RACONTEUR

5G

Open innovation connects industries

Networks transformed for 5G

redhat.com/telco

Red Hat

5G

Contributors

James Gordon
Freelance journalist and executive writer, he has written extensively on business, technology, logistics, manufacturing and sport.

Alexandra Leonards
Freelance journalist, she writes in-depth features on a range of subjects, from current affairs and culture, to healthcare, technology and logistics.

Heidi Vella
Energy and technology writer, she writes for several consumer and specialist magazines, including *E&T Magazine* and *Global Data*.

Mark Hillsdon
Contributor to titles such as *The Guardian* and *BBC Countryfile*, he writes on topics including sustainability, wildlife, health and sport.

Kate O'Flaherty
Tech writer specialising in cybersecurity, her work has appeared in *The Guardian, The Times, The Economist, Forbes* and *Wired UK*.

Raconteur reports

Why private networking will be a game-changer

Excitement over the faster speeds and lower latency promised by public 5G has reached fever pitch, but it will be the advent of private networking that proves most transformative for both businesses and the UK economy

Heidi Vella

Mikhail Pochuyev/TASS via Getty Images

I f fourth-generation networking transformed communication by connecting more people, the revolution of 5G will be connecting more things. The promise of lower latency and increased bandwidth is expected to usher in industry 4.0 and the industrial internet of things (IIoT). However, it's the 5G networks' ability to deliver these benefits from a dedicated, private network that is both cost effective and easy to deploy that could be the real game-changer.

Encompassing micro towers and small cells, which can in some cases be assembled in a matter of hours, a private 5G network can be built to service a specific geographical area for better coverage, increased control and security.

Unlike the public network, its access is restricted, and because it can be "sliced" or "segmented" critical functions can be prioritised and run completely uninterrupted. This is particularly important for industrial applications, says Dritan Kaleshi, head of 5G technology at UK tech accelerator Digital Catapult.

"If companies are using cellular systems to run automated robots and cranes that are co-ordinating with one another and working around people, prioritising these functions over others is extremely important," he says.

Overall, the isolation of a private cellular network can guarantee 5G services and increase security, says Chris Allen at mobile private networking at Vodafone Business.

"Historically, this hasn't been possible because of the unpredictable nature of the general public, but with a private network we will know a company's usage profile and can specifically dimension it to guarantee their needs," he explains.

Private LTE (long-term evolution) networks are not new, but nor are they widespread. However, because 5G supports large-scale deployment of time-saving technologies, such as holograms, high-definition video and automated heavy industrial equipment, the business case for private 5G networking is expected to be more universal.

Hardware manufacturers, telcos and original equipment manufacturers are keen to demonstrate the business case and there are many trials underway trying to do this.

Vodafone, for example, has deployed a 5G private network at a gas terminal to improve productivity by ending paper processes and implementing predictive maintenance. According to Allen, the network and new processes it has enabled will save the company £5 million in one year.

Furthermore, as part of the European Union-funded MoNArch project, the Hamburg Port Authority, Deutsche Telekom and Nokia are testing a 5G dedicated network at the port to transmit movement and environmental data in real time across large areas. Other industries nascently deploying the technology include healthcare, airports and mining.

Kaleshi, however, says the media industry will be one of the early adopters. "There's an opportunity for immediate uptake in the creative industries that typically depend on very high-capacity and very fast communication, which is 5G," he says.

In January, telecommunications provider Swisscom tested a private 5G network at the 2020 Youth Olympic Games in Switzerland. Connecting all the production equipment at the venue wirelessly greatly reduced equipment installation time and the required manpower.

In particular, manufacturing is considered ripe for transformation via 5G private networks. Barclays estimates widespread adoption in the UK manufacturing sector could add £2 billion in revenue by 2025.

Wireless 5G connectivity can free manufacturing machines of cables, making it easier to change assembly lines and connect robots for fully automated processes and new revenue opportunities, says Iain Thornhill, vice president, service providers and IoT, at Ericsson.

"Car manufacturers can customise their cars much more easily and then sell them as a premium product; that's a prime example of increased revenue generation and competitive advantage," he says.

Robert Franks, managing director at West Midlands 5G, a public and-private-funded 5G accelerator that is setting up test beds to give local businesses access to private 5G networking, says the technology can greatly improve manufacturing productivity.

"It's been shown that using dedicated private 5G networks for predictive maintenance, for example, can improve productivity by up to 2 per cent because it reduces the cost of failure," he says.

Though several manufacturers are investing, most notably German carmakers Mercedes Benz and e.GO Mobile, the sector is still figuring out the use-cases. More than 70 per cent of manufacturers surveyed for Digital Catapult's *Made in 5G* report noted a lack of demonstrable return on investment as the main barrier to adoption. Kaleshi says, however, he anticipates an announcement soon relating to a new public-private consortium that will look at these barriers.

Proponents of 5G private networking say costs for hardware and installation should fall as chipsets become more standardised and more players compete to enter the marketplace. This will help small and medium-sized enterprises (SMEs) take advantages of the potential productivity gains.

"From a West Midlands points of view, it's critical the technology is deployed, not just in the largest enterprises, but also in the SMEs because those businesses account for around 95 per cent of the value of the output for manufacturing locally," says Franks.

Like in Germany, the UK regulator Ofcom is allowing any organisation to purchase spectrum, which means any company can operate a private network independently, as opposed to having a managed service from an operator.

"If you build it yourself, it's likely to be capital intensive, whereas if you buy it as a managed service, you can spread out the cost, but you won't own the asset and will have ongoing payments," explains Kaleshi.

Thornhill says while making spectrum more accessible is good for the market, the operators will still play a major role in the ecosystem.

"In most cases we will see the service providers involved as they are needed to guarantee the quality of service, to run it and provide enterprises with value-add around delivery, such as monitoring, security and other areas," he says

It is early days for 5G private networking, with most experts estimating the sector will kick-off properly in two to three years. Right now, however, the sweet spot for deployment is with the big industrial companies, airports and ports, says Allen.

"If you are a smaller company, unless you have a very niche use-case, it's probably not for you right now, but it will be in the future," he concludes. ●

£3.5trn

in value can be unlocked in the UK through 5G use-cases over the next six years

KPMG 2019

£15.7bn

in additional revenue could be generated by UK businesses as a result of 5G adoption by 2025

£2bn

annual revenue growth expected in UK manufacturing alone

Barclays 2019

John Reed/Unsplash

RURAL 5G

Can 5G aid rural connectivity and social mobility?

Rural communities have struggled with unreliable connectivity for years, but 5G technology could deliver a long-awaited solution

Alexandra Leonards

Come rain or shine, many of us expect undisturbed access to consistent and on-the-go mobile connectivity that keeps us perpetually entertained, informed and connected. As it's rolled out across the UK, 5G coverage promises an even faster and more efficient experience. But not everywhere will feel the benefit of the technology right away.

For years rural areas have experienced unreliable connectivity compared to their urban counterparts. According to UK communications regulator Ofcom's latest figures, 9 per cent of the UK, predominantly located in rural areas, still have poor access to 4G.

The Department for Digital, Culture, Media and Sport (DCMS) identifies restrictions on antenna heights on masts, prioritising environment protections over infrastructure, higher costs for mobile network operators and lower return on investment due to lower population density, as key reasons for the urban-rural divide. It's unsurprising then that as the UK 5G rollout makes headway, it's cities and towns that are prioritised.

But there's a strong case for rural 5G coverage. As the DCMS points out, much of the UK's socio-economic activity is taking place online. And so, leaving rural areas behind could pose a threat to economic growth and social mobility.

Commercially, rural 5G coverage appears to be on the backburner. But, as evidenced by DCMS funding of several 5G trials in recent years, it seems to be an increasing priority for the government.

Cisco's 5G RuralFirst project, for example, created testbeds for 5G across three remote sites. The project explored a number of 5G strategies, including 5G cloud core network, dynamic spectrum sharing, 5G radio access technology, agri-tech, broadcast and industrial internet of things.

The government also helped fund Quickline Communications' trial of 5G technology across a range of rural applications, including smart agriculture, tourism and connecting poorly served communities, using shared spectrum in TV bands and a mix of local internet service providers.

Establishment of an ongoing 5G Rural Connected Communities Project demonstrates the DCMS's aim to continue the advancement of 5G coverage in rural areas. In a bid to build the business case for investment in rural connectivity, it's funding up to ten innovative use-cases.

Minister for digital and broadband Matt Warman says: "We are acting now to make the UK a world leader in 5G, and our visionary testbeds and trials show the technology and desire is there for it to have a huge, positive impact on Britain's countryside communities. In the next wave of projects, the trials will focus on the value 5G will bring to the UK economy, how it can be used to tackle real social problems and how these applications can be commercialised."

