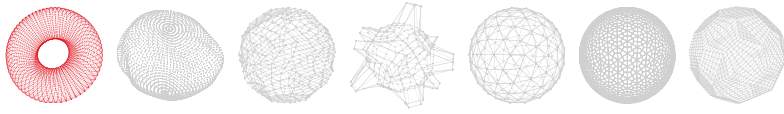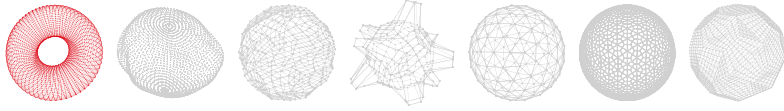# 5G and the future of customer experience

5G will drive the next wave of digital transformation across all industry sectors as enterprises reimagine their products, services, processes and digital business models for customer-centric use cases and place greater emphasis and priority on designing real time experiences well.
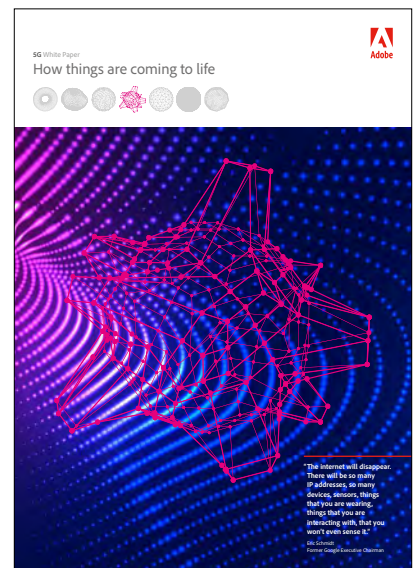
Adobe

Executive summary

The next generation of mobile wireless technology, 5G, is coming and it promises to revolutionise the way we all live and work with faster network and data speeds, greater energy efficiency, lower latency and increased bandwidths. This new generation of mobile internet technology will create a different breed of digitally enabled consumer and will represent a new era of data-generated business opportunities and trends across multiple industry sectors. Our series of six white papers take a look at some of the potential implications and challenges that the roll-out of 5G will bring for consumers and industries in the next wave of digital transformation.
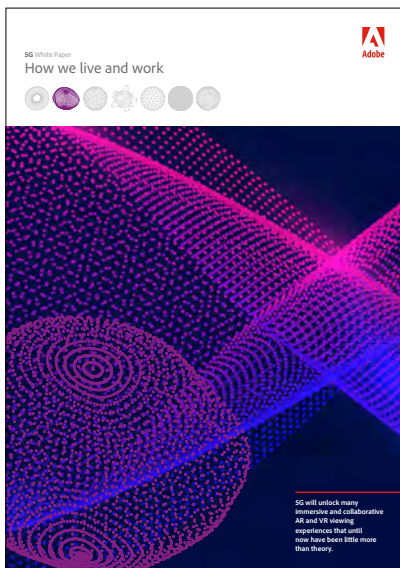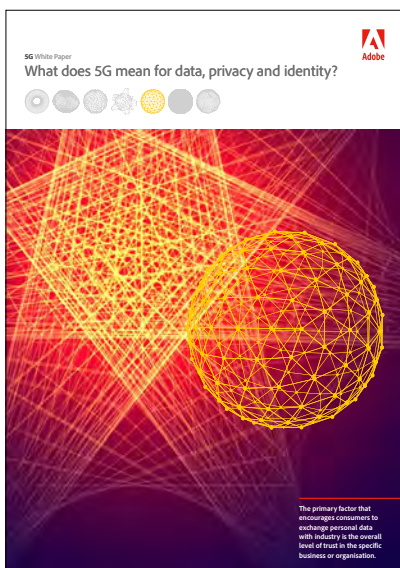

5G White Paper
How we live and work

How 5G promises to change both the way we live and the way we work as we move into an increasingly digitised future.

5G White Paper
How industries go to market

How 5G is set to revolutionise retail
How 5G is set to impact the financial sector
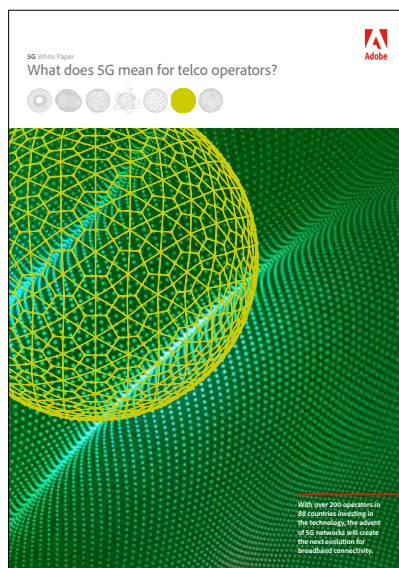How 5G will change media
Education and 5G
How can 5G support governments?

The impact of 5G will have a profound impact across many industry sectors and we look at the opportunities and challenges that this will bring.

5G White Paper
How things are coming to life

"The internet will disappear. There will be so many IP addresses, so many devices, sensors, things that you are wearing, things that you are interacting with, that you won't even sense it."
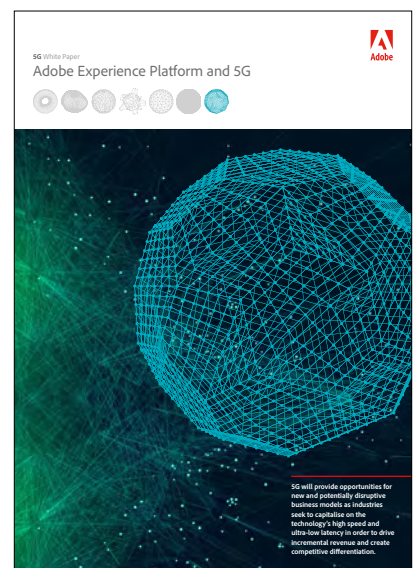Eric Schmidt
Former Google Executive Chairman

Everyday objects will become intelligent assets that can help drive greater efficiencies, increase competitiveness and develop new business models.

5G White Paper
What does 5G mean for data, privacy and identity?

The primary factor that encourages consumers to exchange personal data with industry is the overall level of trust in the specific business or organisation.

The implications that increased connectivity will have on consumer privacy and data security in an age of increased regulation.

5G White Paper
What does 5G mean for telco operators?

With over 200 operators in 88 countries investing in the technology, the advent of 5G networks will create the next evolution for broadband connectivity.

A defining moment for the telecoms industry as it navigates profound industry shifts, competitive challenges and organisational priorities.

5G White Paper
Adobe Experience Platform and 5G

5G will provide opportunities for new and potentially disruptive business models as industries seek to capitalise on the technology's high speed and ultra-low latency in order to drive incremental revenue and create competitive differentiation.

How Adobe's technology and data strategy will transform the 5G ecosystem and deliver on next generation customer experience.

5G is set to revolutionise your business – here's how

Inevitably, 5G will herald the next stage of Internet of Things (IoT) development, enabling billions of devices to be connected both to each other as well as the internet simultaneously. This will help drive productivity and efficiency in the workplace as well as create potential opportunities for companies to deploy new applications and business models.

Dramatic improvements in mobile technology will drive consumer behaviour, raising their levels of expectation of both products and services. Organisations will no longer be able to rely on legacy consumer applications and will have to anticipate new platforms and modes of interaction if they hope to survive in the 5G era.

In order to gain a competitive edge over their rivals, it will become increasingly necessary to form new alliances, often with potential competitors, and develop new services both quickly and at massive scale. Businesses will also need to deploy new technologies, such as AR (Augmented Reality) and VR (Virtual Reality) where appropriate.

Personalisation and customer experience

5G will drive the next wave of digital transformation across all industry sectors as enterprises reimagine their products, services, processes and digital business models for customer-centric use cases and place greater emphasis and priority on designing real-time experiences well to design personalised journeys around the way their customers live and use technology.

Key to success will be the ability to harness data in order to improve the customer experience and increase engagement and loyalty. Rather than data being kept in siloes as they are now, many organisations will need to overhaul their data management infrastructure, adopting common frameworks and open standards where possible. Successful execution on strategy will require industries to assess what new data management technology and infrastructure will be required to deliver on the next level of customer experience and at the same time support an expanding ecosystem of partners and channels.

Real-time consumer data will be needed to drive new levels of personalised services which will help generate incremental revenue. Artificial intelligence will further help in making the experience as useful to the individual as possible by making informed decisions in real time. For example, instead of newsletters being pushed to your email after visiting a store, brands – with your permission – will immediately understand your behaviour and preferences and be able to make suggestions via your mobile as soon as you step into a shop.

Understanding your business

In this series of white papers, we look at the potential opportunities 5G will bring to businesses to help them gain a share of its estimated £1.5 trillion market potential. Examining different industry sectors, including finance, education, media, government and retail, we consider the various factors that will drive growth in each of these areas as well as those that may limit adoption.

We also look at the growing role of IoT and how billions of devices connected to the internet will drive new services for consumers as well as improve productivity and efficiency within industry. Finally we examine how telecom operators and other suppliers are gearing up for the 5G revolution and how businesses can start to make the first steps by updating their data infrastructure with the Adobe Experience Platform.

The future certainly isn't predictable, and we can't possibly yet imagine all the opportunities that 5G will bring. However, it's likely that companies which best understand the needs and desires of their customers will be the ones which are most likely to succeed. On the other hand, those that keep their data siloed and which are unable to develop the new services desired by their customers will inevitably struggle, as will those whose culture and organisational structure is rooted in the past.

In this series of white papers, we look at the potential opportunities 5G will bring to businesses to help them gain a share of its estimated £1.5 trillion market potential.

5G is coming and businesses need to get ready for the massive changes it will bring to us all.
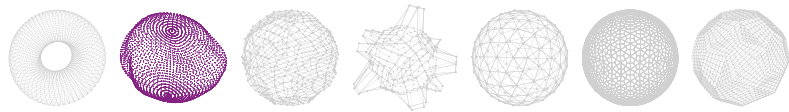
How we live and work
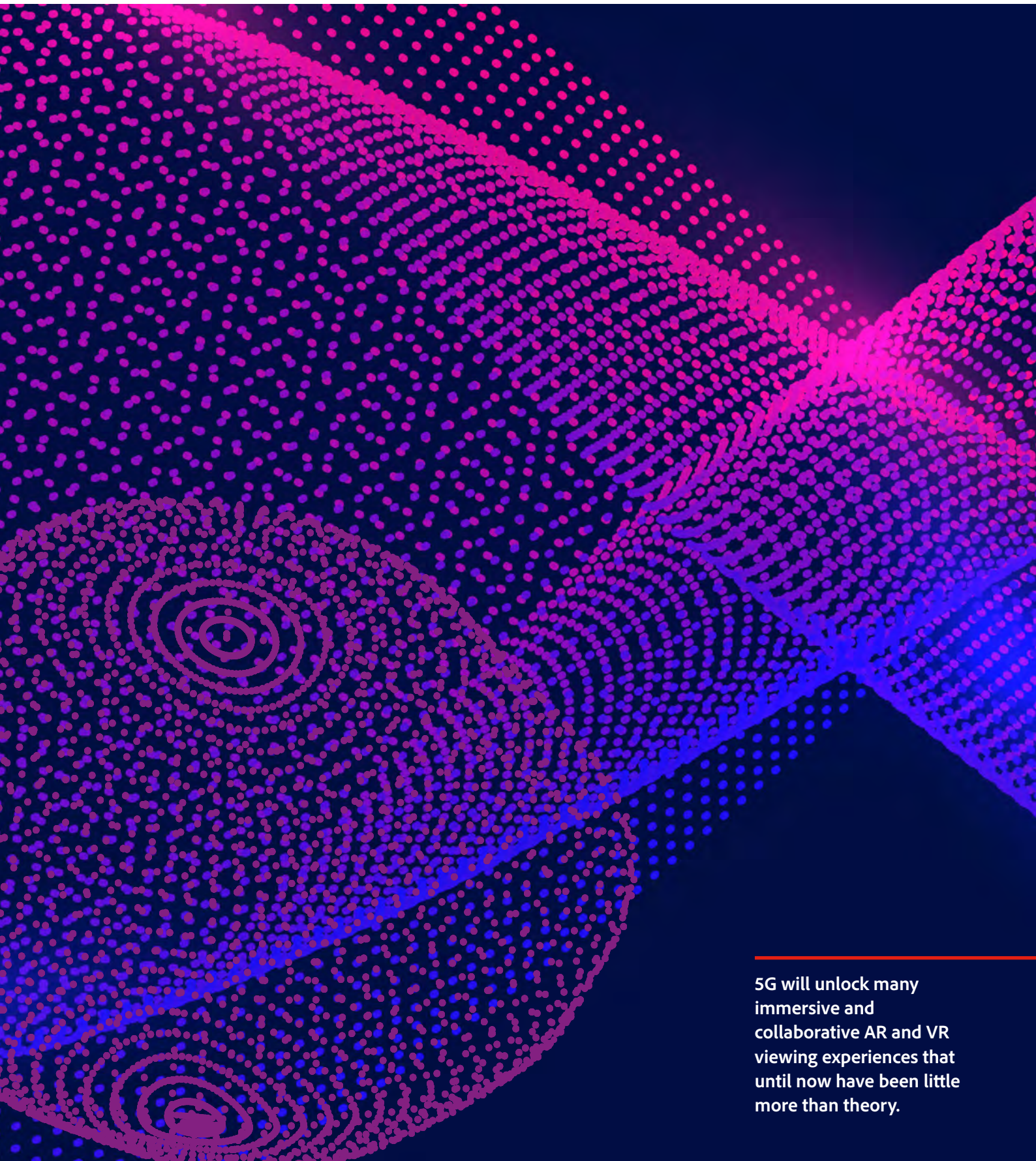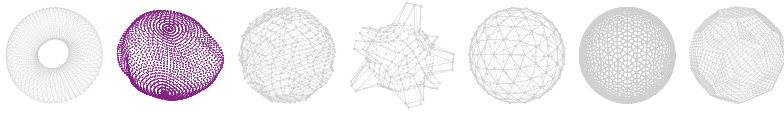
5G will unlock many immersive and collaborative AR and VR viewing experiences that until now have been little more than theory.

5G White Paper

How we live and work

Contents

How we live and work

Technology is playing an increasingly important role in all of our lives. As the COVID-19 pandemic has shown us, many of the tasks that once required face-to-face contact can now be done over the internet via a mobile phone or smart device just as efficiently.

Increasingly meetings are held via services such as Microsoft Teams or Zoom, rather than in a boardroom, while once office-based employees are finding effective ways of working from home without having to travel for hours each day to sit at a desk elsewhere (something that was necessary when consumers couldn't afford the necessary technology in their home).

However, for many businesses the COVID-19 pandemic, while devastating in the short term, has merely hastened their long-term digital transformation journey – a process that involves organisations having to change the way they work and, in many cases, the way they think in order to meet the increasing demands of the modern consumer at the same time as reducing their operational costs and operating more efficiently.

Indeed, Robotic Process Automation (RPA) and AI are becoming increasingly commonplace in industry while technology is also helping new companies to disrupt traditional industries with innovative business models, often providing new types of services directly to the consumer's smartphone.

Of course, the extent to which digital technology has permeated the business world varies widely between organisations and industry sectors. For example, banks and insurance companies already use sophisticated algorithms to determine who is likely to default on a loan or represent a bad risk while online retailers and publishers use the technology to segment their audiences and offer a more personalised experience to consumers.

Chatbots are helping companies to provide a cost-effective means of communication and support to customers for everything from mental health to information on the Coronavirus. And sophisticated AI powered, voice-controlled, supply-chain management systems such as IBM's Watson are able to predict factors that may affect sales such as a change in the weather or a transport delay.

Delivering more data

Undoubtedly at the heart of most digital technology lies data. Industry experts often refer to data as the new oil in terms of value, though inevitably much of this value lies in data scientists and data 'translators' being able to process the crude data effectively.

IDC's "Data Age 2025" whitepaper predicts that the collective sum of the world's data will grow from 33 zettabytes in 2018 to 175ZB by 2025, a compound annual growth rate of 61 percent. (For reference one zettabyte is equivalent to a trillion gigabytes). As it grows, data will continue to be stored in three main locations: traditional and cloud data centres, at the edge comprising cell towers and branch offices and at endpoints, such as smartphones, and Internet of Things (IoT) devices.

For consumers, this rapid growth in data means being able to order goods and services at the touch of a button – such as an online grocery shop – with stock updates provided in real time by IoT sensors on the factory floor. And for businesses, data means being able to make better decisions, such as up-to-date sales information rather than having to wait to receive an Excel spreadsheet with historical data.

Sum of the world's data growth

3 main storage locations

2018
33
zettabytes

61%
Annual
growth rate

2025
175
zettabytes

Traditional and
cloud data centres

Cell towers and
branch offices

Smartphones
and Internet of
Things (IoT) devices
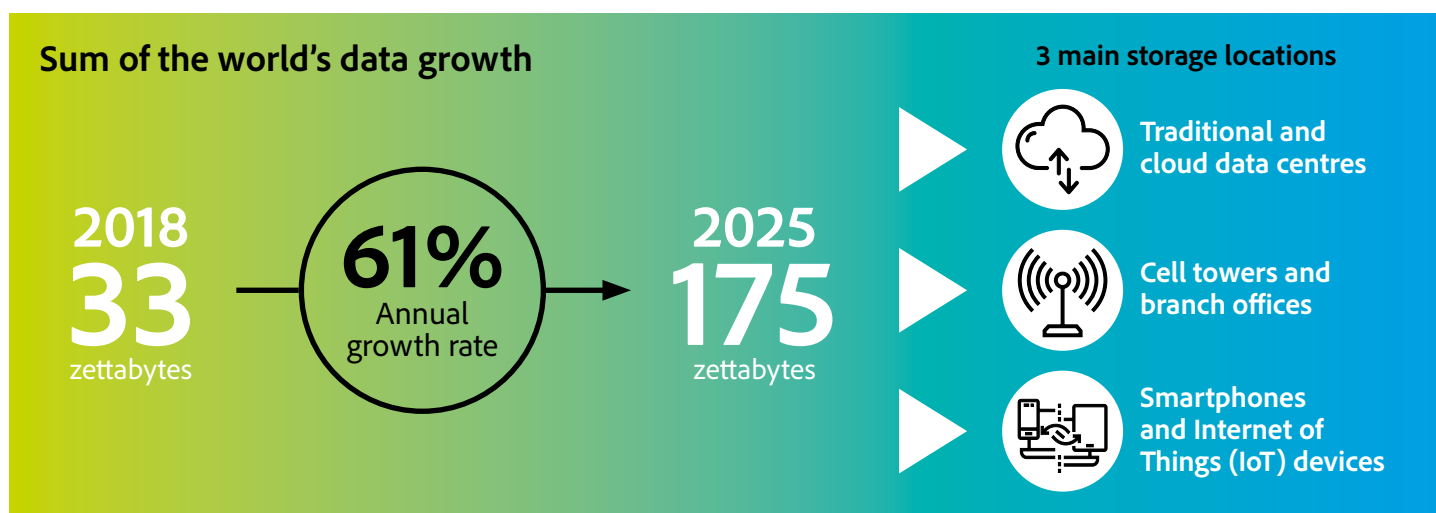
Whereas once data was 'siloed' largely in the IT department, digital transformation means it is not only put in the hands of the people within the organisation who need it most, but in a format that is likely to help them to do their job more efficiently – for example an app on their mobile phone or a bespoke smart device.

Importantly, with a data-driven operating model (DDOM), data and analytics are organised around business rather than data activities with the aim of understanding the customer's journey much better and making better decisions to deliver customer satisfaction. As a result, cross-functional teams are increasingly being deployed in organisations to deliver projects and develop new business models using 'agile' ways of working such as the Scrum framework.
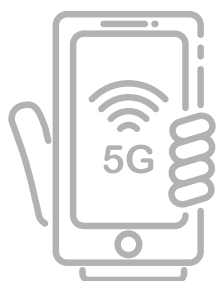
The rise of the smartphone

What's clear is that since the arrival of the first 3G phones in 2003, customers have become increasingly sophisticated in using their smart devices for consuming content and buying goods and services.

And while in the old analogue world the customer was generally loyal to a particular brand or store, the ubiquity of data means that it's now possible for consumers to move from one company to the next at the swipe of a touchscreen, depending on the service they receive.

In particular, the proliferation of apps available on the Google Play and Apple iOS stores makes it much easier than ever before for consumers to access services worldwide in a user friendly form which previously they would have been unable to. Indeed, according to Statista, as of the fourth quarter of 2019, Android users were able to choose between 2.57 million apps, making Google Play the app store with biggest number of available apps. Meanwhile, Apple's app store is the second-largest app store in the world with almost 1.84 million available apps.

But is the growth in smartphones beginning to plateau? In its _Technology, Media and Telecommunications Predictions 2020_ whitepaper Deloitte claims there are currently 3.6 billion smartphones in use globally. However, it claims that smartphone unit sales 'appear to be nearing a ceiling of 1.4–1.6 billion units per year' as the average lifetime of a new handset increases from 23.4 months in 2016 to 26.2 months in 2018.

Instead it seems that many of the future consumer opportunities for 5G may lie in new types of consumer devices such as AR glasses and in-home 5G routers replacing WiFi devices while enterprises may prove to be the largest users of the new technology, at least in the short term.

According to analysis from Counterpoint Research, 5G contributed just 1pc of global smartphone sales in 2019, although its predictions made before the COVID-19 pandemic suggest the 5G handset market may grow to 18pc this year. Counterpoint estimates that, at the end of 2019, South Korean firm Samsung had the biggest 5G market share with 43 per cent followed by Huawei (34 per cent) and LG (10 per cent).
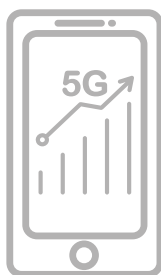
It's estimated that by 2028 each consumer of 5G will use an average of 84.4GB per month, up from just 11.7GB in 2019

Deltatre.

5G opportunities

Certainly, compared to previous generations of mobile phone technology, 5G promises to be a real game changer, especially for enterprises. That's because, in addition to offering much greater speeds than its predecessor 4G (typically around 200Mbps and up to 1Gbps, compared to download speeds up to 60Mbps for 4G), it offers many other key benefits such as much greater capacity and less latency (or lag) than 4G. Effectively this means it can connect thousands of internet-enabled devices simultaneously, from phones to IoT (Internet of Things) sensors.

Whereas with 4G there's a sizeable delay between a command being issued and a response being received (typically between 40 and 50ms) 5G can respond to a command in just 1ms. This potentially makes the technology much better suited to mission critical applications, such as autonomous vehicles where communication in real time is essential to avoid collisions.

It is also particularly useful for new types of business applications. For example, 5G's ultra-low latency will allow drones to communicate with one another for search and rescue missions. It will also allow robotic surgeons to carry out operations remotely or manufacturers to control machinery from anywhere in the world.

