5G

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5G

Distributed in
THE TIMES

Published in association with
UK 5G
5G IA

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IMPACT

Why 5G is more than simply faster 4G

A widespread misunderstanding of the core principles of 5G and a sole focus on speed are key reasons why businesses are failing to realise the transformational benefits of this technology

Simon Rockman

Barclays Bank recently published a report on how British business doesn't understand 5G. Ironically, the report made clear that Barclays itself clearly doesn't understand 5G either. Indicative of this was the executive summary which looked at how you could download a file over 5G much quicker than over 4G. Yes, 5G is faster, but that's not what makes it transformational.

Think of 1G as vinyl records. Then of 2G as CDs, 3G as DVDs and 4G as Blu-ray. 5G, on the other hand, is like the internet: it opens up Netflix, Spotify and iPlayer. It's not the speed that's liberating; it's the way it is built that makes it different.

There is a smörgåsbord of technologies in 5G. Leading this is NR or new radio. The three use-cases for NR are enhanced mobile broadband (eMBB), massive machine-type communications (mMTC) and ultra-reliable low-latency communications (URLLC).

To break these down into what they do for you, eMBB gives faster speeds of more than 1 gigabyte per second (Gbps). According to Three UK's director of network strategy Phil Sheppard, the telecoms provider expects to reach 3Gbps in 2020.

The introduction of mMTC is as much a rival to wifi as to 4G. If you live in a crowded area you might already find your wifi suffers from interference. mMTC is designed to support a million devices per square kilometre. It might be used to control hundreds of lights at a rock concert or a factory might have hundreds of robots each with numerous sensors.

Margot James, minister for the creative and digital industries, says: "If issues are about to arise in the factory, these sensors will detect them and help prevent serious faults further down the line. Our Industry 4.0 project in Worcestershire is showing how 5G can make these realities a reality."

Lastly, the low latency – how reactive and slick a system feels – offered by URLLC is often cited as essential for driverless cars and remote surgery.

A great demonstration of low-latency 5G was a performance at the recent Orchestrating the Orchestra project during the Bristol 5G Smart Tourism event, where musicians in three locations across London and Bristol were able to play in real time, in sync with no delay, across 5G networks.

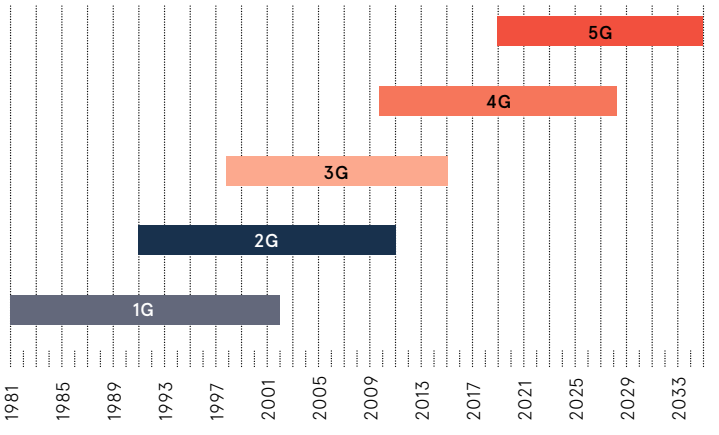

Sean Gallup/Getty Images

Low latency presents a huge business opportunity for the software-as-a-service industries to provide a much tighter link between communications and computing. Controlling all the apps within the network, ensuring they all have enough processing power in the right places, is called orchestration, hence the pun.

One of the places where orchestrating is used is with mobile edge computing or MEC. A great example of this is the AutoAir 5G testbed at the Millbrook motoring proving ground in Bedfordshire, which boasts the first independent 5G-enabled infrastructure for connected and autonomous vehicles in the UK. With 22 cell sites around a two-mile high-speed circuit, vehicles are able to stream video to one another simultaneously.

Streaming video from these sources all the way through the mobile network would be a huge amount of data transfer. AutoAir has deployed MEC where the video server sits at Millbrook; it is also connected to the rest of the O2 network, but for those on the track data doesn't need to go all the way to O2's main datacentre.

EVOLUTION OF CELLULAR NETWORKS



While O2 is a close partner in the project, which uses O2 spectrum, it doesn't supply any infrastructure. The AutoAir network uses neutral-host infrastructure, which enables multiple mobile operators to use the same infrastructure simultaneously. The company DenseAir "owns" the network and sells the connectivity in much the same way as a business might put solar panels on its factory roof and sell power back to the grid. Neutral-hosting allows organisations to do the same with 5G connectivity.

Mansoor Hanif, chief technology officer at the regulator Ofcom, is looking at the option for a state-run neutral host, much like Network Rail providing the rail infrastructure with private trains running on the network. He's also looking at releasing spectrum for public good at a minimal cost. Although this has been criticised for being at a frequency where devices are expensive and not generally available, Ann Williams, commissioning and contract manager for Liverpool City Council, wants to run a network to provide healthcare support.

Ms Williams is doing this because she doesn't trust the networks to provide coverage of the areas where she needs to care for the elderly and infirm. If she was comfortable with coverage, she'd have another option for a private healthcare network, that of network-slicing.

Network-slicing is another new 5G technology, where one mobile network can be made to look like multiple separate networks, giving only selected users access. These might be crew at a venue, emergency services or specialist equipment talking to controlling systems.

Ms Williams' distrust is well founded as UK networks say they plan to only use 5G in areas where there is a strong business case. Another element of 5G, beam-steering, means networks could hypothetically operate with only a few very large cells in rural areas and not experience the usual problems associated with not being able to support enough users.

5G is complicated and it's no wonder Barclays missed the opportunity, but just as the cars at Millbrook are using 5G cameras and artificial intelligence to look into the future, so are the universities and testbeds around the UK.

There is no doubt 5G is going to be big. As O2's chief technology officer Brendan O'Reilly says: "5G will have a bigger impact than the introduction of electricity."

STR/AFP/Getty Images

Inside view of an ambulance with 5G technology, on display at a 5G innovation park in Hangzhou in China's eastern Zhejiang province

HEALTHCARE

Game-changing health tech now within reach

For all the transformative and life-saving benefits that 5G has to offer, a number of obstacles stand in the way of the NHS capitalising on the technology

Stephen Armstrong

At this year's Mobile World Congress in Barcelona, a gastrointestinal intervention was streamed live via 5G from an operating theatre at the Barcelona Hospital Clínic, with a surgeon overseeing the procedure in real time from the congress venue.

Amazing stuff. But the biggest bonus to healthcare in the UK could come from filling the widening gaps in healthcare coverage.

"An NHS app will be the entry point for all patients and it will mean the journey from GP to a specialist, to diagnosis then treatment could happen from your phone," explains Alan Lowe, chief executive and co-founder at Visionable, which currently provides the NHS with a video collaboration platform for healthcare and advanced clinical needs.

"In Anglia, there are not enough stroke consultants so there isn't always one on duty at A&E. You could link to a doctor at home or to a recently retired consultant. But for rural areas without broadband that's difficult; 5G would solve that."

Iain Hennessey, consultant paediatric surgeon and director of innovation at Liverpool's Alder Hey Children's Hospital, a centre of excellence for children throughout the UK, believes 5G will dramatically change hospital-patient contact.

"5G will drive the consumer internet of things and the quantified self, which means people will come to hospital saying, 'My fridge is linked to my diet tracker and to my food shopping; why do I need a paper diary on diabetes when I come into hospital?'" he says.

> **Ambulances will be able to share critical patient data with A&E staff in real time while en route to the hospital**

"If you look at current telemedicine solutions, we're not quite there. Latency and quality of image is a problem. Trust is key; latency in a call can look like you're taking too long to answer and you come across as shifty. Our neurology guys look for micro ticks in patients' faces, which are crucial in monitoring people's condition. Once the signal goes down below a certain level you lose the detail.

"We get kids transferred from North Wales, Isle of Man, Barrow-in-Furness, from all across the country. Some clinical appointments only take five minutes, so mum or dad has to take the day off work and come all the way for a quick chat. 5G will solve that problem."

The benefits of 5G are likely to be felt most in rural areas, assuming coverage is ubiquitous, which is not the case with 4G or even high-speed broadband. Long, rural ambulance journeys to A&E could be transformed. "In a 5G-enabled ambulance, paramedics will be able to share critical patient data with A&E staff in real time while en route to the hospital, speeding up the triage process. And high-quality video streaming will enable A&E staff to begin diagnosis as early as possible," explains Anne Sheehan, director at Vodafone Business.

Greig Paul at the University of Strathclyde, who is co-ordinating 5G RuralFirst's trails of the technology in Shropshire, Somerset and the Orkney Islands, says: "Mobile coverage in Orkney is very patchy, which means, for instance, that fall alarms [for the elderly] are not an option. With the UK's ageing population in outlying regions that's a real problem. The trials are overcoming that and we're connecting an NHS clinic in the north of the Orkney Islands that previously had no coverage."

Sharing could overcome many coverage problems. A recent Ofcom consultation discussed sharing of the 5G spectrum more broadly, beyond those who own the licences. Dr Paul believes this would help make the business case for ubiquitous national coverage if providers had additional revenue streams from other companies.

Perhaps the biggest barrier to the nationwide adoption of 5G in the UK is the uneven and often anachronistic adoption of technology by an underfunded NHS, in places still reliant on fax machines and paper documents.

Visionable's Mr Lowe, meanwhile, is working on connected ambulances for rural areas which carry multiple SIM cards enabling the ambulance to switch between providers with the strongest signal.

So, for the stretched NHS, 5G could offer a literally life-saving series of solutions. The question is, will this be the one time the government gets the technology implementation right?

OPPORTUNITIES FROM A 5G-ENABLED HEALTH SERVICE

Ranked by C-level healthcare professionals

TOP FUTURE USE-CASES FOR 5G IN HEALTHCARE

01 REAL-TIME MOBILE DELIVERY OF RICH MEDICAL DATA SETS

02 CLOUD ROBOTICS FOR ASSISTED LIVING OR REHABILITATION

03 AMBULANCE DRONES

04 SMART OBJECTS, SUCH AS SYRINGES, CABINETS AND BEDS

PAIN POINTS THAT 5G COULD OVERCOME IN HEALTHCARE

01 HIGH DEMAND FOR DATA STORAGE AND SECURITY OF PATIENT DATA

02 EFFECTIVE CAPTURE OF VAST AMOUNTS OF DATA

03 AVAILABILITY OF SUITABLE INFRASTRUCTURE

04 ADAPTABILITY OF MEDICAL EQUIPMENT

Ericsson 2018

HEALTH

Tackling public concerns head on

While no proven health risks have been linked to the introduction of 5G technology, the industry must deal with public concerns openly and transparently

Oliver Balch

You might want to think twice before typing "5G" into your search engine. Add the word "health" and you should definitely be wary about what pops up.

As with every iteration of wireless technology that has preceded it, 5G's pending introduction has generated a flurry of public health concerns. So how should the telecoms industry respond?

Step one is not to keep quiet and hope the concerns will go away. They won't. Public fears may be misplaced but, like a viral disease, they have a habit of spreading when left unaddressed.

"The big risk we're looking at today has to do with radiation; this has to be dealt with responsibly, openly, transparently," says Jürgen Maier, chief executive of Siemens UK.

Gareth Elliott agrees. As head of policy and communications at Mobile UK, he speaks on behalf of the UK's four main mobile network operators O2, Vodafone, EE and Three. All four have taken steps to ensure consumers can use 5G with absolute confidence and trust, he asserts.

Such reassurances may wash with some, but not all. Even Mr Elliott acknowledges this, which is why he would point sceptical consumers to independent third parties and not just to industry sources.

Top of his list is the World Health Organization (WHO). Scientifically empirical and technologically agnostic, WHO has been tracking the safety of radio signals for half a century. In 1996, it extended its focus to electromagnetic fields. As yet, no proven health risks have been identified.

The public might also turn to the sector's global regulator, the International Commission on Non-Ionizing Radiation Protection (ICNIRP), Mr Elliott advises. Governments typically defer to ICNIRP exposure level guidelines when setting their own domestic limits.

Realistically, however, few people have the time or gumption to wade through the findings of these bureaucratic organisations. That places an onus on mobile operators, as the party most closely linked to consumers, to do it for them.

For the most part, this entails making sure the basic facts are made widely available and presented in an understandable, non-technical way, says Howard Jones, head of network communications for EE. Keeping journalists and opinion formers up to date with the latest information is critical in this respect.

For those with very specific fears or local concerns, it may well be necessary to adopt a more direct form of engagement. With Villages Against Masts, for example, a vocal campaign group in the UK, Mr Jones has offered to meet them personally.

Whether it is hardened critics or an everyday consumer, keeping the public continually aware and informed is essential. He concludes: "It is just part of the day-to-day rollout of this new technology."

Commercial feature

Powering the future of connectivity

In a relatively short time, 5G has become one of the most compelling technological services that has the potential to transform how businesses in a wide range of industries operate

From the internet of things (IoT), driverless cars and augmented reality, 5G is going to be an enabler for a whole new wave of applications.

By embracing 5G, companies can ensure they stay at the top of their industry and keep competitors at bay.

"5G is going to give businesses the power to embark on more ambitious projects, through the high-speed, reliable connectivity it offers. In the current competitive business environment, anything that you can do faster and better than someone else is going to be a clear advantage," says Carl Grivner, chief executive of Colt Technology Services, a leading provider of high-bandwidth connectivity solutions.

These innovative solutions will necessitate a much denser network and major upgrades to the conventional 3G and 4G networks if they are to reach their full potential. But many other elements need to come together to create a suitable 5G ecosystem.

The 5G technologies of tomorrow rely on mobile networks being not only able to fulfil low-latency requirements, but also to be physically closer to 5G device users, which means the creation of small cell locations all around high-population centres.