Last year, Ofcom made available airwaves, including a frequency band that supports 5G, which in the past were restricted. "We've opened up a conversation with mobile network operators (MNOs) that was once very difficult to have," says Cristina Data, director of spectrum information and analysis at Ofcom. This is good news for rural areas where businesses and communities can apply to access airwaves, which are licensed to MNOs, but not currently used by them.

Although there are barriers to the technology becoming commercially viable, high-altitude pseudo satellites (HAPS) are also being presented as a possible alternative. It is hoped these satellites, deployed in the stratosphere at an altitude of 20km, will provide connectivity to remote areas, such as rural, coastal or mountainous regions.

"The ability to deploy HAPS over locations that are currently out of range of existing infrastructure will provide an alternative way of enabling 5G into rural areas quickly and without the need to build physical infrastructure which is proving overly expensive," says Barry Ross, chief executive at e2E.

Satellites are another technology currently being trialled in the UK and are potential game-changers. Examples include OneWeb, which is seeking to launch a constellation of 650 satellites to deliver high-speed global connectivity. But there are challenges associated with the technology.

"Using satellites for telecoms still has technical and commercial challenges, in particular with regard to price, capacity and availability of services," explains Warman. "However, the government has been actively involved in the work of European and international telecoms groups to study what technical and regulatory conditions are needed to develop the technology further."

5G coverage may appear to be the silver bullet for rural Britain, but it's not always the best solution.
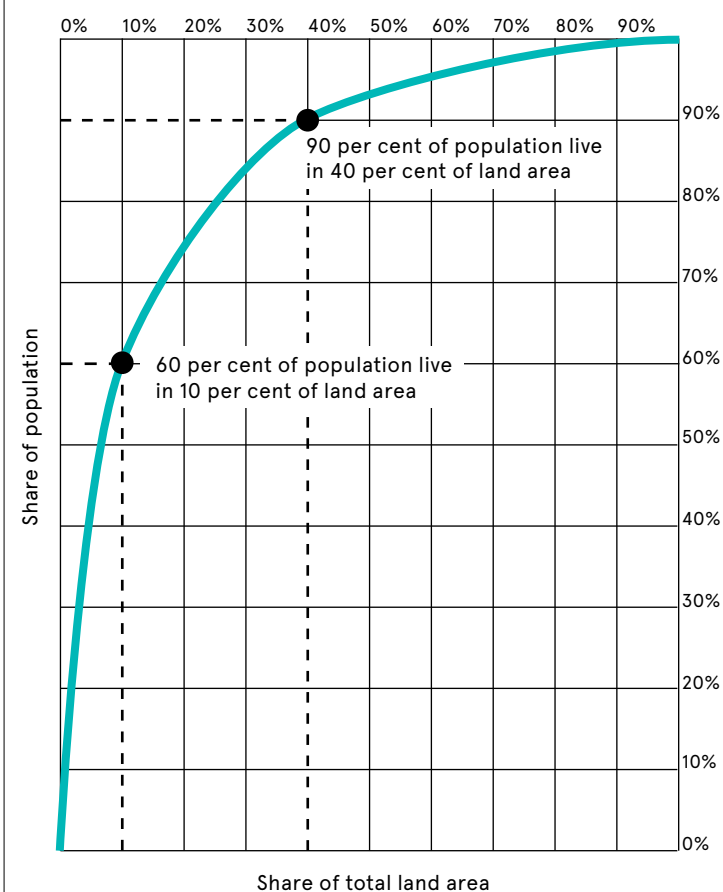
"Connectivity comes in many forms and the requirements in rural areas differ a lot, so even though it's now the buzzword, 5G is not always needed," says Heli Frosterus, principal policy adviser, spectrum group, at Ofcom.

As some rural areas are still operating without 4G, there's an argument to say that the next logical step would be to ensure those locations have access to it. To do this, the government has backed a shared rural network involving all the big MNOs. They are investing in a shared network of new and existing phone masts, which will bring 4G coverage to 95 per cent of the UK by 2025.

"Both technologies [4G and 5G] also have specific characteristics that suit different environments," says Gareth Elliott, head of policy and communications, at Mobile UK. "5G, in its initial rollout, is about providing capacity while 4G is better at extending coverage. Capacity is less of an issue in rural areas, but as the technology improves and new innovations are brought to market, we see a strong role for 5G in rural areas in the future." ●

THE RURAL CONNECTIVITY CHALLENGE

RTACS analysis of government data, which shows that the majority of the UK population live in a relatively small proportion of the land area

90 per cent of population live in 40 per cent of land area

60 per cent of population live in 10 per cent of land area

Share of population

Share of total land area

RTACS/Office for National Statistics

'The country has never before been so ready for what many are describing as a technology revolution'

Bringing a new generation of mobile technology out of the lab and on to the streets is something that sounds quite familiar. This is the fifth time around and yet it's very different.

Each generation before has introduced new technologies first and let industry and consumers figure out what to do with them later. With the introduction of 5G, the telecommunications sector has considered applications first and designed the technology to suit.

Through the Department for Digital, Culture, Media and Sport trials and testbeds programme, and various initiatives from the operators, we have a good understanding of the potentially transformative use-cases that will roll out throughout the 2020s.

The city of Liverpool has used 5G to help some of its most disadvantaged people get better medical support in their homes. Factories in Worcester have reduced machine downtime, and improved efficiency, quality and reliability. Millbrook proving ground, for a long time the best place in the UK to test prototype cars, is now the premier place in the world to test 5G in automotive. The rural testbeds have connected cows, salmon and wind farms.

And the UK is an expert. Work at the University of Surrey, Kings College London, Bristol University and elsewhere has pioneered 5G technology and trained researchers, engineers and scientists in the skills that will help the nation build 5G and use it to generate revenue.

The country has never before been so ready for what many are describing as a technology revolution. Of course, some of the things we envisage as the great hope for the future may still turn out to be a damp squib and there are also wonderful things 5G will enable that we've not even conceived.

The best route to discovering those new ways of living and working is not to ask what 5G can do that 4G can't, but to identify a problem and then look in the 5G toolkit for a solution. Beyond fundamental improvements on 4G of much higher speeds, significantly lower latency and the ability to have far more devices in a small space without interference, there are other 5G abilities.

At a system level, 5G enables operators to cope with escalating capacity demands, particularly around consumption of video. Network slicing gives dedicated access which has applications for healthcare, defence and broadcast. The low power, low data rate technologies give battery life which lasts years.

Asking what 5G can do is the wrong way around. Understanding the problem to get to the solution is the 5G way of doing things.

All current 5G deployments are so-called non-standalone, running on a 4G backbone. It will be a while before true 5G standalone is fully deployed and all the benefits the technology offers become fully available. But preparing early is important, not just because we want to get the benefits and cost-savings from the new technology as soon as possible, but because one of the lessons we've learnt is those businesses that lag in initial rollout can find it tough to catch up.

It is often said it's better to be a fast follower than a pioneer, but with mobile technologies we've seen those companies that start in the lead stay there. Nowhere is this more important than in industry where the technologies that come with 5G are so empowering.

The UK has 5G available from all four major networks. They are up and running in more and more places. With 5G specifically designed to meet the needs of industry in the 2020s, it's great the country is getting ready.

Robert Driver
Head of UK5G

Mobile 5G set to transform what's possible

The fantastic speed on offer from the continued rollout of 5G home broadband and extension of the UK's only real 5G network are providing major opportunities for both consumers and businesses to improve how we live and work

Smartphone users will soon be able to enjoy a near-instantaneous browsing and streaming experience in the palm of their hand as Three prepares to extend what will be the UK's fastest and only "true" 5G mobile network later this month. Three's new 5G services, which use twice the amount of spectrum than any other UK network, will give consumers unprecedented speeds, including the ability to download a 4K movie in just seconds.

Three has acquired 140MHz of 5G spectrum, 100MHz of which is contiguous, making it the UK's only operator able to offer a full bandwidth 5G network, according to the global standards body on 5G technology. Its closest UK rival has just 50MHz of contiguous 5G spectrum, which means Three will be providing peak 5G speeds that are twice as fast as any other operator across the country in this fifth generation of internet connectivity.

Latency, the time it takes for a mobile network to respond to a request, will reduce drastically from 4G averages of 40 to 50 milliseconds to as low as just 1 millisecond with 5G. This will have a transformational effect on business, gaming and society. By providing connectivity for the internet of things (IoT), 5G will facilitate rapid advances in driverless cars, healthcare, robotics and artificial intelligence, with endless opportunities for new innovation as well as simple enhancements in day-to-day life.

5G will also enable mobile networks to offer high-speed internet access in dense urban areas, something that is difficult to achieve on 4G networks. For example, as part of its shirt sponsorship agreement with Chelsea Football Club, Three UK has committed to enabling Stamford Bridge with 5G access from the 2020-21 Premier League season, improving the match-going experience for supporters.