Increased capacity

In addition to ultra-low latency, 5G also offers greater capacity than earlier network technologies across a larger frequency spectrum. This includes higher frequencies, including 'millimetre' wave – between 30Ghz and 300Ghz.

As a result, 5G will support up 100x greater traffic capacity and network efficiency compared to 4G, enabling it to cope much more effectively with simultaneous high-demand applications. This means users can easily access data services at big events where previously it wasn't possible to get a signal.

Also by allowing communications for up to a million devices per square kilometre, 5G provides the platform needed to drive IoT connectivity both for Industry 4.0 and smart cities.

Growing media consumption

Inevitably, 5G's much lower latency, faster download speeds and higher quality video will encourage much greater levels of media consumption. According to Deltatre, by 2028 each consumer of 5G will use an average of 84.4GB per month, up from just 11.7GB in 2019.

With this growth in consumption comes proportional revenue boosts. Research from Ovum indicates that 5G will grow the global media market over cellular networks from £128 billion in 2018 to over £316 billion in 2028. Consumer spending on entertainment will also double in size over the next ten years, hitting £112 billion globally.

Importantly, 5G will open new ways for consumers to interact with media, particularly via Augmented and Virtual Reality. As 5G capacity grows, VR will have the capability to go mobile with, for example, consumers putting themselves right at the heart of the action during a sporting event. Similarly, AR experiences will be possible anytime and anywhere, regardless of how crowded the sports stadium is and how many other individuals are using the same application.

Indeed the high bandwidth of 5G makes it more cost-effective for multiple video streams to be sent over the network, enabling operators to offer multi-angle coverage in 4K and graphical overlays that update with the player in real-time.

All of these use cases and more will contribute to revenues of almost £37 billion in 2028.

Furthermore, improvements to geo-location services that help fans locate each other in larger crowds, enhanced seating and concession experiences and innovative uses of user-generated content all become achievable with fast mobile broadband speeds.
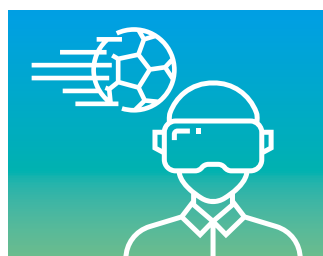
As 5G capacity grows, VR will put consumers at the heart of the action during a sporting event
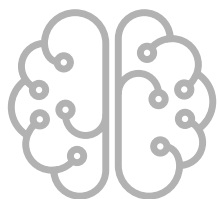
Private 5G networks

Of course it's not just the consumer experience. 5G will also be vital to enterprise. As well as public 5G networks, enterprises will start to opt for their own private 5G networks – either by purchasing their own infrastructure and contracting operational support from a mobile phone operator, or by building and maintaining their own 5G spectrum.

For organisations, one of the advantages of a private network is that it has much greater privacy and security than public 5G and will prove an ideal substitute for private wired Ethernet, wireless and LTE (4G) networks. Unlike 4G, 5G is much more effective in inhospitable locations that are full of metal and radio interference – including factories and warehouses – especially with the forthcoming release of the new standard, known as 3GPP Release 16.

According to Deloitte, more than 100 companies worldwide will have begun testing private 5G deployments by the end of 2020. And by 2024, the value of cellular mobile equipment and services for use in private networks will add up to tens of billions of dollars annually.
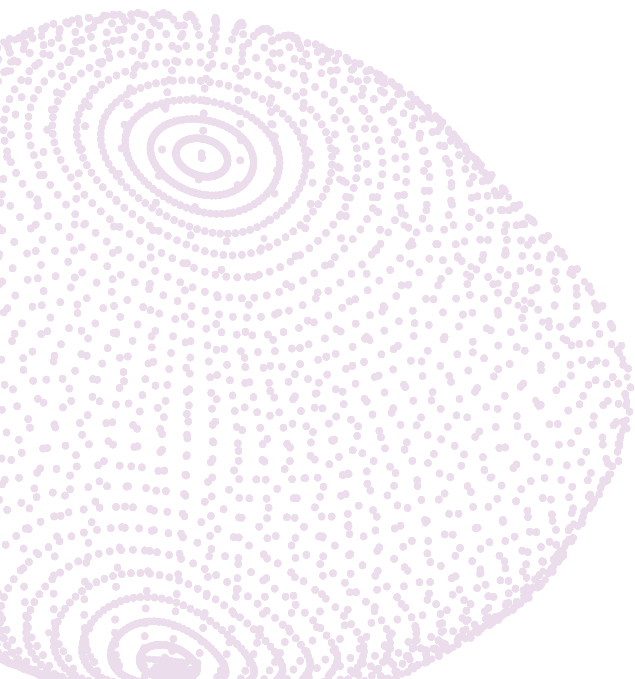
Always connected

In an increasingly data-driven world, 5G is one of a number of technologies that will drive digital transformation alongside big data, AI and machine learning. In factories, public and private 5G networks will be rolled out to improve network connectivity as well as enabling robots and drones to work alongside each other and with humans too – a phenomenon known as Industry 4.0.
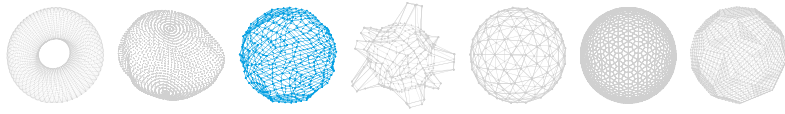
And while 5G's consumer applications may seem less clear at the moment, it's likely the technology's ultra-low latency may bring benefits such as responsive mobile gaming while its high data transfer speeds may lead to users switching from WiFi-based routers to 5G routers for streaming entertainment content. 5G will also unlock many immersive and collaborative AR and VR viewing experiences that until now have been little more than theory.

Just as previous technologies have in the past, 5G promises to change both the way we live and the way we work as we move into an increasingly digitised future.

In factories, public and private 5G networks will be rolled out to improve network connectivity as well as enabling robots and drones to work alongside each other and with humans too – a phenomenon known as Industry 4.0.

5G White Paper

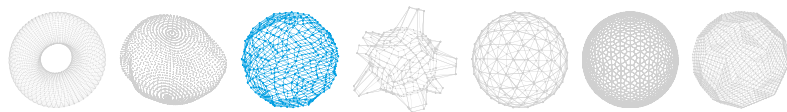# How industries go to market

How 5G is set to
revolutionise retail

How 5G is set to impact
the financial sector

How 5G will change media

Education and 5G

How can 5G support
governments?

5G White Paper

How industries go to market

Contents

How 5G is set to revolutionise retail

The way consumers buy products is changing. Whereas once they were happy to go into a store and put whatever they wanted into a shopping basket or trolley, they now expect to be able to check prices of the products at other stores as well as online in an instant.

For example, Amazon's app allows customers to scan barcodes of products when they are in store and check prices against products on its website. There are even apps, such as Keepa, that enable consumers to monitor ever-changing product prices on Amazon and alert them when they are at their lowest.

Essentially what this means for retailers is that they need to work harder than ever before to get customers, both offline and online. It means using the latest digital technologies to adapt to an environment where consumers can, and will, make their purchasing decisions from any number of different devices using different apps and in different locations.

Along with AI and IoT, 5G will undoubtedly play an important role in retail over the coming years. Recent research from Barclays Corporate Banking, 5G: A Transformative Technology suggests that 5G could 'supercharge the UK by up to £15.7 billion per year by 2025', giving the retail sector in particular a much needed boost.

According to Ian Gilmartin, Head of Retail at Barclays Corporate Bank, 5G will be a shot in the arm for the UK retail sector. "Not only can the technology improve the in-store customer experience, it is also set to transform warehouse management through the use of the internet of things, artificial intelligence and robots," he says.

Data-driven approach

With consumers now demanding to have their buying desires fulfilled at any time – whether that's using a smartphone during the ad break of a TV programme or shopping in store – retailers must adopt what is known in the industry as an omni-channel retailing strategy.

By making sure their entire inventory is collected in a centralised 'back-end' platform that is digitally accessible, retailers can provide a consistent experience to consumers who are now able to browse, purchase, deliver, collect and return goods via any combination of channels.

According to JRNI's Third Annual Modern Consumer Research Report, there is now a global consistency across nearly all product categories, including electronics, clothing, gifts, household, beauty and health, and DIY (except furniture) – illustrating that omnichannel shopping is increasing globally.

The study found that, on average, 74% of consumers research online and purchase offline (ROPO) – predominantly for electronics, clothing and household items. And it discovered there is a rise in 'showrooming', with 57% of consumers actively researching in-store before purchasing online – primarily for clothing, gifts and electronics.

On average, 54% of consumers use click and collect (purchasing online, picking up in-store), particularly for clothing, electronics and household items.

JRNI's Third Annual Modern Consumer Research Report:

74%	57%	54%
of consumers research online and purchase offline (ROPO) – predominantly for electronics, clothing and household items.	actively research in-store before purchasing online ('showrooming') – primarily for clothing, gifts and electronics.	use click and collect (purchasing online, picking up in-store), particularly for clothing, electronics and household items.

Figures from Accenture show that AI could boost retail profitability by as much as 60pc by 2040, while Capgemini predicts AI will net retailers around £256bn in annual cost savings by 2022.

Smart shelves

In order to become even more efficient, retailers are increasingly turning to technology both in warehouses and on the shop-floor. For example, by using IoT-embedded sensors, retailers have a real-time view of their stock leading to faster response and restocking times. This can decrease the likelihood of unsatisfied customers.

One possibility is that Radio frequency ID (RFID) sensors can be built into 'smart shelves' in a supermarket in order to gather data, such as the number of items on a shelf. The shelves' sensors can detect if a particular product is running low and can communicate to the supply chain to send a new shipment or verify when the next shipment is in transit. However, this level of response requires a lot of new data to be added to the network – data which in many cases will have to transmitted over a 5G mobile network.

According to Vodafone's 2019 IoT barometer, 75% of adopters in retail are spending more on IoT than a year ago with 73% having more live IoT projects and 77% claiming that the scale of their IoT projects has grown. Nearly three in five retailers (58%) who have adopted IoT are using it to track light levels, sound and temperature in store while 45% are using sensors to track the occupation of stores and parking areas.

Nor is IoT the only technology being deployed by retailers. In an effort to improve efficiencies in their supply chain and save money, retailers are also turning to AI (artificial intelligence). Figures from Accenture show that AI could boost retail profitability by as much as 60pc by 2040, while Capgemini predicts AI will net retailers around £256bn in annual cost savings by 2022.

5G opportunities

As we've seen above, the retail sector is already extremely sophisticated when it comes to implementing new digital technology with IoT and AI already widely deployed to deliver greater efficiencies and provide higher customer service levels. However, the arrival of 5G with consumers will present even further opportunities for the retail sector. Here we look at just a few of them:

AR and VR

Without doubt, two of the most promising technologies for the retail sector are AR (augmented reality) and VR (virtual reality). Thanks to 5G's ultra-low latency, AR and VR applications will become increasingly widespread for retail use as 5G phones are gradually rolled out.

According to Gartner's Unified Retail Retailer Survey, this year will see 100 million consumers shopping using AR online and in-store, with 46% of retailers across Europe, Asia and the US planning to deploy either AR or VR solutions to meet customer service experience requirements. Gartner's report says that with VR's immersive interfaces, retailers can create task efficiencies or reduce the costs associated with designing new products. They can also enhance the understanding of information through advanced graphical visualisation.

"Retailers are under increasing pressure to explain the purpose of physical stores, and take control of the fulfilment and return process for cross-channel execution," says Gartner principal research analyst Hanna Karki. "At the same time, consumers are progressively defining the value provided by the experiences they receive from retailers. As a result of these pressures, retailers are turning to AR and VR to offer customers a unified retail experience inside and outside retail stores."

Increasingly, retailers are using AR, and to a lesser extent VR, as an extension of the brand experience to engage customers in immersive environments and drive revenue. For example, IKEA's Place app lets customers virtually place true-to-scale 3D models of its furniture in their own home.

Shoe retailer Footlocker has also demonstrated an AR app that enables users to point their mobile phone at a particular pair of shoes on a display wall and instantly find out through a digital overlay on their phone whether the item is in stock in their size. Indeed, retailers with small shops may be able to use AR as a way of engaging the customer via their mobile phone, which previously wouldn't have been possible.

Increasingly, retailers are using AR and, to a lesser extent VR, as an extension of the brand experience to engage customers in immersive environments and drive revenue.

Personalised signage

Inevitably, one of the key advantages of technology is that it will personalise the retail experience. AR and VR will be joined by more subtle communications including personalised signage across the physical retail space. For example, when entering a store, shoppers could see personalised communications that will connect them to highly individualised recommendations.

As Jason Wells, Vice President and General Manager EMEA at Cradlepoint, says: "Facial recognition technology with video analytics can recognise a customer's face and provide truly personal offers through connected digital signage based on that individual's preferences and shopping history."

Meanwhile in dressing rooms of the future, interactive "magic mirrors" could recognise a product someone tries on through an RFID tag and combine this with information about the customer to recommend other items they might also like to try. Nor does the interaction have to end when the shopper leaves the store. The retailer could use information gathered from the instore interaction to offer targeted offers at a later date via email, text message, etc. For example, it could tell the customer when a product they have tried on is reduced in price.

Future 5G shopping centres

Physical shopping spaces could also look very different when 5G is rolled out worldwide, becoming destinations where shoppers can enjoy high speed internet connectivity and new applications. Opened in May 2019, the Shanghai Lujiazui L+ Mall is billed as the world's first 5G shopping centre.

It uses the 5G digital indoor system (DIS) to provide next-generation network connectivity across 12 floors and over 140,000 square metres of floor area. Features on offer for shoppers include HD video calls, guidance provided by 5G smart robots and artificial intelligence-based face recognition.
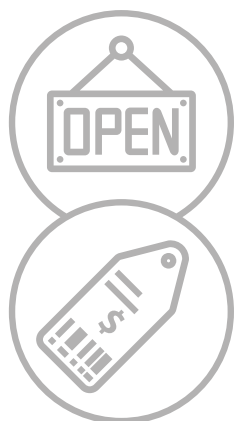
Says Cai Yun, Secretary-General of the Commercial Cultural Tourism Committee of China Real Estate Association: "The deployment and implementation of 5G network capabilities will accelerate the transformation from traditional buildings to smart buildings and provide new opportunities for the further development of the real estate industry."
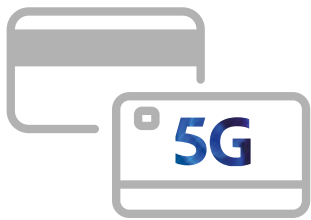
Bright future

The rollout of 5G is set to revolutionise the retail landscape. Behind the scenes, 5G, along with technologies such as AI and IoT, will drive much greater retail efficiency, ensuring shelves are stocked to optimum levels and that customers have the same experience whether they are shopping online or offline.

But that's not all. 5G also promises to blend the virtual and physical worlds in a way that we haven't yet seen before and that we can't yet quite fully imagine. Thanks to 5G's ultra-low latency, AR, and to a lesser extent VR, will transform the retail experience far beyond the marketing-driven stunts we are still seeing at the moment into something truly useful and ground-breaking.

Customers will be able to enhance their 'offline' and online shopping experiences to choose the exact product they are looking for, even receiving personalised recommendations and offers when they walk into a store, should they so choose. While retail still faces a challenging time ahead, 5G technology could actually help some retailers to reinvent themselves over the coming years.

"Facial recognition technology with video analytics can recognise a customer's face and provide truly personal offers through connected digital signage based on that individual's preferences and shopping history."

Jason Wells, Vice President and General Manager EMEA at Cradlepoint.

How 5G is set to impact the financial sector

The last few years have seen a massive shift from high street to online banking. According to a <u>report</u> from consumer watchdog Which? there were 3,303 bank branch closures between January 2015 and August 2019, equating to over a third (34%) of the network.

During this period, the number of branches reduced from 9,803 branches to 6,549, though the number of closures was slightly offset by 49 branches opening. Of the UK's bank branches that remain open, 298 are now operating with reduced opening hours of four days a week or less, the consumer group said.

At the same time, online banking is on the rise. According to Statista, 73% of over-16s now bank online in the UK (as of November 2019) with <u>64% using their smartphone</u> and 34% using a web tablet. Inevitably, growth has been driven in part by new services offered by the 'big four' banks across the UK as well as by the introduction of Open Banking.

This has allowed third-party 'Fintech' developers access to the financial institutions' data via open APIs (application programming interfaces) which in turn has led to a proliferation of innovative apps, enabling consumers to take control of their money much more easily than in the past.
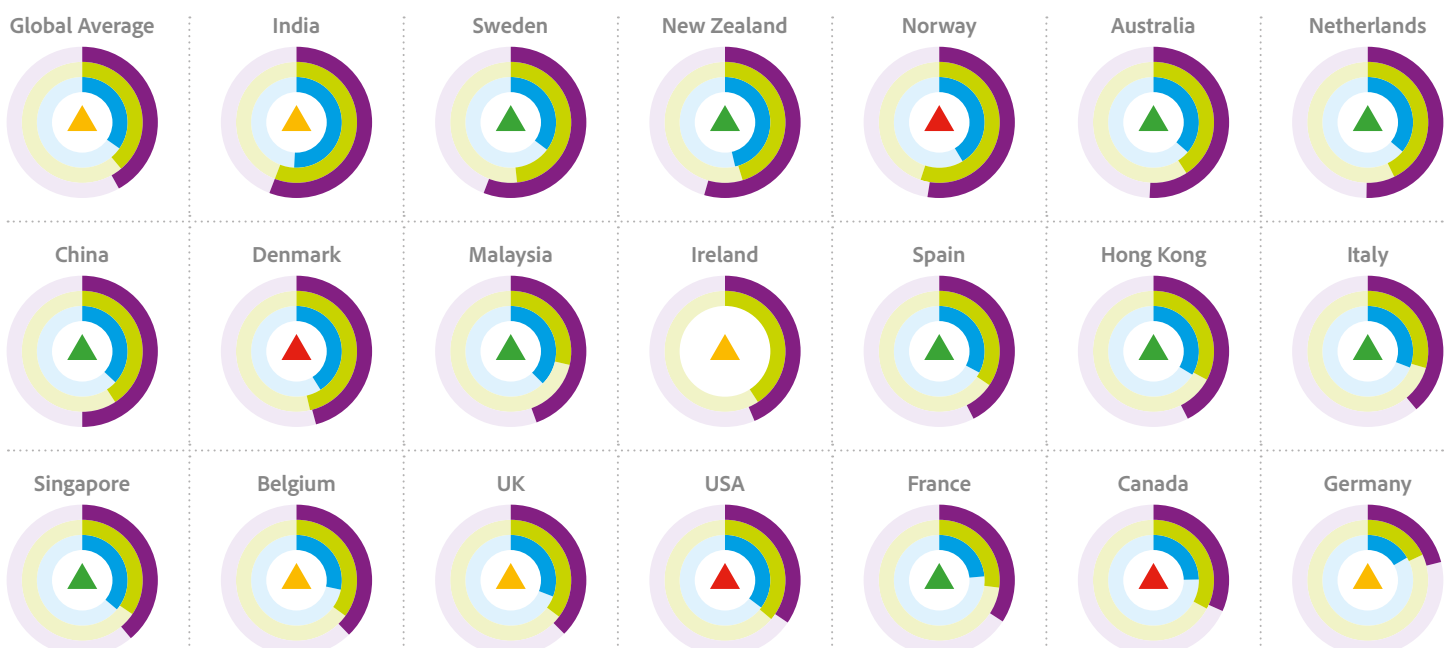
Elsewhere in the world it's a similar picture, with India and Sweden leading the way in terms of proportion of online consumers with a current account who use mobile banking on a daily or weekly basis, according to <u>GlobalData</u>. See illustration below. Overall, the global proportion of frequent mobile banking users witnessed a 3% growth from 39% in 2017 to 42% in 2018.

As mobile usage continues to accelerate and customers seek new applications to explore, banks and other financial institutions are actively looking at how they can best use technology to deliver both existing and new types of services.

Providing both increased data speeds, high levels of security and ultra-low latency, 5G is particularly well-suited to the financial sector. Here we look at just a few of the ways that the new technology is set to transform the banking industry over the next few years.

Proportion of online consumers with a current account who use mobile banking on a daily or weekly basis

● 2018 ● 2017 ● 2016   Percentage point increase in 2018 compared to 2017: ▲ 5% + ▲ 0-4% ▲ < 0%

Global Average	India	Sweden	New Zealand	Norway	Australia	Netherlands

China	Denmark	Malaysia	Ireland	Spain	Hong Kong	Italy

Singapore	Belgium	UK	USA	France	Canada	Germany

Source: GlobalData's Retail Banking Insight Survey.

Adobe

m-commerce transactions will surpass that of e-commerce for the first time globally, accounting for 55% of overall digital commerce transaction volume by 2022.