"There is certainly a discussion right now about the business cases that go with 5G and I believe that is where some of the mobile carriers are working to answer the question, 'Are we going to deploy a new network, which is going to cost billions of pounds to construct?' If so, what are the economics going to look like?" says Mr Grivner.

As the deployment of this technology will prove to be highly expensive, new models of network sharing that haven't been seen in the past are expected to become popular, he says. Consumers, too, will drive the emergence of 5G.

"When the new generation of 5G-enabled mobile phones and devices is released by manufacturers and purchased by consumers, there will be a major shift in the industry. Consumers, who use 5G-enabled phones and are not receiving access to 5G, or even 4G, will start to put a lot of pressure on mobile operators to up their game," says Mr Grivner.

In an increasingly complex ecosystem, faster data speeds are going to become more important if companies want to meet the needs of the customers of tomorrow. The growing demand on wireless networks will require robust fibre connections as this data has to be sent to a location that can handle a high level of data.

Colt has spent the past 27 years preparing for advanced mobile connectivity, with their Colt IQ Network connecting major datacentres across the globe. Today, this network covers over 27,500 on-net buildings and more than 850 datacentres.

"From our perspective, the Colt IQ Network enables 5G technology. It's now the most suited backbone for mobile operators who need dense, metro connectivity to bring about the next generation of mobile networks. Fibre has many more capabilities than wireless spectrums and therefore can connect to anywhere in the world at phenomenal speed and greater bandwidth," says Mr Grivner.

By partnering with Colt, companies are able to make use of an intelligent network architecture that enables them to embrace a multitude of exciting technologies, including IoT, advanced wireless connectivity, as well as transformative big data solutions.

"The impact of many applications based on 5G technologies that are currently in development have yet to be fully realised; they simply just haven't been thought of at this point in time. Over the next 24 months, expect to see a lot more innovation in terms of new devices and new capabilities, all powered by 5G," Mr Grivner concludes.

THE COLT IQ NETWORK CONNECTS TO

213
cities

32
countries

27,500+
buildings

850+
data centres

Carl Grivner
Chief executive
Colt Technology Services

For more information please visit www.colt.net/powering-the-future-of-connectivity

colt

Virtualisation paves the way for affordable 5G

The 5G network is set to drive huge value for mobile operators, enterprises and consumers alike, but deploying it in an affordable way requires an innovative new approach, says Mavenir chief marketing officer **Stefano Cantarelli**

The arrival of 5G, which will vastly accelerate mobile broadband speeds, is fast approaching. Mobile data traffic is expected to increase sevenfold between 2017 and 2022, while the number of internet of things (IoT)-connected devices will grow from around 8.4 billion today to forecasts of 20.4 billion by 2020.

Two thirds of global firms plan to harness 5G by 2020 to support their heavier data usage and IoT goals.

5G will only accelerate the volume and variety of data traffic further, shattering legacy service delivery models and impacting the network economics. For consumers, this is a welcome addition as they want and need more data.

For mobile operators, they face the technical test of squeezing vastly more data into a much faster and more efficient, yet less expensive, pipe. Transitioning to the 5G network requires significant investment in new infrastructures wit new capabilities, such as edge computing to be closer to the users and network slicing to effectively and efficiently utilise resources. 5G means higher bandwidth, lower latency and more capacity, but getting there will need a considerable increase in capital expenditure than carriers currently spend.

In a challenging business landscape, these economics are not likely to be viable for operators, particularly when current levels of capital expenditure are already constraining profitability and holding operators back from participating in new service revenues. GSMA, the global trade body for mobile network operators, forecasts their investments will decrease to $673 billion in the four years up to 2020 from $772 billion in the four years prior. This means they're being forced to build new networks with the same or even less money.

The network economics clearly need to change. To solve the problem, many operators are turning to alternative architectures that drastically reduce the costs of deploying 5G. At the heart of this shift is software-based technology and end-to-end virtualisation. This will open the door to new, automated, faster-to-deploy and less-expensive technology options, and allow them to move away from the traditional, telecom equipment providers and escape vendor lock-in.

In today's mobile networks, the core was the first to be virtualised and enable cost-savings, but the more expensive layer, the radio access network, is still using traditional proprietary technology. Good news for the operators, vRAN (virtualised radio access network) is now a reality and will also generate opportunities to be more flexible at a lower cost. There is no 5G without end-to-end virtualisation because new capabilities like network-slicing are simply not possible.

Through an end-to-end, cloud-native solution, the virtualisation technology allows mobile operators to utilise commodity hardware and only deploy software. Meanwhile, the addition of open interfaces is enabling a more powerful ecosystem and allowing new innovative vendors to offer radio units at much lower prices. Open interfaces and virtualisation also mean operators can finally take control over their infrastructure and their economics.

The densification required by 5G and the ultra-low-latency requirements will make virtualisation even more important, along with micro services and service-based architecture. 5G architecture will need processing to be distributed and for capabilities to be deployed close to users at the edge.

The shift to containerisation is fundamental in evolving from virtualisation to network function virtualisation (NFV) infrastructure and finally to web-scale agility, enabling major differentiation in the market, as well as lowering operational costs through automation and orchestration. The migration towards NFV signifies a recognition among operators that their legacy business models are not sustainable. They need to change their cost-per-bit assumptions and revenue-generation capabilities.

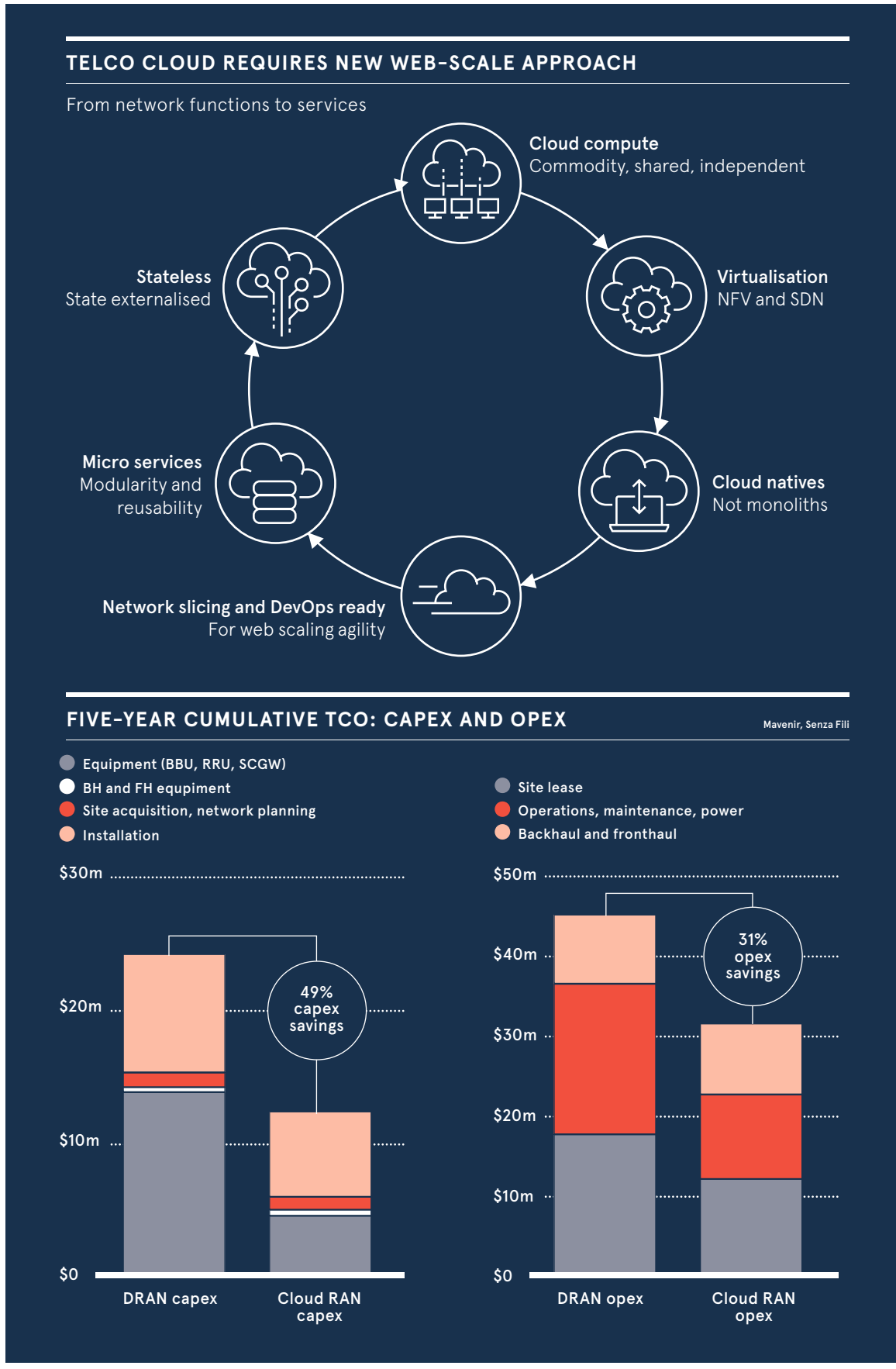
Mavenir has virtualised core network and RAN functions on open-interfaces and standard hardware platforms to bring solutions to the market that meet the 5G standard and provide real options for operators.

The company is embracing mobile edge computing to enable the ability to scale in the 5G era, and provides all the capabilities at the same cost as operators currently pay. This means they can avoid the legacy pricing traditional equipment providers try to protect and instead utilise a more transparent licence system. As an end-to-end network software provider, Mavenir integrates the whole components, guaranteeing the solution works and performs as it should.

Mavenir has developed a total cost of ownership model which demonstrates that vRANs will save operators 37 per cent in deployment and operational costs over a five-year period, which consists of a 49 per cent reduction in capital expenditure and a 31 per cent drop in operational expenditure, according to Senza Fili.

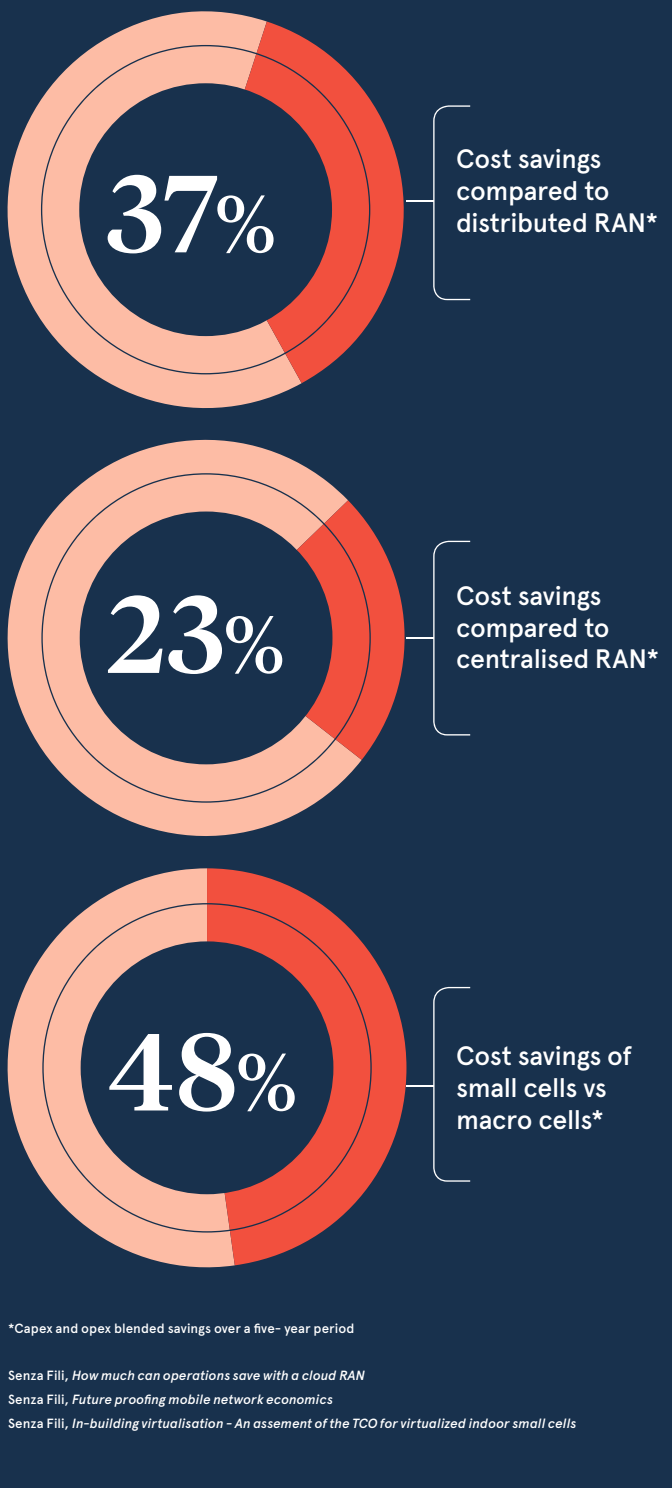
For the core and in future scenarios of densification for radio, the savings can actually be much more substantial by decreasing capital expenditure by up to three times. These savings

Mavenir is redefining mobile network economics and is poised to disrupt the traditional equipment providers as a result, while helping operators succeed and deliver value in the 5G age



THE CASE FOR VIRTUALISED RAN

The choice for RAN virtualisation model has a significant impact on overall cumulative opex and capex cost savings, with virtualised RAN delivering the largest cost savings over a five- year period



*Capex and opex blended savings over a five- year period

Senza Fili, *How much can operations save with a cloud RAN*
Senza Fili, *Future proofing mobile network economics*
Senza Fili, *In-building virtualisation - An assement of the TCO for virtualized indoor small cells*

will allow mobile operators to not only embrace the 5G network, but to turn it into an engine of growth for their business, while still leveraging the 4G network.

