FUTURE OF 5G

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FUTURE OF 5G

Distributed in
THE TIMES

Published in association with
5G IA
UK 5G

Contributors

Jon Axworthy
Journalist specialising in health, tech, science and the future, with work published in *T3, Wareable* and *The Ambient*.

Cath Everett
Workplace, leadership and organisational culture writer, with a focus on the impact of technology on business and society.

Ed Jefferson
Writer and creative technologist, his writing has been published in *The Guardian, New Statesman* and *CityMetric*.

Josh Sims
Journalist and editor contributing to a wide range of publications such as *Wallpaper, Spectator Life, Robb Report* and *Esquire*.

MaryLou Costa
Business writer and editor specialising in marketing, tech and startups, with bylines in *The Guardian, The Observer* and *Marketing Week*.

Sam Haddad
Journalist specialising in travel, with work published in *The Guardian, 1843 Magazine* and *The Times*.

Oliver Pickup
Award-winning journalist, specialising in technology, business and sport, and contributing to a wide range of publications.

Abby Young-Powell
Journalist specialising in social issues, education and technology, with work published in *The Guardian, The Independent* and *Positive News*.

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Publishing manager
John Harvey

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Digital content executive
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Design director
Tim Whitlock

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ECONOMIC OUTLOOK

Kickstarting an economic recovery

The rollout of 5G could play a central role in the UK's recovery post-coronavirus, kickstarting growth in sectors that have faltered because of the pandemic

Abby Young-Powell

It's said the arrival of 5G will power the fourth industrial revolution. The fifth-generation mobile technology promises to connect greater numbers of devices with a high-speed, low-latency network that enables data transmission in real time. As a result it could pave the way for more sophisticated, productive ways of working.

"It was always going to change the world," says David Pugh, manufacturing partnerships lead at Digital Catapult. "There was never any doubt about that."

So with the global economy facing a significant downturn due to the coronavirus pandemic and the UK experiencing the deepest recession since records began, could 5G be a driver of economic recovery in a post-COVID world?

5G has the potential to significantly bolster economic growth. Over the next ten years, it could add as much as £158 billion to the UK economy and lead to the creation of new jobs and business opportunities, according to a report by Vodafone. Research by Barclays suggests 5G could supercharge GDP by up to £15.7 billion a year by 2025.

Unlike 4G, 5G has been designed for enterprise applications. While 4G radically changed the consumer space by leading to the development of social networking sites such as TikTok, Airbnb and Uber, 5G could revolutionise enterprise and the business-to-business side, says Dimitris Mavrakis, senior research director at global tech market advisory firm ABI Research.

An improved network would mean there's no need to search a coverage checker to see whether an area has internet connection. Faster 5G speed and better connectivity could create economic growth in regions of the UK outside London.

"That's why we see it as a real positive," says Matthew Evans, director of markets and former chief executive of the Broadband Stakeholder Group. "Because it would bring the UK onto a more level footing."

West Midlands 5G (WM5G) was set up to accelerate the economic benefits of 5G throughout the region. "We want to utilise 5G's potential to drive economic and social recovery by accelerating rollout across the West Midlands," says WM5G's managing director Robert Franks.

The organisation aims to improve 5G speed and connectivity, transform transport infrastructure, improve healthcare and accelerate skills development. "We believe it could absolutely create jobs and attract investment," says Franks.


peng song via Getty Images

One of the aims of WM5G is to support innovation in manufacturing in the West Midlands, as it's an industry that contributes significantly to GDP. "The sector's been pretty hard hit by COVID-19," says Franks. But with 5G, he believes it's possible to improve productivity and efficiency.

5G has the potential to impact almost every industry, but manufacturing is one of the key sectors that could benefit from its rollout. For example, a stronger network could enable live footage of packages as they are transported and flag up any problems in real time, says Pugh at Digital Catapult. "Getting data [from operating machines] in real time is also really valuable inside the factory," he says.

Many other industries are expected to benefit, from utilities and energy, to smart cities and transportation. Creative and arts industries could also be given a boost, says Emily Savage, creative sector lead of Digital Catapult.

5G creates opportunities for creative companies to use virtual reality to work remotely and to reach wider audiences. "There's huge excitement about opening up the ability to produce new remote services," says Savage.

Thomas Winsor, creative director of Reality Check Productions, says the ability to produce 3D augmented reality shows could transform the sector. "If you have a theatre in London and you want to reach an audience in Japan, it's very expensive to tour," he says. "But if we had the ability to broadcast to many people and to reach an international audience with a strong internet connection regardless of their local wired connection, that would be huge."

In more general terms, this increased appetite for remote connectivity could continue to facilitate a new type of work and a more intelligent economy driven by artificial intelligence (AI). "COVID has accelerated the appetite for remote working and remoteness is at the heart of 5G," says Savage.

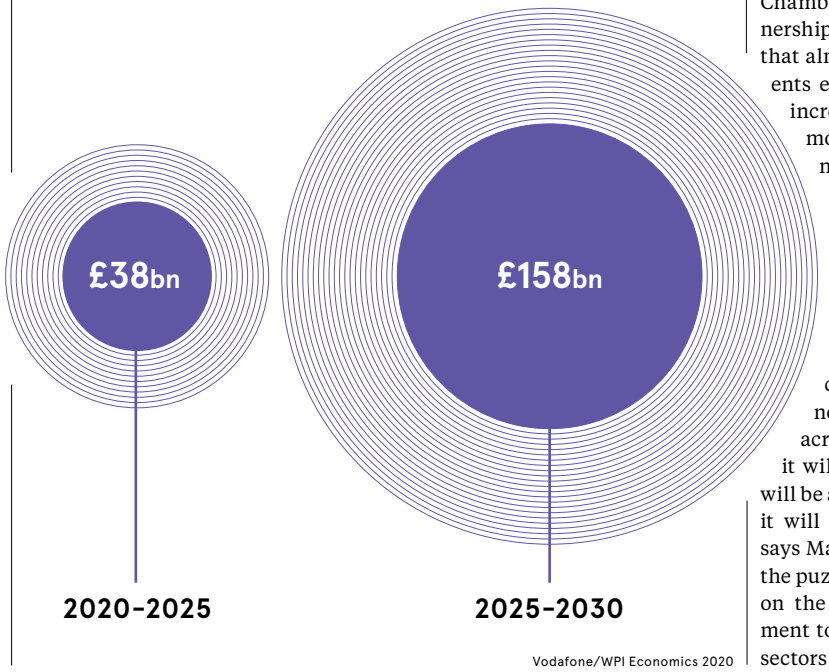
5G networks could also create more jobs and increase human capital. "There is a fear that AI will take away jobs, but at the end of the day we think it will create more jobs," says Mavrakis at ABI Research. "We expect 5G will improve efficiency for workers and open up opportunities, rather than take away jobs."

Research from the British Chambers of Commerce, in partnership with Mobile UK, found that almost 80 per cent of respondents expect to either maintain or increase their lockdown levels of mobile-network usage over the next 12 months. "We expect the new normal to continue," says Gareth Elliott, head of policy and communications at Mobile UK. "Society is changing in the way it works and operates."

In a post-COVID world, 5G could be a key driver of economic growth and recovery across multiple industries, but it will not solve all problems. "It will be a component of the recovery; it will not be the recovery itself," says Mavrakis. "5G is just a piece of the puzzle. How big a piece depends on the willingness of the government to stimulate adoption and on sectors themselves to adopt."

5G IN THE UK

Cumulative benefits to UK output from upgrading national mobile infrastructure to 5G



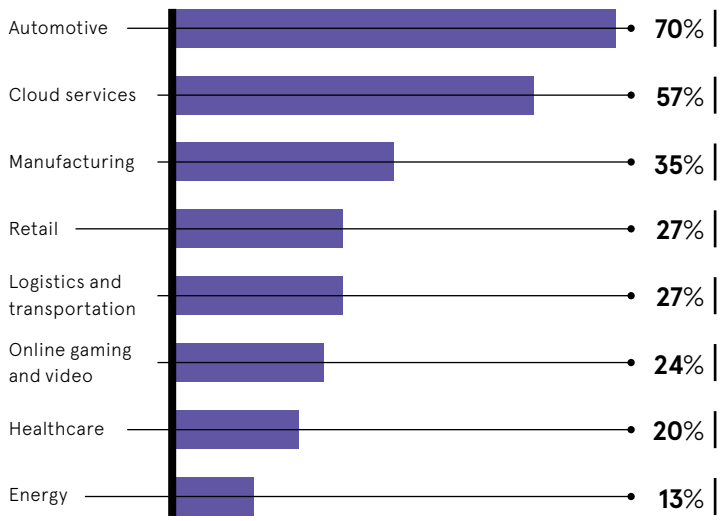
Vodafone/WPI Economics 2020

Alexander Ryumin/TASS Host Photo Agency/Alamy

A passenger inside a Yandex self-driving taxi during a trial run in Moscow

WHERE WILL 5G HAVE THE BIGGEST IMPACT?

Top industries where 5G will cause the most disruption, according to global IT leaders and service providers



Cisco 2020

FUTURE GAZING

Stepping into a 5G future

5G promises a lot, but what will the future be like when the technology is being used in our everyday lives?

Cath Everett

While there's been talk for some time about the difference the next generation of mobile technology is likely to make to the way we live, just how will 5G change the world?

According to Mark Melling, 5G lead and head of Verizon Media's branded content agency RYOT Studio, the shift centres on 5G's ability to "supercharge technologies, such as artificial intelligence (AI), augmented reality (AR) and virtual reality (VR), to make them available for mass consumption".

This scenario is possible because not only are connection speeds estimated to be between ten and one hundred times faster than 4G's, but more data can also be transmitted across the network with minimal delay. Reliability is likewise much greater as connections do not drop out.

As a result, it becomes feasible to move much of the processing currently undertaken by individual devices into the cloud, which in turn enables the creation of a whole new set of richer applications and digital experiences.

Futurist Steve Brown, who founded consultancy Possibility and Purpose, explains: "We can use this technology to optimise traffic flow in our cities, improve the way we grow crops on farms and reimagine healthcare, education and the way our supply chains operate. While many technologies – AI, internet of things sensors, robotics, AR and others – will be part of this transformation, at the heart of all this change will be the 5G network that connects everything together."

How exactly 5G will change the world in day-to day terms, Melling believes it will enable the "true interaction of the physical and digital worlds in real time".

In his view, we currently experience the two worlds as being quite separate, but in future he expects the digitalisation of the physical world to result in their merger. It's a process that was accelerated earlier this year when social media giant Facebook and *Pokémon GO* developer Niantic both purchased AR startups to develop 3D maps of the physical world.

"Although we don't have a digital representation of the world today, once we do, we could put on our AR glasses, say we want to find a certain building and the glasses would show us where it is, what it looks like, share its history and carbon footprint, and also take us there," says Melling. "Some of this is possible now to a certain extent, but 5G will remove the friction points by moving data back and forth much more quickly."

If AI is added to the mix, it becomes possible to process huge amounts of data in the cloud in real time, enabling automatic alerts to be sent to local authority waste disposal trucks telling them full rubbish bins require emptying, for instance. Connected cars would also be able to talk to a city's parking system, locate and book the nearest free space, and navigate the driver directly to it.

Although many of the more sophisticated use-cases are unlikely to become reality for another five to ten years, 5G's mainstream adoption in the major cities of advanced economies, such as the UK and America, should occur over the next three or four, Bill Ray, Gartner's UK senior director analyst for 5G, predicts.

Possibilities and opportunities

To illustrate how 5G will change the world, here are some examples of how it is likely to be used in three key areas of everyday life...

Healthcare

Futurist Steve Brown of consultancy Possibility and Purpose believes 5G networks will "usher in a new era of remote care". Simple home-based devices will monitor and automatically manage the health of people living with chronic conditions, such as diabetes. Wearable devices will alert those in the wider population if any health anomalies are detected, facilitating a conversation with doctors based on the data they gather.

Further down the line, 3D x-rays will become commonplace, while performing precision robotic surgery on people in rural areas from a remote hospital will become possible. 5G-connected ambulances will interact with the local traffic network in an emergency situation to set traffic lights and inform other motorists of their location, thereby ensuring their path is clear.

Retail

Retail will in future provide shoppers with "a far more personalised experience", says Bill Ray at Gartner. 5G-enabled AR and VR-based systems will enable consumers to view how a piece of furniture would look in their living room or an item of clothing on their bodies, all in 3D, and to ask for alternatives using voice commands or gestures.

In-store, simply pointing their smartphone at a food shelf will bring up a list of product ingredients so consumers can establish which ones are ethically sourced and which are nut free.

In around 15 years time though, rather than customers driving to the supermarket themselves, self-driving shopping carts will fulfil their orders and negotiate traffic systems to deliver goods to their home, Guillermo Pedraja head of networks, 5G and internet of things at IT services provider NTT Data UK, forecasts.

Entertainment

There will be big shifts in the worlds of entertainment and sport as content moves from a 2D to 3D format and becomes increasingly interactive, says Mark Melling of RYOT Studio. Movies and TV shows will migrate from green screens to smart stages and virtual sets, created on the same platforms as computer games, while live sports events will be filmed using 3D cameras.

This means future entertainment will become increasingly interactive and viewable through 360 degrees. In other words, viewers will be able to watch films and shows from inside the set and move around it, viewing real-time action from different angles and interacting with characters, not as an avatar but as a photo-real version of themselves.

"The speed and amount of data 5G can deal with at any given time offers a huge step up in terms of providing richer, more interactive experiences," Melling concludes.

OPINION

‘New 5G features are expected to become the catalyst for the creation of an innovation ecosystem’

In a world which increasingly seems to focus on what is new, even when new doesn't necessarily mean better, it is worth reminding ourselves why 5G networks are really different from their predecessors.