"5G is a game-changing technology," says David Dyson, chief executive at Three UK, the nation's challenger mobile network. "The switch from 3G to 4G was evolutionary, but 5G is a revolutionary technology. Spectrum is the lifeblood of the mobile industry and we hold almost three times as much as our nearest competitor. Whether they are using it for faster downloads on the go, a faster home broadband network or for IoT connectivity, consumers and businesses can be assured that Three will ultimately be delivering the fastest 5G network in the UK with speeds far in excess of anyone else."

Many customers have already been enjoying Three's 5G since August, when the operator officially switched on its new network with the launch of its 5G wireless home broadband service. 5G home broadband delivers fibre-like speed, with Three customers receiving peak speeds of 1Gbps and average speeds of 221Mbps, significantly above the national average.

However, it is also much quicker to deploy, with no need for long-term contracts, engineer visits or drilling through walls and can be almost 50 per cent cheaper, Ovum research has found. Customers simply plug the broadband box into the wall and they're connected. With Three's 5G spectrum and new network technology, the amount of traffic it can carry on its network will increase by 28 times in the coming years.

2020 expansion

During 2020, Three will be expanding its 5G network across the UK, which means many UK towns and cities can benefit from enhanced mobile and home broadband services. The backbone to these unrivalled 5G services will be a super-high-capacity dark-fibre network connecting 20 local core edge datacentres to its mobile masts. The datacentres are highly secure and energy efficient, and feature the world's first cloud-native core network that is fully integrated, 5G ready and will enable the fastest possible experience.

Cloud networks are more efficient and reliable than legacy systems and can handle more data, which is crucial given that Three's customers already use more than three-and-a-half times the industry average of data. Legacy datacentres are typically outdated, inefficient and unable to support the huge scalability needed for 5G. Hosting the UK's first mobile network core in

54.2 Mbps

UK average fixed broadband speed

221 Mbps

Three 5G broadband average speed

×4

Faster than UK average fixed broadband speeds
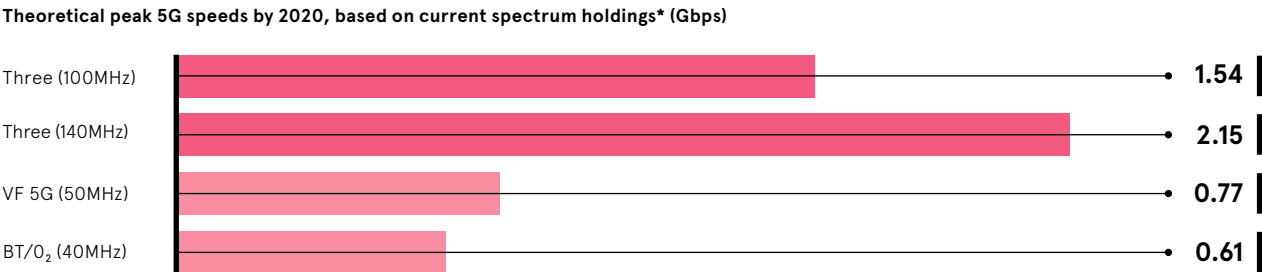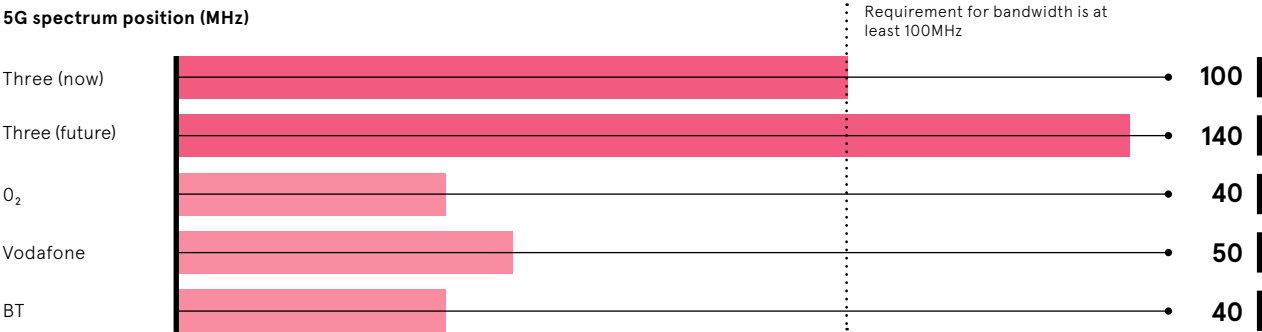
1 Gbps

Three 5G broadband peak speed

Three home broadband customer speeds

> **"Consumers and businesses can be assured that Three will ultimately be delivering the fastest 5G network in the UK with speeds far in excess of anyone else**

Commercial feature

THREE IS BUILDING THE UK'S FASTEST 5G NETWORK

Three's 100MHz contiguous bandwidth sets the benchmark for 5G speeds in the UK

5G spectrum position (MHz)

Requirement for bandwidth is at least 100MHz

Three (now)	100
Three (future)	140
O₂	40
Vodafone	50
BT	40

Theoretical peak 5G speeds by 2020, based on current spectrum holdings* (Gbps)

Three (100MHz)	1.54
Three (140MHz)	2.15
VF 5G (50MHz)	0.77
BT/O₂ (40MHz)	0.61

*Theoretical peak speeds calculated assuming user location and other variables are equal

Three UK

Premier League footballer Alex Oxlade-Chamberlain plays Call of Duty over Three's 5G network

"

We are spending millions of pounds every day to transform our entire network end to end

the cloud, supported by next-generation datacentres, will improve reliability and resilience while accelerating the rollout of any new features.

Three's initial aim is to get 5G on 40 per cent of its busiest sites, carrying 80 per cent of its traffic, by the end of 2021. To enable this it is deploying new RAN (radio access network) technology, which consists of the masts and base-station equipment that links mobile traffic to its core network. The new technology, and an evolved backhaul solution, brings Three's transport network closer to users, improving speed, coverage and overall performance.

"5G requires more than just putting spectrum and 5G antennas on to mast sites," says Dyson. "To deliver the speeds and latency that digital Britain needs, we are spending millions of pounds every day to transform our

entire network end to end. We are using cutting-edge technology in our fibre network, datacentres and the world's first fully cloud-based core network to deliver a cutting-edge service."

Future of gaming

5G is set to revolutionise the world of gaming. Last September, Three announced a new partnership with Activision, a leading video game publisher, that will see its ultra-fast 5G network deliver an optimum online experience for one of the world's most popular games, Call of Duty: Modern Warfare. In a game where split-second decisions are the difference between winning or losing, 5G's mega-low latency is hugely valuable.

A 5G connection is a step-change in what people have been accustomed to from a mobile connection, and it paves

the way for a whole new level of gaming and live streaming without the pain of lagging, freezing or dull loading bars. Gamers using Three's 5G home broadband get plug-and-play access to a seamless online experience and supersmooth gameplay. Whether playing on a console or PC, they can enjoy vastly improved speeds compared to what they're used to with a fixed broadband connection; UK average fixed broadband speed was 54.2Mbps, according to Ofcom in May 2019.

The partnership cemented Three's continued expansion of its 5G home broadband service and further showcased its long-term commitment to enhancing the gaming and home entertainment experience for customers across the UK. For £30 a month, customers receive truly unlimited data, so they can play, stream, download and connect all their devices and apps without any restrictions or worries about hidden charges.

"Ultra-fast speeds are a priority for seamless streaming of entertainment, especially gaming," says Shadi Halliwell, chief marketing officer at Three. "Three is delivering a 5G experience that can't be beaten, making us the natural choice for one of the world's leading games' publishers. The combination of our superior 5G network, which comes at no extra cost, our truly unlimited data plan and this fantastic partnership with Activision, means gamers can play the world's most popular game without boundaries."

Lee Godfrey, Call of Duty UK senior brand manager at Activision, adds: "We're excited to be partnering with Three, whose commitment to delivering the best player experience through its ultra-fast 5G network is a perfect match for Call of Duty: Modern Warfare."

Transforming enterprise

The rollout of Three's 5G network will not only benefit consumers, but also businesses across the UK. Recent research from Barclays predicted 5G could boost UK business revenues by up to £15.7 billion by 2025 and the barriers for adoption are so low that companies of any size can take advantage of the benefits. By 2030, the estimated increase in revenues could be up to £89.6 billion and the overall size of the UK economy could be boosted by up to 1.54 per cent compared to an economy with no national 5G network.

Crucially, 5G has the capacity to connect cities, homes, factories and devices in ways that have never previously been possible, allowing the UK to lead the way in technologies such as machine-learning and the fourth industrial revolution. 5G will also boost worker productivity and collaboration, and help people with accessibility challenges get back into work. This could be particularly impactful given the UK's ageing population.

