



5G Is Going Live in Country After Country

Telecom Industry Forecasts

As 5G is switched on in one country after another, the significance of this technology for all sectors of society will become increasingly apparent. The June 2019 edition of “Ericsson Mobility Report” [1] presents a glimpse of the impressive progress in the mobile telecommunication market, now on the verge of deploying 5G. The report forecasts 1.9 billion 5G subscriptions by the end of 2024. That’s up from 1.5 billion forecast in the November 2018 edition, an increase of almost 27%.

Other forecasts have also increased notably due to the rapid 5G uptake. It is expected that 5G coverage will reach 45% of the world’s population by the end of 2024. This could surge to 65%, as spectrum-sharing technology enables 5G deployment on LTE frequency bands.

Communication service providers in several markets have switched on 5G following the launch of 5G-compatible smartphones. Service providers in some markets are also setting more ambitious targets for population coverage of up to 90% within the first year.

The strong commitment of chipset and device vendors is also key to the acceleration of 5G adoption. Smartphones for all main spectrum bands are slated to hit the market

over the course of this year. As 5G devices increasingly become available and more 5G networks go live, over 10 million 5G subscriptions are projected worldwide by the end of 2019.

The rise in 5G subscriptions is expected to be fastest in North America, with 63% of anticipated mobile subscriptions in the region being for 5G in 2024. Northeast Asia follows in second place (47%) with Europe in third (40%).

The total mobile data traffic continued to soar globally in the first quarter of 2019, up 82% year on year. It is predicted to reach 131 exabytes per month by the end of 2024, when 35% of traffic is projected to be over 5G networks. The number of cellular Internet of Things (IoT) connections is expected to rise from the current 1 billion to 4.1 billion by the end of 2024, of which 45% will involve massive IoT. Industries using massive IoT include utilities with smart metering, health care in the form of medical wearables, and transport with tracking sensors.

The June 2019 report also features three articles written jointly with service providers that offer a glimpse of the progress being made in markets on the verge of deploying or already deploying 5G. Ericsson, with Telstra in Australia, is exploring ways to manage the ever-growing demand for data and video while maintaining a satisfactory consumer experience, particularly for live-

content streaming. Meanwhile, Mobile TeleSystems, a mobile network operator in Russia, is looking at how mobile networks should evolve to ensure that network performance meets customer expectations during preparations for 5G. The article cowritten with Turkcell in Turkey looks at how network performance and service offerings are managed in a successful fixed wireless access implementation.

Global Rollouts of 5G

Nokia announced that the company has confirmed 42 commercial 5G deals (more than have been announced by any other vendor) across the globe. These deals include 22 well-known customers, such as T-Mobile, Telia, and Softbank. Including these agreements, Nokia’s 5G deals, trials, and demonstrations amount to more than 100 5G customer engagements to date. Since the announcement of the 30th commercial 5G contract at the end of March 2019, the company has seen an average of one major contract win each week, with a steady pipeline in place for further agreements.

Nokia’s ability to deliver on crucial network transformation goals has been rewarded by the confidence shown by its existing customers. To date, every 4G customer that has come to Nokia to investigate how the company may work with them for 5G has selected Nokia as a vendor;

cumulatively, Nokia believes that it will have a higher share with these customers in 5G than it had in 4G.

With an end-to-end portfolio that is unique in the industry, Nokia can work in partnership with operators to deliver “real 5G.” Nokia’s in-house 5G millimeter-wave (mm-wave) small cells and AirScale base transceiver station provide indoor and outdoor coverage, while the company’s microwave Anyhaul cloud native radio-access network, antennas, and 5G cloud-native core are part of approximately half of its agreements to date. Beyond the company’s mobile networks portfolio, Nokia offers excellent FP4 network processor-based Internet protocol (IP) routers and Photonic Service Engine 3 chipset-powered optical networking. Nokia’s customers can use its network services platform to make this into a full 5G-strength software-defined connectivity “smart network fabric,” secured by Nokia Security Orchestration, Analytics, and Response technology to ensure resilient 5G.

