Radar

June 2020

The GSMA represents the interests of mobile operators worldwide, uniting more than 750 operators with almost 400 companies in the broader mobile ecosystem, including handset and device makers, software companies, equipment providers and internet companies, as well as organisations in adjacent industry sectors. The GSMA also produces the industry-leading MWC events held annually in Barcelona, Los Angeles and Shanghai, as well as the Mobile 360 Series of regional conferences.

For more information, please visit the GSMA corporate website at www.gsma.com

Follow the GSMA on Twitter: @GSMA

The Radar series focuses on potential drivers of innovation and disruption across the digital economy. These reports highlight potential scenarios and examine the implications of these disruptions for a range of industry players, including the mobile operators. The reports are intended to be the basis for discussion and do not represent official GSMA positions on these future developments.

Contents

1

New disruptions on the Radar

This edition of the Radar is our first since the Covid-19 pandemic has enveloped countries around the world with unprecedented strain on national health systems and economies. The crisis has also thrust the resiliency of telecoms networks to the fore, given the foundational role of connectivity in emergency response, personal communications and entertainment. While our topics are not specifically focused on the implications of Covid-19 on the technology, media and telecoms sectors, we bring attention to it where relevant. For a more in-depth review on the impact of Covid-19, you can refer to recent analysis from GSMA Intelligence.

- In the first chapter, we take a renewed look at the video streaming market, with Disney, Apple and HBO (again) among the most prominent to join the fray in an increasingly crowded field. One question concerns sustainability. Given that Netflix is the clear dominant player, and Amazon Prime and Apple TV+ are offered at zero or minimal cost to users of their platform and devices respectively, how many other streaming services can survive? Another issue concerns the shift to immersive formats, particularly VR, where interactive live sports and music could conceivably be brought to the living room.
- We then switch gears to talk about socially responsible investing (SRI) – the practice of seeking investments that deliver benefits to society in addition to generating a financial return. As more investors demand reform to operations and governance, prominent companies have shifted their mindset from a position of shareholder primacy to the pursuit of a broader purpose. However, SRI can be prone to 'confirmation bias' and 'greenwashing' stemming from the inherently subjective nature of sustainability and limited reporting. Operators have an opportunity to channel this activism to assist in climate efforts, such as raising capital through green finance projects.
- Our third piece seeks to assess the viability of and revenue models for private networks in enterprise settings, with manufacturing, financial services and cities among the early target segments. The lines of competition between telcos, vendors and cloud companies have blurred. For operators to succeed, a nuanced approach is needed – one that will depend as much on operators taking on the role of an IT consultancy as that of a connectivity supplier.
- Finally, our in-graphics chapter analyses developments in quantum computing, which has reached new heights in light of recent achievements from Google and IBM. While expectations have been running high and the race for more powerful computing continues, significant challenges remain ahead of any move to the mainstream.

I hope the topics we examine in this edition of the Radar provide food for thought and help you to paint a clearer image of the path ahead.

Laxmi Akkaraju

Chief Strategy Officer
GSMA

2

Key takeaways

Streaming: no standard definition of success

- A number of new streaming services have launched in the last year, with Disney and Apple among the most prominent to join the fray in an increasingly crowded field. The subscriber base for over-the-top services has grown rapidly and streaming services are increasing their spend on content libraries.
- The proliferation of streaming services and content has led to much debate about who will be the winners and losers. But such a simple distinction misses some of the wider context. For instance, while incumbent pay-TV companies have certainly been the main losers so far, many are now responding with their own streaming services. And for others, success is more nuanced. For example, Amazon and Apple are adopting asymmetric platform models, where content is largely a loss leader to grow their overall user base.
- Declining ARPU levels for the pay-TV incumbents, especially in the US, will free up some spend for cord cutters to subscribe to streaming services, but discretionary consumer spend is already stretched. Given that Netflix is the clear dominant player, and services such as Amazon Prime or Apple TV+ are at effectively zero or minimal cost to users of their platform and devices respectively, how many other streaming services can survive?
- The next wave of content innovation will likely focus on content interactivity and immersive experiences. The arrival of 5G has already led to renewed enthusiasm for the potential of immersive experiences, including 360-degree video and AR/VR. These services could prove to be popular given the growing appetite for shared viewing experiences, particularly for sports events and concerts.

Socially responsible investing: doing well by doing good

- Socially responsible investing (SRI) – also known as sustainable investing or environmental, social and governance (ESG) investing – refers to the practice of seeking investments that deliver benefits to society in addition to generating a financial return.
- Global organisations including the World Economic Forum have urged corporates to focus more on sustainable growth, while an increasing number of large institutional investors (such as asset managers and pension funds) are considering social issues in their decision-making, particularly at the screening and due-diligence phases.
- As more investors demand reform to operations and governance, some enterprises have shifted their mindset from a position of shareholder primacy to the pursuit of a broader purpose. However, SRI can be prone to 'confirmation bias' and 'greenwashing', stemming from the inherently subjective nature of sustainability and limited reporting. The mounting pressure to guarantee strong financial results and a material ESG impact could lead to improved transparency and the development of metrics that better define the boundaries of SRI and quantify the social effects of business.
- The mobile industry has understood the message, as signalled by its commitment to reach net-zero carbon emissions by 2050. With the SRI market poised to grow significantly, it is vital that operators improve the recording and communication of their green credentials, potentially leveraging existing sustainability assessment frameworks.
- Beyond disclosures, there are opportunities for operators to help to address ESG issues in adjacent sectors and to attract investment through green finance products. And with their unique combination of connectivity, customers and technological capabilities, operators could capitalise on the broadening social expectations of corporates to expose new sources of revenue.

Private networks: back in vogue and here to stay

- The 5G era will bring about a paradigm shift in how networks are structured, namely from purely national builds to more localised deployments. Private networks (PNs) represent a significant part of the move to these localised deployments, as they offer dedicated connectivity at a given quality of service to a specific customer.
- An upper estimate would be that PNs could potentially serve 25–40% of SMEs and corporates, starting with high-priority sectors such as manufacturing before transitioning into other areas with more complex layout and delivery requirements.
- How much new revenue can realistically come from PNs in enterprise deployments, though, will depend on a number of factors, including capital investment levels of a given sector and the interplay with complementary technologies. Even a small share can lead to big numbers. In the UK, if 0.1% of capital investment (approximately £200 million) were spent on PNs, it would translate into a 1.1% uplift to UK telco revenues.
- But this assumes telcos capture 100% of PN revenue – an unlikely scenario. Early deployments suggest equipment vendors and cloud companies are likely to participate as partners, separate contractors or even lead contractors. But if telco revenue equated to 50% of the total, the impact would still be material and this should rise over time as more enterprise verticals commit to digital technology investments that serve automation and low-latency requirements.
- The lines of competition between telcos, vendors and cloud companies have blurred. From a telco perspective, the main risk is of influence waning if commercial 5G networks are built and operated by verticals with their own spectrum holdings or by the likes of AWS as extensions to their cloud footprints. For operators to succeed, a nuanced approach is needed – one that will depend as much on operators taking on the role of an IT consultancy as that of a connectivity supplier.