By offering near-immediate connectivity and unprecedented broadband speeds, new businesses will be able to get up and running and on a level footing with established rivals faster than ever before. 5G will also vastly improve the performance of video-calling services as well as office and productivity applications, including on mobile, allowing businesses of all sizes to be global and really embrace flexible working.

Meanwhile, connectivity improvements in speed, latency and capacity will accelerate industrial digitalisation

and the resulting cost-efficiencies. A new generation of communications will develop to offer richer, mobile digital experiences for both businesses and consumers, and 5G-based location-tracking will also enable better precision for fleet management, semi-autonomous vehicles and warehouse efficiency.

"5G allows Three to revolutionise what a mobile service can offer to businesses," says Dyson. "While IoT technology and its applications are evolving for enterprise, it is clear significant opportunities to improve efficiency and launch exciting new services will materialise in the not-to-distant future."

Powering virtual catwalks

Through its existing creative partnership with renowned arts college, Central Saint Martins, Three's superior 100MHz of 5G spectrum will be showcased through a series of revolutionary fashion firsts. Building on its partnership from last year, when the first 5G augmented reality fashion show was revealed, Three's superfast 5G will transform the catwalk into a truly immersive digital experience during London Fashion Week, culminating in Adwoa Aboah walking the catwalk virtually. This will be a unique nod to the future when models will be able to walk multiple shows during fashion seasons all over the world, thanks to 5G.

For more information please visit three.co.uk/5G

THE ECONOMIC IMPACT OF 5G

The fifth generation of mobile networks is here, and is expected to have a bigger impact on the global economy than any previous iterations, contributing more than $13 trillion to output worldwide by 2035. According to forecasts, China is set to see the most economic gains from the roll-out, while manufacturing will be the sector that will benefit most as operators are able to ramp up production and create new revenue streams as a result of industry digitalisation

This data had been provided exclusively by Informa Tech's newly formed research and consultancy business Omdia and in partnership with their upcoming 5G World event in London

$13.2trn

potential global sales activity across multiple industry sectors enabled by 5G by 2035, representing...

5%
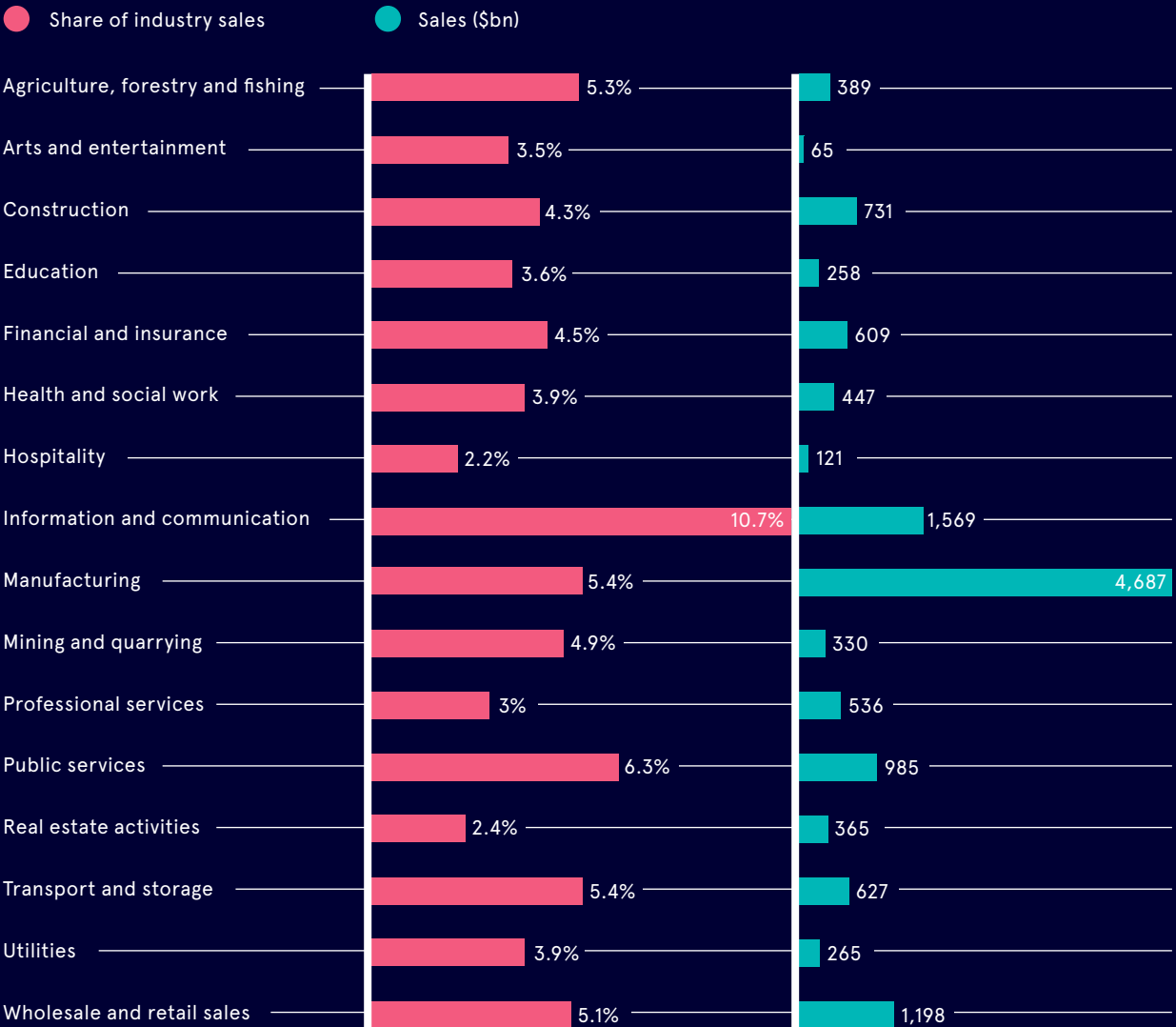
of global real output

22.3m

jobs generated by the 5G value chain by 2035

Throughout this infographic, sales enablement takes into account sales activity that 5G will enable, including intermediate purchases required to make and deliver goods and services in addition to sales to end-users, such as the sale of components from suppliers to manufacturers when making a car (tires, batteries, etc.); GDP, on the other hand, only measures the value of final demand for goods and services
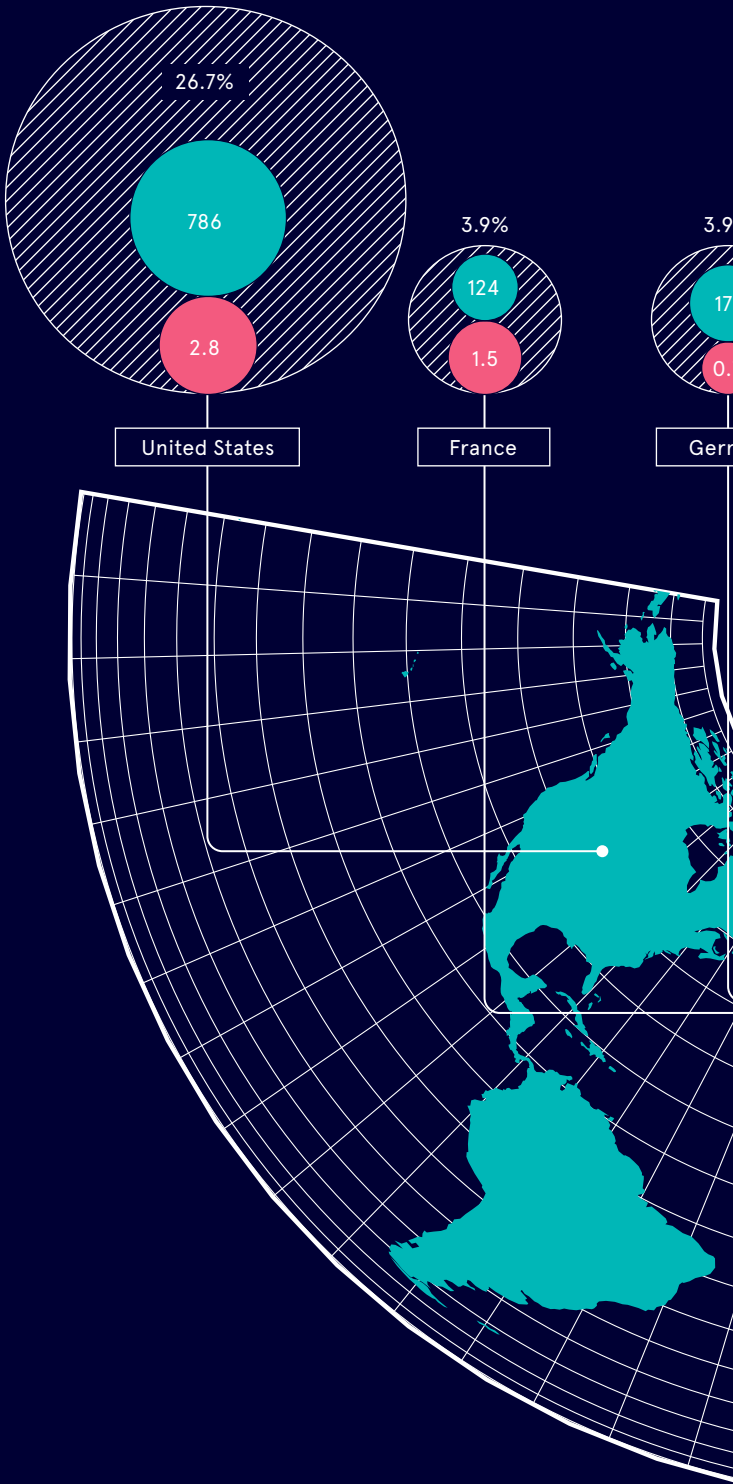
5G-ENABLED SALES BY INDUSTRY