Early rollouts of 5G have been well publicized in North America, Korea, and Europe, and Nokia is looking forward to announcing its work with operators in emerging nations and regions, such as India and Latin America, over the coming months.

5G in the United States

Sprint has announced that the company’s on-the-go customers are among the first in the world to experience the power and performance of True Mobile 5G, with the largest initial 5G coverage footprint in the United States.

The next generation of wireless service is here, delivering extremely fast speeds in Los Angeles; New York City; Phoenix, Arizona; and Washington, D.C., and surrounding areas. True Mobile 5G from Sprint is set to power new experiences for wireless customers, from gaming and entertainment services to IoT and business applications. As of 27 August 2019, Sprint’s customers can

enjoy Hatch mobile cloud gaming on Sprint’s 5G smartphones.

Sprint’s True Mobile 5G service is now available in nine U.S. markets. In May, Sprint launched 5G service in Atlanta, Georgia; Dallas–Fort Worth, Texas; and Kansas City, Missouri, and their surrounding areas. By mid-July, service was available in Chicago. Sprint True Mobile 5G covers around 2,100 mi², with approximately 11 million people expected to soon be covered in total across all nine market areas, more than any other U.S. carrier to date.

Today, Sprint True Mobile 5G is delivering faster download speeds, with Ookla’s Speedtest Intelligence data showing that Sprint’s average 5G download speed of 203.8 Mb/s is nearly six times faster than Sprint’s average LTE download speed of 35.2 Mb/s. Looking ahead, Sprint 5G will power new experiences for wireless customers across a range of industries, including energy, health care, manufacturing, finance, insurance, transportation, and hospitality.

At the foundation of Sprint 5G is massive multiple-input, multiple-output (MIMO), a breakthrough technology that dramatically improves network capacity. In Los Angeles, New York City, Phoenix, and Washington, D.C., Sprint is using 64T64R (64 transmitters and 64 receivers) 5G massive-MIMO radios from Nokia. These radios support a feature called *split-mode* that enables Sprint to simultaneously deliver LTE Advanced and 5G New Radio (NR) service. Sprint’s 5G massive MIMO radios run on its 2.5-GHz midband spectrum, and they are deployed on Sprint’s existing 4G cell sites, providing a nearly identical footprint for both 2.5-GHz LTE and 5G NR coverage.

As Sprint launches True Mobile 5G in metropolitan areas of nine U.S. markets, the company continues to advocate for a merger with T-Mobile to accelerate the deployment of a ubiquitous, nationwide 5G network that includes coverage in rural locations. The combined company will have the resources and technology

to build a 5G network that fuels innovation across every industry, dramatically increasing competition, allowing new economic growth, and creating thousands of jobs and billions of dollars in U.S. economic value. Together, the combined company will lead the world in next-generation technology services and applications, bringing 5G service to nearly all Americans. For additional information, visit Sprint’s website [2].

5G in Alaska

Alaska’s largest telecommunications company, General Communication Inc. (GCI), has selected Ericsson to build the nation’s northernmost 5G network, which is scheduled to launch in 2020 in Anchorage. This marks Ericsson’s 22nd announced 5G contract [3]. GCI will deploy Ericsson’s 3rd Generation Partnership Project standards-based 5G NR hardware and software to 82 macrocell sites across the Municipality of Anchorage. Those sites will be supported by backhaul services provided by GCI’s metro fiber network.

GCI’s 5G deployment will support local government efforts to develop the northernmost smart city in the United States. The Municipality of Anchorage already uses a light grid to improve efficiency for municipal streetlights and is exploring programs that rely on automated systems and connectivity to deliver services more efficiently to residents. The project will be completed in 2020 with GCI’s initial 5G service coming online in the first half of the year.