Increased mobile payments

Undoubtedly, one growing area for the financial sector is that of making payments via a mobile device. Business Wire claims the global mobile payment market (in other words funds transferred with a mobile device) was worth £663 billion in 2018.
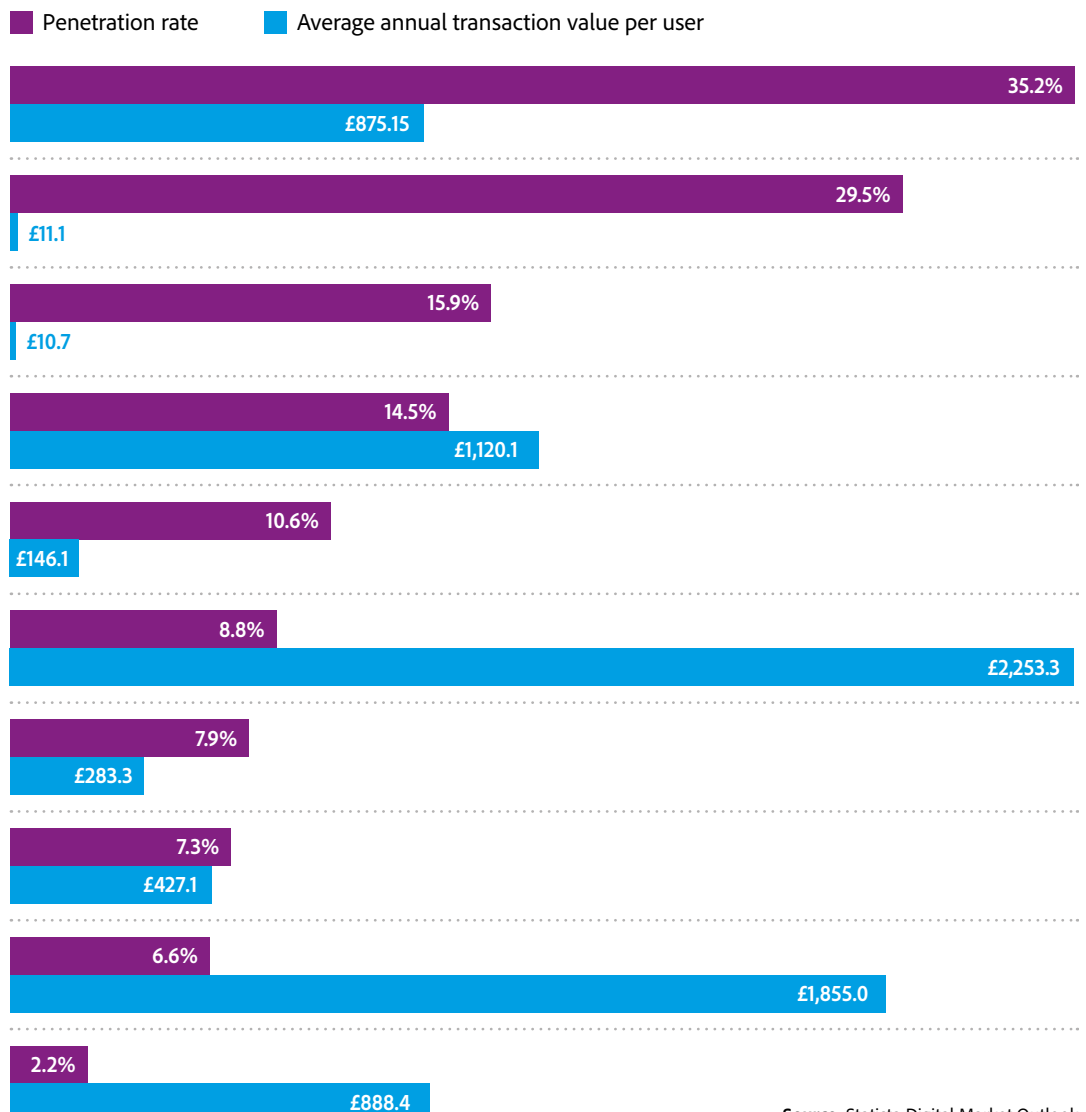
Furthermore, many predict that the volume of m-commerce transactions (mobile browser and native app) will surpass that of e-commerce for the first time globally, accounting for 55% of overall digital commerce transaction volume by 2022.

Not only are mobile payments more convenient for consumers than credit card and cash payments, they are also more secure too. With mobile PoS (Point of Sale) systems, data from the consumer's credit/debit card is not stored on the merchant's PoS terminal. Instead, during the transaction a code is generated that can be sent OTA (over the air) or manually by the consumer.

According to Statista, payment adoption is highest in China, where over one third of people (35.2%) use 'mobile wallets' with an average spend of over £875.15. Next is India with 29.5% adoption, though there the average spend is just £11.14. See illustration below.

In China, Alipay and WeChat Pay are widely used by shopkeepers, restaurateurs and consumers alike for mobile payments whereas credit and debit cards have never been widely adopted.

User penetration in the mobile point-of-sale segment in 2019* (selected countries)

- Penetration rate
- Average annual transaction value per user

Country	Penetration rate	Average annual transaction value per user
China	35.2%	£875.15
India	29.5%	£11.1
South Korea	15.9%	£10.7
Israel	14.5%	£1,120.1
Russia	10.6%	£146.1
USA	8.8%	£2,253.3
Brazil	7.9%	£283.3
Spain	7.3%	£427.1
UK	6.6%	£1,855.0
France	2.2%	£888.4

Note: The Mobile POS Payments segment includes transactions at point-of-sale that are processed via smartphone applications (so-called "smart wallets").

* projected figures, selected countries

Source: Statista Digital Market Outlook

Wearables

Nor are mobile payments confined to smartphones. Increasingly, wearable devices are being used for making mobile payments too. According to MasterCard, transactions from wearables, such as smart watches and fitness bands, increased eight fold between 2018 and 2019 with a third of all transactions (33%) coming from the Netherlands followed by the UK (18%). See illustration below.

Indeed, many industry commentators believe that wearables represent a massive opportunity for the financial sector. As Dan Latimore, Senior Vice President at Celent's Banking Group said at Finovate Asia last autumn: "Don't forget about wearables, because that's now a thin client that can be a much more viable way for people to interact with their bank, probably activated by voice."

By connecting to the cloud using 5G technology, wearable devices could share data with financial services as well as with each other – potentially offering greater reliability and lower latency than is currently possible.

Distribution of payment transactions via wearables across selected countries in Europe in 2019
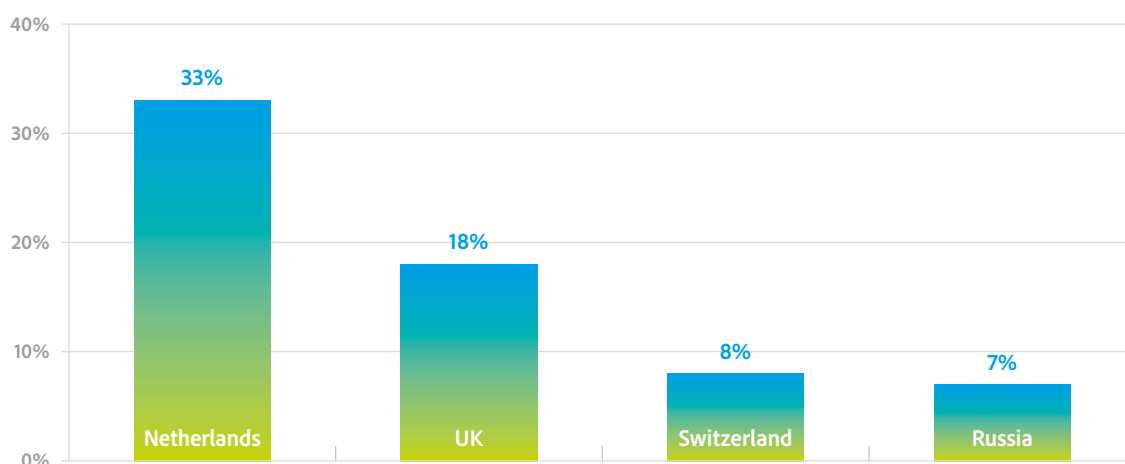
Note: Numbers concern payments processed by MasterCard; Includes both active wearables (which includes a battery), as well as passive wearables (without a battery, like armbands, rings and traditional watches).

Source: MasterCard.
© Satista 2020.

Country	Percentage
Netherlands	33%
UK	18%
Switzerland	8%
Russia	7%

Fraud reduction

One way 5G help will help with mobile payments both via mobile and wearables is by reducing fraud. Firstly, the increase in speed and reduction in latency could allow additional processes to be inserted to help reduce fraud detection errors and thereby reduce the number of wrongly-declined transactions.
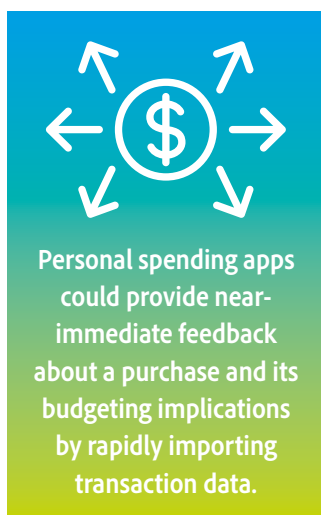
Mobile payments made by 5G-connected devices could be more securely authorised by the instant cross-reference of merchant ID, transaction amount, geolocation, biometrics or even behavioural data such as how someone walks or how they key in a number.

Virtual cashiers

Of course, one of the main benefits of 5G is that it will bring new applications, some of which have yet to be imagined. For example, mobile apps could quickly load interactions with remote virtual cashiers, financial advisors and loan officers, instead of consumers having to go into their branch to bank.

Personal spending apps could provide near-immediate feedback about a purchase and its budgeting implications by rapidly importing transaction data. Instead of poor video and sluggish animations that 3G and 4G offer, with 5G customers could see visually-compelling graphs demonstrating everything from interest received in their account each month to the impact of impulse spending on their monthly budget.

Complementing the advances in 5G banking will be advances in retail – see 5G in retail sector section. Using retailers' advanced AR (Augmented Reality) apps, consumers will be able to check prices and make purchases of products just by holding their phone up to the item they want. Retailers will also be able to direct geo-targeted offers to consumers much more accurately. Indeed, according to 451 Research 56% of consumers said they've received a personalised offer (e.g. based on location or past purchases) from a retailer that resulted in a purchase they didn't intend to make.

Personal spending apps could provide near-immediate feedback about a purchase and its budgeting implications by rapidly importing transaction data.

5G will enable financial institutions to extend their reach by providing a complete branch experience at temporary locations.

Pop-up banking

5G has the potential to accelerate mobile point of sale (mPOS) transaction processing time and improve connectivity. This could further drive adoption of mPOS into new geographies, locations and use cases where network connections have in the past been unavailable or too slow.

For example, 5G will enable financial institutions to extend their reach by providing a complete branch experience at temporary locations like music festivals, sporting events, university campuses as well as disaster-affected areas.

AI Financial help

5G's ability to collect a steady stream of data from customers will also help enable banks to do more than just protect their accounts from fraud.

For example, its low latency bandwidth provides information gathering in real time, including location and payment information, thereby paving the way for new AI-based personal banking services.

According to AT&T Business, an automated financial assistant could remind users that they're reaching a weekly budget limit for entertainment services when they go to the cinema, or suggest new ways to save at the supermarket. Importantly high-speed, low-latency services could offer more accurate advice to customers when they need it the most.

Beyond customers

Finally, 5G's benefits are expected to extend beyond customers into the banking institutions themselves. Financial professionals will be able to use them to create more efficient back-end processes. In insurance, loss-adjusters could use 5G-enabled high-speed connectivity to send dozens of photos back to head office in an instant without having to wait to reach their office or home network.

5G will also enable the remote control of commercial drones beyond line-of-sight to perform claims work, predictive risk analytics and safety operations. A drone could capture high-definition video of rooftop damage from a recent hailstorm and overlay it with government flood data on a mobile device. As a result, customers could receive on-the-spot settlements more quickly and accurately.

In its 5G Future of Financial Services paper, AT&T Business also claims we could use '5G devices to inform purchase decisions by visualising investments, trades and budgets in 3D, and tracking updates in near-real time'. It claims that 'marketing teams might visualise customer journeys in physical space with apps that map and simulate buy flows' and speculates that 5G could transform internal training programmes for compliance and new hires into immersive, media-rich sessions.

Look to the future

Without doubt, the future of financial services is mobile. We have already seen the shift from e-commerce via computer to m-commerce via mobile and this trend will only continue, especially as the limit for contactless payments is increased in various territories, including the UK. At the same time, more consumers are using their mobiles for banking rather than visiting the ever-diminishing branch network.

With Open Banking, new types of Fintechs are emerging with innovative apps to help people aggregate their bank accounts, analyse their spending patterns and personalise their banking services. With 5G, consumers will be able to access new types of services which combine ultra-high definition video with technologies such as AR and VR in order to enhance their banking and retail experiences.

In turn, these technologies will benefit the financial institutions themselves by helping them to detect fraud more easily and process everything from transactions to insurance claims more quickly. Indeed 5G promises to revolutionise the finance sector, destroying the hegemony of the established banks and paving the way for innovative new services for consumers and the enterprise.

How 5G will change media

5G looks set to revolutionise the entertainment industry. Offering average speeds that are much faster than typical home broadband, it will make watching content on the move via a mobile phone or tablet the norm for most of us. Lower latency, or lag, will also enable instant-response gaming.

Media companies or telcos, once restricted in the type of content they were able to provide to customers' mobile devices, will be able to supply personalised, 4K ultra-high definition (UHD) video content directly to users. New entertainment providers with disruptive new business models are likely to emerge, just as Netflix disrupted the traditional broadcasting establishment with its streaming service.

Those unable to receive full-fibre broadband in their home will be able to get high speeds, capable of supporting video content, via a 5G modem/router. Furthermore, the cost of 5G data won't necessarily be any higher than previous technologies, with most telcos currently offering the same pricing for 5G data plans as for 3G and 4G.

According to the 2018 5G Economics of Entertainment Report, commissioned by Intel and conducted by Ovum, nearly £2.2 trillion in cumulative revenue opportunities will be created by wireless technology from 2019-2028. Experiences enabled by 5G networks will account for nearly half of it (close to £973 billion).

The report also claims the average monthly traffic per 5G subscriber will grow from 11.7GB in 2019 to 84.4GB per month in 2028, at which point video will account for 90 percent of all 5G traffic, according to the report.

"5G will inevitably shake up the media and entertainment landscape. It will be a major competitive asset if companies adapt," says Jonathan Wood, general manager of Business Development & Partnerships, 5G Next Generation and Standards at Intel. "If not, they risk failure or even extinction."

But exactly how will 5G change the entertainment industry? Here we look at various areas where change is expected.
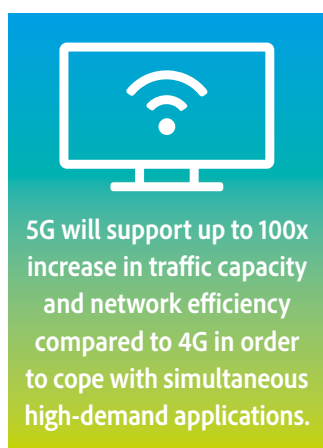
TV programming

Once, watching TV programmes meant sitting in front of a TV set at a time which the broadcaster decided. Those days are long gone. Catch-up services, like the BBC iPlayer in the UK, mean you can now watch what you want when you want. Services like Netflix have been designed specifically for streaming content onto mobile devices, as well as TV screens. With 5G it is likely that consumers will be able to watch 4K UHD content wherever they are.

When it comes to sports, 5G will be used by many of the big footballing clubs to allow those at the stadium to enjoy an even better viewing experience. The technology will allow every inch of the pitch to be broadcast live in perfect detail, with instant action replays from every angle.

In the UK, Vodafone has announced plans with Wasps Rugby and Wasps Netball teams in Coventry to use 5G both to improve the customer experience of the fans and also enhance each athlete's training schedules. Research from the telco reveals that more than three quarters of business leaders from sports organisations (76%) see improving fan engagement – and delivering new and innovative fan experiences – as key to future success.

Says Anne Sheehan, Director, Vodafone Business UK: "Sport is an area where 5G technology will have a huge impact. It has the potential to transform the fan experience; change the way sports organisations operate, open up new revenue opportunities; and help athletes improve their fitness and training programmes."

Here improved capacity is key. 5G offers greater capacity than earlier network technologies across a larger frequency spectrum. This includes higher frequencies, including "millimetre" wave – between 30Ghz and 300Ghz. As a result, 5G will support up to 100x increase in traffic capacity and network efficiency compared to 4G in order to cope with simultaneous high-demand applications. This means users can easily access data services at big events where previously they couldn't get even get a mobile phone signal.

5G will support up to 100x increase in traffic capacity and network efficiency compared to 4G in order to cope with simultaneous high-demand applications.

5G mobile games revenue, including AR and cloud gaming, is forecast to exceed £75 billion annually in 2028 alone.

Gaming

5G will open up the world of gaming. In particular, people will no longer need PCs or consoles to play the fastest games. Instead, thanks to its ultra-low latency and high capacity, 5G will combine with cloud gaming to make many of these premium game titles accessible to more consumers via a smartphone for the first time.

Besides cloud gaming, 5G is also expected to provide a true cross-platform gaming experience too. Cross-play is under the spotlight of the games market, attracting several different companies. Apple Arcade, for example, delivers a multi-platform gaming experience focusing on a common developer environment across iOS, MacOS and Apple TV. Other services currently available that offer the ability to play a game on any device include Steam Link, Omen, Tencent WeGame and PlayStation Remote Play.

And while premium games such as Call of Duty already support cross-play between console and PC, mobile currently presents integration challenges due to mobile hardware limitations. With 5G many of these obstacles can be overcome by moving data processing to the cloud and at the edge. Indeed, 5G can ensure a seamless latency across all gaming platforms. What's more, multiplayer modes, which are already common on PC and console, are expected to flourish across all platforms.

"The global games market is moving towards a future in which platform choice is less relevant, driven by cloud gaming, cross-platform game services and even cross-platform multiplayer – all powered by 5G," says Peter Warman, Newzoo's CEO and Co-Founder in a report entitled <u>The Evolution of Gaming Through 5G</u>.

Undoubtedly, 5G will break the boundaries of gaming. With its high bandwidth and low latency, it will allow gamers to play with and against others across all platforms via online multiplayer modes while on the move. But that's not all. It will also herald the arrival of new AR and VR gaming applications – many of which have yet to be imagined.

According to the 2018 <u>5G Economics of Entertainment Report</u>, commissioned by Intel and conducted by Ovum, 5G mobile games revenue, including AR and cloud gaming, is forecast to exceed £75 billion annually in 2028 alone.

Music

When it comes to listening to music, 5G will bring many benefits. Perhaps most obvious is higher-quality music streaming and quicker downloads. But that's just the start of what the technology could offer.

Artists have already started using AR to enhance live performances. For example, at last year's Coachella festival there was an AR equipped stage where festival goers were able to look through an app on their mobile phone during performances to see objects like spaceships flying through the air.

Not only will 5G make the process of live editing much smoother – allowing for major live music events to be seamlessly edited in real-time, without any delay for viewers at home – it also has the ability to enable remote real-time musical collaboration.

For example, in April 2018 Ericsson organised what it claimed was the world's <u>first jam session over 5G</u> which was then showcased at Ericsson Innovation Day. It then successfully distributed a musical performance between two Ericsson locations in China that were 220km apart.

With its ultra-low latency and high bandwidth, 5G is well-suited to new media applications. Over the next few years we will inevitably see the entertainment industry responding to what the technology can offer with a wide range of innovative services – some of which have yet to be imagined.

Education and 5G

Education has changed a great deal since the days when teachers used to write with chalk on blackboards and the closest thing they got to technology was wheeling in a huge VCR and a teak TV set into the classroom to play an educational video from the Open University.

Blackboards have long since been replaced by interactive whiteboards and students regularly use web tablets and netbook devices such as Google Chromebooks to do their research and write their essays. Once technophobe teachers now use online registration and behaviour-monitoring tools such as SIMS, replacing the paper registers of yesteryear.

Even before COVID-19, teachers were also widely using online solutions such as Google Classroom for creating, distributing and marking assignments without having to be in the classroom. Indeed, according to the UK's Telegraph newspaper, Education Technology – or EdTech as it's known – is set to be worth £128 billion globally by next year – up from £45 billion in 2015.

And while the US and China predictably lead the way, the UK market is set to be worth £3.4bn in 2021. This includes £170m worth of EdTech exports and schools around the country spending about £900m on education technology.

Accelerating change

As we have seen in other industry sectors, COVID-19 has accelerated many of the technological changes that were already starting to happen – in particular the rise of e-learning. This is defined as accessing an educational curriculum outside of a traditional classroom.

Worldwide at the height of the pandemic there were more than 1.2 billion children in 186 countries affected by school closures, according to UNESCO – see graphic below.

Global monitoring of school closures caused by COVID-19 (17/06/2020)

- ■ Localised
- ■ Country-wide
- ■ Open
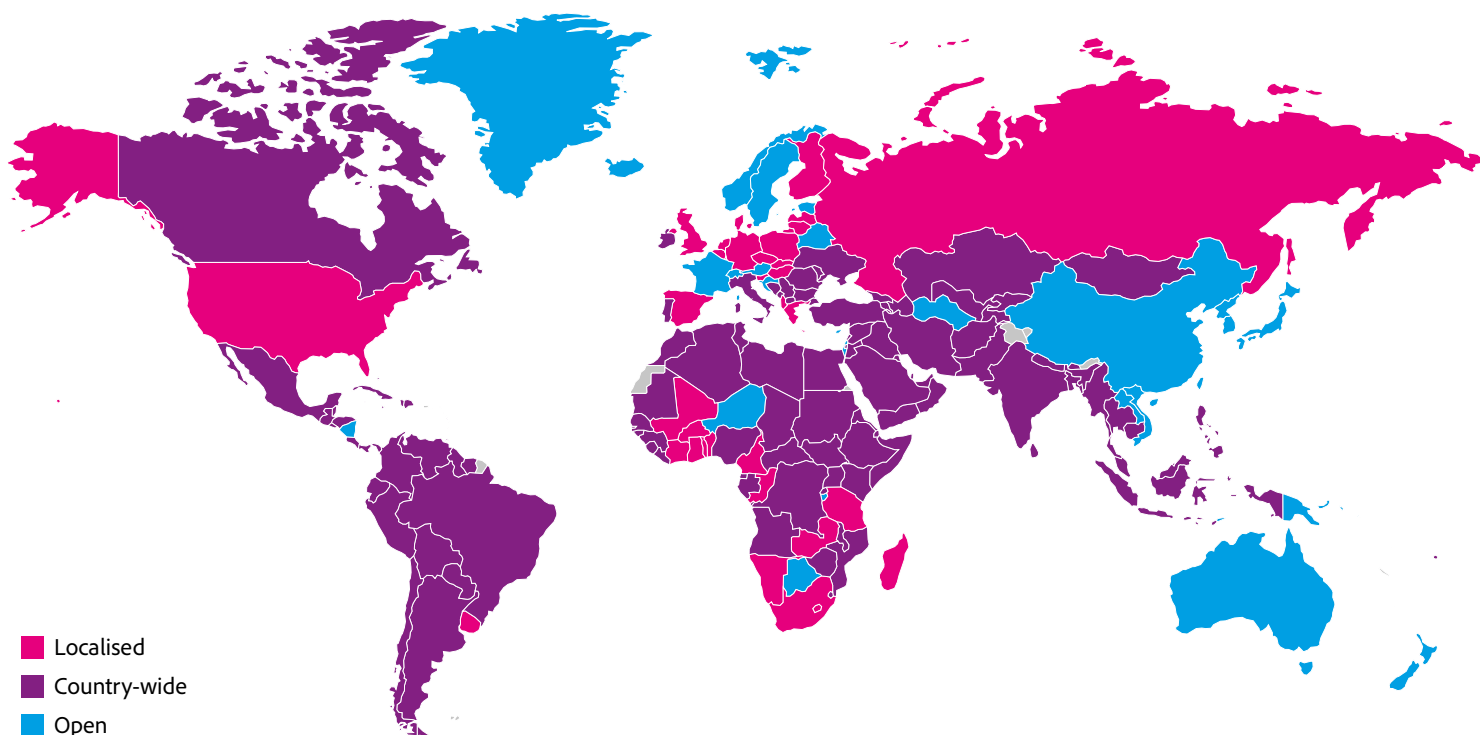
Note: Figures correspond to number of learners enrolled at pre-primary, primary, lower-secondary and upper-secondary levels of education [ISCED levels 0 to 3], as well as at tertiary education levels [ISCED levels 5 to 8]. Enrolment figures based on latest UNESCO Institute for Statistics data.   **Source:** UNESCO.