Potential global sales activity across multiple industry sectors enabled by 5G; based on a 2016 sales benchmark

● Share of industry sales   ● Sales ($bn)

Industry	Share of industry sales	Sales ($bn)
Agriculture, forestry and fishing	5.3%	389
Arts and entertainment	3.5%	65
Construction	4.3%	731
Education	3.6%	258
Financial and insurance	4.5%	609
Health and social work	3.9%	447
Hospitality	2.2%	121
Information and communication	10.7%	1,569
Manufacturing	5.4%	4,687
Mining and quarrying	4.9%	330
Professional services	3%	536
Public services	6.3%	985
Real estate activities	2.4%	365
Transport and storage	5.4%	627
Utilities	3.9%	265
Wholesale and retail sales	5.1%	1,198

OUTPUT AND EMPLOYMENT IN LEADING 5G COUN...

Based on estimated economic activity in the seven countries expecte...

● 5G-enabled employment (m)   ● 5G-engabled gross out...

United States — 26.7% — 786 — 2.8

France — 3.9% — 124 — 1.5

Ger... — 3.9% — 17... — 0....

5G ROADMAP

Estimated trial and adoption of selected 5G use cases

● Initial use/trials   ● Common use   ○ H...

2019

Smartphones
AR/VR
Smart cities
Energy/utility monitoring
Autonomous vehicles
Drones
Industrial automation
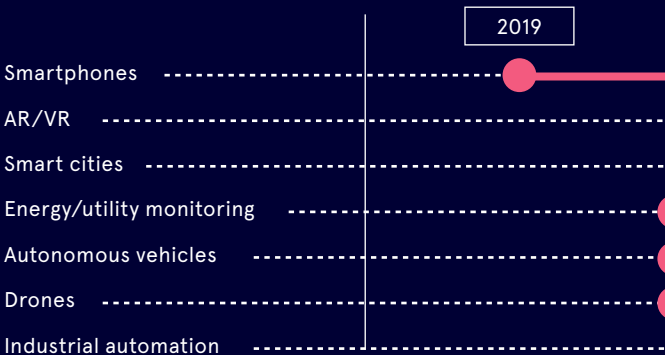
NTRIES IN 2035

d to be at the forefront of 5G development, representing 79 per cent of all investment

put ($bn)   ⊘ Share of value chain R&D and capex

25.5%

3.8%

1,130

%

2.9%

114

0.5

12.4%

10.9

406

128

0.7

2.3

| many | UK | China | South Korea | Japan |
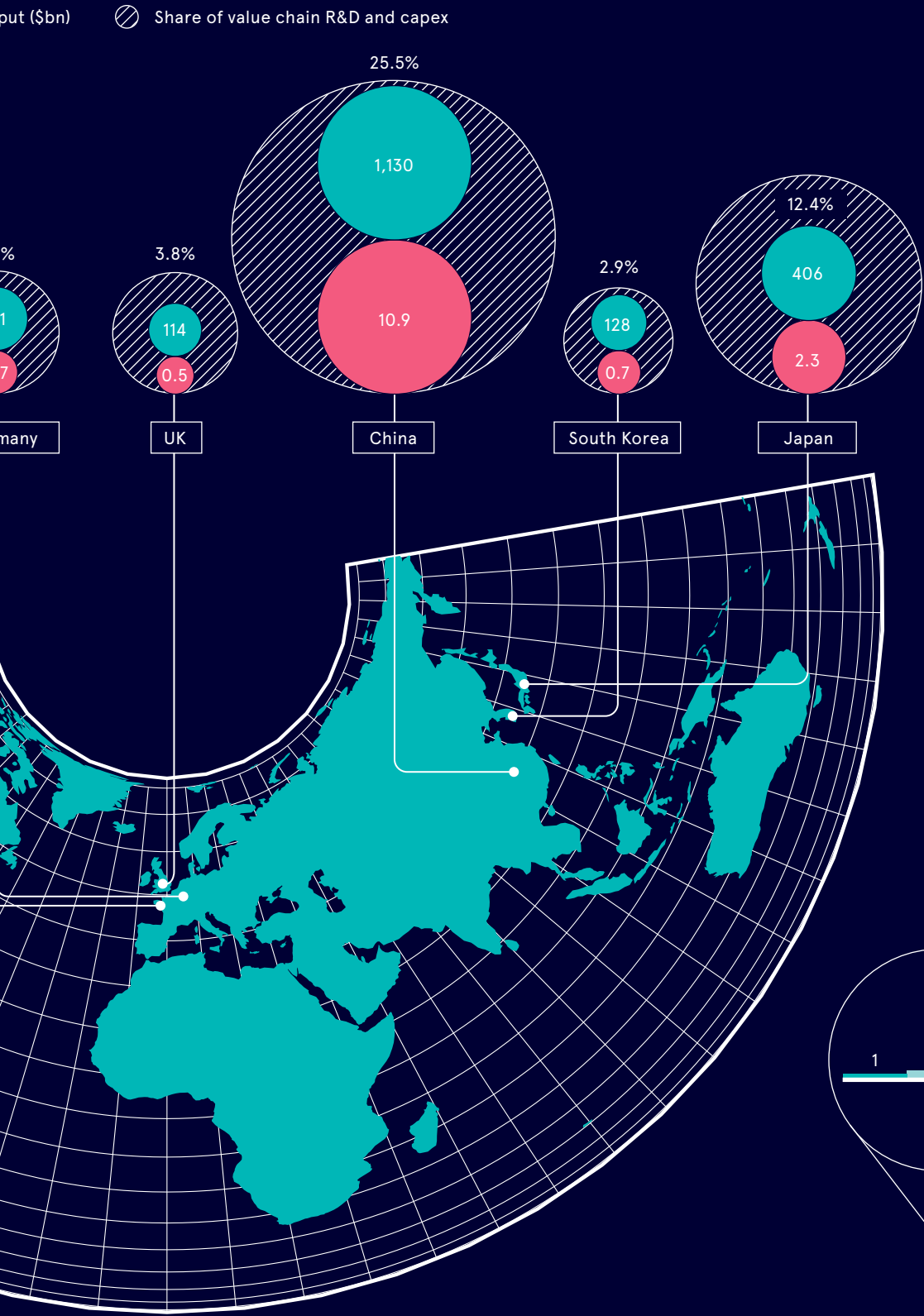
5G MOBILE SUBSCRIPTIONS (MILLIONS)

● Americas   ● Asia and Oceania   ● Middle East and Africa

● Europe   ⬨ Total

2
6
10
63

5
35
49
251

11
99
152
446
688

22
215
274
831
1342

38
318
386
1159
1901

1   2   13

| 2019 | 2020 | 2021 | 2022 | 2023 | 2024 |

eavy use

| 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 |

Jake Givens/Unsplash

AUTOMOTIVE RETURNS

Applications through which 5G would provide the most immediate return on investment, according to automotive equipment manufacturers

27%
Vehicle-to-everything communication

25%
Enhanced infotainment experience

16%
Software-over-the-air updates

12%
Monetisation of data generated by vehicles

10%
Enhanced remote diagnostics

8%
New services and applications

2%
Enhanced security

Omdia 2019

TRANSPORT

Kickstarting an automotive revolution

5G is set to have a transformational impact on the transport industry, but which brands and sectors are leading the way?

Mark Hillsdon

If 2019 was the year that 5G's impact on transportation spluttered into life, then 2020 will see it move through the gears and start to transform the way we travel, from 5G-enabled cars to autonomous trains.

With its low latency, reliability and powerful connections, 5G's impact on transportation is starting to take shape, and it's on our roads where there's the greatest sense of anticipation. While the arrival of the much-vaunted, fully autonomous vehicle is still some way away, most of the world's major car brands are set to release new 5G-enabled models which link into the internet of things (IoT) and offer drivers and their passengers a wealth of new opportunities.