As the cost of keeping up with traffic demand outpaces service revenue growth, the quest for new network economics is more urgent than ever. Operators have been boxed in by their traditional suppliers, and have not been able to leverage new and innovative technology advancements. The time has come to balance the needs of their current operations with the absolute necessity of embracing technologies that allow them to adopt new operational and business models.

With software assets that are natively designed for cloud environments, Mavenir is the leader of a new breed of independent network software suppliers that is delivering the innovation, agility and cost-savings mobile operators need to survive. By delivering end-to-end virtualised solutions from the core to the edge, Mavenir is redefining mobile network economics and is poised to disrupt the traditional equipment providers as a result, while helping operators succeed and deliver value in the 5G age.

For more information please visit mavenir.com

MAVENIR

Q&A

How 5G will transform the way we live and do business

Pardeep Kohli, chief executive of Mavenir, explores how 5G will benefit enterprises, consumers and wider society, but only if organisations embrace new approaches to mobile networks

Q **A lot of people are talking about 5G, but awareness of its capabilities is lacking. What benefits will we see?**

A With the ubiquity of smart devices and the explosive demand for data and bandwidth creating networks that are increasingly dense and complex, 5G can't come soon enough. Through its unprecedented speed, capacity and latency, 5G will provide systems that are more responsive than ever. The new era will prove transformational in numerous areas of business and society, enabling compelling new services built on open software and hardware platforms operating in fully virtualised environments. This all comes with simpler and more flexible architecture that allows distribution to the edge, where processing is required in many cases. Service-based architecture introduced by 5G will also provide simpler and more business-oriented interfaces, ending the days of having to integrate complex protocols. The transition to 5G is as urgent as it is exciting.

Q **What will 5G mean for consumers and how will it improve their lives?**

A There will be vast performance improvements for consumers to enjoy, with greater speed enabling more powerful browsing and gaming experiences. By providing extra capacity, 5G will increase average network speeds from 5 megabits per second to 20Mbps with peaks of 500Mbps. This will create the opportunity to bring more cloud services into the home, addressing security concerns and allowing people to live smarter by accelerating the internet of things (IoT) and bringing many new connected objects to life in quite transformational ways. The additional speed and capacity will also realise the full potential of smart cities. Citizens will experience less traffic, better parking facilities and more efficient utilities' consumption, for example, as a result of more intelligent applications of smart technology.

Q **How will businesses benefit from 5G?**

A There is huge value to be added for enterprises with the introduction of 5G. The entire infrastructure acts as a cohesive platform for innovative applications and is tuned to flex with demand, providing services tailored to their unique characteristics. Businesses are increasingly eager to explore applications, business models and efficiencies in the areas of automation and IoT, but the sheer volume of data means they lack the ability and low latency to respond fast enough to their processes and control systems. Local network capabilities were never distributed before, but this will change with 5G. By providing an enhanced ability to support exponential scale for connectivity, 5G opens the door for businesses to innovative applications across a variety of industries, including healthcare, with 5G allowing remote surgeries among other things, and automotive, enabling self-driving, and better diagnosis and maintenance.

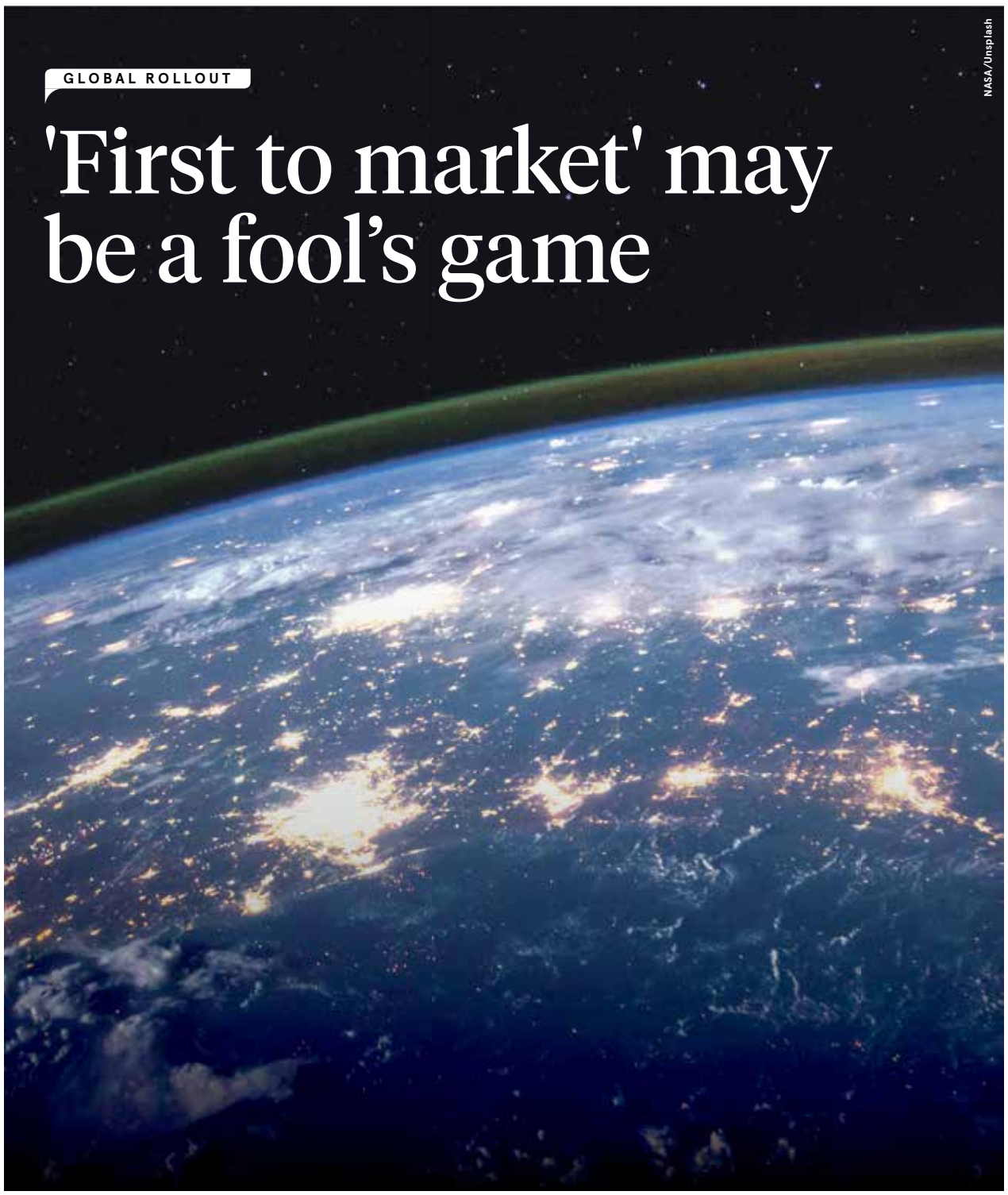
Q **Where exactly is the real value in 5G?**

A Automation, automation and automation again. 5G is coming and both consumers and businesses will enjoy greater capabilities than ever before. Gamers will be immersed in more responsive and interactive experiences, and technologies such as augmented reality and virtual reality will really come to the fore, not just for gaming applications, but for real-life benefits in areas like healthcare and education too.

> **Without virtualisation, there is no 5G; it is as simple as that. MNOs will have to embrace new approaches and Mavenir is here to help**

Q **What is holding us back from fully realising all these benefits?**

A The benefits of 5G are truly endless, but without new approaches to mobile networks through virtualisation and open interfaces, it will not be possible to disrupt the economic model and adopt web-scale agility and flexibility, which is key to its success. Mavenir, with its cloud-native, 100 per cent software, end-to-end solution, is providing that opportunity to operators and enterprises. Without virtualisation, there is no 5G; it's as simple as that. We are here to help with the 5G paradigm shift and will transform the world of telecommunications by enabling companies to deploy it in an affordable way.



NASA/Unsplash

GLOBAL ROLLOUT

'First to market' may be a fool's game

Rushing to be the first country to roll out 5G networks nationwide may not make you the global leader – there are a lot of other factors for governments and manufacturers to consider

Oliver Pickup

In this digital era of exponential technological advancements, when science fiction is increasingly becoming science fact, there are bold claims that the next transformational tech will be the fifth generation of mobile networks. But who are the trailblazers?

"On the world stage, the United States and east-Asian countries like China and South Korea are the early winners in the race for 5G adoption," according to Kamal Bhadada, president of communication, media and information services at Tata Consultancy Services. "Many operators in those markets have already made their 5G plans public and are moving to implement them across their networks.

"Europe is also showing signs of playing an increasingly leading role, with 139 pilots running across 23 countries. Most European countries should have some access to 5G services by next year, which will help open up opportunities for innovation."

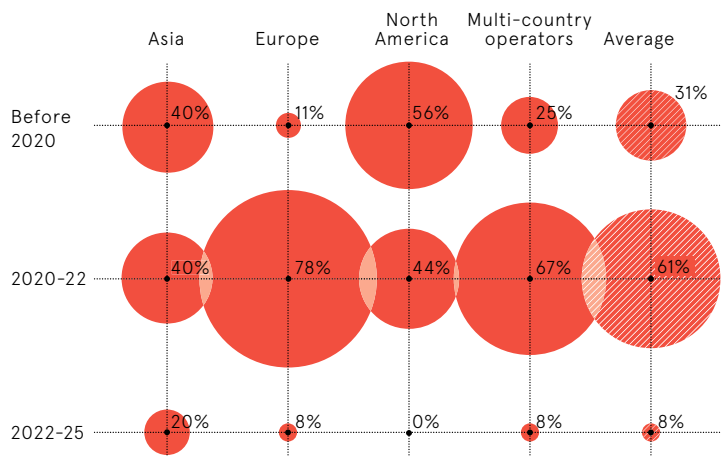
This analysis is echoed by numerous experts. "It is clear that a lot of the initial drive to accelerate the impact of 5G will come from Asia where the high density of fibre networks and more modern infrastructure will enable some of the more advanced technology, such as millimetre waves," says Paul Beastall, director of technology strategy for Cambridge Consultants and member of the UK5G Advisory Board.

Guillaume Weill, head of telecoms at technology consultancy Intralink, says South Korea is leading the pack. "The country auctioned its first 5G licences last summer for $3.3 billion (£2.5 billion) and was one of the first to deploy a commercial 5G network. And in April, South Korea achieved the world's first national consumer rollout of 5G," he says.

> **We need to stop talking about the 'race to 5G', as 5G technology alone will not bring about any revolutions in society or industry**

LARGE-SCALE DEPLOYMENT OF 5G WORLDWIDE

Deployment predictions by telecommunications professionals



McKinsey 2018

That may be good news for South Korea-based electrical giant Samsung, which "is determined to secure a large share of the international 5G equipment market, having enjoyed just 3 per cent of the market share in 2018", notes Mr Weill.

However, in terms of manufacturers of 5G-related products, Scandinavian brands Nokia and Ericsson, and China's Huawei, are "the unequivocal market leaders", says Daryl Schoolar, principal analyst at Ovum.

"They have the broadest product portfolios and global reach along with the strongest service support," he says. "It is hard to imagine a scenario in which a mobile operator looking to deploy a new network does not reach out to at least one of these three vendors during the bidding process. Of the three, Nokia leads based on its combination of global reach, and breadth of portfolio and services."

Huawei's international reputation has been tainted by its links to the Chinese government. In early-May, for example, Gavin Williamson was sacked as prime minister Theresa May's defence secretary over a leak from a National Security Council meeting at which officials discussed whether to give the green light to Huawei investing in the UK's 5G digital infrastructure.

More recently, the Trump administration added Huawei to a trade blacklist, preventing it from doing business with US suppliers without government approval.

"Huawei's competitiveness remains hampered by politics," says Mr Schoolar. "Australia has joined the US in blocking its equipment. India did not approve Huawei for 5G trials and Japan is also sceptical. So, while Huawei is clearly the market leader in revenues and has a portfolio breadth equal to Nokia, its inability to sell in certain markets reduces its overall competitive position."

William Webb, fellow of the Institute of Electrical and Electronics Engineers and chief executive of Weightless SIG, believes that elbowing aside Huawei could be beneficial for the UK and other countries in Europe that hitherto have relied on the Chinese manufacturer.

"Huawei is somewhat ahead of competitors, so not using its equipment will probably delay network rollout," he says. "But this may be a good thing. It is generally the second mouse that gets the cheese in these situations and it is not clear that there are strong national reasons for early 5G deployment."

This could also play into the hands of Nokia and Ericsson that are now benefiting from being first to market with mobile in the 1980s and have developed key intellectual property rights. Their strong position is "partly due to history and partly due to the main focus of the mobile operators on 5G at present: the radio and hence the need to work with the main radio access network vendors", says Ian Goetz, chief architect of mobile solutions at Juniper Networks.

Little wonder Nokia's vice principal for networks, marketing and communications Phil Twist is trumpeting no fewer than 36 commercial 5G contracts with global operators. "We are approaching 100 engagements in total with communications service providers that are evaluating and deploying 5G," he says.

In February, prior to the Mobile World Congress in Barcelona, Nokia published the *5G Maturity Index*. Reflecting upon the research, the organisation's chief executive Rajeev Suri says: "Two things became very clear. First, the remarkable speed of initial pick-up. We spoke to 50 operators across every continent and we found they all planned to complete a limited commercial 5G launch by the end of 2020.

"The second big takeaway was that wider adoption would not be rushed. Most operators expect it to take about four or five years after that initial rollout to get 5G deployed to 75 per cent of their customers. And this cushion of time will be just as vital to 5G as its quick start."