5G in London

Ericsson’s 5G technology was at the heart of Vodafone UK’s launch of 5G for consumer and business customers in London on 3 July 2019. Featuring spectacular cityscape views, London’s Sky Garden hosted a launch event powered by Ericsson 5G technology, including a virtual demonstration with highlights from the latest Ericsson ConsumerLab report “5G Consumer Potential” [4].

In London, Ericsson will provide comprehensive 5G coverage based on the latest Ericsson radio system portfolio. This includes the latest Baseband 6630 and Massive MIMO 6488 products to enable 5G on the 3.5-GHz band. Combined with LTE, this will achieve data speeds up to 10 × faster than 4G for 5G users with much lower latency.

Ericsson Radio System's unique dynamic spectrum-sharing functionality will also enable Vodafone to extend 5G coverage over a wide area, leveraging 4G spectrum on the existing Ericsson radio system infrastructure.

In accordance with the "5G Consumer Potential" report findings, access to 5G connectivity is hotly anticipated by U.K. consumers, who expect to use 10–12 × more mobile data on average on new 5G devices. Vodafone UK's 5G launch will be welcomed by the four out of every 10 subscribers identified by the research who face issues caused by network congestion in crowded and dense urban areas.

5G in Australia

Ericsson has announced that the company and Telstra have successfully completed Australia's first end-to-end 5G stand-alone call at Telstra's 5G Innovation Center on Australia's Gold Coast, accelerating progress down the 5G evolution path. The call was conducted over the 3.6-GHz spectrum using Ericsson's Baseband 6630, Radio AIR6488, and a 5G stand-alone device based on a MediaTek chipset. This milestone follows Ericsson's recent announcement of cutting-edge, stand-alone NR software that enables superfast response times and new capabilities to rapidly extend 5G coverage.

5G stand-alone, which is likely to become the architecture of 5G wireless networks, increases network efficiency and helps in the development of new use cases. It will be the building block of Industry 4.0, where efficient connectivity characterized by 5G's low latency, flexibility, and data speed will drive new technologies and industries. To date, Telstra

has launched 5G in 10 cities. This number will increase to at least 35 cities in the next 12 months.

5G in Moscow

Ericsson announced that the company and Tele2 have launched Russia's first 5G zone in central Moscow on Tele2's commercial network, setting in motion an agreement the two companies signed in June. The nonstop outdoor 5G coverage is live on Tverskaya Street, the busiest part of the Russian capital, stretching from Red Square to the Sadovoe Ring.

The area is ready for all kinds of demonstrations exploring the opportunities of 5G, including immersive virtual reality (VR) entertainment, smart buildings, and other consumer and industrial use cases where high data speed and ultralow latency are deemed critical.

The 5G pilot zone is deployed in the 28-GHz band in nonstand-alone mode, the frequency band for anchor LTE band is Band 7 (2,600 MHz), and the 5G pocket routers supporting 28 GHz are employed as end-user devices for mobile broadband services with ultrahigh data speeds.

Tele2 and Ericsson signed an agreement to deploy 5G technologies in Russia at the Mobile World Congress in Barcelona earlier this year [5]. Under the terms of the agreement, more than 50,000 base stations will be deployed across 27 regions in Russia as part of a five-year network-modernization deal. At the St. Petersburg International Economic Forum held this past June, the partners also signed a memorandum of agreement to launch a joint 5G trial zone in Moscow.

The deployment of a 5G network is a priority of the Russian government. According to the Digital Economy of Russian Federation national program, the establishment of robust 5G communication in all main cities of Russia by 2024 is crucial.

5G Smartphones

On 8 August 2019, Samsung Electronics unveiled the Galaxy Note10, a new

line of premium smartphones that combine elegant design with powerful performance and productivity tools. With the new smartphones, Galaxy Note10 and Note10+, the company designed a mobile experience that is like a computer, a gaming console, a movie-tech camera, and an intelligent pen, all in one device.