According to analysts Gartner, the share of cars actively connected to a 5G service will grow from a current base of 15 per cent to 74 per cent by 2023 and 94 per cent five years later. Jonny Culkin, automotive designer at design agency Seymourpowell, explains: "Manufacturers are looking to leverage all nascent IoT and blockchain that 5G will enable to create service and brand unique selling points to incentivise people to keep buying their vehicles."

BMW, for example, has teamed up with Samsung to bring 5G connectivity to its iNext model and provide real-time information to drivers on road situations, based on high-resolution maps. VW's new Golf is the manufacturer's first new car to use Car2X technology, enabling it to communicate with other vehicles up to 800 metres away. While Volvo has announced the first steps to bring vehicle-to-everything (V2X) communication technologies to its vehicles. The company is linking up with China Unicom to develop its 5G connectivity and by "talking to the infrastructure" says its cars will be able to detect traffic jams, when to slow down and when to take a detour.

As well as the potential to improve safety and in-car entertainment, 5G-enabled cars will also produce valuable data, says Culkin, which vehicle users will be able to sell back to manufacturers, governments and transport bodies. "The likes of Jaguar Land Rover are already encouraging schemes such as this, promoting the idea of 'rewarding' customers for their data, which will ultimately enable manufacturers to build better, more reliable vehicles," he says.

Culkin also hopes this data will be made available to help improve the transport infrastructure as a whole, enabling independent transport bodies, councils and authorities to build a "digital twin" of our transport networks. "This digital sibling would eventually become a simulation tool for these bodies to take pre-emptive action to create a safer, more efficient system which should have a positive impact on all citizens," he says.

When it comes to the railways, things are moving faster towards full automation. Last December, on a little-used stretch of track in eastern Germany, a train fitted out by engineering firm Thales was operated remotely using a 5G network. Vodafone used a technique called Network Slicing to ensure there was always enough capacity to control the train in the test arena, regardless of other internet use nearby.

Alexander Saul, Vodafone Germany's enterprise business unit director, explains: "5G is becoming relevant for many means of transport. Together with Thales, we controlled a train from a distance; together with Airbus, we steered a 12-metre airship by 5G for the first time. And, in road traffic, we are already connecting many millions of cars on the internet of things."

The first rollout of the technology is earmarked for freight services, but passenger trains are central to another German project in which Nokia is working with Deutsche Bahn to test whether 5G technology can deliver an automated rail service along a 23-kilometre section of track in Hamburg.

In the UK, train operator First Group is working with Blu Wireless to use mmWave technology to give its passengers faster, high-quality streaming and connectivity. Blu Wireless's chief marketing officer Mark Barrett explains: "Everyone wants to use wifi on the trains, but there's not enough capacity," which means train operators must continue to pay high prices to data providers to support wifi on their services or developing their own trackside networks.

First Group has chosen the latter route and are harnessing mmWave, which Barrett explains has been designed for high-speed transport applications and is much cheaper than cellular infrastructure. It uses small radio units mounted on trackside poles, which use about 1 per cent of the power of a typical 4G base station. The first stretch of 5G-enabled track, running out of Basingstoke, will launch in the spring.

Barrett also sees applications for mmWave within aviation. "It could be used within the cabin to distribute multimedia content in a more efficient way," he says. But, at the moment, airport 5G stops at the departure gate.

Nokia's private wireless solution, now deployed at Finland's Helsinki Airport, supports critical operational services, while freeing up existing wifi networks to deliver a faster service for passengers.

In Belgium, Brussels Airport launches its own private Nokia 5G network in March. It too will offer a more efficient and faster connectivity than wifi or 4G, as well as providing the higher capacity the airport needs to deploy additional services, such as automated vehicles and track-and-trace technologies.

According to Brussels Airport spokeswoman Ihsane Chioua Lekhli: "We have chosen not to wait on a public 5G network, but to be a pioneer in this area and create one ourselves so that the capacity of the network is guaranteed. This way there is no risk of overload.

"Tests have shown it could further optimise operations at the airport and will enable us to more easily implement new digital innovations and technologies." ●

> **"**
> We have chosen not to wait on a public 5G network, but to be a pioneer in this area and create one ourselves

Commercial feature

Taking 5G innovation to the edge

Red Hat's open source solutions are driving network upgrades and cutting-edge services that will define the 5G era

5G, edge computing and hybrid clouds are some of the most exciting technologies in the business world. But their true potential only becomes apparent when they're viewed together, each technology encouraging uptake of the others, their combined power driving a revolution in the way businesses manage their networks and deliver services.

With 5G's capabilities, enterprises can push compute power closer to the network edge, closer to where it is needed, to help eliminate latency and congestion issues for real-time applications, even when massive volumes of data are being generated and processed. In turn, this should encourage the adoption of everything from predictive maintenance for machinery to autonomous vehicles and smart city services.

Red Hat, the world's leading provider of enterprise open source software solutions, understands these connections only too well. It builds everything in open source communities, many of which are deeply involved with the development of 5G and edge computing.

"In terms of lines of code, Red Hat is the top or top-two contributor to many core projects," says Darrell Jordan-Smith, global vice president of vertical industries and accounts. "This gives us strong insights into where the community wants to go and it enables us to educate the community on use-cases that we believe are very relevant in those spaces, particularly in terms of the far edge of 5G networks and what it will potentially mean to different industries."

In the telecommunications industry, 5G and the desire to handle workloads at the edge is driving the adoption of virtualisation and containerised apps, reducing the need for expensive proprietary hardware, and speeding the development and deployment of new services. By helping to build this agile, software-driven network infrastructure, Red Hat is supporting the wave of enterprise innovation that will follow.

"Open source software brings the innovation which allows the community to build different mechanisms for deploying that network in a building, a stadium or rural area," Jordan-Smith explains. "Telcos can deploy a very flexible, non-traditional network, and that is exactly what they need to do to move things forward and evolve in the 5G era."

In fact, every Global Fortune 500 telco or service provider relies on Red Hat.[*] The company is also working closely with the graphics chip manufacturer NVIDIA to build a cloud-native, highly scalable GPU (graphics processing unit) computing infrastructure for the 5G world, and accelerate enterprise adoption of artificial intelligence (AI), machine-learning and data-analytics workloads.

These technologies are key elements for connected vehicles, which will be at the centre of a new ecosystem of software and data-driven services, like "datacentres on wheels" as some experts have called them.

83%

of IT leaders say enterprise open source has been instrumental in their organisation's ability to take advantage of cloud architectures

The State of Enterprise Open Source: A Red Hat Report, Red Hat/Illuminas 2020

Organisations (i.e. large enterprises) expect an estimated

10–20%

reduction in costs from using edge computing

Strategies for Success at the Edge, Analysys Mason, 2019

50%

predicted increase in the size of the edge cloud services market in 2020

Predictions 2020: Edge Computing, Forrester Research, Inc., November 4, 2019

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Making a platform that is ubiquitous from the core all the way to the far edge, and making it flexible and agile, enables the largest possible group of developers to create applications and services for it

Red Hat is helping leading automobile manufacturers to develop and test these advanced connected services, ensuring they all work together in harmony. "In the automobile industry, there's a lot of talk about autonomous driving and vehicles essentially talking to other vehicles as they drive along the motorway," says Jordan-Smith. "To be able to do that, you need a very fast network with very low latency, which is what 5G and edge computing provide. You need the ability to run AI and map that onto satellite navigation systems and other telemetry data from your vehicle."

5G and edge computing should also allow energy companies to collect machine telemetry and carry out predictive maintenance of their equipment or even control it remotely. Furthermore, manufacturers that adopt predictive-maintenance technologies will no longer have to shut down their production lines to carry out emergency repairs. And the ability to rapidly collect, process and act upon data from internet of things (IoT) devices will enable them to improve radically their logistics processes or automate certain business functions.

In addition, new opportunities are opening up in the connected health space, particularly in terms of biometrics. "For instance, if you're diabetic, 5G will enable you to collect data on your phone and then send it to your GP," says Jordan-Smith. "Some of this can be done over 3G or 4G, but moving forward we'll see devices that can measure your blood sugar levels, your heartbeat, your temperature in real time and use machine-learning at the edge to handle any known conditions."

This will enable patients to have different kinds of interactions with their doctors. "You, as an individual, will be able to take more control over your medical needs and be more pre-emptive in terms of your personal care, perhaps without having to visit a hospital or doctor," adds Jordan-Smith.

5G technology is also a key component of smart cities, where data from sensors, cameras and other connected devices needs to be processed in real time to provide insights and assistance with traffic congestion, crime prevention and property maintenance, for example. "A lot of the interactions with the 5G edge network won't come from individuals," says Jordan-Smith, "they'll come from devices and machines interacting with the edge network."