COVID-19 impact on education (17/06/2020)

1,186,127,211 affected learners

67.7% of total enrolled learners

123 country-wide closures

The number of learners impacted by the COVID-19 caused closures of educational institutions corresponds to enrolment figures at pre-primary, primary, secondary, tertiary levels [ISCED 0 to 3 and 5 to 8] as reported in the UNESCO Institute for Statistics Database, for those countries that have mandated country-wide closures. The number of learners impacted therefore does not include the learners that may have been impacted in countries with localised closures. **Source:** UNESCO.

As a result, many online learning platforms offered free access to their services, including platforms like BYJU'S, a Bangalore-based educational technology and online tutoring firm founded in 2011, which is now the world's most highly valued EdTech company.

Meanwhile, China's Tencent classroom has been used extensively since mid-February after the Chinese government instructed a quarter of a billion full-time students to resume their studies through online platforms.

Alibaba's distance learning solution, DingTalk, also had to prepare for a similar influx: "To support large-scale remote work, the platform tapped Alibaba Cloud to deploy more than 100,000 new cloud servers in just two hours last month – setting a new record for rapid capacity expansion," according to DingTalk CEO, Chen Hang.

Media organisations such as the BBC also got behind e-learning. Launched on April 20th, Bitesize Daily offered 14 weeks of curriculum-based learning for children across the UK with celebrities including Manchester City footballer Sergio Aguero teaching Spanish and Professor Brian Cox teaching science. Many Universities, including Cambridge University, have also announced that all of their lectures for academic year 2020/2021 have been moved online, with only seminars and tutorials conducted face-to-face with social distancing measures in place.

According to Valuates Reports, the e-learning market size was valued at £127 billion in 2019 and is expected to grow at a CAGR (Compound Annual Growth Rate) of 10.85% by 2025.

"To support large-scale work, the platform tapped Alibaba Cloud to deploy more than 100,000 new cloud servers in just two hours last month – setting a new record for rapid capacity expansion."

Chen Hang, DingTalk CEO.

E-learning market size (USD)

E-Learning is delivered through the Internet and used electronic resources to transfer skill and knowledge to several recipients.

One trend in the market is the increase in adoption of microlearning, which refers to learning using bite-sized content. Since educational institutions and the corporate sector focus on personalised learning, there will be a growing preference for microlearning in the coming years.

£127 billion

Compound Annual Growth Rate 10.85%

2019 2020 2021 2022 2023 2024 2025
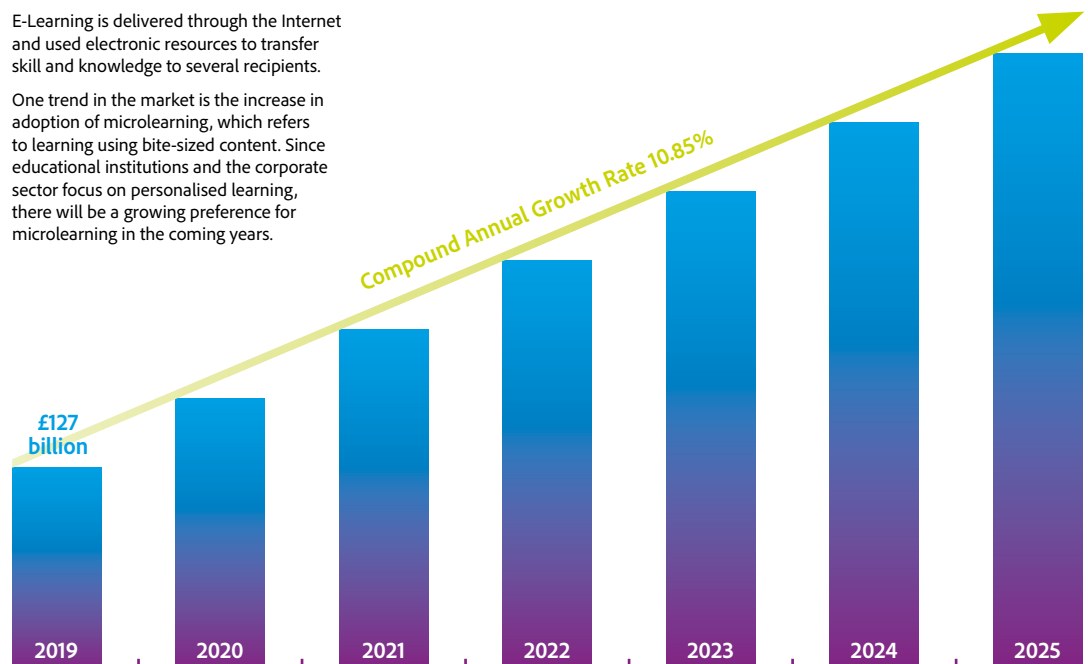
Source: Valuates Reports.

5G learning

Inevitably, this shift to e-learning, driven in part by the Coronavirus pandemic, is just part of a much bigger movement in EdTech which will affect both e-learning in a remote environment as well as traditional learning in a classroom environment.

According to the European Digital Learning Network, 5G could prove a 'breakthrough' for schools, making it possible to 'download videos, applications and images in seconds, instead of minutes.' In particular it claims that 5G will benefit students who may require additional support as well as schools in remote areas. Here we look at some of the ways 5G could help enrich lessons in the future.

1

Immersive AR and VR lessons

Whereas 4G struggles to offer the bandwidth needed for AR and VR content, with 5G these experiences will become seamless. Students could visit the planets with VR while with AR they can explore concepts through touch, for example pinching and zooming through the Earth's layers to go beneath its surface.

One company that is pioneering the use of AR in schools is Curiscope. It has developed AR clothing which allows students wearing a special T-Shirt to explore the anatomy of a human body via its app.

Last year, US telecoms company Verizon also launched its 5G EdTech Challenge in conjunction with NYC Media Lab. Under this scheme, £748,000 was donated to organisations and universities using technologies such as AR to VR to improve middle school education.

2

Artificial intelligence

Artificial intelligence is expected to play an increasingly important role within education. For example, AI could enable robots to become full-time assistants and support teachers by responding immediately to help with learning exercises, claims Getting Smart. This could prove particularly invaluable for students with special needs.

Several companies are now using AI-based learning programmes. One is Exter-based Sparx, which has developed an AI-based maths platform offering tailor-made classes and homework assignments. AI is also being used in online learning programmes, such as Esme Learning's Riff programme, in order to provide more effective collaboration between students.

3

Faster downloads

Every student's learning style and ability is different. 5G will help students continue their education outside the classroom, delivering the same data speeds and responsiveness to their phone or laptop as they experience in the classroom.

With most telecoms companies planning to offer 5G for the same price as 4G, students will be able to use the high-speed cellular network for downloading video files and accessing school networks as a possible cheaper alternative to broadband.

4

Smart Classroom

Setting up devices and gathering feedback in class can take time. With IoT on 5G, teachers can automatically log in to their systems as soon as they enter the classroom. Administrative tasks such as taking the register, logging students leaving the room to go to the lavatory or to the medical room will be automated, and students can deliver feedback for the lessons digitally.

The future of education

There is no doubt that technology will play an increasingly important role within education over the coming years. According to a 2018 Pearson study, 59% of Generation Z agrees that technology will transform how university students learn in the future, compared to 66% of millennials.

In many ways the Covid-19 pandemic has accelerated some of these changes by acquainting both teachers and students with new ways of teaching and learning virtually. As a result, both schools and universities are becoming increasingly sophisticated in the teaching they offer, blending digital learning with face-to-face learning wherever necessary. As in other industry sectors, 5G will enable further advances within teaching, particularly through the use of AI and AR/VR.

Certainly, education has come a long way since the days when the only tools at a teacher's disposal were a piece of chalk and a blackboard.
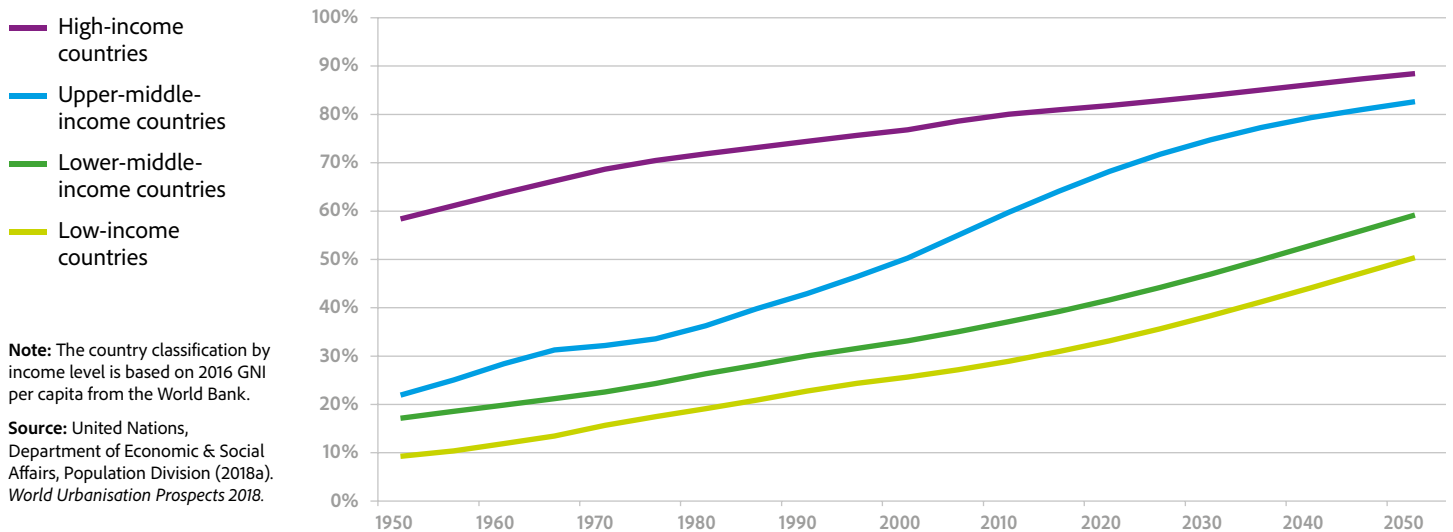
How can 5G support governments?

When it comes to implementing technology to help their citizens, governments have made massive advances over the last few years. For example, the UK Government's Gov.uk website which was <u>launched back in 2012</u>, has, after some initial scepticism, largely been hailed as a success. Stats from Google Analytics show approximately 15 million users per week visit the site with top searches including signing up for universal credit, accessing HMRC services and taxing of vehicles.

However, really this is just the start of how governments can use technology to improve services for their citizens. Thanks to 5G there is now the opportunity for governments to do much more, including encouraging greater citizen engagement as well as supporting the creation of new efficient smart cities. Indeed, with increasing urbanisation (by 2050 the United Nations predicts that about 64pc of the developing world and 86pc of the developed world will be urbanised), smart cities will play an increasingly important role in society.

Furthermore, 5G will enable governments to improve communications with communities through public-service videos and real-time interactive engagement. Government also has a vital role in ensuring 5G networks are fully secure in order to minimise any potential cybersecurity threat.

Percentage of population residing in urban areas by income group, 1950-2050

Legend:
- High-income countries
- Upper-middle-income countries
- Lower-middle-income countries
- Low-income countries

Note: The country classification by income level is based on 2016 GNI per capita from the World Bank.

Source: United Nations, Department of Economic & Social Affairs, Population Division (2018a). *World Urbanisation Prospects 2018.*

Creating smart cities

Inevitably one of the biggest potential benefits of 5G is enabling the creation of smart cities across the world. But what exactly is a smart city and how do people benefit? Defined as a city that uses ICT (Information Communications Technology) to enhance the quality and performance of urban services, it typically involves using IoT (Internet of Things) infrastructure and, increasingly, 5G communications.

A key advantage of 5G over previous cellular technologies is that it has the ability to support massive IoT networks. As part of the transition to 5G, low-power wide-area networks (LPWANs) can connect a larger number of IoT sensors with extended battery life. This means much greater capability to support the creation and operation of smart cities, smart buildings and even, claims <u>GGN</u>, smart military bases.

Specifically, 5G offers the possibility of massive M2M (machine to machine) communications, which is necessary for applications such as such as autonomous vehicles, remote healthcare, efficient refuse collection, electric grid management and traffic safety control.

For example, the ultra-low latency of 5G has the potential to transform the flow of traffic within a smart city. Thanks to near-real-time data, traffic can be quickly re-routed in the event of an accident or help first responders to control traffic signals so they can reach an emergency much faster.

Indeed, 5G could play a massive role in ensuring publicly-funded healthcare services are delivered as cost-effectively as possible, something that is becoming increasingly important particularly in developed countries with ageing populations. Using 5G technology, patients could find out which of their local hospitals has the shortest waiting time for accident and emergency, while wearables could be used to monitor chronic health conditions remotely in order to save patients having to make unnecessary and lengthy journeys to seek specialist medical help.

> Using 5G technology, patients could find out which of their local hospitals has the shortest waiting time for accident and emergency.

South Korea leading the way

One place where smart cities are becoming well established is South Korea, where the world's first commercial 5G network was launched in 2019. Billed as South Korea's first 5G smart cities, Sejong and Busan promise a blueprint for future living that it's hoped can be replicated worldwide.

Founded in 2007 as the administration capital of South Korea, Sejong – which is about 150km from Seoul – is already home to around 300,000 residents. However, the smart city extension will see an additional 20,000 people moving into a new 2.7Km squared greenfield site by 2023. Plans that have been mooted include its own cryptocurrency (Sejong Coins) and drones that can monitor accidents and beam video footage back to ambulances and hospitals to ensure they are fully prepared for any large-scale incidents.

Slightly different is Busan. Already an attractive port city with 3.5 million residents, the new Busan Eco-Delta City will be a 2.19Km squared area in the northeast of the city. Developed in conjunction with K-Water (Korea Water Resources Corporation), the environmentally-friendly city will include smart water and energy management to ensure people have purified water from a tap. It will also offer renewable energy sources such as hydro-electric power.
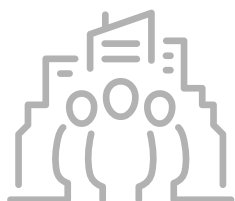
Greater citizen engagement

As mentioned earlier, governments have already made massive advances when it comes to launching digital-based services such as paper-free car tax renewal. However, with 5G, we can, claims GCN, expect new forms of citizen engagement to emerge.

For example, 5G-enhanced connectivity could make sharing video footage nearly as fast as sending text messages is today. Inevitably this will in turn enhance the power of video as a tool to exchange information – whether that's critical public safety issues, videos of pothole repairs or footage of those engaging in anti-social behaviour.

> "We're determined to make the UK a world-leader in 5G and deliver on our promise to improve connections for people and businesses across the country."
>
> Oliver Dowden,
> UK Digital Secretary.

5G will impact nearly everything government gets involved with including school safety, managing the homeless, voter registration and census taking. In February, the UK Government announced £65 million to fund 5G trials. This included investment in robotic environmental management of Sherwood Forest, 5G trials in air and sea search rescue in Dorset and 5G connectivity to track crop growth, monitor livestock and reduce water pollution. Said the UK's Digital Secretary Oliver Dowden: "We're determined to make the UK a world-leader in 5G and deliver on our promise to improve connections for people and businesses across the country."
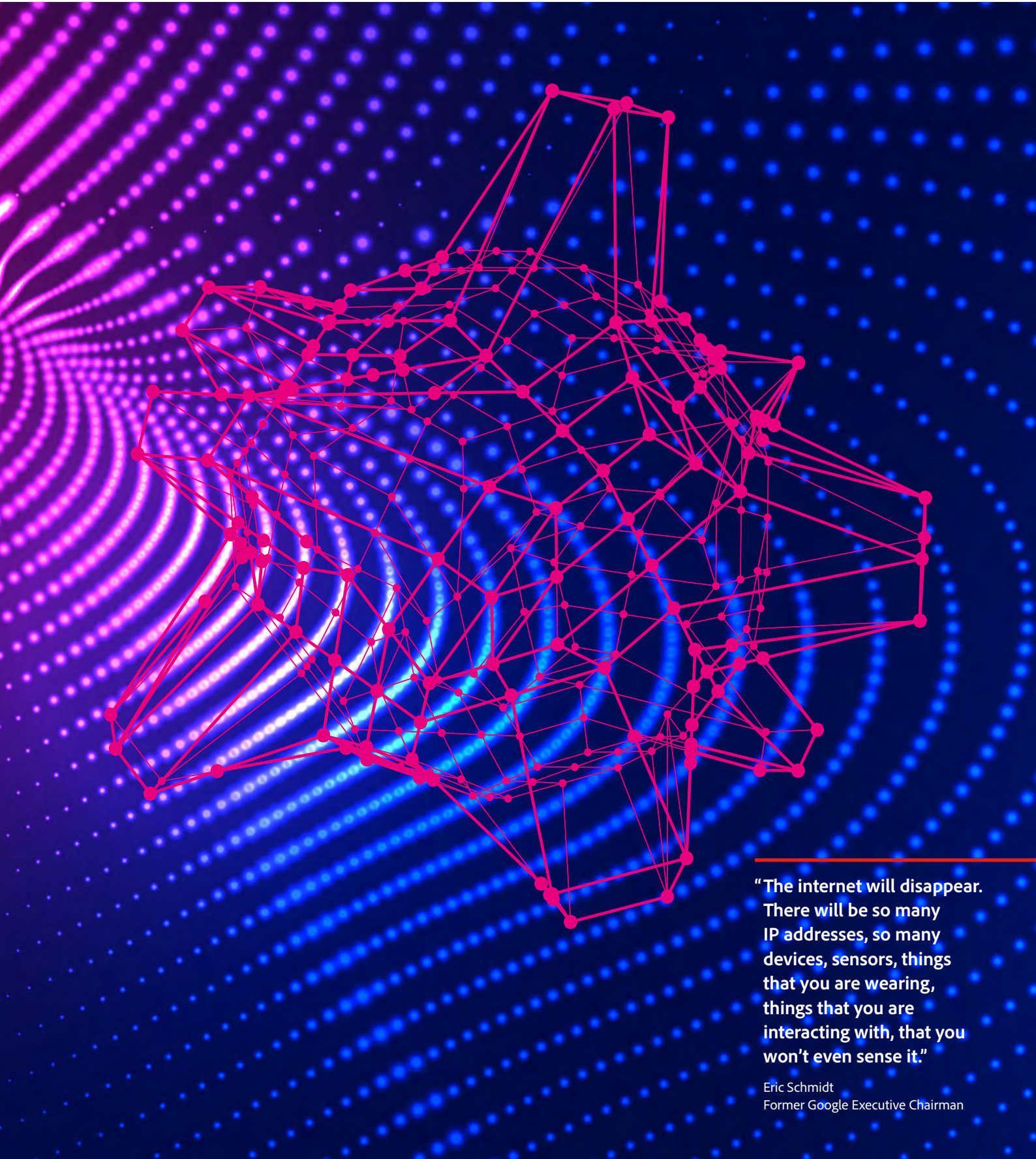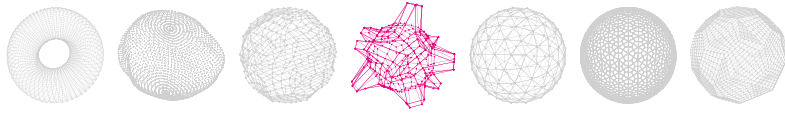
Improved security

Unlike previous technology advancements, 5G will almost certainly be enterprise- rather than consumer-led. In what's known as Industry 4.0, smart factories will increasingly use 5G's ultra-low latency for internet communications, control of drones and IoT while universities will become testbeds for potential new applications.

However, for these advances to be fully realised it is imperative that government ensures the networks they use are fully secure. Unlike early incarnations of IoT sensors which were largely found in consumer devices, 5G will see IoT being used for mission-critical applications. This includes applications where devices are expected to make decisions without any human intervention, such as autonomous driving.

Undoubtedly, 5G holds huge promise for a whole host of applications. But while it is a technology that will primarily be led by enterprises, it will only succeed if governments set industry-specific regulations and ensure devices and networks are well-secured.
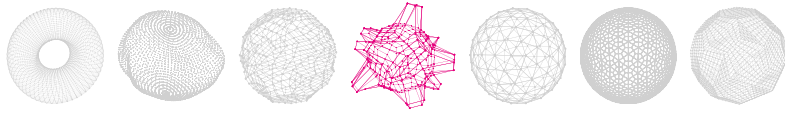
How things are coming to life

"The internet will disappear. There will be so many IP addresses, so many devices, sensors, things that you are wearing, things that you are interacting with, that you won't even sense it."
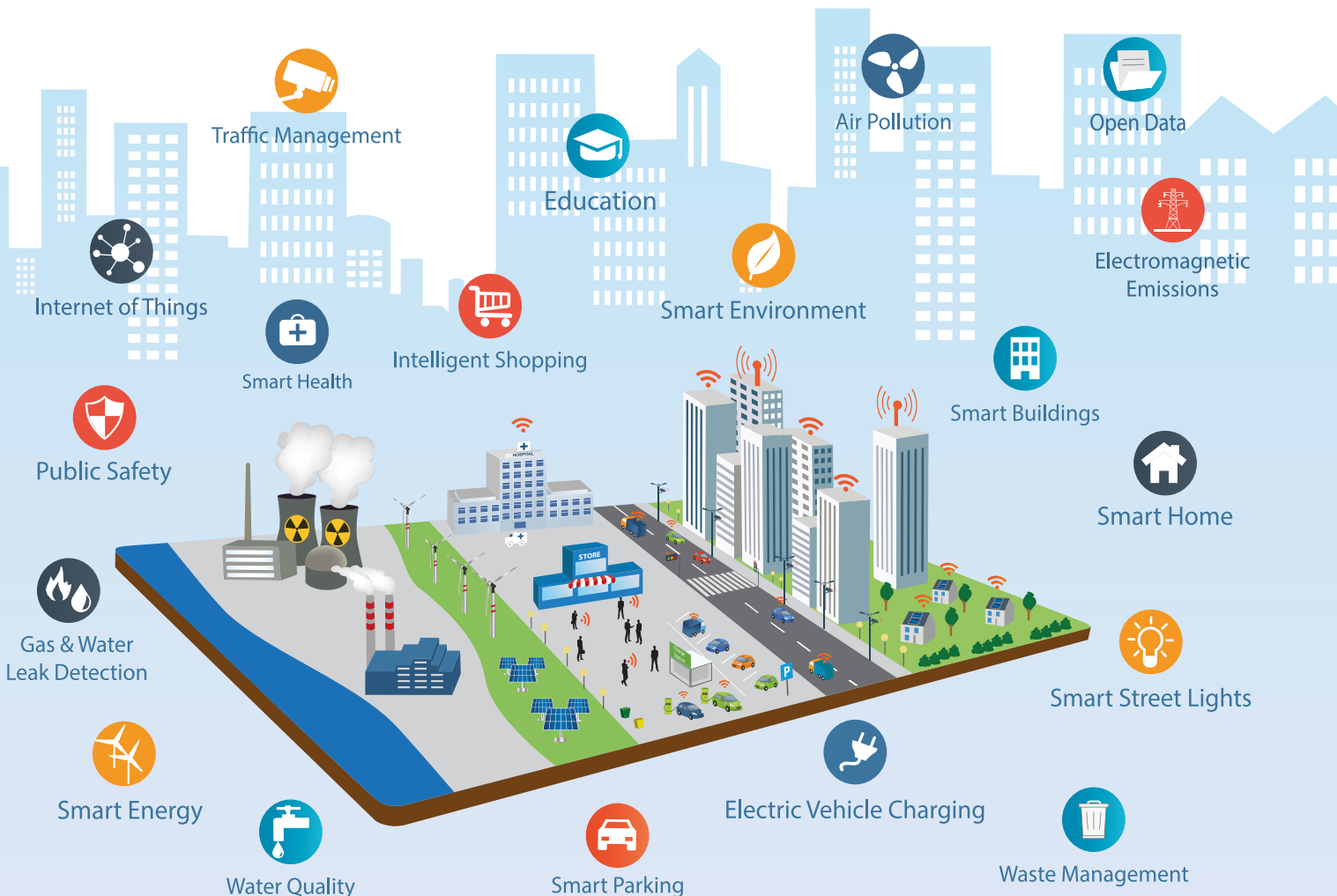
Eric Schmidt
Former Google Executive Chairman

Adobe

5G White Paper

How things are coming to life

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Water Quality

Smart Parking

Waste Management

How things are coming to life

Until recently, it was only electronic devices that connected to the internet. These included smartphones, tablets and PCs. However, the last few years have seen a mass explosion in other objects and devices with a built-in internet connection. And while some of these have become consumer items, such as security cameras, drones and connected heating systems, internet-connected objects are playing an increasingly important role within the enterprise sector too.