For the typical end-user, for example a teenager with a smartphone, a mobile network is judged simply by communication speed and coverage. Others may also keep an eye on other parameters such as transmission reliability or communication delay.

Based on these criteria, 5G does not appear to be a game-changer. Yes, it is significantly faster and it certainly can support lower latency, but if we look only at those aspects, 5G just appears to be a logical progression from 4G, rather than a revolution.

However, 5G has not only been designed for downloading music or videos faster. The new aspect and the big promise of 5G technology is that it will allow the development of breakthrough solutions for the support of vertical industries, such as automotive, energy, food and agriculture, city management, healthcare, manufacturing and so on. This has potential to drastically change the way these sectors work.

In the context of the European 5G Public-Private Partnership (5G PPP) research initiative, scientists and researchers, in more than 60 projects, have worked hard to design, evaluate and validate solutions for 5G networks and vertical solutions enabled by 5G.

These highly innovative solutions enable services that will change our way of life, opening new business opportunities for Europe and creating new jobs across the vertical sectors. Examining some initial verticals’ requirements can create the impression these could, to some extent, be satisfied by existing networks such as 4G LTE (long-term evolution), which is of course a superb system in its own right.

Yet a key lesson learnt from the trials performed in the context of 5G PPP projects is the critical new capability that 5G networks provide is not necessarily communications speed and more reliable networks, but rather flexibility. 5G brings a significantly higher level of flexibility in the deployment and management of new services, which 4G networks cannot offer.

This flexibility is because the network components are no longer monolithic systems fine-tuned to serve a specific set of services, such as phone or video calls and accessing the internet. The network is now supported by multiple modular network functions that can be adapted to serve different verticals, chained together in multiple ways and placed much closer to the end-devices.

While previous generation networks were designed for human-centric applications and other, vertical applications had to adapt to the network, 5G reverses this paradigm and now the network adapts to the service through network slicing.

This paradigm shift created by the introduction of 5G has enabled researchers to create innovative services, parts of which can be implemented over different sets of network functions, called network slices, which operate over the same hardware nodes.

Moreover, this flexibility has greatly reduced the time to deploy new applications and services where and when needed. This flexibility and speed of service deployment will be of upmost importance for the market success of both operators and service and application developers.

It is also worth noting that 5G networks are designed to be more secure than previous generations. This will prove to be a critical factor for the adoption of 5G networks from market sectors where security is of prime concern.

Overall, these new 5G features are expected to become the catalyst for the creation of an innovation ecosystem that will shape the full digitisation of vertical industries. From a technological perspective, it is safe to say the flexibility brought by 5G networks is creating a new and future-proof playground for service developers, which may lead to disruptive new solutions that cannot be easily predicted. ●

Dr Colin Willcock
Chairman
5G Infrastructure Association

5G will transform enterprise

It will have a deeply profound impact on the way enterprises operate, driving economic growth, but operators and governments must ensure 5G is rolled out fairly and effectively

5G is set to be a hugely transformative technology, fuelling far more innovation than the transition from 3G to 4G. This is not just because of faster data speeds and better latency, though consumers will always be a key driver, but rather the opportunities it will provide enterprises to optimise their business processes at large. From transportation and utilities to manufacturing and even mining, every industry stands to benefit.

The technology is also vital to delivering sustainability goals globally. Data consumption on networks is rising by up 45 per cent annually. Nokia is also seeing unprecedented growth in latency-sensitive applications during business hours, including a 400 per cent increase in gaming. Keeping up with this on 4G would require far more spectrum and energy per gigabit to transport the data.

As 5G is far more efficient, using spectrum in a more efficient way, the same amount of data consumption consumes far less energy on a 5G network. By consuming less energy, 5G contributes to global sustainability goals.

“This is why governments as well as operators are pushing hard on 5G rollout,” says Jan van Tetering, senior vice president, Europe, at Nokia, which has more than 1,300 industrial enterprise customers, including around 130 private wireless deployments, while seeing growing demand for private 5G trials or collaboration.

“When we moved from 3G to 4G, it took 28 months between the first of the top-four US operators launching it and the last. With 5G, it took two months. 5G applications for enterprises will have a major impact on how societies operate. In the past, networks were a handy tool. In the future, everything we do will be built on the network, making it a necessity for our day-to-day operations.

> **5G’s influence will be so large that it is imperative for governments to prevent a digital divide from emerging in the access that people have to powerful technology**

“With 5G, building the ecosystem around enterprises is far more important than it ever was with 4G, as it will help drive businesses and societies forward at unprecedented speed. It is the role of the telecoms industry to make businesses and industry aware of these capabilities. Collaboration is vital, bringing together different views and knowledge. We are working with industry associations to discuss what 5G can bring to them and with other players to push different use-cases forward.”

Governments are racing to take a lead in 5G. Though Europe is lagging behind the global leaders, America, China, Korea and Japan, it is still a top priority and major advances are being made throughout Europe. While the telecoms industry educates, evangelises and proves the capabilities of 5G, one of the most important responsibilities of government is making sure people are not left behind as 5G becomes the layer on which societies and economies are built.

The rollout of major new technology typically starts in dense urban areas. It can then be easy for more rural areas to be overlooked because the business case is less attractive, as was the case with both 3G, 4G and fibre. 5G’s influence will be so large that it is imperative for governments to prevent a digital divide from emerging in the access that people have to powerful technology.

Particularly in the post-COVID era, it will be hugely damaging to the goal of achieving economic parity across the country if certain areas have much better infrastructure and tools for home working and collaboration. Governments must therefore introduce programmes that stimulate operators to deploy 5G in less lucrative areas. This is vital as 5G pushes networks to a level beyond entertainment and communications, supporting life-critical, mission-critical applications such as in healthcare, power stations and self-driving cars.

“Trust is an extremely important aspect,” says van Tetering. “To ensure this data is secure and not compromised on its way through the network, the end-to-end security of the network, next to the end-to-end connectivity, is crucial. Who are we trusting to build this end-to-end mission-critical network? It needs to be up and running all the time.”

For more information please visit nokia.com/networks/5g

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ADOPTION

Mass rollout faces new hurdles

A multitude of challenges, some old and some new, stand in the way of the mass acceptance and adoption of 5G

Oliver Pickup

A quotation attributed to American-Canadian science-fiction writer William Gibson surges to mind when assessing the scarcity of active use-cases of the fifth-generation mobile network and the associated technologies and industries required to enable 5G at scale. "The future is already here; it's just not evenly distributed," the father of cyberpunk commented decades ago.

Evangelists promise 5G will provide super-speed broadband connections, up to a hundred times faster than 4G, and flash the green light for autonomous vehicles, among a panoply of other pluses. It will start the internet of things (IoT) revolution and make cities truly smart, finally. What needs to happen, then, to improve the distribution and adoption of 5G?

"The opportunity to take advantage of advanced cellular technologies to drive digital transformation across the board – industrial and robotics, automotive, aerospace and defence, smart cities and more – is unprecedented," says Rob Jones, the UK-based strategic alliances regional director at multinational software and services provider PTC. "Advanced cellular capabilities have the potential to fuel the fourth industrial revolution, but only if the ecosystem co-operates to enable 5G."

It's a sizeable "if", given there remain concerns around the readiness and reliability of supporting industries and services, including collocation, big data, cybersecurity and edge computing, to deliver and enable 5G en masse. Indeed, the financial and ecological cost to build the necessary infrastructure is colossal, says Thomas Spencer, telecoms lead at software firm R3.

"Mobile network operators (MNOs) face an uphill battle to enable 5G," he says. "It is estimated they need to invest up to $1 trillion in upgrading network infrastructure for 5G, while already having to manage sprawling networks of towers, cables and switches just to support their ongoing operations."

There are further complexities. "The challenge of how to finance and optimise infrastructure usage extends to MNO plans for 5G rollout and in particular how to roll out small cell sites," says Spencer. Next year in the United States alone, there will be some 400,000 small cell sites located on public infrastructure, restaurants, offices and homes. "Determining who owns, operates and finances these sites poses a significant and operational challenge," he adds, hinting that blockchain might provide a solution.

Richard Carwana, Dell Technologies' UK telco and service provider director, is similarly ambivalent about what must happen to enable 5G. "We are still joining the dots on how this will be built out," he concedes. "There won't be a 'big bang' of 5G that some had expected, rather a gradual introduction of services and operators moving into the telco space. Partnership and collaboration will be pivotal to make significant progress and drive implementation."

> **Partnership and collaboration will be pivotal to make significant progress and drive implementation**

He points out that "5G requires dense fibre connectivity to underpin use-cases, whereas 4G and 3G did not" and calls for "telecoms providers, industry leaders and governments to come together to understand requirements and build solutions for specific use-cases". As an example, Carwana notes how the German government is collaborating with telco providers to build new motorways with autonomous-only lanes.

Closer to home, the UK government has acknowledged the ban of China's trailblazer Huawei is likely to delay widespread 5G rollout by at least two years, notes Robert Pocknell, intellectual property partner at Keystone Law in London. "European Union research shows Huawei is the number-one leader for patents that are fundamental to 5G rollout," he says.

Politics aside, cybersecurity readiness is one of the fundamental issues holding up the advancement of 5G. Is it any wonder, when achieving 5G's lofty goals relies on billions of interconnected devices, remote workers and the growth of cloud infrastructure? "Add to this the increasingly heavy compute and network infrastructure that is needed to support 5G applications, devices, data and services," says Martin Rudd, chief technology officer at Telesoft Technologies. "Security, 5G and IoT are inextricably linked."

The recent *AT&T Cybersecurity Insights Report: Security at the Speed of 5G* highlights the considerations that stakeholders must address. "A key takeaway is that 76 per cent of the respondents expect wholly new threats to emerge as a result of 5G and the increased attack surface," says Theresa Lanowitz, head of evangelism and communications at AT&T Cybersecurity. "The remaining 24 per cent of participants expect a volumetric increase in existing threats."

Shahzad Nadeem, head of smart cities at design and engineering consultancy Plextek, agrees and says: "On top of security, there are concerns around the ownership of data, along with compatibility and interoperability with existing systems."

Additionally, erroneous claims that 5G is connected to the spread of the coronavirus has further hampered its progress, says Amelia Westerberg, associate strategist at R/GA London. "Conspiracy theorists are the biggest threat to the uptake of 5G," she argues. "Anti-5G attacks on phone masts and general national security and health concerns have caused 5G rollout to be delayed in most markets."

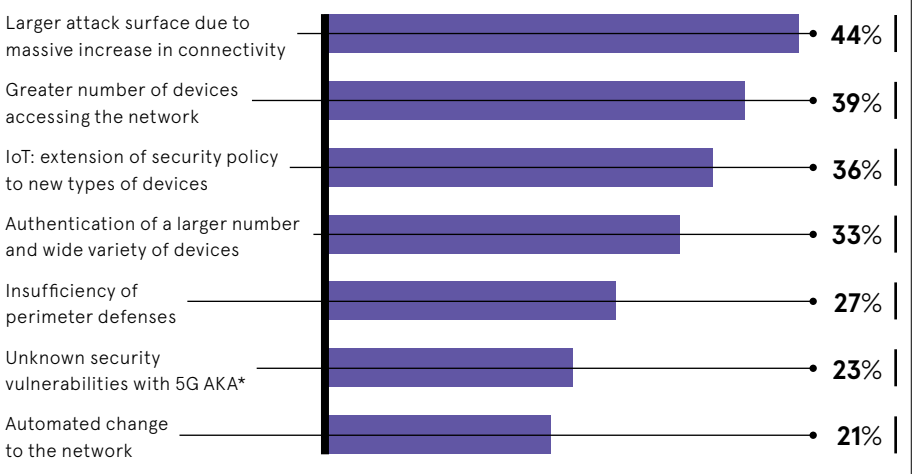
As of mid-September, just shy of 300,000 people and organisations from 220 nations had signed the Stop 5G on Earth and in Space appeal, and investors might be getting spooked. It's a tricky sell in the first place, with all the moving parts. As Nadeem says: "Because the technology is still evolving and its value potential split across its different uses in different domains, there are difficulties in justifying the business case and return on investment."

Also in September, it was reported that in Grenoble, France's answer to Silicon Valley, mayor Éric Piolle, a rising star in The Greens political party, is in no rush to provide access to 5G, questioning the impact it will have on the environment, especially if millions of new handsets are required.

While it is evident that to maximise 5G's vast potential there is a reliance on a confluence of upgrade technologies, as well as multi-stakeholder collaboration and enormous investment, could it be there are more basic hurdles to overcome first? "For people to adapt and trust 5G," Westerberg concludes, "it needs to establish itself as a positive contribution to culture as well as the economy."

TOP CYBERSECURITY CONCERNS OF 5G

Survey of cybersecurity professionals in North America, India, Australia and the UK



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Commercial feature

Smarter, faster, stronger: how 5G can supercharge the UK economy

With a world-class 5G infrastructure, the UK could become a global leader in smart manufacturing, cutting-edge healthcare and connected cities

The UK was one of the first countries in the world to embrace 5G. In fact, every operator has now launched a 5G service, the first step towards a revolution in how we live and work. The technology could also drive the UK's economic recovery from the coronavirus pandemic and set it up for success in a post-Brexit world. But recently this positive future has been overshadowed by political wrangling over the UK's 5G infrastructure.

Thankfully, this long period of uncertainty is now drawing to a close. But the unfortunate headlines and COVID-related delays to 5G rollouts have the potential to undermine the UK's status as an early adopter of the technology. It's therefore essential that discussion of 5G now shifts back to the countless ways it will benefit UK businesses, otherwise, as with 4G, the country could be left facing another missed opportunity.

