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with PwC



5G Outlook Series: Transforming Essential Services for Economic Recovery in the Great Reset

SEPTEMBER 2020



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Executive summary

The global health pandemic and the severe recession that many countries face have brought into focus a number of important challenges as governments attempt to keep their populations healthy and workforce productive. There is a growing crisis for essential services, such as healthcare and public transport as well as inequality in access to opportunities to work remotely. The need for localized lockdowns during second or subsequent waves of the virus is likely to lead to workers having to flex between a hybrid (physical and digital) and purely digital modes of working.

The emerging “new normal” is a window of opportunity to shape the economic recovery for essential health and public transport services and the move to hybrid modes of working. Looking further ahead, countries can accelerate their economic recovery by upgrading their digital infrastructure to enable flexible working, innovation and a more geographically even distribution of work opportunities.

As part of a digital infrastructure strategy, and as an enabler of other emerging technologies – such as the internet of things (IoT), extended reality (XR), artificial intelligence (AI) and edge computing – 5G has an important role to play. A PwC study of the economic impact of 5G-enabled use cases across industries forecasts these technologies will contribute \$350 billion to global GDP¹ by 2025, rising to \$1.3 trillion by 2030. There is a lot at stake and there is a strong case that action should begin with those sectors that are essential for societies to cope during the pandemic.

This paper explores three ways for 5G to accelerate the digital transformation of these types of essential services and workplace activities in the near term:

- Accelerating the move to a value-based healthcare system that is predictive, preventative, personalized and participatory. 5G-enabled use cases in this area have the potential to boost global GDP by \$530 billion by 2030.²

- Building confidence in public transport so citizens can travel safely to their workplace and begin to bring citizens back into city centres. 5G-enabled use cases could contribute \$130 billion to global GDP by 2030.³
- Enabling the widespread use of extended reality using 5G to usher in a more immersive alternative to current collaboration tools will unlock efficiencies and opportunities in the workplace. The use of XR could unlock a \$570 billion benefit to global GDP by 2030 in areas such as training and development as well industrial process optimization.⁴

To turn the challenges across these essential services into opportunities to aid economic recovery, will require governments to play an important role in bringing them to fruition. Here are three sets of actions they should take:

1. Change of mindset from net-receiver to investment catalyst
2. Standardize and simplify local permitting rules and regulations to speed deployment
3. Fight misinformation and increase education, research and awareness about 5G

5G has the potential to be for the Fourth Industrial Revolution what the railways were for the first and second ones. As an enabler of multiple emerging technologies, including IoT, XR and AI, its benefits will eventually stretch beyond the sectors focused on within this paper to all sectors of the economy.

To illustrate the enabling opportunities to transform essential services and boost economic recovery in the Great Reset, see the accompanying Compendium of Use Cases that can be found [here](#).

1

Assessing opportunities for 5G in the new normal

Restrictions and risks in the new normal

The new normal has been typified by virus anxiety, social distancing and cities placed under multiple lockdowns as countries grapple with recurring waves. Until there are effective and widely available

vaccines for COVID-19, countries will need to implement social-distancing measures, which can create bottlenecks in healthcare access, public transport and the need to work remotely.

The pandemic accelerates the need for 5G

As a result of the limitations associated with the lockdown in cities across the world, digitalization trends have been accelerated. When faced with no choice but to provide services digitally, even industries that traditionally lagged in digital

adoption are having to transform rapidly. The new normal represents a window to digitally upgrade certain sectors which are essential in getting societies back to work and an opportunity to reimagine the workplace.

“

The world will experience a competitiveness gap between those countries that deploy 5G and unlock productivity benefits for their enterprises, people and wider economy and those who don't.

Ed Knapp, Senior Vice-President, Chief Technology Officer, American Tower, USA

5G can be an essential enabler of this transformation, however, it cannot achieve this alone. It is a foundational technology that in combination with previous generations of networks and other connectivity technologies such as Wi-Fi 6, and emerging technologies (particularly artificial intelligence, mixed reality and edge computing) can

accelerate the search for new solutions to society's major challenges. And, its unique capabilities such as ubiquity and mobility can be of most value to those cases that require extreme mobile broadband, massive machine-type communication and ultra-low latency.

“

The immediacy and the breadth of actionable data that can be made available through 5G will enable a more resilient response to future crises. Incentivizing investments and removing barriers to accelerate deployments of 5G networks would increase data connectivity across society and enable a wide range of connected devices to ensure people and enterprises have an effective opportunity to come out of this pandemic stronger.

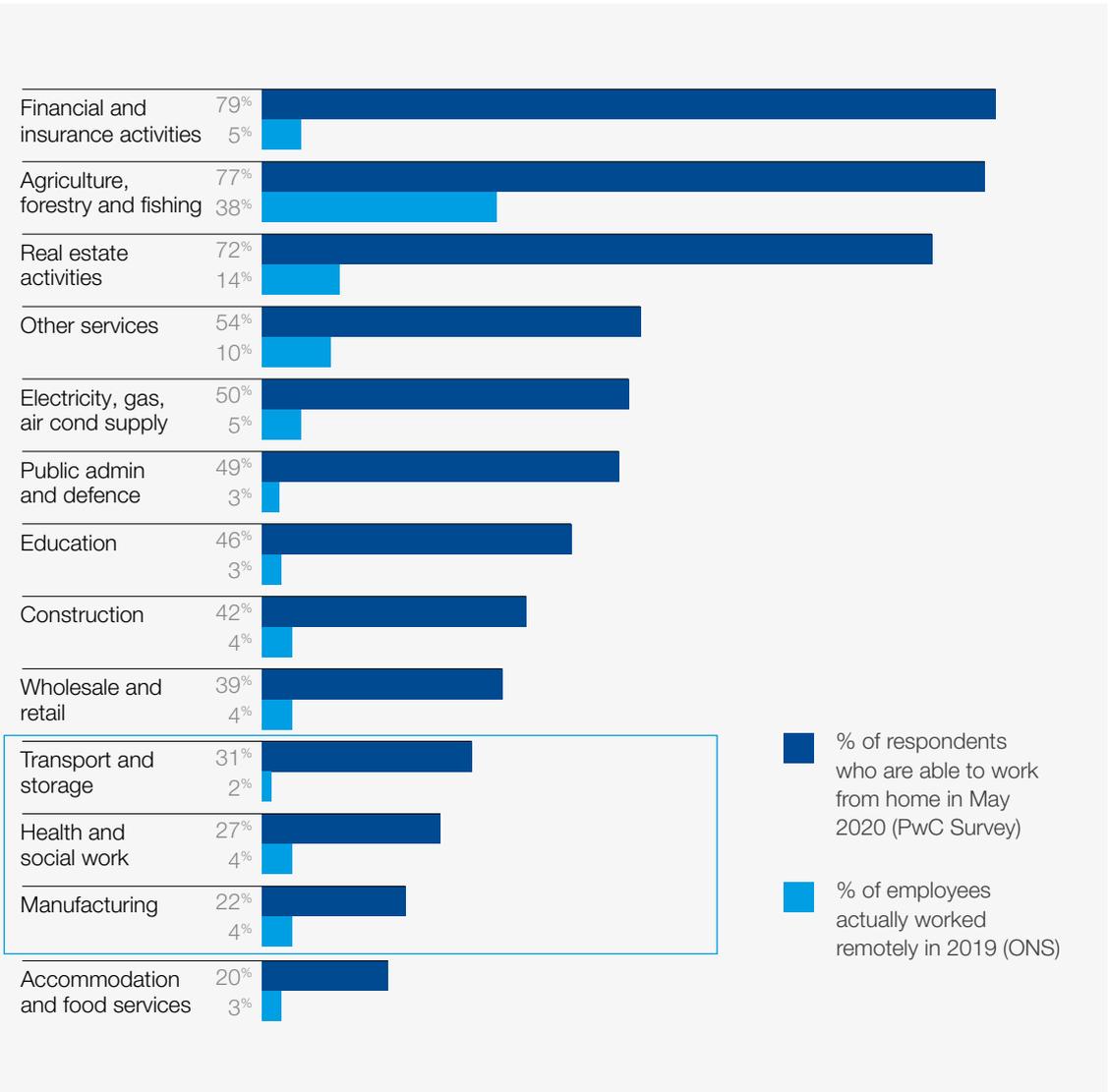
John Smee, Vice-President of Engineering, Qualcomm, USA