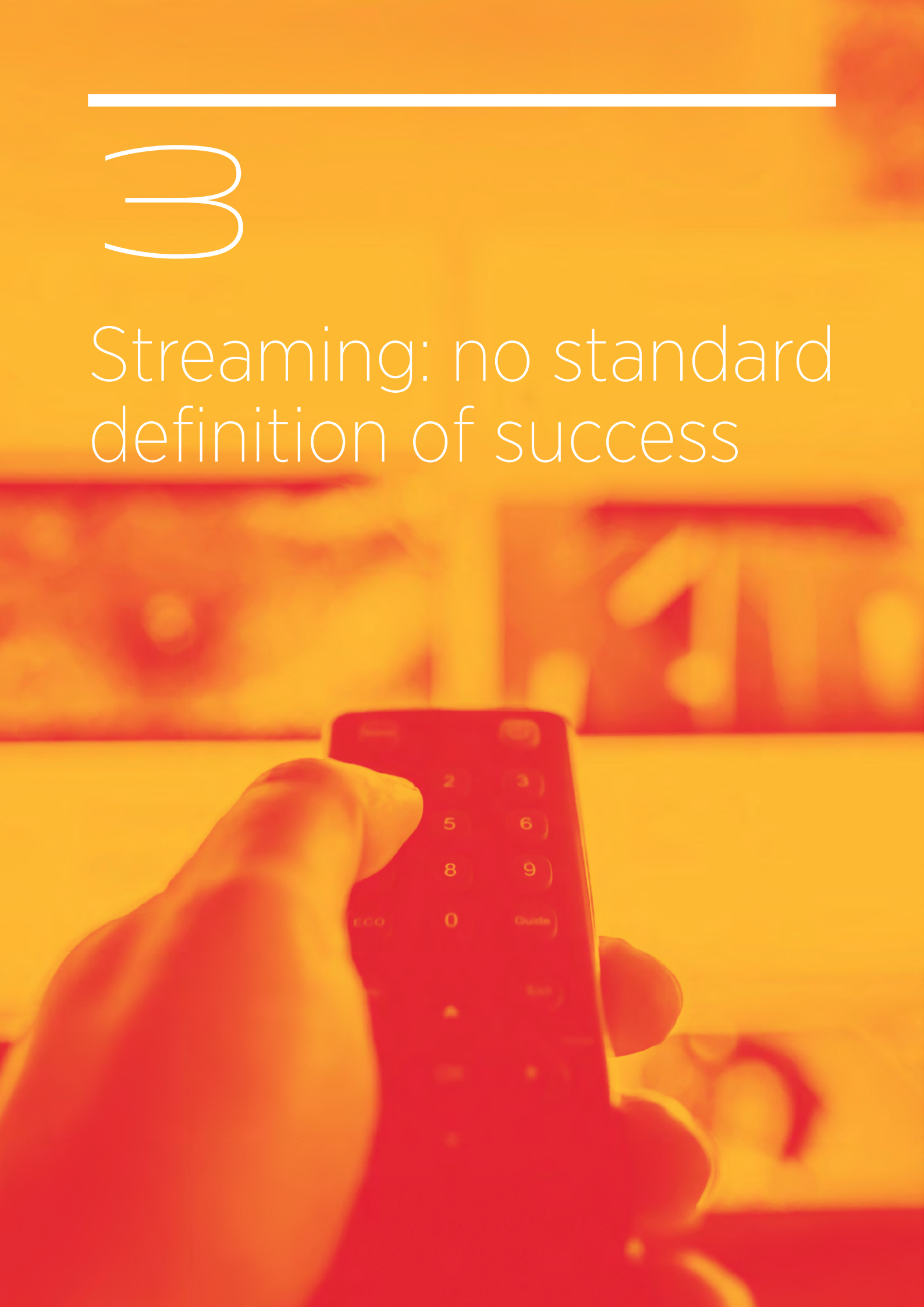
Quantum computing – challenges beyond the hype

- Quantum computing continues to be the subject of considerable discussion, capturing the headlines as its potential is more widely recognised.
- Optimistic projections suggest it could change the world – or at least have a profound impact on a range of industries, including finance, medicine and communications.
- While expectations have been running high and the race for more powerful computing continues, significant challenges remain ahead of any move to the mainstream.

IN GRAPHICS

3

Streaming: no standard definition of success



3.1 Executive summary

The streaming market is increasingly under the spotlight as an array of providers compete to earn consumer attention. We take a look at the current state of play in the market, including the underlying economics, and investigate how the market may evolve as part of the broader competition with other content providers.

A number of new streaming services have launched in the last year, with Disney and Apple among the most prominent to join the fray in an increasingly crowded field. The subscriber base for over-the-top (OTT) services has grown rapidly – forecasts suggest that the global subscriber base will reach 1.3 billion by 2024.

Streaming services are also increasing their spend on content libraries. At the same time, other companies are investing heavily in other forms of content, such as podcasts, e-sports and live entertainment. More broadly, streaming services are not just competing with other types of digital content but also other forms of leisure and entertainment activities for a limited share of consumer free time and discretionary expenditure.

The proliferation of streaming services and content has led to much debate about who will be the winners and losers. But such a simple distinction misses some of the wider context. For instance, while incumbent pay-TV companies have certainly been the main losers so far, many are now responding with their own streaming services. And for others, success is more nuanced. For example, Amazon and Apple are adopting asymmetric platform models, where content is largely a loss leader to grow their overall user base.

Declining ARPU levels for the pay-TV incumbents, especially in the US, will free up some spend for cord cutters to subscribe to streaming services, but discretionary consumer spend is already stretched. Given that Netflix is the clear dominant player, and services such as Amazon Prime or Apple TV+ are at effectively zero or minimal cost to users of their platform and devices respectively, how many other streaming services can survive?

The next wave of content innovation will likely focus on content interactivity and immersive experiences. The arrival of 5G has already led to renewed enthusiasm for the potential of immersive experiences, including 360-degree video and AR/VR. These services could prove to be popular given the growing appetite for shared viewing experiences, particularly for sports events and concerts.

It is often during times of flux and technological developments that we see the greatest disruption to established industries and the emergence of new players. Although it may seem a little early to talk about disruption to the new streaming ecosystem, this will be inevitable as new immersive technologies evolve and mature. The problems faced by even Magic Leap, a well-funded new entrant, highlight the difficulties in predicting who will win or lose out from platform and format shifts. But those that have already reached scale or have deep pockets are likely to survive.

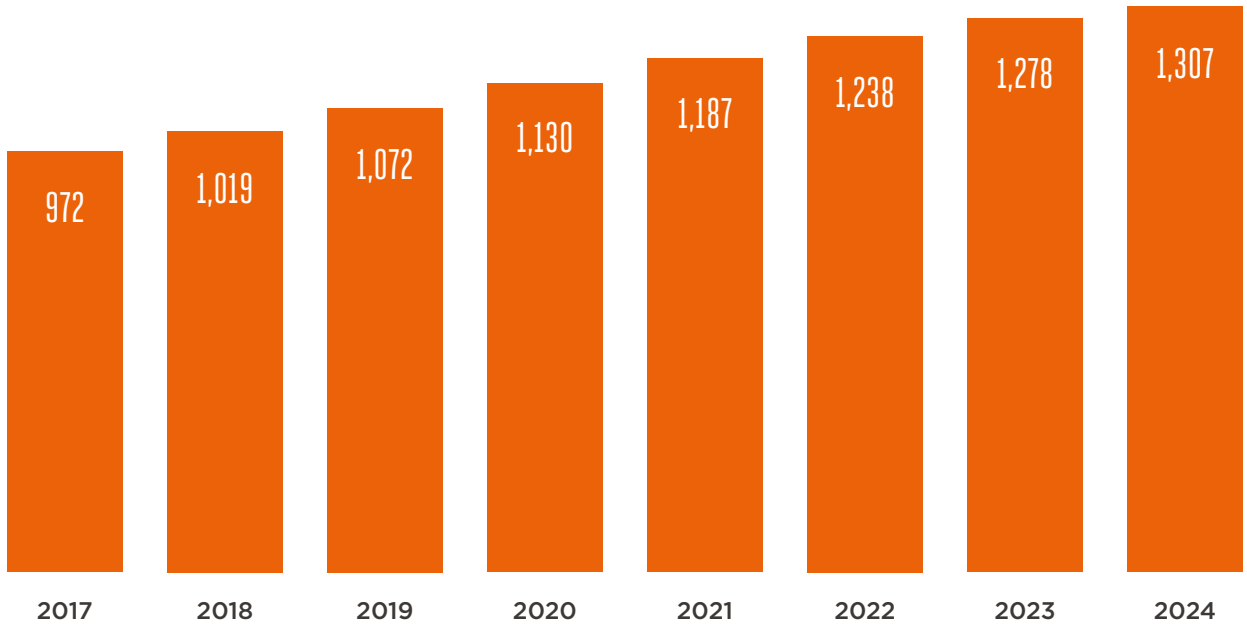
3.2 State of streaming: news subs, services and models

The number of subscription-video-on-demand (SVOD) subscribers across the globe has risen rapidly in recent years, and with a host of new services launching (including several targeted at more price-conscious customers in emerging markets) growth will remain strong.

Forecasts from Statista suggest that the global SVOD subscriber base will reach 1.3 billion by 2024 (note that this compares to the GSMA Intelligence forecast for mobile internet subscribers of 4.8 billion by the same date). Certain companies have shared ambitious forecasts for their own subscriber bases. For example, Disney expects to have between 60 million and 90 million subscribers to its streaming service by 2024 (although recent reports that its base has already surpassed 50 million could leave these numbers looking very conservative).

Source: Statista

1 Global SVOD subscribers (million)



In addition to recent high-profile launches, such as Disney+ and Apple TV+, a number of new services have appeared in recent years, with more on the way. Most streaming services fall into the SVOD category, but several also offer access to live broadcast channels. Another feature that differentiates providers is the inclusion of a cloud digital video recording (DVR) service as either a basic or premium option. The latter may allow content to be viewed in HD or enable multiple accounts on a single subscription.