"The UK's mobile network ability currently ranks 18th in Europe based on coverage, availability and speed of downloads," says Arun Bansal, senior vice president and head of market area, Europe and Latin America, at Ericsson, which has 109 global commercial 5G agreements, including 61 live networks.

Taking the lead

This lacklustre performance has hindered the UK's ability to develop the kind of multi-billion-dollar unicorns that Scandinavia, the United States and China excel in producing, such as Spotify, Klarna, Netflix, Airbnb, Alibaba and WeChat. Thanks to strong government support and a leading supplier ecosystem, about 90 per cent of the South Korean population is also now covered for 5G take-up, according to a recent study by Omdia. Yet 4G trials have only just begun on the London Underground.

Research carried out by ABI and Ericsson also found that the UK is set to spend less than Germany on enabling cellular-connected Industry 4.0 warehouse solutions between 2021 and 2025, even though the UK can leverage more economies of scale than German retail distributors. With the right Industry 4.0 solutions in place, a UK-based warehouse operator would realise operational cost savings of $220.9 million over this period. However, the same warehouse operator would forgo an average of $43.3 million annually in terms of lost opportunity per non-upgraded warehouse.

A rapid shift to 5G would ensure such opportunities aren't lost and help to close the technological gap between the UK and other nations. In fact, with the right investment, the UK could even surpass some of the early adopters of 4G. "There's a lot of innovation that can happen once that infrastructure is there," says Bansal. "The UK has a once-in-a-lifetime opportunity to speed up 5G adoption and create an open platform for the next generation of innovative companies."

> **The UK has a once-in-a-lifetime opportunity to speed up 5G adoption and create an open platform for the next generation of innovative companies**

A recent study commissioned by Vodafone found that 5G could provide a £38-billion boost to the UK economy over the next five years. And there's no reason why the UK's infrastructure can't be upgraded within this timeframe either. Globally, Ericsson has replaced old equipment with 5G capable equipment at more than 100,000 sites in the last two years, more than twice the total number of sites in the UK.

Driving innovation

Once the right infrastructure is in place, it will create a platform for innovation that will transform everything from healthcare to manufacturing. For example, 5G's ability to handle large volumes of data from countless devices with minimal latency will enable industrial-scale internet of things (IoT) networks of sensors in factories, something Ericsson is exploring through its work with BT and the Worcestershire 5G Testbed on the UK's first live 5G factory installation.

Wearable devices, IoT, data analytics and mobile edge computing, all underpinned by high-speed, low-latency 5G networks, will provide an unprecedented level of insight into processes and equipment, and make intelligent, agile, automated manufacturing a reality. And there's no reason the UK can't benefit from this manufacturing revolution, providing it acts quickly to attract innovative firms, says Bansal.

"Twenty years ago, a lot of manufacturing moved out of Europe to Vietnam and India and other countries due to cost reasons," he explains. "Back then, manufacturing was labour intensive. But in the 21st century, manufacturing won't be labour intensive; it will be technologically intensive, using robots and artificial intelligence and machine-learning."

Ports and logistics, other important elements of the UK economy, could also benefit massively from 5G. Ericsson recently lent its connectivity expertise to a smart port initiative in Livorno, Italy, which aims to create a digitally connected harbour. The project showed how sensors, cameras and devices underpinned by 5G technology can deliver an estimated €2.5 million in savings a year and a 25 per cent improvement in productivity, not to mention a CO2 equivalent saving of 8.2 per cent.

Benefiting every industry

In cities, 5G will connect every camera, dustbin and traffic light, thereby improving everything from bin collections to traffic flow. "5G provides the technical feasibility for you to have millions of connected devices per base station," says Bansal.

Network slicing will further allow operators to create multiple virtualised networks that run on the same physical infrastructure, which can be configured to support the specific requirements of different sectors, services and use-cases. For example, automated cars require extreme reliability for safety purposes, something a dedicated 5G network slice can provide.

Healthcare is another area that 5G will truly revolutionise. For instance, Ericsson recently worked on a project with BT and the University Hospitals Birmingham NHS Foundation Trust that demonstrated a remote diagnostic procedure using a 5G-connected ambulance. It connects practitioners in the field with consultants or surgeons in real time, which allows them to review the patient before they arrive at the hospital and prepare equipment and surgical rooms, saving valuable time.

Other critical sectors of the UK economy, such as agriculture, transport and education, could also be transformed by the right 5G investment. In fact, as Bansal says: "The bottom line is that, to be honest, every single industry will benefit from 5G."

However, not every country will, at least not to the same degree. As the shift to 4G proved, those nations that quickly adopt the new standard will reap the biggest benefits. It's the kind of game-changing opportunity that could help the UK recover economically from COVID-19, establish itself as a major independent global economy, and support the kind of innovative companies that will transform how we live and work in the years to come. So let's hope we seize it.

$221m

operational cost savings over a five-year period for a tier one retail hub warehouse in the UK using cellular-enabled Industry 4.0 solutions

$43m

in lost opportunities annually per non-upgraded warehouse

ABI Research 2019

For more information please visit www.ericsson.com/5g

ERICSSON

COMPETITION

From the few to the many

What does the government's forced removal of Huawei mean for the competitive landscape and delivery plans of the UK's 5G network?

Josh Sims

Chintan Patel is pretty relaxed about Huawei exiting the UK's embryonic 5G market, following the government's decision to rein in the Chinese tech giant's hold over this country's telecom infrastructure. Recent months, he notes, have already seen big businesses seal deals with other operators. It's a sign of renewed confidence.

"Obviously there's going to be a lot of focus on cost savings now among network providers," says Cisco's UK and Ireland chief technology officer. "Suppliers are going to be looking to do more with less. There's the impact of the pandemic too and the issue of momentum in the marketplace in terms of device availability. I still think we can expect 5G to develop over the coming years at a slow but steady pace."

However, he adds, with one stark difference: if 5G might once have been expected to be the preserve of the telecom giants building huge networks – if not Huawei, then the likes of Ericsson or Nokia – then now it's increasingly possible it will instead be provided by a conglomeration of smaller enterprises. "What we're seeing is a fundamental shift going on here," says Patel.

Paolo Pescatore at telecoms industry analysts Foresight concurs: "There's now going to be an opportunity in this 5G market not just for big players, including those out of the United States and Japan, but for a lot more smaller players.

"The question is whether these small players are ready for the UK's 5G competitive landscape. Smaller companies make for a more fragmented approach, which comes with its own challenges, such that some standardised platform may be required. What's required is an assessment of how best to work with new players to ensure a smooth transition."

But clearly it's not just the scaling back of Huawei that lies behind this shift in the 5G competitive landscape. Stefano Cantarelli, chief marketing officer for Mavenir, provider of end-to-end network software, argues that two factors are key to its future, not just disaggregation, but what is termed virtualisation.

This refers to the 5G network allowing for the division of hardware resources into functions that can be controlled by software, ultimately enabling those resources to be allocated to service the needs of specific customers without requiring complicated adjustments to physical infrastructure. That, he says, will enable this new ecosystem comprising many new companies, not least integrators specialising in pulling everything together.

> **There's now going to be an opportunity in this 5G market not just for big players... but for a lot more smaller players**

52%

of British citizens think the UK should remove Huawei's products from the country's 5G networks even if it damages trade with China

16%

believe the opposite

YouGov 2020

Virtualisation has, on paper at least, also created a market for what's known as openRAN, radio access networks comprising off-the-shelf hardware and software components from several vendors and operating over open networks. Not all operators will be confident in taking the option, but Vodafone UK has thrown down the gauntlet in beginning openRAN trials, initially for 4G, with software suppliers Parallel Wireless and Mavenir, and could deploy an openRAN 5G network by 2025. Look out too for openRAN software startup Altiostar.

"This approach is going to give operators a unique opportunity to select each best-in-class element to make the best network for their specific needs. It's a chance not to rely on one monolithic vendor," says David Levi, chief executive of networking software company Ethernity. "The situation in the UK isn't much different to that across the rest of Europe. Post-Huawei some operators are scrambling for a solution, but others will now take their time to do some homework."

After all, this coming multi-player approach is still unproven and poses all sorts of complications, security issues for example, or responsibility for maintenance when there's any kind of outage. Given this, whether the 5G competitive landscape in the UK embraces emerging suppliers or simply doubles down on the remaining big guns – Ericsson and Nokia are the only companies bar Huawei to provide complete 5G networks – remains uncertain. As Kester Mann, director of consumer and connectivity for tech analysts CCS Insight, notes: "Operators do tend to be risk averse."

Hence, the relative paucity of 5G mobile phones available so far, nearly all from Samsung or Oppo, a Chinese brand that launched in the UK only last year. Nobody is exactly rushing into 5G in the UK, not least because of the huge infrastructure that needs to be put in place. And this may well be no bad thing.

Certainly, for all the consumer buzz around the coming of UK 5G, it's not with consumers that its future really lies, but with driving enterprise. "Consumers won't pay more for a service they can't get everywhere, especially when the costs [of developing a 5G network] will likely be passed on to them," says Pescatore at Foresight. Until there's some leap in demand for data, through gaming perhaps, 4G remains more than adequate for most uses.

Rather, as Cisco's Patel agrees, the real value proposition for 5G lies with business and what it can do with attendant technologies such as the internet of things, new sensors and meters. That's why Cisco has launched a UK programme focusing on bringing 5G to rural "not spots" to aid more remote industries like agriculture, fishing and renewable energy. And why Vodafone has already started to build the UK's first private 5G network for the oil and gas industry.

Business needs reliability and stability and so, for the next couple of years at least, it's likely that those seeking to be at the leading edge of using 5G in the UK will turn to Ericsson and Nokia, with legacy experience of managing the 4G LTE (long-term evolution) network that the non-standalone initial incarnation of 5G is based on. Then look out for Samsung that has recently struck a $6.6- billion deal with Verizon in America and, though it's been conservative in chasing Western markets, may be changing its mind given the post-Huawei UK landscape.

"The fact is that right now openRAN is just not as good as purpose-built networks from the likes of a Nokia," argues Daryl Schoolar, practice leader for fixed and mobile infrastructure at tech consultancy Omdia. "It's worth remembering that 5G itself is still an immature technology, layered up with virtualisation, another immature technology. But then it's also worth noting how recent years have shown just how quickly technology can advance."

Q&A

5G set to transform the life of the consumer

Kevin Cho, UK managing director of global smart device brand OPPO, discusses the huge impact 5G-powered devices will have on the lives of consumers around the world

Q How has the 5G journey evolved over the last couple of years?

A We have come a long way to where we are now. Over the last year, specifically, we have made some really incredible strides, though there is still a lot more potential to be realised in terms of developing 5G's business use-cases and ensuring the greatest value for consumers. This year, we see the technology is so finely tuned that we're beginning to see a significant uptick in the benefits 5G's faster connectivity can bring to consumers. The coronavirus pandemic has also shifted the 5G conversation forward even more than we had originally anticipated as consumers have become increasingly reliant on their smartphones, demanding faster and better-quality communication and technology.

Q What are the key benefits 5G will provide for consumers?

A In the transitions from 2G to 3G and 3G to 4G, the consistent theme has always been the growing speed of connectivity. However, 5G also brings the added benefits of much lower latency, and higher performance, connection capacity and flexibility. The benefits are really limitless and are growing day by day. Reduced latency means gaming is instantly that much better and that much available on mobile devices. As virtual reality (VR) technology takes off around the world, 5G will be a key pillar facilitating unprecedented gaming experiences for consumers. That's not to mention the explosion of internet of things devices, from connected homes to smart vehicles and cities, which 5G technology will bolster. Then there's the speed of connectivity path, which we are incredibly excited about. It's so much faster with 5G that as soon as consumers get their hands on a 5G device they will immediately feel the difference. Couple this with some of the latest technology, like augmented reality (AR) and telemedicine, and 5G in essence will enable new and more exciting ways to communicate in every facet of our daily lives.

Q In what ways will 5G transform how consumers use their mobile handsets?

A Currently, when it comes to connectivity, consumers tend to use their home or work wifi connection for most of their online activity. This means that while your device might be mobile, your connection isn't always mobile. 5G will completely change that. It will take smartphones to the next level so consumers really can just use one device for all their gaming, streaming, working and social media, consolidating the entire user experience and meaning they won't need to invest in as many devices to meet their connectivity needs. The availability of 5G will make your smartphone the hub or the gateway to everything connected in your life. From controlling the air conditioning to defrosting the fridge remotely, consumers will be able to interact, engage and control all their connected devices anywhere and anytime they want, through their smartphone.

$1.5bn

spent every year to ensure OPPO continues to innovate with 5G

Q What notable proof-points of 5G will we see in entertainment?

A The key entertainment experiences enhanced by 5G are sport and music. Firstly, the increased network capacity on a 5G network will minimise the kind of network congestion that would typically occur during large sporting events or huge live shows, such as the Champions League Final, keeping consumers connected without the risk of interruptions. You may have found when walking out of a concert that it is difficult to send a text message or make a phone call. The mass connectivity benefits of 5G will eliminate those painpoints. We also recently collaborated with the British songwriter Nao and the Kaleidoscope Orchestra to produce a remix of Nao's hit song *Another Lifetime*. They jointly performed the remix during lockdown in a virtual orchestral ensemble that was captured, produced and shared using the 5G-powered OPPO Find X2 Pro. In an increasingly virtual world, 5G enables seamless collaboration in real time. These unique new experiences can be replicated at festivals, theatres and entertainment venues, and I think they will fundamentally change the entertainment industry.

> **The availability of 5G will make your smartphone the hub or the gateway to everything connected in your life**

Q How is OPPO looking to lead the way in 5G?