Focus on the essential areas for “getting back to work”

Many countries are currently grappling with the question of how to restart the economy while limiting the impact of further outbreaks. Citizens need safe access to healthcare systems and public transport and are likely to experience enduring changes in their place of work. As Figure 1 shows, the hospitality, manufacturing, healthcare and

transport sectors have experienced difficulties adjusting to remote working and in some cases unable to. This paper focuses on health and public transport as these areas are essential in enabling other parts of the economy to open. It also looks at how 5G can bring richer experiences and enhance productivity in the workplace.

FIGURE 1 Home working by sector shows relative level of risk for workers⁵



Some of the issues and opportunities highlighted are not new, but take on renewed importance in the new normal. As discussed in the recommendations, countries need to take urgent action if they want

to take advantage of the opportunities that 5G, in conjunction with other emerging technologies, can unlock for societies.

Healthcare

The problem

Even before the global pandemic, in many countries the capacity of healthcare systems to cope with ever-expanding demands as a result of increasing longevity and advances in medicine has been clearly insufficient. During the initial surge of the COVID-19 pandemic, healthcare systems around the world were forced to cancel all non-COVID-19 procedures.⁶ This has left many healthcare systems that were already constrained even more stretched. In the United Kingdom, the National Health Service (NHS) projects that there will be a historically high waiting list of 10 million incomplete elective appointments by the end of 2020.⁷

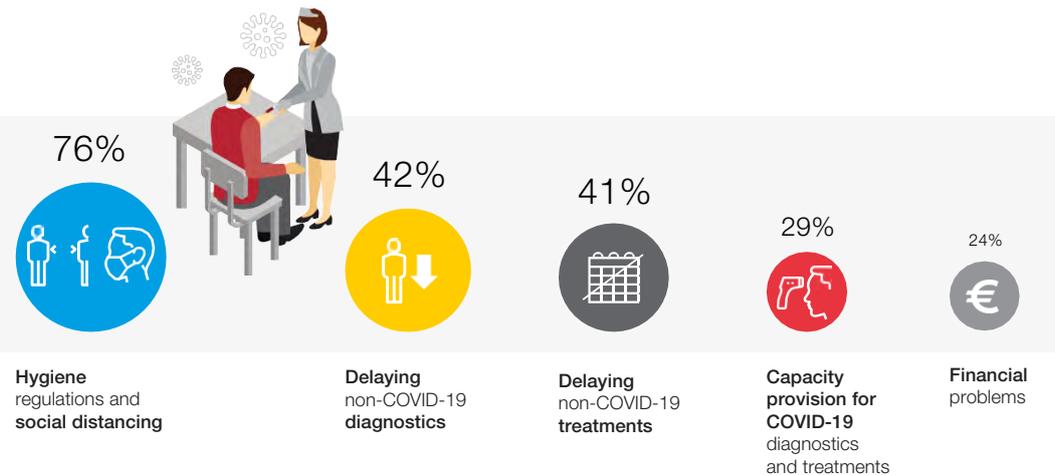
This disruption to healthcare access risks leading to the worsening of neglected chronic and acute conditions. In normal circumstances, a short-term

increase in staff performing additional shifts could reduce waiting lists over a reasonable period. However, the ongoing need for social distancing means there will be reduced capacity in hospitals (due to physical distancing between beds), staggered appointments to eliminate crowding in waiting areas, deep cleans between patients, and reduced staff capacity due to illness and being required to isolate.

In a recent survey of healthcare providers, 76% of respondents cited hygiene regulations and social distancing as a key challenge (Figure 2). The crisis has accelerated the case for using digital technologies to expand capacity under these restricted conditions. While not a new trend, several years' worth of progress in adoption and attitudes have been witnessed in just a few months.

FIGURE 2 Biggest challenges for healthcare providers during the crisis⁸

What are the biggest challenges for healthcare providers during COVID-19?



Potential opportunities

In a hospital ward in Wuhan, China at the peak of the pandemic, 12 robots moved across the floor, taking patient temperatures, delivering meals and disinfecting the facility.⁹ Healthcare workers were afforded distance from contagion and a safer ward to work in while ill patients received continuous attention. Behind this story is a 5G network deployed at a hospital site. Without the speed, reliability and quality of 5G, managing a fleet of robots to do such intricate tasks would be difficult.

5G's features could prove valuable for a range of healthcare applications – from tele-health to remote surgery, from the transferring of large medical files

to tracking patient movements inside facilities, from the use of wearables for real-time monitoring to delivering continuous treatment support to patients. In short, 5G has the potential to provide essential levels of reliable connectivity to enable a new health ecosystem and can do so at substantial scale.

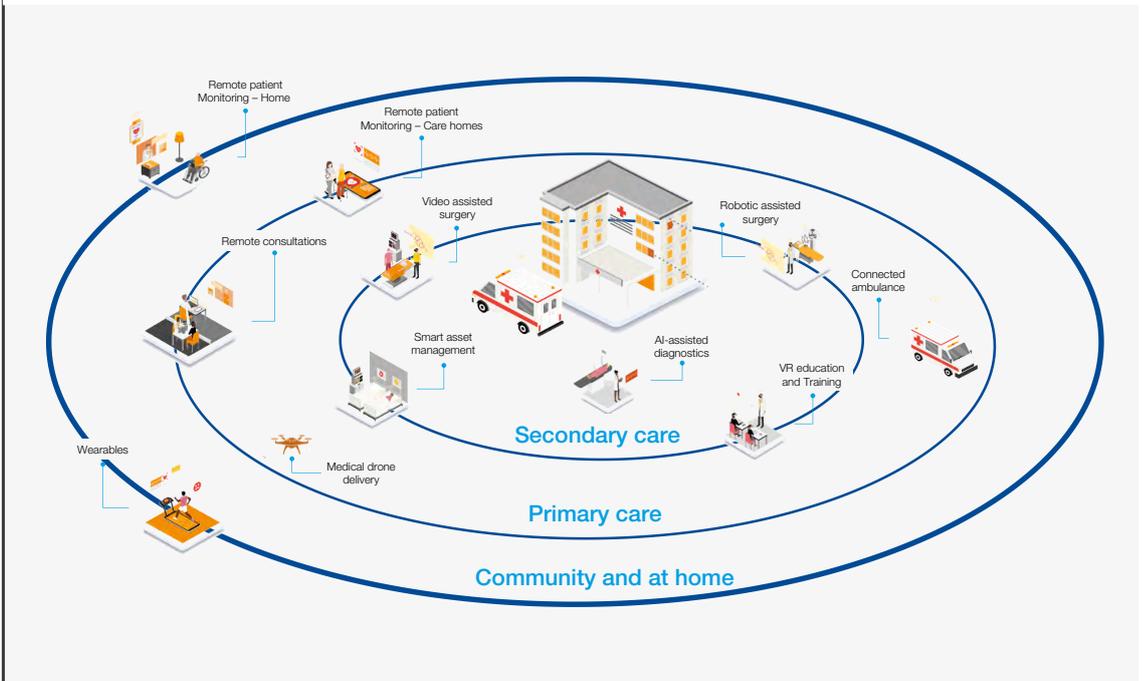
The use of mixed reality through XR technologies enabled over 5G networks can allow surgeons and other medical specialists who are currently tied to a single location to be conceivably employed by many hospitals or practices around the world. XR can also aid doctors with a wealth of information about patients and procedures in real time,

leading to better patient outcomes. Within the community, remote care can be delivered with 5G's features providing a seamless experience that can encourage mass adoption.