Source: GSMA Intelligence, company data

2 Leading streaming services in the US

Service	Price per month (lowest)	Global subscribers (2019)	Comments
Netflix	$8.99	167 million	Largest pure SVOD player and has a global presence
Disney+	$6.99	28.6 million*	Leverages the Disney brand and range of Disney content
HBO Go, HBO Now**	$14.99	2 million	Viewed through an app or as an add-on to other services, such as Hulu
Apple TV+* **	$4.99	10 million****	Limited pool of original content and has no licensed content or back library
Hulu	$5.99	30.4 million	Basic offering with numerous add-on subscriptions that offers major network shows and other Disney content
Sling TV	$30	2.6 million	30 channels, including ESPN and major networks
YouTube TV	$49.99	2 million	A mix of live TV and on-demand content
AT&T TV Now (formerly DirecTV Now)	$49.99	1 million	Live streaming of channels plus on-demand content, some at additional cost

*As of 3 February 2020 **For existing cable subscribers ***Free for one year with Apple device purchases ****Market estimates

Business models can vary across a single provider, as there are a number of routes to creating value. For example, Amazon operates an asymmetric platform model (content used to attract more users to its retail platform), while also acting as an aggregator that sells subscriptions to other content channels (such as Starz).

Source: GSMA Intelligence, company data

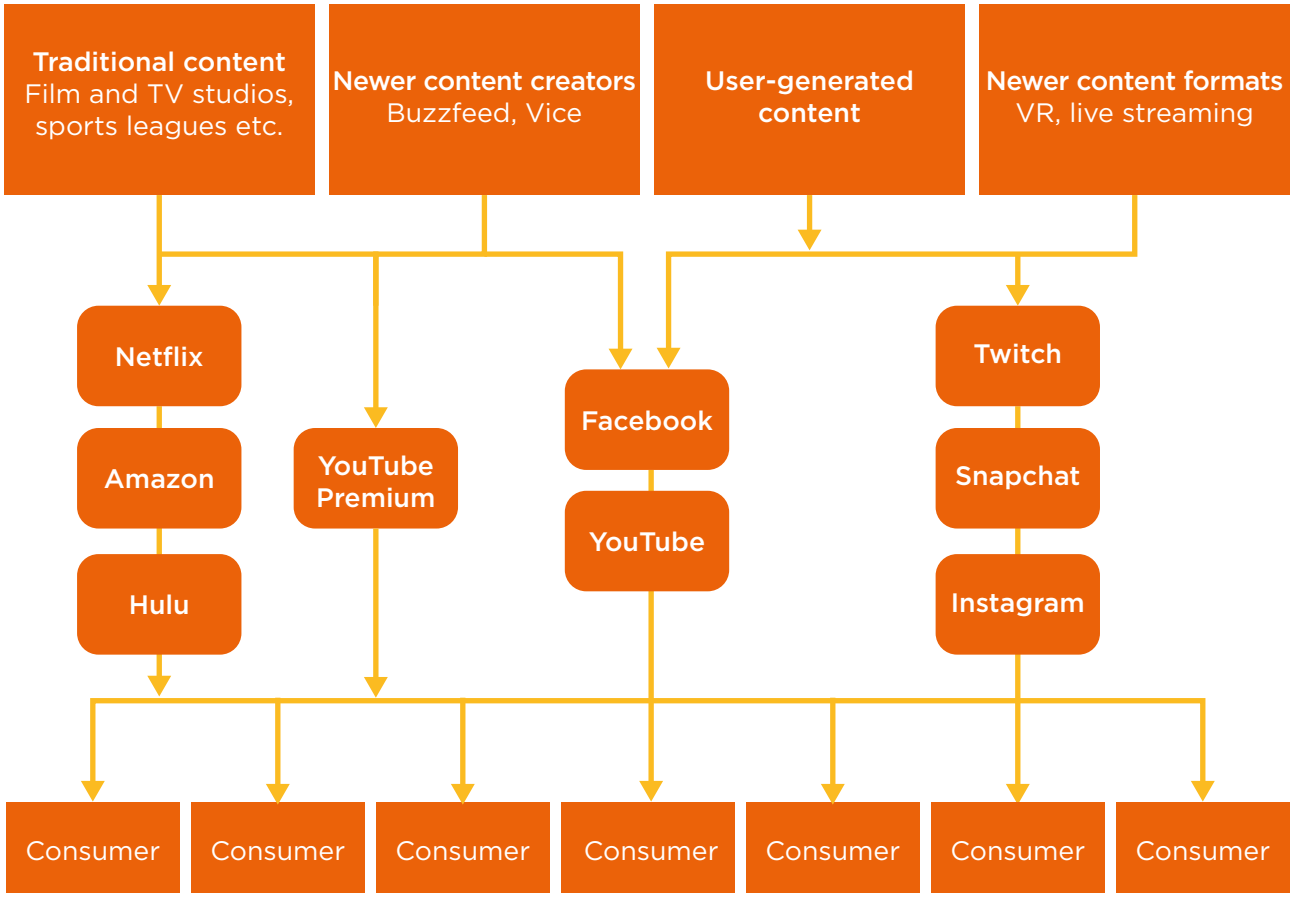
3 Categorisation of leading streaming services in the US

Category	Examples	Comments
Streaming natives	Netflix, Quibi	Aims to maximise their user base with premium content and a global footprint.
Niche players	Shudder, Acorn TV, Sundance	Targets specific audience segments with focused offerings (e.g. horror). Aims to generate higher revenue per title than streaming natives.
New bundlers	Apple, Amazon, Hulu	Uses SVOD to increase the appeal of their overall platform, with subscriptions monetised in other areas.
New streamers	HBO, Showtime, BritBox	Traditional broadcasters that are moving content from existing channels (cable, terrestrial etc.) to streaming platforms to retain viewers and generate incremental revenues.

One notable example of an impending launch is Quibi, which has already raised close to $2 billion in funding. Unlike other streaming services, Quibi aims to deliver short-form content, referred to as "quick bites" (which abbreviates to the name Quibi). It will offer both premium and partly ad-funded options. Its unique content offering puts it more in competition with other short-form video platforms such as Instagram, YouTube and TikTok.

Source: GSMA Intelligence

4 Online video ecosystem



3.3 Economics: how streaming destroys the bundle

The emergence of new streaming players has been facilitated by technological developments. Primary among these is the widespread availability of high-speed internet access (both fixed and mobile), combined with high levels of adoption of connected screens (e.g. smart TVs, tablets, smartphones). These factors have allowed video content to be delivered to consumers at any time and any place but also, crucially, at effectively zero cost to streaming companies.

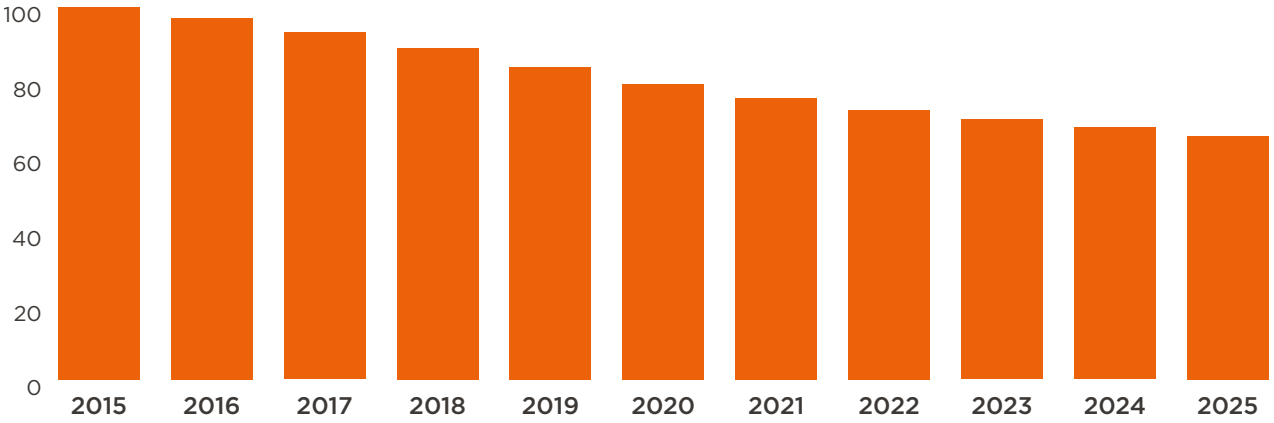
The arrival of streaming services has undermined the economics of existing pay-TV bundles. Operating a TV distribution network involves costs around the building and maintenance of distribution networks as well as licensing and other costs. However, negotiations between a small number of distributors (cable operators and satellite) and a small number of producers (TV broadcasters, film studios etc.) to create and deliver content can be summarised as "bilateral bargains between upstream and downstream oligopolists".[1] Historically, this has allowed cable companies to capture a large part of the 'consumer surplus' (the difference between what someone is willing to pay for a good or service, and what they actually pay), which translated to cable ARPU levels in the $70–90 range. By bundling channels together, which often include high-profile programming such as sports channels, pay-TV companies are able to charge more overall than if consumers were given the choice to pay for individual channels.