So perhaps speed is not of the essence, after all. "We need to stop talking about the 'race to 5G', as 5G technology alone will not bring about any revolutions in society or industry," argues Andrew Palmer, consulting director of telecoms at CGI UK.

"We need to work through the outcomes we wish to deliver, the sustainable use-cases that will deliver these outcomes, and the data and analytics required to support these use-cases. Only then should we worry about the technology that is required to support it."

Three brings 5G to life

Three is building the UK's fastest 5G network in a move that will not only deliver a faster, more reliable mobile service — but will revolutionise business and society

01

The next generation of internet connectivity, 5G, will go live in the UK this year and is set to transform the way we live and work. Films that previously took hours to download will be ready in seconds, while strikingly low latency will mean the time between pressing a button and the network responding will be almost instantaneous.

Although most people have heard of 5G, awareness around what it is and the impact it will have is lacking. In a recent study by Barclays, only 15 per cent of businesses said they are thinking about how to harness it. The bank concluded that 5G could boost the UK economy by £15.7 billion each year up to 2025, but only if this knowledge gap improves.

Indeed, any technical evolution requires time for people to understand and reap the full benefits. It will fall to early-adopters to demonstrate the value of 5G, starting with the launch of a genuine alternative to fibre broadband later this year, which will enable streamers and gamers alike to enjoy a near-seamless online experience.

"5G is not just an evolution, it is a revolution and it's going to transform what is possible," says Dave Dyson, chief executive at Three UK, the country's challenger mobile network. "4G brought faster internet to all, and businesses built new models and applications around it. 5G is about speed, capacity and ultra-low latency, a complete step-change from 4G, and it will enable a whole raft of innovation we can't even imagine today.

"The first big step-change will be 5G home broadband which Three will begin offering later this year. It will not require a long-term contract and customers will just need to plug the box into the wall and they are connected. No need to wait for engineer visits and no need for drilling cables through walls."

By accelerating use-cases of the internet of things, 5G will not only help enable driverless cars and robots, but it will also drive huge efficiencies in industries such as manufacturing and healthcare by connecting devices and automating processes. Councils will be able to better identify gaps in local services such as predicting traffic patterns to subsequently re-route drivers and ease congestion, or adopting smart street lighting to reduce crime. It's all possible, and will improve day to day life to make an impact for the better.

Three is building the UK's fastest 5G network. It is the only operator in the UK to have 100 megahertz of continuous spectrum, which is the international standard for offering a 5G service. The more spectrum an operator has, the better quality service it can offer and Three has almost three times more 5G spectrum than any other UK operator.

In a vast transformation, Three has built a super-high-capacity fibre network which connects 20 new data-centres to its mobile masts. The data-centres are highly secure and energy efficient, and feature a cloud-native core network from Nokia that is fully integrated, 5G-ready and will enable the fastest possible experience. Three's initial aim is to get 5G on 40 per cent of its busiest sites, carrying 80 per cent of its traffic.

"Our customers are data hungry, using more than three-and-a-half times the industry average of data, so we are committed to investing a minimum of £2 billion to deliver the best possible service," says Mr Dyson. "With our 5G spectrum and new network technology, the amount of traffic that we can carry on our network will increase by 28 times in the coming years. We're not in a race to be the first in market, but we will be the best."

Doubling home download speeds

5G wireless home broadband will provide UK households with a cheaper, more flexible alternative to fibre connections, offering customers double the current average download speeds, according to an independent report from analyst firm Ovum.

The technology, which Three aims to launch in the second half of 2019, will deliver fibre-like speeds, a significant improvement on the 46 megabits per second that the average UK customer currently obtains using traditional, fixed broadband services.

At a time when the UK is lagging behind other nations in full-fibre rollout, with only 3 per cent of all broadband subscriptions enjoying fibre to the home, 5G wireless home broadband will provide superfast internet to more people more quickly.

Ovum estimates that 5G wireless could replace traditional connections for 85 per cent of the UK's 26 million fixed-line customers, with equal or better speeds. It is much quicker to deploy than fibre and almost 50 per cent cheaper, the research found.

"The low availability and high deployment costs of fibre make 5G wireless a viable alternative to fixed-line broadband, satisfying customers' fast-growing demand for data," says Dario Talmesio, principal analyst and practice leader at Ovum.

Fuelling the future of fashion

Three launched the world's first 5G mixed reality catwalk at the renowned arts college Central Saint Martins, University of the Arts London during London Fashion Week earlier this year. The live 5G installation began a creative partnership that will see the college's 5,000 students accelerate the convergence of fashion, art, design, performance and technology.

Model Lennon Gallagher walked the catwalk in a mixed reality setting powered by Three's 5G network. Aided by Magic Leap virtual reality headsets, guests of the MA fashion show were given a unique glimpse into the mind of upcoming designer Gerrit Jacob, whose eclectic collection was inspired by fairgrounds and arcades from the 1980s.

The installation has remained for use by the students and staff of Central Saint Martins, who will be encouraged to utilise the many benefits of 5G through a programme of creative projects, key events and in a new 5G-connected laboratory, which Three is helping to reimagine within the college.

"The future of art, design and fashion is intrinsically linked with the evolution of tech," says Jeremy Till, head of Central Saint Martins. "[Our partnership with Three] is an enormously exciting collaboration for both parties and one which will allow our students to speculate on yet unheard possibilities in the creative use of 5G."

02

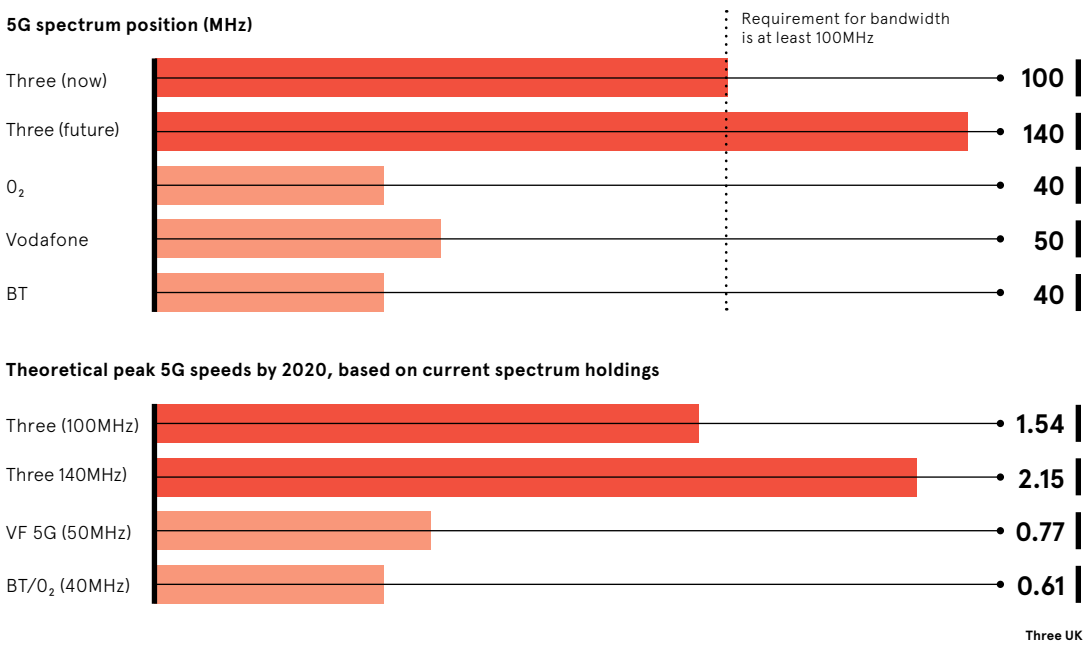
01
Actress Natalie Dormer and supermodel Jourdan Dunn get a glimpse into a 5G future through Magic Leap headsets at the Central Saint Martins MA Fashion show

02
Lennon Gallagher walking the first mixed reality runway fuelled by Three's first live installation of 5G at the college

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

THREE IS BUILDING THE UK'S FASTEST 5G NETWORK

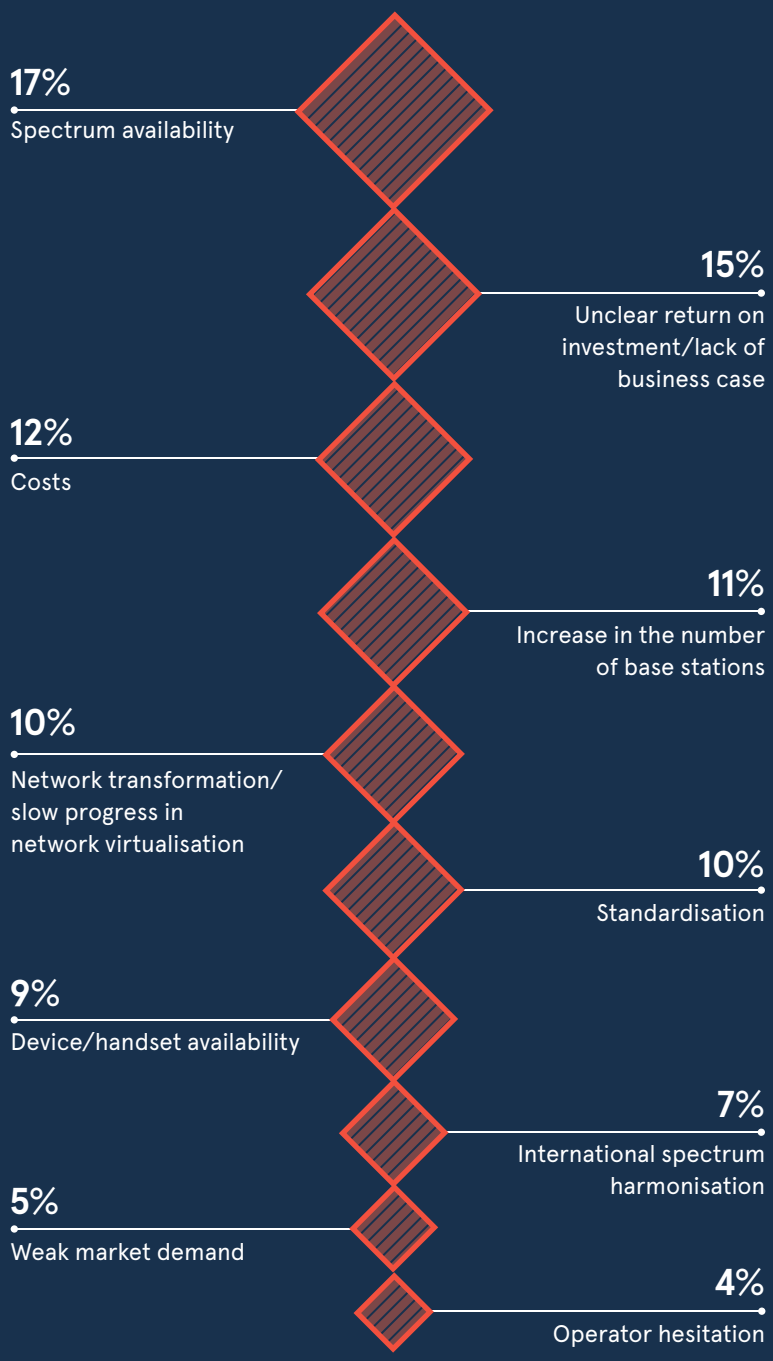
Three's 100MHz contiguous bandwidth sets the benchmark for 5G speeds in the UK



Three UK

BIGGEST OBSTACLES TO 5G SUCCESS

Global survey of telecommunications professionals who rated the following as the biggest obstacle



Telecoms Intelligence 2018

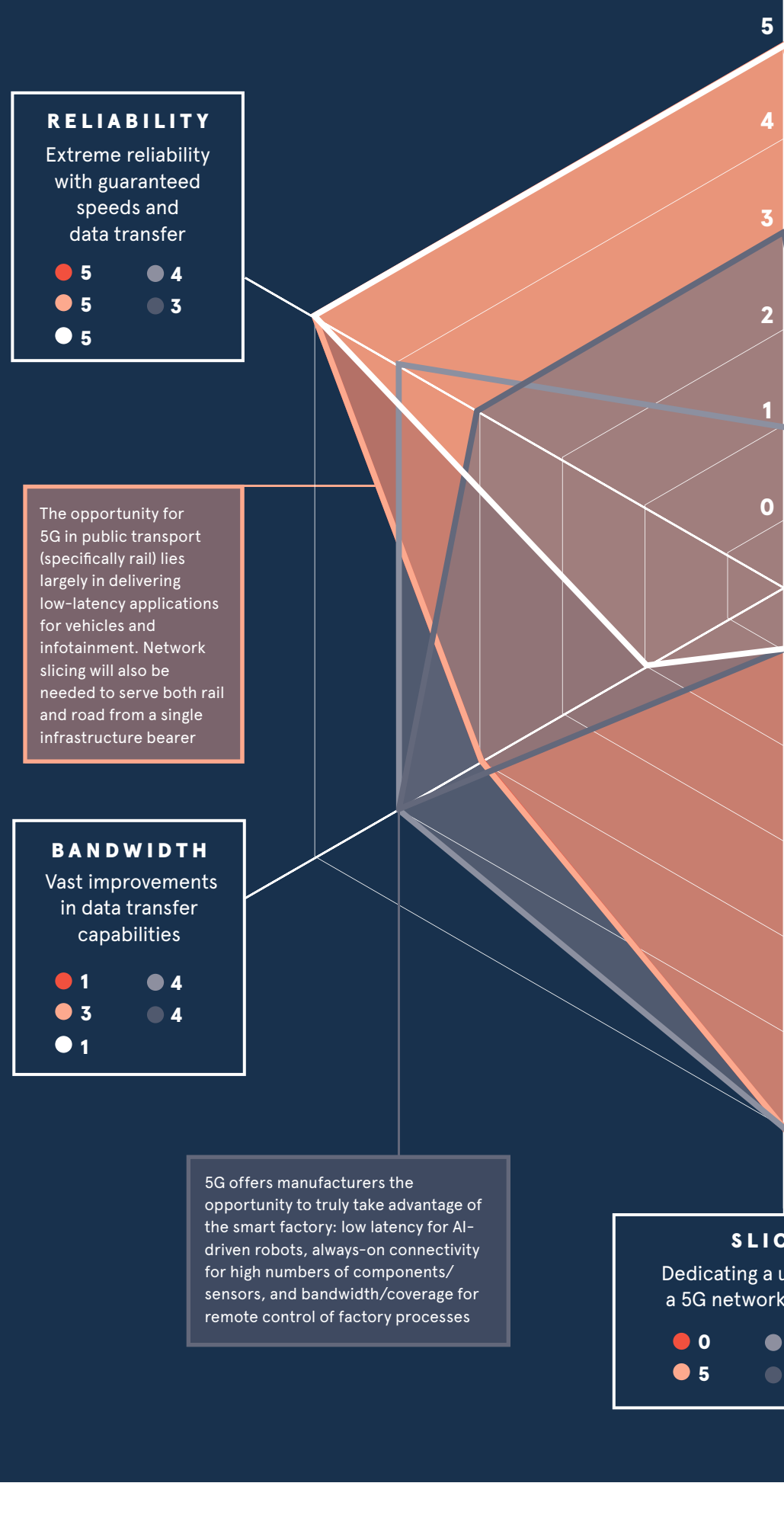
WHERE 5G WILL HAVE THE BIGGEST IMPACT

Requirements for 5G in five different sectors

- Healthcare
- Public transport
- Personal transport
- Manufacturing
- Immersive technologies