A As a company, we've always aspired to be a leader in this space and we're at the forefront of the entire 5G movement. We were the first company to achieve 5G connectivity through a smartphone. In 2019 we launched globally the very first 5G smartphone, and we are spending about $1.5 billion every year to ensure we are on top of our game and continuing to innovate when it comes to 5G. With so much possibility on the horizon, we want to make sure we are always first to the punch when it comes to 5G. We also partner with other leading players to ensure we can deliver 5G in the most effective form. We recently worked with Ericsson and Coventry University to deploy the UK's first 5G standalone network slicing functions on Vodafone's network. The new networks were verified using OPPO's 5G smartphones X2 Pro and Reno3.

Q How affordable and accessible will 5G be for consumers?

A Whenever new technology is introduced to the market there will be some kind of premium to start with, but we are committed to delivering products that meet the needs of consumers at all price points. We appreciate that when it comes to new technology there isn't one size fits all, so we cater for high-end, mid-tier and entry-level devices. We don't want a high price tag to prevent any of our loyal consumers from being able to enjoy the great benefits of 5G. Already in the UK and across Europe we have one of the most comprehensive 5G handset portfolios and in just a few weeks UK consumers will be able to experience the entry-level series of 5G phones from OPPO.

> **OPPO's role will be to provide the powerful smart devices to make sure that our customers are connected all the time, everywhere**

Q What is the future of 5G and what role will OPPO play?

A 5G will be the key to enhancing everything we do online, enabling us to bring a lot of the technology of the future forward. From AR to VR, artificial intelligence to immersive online shopping and education on the go, these science-fiction visions will fast become a reality thanks to 5G. For OPPO as a company, our role will be to provide the powerful smart devices to make sure our customers are connected all the time, everywhere, so they can realise the full benefits of all these exciting opportunities and applications that 5G can bring.

For more information please visit oppo.com

oppo

A 5G WORLD

Nearly 400 operators worldwide are currently actively investing in 5G networks, as commercial launches pick up and mobile subscriptions begin to rise. But which countries and regions are leading the way, and which are set to see network speeds surge?

397 operators in 129 countries/territories were investing in 5G mobile or 5G FWA/home broadband networks as of August 2020

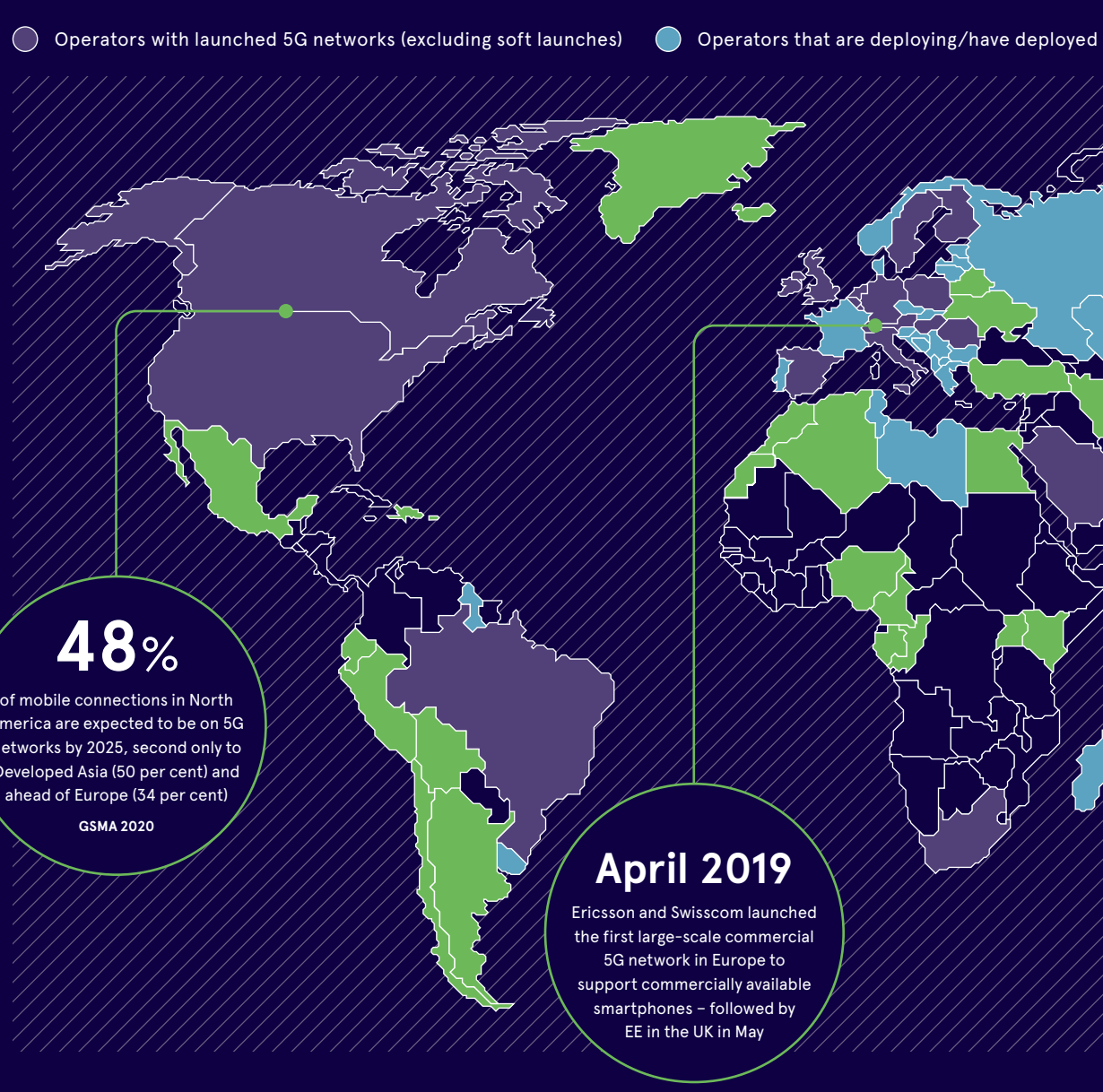
118 operators in 59 countries/territories have announced the deployment of 5G within their live network

96 operators in 413 countries/territories have announced 3GPP 5G service launches

GSA 2020

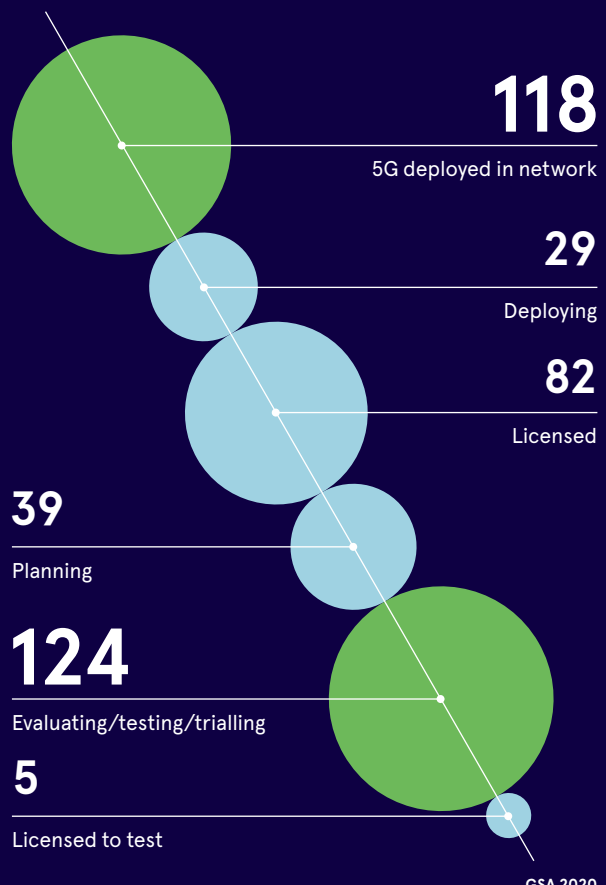
5G COMMERCIAL LAUNCHES

Global operator investments in 5G, including soft launches, as of August 2020



GLOBAL 5G DEPLOYMENT BY STATUS

Operators' status, irrespective of whether commercial services are launched; out of the 397 operators that were investing in 5G mobile or 5G FWA/home broadband networks as of August 2020

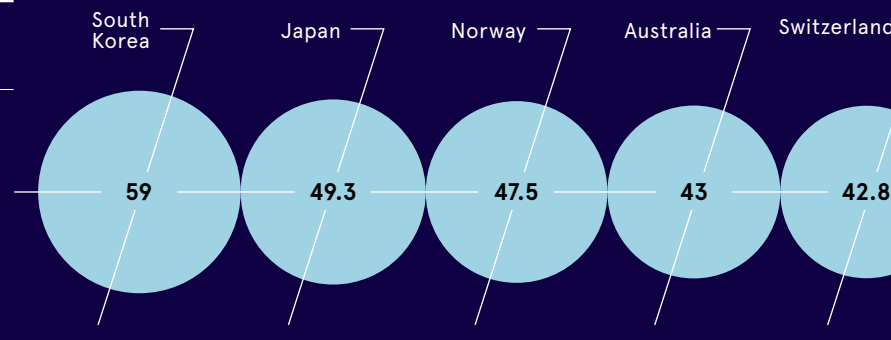


MOBILE CONNECTIONS BY REGION

Share of total mobile connections by network type in 2023

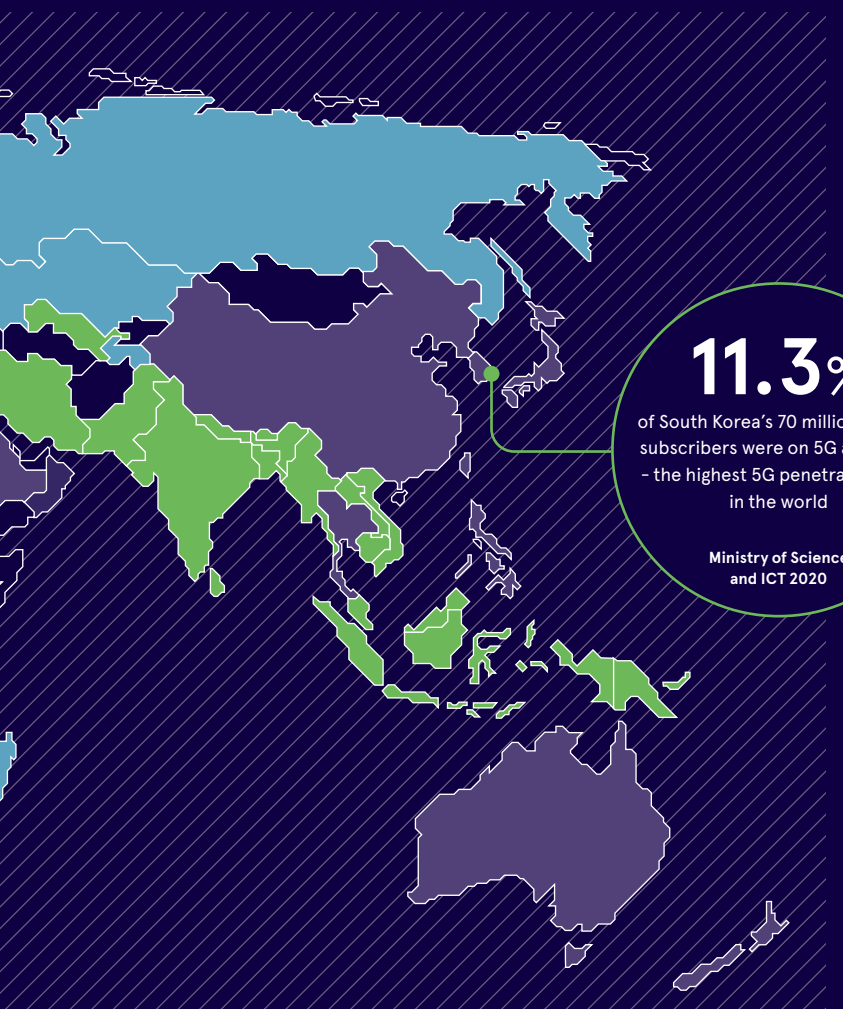
DOWNLOAD SPEEDS IN 5G COUNTRIES

Download speeds in Mbps in the top 20 leading countries that have commercially launched 5G; these are average speeds inclusive of other networks so vary greatly due to the level of mobile subscribers on 5G contracts in each region*



GSA 2020

5G Operators that are investing in 5G

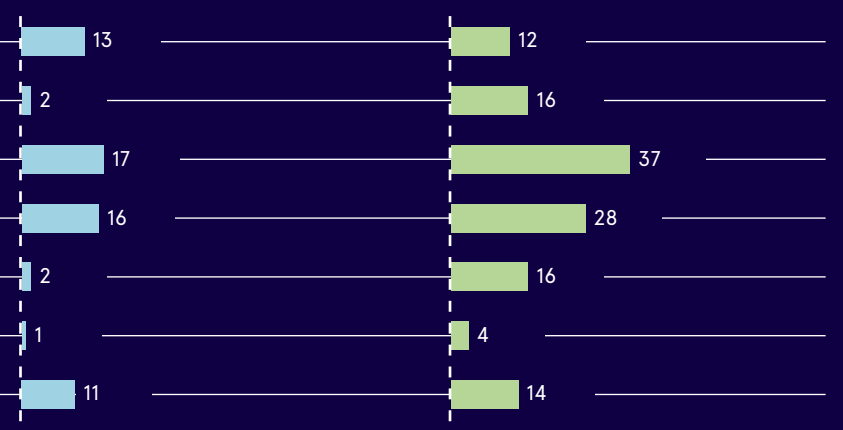


11.3%

of South Korea's 70 million mobile subscribers were on 5G as of July – the highest 5G penetration rate in the world