As illustrated in Figure 3, the potential of 5G is not restricted to only tele-consultation, diagnostics and treatment. Emergency responses can be improved through 5G connected ambulances that can send

HD video feeds of trauma wounds, scan images and perform remote diagnostics that can help to prepare the emergency room before a patient arrives. Drones can be used to deliver emergency response equipment and emergency medicines in remote areas. With faster response times we can reduce the probability of complications from trauma injuries, stroke and heart attacks and potentially reduce mortality rates.

FIGURE 3 **A 5G-enabled digital health ecosystem**



CASE STUDIES **(see accompanying compendium of use cases)**

At a smart hospital in Wuhan, China, robots stepped in to take vital signs, deliver medicines and disinfect the facility.

Pico Interactive, an AR and VR headset company, is partnering with healthcare providers to build VR solutions for mental health therapies and chronic condition management, remote monitoring and remote consultation.

**\$530
bn**

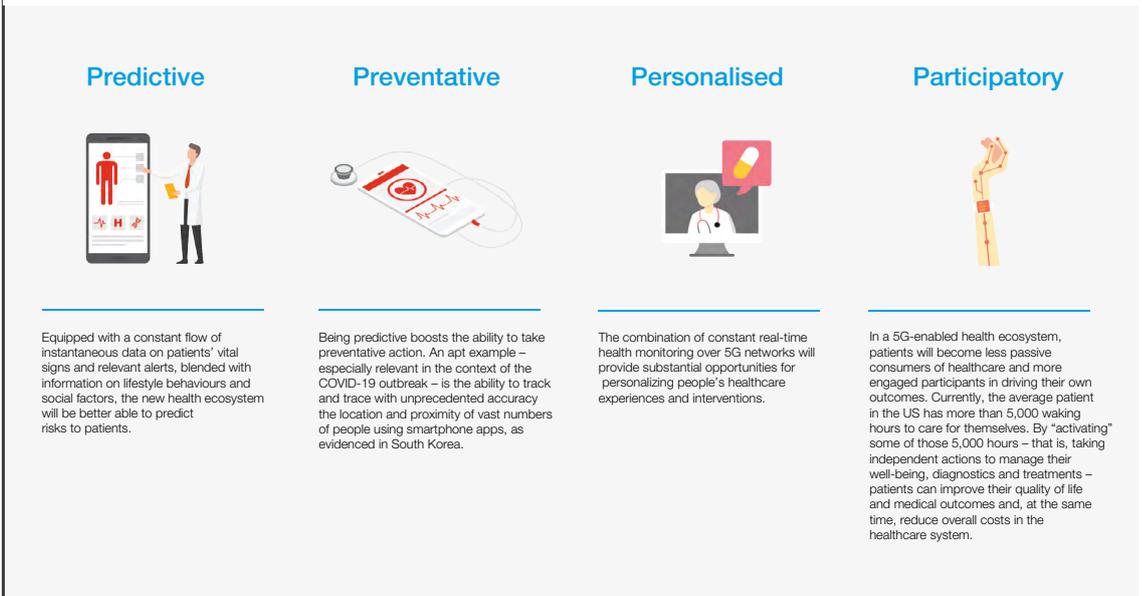
Impact and challenges

Benefit to global GDP from 5G-enabled use cases in the healthcare industry by 2030 (2019 prices)¹⁰

As hospitals deploy 5G networks and new applications are built powered by robotics, IoT and AI, a new connected and value-based healthcare ecosystem can take shape. For the first time, payers and providers can measure the benefits of

preventative measures, transforming the industry from treating sick people to one that keeps people healthy. A PwC economic study forecasts that 5G applications in healthcare will yield a \$530 billion¹¹ benefit to global GDP by 2030. This new ecosystem will have four primary characteristics: it will be predictive, preventative, personalized and participatory (see Figure 4).

FIGURE 4 Characteristics of a new health ecosystem



Among the challenges will be a need to find flexible, outcome-based commercial models for these use cases. There is also a need to modernize governance to standardize new technology-led, clinical pathways, safeguarding patients as well as doctors who might resist adopting new technology out of liability concerns. Adoption will require trials to prove the

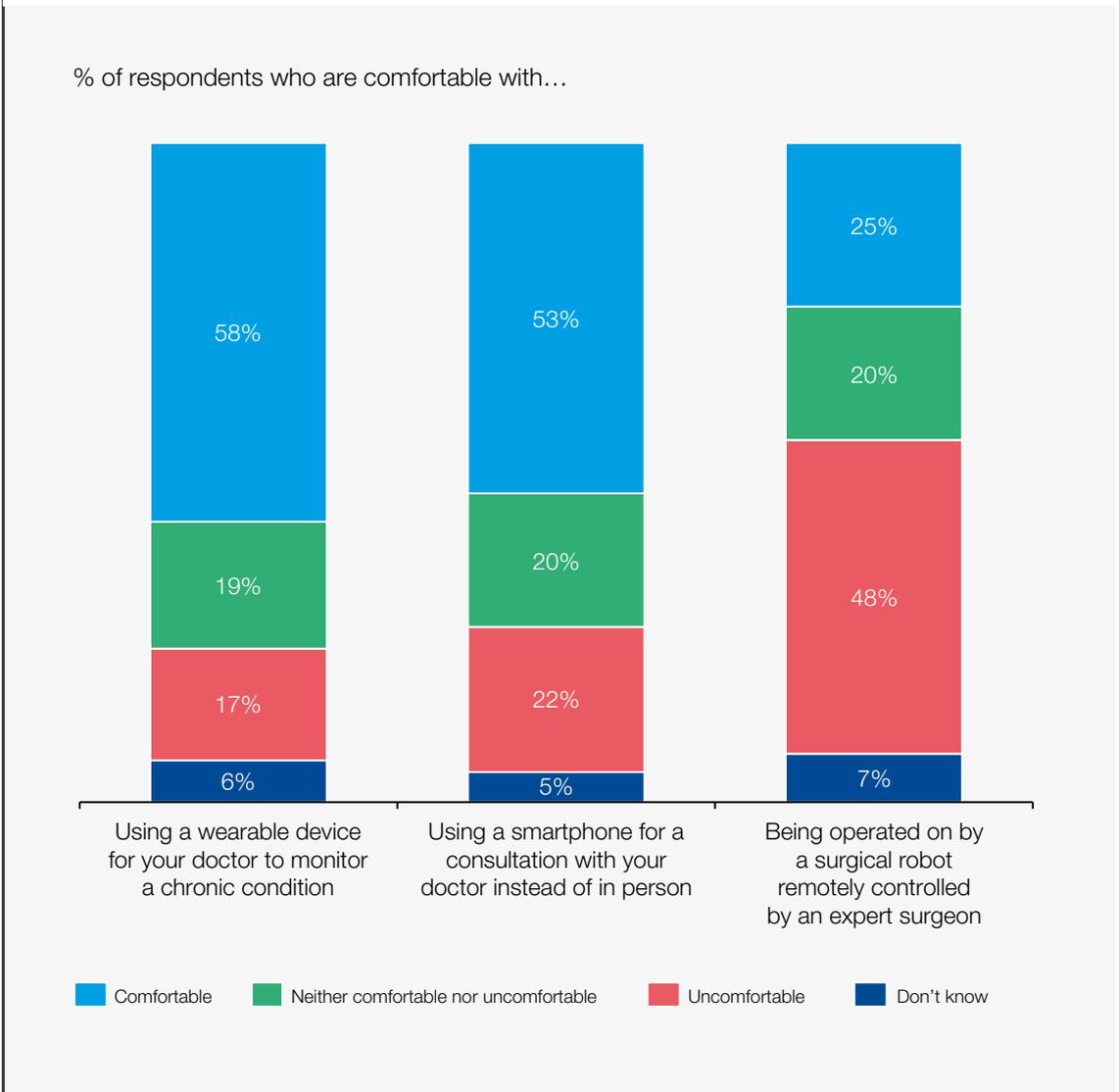
value along with education to illustrate the benefits to healthcare professionals and patients alike. Figure 5 shows that citizen comfort levels vary for different healthcare technology solutions, with remote surgery inspiring lowest levels of comfort. Finally, there are important issues to address to protect the security and privacy of patient data.