Red Hat believes that offering hybrid cloud at the network edge will enable its customers to deliver any application or service on any infrastructure. For instance, these hybrid cloud environments, in conjunction with IBM's Multicloud Manager – Red Hat was acquired by IBM for $34 million in 2019 – and Red Hat OpenShift, will allow enterprises to shift the workload for their applications and services from their datacentres to cloud service providers such as Amazon, Google or Microsoft Azure.

This open source, cloud-centric approach will help to unlock innovation in the 5G era, says Jordan-Smith, drawing a parallel between the ubiquity of the Java platform 15 or 20 years ago and what's happening with containers and open source platforms in the enterprise network now.

"Making a platform that is ubiquitous from the core all the way to the far edge, and making it flexible and agile, enables the largest possible group of developers to create applications and services for it. It creates an ecosystem where innovation naturally occurs," he says. "There are millions of developers out there who we interact with and we believe much of the innovation around 5G is going to come from them."

For more information please visit redhat.com

Red Hat

[*]Red Hat client data and Fortune Global 500 list for 2019. Methodology for Fortune Global 500: companies are ranked by total revenues for their respective fiscal years ended on or before March 31, 2019

SECURITY

Does 5G require more or less focus on security?

5G offers huge business potential, but the technology is much more complex to secure

Kate O'Flaherty

The 5G era is about to arrive, bringing faster speeds and lower latency to enable a host of new business applications. The next-generation cellular technology is designed to be more robust than its predecessors 3G and 4G, but 5G security is also much more complicated to manage.

5G poses an elevated security threat partly because there are more vectors through which adversaries can attack. The technology is set to enable a huge number of connected devices, collectively known as the internet of things (IoT).

Yet IoT devices are a target for cyberthreat actors because they could be taken over to form what's known as a botnet to perform distributed denial of service, or DDoS, attacks to paralyse networks.

The challenge is amplified by vertical 5G use-cases, such as connected cars and healthcare, which bring critical industry-specific security requirements. At the same time, 5G is based on virtualised networks which themselves need to be governed by robust protocols.

The real-life risks posed by 5G are already being demonstrated. Last year, researchers at the Black Hat security conference shared 5G vulnerabilities that allowed them to access user locations and launch attacks on devices.

Later in 2019, researchers at the US universities of Iowa and Purdue demonstrated 11 5G vulnerabilities that could allow denial of service attacks and hijacking of the public paging channel used to broadcast emergency alerts.

5G security creates an urgent need for the ecosystem – mobile operators, physical infrastructure providers, such as Nokia, Ericsson and Huawei, vertical industries, such as automotive, and regulators – to work together. So how can this be done?
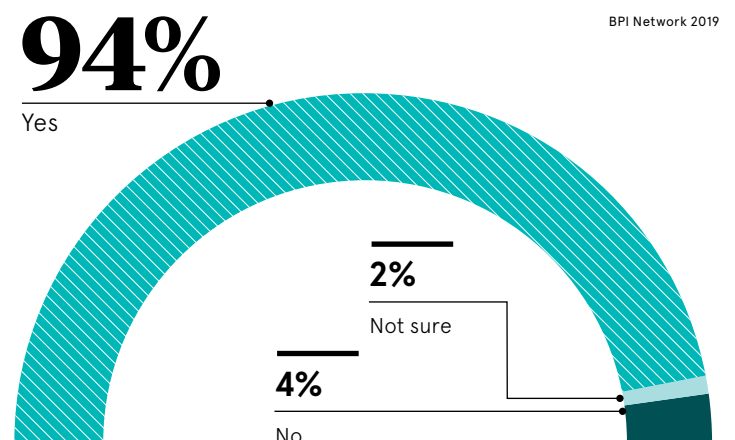
Firstly, the 5G security challenges need to be acknowledged and addressed. Some of the greater threats are posed by high-risk industries using 5G technology for mission-critical applications. For example, 5G will enable smart cities and self-driving cars. Specifically, this will see 5G networks underpinning services such as emergency response and traffic control.

But if the 5G networks enabling these applications are interfered with or shut off, the results could be catastrophic. "What happens if a hacker shuts off a city's water supply or if they are able to gain access to an army of delivery drones?" asks Russ Mohr, engineering director at MobileIron.

Due to the network architecture, 5G will also see the impact of failure of the core infrastructure increased. "Current core infrastructure has isolated functionality so when a component fails, such as mobile data or

INDUSTRY EXPERTS ARE WORRIED

Telecoms operators and industry experts were asked if they expect security challenges to escalate with the advent of 5G networks

BPI Network 2019

94%
Yes

2%
Not sure

4%
No

SMS, it results in a partial degradation of service for a single network," says Alex Farrant, senior researcher at Context Information Security. "5G's shared infrastructure has the potential for mass failure across multiple networks."

Another security risk is posed by the protocol designed to allow 4G or 3G connections when a dependable 5G signal isn't available. When a 5G device switches to 3G or 4G, it's exposed to the vulnerabilities that haven't been addressed in the previous generations' protocol.

When switching from 5G to 3G or 4G, the architecture will rely on seamless handover between those two networks, says Nick McQuire, vice president of enterprise research at CCS Insight. "How can the mobile network operator guarantee there isn't weakness in the handover?" he asks.

The 5G supply chain is a further challenge. Recent concern has centred on the potential threat from network infrastructure provider Huawei, which has just been given the go-ahead by the UK to be deployed in less critical parts of the national 5G network.

But many fear the manufacturer will engineer a "backdoor" allowing it to snoop on data. With this and other 5G security threats in mind, the European Commission issued a 5G toolbox to help European countries co-ordinate their approach.

Standards bodies, such as the 3GPP ETSI and the IETF, are also working on 5G standards and specifications to secure the standalone version of the technology set to enable business applications.
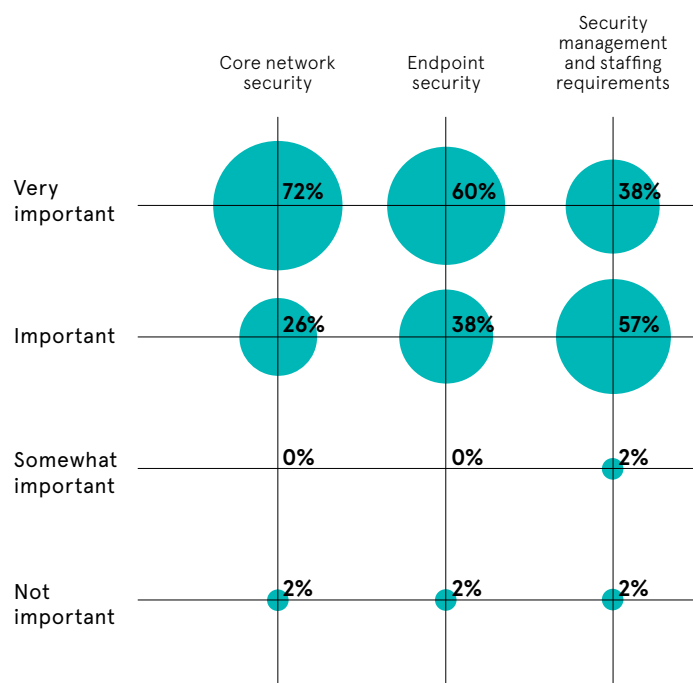
As the threat landscape widens, 5G security is certainly a complex task. But if the ecosystem addresses the

issues, the technology will be more secure due to better encryption than 3G and 4G, says Daniel Valle, chief technologist at World Wide Technology. "Each evolution is more secure than its predecessor and that doesn't change with 5G," he says.

At the same time, while things are at an early stage, 5G's architecture allows mobile operators to offer security insights to businesses. "The operator can provide visibility of traffic going across the network, so companies can

see anomalies or if someone is trying to intercept it," says McQuire.

Meanwhile, network slicing, which allows mobile operators to effectively slice the network into different use-cases or requirements, could add security capabilities for 5G. McQuire says slicing can add security because it is "almost your own private channel".

"If there's an attack on the public network, for example Vodafone's network goes down, the sliced environment would, in theory, be immune," he says.

Work is being done to secure 5G, but who is responsible for this? "In the early phases, a lot of responsibility has to fall on the service and vendor ecosystem," says McQuire. "Operators will sell 5G services to enterprises. The emphasis will be on network and infrastructure providers to be on the same page, looking at the benefits and risks."

In many ways 5G is a "shared responsibility model", much like cloud services, says Cradlepoint chief security officer Todd Kelly. He says: "Standards bodies dictate how to implement a secure 5G network architecture and operators are responsible for the security of the network."