One week later, Samsung Electronics announced that the new Galaxy Note10+ 5G received the number-one ranking on the DxOMark for both its front-facing and rear-facing cameras as well as the top score for video. The DxOMark scale provides a ranking system to evaluate the image and video quality of smartphone cameras [6].

The Galaxy Note10 and Galaxy Note10+, state-of-the-art tools for capturing superior video and photos, have been built with content creators and everyday users in mind. Through a combination of advanced imaging technology and software, the Galaxy Note10 takes videography and photography to a new level, enabling users to make a bigger impact with their social media channels, stories, and posts.

The Galaxy Note10+ 5G won first place on the DxOMark Selfie scale for its front-facing camera with a score of 99. It placed first for its rear-facing camera with an overall mobile score of 113.

Galaxy Note10 users can also edit on the go, without having to connect to their PC. The native video editor enables easy editing functionality on the phone. With the S Pen, users can choose the precise moment they want to trim. Additional features, including a screen recorder, Doodle AR, a 3D scanner, and night mode on the front-facing camera, round out an upgraded Galaxy Note10 camera experience.

5G Car Manufacturing

Ericsson has announced that the company is teaming up with Telefónica Germany to enable 5G car production for Mercedes-Benz via a private 5G network at the company's Sindelfingen plant in southern Germany.

All production systems and machines in the new Factory 56 will be connected and operated via secure 5G with gigabit data rates and almost real-time latency while handling large amounts of data. The 5G network will enable Mercedes-Benz to boost flexibility, production precision, and efficiency as industry digitalization and the IoT become a reality in car production.

The 5G network will facilitate data linking or product tracking on the assembly line. All processes will be optimized and made more robust and will be able to be adapted at short notice to fit market requirements. As a private 5G network, the intelligent connection of production systems and machines in Factory 56 will be done in a secure way.

Ericsson and Telefónica Germany are building the network, made up of products from Ericsson's Private Networks products, in the 20,000-m² complex and will hand it over to Mercedes-Benz upon completion for operation. Mercedes-Benz says experiences gained from Factory 56 will be incorporated into plans for future 5G implementation in other plants.

3D Holographic Communications

Vodafone Portugal has made a 5G hologram call to *Televisão Independente* (TVI) Studios in Lisbon using Ericsson's cutting-edge 5G technology. This exciting demonstration allowed a reporter to appear at the Vodafone Paredes de Coura festival in hologram form on national news. The high-definition hologram showed an interaction with the chief technology officer of Vodafone, João Nascimento, in 3D with minimal transmission latency. This means that there was minimal delay in the interaction, despite the huge amount of data being transmitted, a key benefit of 5G.

To make this happen at one of Portugal's largest festivals, Musion 3D provided high-definition audio/video images of the reporter from TVI studios in Lisbon, which were then transmitted through the Vodafone

Portugal 5G network to Paredes de Coura. Ericsson supplied the 5G end-to-end equipment, including a virtual Evolved Packet Core in a Box, and two 5G NR AIR 6488 radios, an Ericsson Router 6000, and 4G radios for the non-stand-alone NR anchor band.

This holographic call was particularly exciting to festival goers in Portugal, as they got to experience what 5G from Vodafone Portugal and Ericsson will look like as it emerges in the country.

5G Remote Surgery

China Mobile and Huawei received the Asia Mobile Award for the world's first successful 5G remote surgery on a human patient. This was enabled by a 5G deterministic network (DN). The award was announced during the 2019 Global System for Mobile Communications Association Asia Mobile Award ceremony, which was held in conjunction with the Mobile World Congress Shanghai 2019 (MWC'19 Shanghai).

The 5G DN was built jointly by China Mobile and Huawei for China's 301 Hospital (also known as People's Liberation Army General Hospital). With its "differentiated and deterministic" network capability, the 5G DN guarantees the stability required to perform this surgery, which took 3 h and was accomplished 3,000 km from Beijing in Hainan. 5G remote surgery is an effective means for China to flexibly provide high-quality medical resources to less-developed regions.