In prior years there have been suggestions in the US by both the Federal Communications Commission and politicians that cable companies should be required to sell smaller packages or individual channels. While there were no regulations to enforce this, the market stepped in and caused this to happen with the rise of streaming, which has given consumers the choice to pay for the services they want at significant discounts to existing pay-TV prices. This in turn has forced the incumbents to respond by offering skinnier bundles, often in parallel with, or as part of the launch of, their own streaming services.

This has already led to declines in pay-TV subscribers in the US, with reported subscriber numbers across cable, satellite and IPTV falling by around 16 million between 2015 and 2019. Further declines are likely as new streaming services emerge and existing content portfolios grow. Recently released broadband and pay-TV forecasts from GSMA Intelligence show how this trend is expected to play out in the US.[2]

Source: GSMA Intelligence

5 US pay-TV subscribers (million)



1 "Should cable television channels be offered à la carte?", Microeconomic Insights, January 2016
2 Fixed broadband and pay TV: future outlook at a glance, GSMA Intelligence, 2020

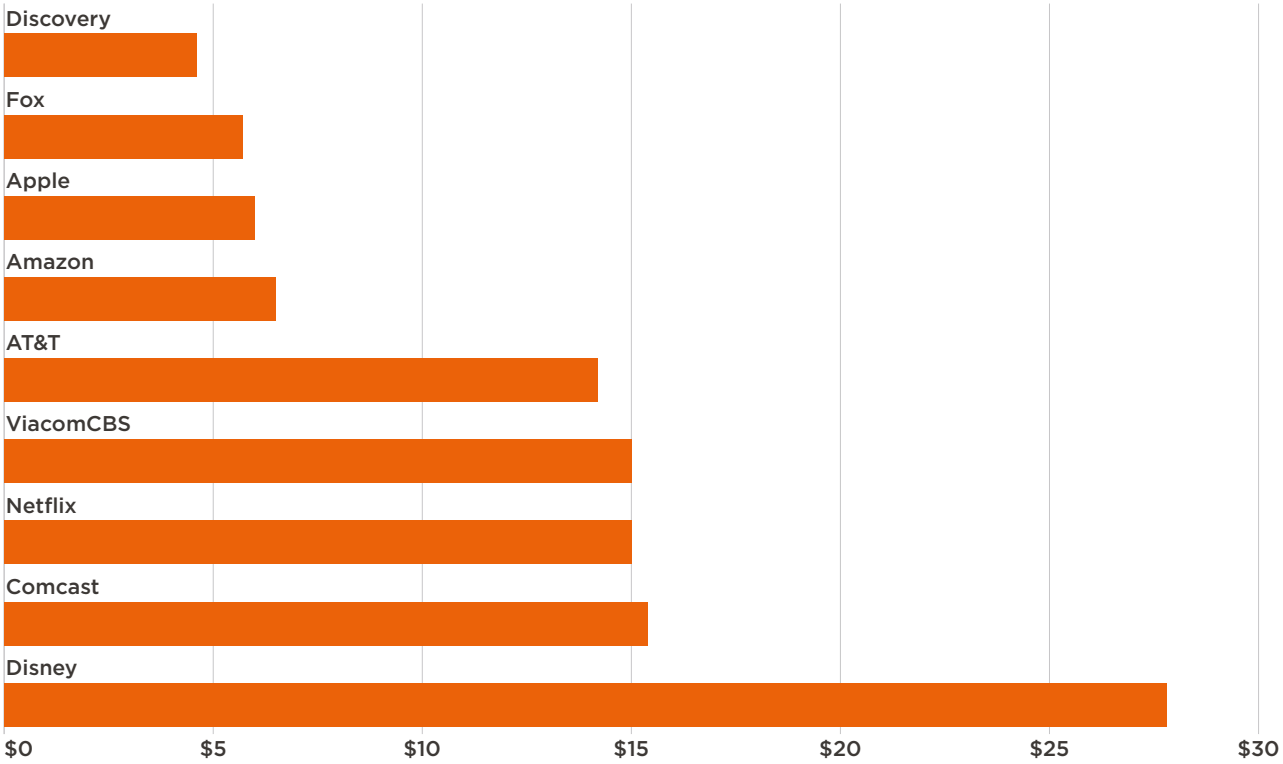
3.4 Content, content everywhere

The range of new SVOD services is only one part of the equation when it comes to the expanding ocean of content that is now available to consumers. Streaming services are also bolstering their spend on original shows and movies, while other companies are doing the same for other types of content, such as podcasts, e-sports and live entertainment.

Market forecasts suggest that Netflix will spend around $17 billion on new content this year, up from $15 billion in 2019. However, this will still leave Netflix trailing behind Disney, which spent $27 billion on original content in 2019 (see Figure 6), spread across its various operating units.

Source: Company data, Financial Times, BMO Capital Markets, Credit Suisse, RBC

6 Original content spend, 2019 (billion)



In addition to these investments in traditional TV programming (both feature films and series), other companies are investing heavily in other forms of content. Spotify, for example, has announced that it is spending $500 million on podcasting, while both Facebook and Snapchat have previously announced plans to generate more video content for their platforms. Traditional content producers are also getting involved: 21st Century Fox (now a part of Disney) previously announced a joint venture with Caffeine Studios, a social live-streaming startup, to produce exclusive e-sports, video game, sports, and live entertainment content.

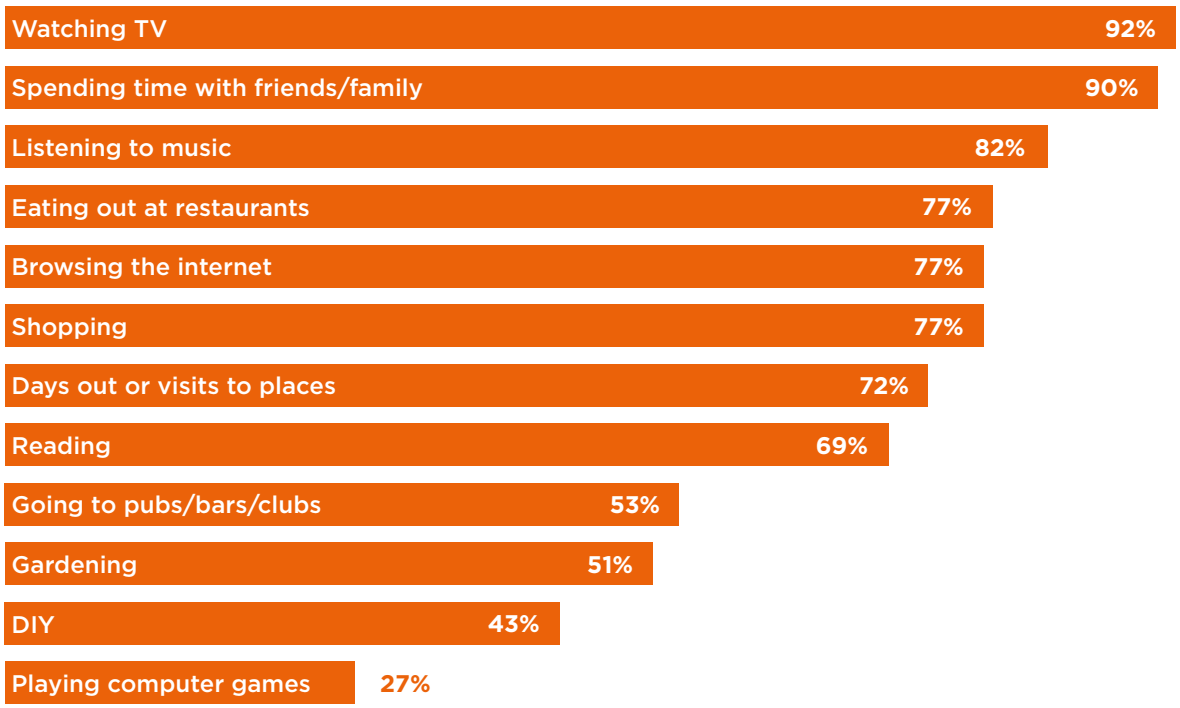
Indeed, streaming services are now competing not just with traditional broadcast television for consumer attention but also with a whole range of other content providers. This includes gaming platforms such as

Twitch, which allows subscribers to watch streams of gaming as well as a growing range of other content, such as art creation, music and talk shows.

More broadly, digital content in its various forms is also competing with other forms of leisure and entertainment activities for a limited share of consumer free time and discretionary expenditure. The overlap between digital and real-world pursuits will only continue to increase over the next few years as new services are developed and experience mainstream adoption. Gigabit connectivity paired with advanced headsets will enable immersive reality experiences that could allow users to experience live events such as sports or music from the comfort of their own home. These new digital experiences could increasingly compete with the real-world alternatives, allowing new players and platforms to come to the fore.

Source: UK Department for Digital, Culture, Media and Sport

7 Free-time activities of adults in England, 2018



Proportion of adults who participated in specific free-time activities in the previous 12 months.