Ministry of Science and ICT 2020

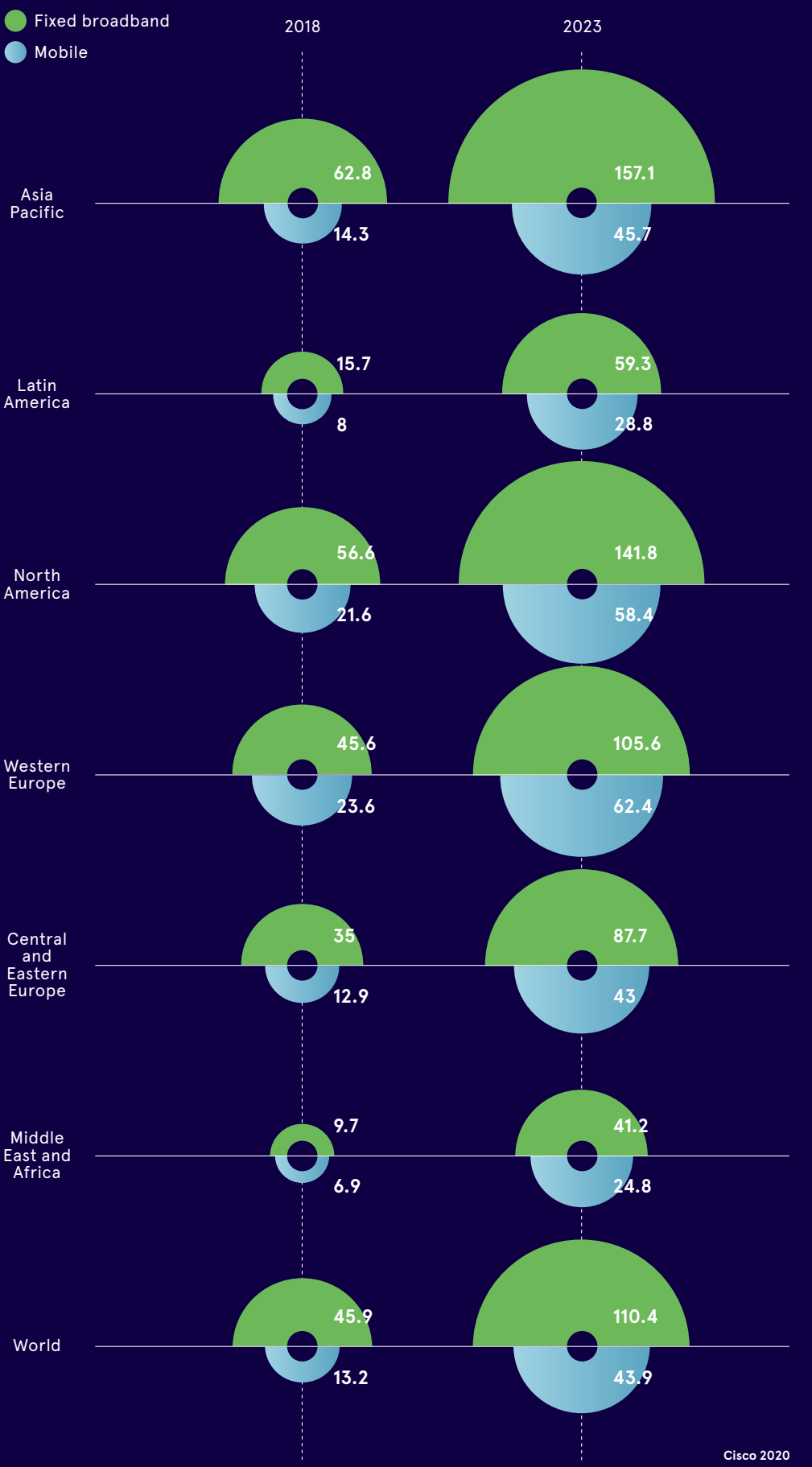
3G and below 4G 5G LPWA



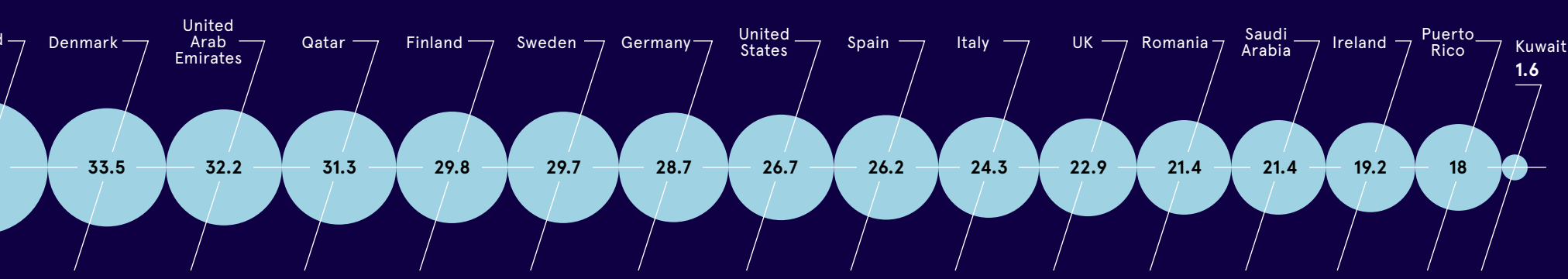
Cisco 2020

5G TO BOOST BROADBAND AND MOBILE SPEEDS

Comparing fixed broadband and mobile speeds speeds in 2018 and 2023 (Mbps)



Cisco 2020



Andrew Harnik/Pool/AFP via Getty Images

US Secretary of State Mike Pompeo announces a visit to the UK at a press conference in July, following a decision to limit Huawei's involvement in the UK rollout of 5G infrastructure

POLITICS

From Huawei to hysteria: the politicisation of 5G

From vandalised base stations to banning Huawei equipment for the threat it poses to national security, why has it been such a politically charged year for 5G?

Sam Hadad

The UK's 5G network is not yet in place, but that hasn't stopped the technology dominating the political news headlines twice this year, albeit for very different reasons.

The first media scream came in April, when online conspiracy theories linking the 5G network to coronavirus spilled over into the real world. Base stations were vandalised and set alight, telecommunications engineers suffered physical and verbal abuse, and cabinet secretary Michael Gove was forced to warn against the spread of this "dangerous nonsense".

Then in July, Boris Johnson's government announced an unexpected ban on buying new Huawei 5G equipment from the end of the year and stated that any existing kit from the Chinese telecom giant would need to be removed from UK telecommunications networks by 2027.

Following in the footsteps of President Donald Trump's United States, the government implied there was a threat to national security from continuing to work with Huawei, though notably not an immediate security threat, given the timeline.

Governments have always participated in tech standard initiatives around communication infrastructure. "The fact they're involved in 5G is nothing new," says Dr Robin Mansell, professor of new media and the internet at the London School of Economics and Political Science. "But that doesn't explain the politicisation of it."

She believes the decision to ban Huawei equipment was less about a threat to national security and more to do with the wider geopolitical and trade issues between America and China, tied into the enormous economic potential of 5G. "Whether you can snoop using these technologies is the least of the transformation that is taking place," says Mansell.

> **The diplomatic fireworks... highlight great power rivalries that are currently being fought in cyberspace**

As *The New York Times* commented in April, 5G has an "an outsize political importance" because the technology could be revolutionary, providing a competitive edge for countries within the global economy, as ultra-fast wireless network speed and latency (data transference) enables all manner of virtualised innovation.

According to Dr Mischa Dohler, professor of wireless communications at King's College London, who specialises in 5G networks, governments are especially interested in this new enhanced level of connectivity and its ability to provide services on demand, as research suggests it could bring happiness as well as productivity to a population.

He says: "Looking back over the past 20 to 40 years, we're able to build fairly reliable statistics on the direct correlation between the degree of connectivity and happiness as well as GDP."

Thanks to Huawei equipment, China is already well ahead with its own 5G rollout. By the end of the year, 300 of its largest cities will have 5G coverage, and that's when the innovation and resulting economic growth could really kick in.

So, it's perhaps no surprise that an increasingly protectionist American administration wanted to clip China's wings and get in on the act themselves. "The diplomatic fireworks... highlight great power rivalries that are currently being fought in cyberspace," says a recent report titled *Network and Geopolitics*, from cyber-intelligence experts Oxford Information Labs.

For the United States, and the countries that followed in its wake including the UK and Australia, the big risk with removing Huawei equipment from their networks, aside from being costly and time consuming, is it stunts their own 5G rollouts.

For Mansell at the LSE, it's less about how fast a country's 5G rollout happens but "who moves slightly more quickly than others". She says: "The US government view has been 'let's Balkanise everything and develop our own 5G standards... we'll catch up'. But I would be extremely dubious about that."

Especially given that China will be encountering no such delays. "China is poised to assume first-mover advantage in 5G technology," says the Oxford Information Labs report. This could help China quickly establish its own independence in terms of knowledge, and the hardware and software they need to build out in other parts of the world, be that in Asia, Africa or South America.

This could be very successful for them, but also lead to a divided, less-collaborative cyberspace, a "splinternet". The report goes on to warn it could lead to "walled gardens of devices and services, capture of markets, further reduction in market competition and the emergence of a vertical, Chinese 5G tech monopoly". Which, of course, poses a stark economic disadvantage to countries left behind, such as the UK, but also a new kind of security risk as countries pursue their own digital sovereignty.

Germany has a more-measured approach to Huawei, in part because Deutsche Telekom uses a lot of their technology already, but a decision on their future relationship with the Chinese telecom is expected this autumn. "The pressure on them is enormous," says Mansell.

Instead of worrying about Huawei, Dohler from King's College London advocates shifting the focus towards other ways the UK government can help facilitate 5G networks, such as by subsidising dark fibre rollout, a vital component in 5G connectivity. He says: "In the UK, one metre of road costs £100,000, but a metre of dark fibre costs 50p. You could lay dark fibre along any road, adding 0.001 per cent of budget and actually help rolling out a very strong fibre structure, which is very expensive for the operator."

Dohler imagines China has such a framework already in place, while in India the government is rolling out 100,000km of dark fibre every day. "They don't dig tunnels, they do it over roads, or through trees. But it serves a purpose; they are connecting their villages," he says.

Also, the UK government could help with reducing the administration for operators around securing base stations. "Why not have a national auction framework? That would put the UK ahead of the game globally very quickly," says Dohler.

Helping operators deal with the real-world consequences of online conspiracy theories relating to 5G is another task for governments all over the world, especially in the UK, America and Australia, though notably not in China. Dohler adds:

Richard Baker / In Pictures via Getty Images

Anti-lockdown conspiracy theorists and coronavirus deniers protesting in Trafalgar Square in August

"China has a governmental narrative that they really support 5G... none of my Chinese students talk about 5G being the end of the world."

Nonetheless, it's a serious problem in the Western world, with the FBI even labelling fringe conspiracy theories as "domestic terrorism" last year. Dr Daniel Jolley, senior lecturer in psychology at Northumbria University, whose research during lockdown proved a link between violent behaviour towards the telecommunications sector, paranoia and a belief in 5G COVID-19 conspiracies.

Why does he think these ideas gain such traction? "They offer simple solutions for complex problems.

China has a governmental narrative that they really support 5G... none of my Chinese students talk about 5G being the end of the world

Ideas that 5G causes harm have been around for a few years, so during lockdown in the whirlwind of 'Is this really happening?' people quickly linked that to COVID-19," he says.

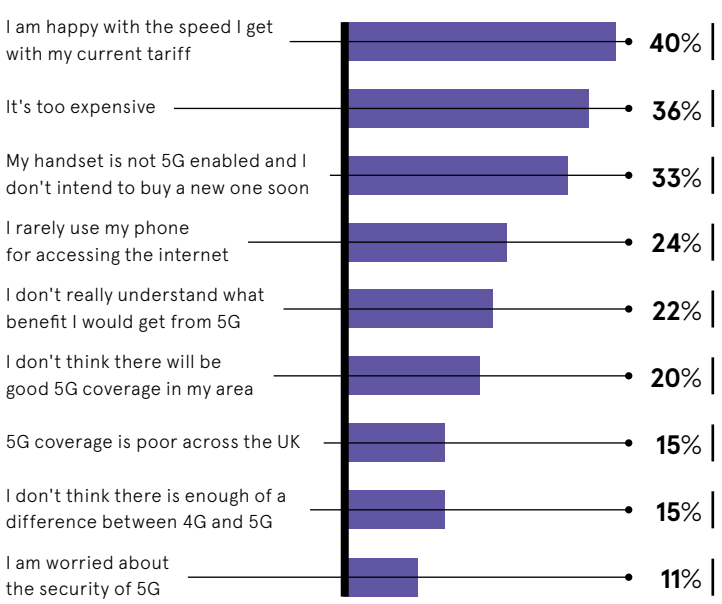
The government has tried to counter the conspiracies with facts and urged local councils to send out information pamphlets to "quell quack theories about 5G" by citing UK communications regulator Ofcom's research, which debunks claims that 5G carries health risks.

But Jolley points out that while educating the public is important in reducing belief in conspiracies, the more hardline believers don't trust the government anyway, so are unlikely to take their advice.

Perhaps the answer, when it comes to quashing 5G conspiracy theories and dealing with the wider global rollout of 5G, is to try and focus on more collaborative and less politically charged approaches that draw on the expertise across academia, telecommunications networks, media, tech, intelligence agencies and independent regulators. All this at the behest of governments, but not in their name.

ARE MISCONCEPTIONS AND MISUNDERSTANDINGS HOLDING BACK 5G?