The 5G DN technology addresses the requirements set by United Nations' Sustainable Development Goal 3: to ensure healthy lives and promote well-being for all at all ages.

5G Core Technology Trends

On 17 July, ZTE released a white paper, "5G Core Technology Trend" [7]. Based on current 5G standards and the development status of 5G-related industries, it presents an in-depth analysis and exploration of the problems and challenges of developing the 5G industry. The report shares knowledge and insights about

5G core technology trends from the perspective of core networks. As a key element of the 5G network, the evolution and development of 5G core technologies play a vital role in promoting the maturity of related technologies, such as for the Internet of Everything (IoE), industrial intelligence, and automatic driving.

According to the white paper, the development of 5G is accompanied by a boom in artificial intelligence (AI), the IoT, cloud-computing, big data, network-slicing, and edge-computing technologies. Therefore, the research and innovation related to 5G core technologies must focus on massive connections, service-based architecture enhancement (SBA+), slice networks, decentralization deployment, AI operation and maintenance (O&M), and simplified network convergence. This will foster the evolution from mobile Internet to the IoE, cloud ready to cloud native, single networks to slice networks, core computing to edge computing, manual O&M to AI O&M, and non-stand-alone to stand-alone networks. Thus, 5G networks, when their full potential is harnessed, will promote the vigorous development of new vertical industries.

By virtue of the research and deep understanding of 5G core technological trends, ZTE has been committed to building new 5G core technological capabilities. ZTE takes the lead in launching the industry's first SBA+-based 2G/3G/4G/5G fully converged common core. Currently, the company has cooperated with more than 60 operators worldwide in 5G and accumulated ample experience in providing products and services for the commercial deployment of 5G networks across the globe.

Automated Guided Vehicles

MWC'19 Shanghai is Asia's leading event for next-generation technology, including 5G, the IoT, AI, and big data. At the event, held in Shanghai from 26 to 28 June, Ericsson and China Mobile demonstrated an automated guided vehicle (AGV)

prototype on an end-to-end, stand-alone 5G network.

With the growing adoption of industry digitalization and improvements in industrial automation and intelligence, AGVs are coming into wider use in manufacturing and at ports. The powerful mobility management of 5G networks, their seamless coverage, and quality-of-service assurance enable 5G networks to provide the reliable data communication infrastructure needed for various AGV applications, i.e., tractors, pallet movers, and forklifts.

The AGV prototype that China Mobile and Ericsson demonstrated at MWC'19 Shanghai shows how AGV technology helps automate product testing using a 5G network. This validates the idea that stand-alone 5G architecture can adequately be used for industry digitalization.

Public Safety Radio Networks

Security is essential when it comes to preventing unauthorized activities on mission-critical communication networks, radios, and equipment. On 12 August 2019, Motorola Solutions announced two new security solutions for Astro 25 radio networks: Avigilon video for radio site security and the KVL 5000 key variable loader for secure communications.

Astro 25 systems are built at various sites located throughout a city, county, or state. The NR site video service, using Avigilon cameras, is designed to secure remote sites from theft, vandalism, or damage from natural events, such as floods. This service will allow site owners and operators to record activities in and around the site. The full offering will include hardware, software, and services provided by Motorola Solutions and is expected to be available by the end of this year.

The KVL 5000 provides encryption key loading and encryption algorithm loading for Motorola's P25 two-way radios and secure-infrastructure components. The device was built based on direct input from public-safety professionals. It is easy

to use and designed to be held in one hand. It has an intuitive touchscreen interface that allows users to quickly and securely generate, transport, and load encryption keys into communication products.

Wi-Fi 6 Products

Qualcomm Technologies introduced the Qualcomm Networking Pro Series platforms, its second-generation Wi-Fi 6 networking products. These are designed to deliver superior Wi-Fi 6 connectivity experience across the widest range of applications.