3.5 Taking a nuanced approach to measuring success

There has been much debate about who will win or lose the 'streaming wars'. The reality is that such a dichotomy misses some of the wider context. For example, it is certainly true that the main losers so far have been incumbent pay-TV companies, but many are now offering their own streaming services. The challenge, then, is to balance traditional linear and streaming services while minimising the degree of self-cannibalisation, to maintain overall profitability.

Among OTTs, Netflix is undoubtedly an early winner, as it continues to add subscribers at a healthy pace. However, what success looks like is more nuanced for others. For example, Amazon bundles content into its Amazon Prime service in order to increase the overall perceived value of the platform; the primary objective is to drive more visits (and regular users) to its commerce plans. Amazon founder Jeff Bezos has been explicit about this:

> *When we win a Golden Globe, it helps us sell more shoes.*[3]

A similar argument could be made for Apple. The launch of Apple TV+, in combination with other content services such as Apple Music and the gaming-focused Apple Arcade, demonstrates a desire by the company to grow its non-hardware revenues. However, these offerings are also complementary to an extent, as free subscriptions are linked to new device purchases, and they increase the value of the overall Apple hardware and software ecosystem.

Facebook launched its Facebook Watch service several years ago, offering a mix of live and recorded content to viewers. The goal was to combine the benefits of a streaming video service with a social platform, so that individuals could immediately comment on their video experience with friends and other people. From a strategic perspective this is similar to Amazon Prime, as the goal is more about encouraging engagement on the overall platform than purely driving video views.

The broader digital economy has typically seen a winner-takes-all outcome, with one or two players dominating in specific fields e.g. Amazon for retail, Facebook for social media, Airbnb for travel etc. However, the network effects are not as apparent in the streaming market, as even the largest players can never own all of the available content.

Consequently, outcomes in video are more difficult to predict, especially considering the different strategic priorities of key players. WarnerMedia CEO John Stankey highlighted this on an internal staff call to HBO staff in 2018, commenting on the uncertainty of how many viable direct-to-consumer (D2C) services there would be:

> *It's not going to be 10, probably won't be two. Now is it eight, six or four? I don't know.*[4]

This raises particular challenges for newcomers to the streaming space. Declining ARPU levels for pay-TV incumbents, especially in the US, will free up some spend for cord cutters to subscribe to streaming services. There is also an important demographic component: younger viewers will often not subscribe to traditional pay TV but are willing to subscribe to several streaming services where the individual cost is low. However, discretionary consumer spend is already stretched. Given that Netflix is the dominant player, and services such as Amazon Prime or Apple TV+ are at effectively zero or minimal cost to users of their platform and devices respectively, how many other streaming services can survive?

3 "Amazon's internal numbers on Prime Video revealed", Reuters, March 2018
4 "The streaming wars: its models, surprises, and remaining opportunities", REDEF, July 2019

> **Given that Netflix is the dominant player, and services such as Amazon Prime or Apple TV+ are at effectively zero or minimal cost to users of their platform and devices respectively, how many other streaming services can survive?**

As a new player, Disney will look to leverage its large library of existing content and overall (family-friendly) brand to differentiate itself. In many ways it offers a different value proposition to other services. However, even with its various strengths and assets, Disney's strategy still seems to be evolving, given the lack of new content in the short term and some confusion over the positioning of its various brands. Press reports suggest that some of its programming has been moved to Hulu because of the nature of the content, while other productions have been cancelled outright.[5]

Success, then, means different things for different providers:

- **Pure OTT platforms:** Success will be driven largely by scale and the opportunity to realise ongoing economies of scale. This allows leading players to add more premium content (amortised over a large subscriber base), further increasing the overall attraction of the service. As a result, global players will likely succeed over their regional counterparts. The quality of content is also an important factor, potentially allowing niche players to emerge, although such competitors are always likely to remain vulnerable.
- **Traditional media companies and broadcasters:** The development of streaming offerings is important to help offset the declining economics of linear channels and to help preserve the overall value of offerings. As streaming unpicks bundles, overall revenues are likely to suffer; however, margins may prove more resilient as carriage fees and other subscriber-related costs reduce.
- **Digital platform companies:** Streaming services are primarily a complement to drive more traffic and users to digital platform companies. Success therefore means delivering a service that consumers believe offers some genuine incremental value. This is measured more in terms of growing the total user base and reducing churn than on the narrow profitability of the OTT service.

5 "Bob Iger's next priority? Streamline Disney+ development", The Hollywood Reporter, March 2020

3.6 Aggregation and shared viewing: adapting the appeal of linear TV

One of the attractions of the traditional pay-TV bundle (or free-to-air linear TV) was that all content was available in one location, making it easy for consumers to discover and access programming. However, content discovery has suddenly become more difficult with new streaming services, especially as they are often accessed across multiple devices.

In light of this challenge, super aggregators are likely to become more important, as they can make content access and discovery easier and more manageable, particularly as the variety of content continues to grow. Content searches can extend to cover programming on any of the apps supported, effectively re-aggregating content into a single point of delivery for consumers. A number of players are already looking to fulfil the aggregator role with either hardware- or software-based solutions:

- **Hardware-based solutions:** Cable and satellite operators in both the US and Europe are offering more sophisticated boxes that provide a range of functionality. This includes the ability to access third-party apps through the device, including YouTube, Netflix, Disney+ and Amazon Prime. In some cases, these subscriptions can be added on to the overall pay-TV subscription package.
- **Software-based solutions:** A good example of a software-based aggregator is Amazon's app. As well as offering content from Amazon Prime, the app allows users to subscribe to a broad range of channels, including HBO, Showtime, Starz, PBS and BritBox. Content can be accessed through the app or using the Fire TV stick. YouTube TV offers similar options to add additional premium content.

As well as aggregating content, these services are creating a marketplace for content apps. Aggregation provides clear value for customers – but as with streaming services themselves, the market is beginning to look crowded, and demographic and social factors are likely to come into play. The features of the latest generation of set-top boxes will help reduce churn for the still significant base of traditional pay-TV customers, even if some are encouraged to move to skinnier bundles. In contrast, younger generations are typically either cord cutters or cord nevers (and in some cases lack a television entirely). These digital natives will typically view content on phones or tablets, with limited interest in traditional linear programming. As in other areas, such effects will reward scale and benefit the more established players.

Another key selling point of linear television was the shared nature of the viewing experience, as headline shows created 'water cooler talk' and a mass cultural experience. However, as content and audiences have become fragmented across viewing platforms, much of the content is now being consumed at different times and in different locations, even within a single household.

This has not stopped the desire for shared experiences, though, especially for sports. A number of new apps and services have started to fill this gap. Netflix Party (not an official Netflix offering) and Kast, for example, allow users to share their browser and stream with others, albeit with some impact on quality. Facebook Watch has a shared viewing capability that allows users to view videos simultaneously, but few other streaming platforms have to date chosen to offer such a function.

Gaming platforms, such as Twitch and Discord, allow gamers to live stream games to a broad audience and have attracted large numbers of users. Twitch remains the leading game-streaming service, despite the loss of high-profile gamers to competitors such as Microsoft's Mixer, Facebook Gaming and YouTube Live. Such video streaming services are also being used to show a broader range of content, including music performances by professionals and amateurs, and exercise and fitness classes.

3.7 Looking towards the future with immersive experiences

Overall progress in AR/VR has tended to disappoint and the market continues to search for a truly compelling headset form factor and use case. Even VR startup Magic Leap, which raised more than $2 billion and at one point was valued at $6–8 billion despite not having generated material sales volumes, has struggled, with recent press reports indicating that the company has been looking for a buyer.[6]

In the medium term there will undoubtedly be improvements in AR/VR technology and use cases will become more convincing. The arrival of 5G has already led to renewed enthusiasm for the potential of immersive experiences (or extended reality), including AR/VR and 360-degree video. However, this will likely require extensive network buildouts and the deployment of standalone 5G networks. These services could prove to be popular given the growing appetite for shared viewing experiences, particularly for sports events and concerts.

Immersive experiences also promise greater levels of interactivity, something that is still missing from digital streaming services (excluding gaming). Netflix has experimented with interactive series, in which different scenarios play out depending on a number of binary choices made by the viewer. While this has been the exception to date, the possibility of watching a horror movie or a sports match in a 360-degree immersive video environment could become a truly compelling option. This would require both greater levels of hardware adoption and the willingness of producers to deliver the relevant content.

> **“ The arrival of 5G has already led to renewed enthusiasm for the potential of immersive experiences (or extended reality), including AR/VR and 360-degree video.**

6 “Desperate to exit, a $10B price tag for Magic Leap is crazy”, TechCrunch, March 2020

As technology advances and the boundaries blur between the digital and physical worlds, these immersive experiences could serve as both an individual, in-home experience and as part of an extended real-world experience. Watching a sports match through an immersive headset, possibly with video chat options to friends and family, could be a far more enticing option than simply watching on the television.