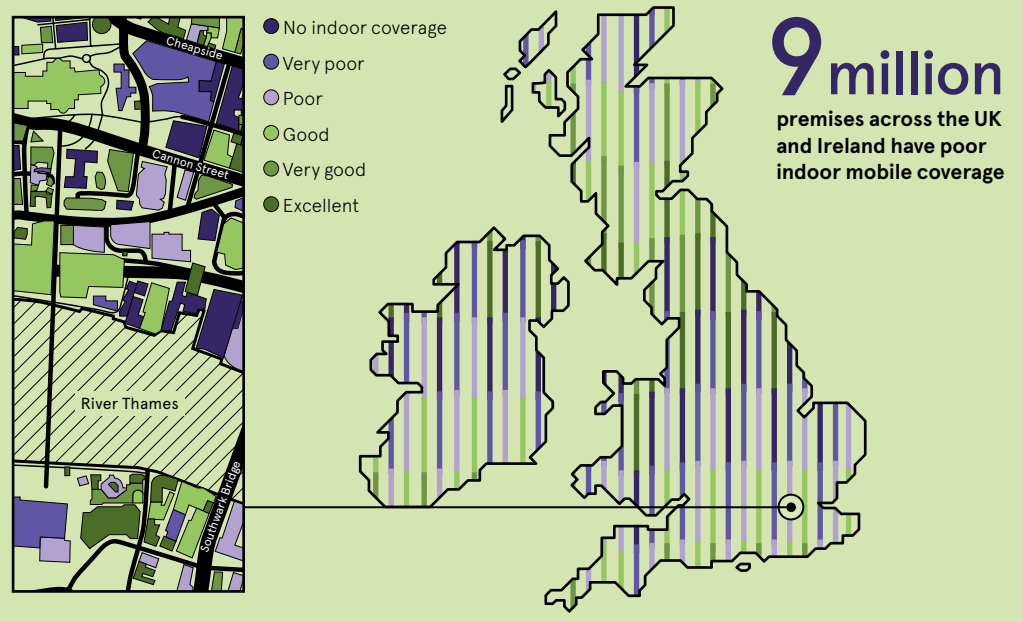
Some 28 per cent of people surveyed in mid-2019 said they were quite or very unlikely to get a 5G tariff; of those, the following reasons were given:



YouGov 2019

INDOOR MOBILE NETWORK CONNECTIVITY ACROSS UK AND IRELAND

Data compiled over a three month period based on the Signal Strength and Signal Quality from anonymised data sources



The big and the small of densified mobile networks

Paul Senior, chief executive of Dense Air, explains how the company is using big data to inform the placement of small cells for densified 5G networks

With 28 per cent of UK and Ireland consumers enduring poor indoor 4G coverage, it's imperative that 5G's rollout doesn't suffer the same fate. The key to ensuring that lies in network densification.

Mobile operators are starting to use higher and higher frequencies to roll out the features and benefits of 5G to its users. However, in doing so there are now more and more areas where those existing macro cell sites won't illuminate.

Solving this particular puzzle isn't traditionally in the repertoire of those operators responsible for its rollout. So, since 2017, Dense Air – a UK-based, multinational operator – has sought to provide that missing piece of the jigsaw, helping to penetrate and reach congested or disparate areas economically.

Dense Air's chief executive Paul Senior explains: "Our methodology revolves around an alternative method by using very low powered small cells. Dense Air deploys small cells closer to users, allowing a densification of the network for mobile operators."

Having spent the past three years optimising big data around network shortfalls and acquiring spectrum assets to run its services, Dense Air is now gaining traction across Ireland, Belgium, Portugal, Australia and, in particular, New Zealand.

"New Zealand is the perfect example of both contrasting issues we're looking to mitigate," says Senior. "In places like Auckland with high footfall, lots of businesses and built-up areas, smaller cells, whether they're plug-and-play solutions or street-furniture installations, penetrate effectively. While, in the many remote areas of the country, we can ensure network coverage by solving the proximity problem."

Having the flexibility to enhance network reach or capacity in those places that are most in demand will be essential to converting 5G's potential.

This idea has taken on extra significance in 2020, however, with in-demand areas broadening through the rise of remote working during the pandemic and possibly beyond.

"Suddenly, with the 'new normal' of remote working, mobile coverage is much more than just a nice thing to have," says Senior. "We're now facilitating people being able to work or stay in business in a lot of cases."

The idea of having holes or weak spots in the mobile network has subsequently transformed from being a nuisance to a serious issue and mobile operators are realising that user unrest is likely to build as a result.

"Part of our mission is to educate people about network quality and how that applies to their day-to-day lives. They have a right to understand what they're paying for," Senior explains. "To this end, we are about to release a suite of tools, including an app which would allow people to score their own network coverage."

In theory, by empowering users to qualify their service, and by providing operators with the toolsets and solutions to make improvements in an economical way, Dense Air can help operators avoid being exposed to network shortfalls. Although already prevalent in present 4G networks, 5G won't be so forgiving.

"It's a bit of a vicious cycle," Senior concedes, "but operators will also have access to that data. By giving them the tools to target improvements using cell densification we can help to accelerate 5G rollout and user adoption."

The prospect of 5G is an exciting one, but an improved user experience hinges on faster speeds and lower latency, two facets that are almost impossible to achieve with the current, disparate network footprint.

"Our vision isn't explicitly to make sure coverage is the same everywhere, but to ensure there is transparency, so users in both urban and rural areas, businesses and high-footfall facilities better understand their coverage, and that there is a fast and economical way to improve it," Senior concludes.

"As we enter a world where many are forced to work in different ways, and people have more agility around where they choose to live, network densification is a necessary facilitator of 5G's role and impact."

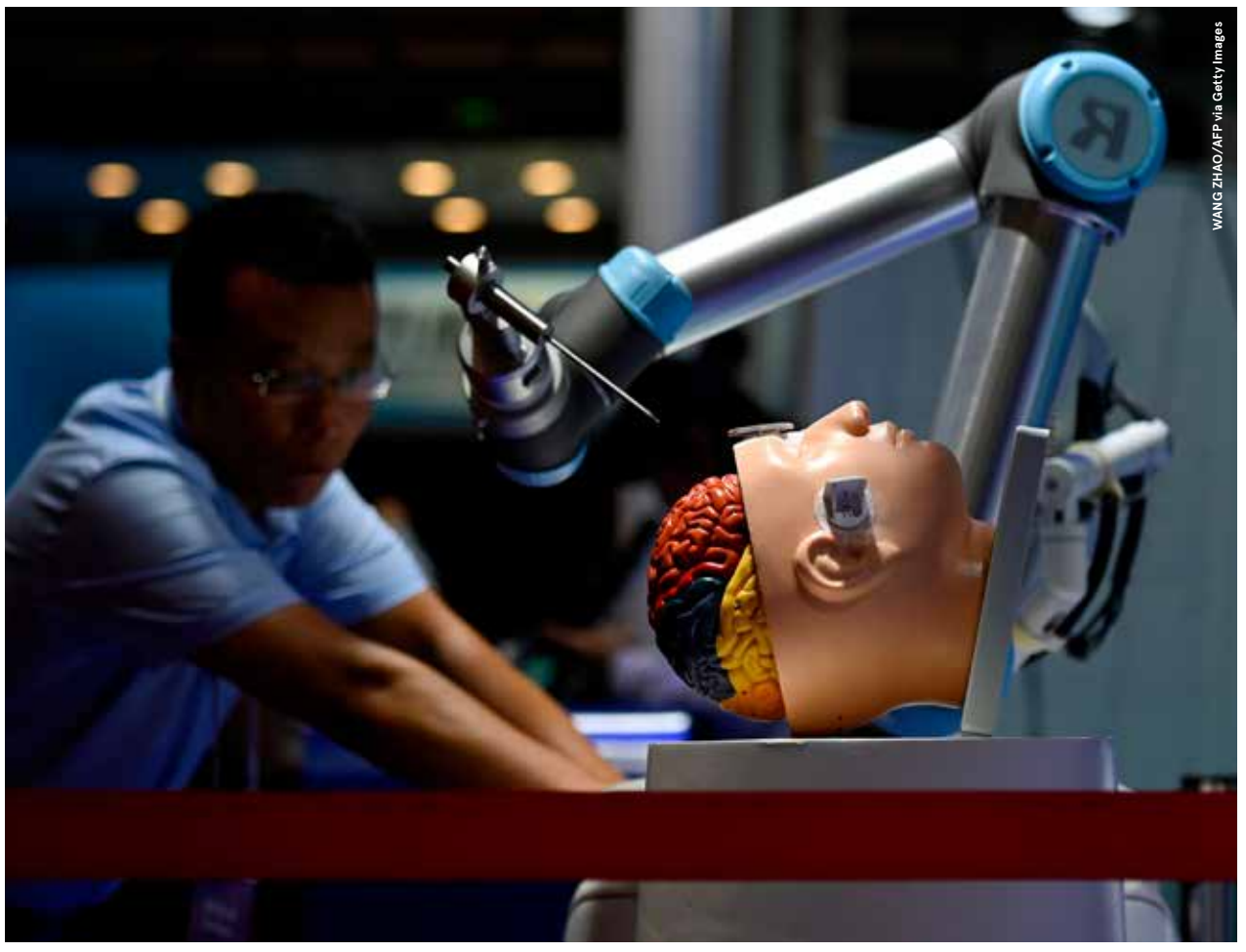
For more information please visit www.denseair.net

DENSE AIR

HEALTHCARE

Unlocking healthcare's future potential

Telemedicine has proven its worth over the past few months, but 5G will enable it to truly transform healthcare as we know it



WANG ZHAO/AFP via Getty Images

5G will kickstart the next generation of medical technologies, enabling surgeons to perform remote operations on patients using robotic arms

Jon Axworthy

During the coronavirus pandemic and lockdown, as surgeries were forced to close their doors to patients and GPs had no choice but to triage and consult remotely, the value of telemedicine became clear.

Government digital-first policy meant GPs connecting with patients digitally went from around 10 per cent of general medicine before the pandemic to around 75 per cent at its early peak.

The NHS had no choice but to accelerate the implementation of video consultation and other technologies in an attempt to keep pace with the crisis.

Video consultations were seen as an extension of a GP's phone call, but on 4G networks the video quality often wasn't good enough to support remote diagnosis and technology. Recording the video and linking it to a patient's clinical records was also too much for many GPs working with their personal 4G mobiles.

These shortcomings highlight the transformative quality of 5G technologies at telemedicine's most basic level, as lower latencies and higher speeds would have helped GPs immeasurably.

According to communications regulator Ofcom, of the 36 million 999 calls received by operators in the UK each year, two-thirds originate from a mobile and, under the umbrella of a 5G network, the chances those calls will result in a better outcome for the patient will almost certainly be increased.

However, the benefits of 5G will not end there, as the ambulance that arrives on the scene will also become increasingly connected, turning the vehicle into a mobile edge that localises the computational processes and greatly increases the real-time capabilities of medical equipment and streaming.

This was demonstrated by University Hospitals Birmingham (UHB) late last year when they trialled a mock emergency situation and had a doctor remotely treat a patient in an ambulance over a 5G network, operated by BT.

"It was like having a hand in the ambulance," says Dr Tom Clutton-Block, UHB's clinical director who carried out the trial.

Sat in front of a high-resolution screen which relayed a real-time feed from inside the ambulance, the clinician had a range of live medical metrics at his disposal and was able to work, quite literally, hand in hand with the paramedic in the vehicle via a joystick that was digitally connected to a robotic glove worn by the paramedic. This allowed him to access an ultrasound scan of the patient and even influence the angle of the ultrasound towards specific organs.

The scans were then sent back to the heart rate monitor in real time and allowed him to determine whether treatment could be contained in the ambulance or if a hospital intervention was needed.

The ability to make these kinds of decisions without the need for a clinic room would have been invaluable when the pandemic was at its peak and is needed now more than ever as the medical community fights against a second wave.

It's an astonishing insight into the skill of a surgeon to realise that to achieve safe outcomes they need to be able to react to physical and visual stimuli in milliseconds. This slender margin of error has been one of the limitations of robotic surgery and why, until now, the only option for surgeons has been to scrub up in person.

"5G has a very exciting role to play in remote surgery," says Prokar Dasgupta, professor of robotic surgery at King's College London and a pioneer in the field. "The main challenge is time lag across time zones, but 5G with its ultra-low latency and speed has the potential to reduce this time lag to around 10 to 15 milliseconds."

That's enough to free specialists from the operating theatre so they can operate remotely, seeing and directing the robotic surgeon in real time, but also getting the sensory feedback that is so vital to their work.

"To avoid arterial cuts the robotic surgeon must be able to feel the scalpel touching artery tissue and have that transmitted to them within one to twenty milliseconds to stop them moving further," says Mischa Dohler, professor of wireless communications at King's College London.

"This is where 5G comes in as it's the only network able to do these short latencies and it allows us to transmit a haptic signal, in addition to video and audio, using touch sensors at the end of the scalpel and transmitting that signal to a glove so surgeons can 'feel' what they are cutting during an operation."

As well as enabling surgeries for remote patients who wouldn't otherwise have had access to a specialist, telehaptic robotic surgery like this also opens up exciting new possibilities for highly skilled clinicians to instruct surgical techniques or diagnosis methods from afar.

"Robotic surgery is highly complex and takes rigorous team training," explains Dasgupta. "Trainees from the UK and overseas come and spend a year or more with us, learning their craft. Would it not be amazing if they could also be trained remotely? Making surgical expertise available to everyone, irrespective of where the patient may be; this is where 5G can play an important role."

Just prior to the pandemic, Dasgupta and his colleagues began using an augmented reality platform, called Proximie, to achieve this, which allows surgeons to guide trainees as if they were in the operating theatre with them.