The security features of 5G alongside ability to push out the cloud to the edge will enable new digital health solutions where currently security tends to be a key barrier for healthcare providers.

Beomseok Brandon Suh, Chief Executive Officer, Lunit Inc., Republic of Korea

FIGURE 5 UK consumer levels of comfort with health tech solutions¹²



Recommended actions

To overcome these challenges, we recommend a set of proposed actions for different players in the ecosystem in Figure 6. These focus on creating more awareness of new technology in healthcare facilities, developing the regulations that create the conditions for adoption and designing outcome-linked business models for healthcare providers to

adopt these technologies. Alongside these there are three key recommended actions for governments to support the roll out of 5G: change the mindset from net-receiver to investment catalyst; standardize and simplify local permitting; and fight misinformation, increase research and awareness about 5G.



Creating a human-centric, value-based healthcare system focused on proactive and preventative health management requires a holistic revamp of the healthcare industry. We have started to build the foundation, but we need more investment, collaboration and governance coming to fruition.

Caoimhe Vallely-Gilroy, Head of Data Analytics and Strategy, Healthcare, Merck, Germany

FIGURE 6 Recommendations for ecosystem players to realize 5G opportunities in healthcare

 Actions with significant importance and urgency in the new normal – others still remain critical

| Ecosystem player | Recommended actions | Examples |
|---|--|---|
| Providers (primary, secondary and tertiary care) | <p> Each university hospital should create a medical innovation hub enabled by 5G. It would include an operational local or public 5G network, a prototyping lab, medical IoT devices and platform. The innovation hub would bring together academic researchers, medical practitioners, tech start-ups, medical device companies and network operators in order to proliferate use of 5G-enabled medical innovation. The commercial arrangements for the hub could include sharing of both seed investment, patents and eventual monetisation proceeds.</p> | <p>The Emory Healthcare Innovation Hub (EHIH) partnered with Verizon to provide 5G Ultra Wideband service to create a 5G healthcare innovation lab.</p> <p>Samsung Medical Centre (SMC) and Korea's largest telecommunications company KT Corporation have partnered to develop an innovative 5G medical service to support the development of smart hospitals.</p> |
| Payers (public health and insurance providers) | <p> Most new technology fails due to poor user adoption by nurses and clinicians. Create programmes for digital upskilling for clinicians, nurses and staff to understand the potential of and utilise relevant 5G-enabled technology, including XR, IoT, connected medical devices, etc.</p> <ul style="list-style-type: none"> Public health bodies should encourage the use of the cloud in development and delivery of new solutions as well as open API architecture platforms to enable interoperability between systems and foster collaboration. | <p>The United Kingdom's NHS Digital has launched Digital Academy, a countrywide, digital upskilling programme for hospital chief information officers.</p> <p>Denmark has created OpenTeleHealth, which encourages the development of new applications by third-party vendors.</p> |
| Governments and regulators | <p> Build pathways for fast approval and redefine clinical pathways to include use of digital tools for diagnosis, remote monitoring and treatment to provide practitioners with legal safety net for use of digital tools.</p> <ul style="list-style-type: none"> Develop security standards for connected devices, data processing equipment and always-on networks that give end users control over the data generated, stored and communicated by 5G-driven equipment and networks. | <p>FDA approved and provided guidance for use of remote communication between patients and healthcare providers.</p> <p>The German government passed the Digital Healthcare Act 2019, which states that digital health applications that meet requirements (including proof of privacy law compliance, a high level of data security and a concept for evaluation of the medical benefit of the app by an independent expert) will be covered by the German state health insurance schemes from 2020.</p> |
| Service providers (telecom operators, technology and medical devices providers) | <p> Develop new 5G-enabled business models delivered through ecosystem of partners using service contracts with payments linked to outcomes.</p> <ul style="list-style-type: none"> Operators and service providers should create solutions tailored for healthcare customers using human centred design tools to develop problem-driven solutions for practitioners, nurses and patients. | <p>Hitachi signed a 10-year contract with Salford Royal NHS trust to build a "digital command centre" on a risk-reward contract with KPMG, ExtraMed, Microsoft and CenTrak.</p> <p>Telus has developed a separate BU for its health business with tailored offerings for healthcare providers.</p> |

3

Public transport

The problem

The global lockdown has caused major changes in commuting and other types of urban travel, with many people working from home. Key workers including those on the clinical frontline or people with jobs that cannot be done remotely still need to commute. Only 21% of the respondents to a UK consumer survey¹³ said they would feel comfortable using public transport to go to work in the current climate with many preferring private car use. It is evident that these changes will have lasting repercussions as businesses rethink ways of working, distributed between home and the workplace. In this scenario, public transport operators face the important challenge of redesigning their services with greater flexibility to respond to the expected behavioural changes of the coming months and years. The main challenges facing public transport systems are:

- Delivering services in compliance with government requirements (e.g. social distancing, reduced load factor, etc.)
- Implementing solutions that increase public confidence in transport systems
- Ensuring a gradual recovery in the financial position of public transportation services by optimizing costs and improving efficiency in the management of passenger flows and fleet utilization

These challenges are occurring in the context of government budgets facing a twin dilemma: a huge call on capital for new transport construction, and a tail of operating deficits almost as large.

Potential opportunities

In many large metropolitan areas, public transport is the main option to travel for work or leisure. There is a need to rethink public transport to ensure

it is safe, to forecast passenger flow and crowd management, and to provide real-time data for travelers to switch between modes of transport.



We are already seeing transport operators trial the use of cellular technologies for safer commuting including data analytics solutions to monitor crowding and social distancing. With 5G we expect to see these technologies used at large scale to enhance customer experience.

Justin Berger, Chief Strategy Officer, BAI Communications, Australia

One of the opportunities is proximity and capacity management in transport hubs like trains and airports (see Figures 7 and 8). With the ability to use Bluetooth capabilities on phones, 5G-connected CCTV to monitor crowds and beacon technology to manage load factors on carriages, the safety and comfort of passengers will be enhanced while transport operations are optimized. 5G-enabled transport systems will make the transfer and processing of large amounts of passenger flow data in multiple locations more reliable, efficient and secure.

Algorithms can be used to predict social-distancing pinch points in the system and to allow operators to adjust schedules and capacity and for the dynamic routing of crowds through stations. Passengers can have access to real-time information about crowding to enable them to switch their route or time of travel. This can be coupled with the ability to book seats on trains in peak times. By combining real-time usage data across multiple modes, passengers can be empowered to make multi-modal journeys and encouraged towards more sustainable methods of travel.