There is also scope for immersive technology to enhance many real-world experiences, such as visiting a shopping centre or taking a trip to a theme park. Two museums in London, the National History Museum and the Science Museum, have already begun adding interactive features to certain exhibits.

So where is the balance between these types of immersive experiences? Will the purely digital, personal experience displace the extended real-world experience? Such forecasts can be difficult to make, and the current global pandemic could certainly tilt the balance in the short term in favour of the personal digital experience*. However, such setbacks are historically transitory and the social component of in-person gatherings will inevitably reassert itself.

From a more holistic perspective, we often see greatest disruption to established industries and the emergence of new players during times of flux and technological developments. Although it may seem premature to talk about disruption to the streaming ecosystem, this will be unavoidable as immersive technologies evolve and mature. The problems faced by even Magic Leap, a well-funded new entrant, highlight the difficulties in predicting who will win or lose out from platform and format shifts.

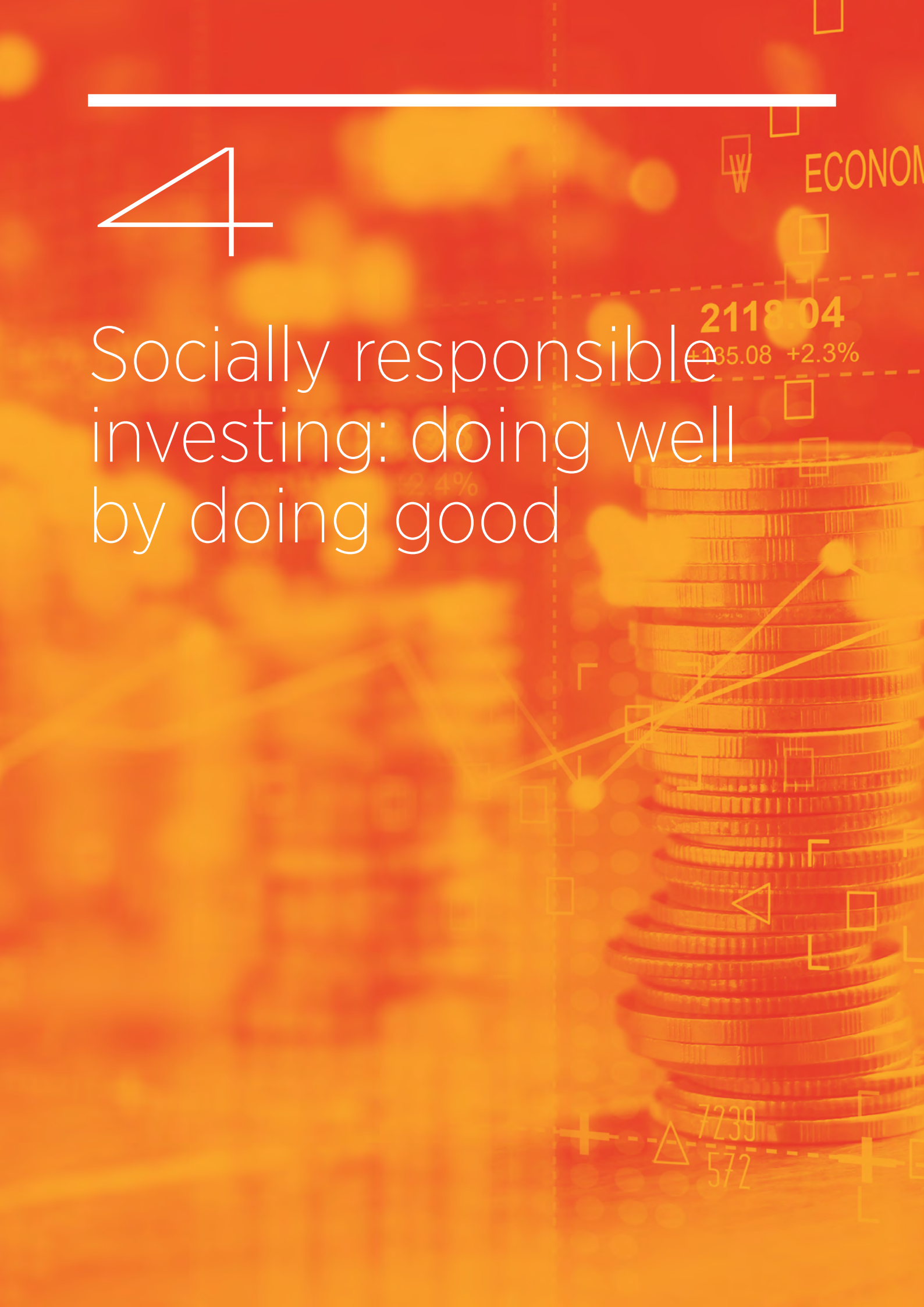
Another source of disruption is the ongoing rise of mobile video consumption, which suggests an opening for content that is better suited to the mobile format. In particular, short-form video (such as that proposed by Quibi) may be more appealing to younger generations with shorter attention spans. However, short-form videos that don't rely on user-generated content remain an underdeveloped format. Other new players and related services will likely arise in this space, in a similar way to how the emergence of the smartphone created opportunities for app developers and new content providers.

It is likely that the established digital pioneers will be well placed to ride the next wave of technological disruption. Amazon continues to move nimbly, both in terms of content and technology (e.g. Alexa and the Fire Stick), with a clear and coherent strategy to add value to its overall platform. Facebook and Google have struggled more on the content front, but their scale (and for Facebook, engagement levels over its multiple platforms) still puts them in a strong position going forward.

*For more information on the impact of the Covid-19 outbreak on streaming, see **Covid-19 impact: fixed broadband rises to the challenge amid unprecedented demand**

4

Socially responsible investing: doing well by doing good



4.1 Executive summary

Socially responsible investing (SRI) goes by many names – including environmental, social and governance (ESG) investing, and green investing – and comes in various forms. It refers to the practice of seeking investments that deliver benefits to society in addition to generating a financial return.

The market has already eclipsed $30 trillion in value according to the Global Sustainable Investment Alliance (GSIA), while capital inflows are projected to accelerate, especially as evidence builds that certain approaches to SRI can achieve earnings above market level.

Global organisations including the World Economic Forum have urged corporates to focus more on sustainable growth, while an increasing number of large institutional investors (such as asset managers and pension funds) are considering social issues in their decision-making, particularly at the screening and due-diligence phases. Some are launching or modifying funds to invest in companies according to ESG criteria. In January 2020, BlackRock's CEO predicted that the near future would see a "significant reallocation of capital" and claimed "sustainable investing is the strongest foundation for client portfolios going forward".[1]

As more investors demand reform to operations and governance, some enterprises have shifted their mindset from a position of shareholder primacy to the pursuit of a broader purpose. Some 62% of CxOs indicate that making a profit while positively contributing to society is an Industry 4.0 priority for their organisations.[2] However, SRI can be prone to 'confirmation bias' and 'greenwashing', stemming from the inherently subjective nature of sustainability and limited reporting. The mounting pressure to guarantee strong financial results and a material ESG impact could lead to improved transparency and the development of metrics that better define the boundaries of SRI and quantify the social effects of business.

"Some enterprises have shifted their mindset from a position of shareholder primacy to the pursuit of a broader purpose.

The mobile industry has understood the message, as signalled by its commitment to reach net-zero carbon emissions by 2050, while some operators have issued climate bonds to help finance investment and environmental objectives. With the SRI market poised to grow significantly, it is vital that operators improve the recording and communication of their green credentials, potentially leveraging existing sustainability assessment frameworks.

Beyond disclosures, there is an opportunity for operators to add value by helping to address ESG issues in adjacent sectors. And with their unique combination of connectivity, customers and technological capabilities, operators could capitalise on the broadening social expectations of corporates to expose new sources of revenue.

1 A Fundamental Reshaping of Finance, BlackRock Investment Management Company, 2020
2 The Fourth Industrial Revolution: At the intersection of readiness and responsibility, Deloitte Insights, 2020

4.2 Investors are responding to social and environmental issues

SRI represents an expectation, if not an obligation, that an investment strategy should take into account both financial returns and the effects on society at large.

Such strategies, which include active ownership, negative exclusions and thematic investing, are not new, but the SRI community is moving swiftly on from acquiring investor buy-in to melding financial and sustainability goals. As momentum builds, shareholders are increasingly demanding action, and the implications will grow for companies that fail to adapt.

The European Investment Bank issued its first green bond – a €600 million equity index-linked security – in 2007. This was followed by the World Bank a year later. Since then, social responsibility has become a central pillar of many organisations' strategic thinking. The financial services industry has responded with a range of new products designed to generate fair market returns and align with client values to deliver benefits to society (see Figure 1). Much of the innovation in financial instruments has been driven by close collaboration between the public sector, private firms and non-profit institutions.