"We want to ensure people receive the highest-quality surgical care regardless of where they live and we want to do this at scale," says Dr Nadine Hachach Haram, a practising surgeon and chief executive of Proximie. "That's over 300 million surgeries a year globally and

> **We want people to receive the highest-quality surgical care regardless of where they live**

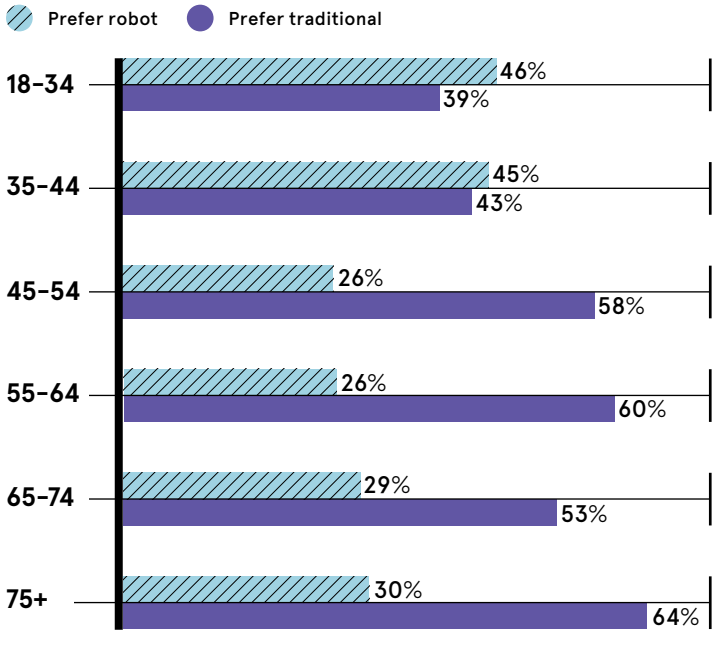
petabytes of data each day, so bandwidth, quality of service and latency are all critical."

The rapid dissemination of crucial information is more important than ever in medicine as doctors continue to work in the shadow of the pandemic and connectivity is at the heart of successful and resilient health services.

From the most fundamental requirements like video consultations to scaling surgical expertise, 5G has the potential to revolutionise healthcare and save lives. ●

PUBLIC NOT SOLD ON ROBOTIC SURGERIES

Preference of different age groups between robot-assisted or traditional surgery



Accenture 2018

Why 5G private mobile networks and cybersecurity must go hand in hand

When Industry 4.0 was first coined in Germany a decade or so ago, technologists envisaged an industrial landscape where intelligent machines would talk to each other, drive efficiency and productivity enabled by 5G

While some extraordinary progress has been made in realising the exciting vision of the fourth industrial revolution, many see the emergence of 5G as the catalyst that will bring about further change. 5G has the potential to accelerate the adoption of the internet of things (IoT) and Industry 4.0, and drive further innovation.

However, if businesses are to harness the digital transformation capabilities that 5G will bring to Industry 4.0, governments, mobile network operators and organisations need to build a complete 5G infrastructure and services.

But this takes time and money. To illustrate the point, the GSMA, representing the interests of mobile operators worldwide, says 5G networks are likely to cover one third of the world's population by 2025, yet only a handful of nations have so far created public 5G mobile networks.

Industrial giants build their own private 5G networks

With public 5G networks developing at a slow pace, many industrial leaders, such as Mercedes, Rio Tinto, Port of Rotterdam and Siemens, have taken matters into their own hands. They have all created their own private mobile networks, which rely on 4G and 5G technology.

But why? Ronen Shpirer, director of solutions marketing at Fortinet, a global leader in network and cybersecurity solutions, says first-movers investing in 4G and 5G private mobile networks "do so for a number of very good reasons".

He explains, "Mobility, coverage, quality of service, ultra-low latency, service continuity and very high reliability are some of the main capabilities a private mobile network can provide. These are all critical requirements that can enhance and revolutionise automation, safety and innovation in industry. Finally, companies choose to invest in private 4G and 5G networks because they provide them with better control and privacy."

Private mobile networks: managing exposure to cyber-risk

However, Shpirer has concerns that companies with private mobile networks may be "lulled into a false sense of security" regarding cyber-risks and threats, which he says "are becoming more and more sophisticated and are increasing year on year".

Shpirer says: "The phrase 'private 5G network' is a little misleading. With your own mobile network, logically you'd think security becomes less of an issue; actually, the opposite is true."

Complex markets call for a more nuanced security solution

A company looking to build its own private mobile network may involve a myriad of different architectures and actors to create and manage it. "This complicates the understanding and deployment of the appropriate cybersecurity controls needed to protect the private network," he says.

"Essentially, whoever builds and manages the network for the enterprise must understand what that organisation is trying to achieve, the specific use-cases and the unique security implications for each individual scenario. Failure to do so not only exposes the private mobile network to cyberthreats and increased risk, but also the company. You might as well leave the gates to the factory unlocked at night. It's the same result."

Fortinet providing cybersecurity expertise for 5G

It is for this reason that hundreds of organisations each year seek out the help of Fortinet.

Fortinet's leading-edge products provide enterprises and mobile operators with security, visibility and control, protecting enterprises deploying private 4G and 5G mobile networks against both internal and external cyber-risks. These include, but are not limited to, protection from IoT-originated threats such as signalling storms, infected or malfunctioning devices and IoT bots, internet, and insider and third party-originated threats and attacks.

Take an industrial manufacturer that has invested heavily in AI-driven automation and robotics and relies on the IoT.

Shpirer explains: "Imagine the IoT devices as physical extensions of a brain, which is the IoT platform and its applications, and relies upon input from the IoT devices to takes decisions that are then distributed to different parts of the factory floor and production process.

'You don't need hackers to infiltrate the system to confuse the brain. A bad upgrade or configuration to a set of connected machines or production lines, for example, could cause problems and cause delays, inefficiencies and even safety problems. On the other hand, if professional hackers use the private mobile network to exploit vulnerabilities in the system, the consequences for the plant could be a lot worse."

5G cybersecurity platform

Fortinet enables enterprises and mobile network operators to protect private mobile networks infrastructure, services and the enterprise using it.

FortiGate protects the private mobile network and the enterprise against IoT and internet-originated threats, while FortiWeb protects the IoT platform's industrial applications and their application programming interfaces from attacks.

But perhaps it is the solution's adaptability and inter-operability that really sets it apart. Shpirer explains: "The platform is hugely flexible to support a wide range of private mobile network architectures and use-cases. It can be deployed and managed by both the enterprise and the mobile network operator."

While extremely robust, the platform's multi-faceted capabilities extend to security visibility and encompass other services that transcend the private mobile network and its use-cases.

> **With your own mobile network, logically you'd think security becomes less of an issue; actually, the opposite is true**

"The security platform technology is very versatile and can be implemented as physical, virtual or in a container form factor. Put all these individual components together and you get a fairly unique, automated and integrated cybersecurity solution for private mobile networks and the enterprises using it," says Shpirer.

Embedding a new culture of cybersecurity

In addition to Fortinet's malleability, Shpirer says the advent of 5G and an increased security threat landscape is "motivating both service providers and enterprises to pre-emptively secure their environment, including their customers".

He adds: "Fortinet is best positioned to provide leading telecommunications companies and industrial organisations with unique cybersecurity solutions, all of which have been validated by industry-leading third parties, including Gartner and NSS Labs."

With more than 680 patents, 465,000 customers and continued growth that beats market estimates, more and more enterprises and service providers are embracing Fortinet's leading-edge cybersecurity solutions for 5G. Without a robust security infrastructure in place, they know that the growth of their 5G private networks could be stymied, and with it the promise of dynamic and lasting growth.

For more information please visit secure.fortinet.com/5GPrivateNetworks

FORTINET

REMOTE WORKING

Ushering in a new era of home working

The critical importance of overcoming technological issues with the rollout of fifth generation cellular tech should not be underestimated as businesses look to 5G for new opportunities and ways of working

MaryLou Costa


Chris Montgomery / Unsplash

Jittery Zoom calls and that spinning wheel of doom might be what remote working is coming down to as multiple users in the same household compete for increasingly stretched bandwidth on wifi networks.

Indeed, a global *Future of Work* study from IT firm Riverbed revealed that 94 per cent of decision-makers felt technology glitches had impacted their employees while working remotely. The most common problems were poor video call quality, frequent disconnects from corporate networks, slow file downloads and long response times when loading apps. The cause? Unreliable home wifi.

Enter the 5G rollout, the deployment of the next-generation mobile spectrum that dozens of industry commentators are heralding as the catalyst for revolutionising remote working. It's set to pave the way for Zoom fatigue to be revived with augmented and virtual reality sessions, for the spinning wheel of doom to become a distant memory, and for all members of the same household to access their choice of apps and tools with no lag.

But with the UK government's now infamous banning of Chinese 5G network provider Huawei from supplying the necessary technology, it's unclear when this 5G-fuelled remote working utopia will become reality. According to a Huawei-commissioned report by research company Assembly, an estimated three-year delay to the UK's 5G rollout could cost the UK economy £18.2 billion in lost opportunities and productivity.

Yet with remote working very much here to stay, and Riverbed's report confirming that business leaders worldwide anticipate a 50 per cent jump in employees working from home post-COVID, how crucial will it be to overcome technological inefficiencies with supporting 5G technologies?

79%

of UK SMEs surveyed in July said they expected to either maintain or increase their lockdown levels of mobile-network usage over the next 12 months

67%

have increased the usage of activities that utilise mobile networks

59%

agreed that enhanced mobile coverage and data capacity would support their business to restart operations

British Chambers of Commerce/Mobile UK 2020

For Bernie McPhillips, sales director at internet of things and 5G specialist Pangea, the corporate demand for a 5G rollout across a remote workforce has been clear among clients including Pizza Hut, Addison Lee, Etihad Airways and Birmingham City Council. From companies placing 16,000-strong orders for plug-in 5G routers and portable "mifi" dongles, to those testing the technology first with senior executives before considering mass deployment, the need is becoming more evident.

"What was established early on during the lockdown was a lot of people's home connectivity wasn't up to supporting full-time mass remote working. Those types of demands have never been placed on our connectivity before," says McPhillips.

"Having more households home all day than ever before has just put an incredible amount of strain on our data networks. We put up with delays as consumers, but we can't tolerate them as business people. As the speeds 5G can handle outperform ADSL [asymmetric digital subscriber line] and in many cases fibre, you're then going to be able to give people an office-type experience while in their own home."

But businesses are still getting their heads around price and practicalities, with the plug-in 5G router costing £350 a unit and the 5G mifi dongle coming in at around £100. There also remains a misconception that 5G is the same as 4G but better, notes McPhillips, adding that while a lot of education is still required, businesses are on the whole conscious of the mounting pressure to future-proof.

"Organisations are now seeing this as a long-term solution and actually forming a part of their core infrastructure, rather than an intermediary solution giving people a router

> **Having more households home all day than ever before has just put an incredible amount of strain on our data networks**

in the short term to just work from home for a few months," he says.

But a delayed 5G rollout shouldn't be cause for alarm, Cisco's chief technology officer for UK and Ireland Chintan Patel argues, as according to recent communications regulator Ofcom's data, 95 per cent of UK households can access superfast broadband.

"In the UK, our networks have coped well with the mass adoption of remote working. We have a broadband infrastructure that's solid and still advancing. So while 5G will play a big role in advancing many new and exciting tech innovations, in reality it isn't needed to support those in desk jobs," he claims.

For businesses with primarily desk-based workforces, Patel believes their focus should be on three key technologies to help them work productively, effectively and securely: video and collaboration tools, automation, and cybersecurity.

"The crisis has also underlined the importance of automation for reaching the spaces, places and areas that people can't access during an outbreak. Automated systems have the potential to keep factories operational. They also enable remote changes to be made to critical IT infrastructure, datacentres and networks," he explains.

"All of this needs to be underpinned by robust cybersecurity systems that encompass people, processes and technology. With the increasing number of malicious cyber-actors seeking to exploit the pandemic, cybersecurity is fundamental to ensure teams of employees operating remotely can do so safely and effectively."

But 5G will in fact play a key part in delivering more robust security for remote teams, counters Fotis Karonis, chief technology and information officer of BT Enterprise, parent company of mobile provider EE.

"5G combined with mobile edge computing will create new opportunities for operators to deploy advanced cloud services and deliver more robust security for mobile data and applications. With enterprises currently processing data from multiple locations as employees log on from home, this secure and efficient data and application processing ensures business continuity, even when faced with considerable challenges," he says.

Cisco's Patel, however, is adamant internet service providers and their technology parents have moved quickly to build in extra capacity to meet the unprecedented rise in demand, highlighting that there is no direct dependency on 5G for remote working itself.

He points to the real potential as being "in ground-breaking practical applications and immersive experiences", such as students learning through augmented reality, doctors practicing remote surgery and manufacturing engineers troubleshooting failing equipment.

Notwithstanding such arguments, perhaps one of the most significant benefits 5G creates is enhancing connectivity within rural areas.

"Ofcom recently announced the clearing of the 700 megahertz band, which is significant for rural mobile broadband service because it is low frequency. You can have the base stations further apart and still have a good signal, whereas the current 5G service in the UK is launched from a higher frequency band that doesn't work so well in rural areas," says Ian Fogg, vice president of analysis for mobile insights firm Opensignal.

Cisco's own data reveals the UK's rural economy could grow by an additional £17 billion over the next ten years if good-quality 5G services are accessible.

With more widespread remote working opening up opportunities for people to escape to the country, as suggested by data from property website Rightmove, the connection between 5G and remote working remains integral.

OPINION

‘These 5G innovation projects are all focused on delivering a better way of life for businesses and citizens’

Arrival of coronavirus and lockdown has been no less turbulent for telecoms than for many other industries. Among various activities, we have continued to progress the selection and delivery of the Department of Digital,Culture, Media and Sport (DCMS) 5G Testbeds and Trials (5GTT) programme, and to support the more than 1,500 organisations involved in UK5G.