FIGURE 7 Train station scenario

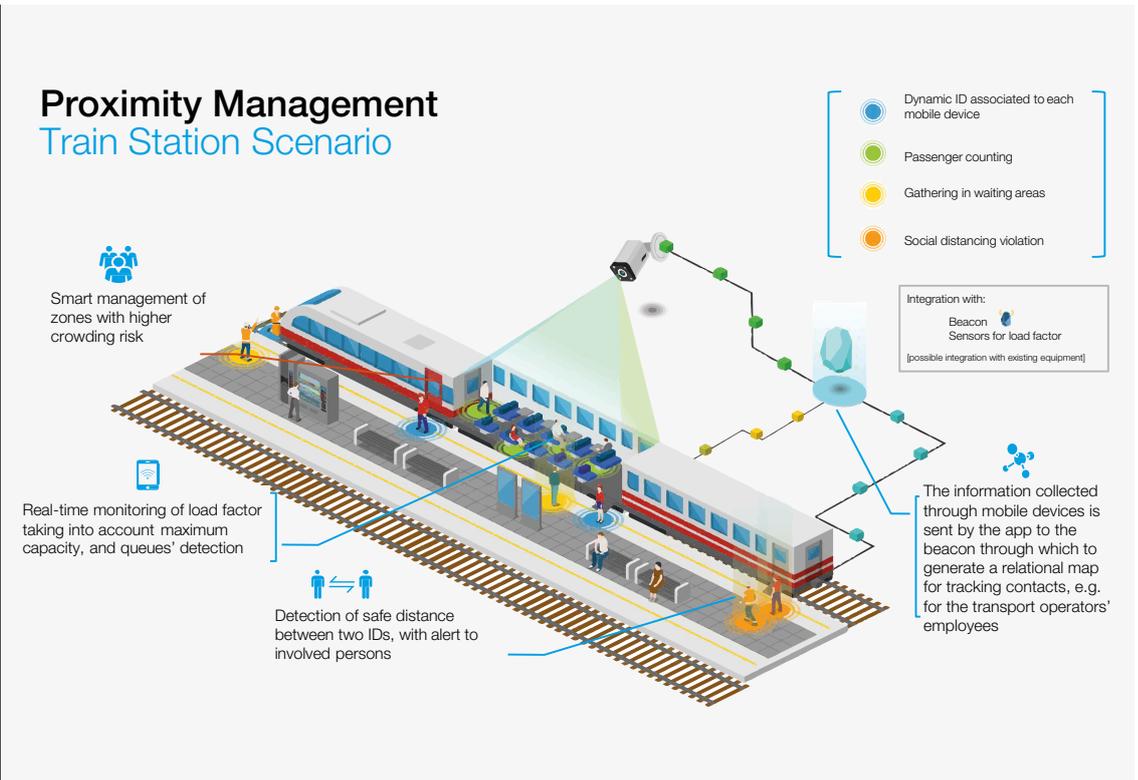
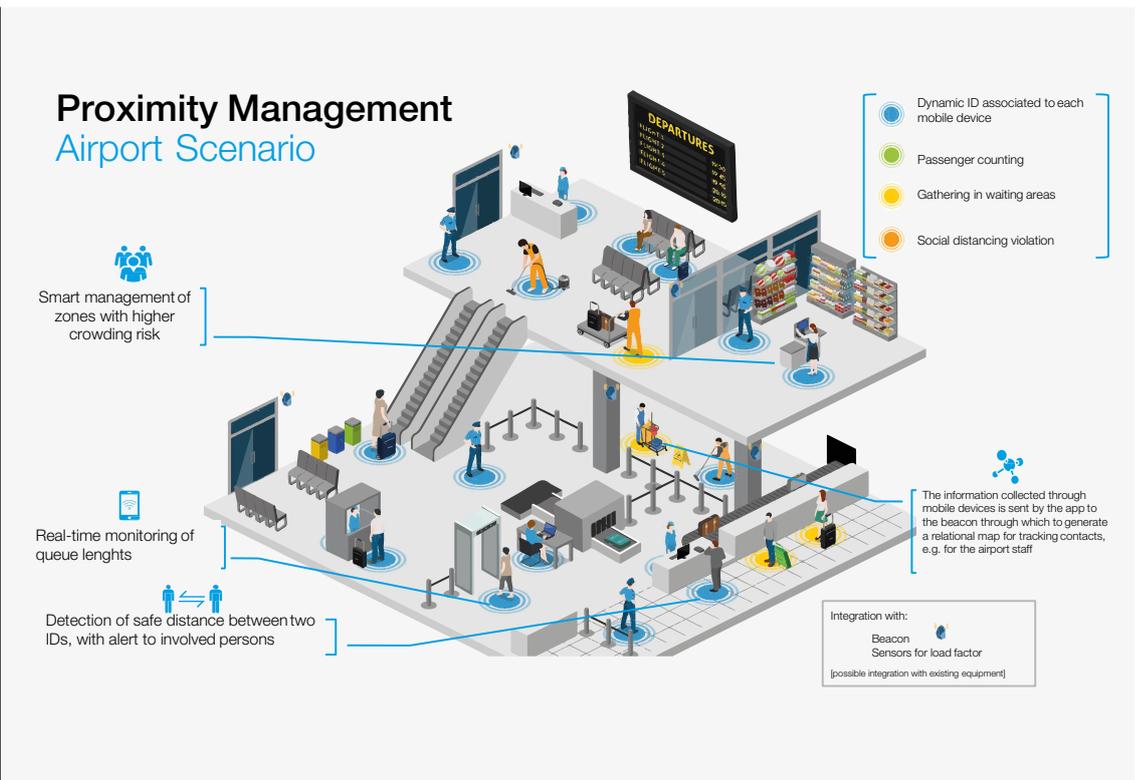


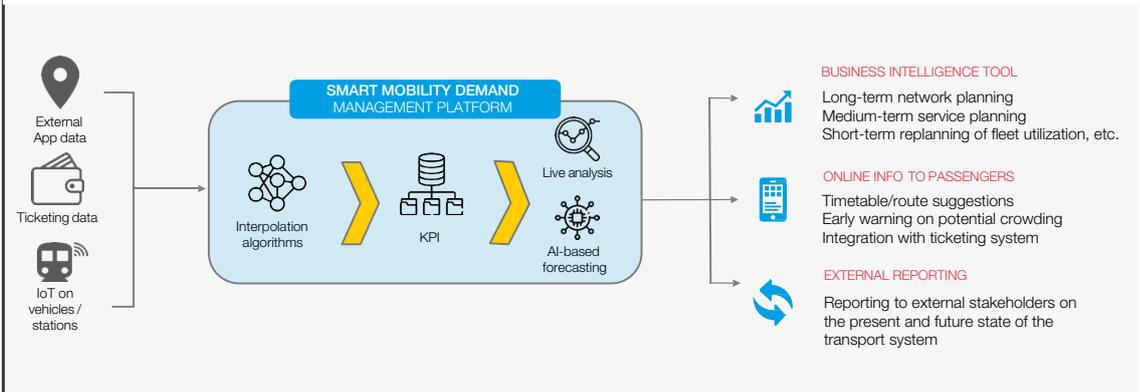
FIGURE 8 Airport scenario



In a recent UK consumer survey, 50% of respondents said they were willing to stagger their travel to work time if given the opportunity.¹⁴ However, for this to be managed efficiently, a smart mobility demand management platform (see Figure 9) is needed to provide transport operators with data such as load factors and numbers

of passengers embarking or disembarking at a station. The multitude of sources that will collect data across a system including cameras, access gates, sensors and apps, alongside the need for near real-time, AI-assisted processing of images and geolocation data lend themselves to a 5G connectivity solution.