Internet of Things

First coined by Kevin Ashton of Procter and Gamble in 1999, the term Internet of Things (IoT) is now widely used to describe these objects that have integrated internet connectivity.

McKinsey predicts the worldwide number of IoT-connected devices will rise to 43 billion by 2023, an almost threefold increase from 2018, while according to Cisco in its Annual Internet Report (2018–2023) White Paper, the number of devices connected to IP networks will be more than three times the global population by 2023.

There will be 3.6 networked devices per capita by 2023, up from 2.4 networked devices per capita in 2018. And there will be 29.3 billion networked devices by 2023, up from 18.4 billion in 2018, the report claims.

2018
18.4 billion networked devices

2023
29.3 billion networked devices
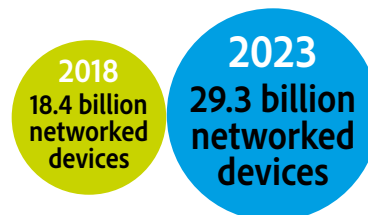
Moreover, IoT is accounting for an increasing amount of internet traffic too. According to the Cisco report, M2M (machine to machine) modules accounted for 3.1 percent of IP traffic in 2017 – obviously video accounts for a much greater percentage of traffic because of the bandwidth required. However, by 2022 IoT and M2M will have more than doubled to 6.4 percent of IP traffic while M2M connections will represent 51 percent of the total number of devices and connections on the internet by 2022.

M2M (machine to machine) connections will represent 51 percent of the total number of devices and connections on the internet by 2022.

"Eventually 'things' will simply become part of the internet and the distinction between different types of connected devices will no longer be relevant. The internet will disappear. There will be so many IP addresses, so many devices, sensors, things that you are wearing, things that you are interacting with, that you won't even sense it. It will be part of your presence all the time. Imagine you walk into a room...and you are interacting with the things going on in the room."

Eric Schmidt, former Google Executive Chairman, World Economic Forum, 2015
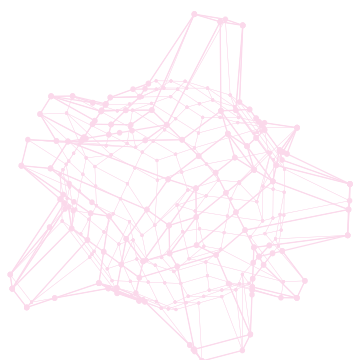
Business growth and applications

Increasingly, businesses are connecting devices to the internet and turning them into intelligent assets that can help drive greater efficiencies, increase competitiveness, develop new business models and provide solutions to problems.

For example, the Vodafone IoT Barometer 2019, found that over a third (34%) of organisations have incorporated IoT technology into their business, with 95% of adopters having seen measurable benefits from their IoT projects and over half (52%) realising significant returns on their investment.

However, adoption can vary greatly between sectors, the study showed. For example, the transportation and logistics sector represents the highest IoT adoption rate at 42%, with companies using IoT sensors to track fuel consumption as well as the location of vehicles and cargo remotely. On the other hand, adoption in the financial services sector is a little way behind at 34%. Nevertheless, IoT applications are now widespread in the insurance industry, with IoT sensors increasingly being used to alert homeowners as to when they've left a window open, a door open or an appliance turned on.

The transportation and logistics sector represents the highest IoT adoption rate at **42%**
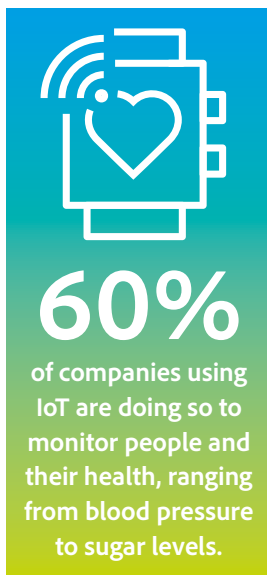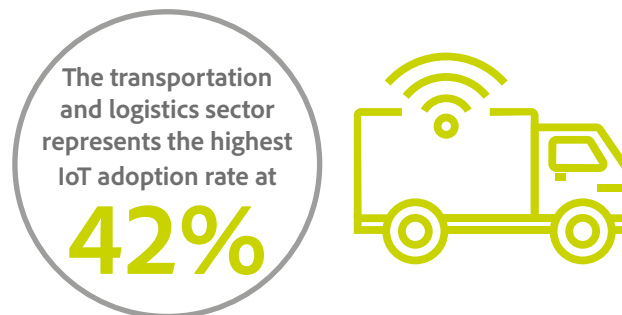
Monitoring infrastructure

Nor are these the only industry sectors where IoT-based projects are gaining traction. In the health and wellness sector, Vodafone claims three fifths of companies (60%) using IoT are doing so to monitor people and their health, ranging from blood pressure to sugar levels. Health services are also using IoT sensors to get real-time updates on the availability and location of nearby ambulances and hospitals with capacity.

Furthermore, in the energy and utilities sector, IoT is being deployed for measuring usage via smart grid systems and smart meters as well as monitoring assets. For example, in the UK the Environment Agency (EA) traditionally managed 30,000 bridges, culverts (which allow water to drain off harmlessly) and grids using engineers to check for blockages. However, it is increasingly turning to remote visual monitoring cameras which can send images of infrastructure to be viewed, in turn, by engineers using a mobile device.

60% of companies using IoT are doing so to monitor people and their health, ranging from blood pressure to sugar levels.
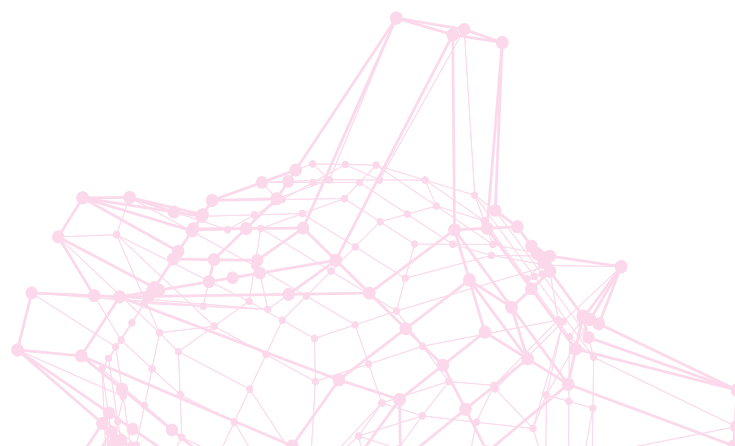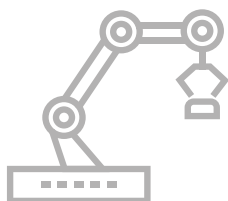
Manufacturing and retail

Undoubtedly, one of the biggest benefits of IoT is helping to drive greater productivities in industry by increasing efficiency. For example, warehouses and trucks can now provide up-to-date information on stock location, helping to control inventory, plan routes to avoid traffic jams and keep customers informed of any delays.

According to the latest Vodafone IoT Barometer, adoption of IoT in manufacturing has risen from 30% to 39% in the last year. Around 63% of companies which have deployed IT are using it to monitor environments, such as light, temperature and humidity, in order to maintain product quality and workplace safety. Furthermore, IoT is also bringing the concept of digital twins to life. A virtual replica of a physical system, a digital twin can be used to optimise production lines in a factory or solve issues such as identifying a correlation between equipment failure and sudden temperature changes.

In retail, IoT can be used to track environmental factors such as light levels, sound and temperature as well as generate valuable data on visitor movements and behaviour, including the occupation of stores and parking areas. Indeed, the retail sector showed the highest concentration of IoT sophistication in Vodafone's study, perhaps because retailers are under great pressure to innovate and keep up with changing customer expectations to stay competitive.
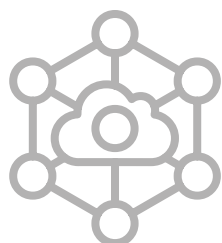
Cutting out the middleman

But this is just the beginning. By 2023, new low-power IoT technologies such as LP-WAN (lower-power wide-area network) will help drive the next wave of IoT adoption, with its promise of increased network coverage and greater cost efficiency. What's more, IoT will help businesses take up other technologies such as artificial intelligence (AI) and machine learning, resulting in the next wave of the industrial revolution – known as Industry 4.0.

As Goldman Sachs states in its report The Internet of Things: The Next Mega-Trend: "The global industrial sector is poised to undergo a fundamental structural change akin to the industrial revolution as we usher in IoT. Equipment is becoming more digitised and more connected, establishing networks between machines, humans and the internet, leading to the creation of new ecosystems that enable higher productivity, better energy efficiency and higher profitability."

Potentially, IoT will also result in even greater disintermediation – reducing intermediaries in the supply chain or 'effectively cutting out the middleman.' For example, by fitting cars with an increasing number of IoT sensors, manufacturers will be able to stay much more connected to their products even after they have been sold, effectively turning goods into services.

For example, Tesla is already able to disable parts of a car battery remotely to limit a vehicle's range, while manufacturer John Deere has implemented software restrictions that prevent customers, or presumably unauthorised third parties, from repairing its hi-tech tractors (The Economist, 'Chips with Everything', 14 September 2019).

Once the internet is built into everything, service-focused business models – where customers pay a subscription, rather than buying the product outright from a manufacturer – could well become the norm. However, with this inevitably come possible security risks as well as the potential for the big five FAANG tech companies – Facebook, Apple, Amazon, Netflix, Google – to extend their dominance into traditionally non-tech industries.

"The global industrial sector is poised to undergo a fundamental structural change akin to the industrial revolution as we usher in IoT. Equipment is becoming more digitised and more connected, establishing networks between machines, humans and the internet, leading to the creation of new ecosystems that enable higher productivity, better energy efficiency and higher profitability."

The Internet of Things: The Next Mega-Trend (Goldman Sachs)
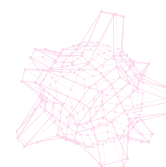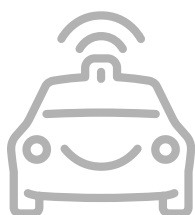
One sector where this seems most likely to happen is with the emergence of autonomous vehicles, which will almost certainly become dominated by tech companies offering subscription-based business models rather than traditional manufacturers selling their cars to the public through a network of dealers.

In conclusion, IoT isn't just about making dumb products much 'smarter', it also has the potential to change entire business models through disintermediation, bringing new opportunities to companies and possible benefits to consumers as long as security and regulatory concerns can be addressed.

IoT: the story so far

1983 British inventor Charles Walton invents RFID (radio frequency identification), which allows companies to manage and track their assets

Ethernet becomes standardised and quickly becomes established in the workplace for communications

1989 Tim Berners-Lee creates Hypertext Transfer Protocol (HTTP), which enables the creation of the World Wide Web

1991 Swiss-based nuclear research organisation CERN creates first website (info.cern.ch)

1992 Pipex introduces dial-up internet access in the UK, offering speeds of up to 56kb/s

1997 Wireless M2M technology becomes prevalent in industry

1999 Phrase "internet of things" first coined by Kevin Ashton during his work at Procter & Gamble; initially used to promote RFID technology

2000 UK cable companies begin roll-out of broadband with a maximum speed of 512kb/s

The world's first internet-connected refrigerator, the LG Internet Digital DIOS, is launched

2002 Work begins on Songdo in South Korea, the first fully equipped and wired smart city; built from scratch, it is expected to be completed by 2020

Amazon Web Services launches; cloud computing becomes more widespread

2006 First drones for non-military use are deployed, used by government agencies for disaster relief, wildfire fighting and border surveillance, and by industry for spraying pesticides and inspecting pipelines

OPC Foundation develops OPC Unified Architecture (OPC UA), a machine-to-machine communication protocol for industrial automation

2009 First low-power wide-area network (LPWAN) built in France; designed to allow long-range communication at a low data rate, LP-WAN networks reduce the power and cost of transmission in an IoT network

2010 BMW and Siemens unveil smart traffic lights that use sensors and AI to route traffic intelligently

Sensors drop in price, driving smart home technologies including smart lighting, security and heating systems

2011 BYOD (bring your own device) becomes mainstream as employees start using their own smart devices in the workplace

2023 McKinsey predicts the worldwide number of IoT-connected devices will rise to 43 billion
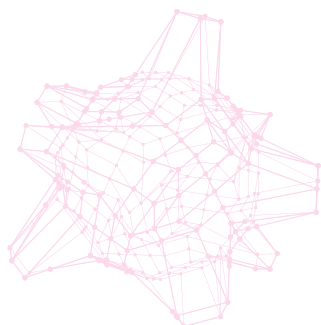
A glimpse into the future

The IoT: the next 5 years
Our predictions for 2023

1

Tiny low-powered devices that use the latest narrowband-IoT (NB-IoT) technology will become the norm. These devices will become essential for the remote monitoring of infrastructure such as roads and bridges.

2

5G will drive wide-scale industrial automation (known as Industry 4.0) using IoT technology. Its low latency makes it ideal for use in automated trucks as well as drones for factory maintenance and parcel delivery. According to research from the McKinsey Global Institute, digitisation of factories could lead to increased growth of between £904bn and £2,767bn over the next 10 years.

3

Partnerships will be key. Even now it is rare that organisations have all the skills and resources to launch a successful IoT project on their own; the digital skills shortage will make this even more difficult in the future.

4

IoT, combined with AI and machine learning, will make the digital supply chain much more transparent. For example, IoT sensors will be able to locate any item at any time.

And beyond to 2030...

1

Using IoT sensors, in conjunction with 5G and AI, autonomous trucks and vans will become widespread on UK roads. They will become the major means of transporting goods between warehouses and to the end user.

2

The ethical and environmental values of the young will increase pressure on businesses to seek purpose beyond profit. As automation fulfils the "dangerous, dirty and dull" roles, there will be a premium on human creativity.

3

Smart cities where sensors control everything from street traffic to drainage and rubbish collection will become the norm. New green spaces, including vast "vertical forests" on the roofs of skyscrapers, will clean the air while urban agriculture (in tunnels and skyscrapers) can grow fresh food in city centres.

What does 5G mean for data, privacy and identity?

The primary factor that encourages consumers to exchange personal data with industry is the overall level of trust in the specific business or organisation.

What does 5G mean for data, privacy and identity?
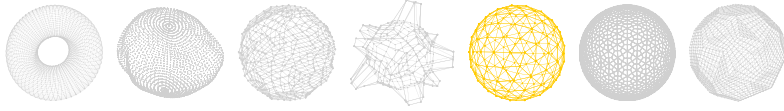
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Adobe

What does 5G mean for data, privacy and identity?

The 5G era has arrived, promising to bring with it a host of new business and consumer applications. But while 5G offers much greater connectivity than its predecessors, 3G and 4G, it also offers more contextual information about a user, including what devices they own and potentially what they like to watch.

In particular, 5G's increased capacity – typically 100 times greater than 4G – will accelerate the Internet of Things (IoT) revolution, turning previously 'dumb items', such as light bulbs, speakers and fridges, into 'smart' devices by connecting them to the internet. From these devices, concerns have been raised that telecom providers, advertisers and technology companies will all have the ability to glean incredibly valuable information about their users, potentially without them having any idea their data is being used, which is why it is important for businesses to build consumer trust during 5G rollout.

Because 5G has a smaller coverage area than 3G and 4G, it requires more cellular towers to be placed together within a smaller radius, helping mobile operators track a user's precise location and even understand their movement much more closely than at present. This will in turn increase the amount of consumer data moving across networks and so there is an increased requirement for operators to handle data more responsibly and review current practices in line with consumer expectation.

Governments, too, are increasingly focussed on how the technology should be used by companies more responsibly and also on how 5G networks should be deployed in sensitive parts of the government's IT infrastructure.

In this whitepaper we look in more detail at some of the risks and benefits of 5G when it comes to data security and what can be done to mitigate these.

Increased consumer data – balancing risks and opportunities

There is no doubt that we are all extending our digital footprint. Individuals who until a few years ago only connected to the internet via a laptop or desktop computer now typically have several internet connected devices, including a smartphone, smart speakers and wearable devices to monitor their health and fitness.

Companies which once only used the internet for email communications between employees are now using IoT devices for monitoring energy efficiency within a building, optimising the supply chain and monitoring stock levels. According to Vodafone's 2019 IoT Barometer, nearly half of companies (48%) adopting IoT are seeing improved collection of accurate data and 58% of those companies are using analytics to improve business decision making.

Enterprises are at a particular risk of getting valuable data stolen by hackers for multiple reasons, including financial gain or even from rival firms trying to gain a competitive advantage. The 2019 Verizon Data Breach Investigation Report (DBIR) found that 69% of cybercrimes were perpetrated by outsiders and 34% involved internal actors. Around seven in ten were financially motivated and around 25% related to cyber-espionage.

Further research from insurance company Hiscox from 2018 shows that small businesses are the target of 65,000 attempted cyber-attacks every day, with nearly one in three having suffered a breach in the previous year. This costs an average business over £25,000 in direct costs (i.e. paid ransoms, replacement hardware) but potentially much more in terms of damage to reputation and lost customers.

The 2019 Verizon Data Breach Investigation Report (DBIR):

69%
of cybercrimes were perpetrated by outsiders

34%
involved internal actors

70%
were financially motivated

25%
were related to cyber-espionage

Increasing data awareness

Undoubtedly, high-profile data breaches have helped to raise customers' awareness and concerns over data protection issues and this has in turn led responsible businesses to give clear disclosure and transparency on how their data is used. At the same time, legislation such as GDPR (General Data Protection Regulation) in Europe and the California Consumer Privacy Act in the US are helping to inform, and help both consumers and industry manage, the way data is used.

There is still some way to go for industries to articulate the benefits and rewards to consumers in sharing their data. According to the DMA Group's _Global Data Privacy: What the Consumer Really Thinks_, there remains an imbalance on who is perceived to benefit from the current data economy. On average, 78% of consumers still believe that industry benefits most from data sharing, with just 9% believing that consumers currently benefit the most.

A 2018 study from globalwebindex showed that around 70% of internet users in the UK and US were more concerned about their online privacy than they were 12 months earlier, with a similar percentage (72%) saying they were more aware of companies collecting their data. However, less than half (49%) of those surveyed said they felt in control of their data online.

Data security and consumer privacy is top of mind in the digital economy and to address the imbalance in the mind of consumers companies are becoming more transparent about the benefits that data sharing has for consumers in terms of personalisation and enhanced customer experience and also by being responsible in the way they handle and share customer data and this is a positive progression on both sides.

To what extent do you either agree or strongly agree with the statements below?

● I am concerned about the internet eroding my personal privacy

● I worry about how my personal data is being used by companies

NORTH AM — 62% / 65%
EUROPE — 51% / 60%
MEA — 63% / 65%
LAT AM — 59% / 82%
APAC — 61% / 60%
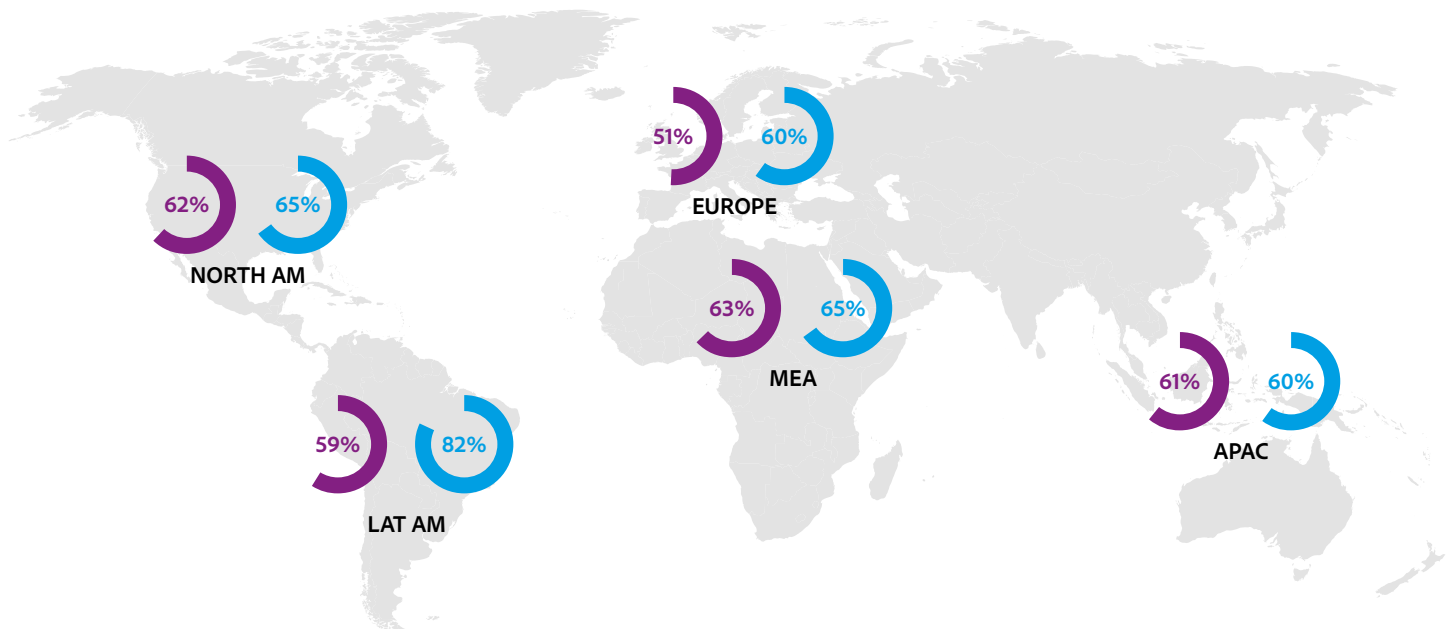
Source: GlobalWebIndex Q2 2018.
Base: 91,913 internet users aged 16-64.