The government announced an update to the telecoms supply chain review recommendations, a challenging regime for telecoms security, with high-risk vendor equipment to be removed from 5G networks by the end of 2027. This will be followed by a bill in the autumn focused on security. This drives us to focus on the nurturing of UK and less-established vendors, as well as openRAN solutions, and presents an opportunity to accelerate innovation in the telecoms space and support a diverse and interoperable supply chain

DCMS and UK5G have been collecting feedback to improve with each iteration of 5GTT and in response to this have established the UK5G Supplier Directory as a first step in simplifying the vendor technology landscape. This is particularly useful as the majority of trials are user and application rather than technology led and so need support to understand what partners they may need in their consortia. The directory is growing and lists suppliers from global giants to specialist small and medium-sized providers, and we invite suppliers not listed yet to participate.

In contrast the growth of conspiracy theories around 5G has led to significant amounts of abuse for wired and wireless telecoms engineers working to deliver and maintain vital services across the country, with arson attacks on several masts. Ofcom and the DCMS have published a guide explaining how 5G technology is to provide clear and simple information. There remains further work to be done to communicate the benefits of the technology more widely.

But it’s no secret that the UK is now expert in pioneering the uses of 5G technology. 5GTT provides an impressive and growing showcase of transformative use-cases, from supporting disadvantaged citizens in their homes via private 5G networks, driving efficiency, quality and reliability in manufacturing, bringing high-speed mobile connectivity to rural areas, and exploring immersive real-time applications in augmented and virtual reality. These are just a few of the impressive projects celebrated by researchers, engineers, businesses and public sector organisations happening across the whole country, all brought together in projects which are supported and partially funded by the government.

This DCMS programme is now accelerating through the £30-million 5G Create funding competition boost. Six projects were announced on June 30, with applications including traffic lights controlled by artificial intelligence, virtual reality for live sports, autonomous trucks at the Nissan factory and cost savings for the RAF’s Tempest fighter. The remaining cohort of 5G Create projects will be revealed later in the autumn following a record number of entries, which proves innovation in this sector is alive and kicking.

It will be fascinating to discover the new use-cases they’ll be exploring and to watch them develop. We are working hard to make sure they can benefit from the lessons learnt by their predecessors and by working with each other to overcome obstacles.

The UK has a very impressive and increasing number of transformative 5G projects located across the whole country and covering a wide variety of sectors, from social care to manufacturing. These 5G innovation projects are all focused on delivering a better way of life for businesses and citizens, a better way of working, living, commuting, caring and entertaining, which is so important in the unusual times we are living through.●

Robert Driver
Head of UK5G

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INDUSTRY

Three sectors set to win big with 5G

It has the potential to impact almost every sector, but 5G is particularly important to industries where data is a critical resource

Ed Jefferson

Stephan Sorkin/Unsplash

1

Kickstarting IoT's potential

An area with a lot to gain from 5G is the internet of things (IoT), networks of sensors and software that can give almost anything the ability to send and receive data. Indeed, IoT technology is becoming so widespread that any benefits for IoT translate into pluses for practically every other industry.

> **A 5G network could support more than two million connected sensors per square mile**

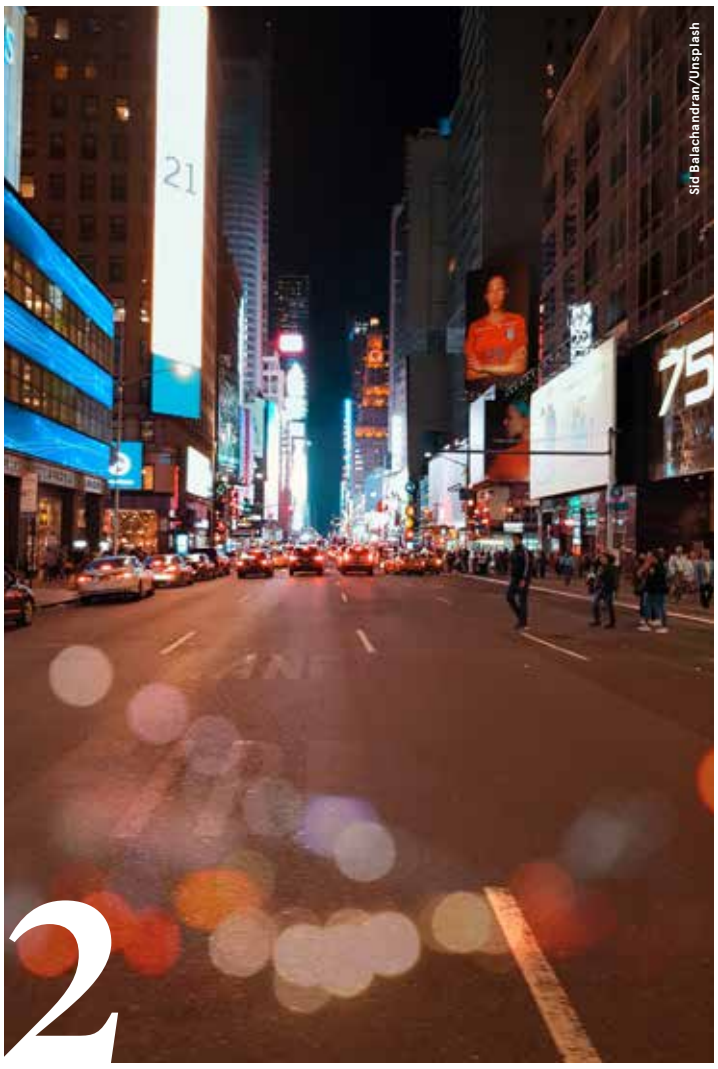
There are obvious applications in the consumer IoT device sector. Practically speaking, smart devices tapping into 5G infrastructure will be more appealing to the consumer because they can still turn the heating on, for example, even if the wifi has crashed. The increased reliability and speed of smart home gadgets will be particularly important in the case of security devices like cameras and locks. You want as fast a response as possible when a sensor in your home has detected an intruder or a fire.

There will be possibilities for IoT in the entertainment sector as 5G's ability to transfer massive amounts of data with such low latency will enable ultra-immersive augmented and virtual reality (AR/VR) and gaming experiences. As all the actual processing power can sit at a distance without any detectable lag, uncomfortably bulk headsets will be a thing of the past.

IoT can also make use of 5G's networking slicing technology; once installed, 5G hardware can operate multiple virtual networks on the same equipment. This means that a distinct network could be used for security-focused IoT devices so their uptime can be prioritised over less-essential services.

Steve Szabo, vice president of IoT at Verizon Business, says: "The potential of 5G to transform business operations is immense, enabling use-cases that don't exist today. As an example, a 5G network will potentially be able to support more than two million connected sensors per square mile."

In terms of the possibilities 5G will allow, he points to near real-time simulations, assessment, prediction via artificial intelligence (AI) and machine-learning, and remediation as just a few of the applications that an internet of things with low-latency transmission will enable in all sorts of sectors, from smart homes to robotics to autonomous vehicles.


Sid Balachandran/Unsplash

2

Smarter vehicles in smarter cities

A Gartner report last year predicted that by 2023 more than half of installed IoT devices will be found in connected vehicles, and 5G is going to be a key part of the story of how this is going to enable data and computation to transform the automotive sector.

Over the last few years, the Cellular V2X (C-V2X) communications standard has been developed for transferring data between a vehicle, other vehicles on the road, nearby infrastructure and devices, and the wider internet. While C-V2X can operate over 4G networks, 5G is vastly more preferable due to the volume of data that can be collected, potentially many terabytes an hour. The more data that can be gathered by the AI software that powers autonomous driving systems, the better the decisions they will be able to make and the closer the much-vaunted fully autonomous vehicle becomes.

Even before we reach that point, there are plenty of semi-autonomous operations that are made easier by a car that can communicate and can be communicated with, such as parking, braking or changing lanes. Being able to gather real-time data from surrounding cars and a wide range of nearby information sources via a low latency 5G connection will both make it easier to avoid human error and increase the complexity of tasks that can be handed over to autonomous systems entirely.

It will also have an impact on commercial automotive operations. An IoT-enabled fleet of trucks can feedback all kinds of data about their routes and performance, enabling operators to optimise

> **[5G will] both make it easier to avoid human error and increase the complexity of tasks handed over to autonomous systems entirely**

operations, not to mention all the potential benefits of fully fledged autonomous driving.

There is one thing that might stop this technology from becoming an integral part of driving: infrastructure. Communications regulator Ofcom's *Connected Nations 2019* report estimated that only 62 per cent of motorways (and only 46 per cent of B roads in the UK even had 4G coverage from all operators. Without massive improvement as we move into the 5G era, it's hard to see how any new safety features can be as taken for granted as they would need to be.

But developments in the automotive industry could be a spur to improving connectivity. As cities become connected, with sensors and cameras monitoring everything from water pipes to traffic lights, increasingly smarter cars will be able to tap into all these systems for live feedback. This will enable them to make decisions on the fly, leading to safer and more efficient journeys.

Protecting digital lives in the age of 5G

5G will provide endless benefits to society, enhancing the way people connect and engage online. But it will also amplify the cyberthreats they face, necessitating a new approach to security

5G ushers in the promise of powerful innovation, supported by rapid speed, mega-low latency and unprecedented quality of service. There is no doubt it will improve society and accelerate the vision of smarter, more connected homes.

The ultra-high performance of 5G networks will mean consumers, in the long run, will no longer require wifi routers, instead attaching almost ubiquitously to their operator's network, wherever they are. Not just on their smartphones, but also on tablets, PCs and smart devices.

In parallel with all these great benefits, however, a new wave of cybersecurity threats and challenges will arise. The sheer number of connected devices will allow for bigger botnets, while more bandwidth will enable much larger distribution denial of service (DDoS) attack capacity. Greater visibility of devices on 5G networks will create entirely new attack vectors for cybercriminals.

Put simply, 5G networks will amplify the number of threat vectors facing devices and consumers. Family security, privacy and online safety present significant concerns for people, making advanced network security a necessity. The ability to offer a converged protection from malware, network attacks and fine-grained parental controls over access and content will be a valuable differentiating service.

"There are going to be a lot of new things that families and employers will need to think about in terms of internet safety and privacy with the realisation of 5G," says Sean Obrey, head of sales for the Partner Business Unit at Avast, the largest global cybersecurity company with more than 435 million users.

"This will require solutions that understand the ways people want to live and manage their connected lives and those of their children and employees. The myriad new applications of 5G will make it tough to manage security and privacy control, especially as there will no longer be a router in the home to act as an important aggregator."

Avast recently launched Avast Smart Life for 5G, a smart home security solution for 5G, delivered as a virtualised network function. The solution enables operators to secure their subscribers' smart home and connected devices at the virtual-network level, based on Avast's threat detection technology driven by artificial intelligence (AI).

By analysing traffic and immediately blocking security risks on a consumer's devices, Avast Smart Life for 5G protects people's digital lives and allows them to connect wherever and however they want. Parental controls mean families can filter the content and apps their children can access.

End-point security has always required some kind of installation on a device, which becomes increasingly onerous as society is more connected. Utilising AI, Avast's technology taps into parts of the data stream to get certain identifiers about each connected session, protecting consumers from malicious activity without them ever having to install any software on their individual devices. Instead, consumers simply sign up once for protection to secure all their different devices.

"It's one-click protection and it's transforming the customer journey in cybersecurity," says Obrey. "We can protect any device, whenever it connects to a network. We have one of the largest threat-intelligence networks in the world, which fuels our machine learning-based protection for our customers. All that information drives our vast wealth of knowledge to protect individual devices as they connect to the internet.

"To keep people secure in the 5G age, we need to understand the different types of malware threats and anomalies coming to their devices, analyse them very quickly, and create the signatures and the data patterns we know help us protect those devices and block that behaviour."

> The myriad of new applications of 5G will make it tough to manage security and privacy control

For more information please visit avast.com/partners

avast

Manufacturing in the era of Industry 4.0

Manufacturing is another sector that will be revolutionised by 5G. At the most basic level, wired networks connecting machinery can run into the hundreds of dollars per metre of cable, so a wireless network that provides similar reliability and latency has obvious cost benefits, even after factoring in retrofitting older equipment with wireless connectivity.

The lower latency of 5G connections opens up a whole range of possibilities. Since control units can be trivially placed anywhere on, or even off, the floor in relation to machinery, fewer of them may be needed and production lines can become more cost efficient. Further efficiencies might be identified by the application of big data and analytics through 5G-enabled equipment.

There are also implications for the safety of automated elements of manufacturing systems, as improved communication speed can help avoid accidents as different systems can update each other near-instantaneously, with latency as low as 1 millisecond, compared to 25ms with 4G connections, in case of an emergency.

In addition, there are remote control applications for this technology, like a joystick control connected to a robotic arm via a prototype version of 5G as demonstrated by Ericsson in 2016. The low latency enables the person holding the joystick to receive almost instantaneous physical feedback on what the arm is doing, enabling far greater precision in movement.

> Those that embrace 5G to get the right data to the right place at the right time will rapidly gain an edge on their competitors

The capability to rapidly transfer large amounts of data can work in tandem with the use of AI in manufacturing. When using machine vision to detect flaws in components, the faster you can get the data from the sensors to the machine actually running the algorithm that looks for defects, the more efficient your process will be.

The potential improvements to AR/VR interfaces that 5G unlocks can also be applied to manufacturing. AR is already being used in factories to speed up troubleshooting processes where instead of consulting documentation to diagnose a problem, the relevant information can be superimposed over the actual components you're looking at.

Whether it's by increasing the ability and speed of automated systems to run without human intervention or by making human intervention more efficient, manufacturers that embrace the ability of 5G to get the right data to the right place at the right time will rapidly gain an edge on their competitors.

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5G is the **journey**. Shouldn't you own the **destination** too?
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