At Qualcomm Wi-Fi 6 Day in San Francisco, executives demonstrated the Qualcomm Networking Pro Series, comprising four platforms (the 1200, 800, 600, and 400), distinguished by format, scale of application, and computing needs. The platforms leverage the company's unique Wi-Fi 6 architecture and approach. Designed for densely congested networks, they deliver high performance while accommodating hundreds of devices without degrading user experience.

Modern networks are overwhelmed by the number of devices and data demands placed on them today in the most densely populated environments. Networks must meet expectations for high bandwidth, low latency, and fair and simultaneous access. This challenge demands a new architectural approach to wireless-networking silicon optimized for this environment. The Qualcomm Networking Pro Series platforms are built for the dense connectivity requirements of modern Wi-Fi networks, with Wi-Fi 6 features offering increased network capacity for high-density environments, such as university lecture halls, malls, stadiums, and office buildings.

Digital Future of Airports

Huawei and ABI Research have jointly released "The Digital Future of Airports," [8] a white paper that elaborates on the roles of 5G and mobile broadband in supporting digital air-

ports. According to the white paper, indoor digitalization is the only way for indoor transitioning to 5G and represents the best choice for providing 5G coverage in airports.

The white paper points out how airports, as transportation hubs, are the industry trendsetters for digital transformation. Due to rapidly increasing passenger traffic and the emergence of new services, airport networks require enhanced connectivity capabilities as they adapt to new technologies. These include ultrahigh data speed, large-scale connectivity, security and efficiency, mobility, and scalability.

Currently, wireless network technologies used by airports include cellular networks, Wi-Fi, Bluetooth, and Project 25. Considering such factors as performance, cost, and support for future technology, 5G differentiates itself by essentially supporting the construction of digital airports and solving network-connection challenges.

The white paper also shows how traditional distributed antenna systems can neither satisfy the needs of digital airports nor enable smooth transitions to 5G. The digital indoor system offers both large capacity and scalability, delivers premium experiences, and adequately supports the transition to 5G. Having already been deployed at numerous large airports around the world, it is the ideal choice for 5G-fueled digital airports.

Drone Applications

Japan's NTT Docomo has announced that the company, together with its capital affiliate Far EasTone Telecommunications (FET), one of Taiwan's largest mobile operators, has successfully tested the Docomo Sky service for inspecting base-station towers in Taiwan. The service uses drones to photograph the towers and then wirelessly communicate the information to a command center in real time. This is the second overseas deployment of Docomo Sky, following Indonesia.

The first test, conducted on 20 June 2019 in the Hsinchu area of northwestern Taiwan, involved checking FET's towers for equipment damage and rust using images taken by drones. The test results, which were compared with the results of conventional inspections, confirmed that towers could be inspected in just one-third the time while significantly lowering related safety risks. Further tests are being conducted to confirm the service's comprehensive effectiveness.

The overall tests are expected to verify the service's effectiveness in realizing safe and efficient inspections. Personnel in the field typically are required to climb base-station towers to perform inspections. With the advanced drone service, FET is hoping to reduce the associated personnel costs and safety risks.

The service being tested is based on the Docomo Sky service now operating in Japan. Docomo is providing FET with a cloud platform for operational support and data analysis and a ground-control station application that enables drone operators to easily input flight data. The drones fly automatically, take photos, and transmit the images via the platform in real time, enabling technicians to inspect the towers via the Docomo Sky website immediately.

Docomo is expanding its drone-related businesses on a global scale in fields where demand is high. Docomo will continue to develop and enhance its advanced drone services, one of many ways the company aims to serve society by leveraging its mobile-network technologies, platform businesses, and related technical assets and expertise.

News from 5G Americas

5G Americas, the industry trade association and voice of 5G and LTE for the Americas, announced on 15 August 2019 the publication of "Advanced Antenna Systems for 5G," [9] a white paper exploring current trends in technology and spectrum enhancements for advanced antenna systems that will increase

data speeds, expand coverage, and improve user experiences.

