbot in Swahili that helps patients and doctors diagnose diseases ranging from malaria to diabetes.[32] The combination of fast data speeds and AI could bolster healthcare quality, particularly when AI is already used in the detection of diseases or in the reduction of costs. Other applications in healthcare that would require high-speed connectivity include remote-control surgery, as well as downloading large data files, as the healthcare industry generates massive amount of data daily, including heavy imagery such as MRI, CAT, and PET scans. The resulting data in turn could be processed using AI for faster diagnosis and treatment. Real-time remote monitoring and sensor innovation aimed at developing do-it-yourself innovation would place medical devices in the hand of patients who would be able to monitor their health at home.[33]

The global market for AI in **education** is expected to reach $2 billion globally by 2023, which represents a 38 percent annual growth rate from 2018 to 2023. While emerging markets constitute just a fraction of this market, they are seeing growth, too. In Africa, for example, the eLearning sector is in full expansion with a market size of $530 million in 2017, which is expected to reach $1.4 billion by 2022. The use of AI is limited in this sector, but there is considerable potential.

The combination of AI and 5G can help make immersive education methods such as virtual reality possible, as many such methods require high bandwidth and low latency to perform optimally. With 5G, download speeds could be reduced to seconds, freeing teachers to use their time in other areas. In addition, IoT devices can be used to automate administrative tasks.[34]

## Challenges and Next Steps

AI and 5G represent a powerful combination of technologies that will be the engine of the Fourth Industrial Revolution. However, true applications for the combination of AI and 5G that would trigger massive adoption have yet to emerge. Also, the adoption of both technologies has associated challenges.

Artificial intelligence is already having a profound impact on business and industrial processes where machines are taking over tasks previously performed by humans. The ongoing ethical debate around AI aside, there is now an urgency to prepare and/or reskill current and future labor forces in preparation for the job displacement that will result from the intersection of AI and 5G, as together they offer a level of productivity and efficiency that humans cannot match. Therefore, the focus of retraining and reskilling should be on human skills that machines cannot model.

5G is part of a succession of cellular technology standards that have transformed the way we communicate—and indeed the way we live. Each of these generations brought about a key differentiator that has had a transformative impact on consumers' communication experiences, yet each also exhibited weakness that would be addressed by the following generation. Some of these standards are still relevant today. For example, primary 2G mobile brought digital telephony and messaging. Successful business models were built on the back of this standard. M-Pesa, a Kenyan mobile fintech application, is arguably one of the most successful business models leveraging 2G cellular technology. However, 2G network data rates are very low and can barely support internet connectivity. The advent of 3G and 4G connectivity enabled faster data transmission, and both standards will remain dominant in emerging markets until at least 2025, which will delay the development and adoption of 5G in those regions.

**Spectrum availability is currently a challenge to the growth of 5G.** The power and speed of 5G rest on the frequency used. One way to circumvent spectrum-related challenges is to use frequencies with lower bandwidths that may have advantageous properties. For instance, a frequency of 600 MHz may not lose power quickly and therefore can easily reach 5G phones while overcoming physical obstacles such as thick walls.

Also, the 5G standard is very expensive to implement. Many mobile operators in Africa and elsewhere have yet to make an investment in infrastructure supporting 5G because of the significant capital costs involved and the lack of a clear business model that would recoup the investment. Operators would need to upgrade base stations, add new base stations, and upgrade the backhaul high-speed, high-capacity mobile access networks (4G, 5G etc.) that are often not available in emerging markets. That renders the investment hurdle even higher, as not only will operators have to implement 5G radio technology, they will also have to upgrade their networks end to end. In contrast, operators in advanced markets will have already made extensive progress.

5G also poses unique security challenges because the role of equipment integrators will be much larger than for previous generations of mobile technologies. The security risks will increase significantly as 5G architecture pushes functionality that was once at the core of networks out to the "edges" where it is more difficult to control and more vulnerable to tampering. With the sheer number of connected devices, the number of unsecured and compromised devices will increase. These could be used for nefarious purposes, for example in the case of a distributed denial-of-service, or DDoS, attack. In addition, the volume of data generated will increase the difficulty of detecting abnormal or malicious traffic. Aside from these technical concerns, a greater share of the global economic output that would depend on the data generated will be at greater risk.[35]

Currently, AI and 5G are at the center of geopolitical tensions. These tensions have given momentum to a race for technological innovation dominance in a 5G-enabled world. Regardless of who wins that race, there is a call for close collaboration between developers and other actors in the cellular communication ecosystem to come up with solid 5G use cases and appropriate implementation models. Previous network generations will not disappear overnight because of the advent of 5G. It is therefore important for operators to devise a clear strategy toward a 5G-enabled digital ecosystem and paths to maximize returns on investment.

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**Please see the following additional reports and EM Compass Notes about technology and its role in emerging markets:** *Reinventing Business Through Disruptive Technologies - Sector Trends and Investment Opportunities for Firms in Emerging Markets* (March 2019); *Blockchain: Opportunities for Private Enterprises in Emerging Markets* (January 2019); *How Artificial Intelligence is Making Transport Safer, Cleaner, More Reliable and Efficient in Emerging Markets* (Note 75, November 2019); *Bridging the Trust Gap: Blockchain's Potential to Restore Trust in Artificial Intelligence in Support of New Business Models* (Note 74, Oct 2019); *Artificial Intelligence: Investment Trends and Selected Industry Uses* (Note 71, Sept 2019); *The Role of Artificial Intelligence in Supporting Development in Emerging Markets* (Note 69, July 2019).

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