FIGURE 9 Smart mobility demand management platform



“ Governments should see the pandemic as an opportunity to modernize our nation’s transportation and 5G infrastructure that is fundamental to deploying the autonomous revolution of the future. In the short term, this will improve air quality, relieve congested areas and ensure that people receive critical goods and services in a safe, timely manner.

Maha Achour, Chief Executive Officer, Metawave, USA

Looking beyond public transport to private vehicles, in China, a system of telematic tracking has been extended to cars to prevent spread of infection from an area of recent outbreak to areas with no cases by assigning digital IDs to cars.¹⁵ This is possible through upgrading of infrastructure that enables V2X communication both between moving vehicles (either private or public such as buses), but also between infrastructure and city administrators to report on congestion,

crowds and air quality. This V2X infrastructure can provide city administrators with data to plan city commuter routes in a way that ensures safety but also manages pollution levels in busy city centers. Furthermore, cities could deploy drones using 5G-connected cameras to monitor highways, railway tracks and public infrastructure to identify issues that could be addressed through preventative maintenance thereby reducing failure rates and O&M costs.

“ Current cellular technologies mean that live streaming and video feedback for drones is often pixelated or even not available at all; 100% coverage and high speeds guaranteed by 5G can help unlock many drone use cases not seen deployed commercially today.

Tom Plümmer, Co-Founder and Chief Executive Officer, Wingcopter, Germany

CASE STUDY (see accompanying compendium of use cases)

OpenSpace installs real-time passenger movement systems to monitor passengers and ensure that COVID-19 social-distancing guidance is being adhered to at St Pancras Station in London.

BAI communications is trialing the use of smart sensors for crowd control in Toronto on platforms and within carriages to ensure social-distancing rules are being met.

\$130
bn

Impact and challenges

Benefit to global GDP from 5G-enabled use cases in the transport and logistics sector by 2030 (2019 prices)¹⁶

For transport operators the benefits are twofold. First, the insights generated by a smart mobility demand management platform can enable a range of services that address the funding gap, created

from the dramatic reduction in demand, while supporting a more efficient, safer and smarter mobility system. Second, there are efficiency gains for operations through predictive maintenance of tracks and trains, robotic surveying of infrastructure, improved asset reliability and dynamic train routings.



COVID-19 has been a proof point for 5G technology and the value it brings to society. We now need more focus and innovative business models to accelerate the development of 5G smart cities and a fully connected, intelligent world.

Ray Williamson, Director of Product Management, Huawei Technologies, People's Republic of China

As with most large-scale transformations, there are challenges in making this vision a reality. Public transport is not dissimilar to healthcare in having some institutional conservatism when it comes to innovation. Importantly, as a key public service, there is a need to actively manage public safety and opinion. In addition, transport authorities traditionally

have an investment horizon of 10-15 years, require bespoke solutions and have a shortage of funds for capital investment. Lastly, tracking data of passengers, using video analytics and connecting critical infrastructure to the internet presents privacy and security challenges that require a debate at a national level and action at local authority level.



The industrialization of the internet through 5G presents a large opportunity but also opens up countries, enterprises and individuals to new security threats. We need leadership at the global and local level on cyber norms and incentives for local authorities and enterprises to prioritize cybersecurity.

Robert Lee, Chief Executive Officer, Dragos, USA

Recommended actions

Realizing this vision requires governments to take action to secure the future of many public transport operators as they face a historic decline in ridership, increasing deficits and calls for large capital investment. The following table (see Figure 10) provides recommendations for different ecosystem players, focusing mainly on creating the right conditions for operators to invest in 5G

and associated technologies. These should be considered alongside three key recommended actions for governments to support the roll-out of 5G: change the mindset from net-receiver to investment catalyst; standardize and simplify local permitting; and fight misinformation, increase research and awareness about 5G.

FIGURE 10 Recommendations for ecosystem players to realize 5G opportunities in public transport

 Actions with significant importance and urgency in the new normal – others still remain critical

| Ecosystem player | Recommended actions | Examples |
|---|--|---|
| Infrastructure operators (train, rail, bus, airport and road operators) | <ul style="list-style-type: none">  Increase ridership confidence by redesigning rider journeys to enable social distancing and multi-modal journey options using a platform approach to integrate live traffic and crowd data <ul style="list-style-type: none">  Implement programmes to digitize operations, e.g. predictive maintenance of infrastructure through mass industrial IoT, machine learning and digital twins to reduce cost base | <p>Toronto Transport Commission trialling the use infrastructure and train maintenance through use of AI technologies combined with Industrial IoT</p> |
| Governments and regulators | <ul style="list-style-type: none">  Create incentives and streamline procurement for transportation operators to propose 5G and other technology enabled solutions for the new normal; incentives could include matched funding, easy contract variation and tax rebates <ul style="list-style-type: none">  Leverage stimulus funding to upgrade public transport efficiency using v2x and 5G neutral hosts – to avoid duplication of network roll-outs  Set privacy and security standards for storage and sharing of data that assess crowd control through device tracking or video analytics  Provide support through either subsidies or temporary contract variation for operators to alleviate pressures of funding deficits <ul style="list-style-type: none">  Leverage stimulus funding to upgrade public transport efficiency using v2x and 5G neutral hosts – to avoid duplication of network roll-outs  Set privacy and security standards for storage and sharing of data that assess crowd control through device tracking or video analytics | <p>Israel's Transportation Ministry introduced a nationwide pilot of Mobility as a Service (MaaS) programme – with savings estimated at \$25m annually</p> <p>The Department for Digital, Culture, Media & Sport's (DCMS) in the UK has created a 5G rail testbed at the Rail Innovation & Development Centre and is part of government's £740 million National Productivity Investment Fund (NPIF) activities, to support the next generation of digital infrastructure, including 5G and full fibre broadband</p> <p>City of Dublin launched a project to work with a neutral hosts to create a blueprint for deploying network infrastructure on city-owned assets</p> |
| Service providers (telecom operators, technology and equipment providers) | <ul style="list-style-type: none">  Build partnerships with transport operators to identify clear commercial opportunities and business case for 5G-enabled services through trials. <ul style="list-style-type: none">  Provide end-to-end solutions by bringing together consortia of partners who can manage contracts to reduce complexity of procuring new technologies for public transport authorities. | <p>Vodafone has set up a live 5G network in Birmingham's train station to provide high-speed connectivity to test consumer and enterprise use cases in a transport setting</p> <p>In Germany, Thales has combined with technology and connectivity partners (Vodafone) to trial driverless trains</p> |

4

Future of the workplace

The problem

The continued need for social-distancing measures mean remote working is here to stay for now, with many businesses signaling that they will adopt more flexible work policies moving forward, mixing home and office work.

The results from a recent UK consumer survey show that of those who worked from home between March and June 2020 as a result of COVID-19, 73% want more flexible workplace policies in the future.¹⁷ In a world where employees are unable to gather face-to-face for meetings or

to chat over the water cooler, there is the question of how businesses can enable effective teamwork and collaboration virtually. In the pre-COVID-19 world, many sectors relied on frequent and affordable business travel to gain access to experts and broker relationships with customers – these interactions will have to be re-imagined. And while existing employees collaborate virtually effectively, there is also the question of how to onboard and train new employees who need to rapidly assimilate their work situation.