0 = no change required from existing technologies

5 = substantial change required from existing technologies



MEASURING THE TRUE IMPACT OF 5G

The advent of 5G has the potential to transform every sector through reductions in latency and improved bandwidth, reliability and speed. But which sectors stand to benefit the most?

RAGE
ases in coverage
ty expected
1 5
3

Vehicle-to-vehicle and vehicle-to-infrastructure communications are key enablers of autonomous cars, which will require low-latency, high-volume transmission of data

NEW DEVICE REQUIREMENT
Equipment needed to cope with the high bandwidth and low latency promised
3 2
1 0
5

Remote healthcare applications that use real-time data via 5G will transform services, and will require low latency, and high coverage/ bandwidth

LATENCY
How reactive and slick a system feels
5 5
2 5
5

Virtual and augmented reality technology need low latency to enable streaming of data and large-scale experiences

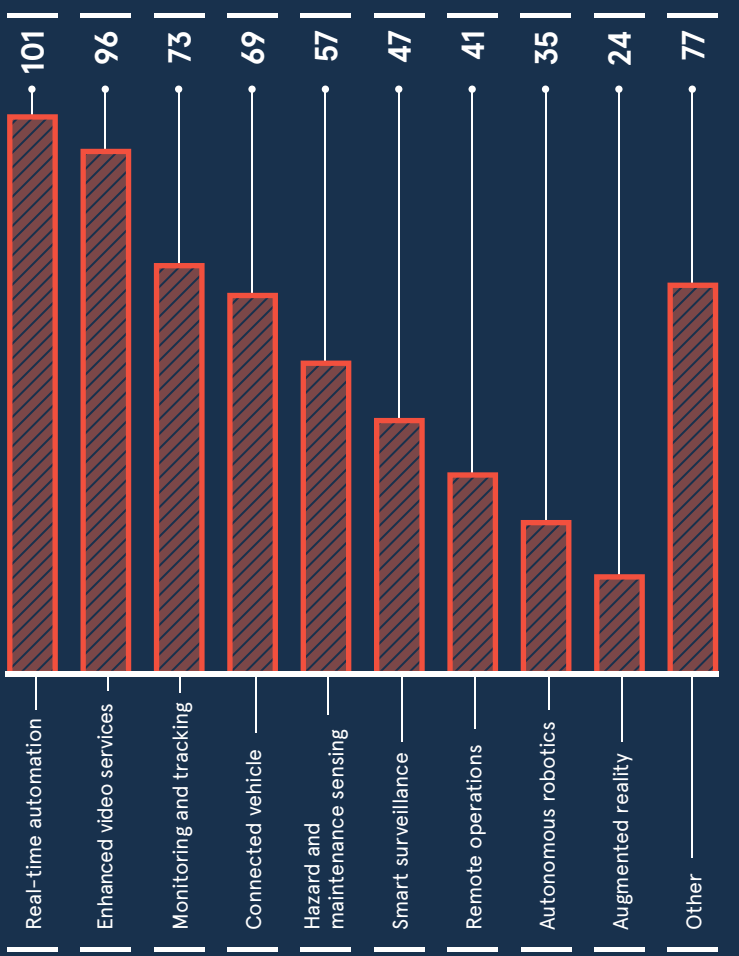
0
1
2
3
4
5

CING
unique part of
for a service
5 0
0

Digital Catapult/Innovate UK 2018

POTENTIAL REVENUE GAINS FROM 5G BY TECHNOLOGY

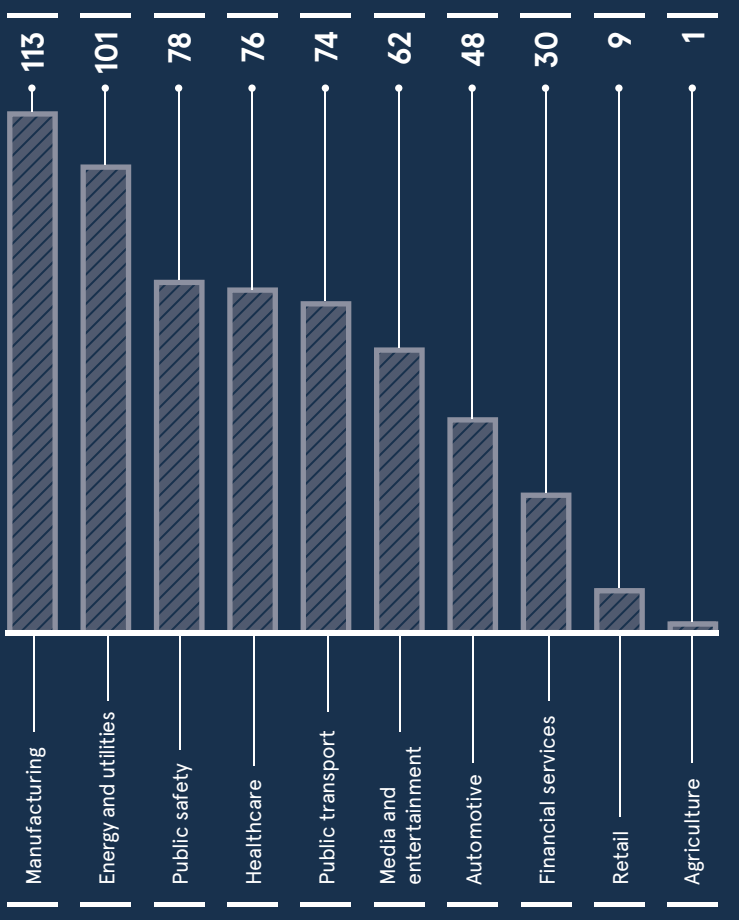
High-end estimate of additional revenues by 2026 ($bn)



Ericsson 2018

POTENTIAL REVENUE GAINS FROM 5G BY INDUSTRY

High-end estimate of additional revenues by 2026 ($bn)



Ericsson 2018

Commercial feature

Natalie Duffield, chief executive of IntechnologyWiFi (Smart Cities), with technical manager Bill Young at Wetherby, West Yorkshire

5G for the many, not the few

5G has to cover all the UK and smaller businesses must help to build the network, says **Natalie Duffield** at IntechnologyWiFi (Smart Cities)

Amid all the noise and confusion around the advent of 5G, three things should not be overlooked. Innovative small and medium-sized enterprises (SMEs) should be involved in the design and delivery of 5G networks. These networks should cover all parts of the UK, not just the main cities. And tried-and-tested secure technologies such as wifi will absolutely be part of these networks.

But first some background. I am chief executive of IntechnologyWiFi (Smart Cities), a provider of robust, next-generation digital infrastructure and services, and committed investor in towns and cities across the UK. We started in Harrogate, North Yorkshire in 2013 as a provider of free public wifi to boost digital inclusion in locations as diverse as Coventry, Edinburgh, Southend, Watford, Wetherby and Windsor. We have since developed the tools to provide smart city services to local authorities across the UK for the benefit of citizens and businesses alike.

Our parent company, Intechnology, has a long track record of producing commercially successful innovations, including Planet Online, the UK's first viable business internet service provider, Sports Internet Group, the internet-based content business sold to Sky, Freeserve, the UK's first free consumer internet service provider, and IMS, the trusted host of key national infrastructure such as the NHS Spine.

Through our work in smart city services, we have learnt how important it is to get the building blocks in place if you want to create strong, feature-rich and scalable digital infrastructure. We agree with Colin Willcock, chairman of Europe's industry association 5G IA, who says: "It is not about who deploys first; it's about who deploys correctly." Only then will the UK be able to realise the full benefits of 5G in industries like automotive, healthcare and media as well as in public services such as social care and social housing.

In Coventry, the UK's next City of Culture, we have built one of the country's largest city-wide internet of things networks. We are working on pilots with the city council to improve air quality, waste management and vermin control.

INTECHNOLOGYWiFi (SMART CITIES) IN NUMBERS

10
towns and cities, including Edinburgh and Coventry, next UK City of Culture

1.27m
registered users

1.2k
new user registrations per day

1
gigabits per second maximum speed

The building blocks are in place.

The first level is the public platform. This is safe and secure, but also open and accessible. Once installed, everyone in the city centre becomes digitally enabled. At the second level is the data, where users store, view, control and share information, in a way compliant with the EU General Data Protection Regulation. At the third level is the service interoperability with open interfaces, enabling collaborative working across many different partner organisations. This is how we transform public services.

In Wetherby, a market town on the outskirts of Leeds that dates back to the Domesday Book, we have just installed one of the fastest wireless networks in the UK in partnership with the local council. This is bringing a stream of benefits to residents, visitors and local businesses. By the definition of emerging industry standards on speed, Wetherby would qualify as having a 5G-equivalent network. Market traders in the historic town square are now able to benefit from new technologies such as cashless payments. We're proud to be delivering networks that meet the new 5G standards.

According to Margot James, minister for digital: "5G has the potential to revolutionise every aspect of our lives, from increasing productivity to improving quality of life." We know from experience that she is right. We just need to make sure that all the UK benefits from 5G, and not just big business and main cities at the expense of everyone else.

New research from tech incubator Public found that technology SMEs are being routinely shut out of bidding processes, with procurement tending to favour insiders and incumbents. Innovative SMEs like ours should have the chance to compete fairly and squarely for contracts to design and deliver 5G networks, services and applications. It will not be in anyone's interests if big business is allowed to swing in and cherry-pick the easy revenues from 5G and leave vast swathes of the UK without access to the new opportunities that will emerge from these exciting new technologies.

For more information please visit www.intechnologywifi.com

intechnologyWiFi

OPINION

'The UK is well placed to be among the first wave of countries to adopt and demonstrate the potential of 5G'

5G represents the next generation in mobile technology. While 2G enabled basic mobile communication and 3G introduced access to the internet and email from the palm of our hands, 4G went further by ushering in a new digital economy

Now is the turn of 5G. While 5G continues the trajectory of dramatically increased speed, there is much more to it. Its properties allow for richer and more data-intensive connectivity between devices.

There won't be a 'Big Bang' moment for 5G. The first phase, later this year, will see the launch of 5G broadband services for consumers and business customers. Over time, 5G will lay the foundation for smarter and more efficient cities and industries, such as interconnected traffic lights and autonomous vehicles, factories where production lines adjust to demand in real time, and immersive experiences that bring classrooms and stadiums into our living rooms.

Unlocking its potential at this scale will require extensive and secure digital infrastructure, new commercial business models, and closer collaboration between government, operators and industry to develop 5G use-cases and services.

Developing a 5G network is a significant undertaking that requires considerable investment. There are over 30,000 mobile cell sites in the UK and many of these will need to be upgraded to deliver 5G, alongside thousands of new sites likely to be required.

Our commitment to making use of public buildings for hosting digital infrastructure will help ensure that 5G networks are widely available. We also recognise that a next generation network requires up-to-date planning regulation, keeping pace with advances in technology, so we are keeping planning regulations under review and continue to work with industry to promote understanding and take-up of the existing wide range of planning reforms.

The arrival of 5G also requires greater bandwidth from the underlying broadband network. So Ofcom are making it cheaper for operators to lay fibre by opening up access to existing duct and pole networks. And the UK is also releasing additional spectrum to support the demand for new 5G services.

Finally, given the potential role of 5G across a number of sectors, it is essential that robust measures are in place to ensure that our 5G networks are secure. That is why the UK has undertaken a comprehensive, evidenced-based review of its telecoms supply chain in order to assure the security and resilience of our networks.

All of this work is critical in laying the foundations for 5G, but it is the way the network is used that will set 5G apart. DCMS's £200-million 5G Testbeds and Trials (5GTT) Programme is helping to stimulate new 5G use-cases and accelerate adoption in key sectors. Phase 1 brought together 72 organisations across six projects in sectors including healthcare, transport, agriculture, tourism and logistics.