Source: Summary of The State of Socially Responsible Investing, Harvard Business Review, 2019

1 ESG-based financial instruments

Product	Description
Risk-sharing impact bonds	Municipal bonds that transfer a portion of the risk involved with, for example, implementing climate adaptation or mitigation projects from the public agency to the bondholder.
Financially passive, socially active funds	Exchange traded funds (ETFs) are created by assessing companies against criteria provided by a specific firm. The ETF is managed separately, while the relevant firm actively engages with indexed companies to improve ESG practices.
Impact securitisation	A highly effective means for gathering large amounts of (cheaper) capital in a relatively short period of time for environmental and social investments.

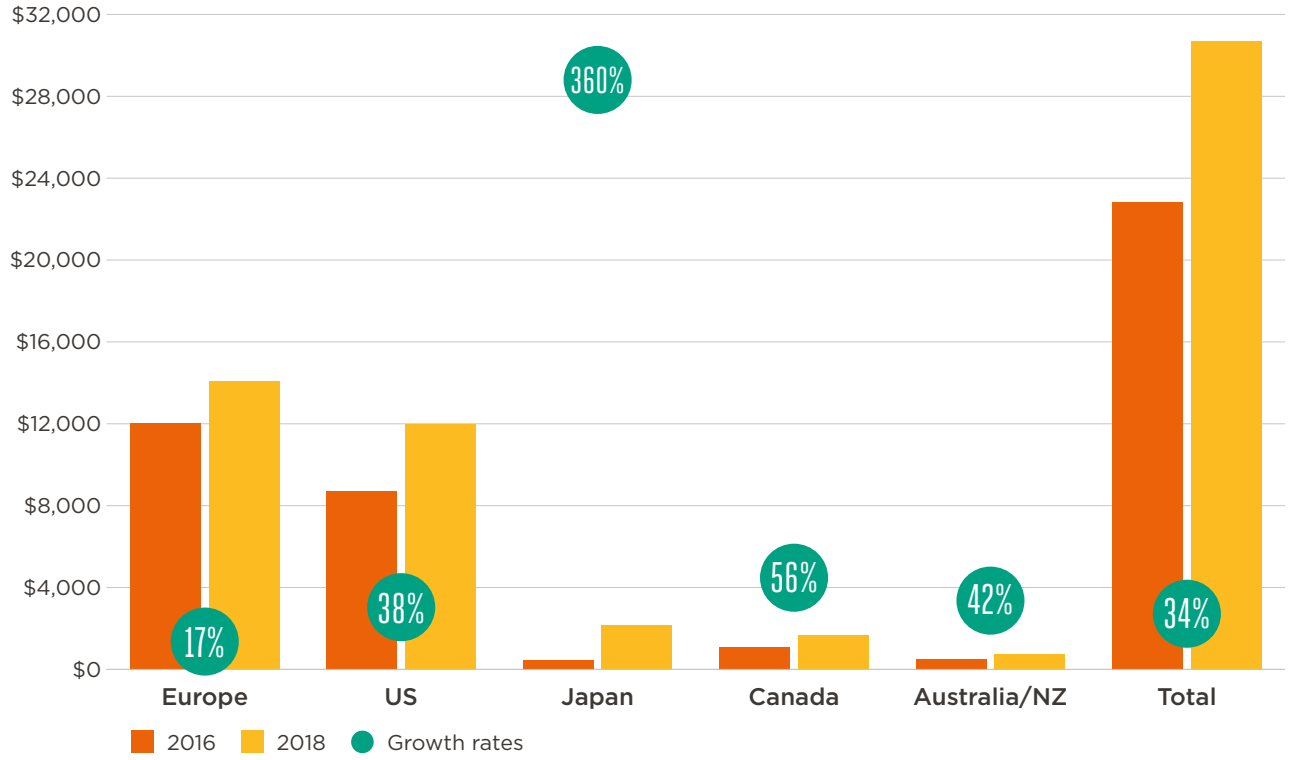
The emergence of these products reflects the fact that investors are increasingly conscious of the social and environmental consequences of firms' actions. The result has been louder calls to integrate ESG criteria into business decisions and growing demand for funds that include companies addressing sustainability challenges but eschew 'bad' stocks such as tobacco. Some existing and new investment vehicles will only buy into companies that are on track to meet the UN's Sustainable Development Goals (SDGs), which – among other targets – aim to end poverty and hunger by 2030.

According to the GSIA, the value of the SRI market across major economies exceeded $30 trillion at the end of 2018 (see Figure 2) and is set to continue growing at pace. Bank of America forecasts that a further $20 trillion will flow into ESG funds during the next two decades. Purpose-led investing is longstanding, but while it was once deemed niche, hundreds of new funds are expected to launch over the coming years. SRI can hold particular appeal for pension schemes, with the long-term nature of many sustainability-focused investments a good match for scheme liabilities.

Source: GSMA Intelligence[3]

2 The state of the SRI market

Billion



Positive returns achievable but not guaranteed

Proponents of SRI favour the introduction of social and environmental factors into decision-making – a practice they believe highlights how growth, sustainability and share price can all be positively linked. To that end, one study shows how foreign investment can be driven by corporate social responsibility (CSR).[4] The authors consider that foreign investment plays a key role in enhancing competitive advantages and raising performance, by allowing firms to better access capital, improve management efficiency and obtain knowledge and resources. They argue that a high level of CSR performance contributes to an improvement in reputation and, in turn, foreign investment.

Responsible investments were once thought to mean sacrificing returns, but have since demonstrated they can be market-beating. According to Morgan Stanley, the performance of around 11,000 ESG-focused funds over 2004–2018 was in line with traditional funds, "while offering lower downside risk for investors".[5]

JP Morgan, meanwhile, found that the top quintile of emerging market stocks it covers outperformed the MSCI Emerging Markets index by an annualised 5.6 percentage points between 2013 and 2019.[6] Nevertheless, there is contrary academic evidence that undisciplined approaches to sustainability can be ineffective.[7]

Findings from the London Business School indicate that firms that strive for social responsibility in areas relevant to their industry (e.g. data security in the tech ecosystem) and show restraint elsewhere achieved higher returns over time than peers who extended beyond their remit. The university's research also states that companies that concentrate on ESG factors central to their business, such as how they treat their employees, can enjoy long-run stock returns above those of their competitors – though this must be underpinned by success against genuine ESG policies, rather than a reliance on public declarations.

3 All 2016 assets are converted to US dollars at the exchange rates as of year-end 2015. All 2018 assets are converted to US dollars at the exchange rates at the time of reporting. 2018 Global Sustainable Investment Review, Global Sustainable Investment Alliance, 2019

4 Corporate Social Responsibility as a Strategic Means to Attract Foreign Investment: Evidence from Korea, Lee, Kim and Kwon, 2017

5 Sustainable Reality: Analyzing Risk and Returns of Sustainable Funds, Morgan Stanley, 2019

6 "'Sustainable' emerging market stocks outstrip indices", Financial Times, February 2020

7 See The price of ethics and stakeholder governance: The performance of socially responsible mutual funds, Renneboog, ter Horst and Zhang, 2008

4.3 Challenges remain in defining and proving responsible investments

Credible research shows that targeted sustainable investment strategies can deliver superior shareholder returns over the long term. However, the SRI space has been susceptible to 'confirmation bias' – that is, interpreting information to support an existing belief and ignoring anything that disputes it.

In some cases, this has led to disproportionate attention on studies claiming that ESG-centric investing always sees handsome returns, because this mirrors what people would like to be true. In parallel, there is empirical evidence that investing in 'immoral' stocks (e.g. alcohol and gambling) might result in relatively better financial performance.

There is the further challenge of ensuring that firms that claim to be socially conscious are behaving appropriately. In this burgeoning and potentially lucrative market, there is scope for exaggerated ESG declarations – and even software-based emissions testing violations in the scandal that embroiled Volkswagen. Certain highly carbon-intensive companies have benefited from the SRI movement – sometimes merely by making statements about the need to combat the malign effects of climate change. Meanwhile, the mobile industry has committed to meeting the UN's SDGs and lowering carbon emissions; however, the focus on going green has not boosted investment or share prices thus far, with financial markets still considering the sector a defensive play.

The limited availability of uniform ESG data makes it hard to assess what companies are doing and to evaluate which firm is doing best. Though money managers and third parties have invested in technology and algorithms to establish scoring systems, the outputs can be reliant on incomplete, inadequate or 'dirty' data, or on information firms have chosen to disclose because it appears favourable to them. This can obscure reality and present an opaque picture of ESG performance. The difficulty here is compounded by the fact that sustainability is inherently subjective and understandings are wide-ranging.

"

Sustainability is inherently subjective and understandings are wide-ranging.