Potential opportunities

Innovations in VR and AR could revolutionize the future of work through immersive experiences that mirror and extend real-life situations. Use cases are proliferating in the delivery of consistent onboarding and training remotely and at scale. VR enables training where it is either not safe or not practical to do so in person. For example, VR is being used to give training of real-life situations where

there are limits on the number of in situ observers. VR-enabled workshops and meetings, bringing colleagues and customers together to interact in a single virtual space from multiple locations. Maintenance and repair of industrial machinery and processes can be made more efficient using an AR interface to guide the engineer and highlight parts in need of attention.



The real value of 5G in the near term will be amplified as more decisions are made in real-time leveraging video analytics.

Steven Carlini, Vice-President, Innovation and Data Center, Schneider Electric, France

The use of digital twins, combined with advanced IoT, analytics and edge computing technologies can allow manufacturers to assess performance, manage production schedules, maintain supplies and orchestrate all the activities on the factory floor

remotely. This can also provide the added flexibility to change production lines to produce goods needed in an emergency as many manufacturers in Europe and North America did in the early part of the pandemic.



At Bosch, we are making a long-term bet on 5G because we believe that to address future crises, we need highly flexible and automated manufacturing facilities. This will allow us to more rapidly adapt to changing conditions and market needs.

Andreas Mueller, Head of Communication and Network Technology, Bosch, Germany

CASE STUDY

(see accompanying compendium of use cases)

ABB's engineers guide local technicians in their factories globally with 4K video and VR goggles.

Oculus is prototyping Facebook hardware and software on VR headsets for future of work use cases.

\$570
bn

Impact and challenges

GDP contribution of AR and VR to the economy by 2030 globally¹⁸

Extended reality drives financial benefits through cost-savings, lower failure rates and improved efficiency. It also has positive impacts on carbon emissions from reduced travelling and on the scalability of skills globally. In the short term, XR use cases in the workplace can enhance the experience of teams who are now having to collaborate,

onboard and train at distance. In the medium term, the impact could be transformational, bringing to life an internet of skills where access to expertise is no longer location dependent. AR, VR, haptics and other technologies will benefit from 5G's low latency, high bandwidth and high reliability. A 2019 PwC report forecasts that AR and VR applications will contribute \$570 billion by 2030.¹⁹



With a combination of Industrial IoT, cloud and mixed reality, we are creating 'experts in the cloud' which allow expert engineers to provide expert guidance for repairs for complex machinery globally.

Christopher Ganz, Group Vice-President, Service Research and Development, ABB, Switzerland

5G networks combined with XR can ultimately enable a "virtually there" workplace experience, especially in those use cases which are outdoors or used on the move. This transformation could have implications for labour markets which may, for example, lead to previously permanent roles pivoting to "gig" type roles with specialists working remotely with multiple companies. Agile scrum sessions could turn virtual with collaboration experiences transformed from two-dimensional interactions to a virtual physical experience.

XR's use in the delivery of safety training can provide realistic virtual situations to better equip users to deal with hazards at work where previously

they would have only engaged with crisis scenarios in a theoretical setting.²⁰ They can also contribute to mental well-being and positive engagement for the workforce. XR applications can ensure that when employees can work from anywhere they can be better engaged, but also able to switch off without having to physically travel to and from work.

5G-enabled XR can lead to a multitude of experiential and productivity enhancing tools for employers to hire the talent they need, train and retain and keep them engaged, but there are a number of challenges in getting to mass adoption of these tools.



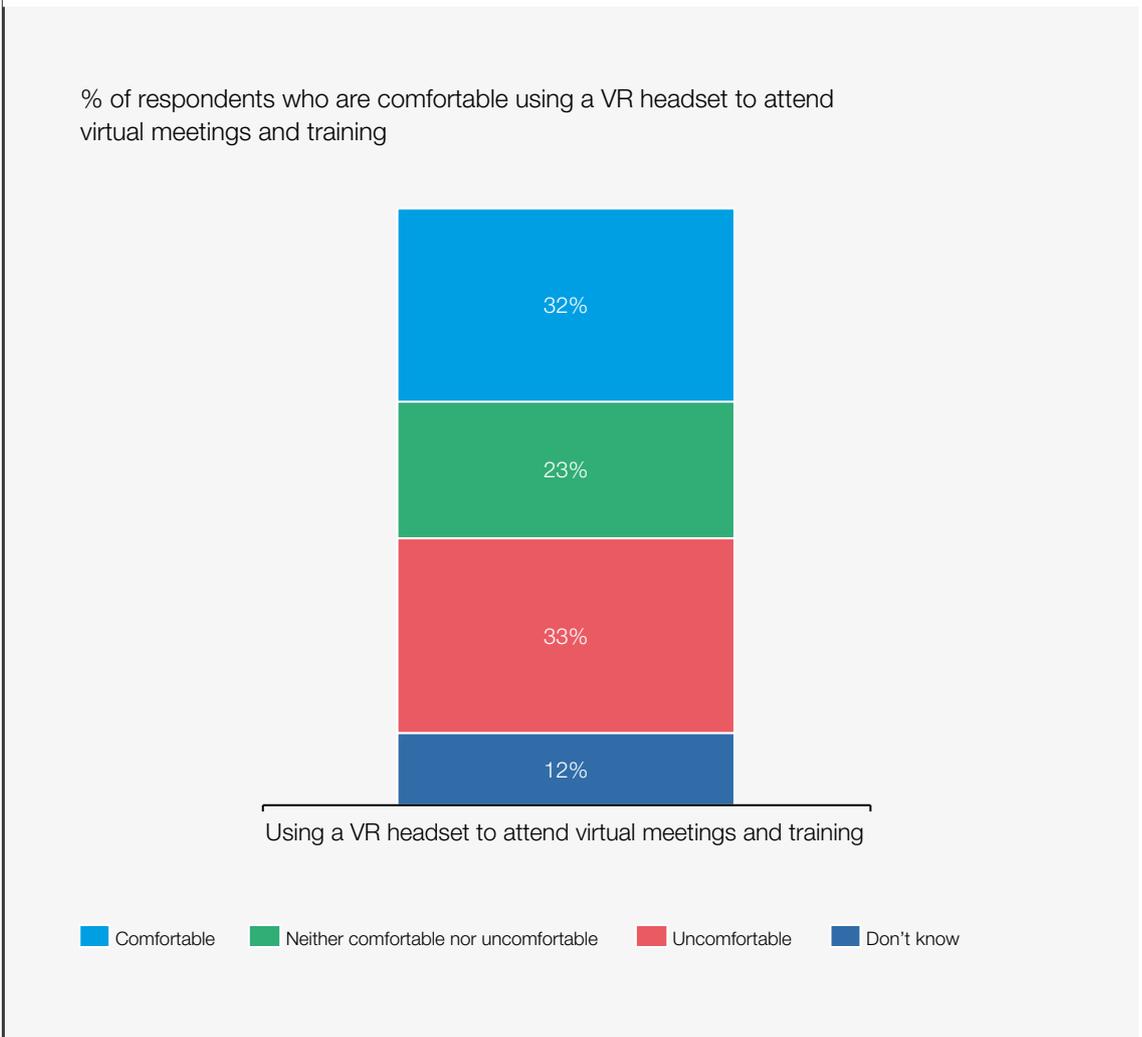
While still in its infancy, VR and AR adoption has been growing rapidly with the pandemic a key catalyst. However, user experience and economics remain key challenges which we see the future of 5G and edge computing can help resolve.

Leland Hedges, General Manager, Pico Interactive Europe, Spain

Widespread adoption will require the development of a broader ecosystem of XR developers across both hardware and software. Many of today's VR headsets perform processing in-device, making them heavy, and uncomfortable to wear. The establishment of edge computing connected over 5G and fibre networks will mean that processing is no longer in-device, thereby improving the device user experience and affordability.