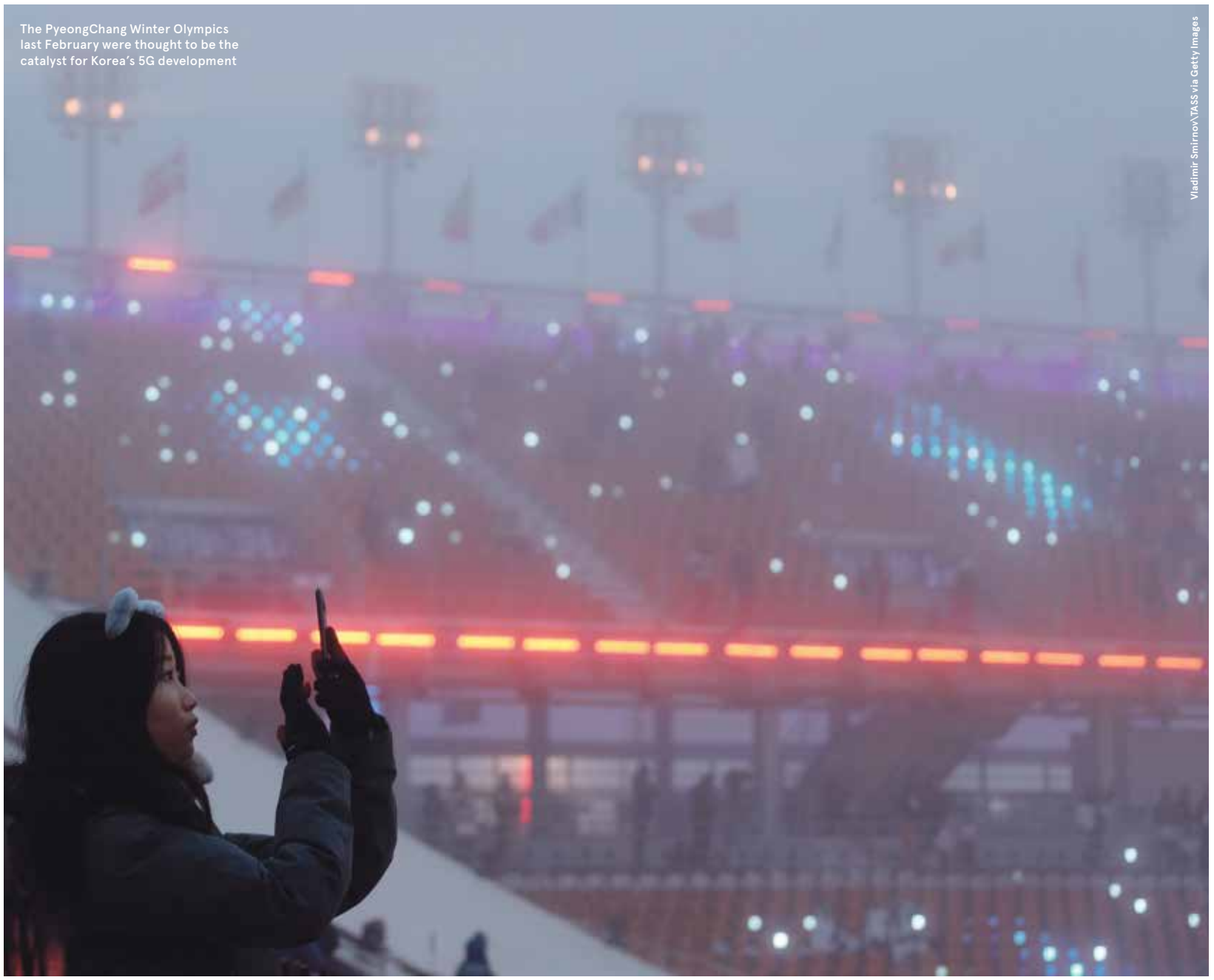
One example is the Liverpool-based health and social care testbed. Smart sensors that can detect falls and monitor medication are being trialled to improve the quality of care for some of the most vulnerable members of society.

The next phase of the 5GTT Programme is our major collaboration with the West Midlands (WM5G). In this trial, we will see patients diagnosed by teams of doctors in virtual cross-site consulting rooms, and whether connected vehicles improve traffic flow. These examples demonstrate how 5G can transform the way we engage with public services and spaces in our day-to-day lives.

Just as valuable are opportunities to boost the productivity and competitiveness of our businesses and industries. 5G could underpin their digital transformation – and so we will soon be seeking to fund sector-specific projects, focused on industrial use-cases in manufacturing and logistics.

Our work to date gives me confidence that the UK is well placed to be among the first wave of countries to adopt and demonstrate the potential of 5G. As the first services for consumers go live in the coming months, it is crucial that operators and business leaders step up their collaboration to reap the full benefits of 5G. ●

Margot James, MP
Minister of State for the Department for Digital, Culture, Media and Sport



The PyeongChang Winter Olympics last February were thought to be the catalyst for Korea's 5G development

Vladimir Smirnov\TASS via Getty Images

SOUTH KOREA

Leading the pack, or jumping the gun?

5G rollout is a national imperative for South Korea, but its big investments in infrastructure and cellular technology may not have given it first-mover advantage

Oliver Pickup

South Korea is leading the pack when it comes to deploying 5G, insists Guillaume Weill, head of telecoms at technology consultancy Intralink, and it's hard to argue with him.

"The country auctioned its first 5G licences last summer for $3.3 billion (£2.5 billion)," he says, "and in April South Korea achieved the world's first national consumer rollout of 5G."

Given this was announced before international standards of 5G have been agreed, has South Korea, home of Samsung Electrics that launched the 5G-enabled smartphone Galaxy S10 in February, jumped the gun or gained a fair advantage over other nations? The jury is out for the moment.

There was little surprise that the east-Asian nation, which has one of the world's top smartphone penetration rates, was the first to cross the line. "It has for many years been at the forefront of cellular technology deployment, being one of the first to deploy a number of advanced 4G features," according to the 5G Infrastructure Association, an organisation committed to the advancement of 5G in Europe.

In February 2018, PyeongChang hosted the prestigious Winter Olympics, which the 5G IA says was a catalyst for South Korea's 5G development. "The games were clearly a driver," says a spokesman, "but this should not disguise the fact that there is real commercial pressure for extended mobile network capacity with strong customer demand and high usage of the existing frequencies.

"It is unclear, though, whether South Korea has stolen a march on other nations. There is certainly a case to be made that the current deployed 5G equipment is focused mainly on massive broadband and it is the other features, such as low latency and robustness, that will be needed to unlock the value of the verticals."

Commentators argue that South Korea is determined to get its nose in front of China, the United States and Japan in the 5G race, in the hope that it will spur breakthroughs in fields such as smart cities and autonomous cars, and most importantly accelerate its economic growth that slowed to a six-year low in 2018.

"The rapid recent growth of Chinese telecoms capabilities and recognition of the importance of 5G infrastructure in the next industrial revolution have spurred successive South Korean governments to make a 5G rollout a national imperative, and pushed the telcos to invest in the infrastructure," says Mr Weill, who is based in South Korea's capital Seoul.

"While profits in the South Korean telecoms industry have suffered lately, earnings have been strong, which has enabled these companies to invest. All three South Korean mobile carriers, SK Telecom, KT and LG Uplus, are now offering 5G service to consumers and businesses. There may well be a dip in profitability at the telcos if they can't create must-have services, but risk and reward are the inevitable two sides of the first-mover coin."

What does national 5G rollout mean, though, and how has it improved the life of the average South Korean citizen? The trio of telcos have installed more than 10,000 5G base stations across South Korea, and SK Telecom alone is launching in 85 cities, providing 5G services to support the consumption of high-resolution video content as well as augmented reality (AR) and virtual reality applications. Further investment is expected to transform transport hubs, such as airports and railway stations, and motorways in the coming years.

> **All three South Korean mobile carriers, SK Telecom, KT and LG Uplus, are now offering 5G service to consumers and businesses**

"The country has a population of 51 million, with 25 million of those living in the greater Seoul area and the network is mostly available in the capital," says Mr Weill. "The second largest city, Busan in the southeast, also has good 5G coverage. Immediate benefits for users are hard to discern, and it's clear this has been an effort to deliver the infrastructure in the hope that services and applications will follow.

"For the moment, the real impact of 5G is yet to be seen as 4G speeds are fast and stable enough to broadcast most of the content currently available. While South Korea has excelled in infrastructure development, it is weaker in developing applications and this is where UK telecoms firms could step in."

Indeed, now that the horse has bolted, it might be wise to adopt a fast-follower strategy, and explore collaboration opportunities to speed up 5G innovations and applications closer to home. UK residents should be heartened that in late-April the UK and South Korean governments announced a joint £2.4-million project encouraging businesses to pilot 5G technology on Seoul's metropolitan subway system.

Digital minister Margot James believes the competition will enable businesses and researchers to investigate and address a number of user and technical challenges that are crucial to the future rollout of 5G. These might include AR experiences in packed public places, the optimisation of traffic management systems and uninterrupted "infotainment" services for commuters.

"We want the UK to be a world leader in 5G services, and this collaboration with South Korea will create new opportunities for UK businesses abroad and encourage more inward investment," Ms James said when the project was launched.

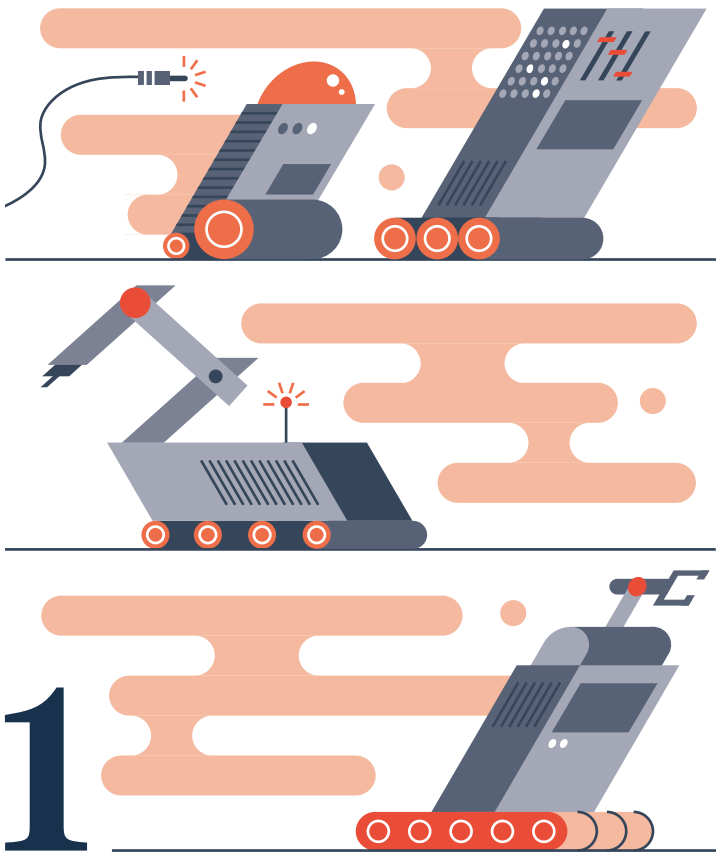
Thanks to South Korea's unshakable desire to lead the 5G revolution, the rest of the world stands to benefit, sooner rather than later.

MANUFACTURING

Five ways 5G will kickstart Industry 4.0

Fifth generation mobile networking is set to transform several industries, none more so than manufacturing. According to a study by Ericsson, the 5G business potential for the sector in 2026 is some $113 billion. But how exactly will the new network ignite the fourth industrial revolution?

Heidi Vella



More flexibility with wireless factories

Network-connected machines can do more than so-called dumb ones. However, manufacturers typically use ethernet and wifi, and progressively 4G LTE, to connect factory devices.

But with 5G, operators can power their entire facility, on and off-premises, seamlessly with one network for near-wireless operations and quicker adoption of new technologies.

"A robot can come with an inbuilt SIM that is easily connected to the 5G network, so operators can plug and play, as opposed to establishing a new network for it, which creates barriers to adoption," says Guido Jouret, chief digital officer at ABB. "A factory with good wireless connectivity can produce more because robots can work 24/7."

Wireless machines can also roam more freely, increasing flexibility and productivity. And with the low latency provided by 5G, around 10 milliseconds and eventually 1 millisecond compared with 20 to 30 milliseconds with 4G, they can be monitored in real time by the human in the loop.

Furthermore, adoption of 5G for manufacturing will move function normally located inside the robot to a central computer via distributed cloud or edge computing.

"This reduces cabling costs and increases flexibility as machinery can be reprogrammed and moved around easier; manufacturing needs to be adaptable to cater for increasing demand for more personalised products," says Mats Norin, programme manager at 5G For Industries, Ericsson Research.

Increased productivity

For manufacturers, productivity gains equal cost-savings. The 5G network allows for up to one million sensors per square kilometre, as well as ultra-low latency, which can provide operators with real or near-time data from sensor-equipped devices to improve productivity.

Using 5G-enabled technologies for increased data capture, MTU Aero Engines, a company that produces bladed disks for engines, working with Ericsson and Germany's Fraunhofer Institute for Production Technology, managed to reduce its process design phase by 75 per cent.

Additionally, the real-time monitoring provided by 5G's low latency enables the company to improve monitoring of the manufacturing process to avoid errors; within milliseconds operators know when they need to change machine parameters or risk having to reconfigure the part. According to Ericsson, this case study alone could create annual savings of approximately €27 million for a single factory.

In fact, the more complicated the factory process, the more of it can be automated for bigger savings.