4
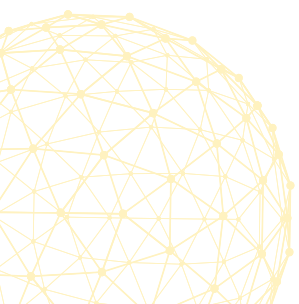
% who say they do/do not trust the following industries to handle their personal data online

Service	1	2	3	4	5
Search Engine/Email Service	24%	24%	27%	13%	11%
Music/Video Streaming Service	27%	22%	30%	11%	9%
Online Retail Service	33%	27%	24%	12%	5%
Social Media Service	19%	17%	30%	16%	19%

1	**2**	**3**	**4**	**5**

I trust this service with my personal data   **I do not trust this service with my personal data**
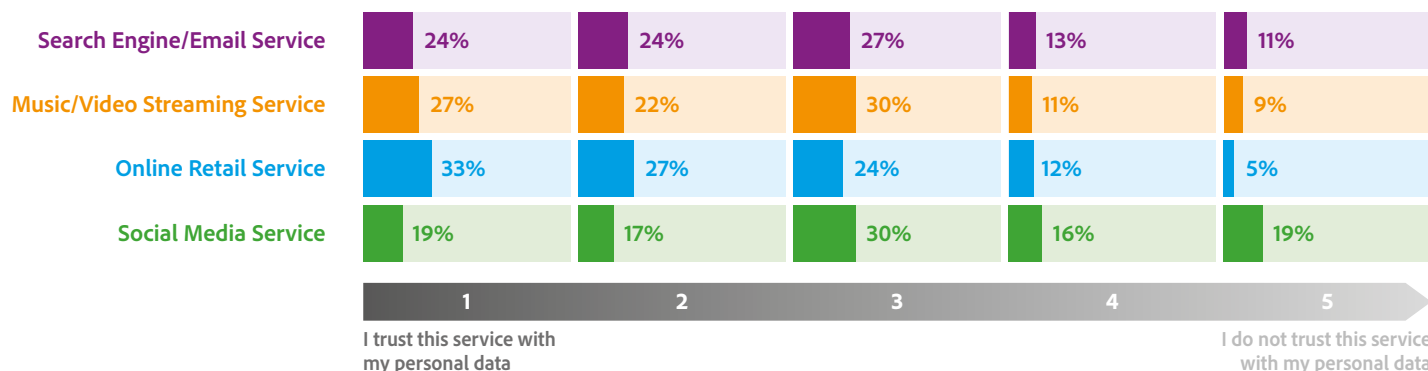
Source: GlobalWebIndex 13-15th September 2018. **Base:** 1,329 (US) & 1,305 (UK) internet users aged 16-64.

Building trust and transparency

Such a discrepancy between being aware of the data being used, but unaware how to control its use, inevitably only serves to increase potential mistrust between the consumer and the brand. Establishing, or re-establishing, this trust must be at the heart of building an online relationship with the consumer and the switch to 5G provides another opportunity to build on that trust.

According to GlobalWebIndex, consumer trust of brands varies considerably depending on the sector and according to age. Only 19% of respondents strongly trust social media companies with their data, compared to 27% for a music/video streaming service and 33% for an online retail service. However, almost half of 45-64 year olds say they don't trust social media services with their personal information.

Indeed, the primary factor that encourages consumers to exchange personal data with industry is the overall level of trust in the specific business or organisation, claims the DMA Group in its *Global Data Privacy: What the Consumer Really Thinks* paper. Its findings show just over half (51%) of consumers across global markets put 'trust in an organisation' in their top three factors that make them happy to share personal information with a company.

The vast majority of consumers across all markets also claim that increased transparency over how their data is used and collected is critical when sharing personal information with businesses. Indeed, 86% of consumers globally state that transparency over how their data is used and collected is important when exchanging data with a company, the DMA Group claims.

"Just over half (51%) of consumers across global markets put 'trust in an organisation' in their top three factors that make them happy to share personal information with a company."

Global Data Privacy: What the Consumer Really Thinks paper (DMA Group)

5G is improving data security

Yet despite some concerns around data security, 5G is, in some ways, actually more secure than both 3G and 4G in several key areas. Firstly, it encrypts more data, leaving less unencrypted data for anyone to intercept.

For example, 5G provides much better roaming encryption than 4G. When a 4G phone connects to a base station, it authenticates the user's identity, but does so without encrypting the information, leaving it vulnerable to attack. With 5G, both the user's identity and location are encrypted, making them virtually impossible to identify or locate from the moment they get on the network.

5G is also a much more software and cloud-based system than previous wireless networks, which allows for better monitoring in order to spot potential threats.

Finally, 5G enables operators to do what's called "network slicing", segmenting the system in numerous virtual networks, rather like having your own private network. Capable of being managed and customised separately, these different "slices" can be given different tailored protections for different devices and use-cases.

New era of digital connectivity

5G networks are set to herald a new era of digital connectivity – one in which more and more devices will be connected to the network and to one another. Inevitably, as these devices proliferate so too will the amount of data that can be collected.

In particular, 5G's ultra-low latency and high capacity makes it particularly well suited for mission-critical applications such as smart city infrastructure, making security of paramount importance. For individuals, 5G will enable new types of applications that enable us to monitor everything from how we run our homes to potential signs of our bodies developing an illness.

Given this sensitive data, it's imperative that end users trust the brands they are dealing with and brands manage this data appropriately. This means companies must be transparent about how data is being used and monetised. They must also take steps to ensure that data is kept securely by putting in place processes to deal with and mitigate security incidents, including responding appropriately if, and increasingly when, there is an incident.

While there is a still long way to go before many consumers have a full understanding of how their data is used, there is increasing evidence that it is becoming more important to them since the introduction of regulation such as GDPR. In the 5G era, only companies that take data privacy seriously can hope to succeed.

What does 5G mean for telco operators?
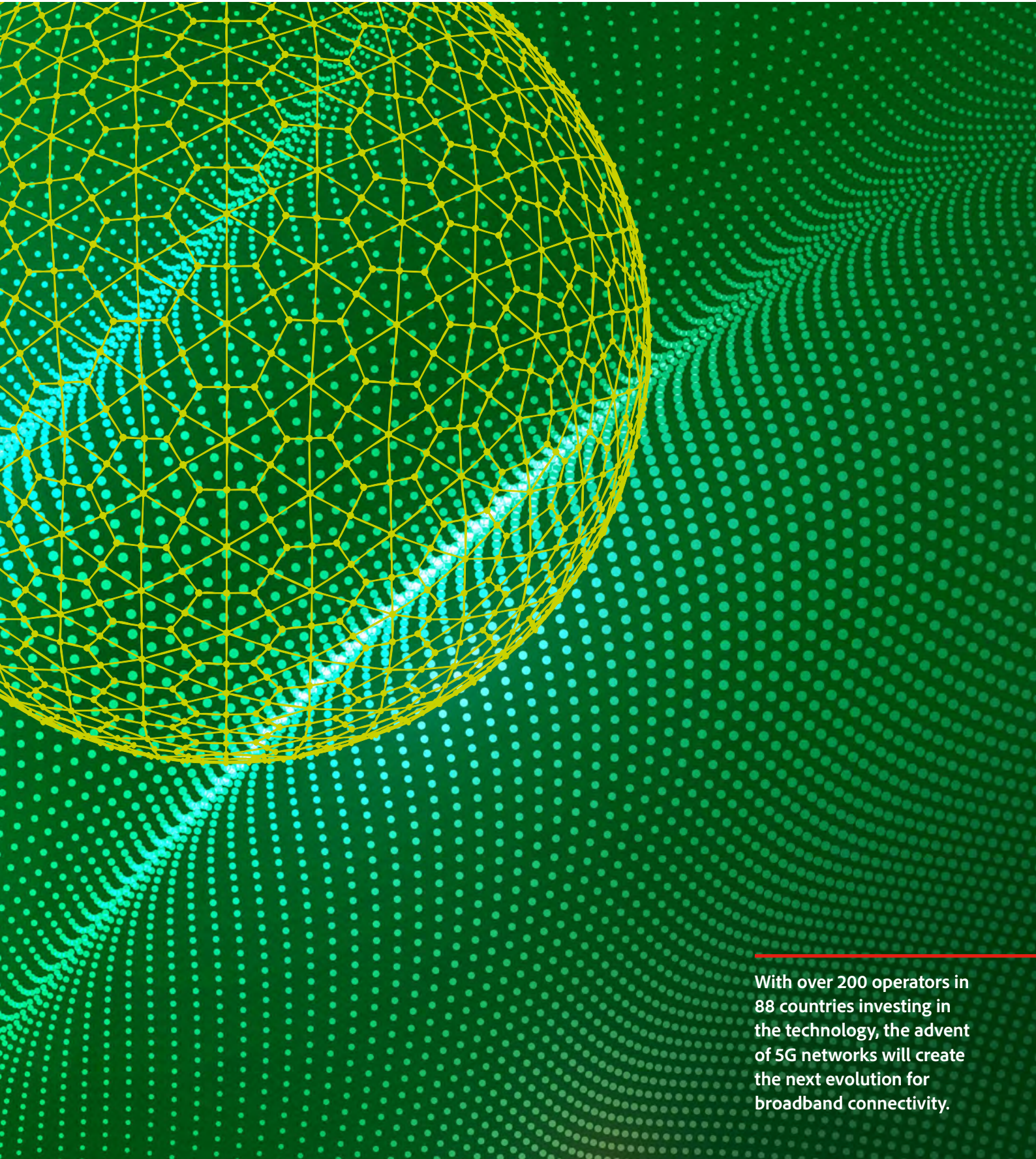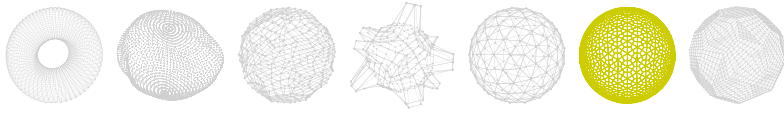
With over 200 operators in 88 countries investing in the technology, the advent of 5G networks will create the next evolution for broadband connectivity.

What does 5G mean for telco operators?

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What does 5G mean for telco operators?

With over 200 operators in 88 countries investing in the technology, the advent of 5G networks will create the next evolution for broadband connectivity. Unlike the shift from 3G to 4G, the adoption of 5G is much more than simply offering higher speed. With 5G, latency, or lag, is significantly lower and capacity much greater than its predecessor – typically 100 times greater than 4G.

It's also much 'smarter' than 4G, opening up a wealth of new opportunities for telecom operators. Once it becomes truly viable, certain device segments will be connected in entirely new ways, including vehicles, appliances, robots and city infrastructure for 'smart cities'.

However, rolling out 5G certainly isn't without its problems. These include the costs of building out a new network, security and privacy concerns, as well as the availability of 5G handsets. Here we look at some of them.
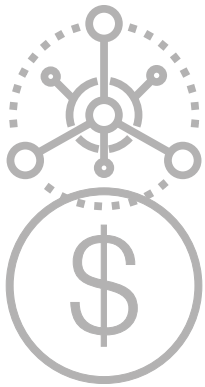
Infrastructure costs

Much like 4G plans incurred a higher initial cost, 5G is following a similar path. The difference is though that it's not quite as simple as building a layer on top of an existing network. 'Instead it's like laying the groundwork for something new altogether,' believes Futurithmic.

Despite 5G offering a significant increase in speed and bandwidth, its more limited range requires much greater infrastructure. Higher frequencies enable highly directional radio waves, meaning they can be targeted or aimed, a practice called beamforming. But while 5G is able to handle more users and more data, the challenge is that its antennas cover shorter distances.

This means that more of them have to be installed on buildings or homes, with cities having to install extra repeaters to spread out the waves for extended range. Spreading out access to rural areas will be as much of a challenge as it is with 4G.

The result is that investment in 5G will be huge. According to _Heavy Reading's Mobile Operator 5G Capex_, total global spending on the technology is set to reach £65 billion by 2023 – see graphic below. But Greesill, a company that provides working capital to industry, claims the global cost of 5G infrastructure investment and enabling the 'Internet of Things' (IoT) could run as high as £2 trillion by the end of 2020.

Excerpt: Forecast Annual Global 5G Capex by Mobile Operators


Source: Heavy Reading.

3

Greater consolidation

Inevitably, for telcos, getting the necessary funding required for 5G remains the biggest challenge. For Alex Evans, Head of TMT, Barclays EMEA, publicly listed telcos are currently struggling to get support from investors. "One of the problems you have if you are a listed telco is that the stock market isn't supporting you despite the need for broadband and 5G," he recently told the audience at Deloitte's Media and Telecoms 2020 and Beyond Conference. "The reason is that the businesses aren't delivering financial growth and significant returns on capital."

Indeed, Telecom Italia's Lucy Lombardi outlined the difficulties being faced by the operators during a Madrid 5G core conference last year. Between 2010 and 2018, Lombardi suggested in an article on Telecoms.com industry revenues were down £20 billion, but the telcos had invested £187 million in the network. Over 2019-2025, Lombardi suggested another £1.04 trillion would be spent by the industry, 70% of which would be on deploying 5G.

As a result, according to Barclays' Mr Evans, we will see much greater consolidation among telcos over the next few years. "Given the scale of capital required for 5G and fibre to connect Britain, the volumes are so big you are going to have this continual tension between the private networks and the public networks," he said. "Either way you go you need consolidation because that's the only way you will get the financial return to deliver the critical infrastructure."

European telecoms share performance 2009-2019
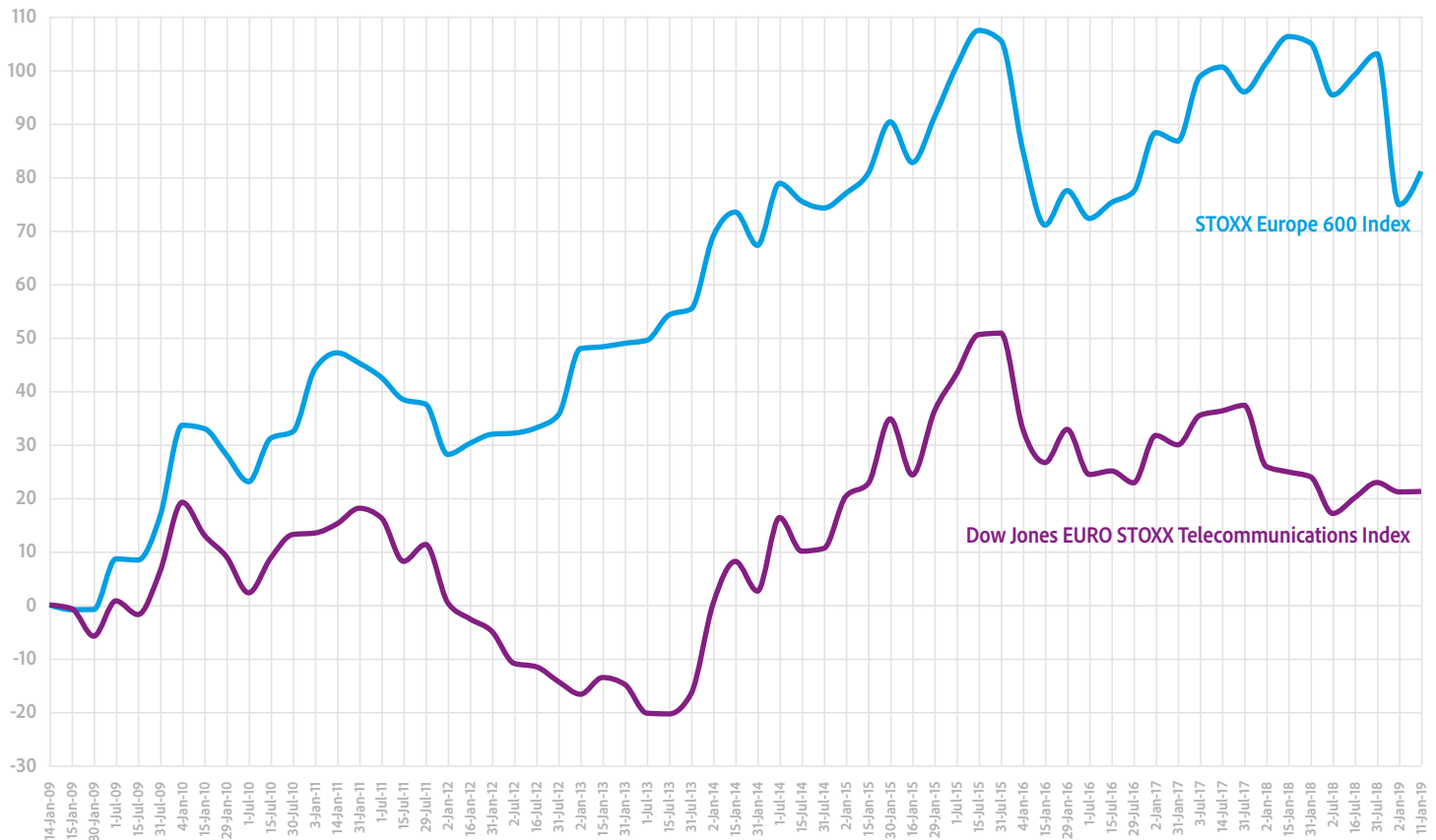
Source: CapitalIQ; EY research "The Mobile Economy 2019" GSMA, February 2019.

"One of the problems you have if you are a listed telco is that the stock market isn't supporting you despite the need for broadband and 5G."

Head of TMT, Barclays EMEA
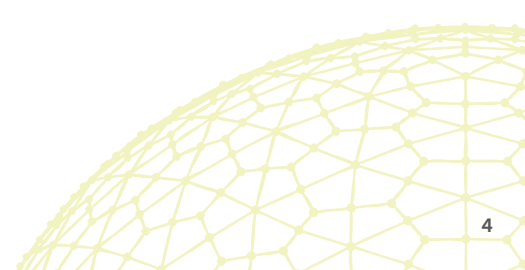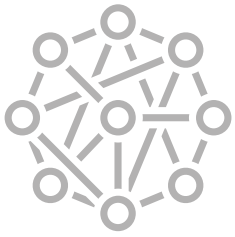
Network sharing

Already, network sharing has become commonplace among telcos and this will only accelerate as 5G rollouts continue. According to McKinsey's 2018 paper, *Network Sharing and 5G: A Turning Point for Lone Riders*, operators have been able to reduce 'the total cost of ownership by up to 30 percent while improving network quality through sharing a variety of both active and passive equipment'.

The report claims that 5G will be no exception, with operators eyeing new ways of accelerating the deployment of an 'otherwise daunting investment'. To proceed alone, the report claims, network investments would have to increase by up to 60 percent with a significant increase in operating expenses, doubling total costs from 2020 to 2025. This investment is required for the 'deployment of a new, countrywide 5G IoT macro layer, small cells in urban areas and the evolution of, and capacity upgrades to, the existing 4G macro network.'

"Network sharing will be vital to mobile operators still grappling with ways to make the economics of 5G add up," adds Kester Mann of CCS Insight in an article on Telecoms.com from January 2020. He claims Deutsche Telekom has projected that cost to deploy 5G across Europe will come out 'at between €300 and €500 billion' and that Poland is considering plans for a single national 5G network at 700MHz.' He said it would be no surprise to see a European city take the plunge and deploy all 5G mobile infrastructure through a third party."

Meanwhile, in the UK, four telcos (EE, O2, Three and Vodafone) have developed a Shared Rural Network investing £500 million into the project, with another £500 million being put forward by the UK Government.

Overseen by a jointly owned company called Digital Mobile Spectrum Limited, the plan includes reciprocal agreements between the telcos to share existing infrastructure and also joint investments to build telco-neutral sites for total 'not-spots'. And while it's currently based around improving the 4G network in rural areas, if successful it will no doubt be extended to 5G in the not too distant future.
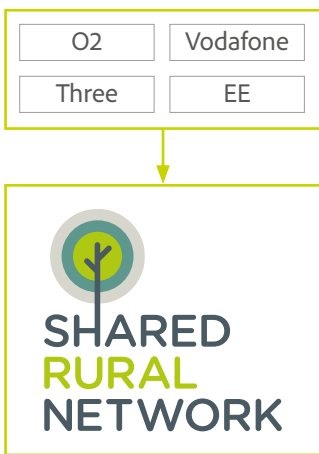
Cumulative number of active network-sharing agreements announced 2010-2017
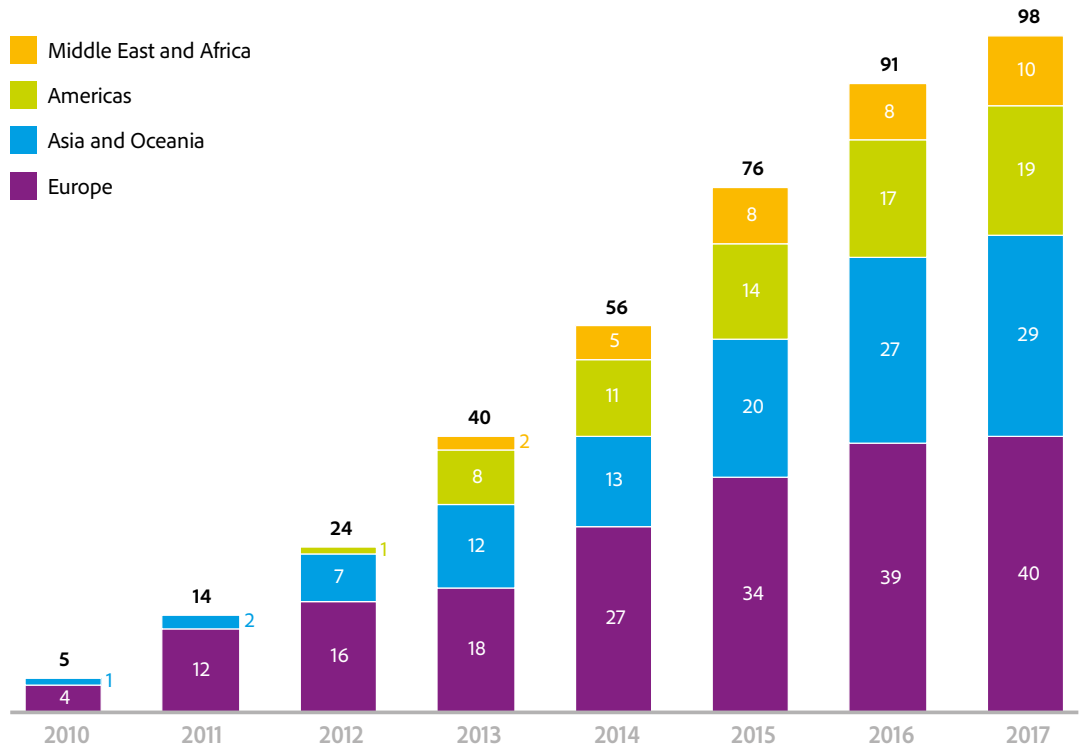
Source: GSMA Intelligence; Ovum; McKinsey analysis.
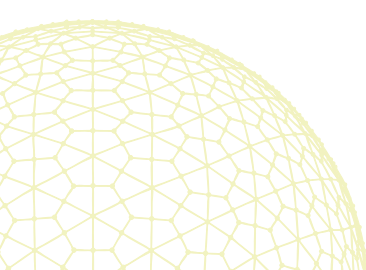
Potential disruption

Nor is the cost of infrastructure the only challenge for telcos when it comes to rolling out 5G. Inevitably, Covid-19 has brought a new set of problems, most notably the bogus conspiracy theories linking 5G technology with Coronavirus, which has seen over 20 phone masts vandalised in the UK.