The white paper identifies how advanced antenna systems will be commercialized, provides technical details regarding the increasing complexity of wireless antenna systems, and illustrates how they are central to the development and deployment of 5G networks. Specifically, the report provides considerations on the following:

- how improvements in beamforming and beam management (beam switching, recovery, and refinement) techniques increase coverage and capacity across more control and broadcast channels compared to LTE, with a radio offering 64 or more transceiver and antenna elements
- how massive MIMO provides even more capacity without adding more antenna elements, due to increasing the degrees of freedom an antenna array has available to modify a transmitted signal, even for multiple users and antennas
- how opportunities for using the mm-wave spectrum band improve with fully integrated radio arrays, which can include more than 100 transceiver and antenna elements
- how use of spectrum below 6 GHz and in the mm-wave range allows for significantly improved coverage and capacity not possible with previous radio techniques
- how different deployment scenarios can be based on network locations, services, and use cases.

The new antenna technologies will work with both stand-alone and non-stand-alone versions of 5G NR.

Megatrends in ICT

On 8 August 2019, Huawei brought out its "Global Industry Vision" (GIV) report [10], which contains its predictions for technology and industry development up to 2025. This year's report identifies 10 megatrends currently shaping how we live and work. The GIV report's predicted technology trends to 2025 include 5G coverage, AI deployment, home robot

adoption, and smart assistant use rates. The 10 megatrends and examples of the GIV report's key predictions for 2025 are as follows:

- *Living with bots*: Advances in material science, perceptual AI, and network technologies are powering the introduction of robotics in a variety of home and personal settings. The GIV report predicts a 14% global penetration rate of home robots.
- *Super sight*: The convergence of 5G, VR/AR, machine learning, and other emerging technologies will let us see beyond distance, distortion, surface, and history, opening up new vistas for people, business, and culture. The GIV report predicts that the percentage of companies using AR/VR will increase to 10%.
- *Zero search*: As data-driven and sensor-equipped appliances and devices begin anticipating our needs, information will find us. Future searches will be button free, personal social networks will be created effortlessly, and industry will benefit from "zero-search maintenance." The GIV report predicts that 90% of smart-device owners will use intelligent personal assistants.
- *Tailored streets*: Intelligent transport systems will connect people, vehicles, and infrastructure, reducing congestion, speeding emergency response, and making traffic circulate more efficiently. The GIV report predicts that 15% of vehicles will have cellular vehicle-to-everything technology.
- *Working with bots*: Smart automation, which is already transforming many industries, will take on more hazardous, repetitive, and high-precision tasks, a boon for safety and productivity. The GIV report predicts that there will be 103 robots in industry for every 10,000 employees.
- *Augmented creativity*: Cloud AI will cut the costs and reduce the barriers of entry to scientific experimentation, innovation, and art,

opening up a gold mine of creative potential that's available to all. The GIV report predicts that 97% of large companies will deploy AI.

- *Frictionless communication:* AI and big data analytics will create seamless communication between companies and customers and break down language barriers. Accuracy, understanding, and trust will underpin tomorrow's communications. The GIV report predicts that enterprises will fully use 86% of the data they produce.
- *Symbiotic economy:* Companies across the planet are adopting digital tech and smart applications on unified access platforms, which foster greater collaboration, more sharing of resources, stronger global ecosystems, and higher productivity. The GIV report predicts that every company everywhere will be using cloud technology and

that 85% of business applications will be cloud based.

- *5G's rapid rollout:* 5G is here, and it is spreading far faster than any previous generation of wireless technology. Its potential for individuals, businesses, and society is enormous. The GIV report predicts that 58% of the world's population will have access to 5G.
- *Global digital governance:* Advancements in digital technology must be balanced by shared data standards and principles for data use. The GIV report predicts that the annual volume of global data will reach 180 trillion GB.

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