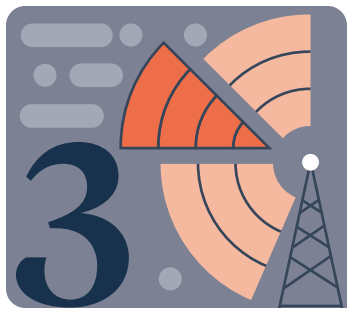
"The more parts that need to be transported, the more production steps and vendors, the more distributed the set-up is, the higher the benefits from 5G industrial digitisation," says Bela Virag, managing partner at technology management consultancy Arthur D. Little.

Tailored connectivity

Managing connectivity is a major cost for manufacturers and inevitably increases security considerations, especially for critical operations. However, the ability to slice the 5G network into multiple virtual networks, so speed, capacity, coverage and encryption can be tailored to the specific needs of different machines and operations, can improve security and keep costs down.

"Slicing offers manufacturers a dedicated system which they can fully control to support their internet of things (IoT) solutions," says Dritan Kaleshi, head of technology for 5G at UK innovation centre Digital Catapult. "It provides reliable communications with guaranteed quality of service, along with cloud-based computation that is under the operator's absolute control."

Though dedicated networks already exist, the 5G network is more easily segmented, so factories could even provision additional network slices, as and when needed, to support

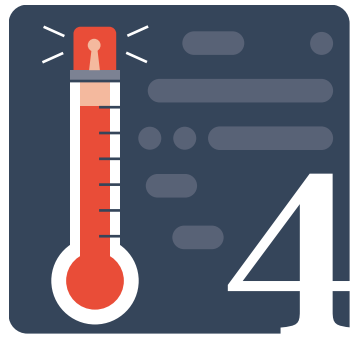


changes in the volume of production.

"This means manufacturers are only paying for what they need, creating longer-term savings," explains Jason Elliott of 5G Market Development at Nokia.

Using multi-access edge computing with 5G, Nokia has demonstrated that data can be processed closer to the factory assembly line where it's needed, reducing latency further.

A study conducted by Ericsson and BT found that compared with conventional networks, network slicing is the best and most economic model for IoT service delivery and can provide a 150 per cent economic benefit.



Real-time predictive maintenance

Maintenance is of course another outlay, as broken machines halt production costing anything from thousands to millions of pounds. 5G-powered predictive maintenance, however, can help prevent failures before they happen.

Experts at the Worcestershire 5G Consortium, a UK hub to test use-cases of 5G, working with Worcester Bosch, managed to increase factory productivity by around 1 per cent by adding thousands of sensors to machines for health monitoring, which enabled them to prevent breakdowns.

Over a year, just for the manufacturing sector, this translates into a £2-billion contribution for UK GDP, says Mark Stansfeld, chair of Worcestershire Local Enterprise Partnership and 5G lead for Midlands Engine.

Predicative maintenance is possible now, but the ultra-low latency provided by 5G increases the risk of catching breakdowns before they occur.

"Latency is truly important here because with an overheating machine, a mere few seconds later, hundreds of thousands of pounds-worth of damage could be done," says Mr Stansfeld.

New business models

As purchasing of goods changes, new manufacturing business models will arise that firms need to be ready to exploit. Through its research, the Worcestershire 5G Consortium has identified a new opportunity for machine manufacturers to sell time on machines through dedicated networks via a platform model commonly used in the consumer sector.

"In the past, these manufacturers would have sold several machines a year, but due to the increased flexibility enabled by 5G, they can instead sell machines on subscriptions," says Mr Stansfeld of Worcestershire Local Enterprise Partnership and 5G lead for Midlands Engine. "This reduces capital expenditure for the purchaser as buying a machine can be upwards of £500,000, while also providing more flexibility." The consortium is in the process of testing the model.

This is particularly pertinent for manufacturers producing materials

for the automotive sector, he says, whereby smaller providers are tasked with experimenting and developing new products.

Furthermore, Mr Jouret at ABB says increased flexibility will enable manufactures to say yes to more work they would otherwise have to turn down.

"Any factory is in some sense inflexible because it's optimised to produce certain things; however, if it's possible to easily reprogram equipment, manufacturers can produce items in smaller batches, for example in less than 10,000 units, which they typically find hard to do today," he explains.

OPINION

‘It is perhaps not key to deploy 5G first, but rather to deploy 5G best’

5G technology has the potential to change dramatically the world we live in. The 5G vision of a fully connected digital society will fundamentally change both the private and commercial lives of each and every one of us.

On the private or societal side, it will provide us with the tools to at least partially tackle some of the major issues of our times, such as ageing populations, increasing urbanisation, environmental protection and global warming, in an integrated and automated way, considering the needs of the individual and the benefits to society as a whole.

While on the commercial side, by bringing digitisation to many new sectors, 5G will act as the lifeblood of the next industrial wave, dramatically improving productivity through better connectivity, processes and services. 5G will enable big data to flow in such a way that the necessary information will be available to us anywhere when we need it, to support all important decisions.

This vision of a world-changing network communication technology is compelling, and explains the current interest and expectations associated with this technology. However, for this vision and potential to be achieved, a number of barriers and obstacles are yet to be overcome.

Some of these obstacles are technological. 5G is currently still in its infancy. The first working versions of the standard have been created and the first products have been delivered, but this is by no means the end of the story. 5G technology will continue to develop for many years to come and many new features will be needed to realise the 5G vision.

Likewise, there are a number of regulatory issues, such as the availability of spectrum and new regulations for the building of the 5G base stations, that are required to enable a smooth rollout of this technology. Finally, the industry needs to identify use-cases and a solid return on investment for 5G to be a commercial success.

Much of the potential of 5G technology is beyond the current classical telecoms market with its focus on smartphones and teenagers. The promise of 5G is to digitise all industrial segments and provide compelling new services. Examples of these vertical industries considering digitisation are automotive, healthcare, manufacturing, energy, smart cities, media and agriculture.

However, to be successful in these new domains, it is essential to work together with these vertical sectors and demonstrate 5G technology provides a compelling solution to their future needs. With this in mind, for Europe, it is perhaps not key to deploy 5G first, but rather to deploy 5G best. In other words, to focus on deploying 5G systems that can fully support the vertical industries and actually stimulate them to grow.

As well as deploying the emerging 5G technology, it is important Europe continues to invest in network infrastructure research and development. It is clear there will be further versions of 5G developed in the next few years and in the longer term systems beyond 5G will be needed. Considering the increasingly fragmented global political landscape, it is vital Europe enhances the technological basis and competence to create such advanced communication systems to ensure a competitive industrial infrastructure and, indeed, the ability to tackle future societal problems.

Colin Willcock
Chairman
5G Infrastructure Association

APPETITE FOR CHANGE

Firms still unprepared for 5G transformation

Consultancies and research institutions will have an important role to play in enabling businesses to reap the benefits of 5G

Christine Horton

Despite the hype around 5G, many organisations are still in the dark as to the potential benefits the technology could deliver to their business.

A 2019 study by global consulting firm Accenture suggests both business and technology executives underestimate the disruptive potential of 5G. More than half believe there are very few things that 5G will enable them to do that they cannot already do with 4G networks, and fewer than two in five expect 5G to bring a revolutionary shift in speed and capacity.

It is no surprise then that nearly three quarters of businesses say they need help imagining the future possibilities and use-cases of 5G. This is where specialist consultancies and market research companies will have an important part to play, helping organisations understand the benefits – and challenges – associated with the roll-out of 5G, and tailoring a service to their individual requirements.

"The role of consultancies and research institutions is to provide simple and relatable insights about what 5G could mean for enterprises," says Amol Phadke, global network practice lead at Accenture. "They should help create a strategy and monetisation model with business leaders around who to partner with, and how, and where and when they should invest in the technology to achieve the business benefits."

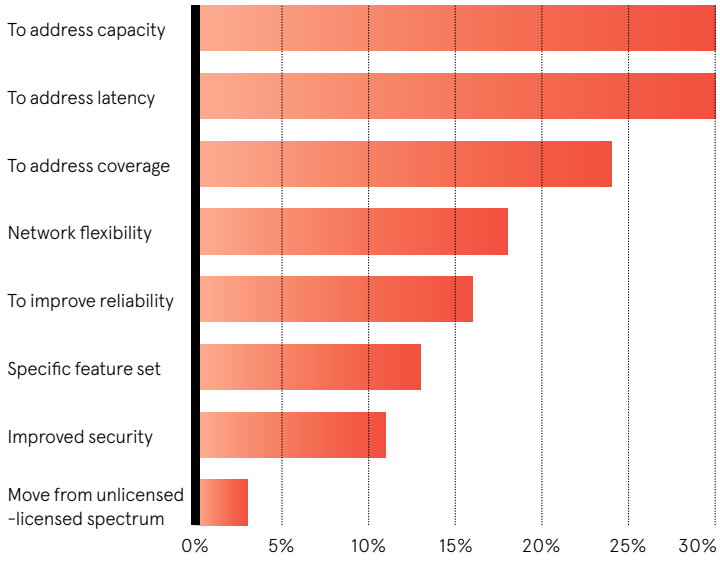
So why might a business choose to partner with a specialist consultant over their telecoms service provider? It's easy to imagine service providers, that will already be supplying the connectivity, helping their customers navigate this new hyper-connected world.

For many though, it's a question of industry-specific expertise. "Not only should any adviser understand the technology and likely rollout and performance benefits of 5G, they should be experts in the specifics of operations in each sector," says Tim Devine, technology expert at PA Consulting.

This view seems to reflect businesses' own concerns – 60 per cent of the executives surveyed by

REASONS WHY COMPANIES ARE INTERESTED IN 5G

Survey of companies across the 5G value chain



Digital Catapult/Innovate UK 2018


Steven Rojas/Unsplash

Accenture believe there is a lack of knowledge among telecoms companies about the challenges their individual industries face.

Businesses say they need a partner that will work with them to identify 5G applications that are relevant to their unique environments. For example, Mr Devine says that if an organisation is using 5G to improve the operations of a transport network, the 5G device will need to be embedded in a remote video-monitoring system rather than being a handheld phone.

"This level of integration between network technology and applications has been an area where many telcos have struggled in the past. This is mostly because they don't have the deep sector insight available to consultancies who work with organisations in each sector and thus, they should play an invaluable role in the development of 5G," he explains.

A consultancy can also recommend a range of products and approaches whereas service providers may only put their own services on the table. Moreover, they can provide detailed and independent advice regarding which products from which telco will best suit their business.

"Consultancies and research institutions play a vital role in providing independent analysis and insight about the latest technologies, and more importantly, the benefits they can bring to businesses," says Dr Heidi Pinkney, lead consultant, technology strategy at Cambridge Consultants. "Research institutions can demonstrate the art-of-the-possible for new technologies in business environments, while consultancies, being inherently client focused, are well positioned to provide tailored advice to clients."

> **A deep understanding of each business and the market in which they operate is key for 5G capabilities to be successfully adopted**

Dr Pinkney believes that while telecoms companies "are well placed to develop and offer convenient enterprise services platforms based on 5G capabilities, a deep understanding of each business and the market in which they operate is key for these to be successfully adopted."

However, Accenture's Mr Phadke believes there is still "a very clear role" for communications service providers (CSPs). "Breakthroughs in immersive television, connected health, education and smart-city infrastructure will unleash opportunities that are difficult to imagine today. CSPs will play a pivotal role in bringing these prospects to light. The communications industry and CSPs will be at the forefront of rethinking its value chain to sell, deliver and support these new 5G solutions and the partner ecosystem will evolve accordingly," he says.

At a fundamental level, says Dr Pinkney, "operators and businesses require a bridge, which may be a consultancy, ensuring that operators provide the right solution to this new category of client and that businesses truly understand both the language and the opportunity of emerging 5G technology."

With 4G likely to continue to cater to consumer needs for the foreseeable future, it will fall to businesses to be the standard bearers for 5G – so companies should be getting to grips with the technology sooner rather than later.

"There is a lot of misunderstanding of what 5G is and what potential it can offer in short and long term," says Zahid Ghadialy, principal analyst and consultant at advice site 3G4G. "Many buzzwords commonly used in the press like wireless fiber, less-than-a-millisecond latency and millimeter waves are just some of the aspects of 5G and won't be realised in the near term. In the short term 5G will be like 4G on steroids."

Consultancies are ideally placed to help cut through this hype. While the phrase 'trusted advisor' may be somewhat of a cliché, there is a valuable opportunity for consultancies to partner with businesses to plug their knowledge gap around 5G and enable them to benefit fully from the rollout of the technology.

Get ready for the 5G revolution

Nations and industry are preparing for the opportunities 5G investment will bring, says **Dr Luyun Jiang**, IDTechEx technology analyst on 5G

By 2030, 5G is forecast to contribute $700 billion to the global economy with a compound annual growth rate of 20 per cent. This is a revolutionary rise that will both accelerate the growth of the telecommunications industry and redefine a whole host of industrial, entertainment and IT sectors in its wake.

Its arrival is imminent too, with the United States and South Korea already having launched commercial consumer 5G networks in April 2019 to great effect. Subsequently, more than half of all telecoms operators around the world have sped up their 5G rollouts and targeted a commercial launch in either 2019 or 2020. China alone expects 5.8 per cent of its GDP growth to derive directly from 5G technology by 2030.

So how can business leaders and those responsible for innovation benefit from the infrastructure, user equipment and services that come with 5G?

The first wave of 5G investment is the deployment of 5G infrastructure. The US and South Korea spent $41 billion while the global capital expenditure on 5G was around $161 billion in 2018. Over the next ten years, global telecom operators will invest $1.2 trillion to $1.5 trillion on 5G network rollouts, most of which will be for sub 6GHz 5G.

Companies accounting for the largest share of infrastructure investments include heavyweights such as Ericsson, Nokia and Huawei. The largest supplier with a 28 percent global market share, Huawei, has signed more than 40 commercial 5G contracts and shipped more than 70,000 base stations already.