5G's impact on wireless radiation is also attracting attention, posing challenges to national and regional regulators to mitigate health and environmental concerns. Universities are playing an increasingly important role in trials of new 5G use cases across a range of industries, claims EY.

Controversy over the relationship between Huawei and the Chinese government has also led to handset supply problems, particularly in Europe, while Apple is apparently considering pushing back the launch of its first 5G iPhones – initially planned for September – until 2021 because of possible weakened demand in the midst of a global pandemic.

Finally, there is potential for the telcos themselves to be disrupted, with technology specialists and industry vertical leaders looking to act as 5G mobile virtual network operators (MVNOs), taking advantage of new capabilities in network slicing. With the advent of private 5G networks, operators could be fully disintermediated from providing connectivity, just as Open Banking initiatives threaten the existing hegemony of long-established banks.

Revenue-generating opportunities

Nevertheless, despite these undoubted problems facing telcos, 5G undoubtedly represents a vast opportunity for operators, especially over the longer term.

According to telecoms industry association, GSMA, which hosts the Mobile World Congress, the number of devices connected to the IoT will triple to 25 billion by 2025, generating a fourfold rise in revenues to £822 billion. In Europe, mobile technologies and services are expected to account for 4% of regional GDP by 2022, up from 3.3% in 2017, its figures show.

Moreover, 5G chip manufacturer Qualcomm predicts that by 2035, when 5G's full economic benefit should be realised across the globe, there could be as many as £9.87 trillion worth of goods and services enabled by 5G mobile technology. The 5G mobile value chain alone could generate up to £2.7 trillion in revenue in 2035 and support up to 22.3 million jobs.

However, EY believes other regions are currently ahead of Europe in terms of 5G commercialisation with industry forecasts suggesting that 5G adoption rates in Europe could lag behind other developed regions over the next five years.

The 5G mobile value chain alone could generate up to:

£9.87
trillion worth of goods and services

£2.7
trillion in revenue

22.3
million jobs

5G as a proportion of total mobile subscriptions in 2025 (by %)

South Korea
56

United States
50

Japan
48

Europe
29

China
29

Gulf Cooperation Council
16

Latin America
8
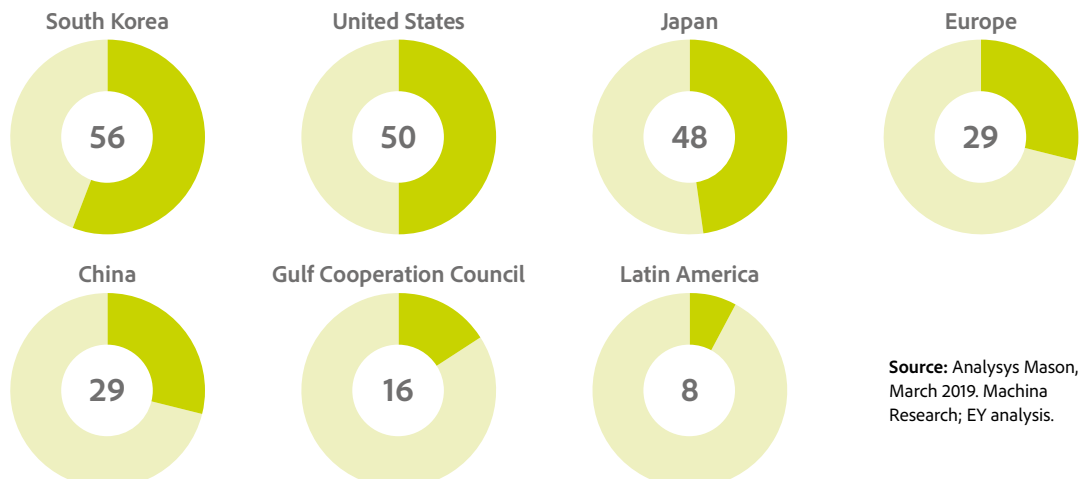
Source: Analysys Mason, March 2019. Machina Research; EY analysis.

5G for operators: reasserting control?

With 5G set to play a crucial role at the heart of digital connectivity, telcos stands on the verge of a massive transformation. Improved data rates and ultra-low latency will bring new levels of network responsiveness. 5G can also support a hundredfold increase in connected devices per unit area, redefining what's possible in IoT with network slicing enabling highly differentiated services at specific locations.

Furthermore, emerging technologies are set to complement 5G, outlined in EY's paper, _5G is Redefining Telecoms Fast. Are You Up to Speed?_ It claims mobile edge computing will help unlock more efficient data transfer and perimeter security, enabling operators to relieve network congestion and realise low latency. Network function virtualization (NFV) and software-defined networks (SDN) will also bring long-term CAPEX and OPEX savings, at the same time as delivering greater network automation.

By leveraging analytics, artificial intelligence (AI) and machine learning in conjunction with 5G, operators will be able to offer a range of location-based and context-aware services across millions of end-points, claims the EY report. "As a result, operators can play a more assertive role in the industry value chain. No longer relegated to the role of dumb pipe provider, operators' much more intimate relationship with their networks will help them pave the way for new forms of customer experience and service monetisation."

New business models

Three main areas that telcos will be looking at developing for 5G

Across the board, it's clear that 5G will bring opportunities for telecom operators, not all of which have yet to be developed. However, Tantra Analyst in its paper _Building 5G IoT on the Solid Foundation of LTE IoT_ outlines three main areas that telcos will initially be looking at developing for 5G. These include the following:

1

Enhanced mobile broadband (eMBB)
The gigabit user data speeds and huge amounts of capacity ensure that 5G offers always-on connectivity no matter how crowded the network. As well as ultra-high-speed mobile broadband, 5G will provided an alternative to fixed broadband for consumers and for enterprises as well as new types of applications and services using AR and VR technologies – many of which have yet to be developed.

2

Massive IT roll-out
While IoT is already available over 4G networks, most predict that 5G will take it to the next level. That's because 5G has the ability to support a very high density of low-power IoT devices in a very small area – up to one million devices in one square kilometre area.

### 3

Industrial automation mission critical infrastructure
Low latency and high speeds make 5G a perfect fit for time-sensitive IoT applications. Autonomous vehicles, drones, first responder devices and healthcare wearables are just a few of the devices that will benefit from 5G. Replacing fixed Ethernet infrastructure and legacy mobile networks with the latest version of 5G will help to drive the latest phase of industrial automation, known as Industry 4.0, as well as encourage the growth of connected 'smart cities'.

Look to the future

Undoubtedly for telcos there are a number of challenges that 5G poses. These include huge infrastructure costs, possible disintermediation from virtual network operators and concerns around wireless radiation. Added to this, Covid-19 has presented its own problems, with rumours of delay in the first 5G iPhone handsets and misinformation on social media falsely linking the spread of Coronvirus with 5G masts.

However, many of these problems are short-term and in the longer term the technology will bring many benefits both to the enterprise sector and to the consumer. Coupled with new technologies such as Network function virtualisation (NFV) and software-defined networks (SDN), 5G can help reduce operating and capital expenditure costs while new business models, most notably around IoT, will help drive the revenues of telecom operators over the next few years.
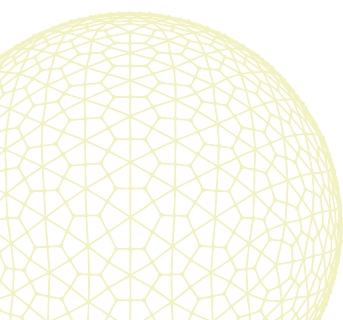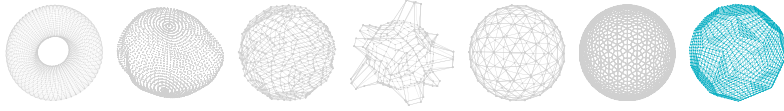
Adobe Experience Platform and 5G
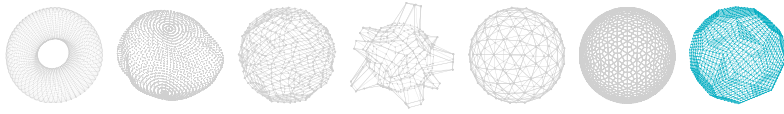
5G will provide opportunities for new and potentially disruptive business models as industries seek to capitalise on the technology's high speed and ultra-low latency in order to drive incremental revenue and create competitive differentiation.
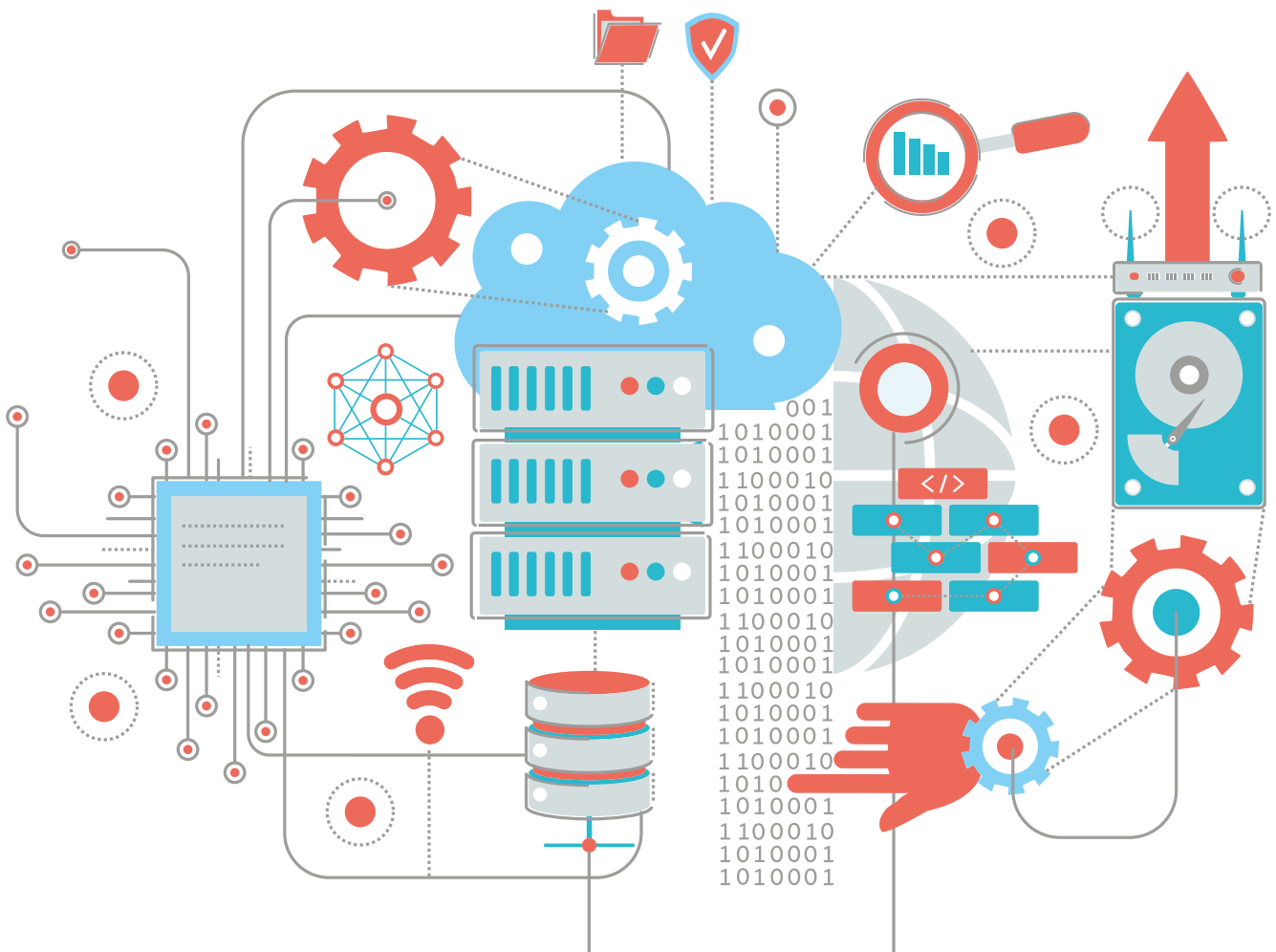
Adobe Experience Platform and 5G

Contents

Adobe Experience Platform and 5G

5G will not only change the way we all communicate, it will also change the way businesses operate and the services they offer. Whereas previous generations of mobile technology created a new breed of digitally savvy consumer and accelerated digital transformation in customer experience, the adoption of 5G will transform the business environment through the creation of a vast IoT (Internet of Things) digital ecosystem.

New networks will form to serve the communication needs for billions of interconnected connected devices, supporting an even wider range of products and services. 5G, IoT, data and analytics will combine to provide new business models across all sectors. To support the ever-expanding ecosystem of partners and channels, businesses will need to move away from their siloed, legacy systems to cloud-based data and content management strategies which are capable of supporting rapid application development.

Improving customer experience

Undoubtedly, 5G will provide opportunities for new and potentially disruptive business models as industries seek to capitalise on the technology's high speed and ultra-low latency in order to drive incremental revenue and create competitive differentiation. Improvements to network infrastructure will also fundamentally change consumer behaviour and their expectations of what the technology can offer.

Consequently, companies that want to be successful will have to place an even greater emphasis on customer experience, broadening their service offerings and improving their personalisation strategy to meet rising consumer expectations. This will require building extensive new partnerships, rapidly deploying new type applications and launching new formats such as AR and VR.

In order to gain a share of the estimated £1.5 trillion 5G market potential, many businesses will also have to transform their organisational structure, processes and tools so they better understand the customer journey and gain further insight into potential new services that can drive growth and hopefully build long-term loyalty.

As technology accelerates, we will inevitably see a bigger divide open up between well designed interfaces and those that can't deliver on the capabilities of the newly upgraded 5G infrastructure.

While some businesses will respond to the challenge, delivering personalised journeys and immersive experiences demanded by consumers, there will be those clinging to websites that aren't optimised for mobile and clunky website portals who struggle to survive in the 5G era.
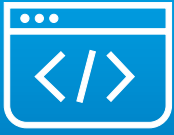
Shift to open source

As part of moving to a broader ecosystem framework, which will become increasingly necessary to remain competitive over the next few years, many large organisations find themselves constrained by legacy technologies in both applications and infrastructure. These legacies tend to have formed a centrally developed, hosted and managed enterprise system that is difficult to replace and equally difficult to integrate with other systems or organisations.

With the increase in global distribution of content and collaborative projects between organisations, it is important to unpick these enterprise systems to decentralise applications and data to avoid these complexities; reducing the overall cost to all parties involved and allowing the data to be stored where it is most effective – see data strategy.

As data and content workflows become increasingly digitised, there has been a huge increase in the demand for hybrid-cloud computing – an infrastructure architecture that connects public cloud services to private, local area or on-premise cloud services. For example, many of the world's largest media organisations use hybrid-cloud as a way to benefit from the scalability and flexibility of the public cloud to store streaming media while maintaining the security and control of on-premises infrastructure.

> Open source is no longer seen as a fringe approach to software, with several industries, in particular the media industry, moving their core software systems to open source.

The cloud environment simplifies the development, deployment and management of application development across disparate types of infrastructure that encompasses the edge across identity, data, application platforms, security and management. This will encourage the rapid diversification and launch of products and services which will become even more important with the rollout of 5G.

By adopting open-source application and data software, as well as using microservice and event streaming frameworks, businesses will be able to support the development of new products and experimentation with different business models.

Open-source applications have massive and rapid adoption when they achieve product-market fit and, in turn, this virality also allows for open-source software providers to be far more efficient than traditional software businesses from a cash consumption basis. Due to the open nature of the platforms, they often allow for greater customisation to requirements than a proprietary solution.

Indeed, open source is no longer seen as a fringe approach to software, with several industries, in particular the media industry, moving their core software systems to open source.

Technologies such as Adobe Experience Platform support such open source environments in a number of ways – from open sourcing their own data models (XDM) to using open-source technologies such as Kafka and Spark within their own tech-stacks. By providing an API-first approach to development, these experience platforms offer a simple and seamless integration into architectures that support the flow of data across any closed or open sources technologies, often federating those technologies into a governance-focused, real-time enabled, responsive technology stack.
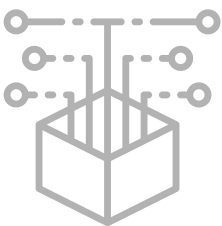
Separating data and function

Nor is moving towards open source the only move that organisations will have to make in the 5G era. In order to make the transition required to take customer experience to the next level – as well as support an expanding ecosystem of partners and channels required to create new services – businesses also need to assess their data management technology and infrastructure.

Ultimately this shift will require enterprises to move away from supporting legacy applications towards frameworks that allow for faster and continuous applications to keep pace with rising consumer expectations. In short, companies will need to find new and more efficient ways of managing and processing an ever-increasing amount of consumer data and enabling real-time access to that data by authorised front-end applications.

Adobe Experience Platform: Complete Data Platform
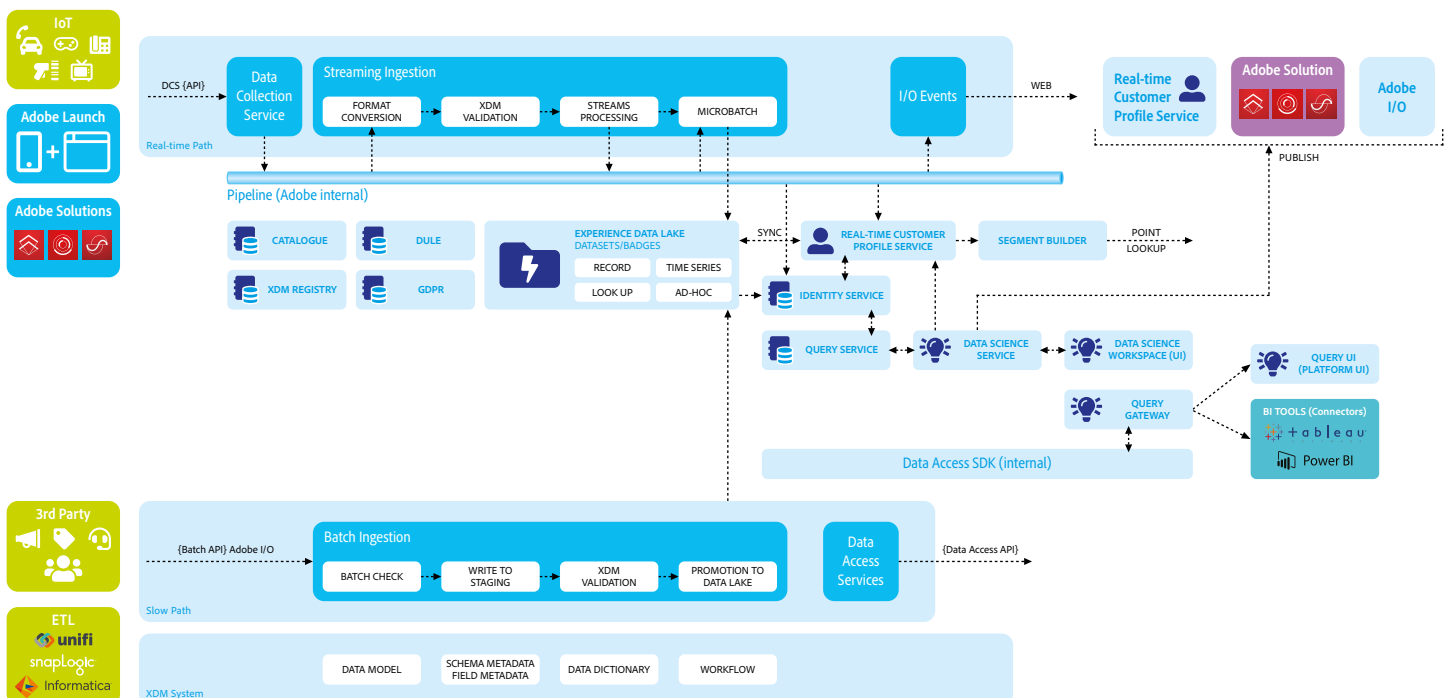
Supported by this unified, cloud layer across a wide range of functions... this new data model represents an essential business enabler providing access to new revenue streams.

Enterprises will need to evolve from just managing subscriber data to managing a whole variety of real-time data, including information on policy (such as GDPR), session, application and configuration across networks and digital eco-systems.

In order to address this complexity, data management solutions will require a common semantic data model framework, such as Adobe XDM, which can separate data and function. This new system architecture – built into the Adobe Experience Platform (AEP) – allows applications for network and business operations to securely store and access data and for operators and developers to have a unified view of it.

Working with open-source data models has a number of use cases: firstly it simplifies the exchange of data between business systems – crucial when you consider how 5G will potentially increase the transit of data between applications and platforms both owned and 3rd party. Secondly, it allows a business to tap into emerging industry data models, such as those within the finance and pharmaceutical industries. These allow for an enterprise to leverage those standards by integrating their own standard to the industry model, removing the need to perform multiple point-to-point integrations to multiple vendor data models. Thirdly, software vendors themselves are simplifying data flows by agreeing common data models. The Open Data Initiative (between Adobe, Microsoft and SAP) is an example of this, allowing businesses to access any ODI-compliant data sources through a single model.