Enterprises are responsible for data being transported across networks. "But mobile network operators must embrace a continual risk-based approach to monitoring their network and services, evolving their security controls around emerging threats," Kelly adds.

Mark Hawkins, fellow and 5G lead at QinetiQ, says it's important these groups are "aligned and collaborating to ensure end-to-end security".

In the meantime, businesses need to be aware of 5G security problems and risks so they can prepare for its arrival. It's true that 5G will offer huge benefits, but one thing is certain: the technology will require much more focus on security. As McQuire concludes: "If it's going to realise its vision, 5G security needs a lot more attention." ●

BIGGEST SECURITY CONCERNS

Telecoms operators and industry experts rated the importance of the following concerns when rolling out 5G infrastructure and services

	Core network security	Endpoint security	Security management and staffing requirements
Very important	72%	60%	38%
Important	26%	38%	57%
Somewhat important	0%	0%	2%
Not important	2%	2%	2%

Figures may not add up to 100 per cent due to rounding
BPI Network 2019

viewimage/Shutterstock

HUAWEI

Huawei, China and the rise of techno-nationalism

Questions still remain over the impact Huawei Technologies could have on the telecoms landscape in the UK and the world over

James Gordon

The UK's move to give Huawei a limited role in building its 5G network was a landmark decision and one that continues to divide MPs and the British public. But could it be a decision Boris Johnson and the country will come to regret? Can our security be guaranteed by only letting Huawei build the UK's periphery 5G network?

With the CIA openly accusing Huawei of receiving funds from Chinese state intelligence, many politicians are worried. Conservative MP and chair of the House of Commons Foreign Affairs Committee Tom Tugendhat compared the decision to "nesting a dragon".

On top of this, the Trump administration has imposed a total ban on Huawei Stateside, while warning its Five Eyes allies, an English-speaking intelligence alliance comprising Australia, Canada, New Zealand, UK and the United States, that access to intelligence might be restricted should they not follow America's example. Australia did, but the UK decided to choose its own path.

According to Emily Taylor, a 5G expert, removing Huawei from the core of the network might not be enough to guarantee our security. As 5G is a more integrated and intelligent network than either 3G or 4G, what really counts is the quality of the software and the cybersecurity practices adopted by the provider, she explains.

"As far as Huawei is concerned, we know from the *Huawei Cyber Security Evaluation Centre 2019 Annual Report* that there are 'serious and systematic defects in its software engineering and cybersecurity competence'. Bugs in software make any system vulnerable to attack," says Taylor.

A spokesperson for Huawei acknowledged that the 2019 Oversight Board report detailed some concerns about its software engineering capability, adding it takes such concerns seriously and is investing more than $2 billion "to further enhance those capabilities".

But Taylor, who also heads up Oxford Information Labs, says the issue extends beyond Huawei. She says: "Firstly, in terms of competitors, it's worth remembering that Huawei openly shows its code to GCHQ [UK government intelligence and security organisation]. Others do not. As there isn't similar transparency regarding the software and hardware of Huawei's competitors, it's impossible to know the overall rate of defects in their computer systems.

"Secondly, with 5G the primary driver behind the internet of things, we're going to see millions of poorly secured devices connecting to mobile networks. The 5G environment will offer multiple opportunities for bad actors, including states, to cause harm, without necessarily having built the network."

But Huawei disagrees. The company points to a recent National Cyber Security Council (NCSC) blog post which states that UK telecoms networks "are secure, regardless of the vendors used". However, a spokesperson adds: "The NCSC has said there's no 100 per cent secure system, but is confident it can manage these risks."

Try telling that to the Trump administration. Whether the UK's

decision to give Huawei a limited role in its 5G networks will impact on transatlantic security co-operation in the future is unclear. MI5 director general Sir Andrew Parker says it won't, but Taylor is not so sure.

"What if it isn't sabre-rattling? Can intelligence services in democracies really choose to ignore the explicit direction of their political masters? That's what the US administration cannot square and it may do great harm to the Five Eyes partnership," she says.

To minimise this risk and open up 5G competition, Taylor is in favour of a multi-vendor approach. This is a view also shared by Huawei, which says "a diverse-vendor market is key to secure networks".

However, there's the rub. Taylor says that while Huawei's closest rivals, Nokia, Ericsson, Samsung and Qualcomm, have the required knowledge to add value, they're more expensive than Huawei.

"This isn't an issue for Huawei, and others, but it's a problem for states and mobile operators that would like to see more competition in 5G markets. Indeed, it's a lack of healthy competition that's stymying progress both in technology and in geopolitical circles," she says.

It's a predicament that Professor Paul Evans, at Canada's University of British Columbia School of Public Policy and Global Affairs, recognises only too well. He says the Huawei spat transcends technology and has more to do with the US-China trade war. He believes the UK, Canada and others "are not only being dragged into the trade war, but are being asked to pick sides".

"We're seeing two of the world's superpowers rejecting globalisation in favour of techno-nationalism. From the US perspective, techno-nationalism is about protecting America's dominance in ICT fields and securitising the issue, even if that means banning companies like Huawei from the US market," says Evans.

He is worried for the future and thinks America is on the wrong path. "Banning Huawei and others because they pose a threat to your own tech companies is not the answer," says Evans. "It will only serve to reduce US competitiveness and will restrict US penetration in global markets. Indeed, if this were a battle for hearts and minds, it's a fight the US is losing."

The big question, of course, is what effect techno-nationalism will have on America's tech titans and consumers who use them? Taylor, from Oxford Information Labs, has one principal worry.

"I don't think the FAANGs [Facebook, Amazon, Apple, Netflix and Google] will be affected," she says. "It's more that there could be splits at quite deep levels of the infrastructure which will result in users in the East and West having a different internet experience. To some extent, we're already seeing this being played out in the world of international technical standards," she says.

"China is playing a patient strategic game in technical standards organisations, whereas some in the West have been asleep at the switch. That's perhaps the biggest takeaway." ●

> **"**
>
> **Banning Huawei and others because they pose a threat to your own tech companies is not the answer**

'The advantages of such a digital world will not just be commercial, but also societal'

As the political dynamics of Europe shift, it is vital that the existing co-operation on developing future network communication technologies is retained and ideally enhanced to ensure technological access and future economic prosperity.

The existing co-operation is based on the 5G Public-Private Partnership (5G PPP). This is a large 5G collaborative research initiative that is organised as part of the European Commission's Horizon 2020 programme.

The 5G PPP has been a clear success for Europe, including the UK, with thousands of researchers and developers across Europe successfully working on innovative solutions for the definition of 5G. These efforts have had a significant effect on the 5G standards we have today, especially in the areas of system design, evaluation aspects, air interface innovations, network management, security innovation, virtualisation and service deployment innovations.

However, the 5G PPP is nearing its end and communication infrastructure will continue to evolve, driven by cutting-edge research. To ensure Europe, including the UK, has access and influence on this technology, it is vital these research activities can continue. We need a new communication technology partnership between the European Commission, UK government and the private sector to ensure Europe stays in the forefront of this important area. We need the next chapter in mobile communications – smart networks and services – to be created in Europe (including the UK).

The future is digital. The combination of digitalisation, artificial intelligence (AI), advanced satellite technologies and ubiquitous communication will change the world we live in, moving well beyond 5G.

The advantages of such a digital world will not just be commercial, but also societal. 5G networks will lay the foundations to tackle efficiently the grand challenges of an ageing population, environmental and resource management, mobility, increasing urbanisation and industrial competitiveness. In this bold new world, the vision of a truly networked society where technology enables meaningful societal change, such as zero casualties on European roads, becomes possible.

However, this future vision, like the promise of AI, big data or high-performance computing (HPC), is only realisable if we have the matching advanced communication networks. These so-called smart networks provide the lynch pin to join all the critical pieces together and make future visions possible. The smart network acts like a nervous system allowing the intelligence to control the whole.

Smart networks envision a fundamental change to the communications network beyond 5G. In a world where everything will be networked in a seamless way, with a seemingly infinite bandwidth, we need a flexible communications network that can adapt and evolve. Smart networks will combine distributed communications and intelligence, providing scalable communications, computing and memory resources at any location.

In addition, as communications networks become evermore fundamental to our everyday lives, even in safety-critical aspects, smart networks need to embrace security both in terms of guaranteeing the network infrastructure integrity as well as the safety and privacy of personal data.

Smart networks will be the foundation of the future digital world. AI, big data and HPC will all play their role, but without a suitable advanced communications network their potential will be sorely limited.

With communications networks being a technological area where Europe can still claim leadership, smart networks should be a major focus in Horizon Europe, the next European Union programme for research and innovation. All European countries, including the UK, should understand research and innovation will be central to taking leadership in future smart networks to support a smart move into a digital society supporting European values. ●

Colin Willcock
Chairman
5G Infrastructure Association

We're building
the UK's fastest
5G network