However, future competition is still unclear as the US government increases pressure on many countries to ban Huawei from supplying equipment for 5G networks. Samsung has already moved to enhance its position and dominates South Korean 5G deployments with more than 53,000 base stations installed.

The second wave of 5G investment will comprise new 5G user equipment. More than 40 commercial 5G devices, most of which are 5G smartphones, will reach global markets in 2019, with a mission to rescue a declining global mobile market. Pioneers include the Samsung S10 5G, Huawei Mate X and the Motorola 5G moto mod. With the agreement to drop all litigation with Qualcomm, Apple is also likely to launch its 5G iPhone soon.

Additionally, the customer premises equipment market is set to deliver economically viable broadband services to homes and small and medium-sized enterprises on top of their existing mobile broadband offerings. Increasingly, devices such as augmented and virtual reality glasses, 8K TVs and wearables will integrate with 5G, creating a significant growth in the technology market which is expected to exceed hundreds of billions of US dollars by 2025.

A primary reason for such a spike derives from the market opportunities 5G presents. 5G enables the possibility to link various wireless services to one universal cellular network. These various vertical applications will create a whole new world of technology products.

> **Global capex on 5G was around $161 billion in 2018**

The potential for a range of segment growth in support of 5G is unprecedented. Sectors including automotive (autonomous drive, in-car entertainment systems), industry 4.0 (remote-controlled robots and drones, intelligent machines), media experiences (5G TV, cloud game-streaming) and healthcare (remote diagnostics and surgery, digital health) are all set to be influenced by the impact of 5G.

IDTechEx provides research, consultancy and events to a wide range of businesses to enable them to make strategic decisions to capitalise on 5G and other emerging technology opportunities. For more information please visit www.IDTechEx.com/5GTimes

IDTechEx Research

5G MARKET OPPORTUNITIES ($BN)

By 2030, 5G will contribute

$700bn

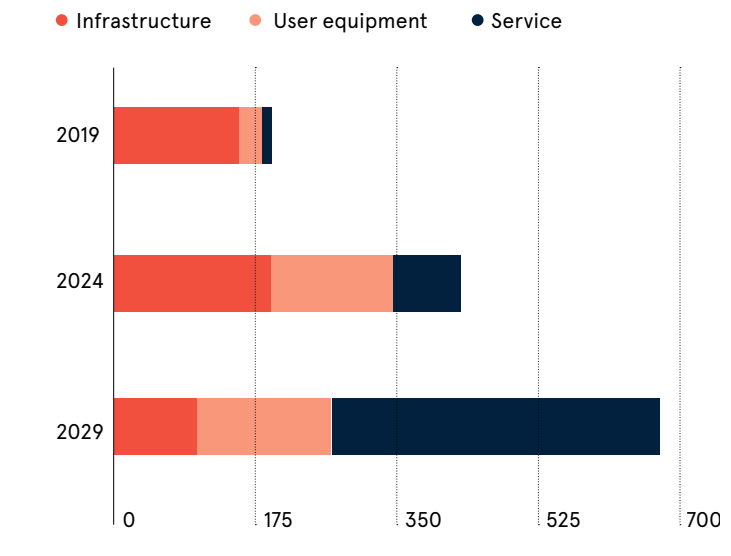
to the global economy with a CAGR of

20%

In the next ten years telecom operators will invest up to

$1.5trn

to roll out 5G globally



SMART ROADS

Intelligent roads are nearing reality

While truly autonomous vehicles may still be some way off in the UK, 5G roads connected to sensors and smart highways will pave the way


Alexander Popov/Unsplash

Mark Hillsdon

In Finland, for so long a hotbed of technical innovation and telecoms creativity, it is the humble lamppost that is sparking life in a "robot bus" service.

By the end of the summer, 15 futuristic poles will line the 1km route from Nokia's head office to the train station at Kera, each fitted with an array of sensors and antenna, which together create a 5G network that will allow the bus to drive autonomously.

The poles are part of LuxTurrim5G, a project driven by Nokia Bell Labs, and if successful the system will form a key part of a new smart city of 15,000 inhabitants in Espoo that Nokia hopes to build over the next ten years.

"A wider use for the poles, in more isolated, rural areas of Finland, would be to utilise their in-built cameras to survey the environment and give a heads-up warning to cars of possible collisions with moose and other animals," explains Pekka Wainio, project manager at Nokia Bell Labs.

Finland already has an operating smart road, the Aurora public tests ecosystem, which was established in 2017 when a 10km stretch of Route 21 in the Arctic north of the country was equipped with sensors. The intelligent road has helped drivers to tackle issues including freezing fog and extreme temperatures.

"The 5G road is a concept not far off from being a reality," says Mohsen Mohseninia, vice president of market development at internet of things solutions provider Aeris. China and Finland are on track to have functioning smart highways within the next few years, he says, and the UK government is now prioritising the rollout of 5G services.

In May, Switzerland launched its 5G network, mainly covering urban areas, while the European Union's 5G Action Plan for Europe details how one major city in every member state will have 5G by 2020, with all major road networks covered by 2025.

5G is all about lower latency – the lag experienced by signals travelling over the internet – speeds that are hundreds of times faster and greater reliability. "It provides the capability to connect lots of things all at once," says Peter Claydon, project director at pioneering 5G initiative AutoAir.

Most of the data in the current mobile network is termed the "downlink", he explains. "It's information that's going from somewhere else in the world to the vehicle. With 5G there's the capability to send a lot more information from the vehicle back to transport authorities and car manufacturers," says Mr Claydon.

> **Transport bodies will be able to manage a road network in real time, controlling traffic lights, traffic flow and congestion through automated machine-learning and AI programmes**

While 5G roads won't look drastically different, they will fundamentally change the way we think about transport networks, says Dr Mohseninia. "At the heart of the 5G road is data that is transmitted both with speed and volume, through millions of datapoints that speak to each other," he says.

"5G roads will have large numbers of sensors and smart devices which, when combined, will enable real-time interaction between the infrastructure and the vehicles that use it."

Guy Matthews, director of emerging technology at CGI UK, says: "Transport bodies will be able to manage a road network in real time, controlling traffic lights, traffic flow and congestion through automated machine-learning and artificial intelligence programmes.

"There will be significant improvements in transit-route planning and road safety, through the increased capture and transmission of real-time information."

Alongside weather warnings and traffic updates, 5G also means receiving alerts from other road users. "It's effectively 'seeing round the bend', so your car will be able to know what's round the corner because there are other cars there that are sending back information," says Mr Claydon.

But network connectivity is not just about high speeds; it is also about reliable coverage that won't drop out, a crucial factor when it comes to the future development of autonomous vehicles.

"The big thing that will come with 5G is the possibility to actually rely on that connectivity," says Maxime Flament, chief technology officer at 5G Automotive Association, an organisation that brings together the telecommunications and automotive industries, with partners including Audi, Nokia and Huawei.

For instance, he says, today you can only inform drivers. They receive information from the cloud about speed restrictions or weather conditions and eventually it is displayed on the dashboard; that's the limit of 4G connectivity.

With 5G, Dr Flament explains, the data will be reliable enough for vehicles to receive details of upcoming speed restrictions and actually adapt their speed accordingly.

The next step could see the driver engage automated mode. "Perhaps a pop-up on the dashboard could alert the driver that for the next 100km or so there is strong coverage and an external service provider that can take care of the car,"

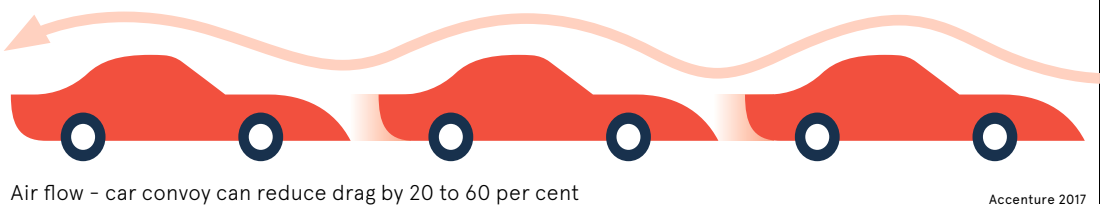
5G COULD ENABLE SMART CAR CONVOYS

5G and vehicle-to-vehicle (V2V) communications may enable cars to make others aware of upcoming hazards, increase reaction time and allow car convoys safely

Safe distance without 5G or V2V (self driving cars by 2020)

Air flow - drag constitutes 50 to 75 per cent of highway energy

Safe distance with 5G or V2V (future autonomous cars with 5G)



Air flow - car convoy can reduce drag by 20 to 60 per cent

Accenture 2017

he explains. In essence, for the cost of a few pounds, the driver can sit back, while the car is controlled by a remote operator.

"Ultimately, all this data means there will also be improvements in vehicle positioning information, which will enable much closer clustering of autonomous vehicles," says Mr Matthews. "This will mean better use of road space, reductions in congestion and improvements in vehicle energy consumption." The platooning of road freight, when a series of lorries autonomously follow a lead vehicle, could also increase, he says.

Although truly autonomous vehicles on the UK's roads may still be some way off, says Mr Claydon, all this data and connectivity will help overcome one of the biggest hurdles to autonomous cars which is public trust. It will give people confidence that even if a vehicle is being driven remotely, the driver is still in control, he says.

Dr Mohseninia sees other benefits too and believes that 5G could lead to the wider deployment of drones over our roads, taking on tasks such as road surveillance, structural surveys of bridges, and replacing traditional speed cameras by tracking speeding drivers and sending information directly to the police. 5G could also support the emergency services, he says, by helping them to navigate the quickest route to an accident.

It will even be able to help electric vehicle drivers navigate their way to the best available charging point, taking into account how much power they have left, whether there is a queue and how far it is to an alternative point.

As well as featuring on motorways, and major routes in and out of cities, 5G also has a role to play on urban roads, particularly with public transport. The typical London bus has 13 internal and external cameras, says Mr Claydon, and the extra capacity offered by 5G means this video can be streamed back to an operating centre in real time. This allows for dynamic bus-routing that avoids congestion, takes into account crowded buses and can also improve passenger safety.

And, of course, 5G is set to play a vital role in the traditional family holiday, with the network's ability to stream an unending succession of movies to bored children, a boon to any frazzled parent.

PREDICTIONS FOR 5G-ENABLED ROAD MANAGEMENT SYSTEMS IN THE UK

10%

reduction in time spent stuck in traffic commuters that drive to cities

£880m

saving in lost productivity caused by congestion

370k

metric-tonne reduction in CO2 emissions each year

O2 2018

Millbrook Proving Ground

Having starred in numerous episodes of *Top Gear* and acted as the perfect backdrop for automotive hi-jinks in 007's *Casino Royale*, the Millbrook Proving Ground is now playing a leading role in the UK's 5G revolution.

Covering a square mile of the Bedfordshire countryside, from the air the site is a swirl of tight, twisting roads, sharp hairpin bends and a perfect circle of concrete, which makes up the two-mile high-speed circuit.

The state-of-the-art facility hosts the UK's only 5G testbed for connected and autonomous vehicles (CAVs), part of the AutoAir project, which is bringing 5G to the transport and technology sectors.

Millbrook provides CAV developers with high-speed, real-time connectivity that means self-driving vehicles can be put through their paces on a track where developers can simulate weak and strong connectivity. They can also gain a better understanding of how hills and other terrain impact on vehicle performance, and create "virtual events" allowing them to test complex scenarios.

The network uses small cells that operate on a "neutral-host" basis, which enables multiple mobile operators to use the same infrastructure simultaneously, radically improving the economics of 5G networks.

Grab the future by the

The future is always in front of you, something your eyes catch a glimpse of but never see fully, a constant presence – sort of like your nose. Well now with the launch of 5G, the future is about to hit you in your actual nose and every other part of your existence. Everything that was just out of sight will crystallise into reality, the future will become the present, and we'll have to think up another future.

There is a lot of excitement about what 5G connectivity will make possible, we already know what the stupid fast speed of 5G will do to your current mobile. But the launch of 5G is going to bring the superfast future flying into reality. 5G will save lives, propel humanity forward, and usher in the utopia that will solve the literal hot mess we're in. But we know what you're thinking, it's what we're all thinking: what happens to Tinder on 5G? 5G Instagram filters? And sex robots? One can only imagine what the future will hold…

The year is twenty-twenty-something. In your 5G connected home (so long, broadband) you flush the toilet, which then orders you a bespoke vitamin replenishing breakfast smoothie. A Deliveroo drone arrives in minutes and lets itself in because you're busy playing Fortnite lag-free against your 12-year old nemesis. Finally victorious, you decide to mark the occasion with a tattoo from an LA-based artist thousands of miles away thanks to tech intended for remote heart surgery. With your arm wrapped in future cling-film you jump in your VR shower and explore the Even Greater Wall of China. Clean and well-travelled, you download the latest AR fashion trends while you swipe through Tinder in search of a hot date. It's a match! Your driverless Uber flies through traffic-free streets as 5G has made autonomous vehicles the best way to travel. Relieved your date isn't an AI catfish, you bag table 16 at your favourite gourmet Portuguese chicken place. After dinner you head to a 5G karaoke bar where you and holographic Ed Sheeran serenade your date. Then it's back to yours to stream every episode of Friends simultaneously. Just another day in your 5G future.

Whatever the future holds, all we know for sure is cool things will be cooler, weird things will be weirder and emojis will be even more suggestive. And as we're building the UK's fastest 5G network, Three customers will be able to revel in all the wonders the future will spring on us more than anyone else.

When the future comes, you'll be glad you've got 5G.
When the future comes, you'll be glad you're on Three.

With more than twice as much 5G Spectrum as any other network, the UK's first cloud core network, state-of-the-art data centres and radio tech, our 5G network will be the UK's fastest - see three.co.uk/5G