Adobe Experience Platform's XDM models take this idea a step forward, by combining data labelling into the data model. This data labelling allows users to know what data the data actually is – identifying PII data, consented data or geographically ring-fenced data. Once data is labelled, it makes it easier to define how that data can be used and therefore apply data governance. By making this part of the data ingest stage, businesses can have more confidence that they are using data as intended and as consented; especially important when 5G promises more rich and comprehensive data to be manipulated.

Supported by this unified, cloud layer across a wide range of functions – including network automation, efficiency and mobile edge computing – this new data model represents an essential business enabler providing access to new revenue streams.

Adobe Experience Platform: Data Flows
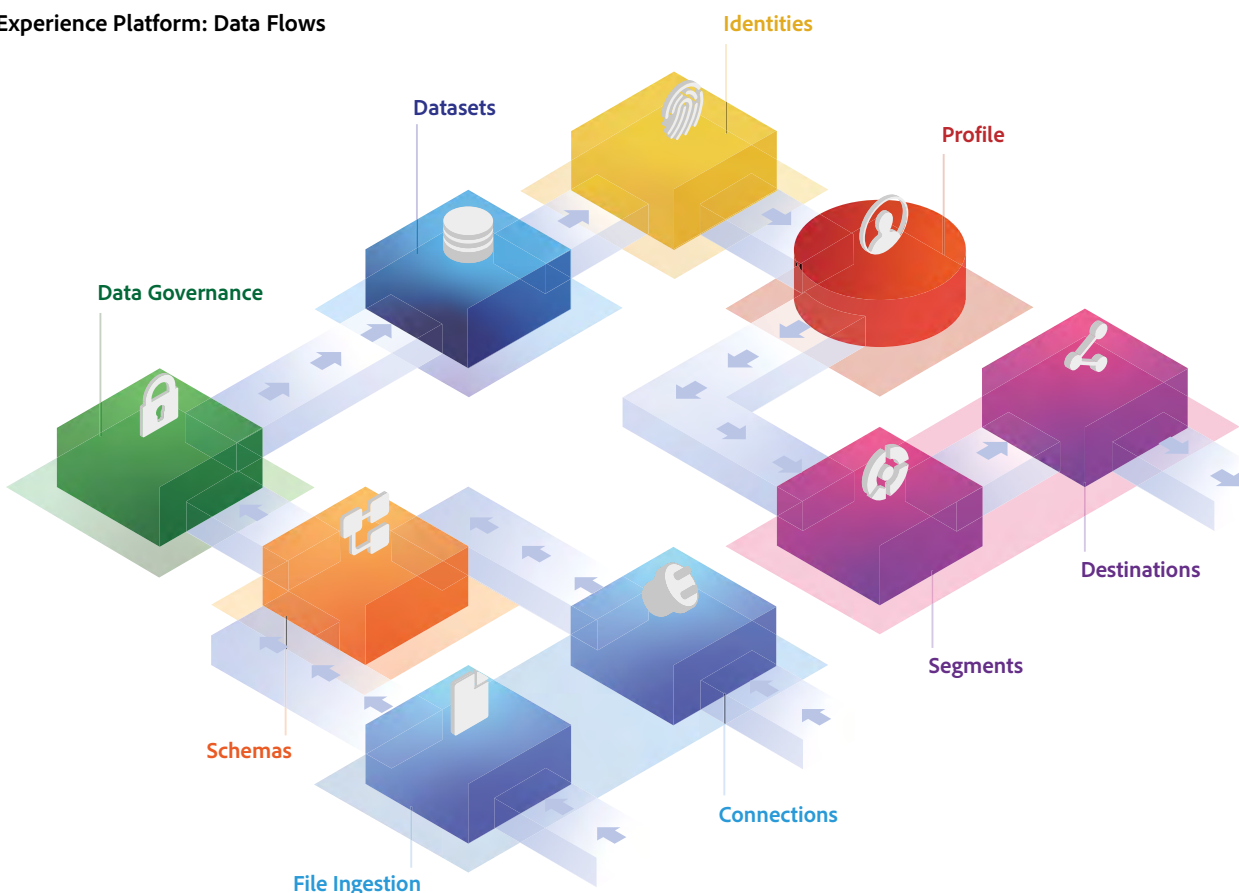
Creating an individual profile

Key to building engaging and relevant customer experiences in the 5G era is the ability to create a real-time, unified profile of an individual customer. At present, this is difficult for most businesses because they either have an unmanageable amount or too little, fragmented data. And it's a situation that is only like to get worse as businesses form new partnerships and business models to become competitive, while individuals impose their right for privacy through legislation such as GDPR in Europe.

One solution is to adopt a new type of data management system such as AEP. With AEP, enterprises can aggregate data from a number of sources, applying relevant governance to ensure only data that has already been authorised for use by individuals or organisations is used. Importantly, AEP allows companies to create a 360-degree customer profile, representing their behaviour and interests.

Using AEP's Identity Service, even businesses with fragmented data – such as logins, email addresses, loyalty cards as well as device IDs and browser cookies – can stitch together information to form an 'identity graph'. Storing all identifiers that correlate with individual customers, an identity graph combines deterministic data (i.e. data which is attributable to the individual through authentication) with pseudonymous data in the form of 'person clusters'. These are identities based on deterministic data enriched with additional anonymous data associated with an individual through probabilistic matching, derived from Machine Learning algorithms.

Using an algorithms powered by Adobe Sensei, or advanced segmentation tools within Experience Platform, person clusters can be used to develop highly personalised experiences for the individual customer and can also help marketers achieve scale through grouping. For example, person clusters can be grouped into household clusters representing people who live under the same roof or business clusters representing employee-employer relationships. Marketing messages can then be tailored to the larger group.

Adobe Experience Platform: Profile
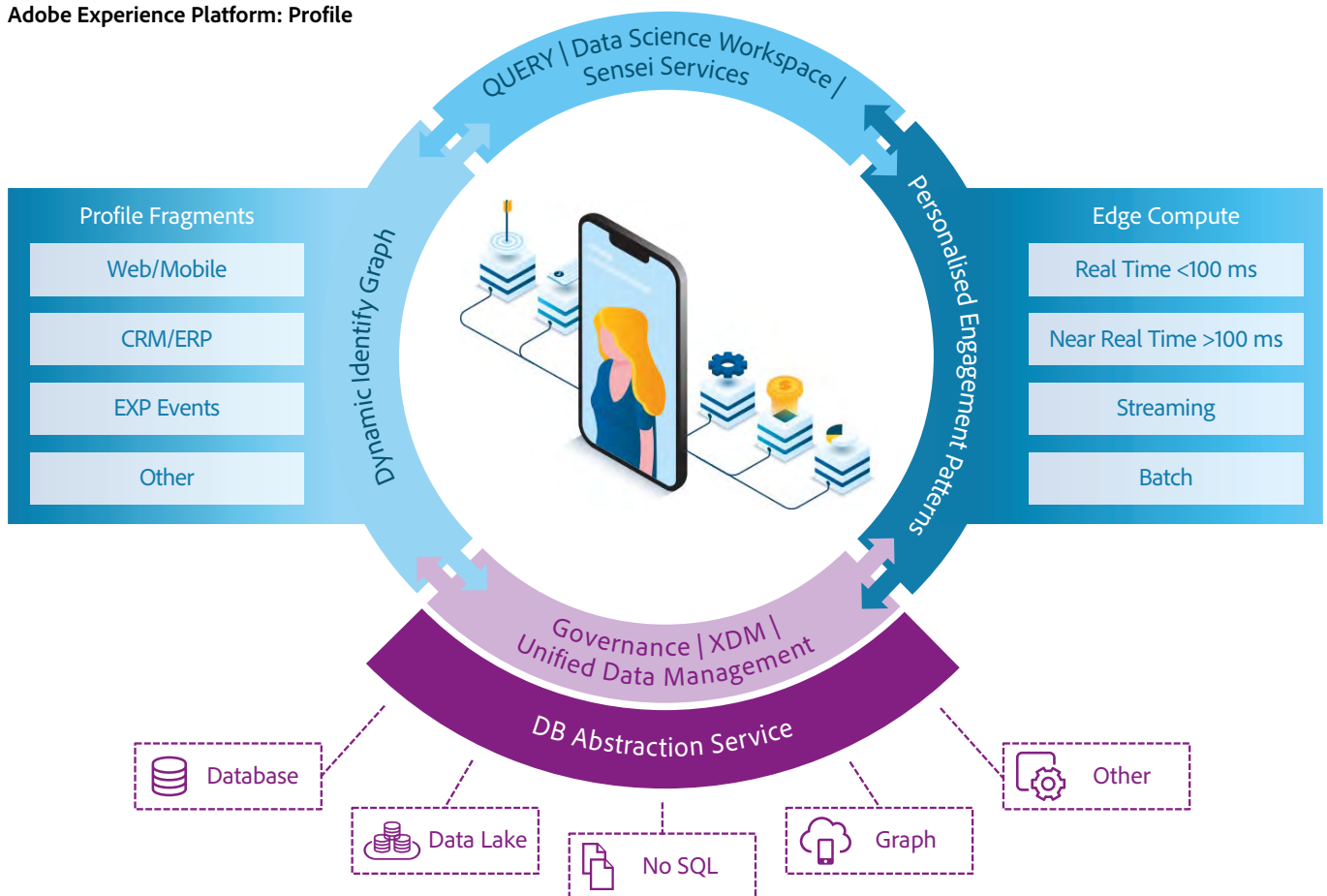
Adobe Experience Platform: Data Platform Architecture
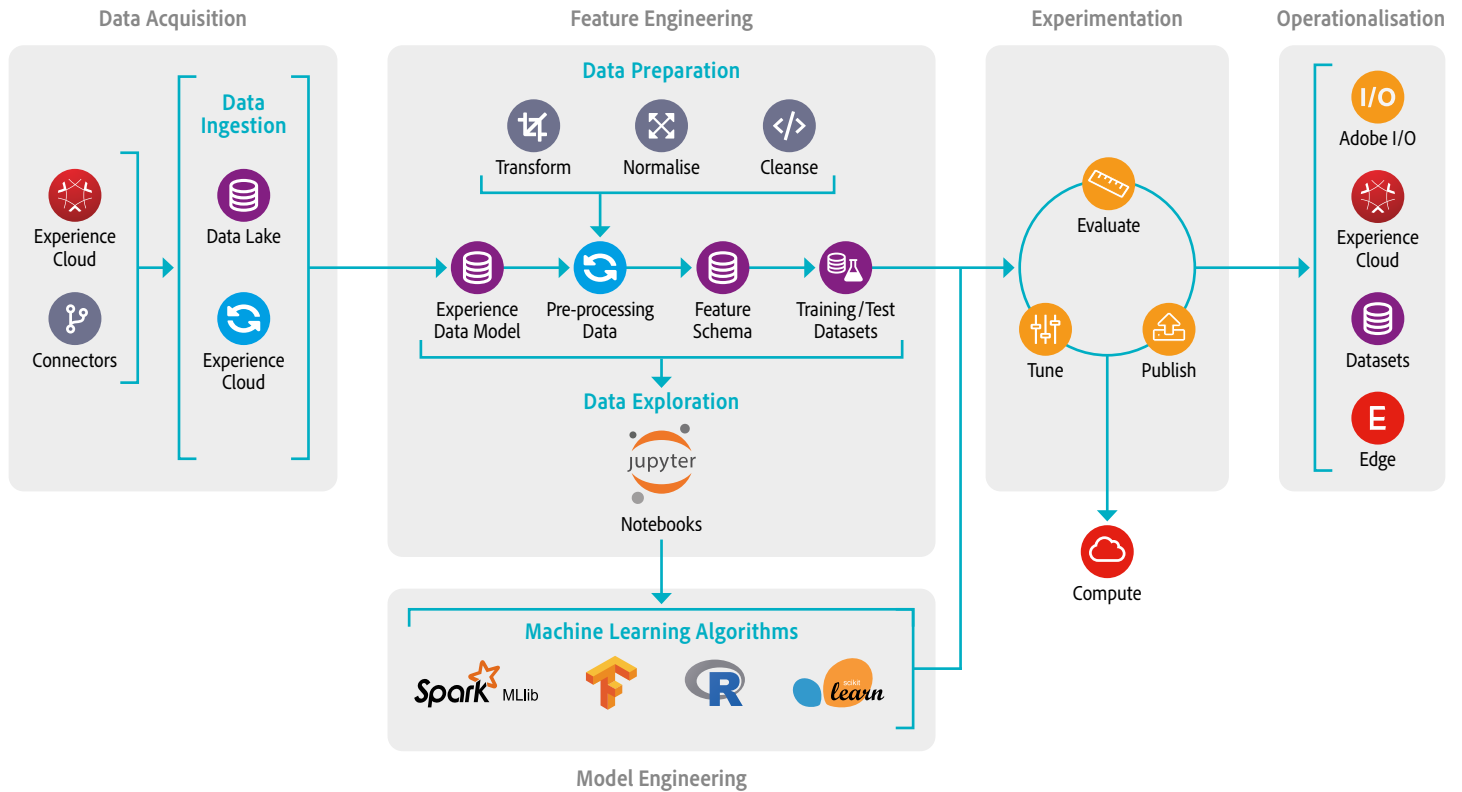
By connecting the data between all the touchpoints a customer has with a brand, Identity Service helps marketers know their customers more fully through identity graphs, allowing them to nurture customers through their entire journey with more relevant experiences along the way.

Working with identity graphs using Identity Service integrations within Adobe Experience Platform

Identity Service integrates with a broad set of APIs within Adobe Experience Platform in order to power cross-device features and solutions. Here are a few examples:

1 With **Adobe Analytics**, you can compress all your unique visits down to the number of people who actually generated those visits. This integration will also provide Cross-Device Analytics very soon that will allow you to visualise the paths that consumers take across your website and apps and with any device even when they are not authenticated.

2 You can use your identity graphs with **Adobe Audience Manager** to expand segments to include other devices belonging to the same consumers as devices that natively qualify for the segment.

3 **Adobe Target** allows you to extend personalisation to additional devices with AI-powered automation at scale and to optimise those experiences with A/B and multivariate testing.

4 Identity graphs can also be used with **Adobe Ad Cloud** for better forecasting and to provide more accurate people-based attribution allowing you to develop messages for people instead of devices.

Real-time segmentation, governance

Normal databases store data into tables. This is generally adequate for you own analysis. However, when you try to do that thousands of times per minute for the customer, and for millions of records at a time, it starts to become an issue as it doesn't scale very well.

Importantly, with AEP there isn't a single database which holds all of the information about a particular individual. This would simply be too unwieldy and cumbersome. Instead fragments of schemas are pulled together in real time in a 'virtualised data layer'. Comprising historical CRM (Customer Relationship Management) data and current experience events such as click streams, this is then mapped to the experience data model. This is a public source data model which Adobe has created with its own technologies that allows companies to map different data sources to each other.

Governance is also built into the data model so when data is ingested, it is being marked at the same time as to how the data can be used legally. For example, it looks at factors such as whether the data is consented, if it's personally identifiable, whether it's partner content and if the company is contractually allowed to use it. This means that when organisations come to use that data they are only using it for the purpose for which it has been allowed, making it compliant with legislation such as GDPR.

Once data is cleared for use and ingested into the AEP, it can then be used in conjunction with machine learning algorithms to make personalisation recommendations to customers in real time. It is even possible to make the values of these calculations in a profile so, for example, a business can identify people who match a certain criteria and whether they are likely to open an email. That makes it a powerful segmentation tool which can be used to build potential new business models, such as new microservices and new applications. Furthermore, to make the process as quick as possible, much of the segmentation and computation has been pushed to the edge network.
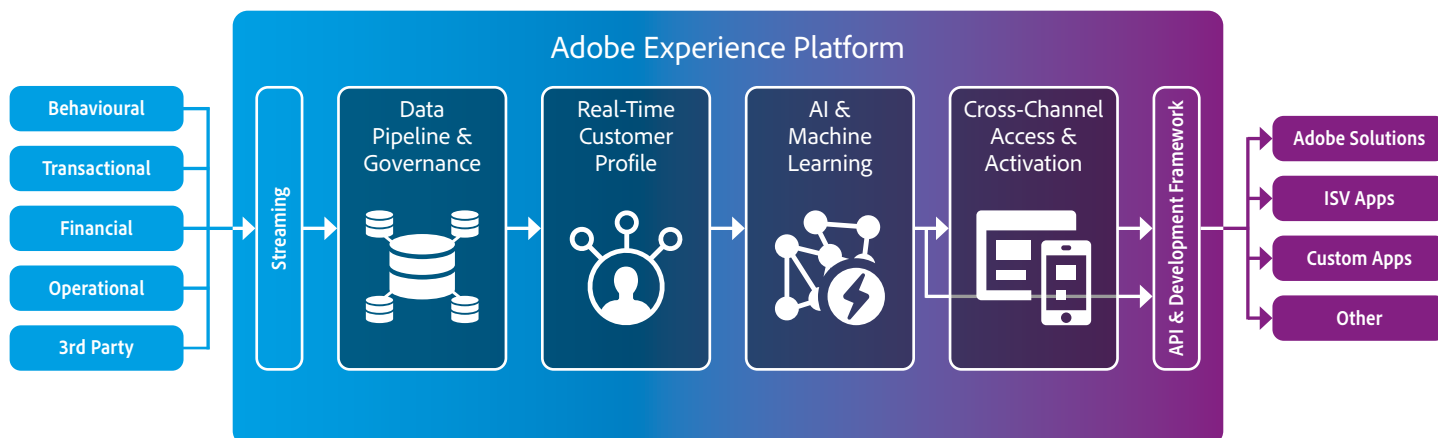
By combining data in real time to create personalised experiences for the consumer with the bandwidth capability and speed of 5G, companies now have the opportunity to innovate with new types of technology such as AR and VR too. For example, in the retail environment this may be someone using an AR app to take a selfie and 'try on a dress' while an individual holding up their camera to take a picture of, say, a flower could get information about it including its Latin name and where it grows.

For businesses, what AEP does is it allows them to build these highly experience orientated environments using the knowledge of their conversation with the customer up to that point from any data source that is both normalised and standardised. This means that eventually Adobe's current applications will become microservices – in other words the logic and workflows of how the data will be used to fulfil a business task. Companies can then build their own workflows on top of this, using standardised data underneath. Furthermore, because AEP uses a virtual data layer rather than a standard database, businesses don't have to carry out an immense overhaul and re-architecture their entire data system each time they create a new application, form a new partnership or develop a new business model.

By combining data in real time to create personalised experiences for the consumer with the bandwidth capability and speed of 5G, companies now have the opportunity to innovate with new types of technology such as AR and VR.

Adobe Experience Platform: Data Flow Value
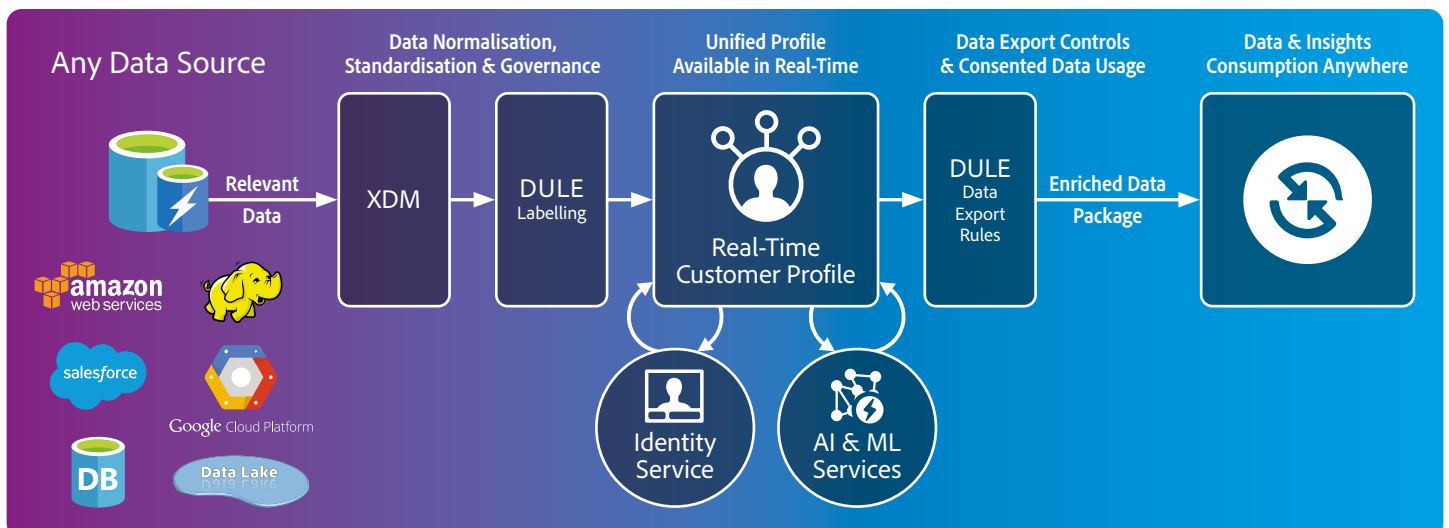
Adobe Experience Platform: High Level Overview

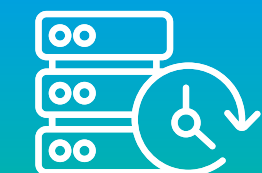
Continuous 'best in class integration'

As industries become increasingly disrupted by technologies and new entrants into the market, companies will need to build a much broader digital ecosystem if they hope to boost their competitive strength and increase incremental revenue over the coming years. This will require forming joint ventures and partnerships across their own industry, as well as with others outside their industry, in order to build best in class solutions for their customers.

Not only will 5G serve the communication requirements of billions of connected devices for customers as well as businesses, it will also fundamentally change user behaviour and increase expectations around existing services and the promise of new services and new technologies such as AR and VR. In particular, companies will have to place much greater emphasis and priority on designing real time experiences if they hope to gain a share of the £1.5 trillion 5G market potential.

Importantly, for most companies this requires adopting a cloud-based data and content management strategy which is not only capable of handling exponentiating volumes of data, but one which also combines higher standards of reliability and performance with greater cost efficiency - and at much larger scale.

Rather than supporting legacy frameworks and proprietary technologies, organisations will need to adopt a common data model such as Adobe's XDM, separating data and function in order to support the rapid development of new applications and services from multiple vendors which will become increasingly necessary in the 5G age.

Finally, AEP's virtualised data layer, combined with Artificial Intelligence and Machine Learning, means that businesses can now collate real-time data about their customers in a way that they have never been able to before. This will enable them to hone their personalisation strategy and offer new services which will take customer experience to the next level in the 5G age.

Companies will have to place much greater emphasis and priority on designing real time experiences if they hope to gain a share of the £1.5 trillion 5G market potential.