A second challenge is the need to educate users about the technology from a consumer and enterprise perspective. The results of a UK consumer survey indicate neutrality towards VR workplace solutions (see Figure 11), requiring efforts in building awareness to drive adoption.²¹

FIGURE 11 | Percentage of respondents who are comfortable using a VR headset to attend virtual meetings and training



Recommended actions

There are specific actions for enterprises, governments and service providers (operators, OEM providers, AR/VR players) to address the key challenges. The following table (see Figure 11) provides recommendations for different ecosystem players. Without these actions being in some way synchronized between ecosystem players, there

may be delays. These should be seen alongside three key recommended actions for governments to support the roll-out of 5G: change the mindset from net-receiver to investment catalyst; standardize and simplify local permitting; and fight misinformation, increase research and awareness about 5G.

FIGURE 12

Recommendations for ecosystem players to realize 5G opportunities in the workplace


 Actions with significant importance and urgency in the new normal – others still remain critical

| Ecosystem player | Recommended actions | Examples |
|---|--|---|
| Enterprises | <ul style="list-style-type: none">  Initiate XR working programmes using the following steps: <ul style="list-style-type: none"> • Identify and assess hardware and software partners • Prepare a logistics system • Run a pilot programme • Assess the entire UX journey and create your own virtual spaces • Maintain high standard of hardware hygiene • Budget for investment  Assess and fulfil the technology needs for remote working, including connectivity, devices and access to cloud-based applications | <p>ABB is deploying VR programmes for its engineers in response to COVID-19 to inspect complex machinery</p> <p>IKEA uses VR technology for training its employees on HR topics and for new employees as onboarding to learn about IKEA</p> |
| Governments and regulators | <ul style="list-style-type: none">  Incentivize development of emerging technology ecosystems, e.g. through applying AI, IoT and XR through loans, grants, funds and specialist public-private bodies that promote the technology, conduct industry events, discuss issues, provide funding and provide directory of suppliers <ul style="list-style-type: none"> • Design policy and standards for access to license spectrum bands for end users (requiring a 5G network) or sharing with network operators (applying to regulator to use operator's unused spectrum) | <p>UK government has launched Immerse UK to promote immersive technologies including AR and VR by running events, directory of suppliers, funding and knowledge sharing</p> <p>The Bundesnetzagentur – the regulatory authority responsible for frequency allocation in Germany – allows companies to obtain licenses for their private use. The US, UK and France all allow end users to license 5G spectrum</p> |
| Service providers (telecom operators, technology, OEMs and AR/VR providers) | <ul style="list-style-type: none"> • Keep updated on upcoming legislation and funding opportunities, engage with industry networking groups, and look to join lobby groups where possible to influence decision-making • The XR ecosystem should collaborate as the mobile ecosystem has done with 3GPP to develop a global standard operating system for XR devices and developers • Telecom operators and other ecosystem players should develop B2B2X business models to establish the best go-to market approach and commercial propositions to bring new solutions for the workplace with an emphasis on collaboration | <p>Key mobile equipment players like Huawei, Qualcomm, Ericsson and Nokia work closely with 3GPP to create standards for mobile ecosystem</p> |

Conclusion

5G as a key component of the Great Reset

Our collective experiences globally have shown that despite entire nations being locked down at home, we have continued to work, coordinate health responses, pass important legislation for stimulus and keep essential services running. Without the existing digital backbone of connectivity, the cloud and applications, this would have not been possible. Despite this, the aftermath of those strict lockdowns has also shown that the value created

in the digital economy is not evenly distributed, with many businesses and citizens left out and some now on the brink. There is an urgent need to use 5G-enabled technologies to accelerate a broader distribution of economic resilience as well as creating significantly greater access to healthcare and safe and efficient means for urban populations to move around.



5G will be the enabler of a resilient and human centric world, which will help support industries as we come out of the crisis caused by the pandemic.

Fotis Karonis, Chief Technology Innovation Officer, BT Enterprise, BT Group, United Kingdom

So, as countries face increasing unemployment, potential business bankruptcies and stretched public purses, it is imperative that governments create conditions conducive to economic recovery. 5G is a key enabler for the digital transformation of industries, providing hundreds of use cases that citizens and enterprises can benefit from. It has the

potential to be to the Fourth Industrial Revolution what the railways were to the First Industrial Revolution and Second Industrial Revolution. A PwC study of the economic impact of the most impactful cases across industries forecasts that 5G can contribute \$350 billion by 2025 to global GDP,²² rising to \$1.3 trillion by 2030.



Through our five different enterprise innovation labs - oil & gas, manufacturing, automotive, agriculture and food production - we are seeing the transformative power of 5G in creating new value pools.

Jacob Groote, Executive Vice-President, 5G, KPN, Netherlands

5G – A potential source of economic stimulus

The immediacy of the threat that COVID-19 has placed on healthcare and transportation systems and the looming economic crisis necessitates the global community to act now. 5G investment, as a central pillar of a wider digital investment programme, presents a viable way to contribute to economic stimulus, especially when it is targeted at addressing impediments to sustainable economic growth. Through targeted deployments, 5G will create value for economies and has transformative power for the way health, travel and work are accessed. Those countries and companies that invest early will likely create competitive advantages over those who wait.

There are three overarching actions for governments to take in order to accelerate the roll-out of 5G:

- 1. Change of mindset from net-receiver to investment catalyst:** Traditionally governments have viewed the mobile telecoms sector as a source of capital funds from the auctioning of spectrum. As we move, spurred by the global health emergency, into an era in which ubiquitous ultra-fast connectivity is as important – if not more important – for economic resilience and growth than other types of infrastructure such as roads and airports, there is the opportunity to reassess this approach. Would awarding spectrum based on 5G coverage commitments, speed of deployment and network quality be more impactful to catalysing a country's economic growth than raising a few billions from auctions? Could rolling out 5G networks in areas that are unlikely to be reached by fiber in the short-to-medium term prevent an

increase in the digital divide that will otherwise result from the combination of COVID-19 plus an economic recession?

2. Standardize and simplify local permitting rules and regulations:

Governments should pursue the harmonization and coordination of national and local government rules and permitting processes to ensure complex processes for permitting new sites for roll-out or densification of networks are made as streamlined and efficient as possible with a harmonized approach to environmental considerations.

3. Fight misinformation, increase research and awareness about 5G:

In some countries during the pandemic, misinformation campaigns propagating conspiracy theories about 5G resulted in 5G masts being set on fire and some field engineers being threatened. For 5G and associated technologies to be part of the solution rather than being perceived as a problem, governments should launch public information campaigns, require newspaper

and social media sites to fact-check and commission studies of the long-term impacts of 5G on health and society to build trust in 5G networks and services. This is pivotal in shaping the narrative that has been shrouded in geopolitics and conspiracy theories into one that clearly explains the positive societal and economic impact that 5G can have.

For some time, 5G has been viewed as a longer-term opportunity and left to the telecoms industry's financial fortunes to determine the timing of deployment. However, with much of the required technology now available and clear and crisis-relevant use cases identified, it is important that governments incentivize the large investments required to realize the external benefits and to increase resilience in their economies to survive further waves of COVID-19 or other crises.

In the final publication of this 5G Outlook Series, we look further into the future to explore the longer-term opportunities that 5G can bring across multiple sectors.



Contributors

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More details about the community and the activities of the 5G Global Accelerator programme can be found at: <https://www.weforum.org/projects/5g-global-accelerator>.

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