Without agreement on what SRI means, some strategies are excluding entire industries, while others track indices that include companies from any sector operating by ESG principles. In addition, some funds feature tech and consumer goods stocks, which are often profitable but not necessarily sustainability-first. There can also be crossover between so-called ESG funds and their traditional counterparts: the iShares MSCI KLD 400 Social ETF, for example, includes both Occidental Petroleum and McDonald's. This haziness has seen the rise of 'greenwashing', whereby some agents have mislabelled an investment as responsible in order to bolster ESG credentials. The line between what is and is not sustainable will continue to blur as the SRI market expands.

Some popular sustainable funds have received criticism for the companies they hold, amplifying concerns about investors being misled. In 2019, Vanguard was found to be holding oil and gas firms in a $500+ million ESG fund it claimed was free of fossil-fuel stocks.[8] Vanguard later reviewed its ESG funds and ejected a gun manufacturer, a private prison operator, some media groups and other businesses, blaming an indexing error. Many fund managers, however, argue that staying invested, raising grievances with executives and voting at annual meetings are more effective in achieving change than ditching certain companies.

8 "Vanguard 'green' fund invests in oil and gas-related stocks", Financial Times, July 2019

4.4 The spotlight will shine brighter on companies and funds

SRI is being incorporated quickly into the financial mainstream. Institutional investors are sharpening impact-monitoring activities and assigning valuation multiples to leading socially responsible companies between 3% and 19% higher than sector medians.[9]

A survey of 6,000 people by the UK's Department for International Development (DFID) found that 70% of respondents wanted their investments to "avoid harm and do good for people and the planet", and that the majority would save more if they knew their investments and savings made a positive difference in society.[10] However, there are several barriers to investing in sustainable products (see Figure 3).

Source: DFID

3 Barriers to sustainable investing

According to DFID, there is demand in the UK for sustainable financial products, but people want to be able to trust that their investments will make a tangible difference in the world. A key driver of SRI growth will therefore be ensuring transparency in how managers approach sustainability, enabling people to navigate and assess the quality of sustainable products, and become convinced of the merits. There also needs to be better sharing of simple and customer-friendly information through mainstream channels to build public awareness and engagement.

The challenge ahead is for companies, investors and markets to work together in relatively unfamiliar territory to address the complexities and mitigate the potential downsides of SRI. Definitional issues and the scope for greenwashing signal the need for better reporting and measurement tools, as well as more supportive evidence to ensure alignment between investor requirements and available ESG investments. Businesses and investors, who routinely assess performance as a function of profit, growth and share price, will have to act appropriately to ensure openness and crystallise sustainability metrics.

> **"Definitional issues and the scope for greenwashing signal the need for better reporting and measurement tools.**

9 How Telcos can Unlock New Value Through Total Societal Impact, GSMA/BCG, 2020

10 Investing in a better world: Understanding the UK public's demand for opportunities to invest in the Sustainable Development Goals, Department for International Development, 2019

Developing a common understanding of SRI

The first step towards a common approach to SRI is to enhance the visibility of sustainability data through recognised reporting mechanisms. Stakeholders are paying closer attention to what constitutes a virtuous company, but a lack of transparency can leave investors confused. Organisations such as the Task Force on Climate-related Financial Disclosures, the Sustainability Accounting Standards Board (SASB) and the Global Reporting Initiative (GRI) have emerged to provide a steer on how to translate ESG costs and benefits into comparable units. Though this 'alphabet soup' of standard setters is sometimes derided as a distraction, their principles can help companies articulate how they are responding to ESG challenges, building shareholder trust. As investors insist on disclosures around sustainability, such guidelines could become mandatory if voluntary reporting is insufficient. Some managers, such as BlackRock, are now championing the SASB framework as a minimum standard that companies should reach.

There is also an argument that democracy and human rights should be added to the ESG mix.[11] Some suggest that the kind of concerns shown for climate change should be harnessed to confront the global threat to democracy. Measuring democratic standards would be difficult but not impossible and could leverage the likes of the annual Freedom in the World report index. While support for this dimension may not materialise, measurement and disclosure can provide first-mover corporates a competitive advantage as they weave trackable sustainability metrics into business analysis alongside traditional financial indicators.

Source: GSMA Intelligence

4 Possible metrics from across the SRI spectrum

Environmental	Social	Governance	Democracy
Scope 1, 2 and 3 emissions	Gender equality	Board oversight	Electoral process
Emissions reduction target	Health and safety	Management's role	Political pluralism and participation
Fuel mix	Privacy and security	Risk management process	Functioning of government
Carbon footprint strategy and measures	Community engagement	Anti-bribery and corruption	Freedom of expression and of belief
Climate-related risks			Rights of association

Raising the standard and consistency of data can enable fund and asset managers to better gauge the social impacts and risks of a company's products/services, operations and supply chains, while preventing overstatements or indiscriminate labelling of the SRI tag. This information can then feed into the ESG scores of companies and funds by managers and other ranking providers, which could become nearly as important as credit ratings. Greater transparency can also allow investment advisers to develop data-driven solutions that enable clients to create customised portfolios using a comprehensive set of ESG tools (including asset classes and themes).

With scrutiny of managers increasing, index methodologies are becoming more open, which should direct capital to veritably sustainable businesses. From March 2019, BlackRock started to disclose how each of its ETFs scores on ESG principles, as well as carbon intensity and the number that are exposed to

11 "Democracy is under threat, we must add a D to ESG", Financial Times, February 2020

'sin' stocks, including producers of civilian weapons. Hedge fund Man Group has also begun organising its funds into one of three categories based on the level of value they place on responsible investment. Man considers this would "provide credibility, clarity and consistency" across its fund range. For investors, a deeper understanding of sustainability can help them beat the market through a genuine SRI-based strategy. However, there is likely to remain a multitude of benchmarks and methodologies in the market, providing conflicting insight and ratings.

Moving from rhetoric to specifics

The push for a recognised understanding of social investing could result in greater intervention by regulatory bodies. Under the EU's Mifid II regulations, transparency is paramount, and investment firms must factor ESG considerations into their advisory or management services. In 2018, the UK's Financial Conduct Authority highlighted the absence of universally agreed minimum standards and guiding principles for measuring the performance and impact of green finance products.[12] It has since proposed that UK-listed companies disclose comprehensive, reliable information about their climate change risks from 2020 – a move that goes beyond official government policy.

In December 2019, the European Parliament agreed to establish common rules for which financial products can be considered (and marketed) as sustainable investments within the EU. The "taxonomy for sustainable activities" has three tiers, with coal excluded from any definition. Member states had clashed over the inclusion of nuclear power and "transition" energy sources such as gas. In the final compromise, nuclear will be screened under a "do no harm principle". With this left undefined, policymakers will have to ensure that the system cannot be gamed or have unintended consequences, and that companies provide full and proper disclosure of their activities.

China is interested in green finance in order to boost foreign investment. The Shanghai and Shenzhen stock exchanges are expected to follow Hong Kong's lead this year and require all issuers to increase ESG disclosures. However, it could be some time before the sustainability trend makes progress in other parts of Asia where financial performance is still managers' raison d'être.

Emergence of impact-weighted accounts

As the SRI market matures, the investment community is seeking more sophisticated means of quantifying social impact. According to the Global Impact Investing Network, impact measurement and management is fast becoming an important responsibility of investment teams, with accountability often shared among senior leadership.[13] However, these practices do not yet permit investors to evaluate impact performance against the market and peers in a transparent way, while the comparability of investments remains challenging on a sectoral and time basis. Beyond new ESG measures, this could lead to more frequent calculations of impact-weighted accounts, effectively creating two bottom lines.

At least 56 large companies have produced a version of these accounts, according to a collaboration led by Harvard Business School's Impact-Weighted Accounts Initiative. This has allowed for the determination of the monetary environmental impact of 2,000 large companies globally. The parties consider that impact-weighted accounts could have high catalytic potential similar to the development of modern risk-measurement techniques, which provided investors with a systematic way of optimising return for a given level of risk (and led to high inflows to the venture capital and private equity industries in the 1970s). In the future, more widespread use of this performance methodology could enable companies to understand the value of information to differentiate and attract incremental capital, while emboldening investors to incorporate social impact-adjusted measures into their decisions.

12 Climate Change and Green Finance, Financial Conduct Authority, 2018
13 The State of Impact Measurement and Management Practice, Second Edition, Global Impact Investing Network, 2020

4.5 Telecoms operators can seize the sustainability opportunity

Milton Friedman's mantra that "the social responsibility of business is to increase its profits" dominated boardrooms for decades. Now, sustainable investments are finding greater traction among money managers, executives and society more broadly. However, determining the boundaries of SRI and eliminating greenwashing remain problematic.

As the pressure for clearer definitions mounts, so too will the demand for visibility of ESG data and for common sustainability metrics, which can be used to optimise risk-return-impact decisions. Benchmarking is likely to be important to advance SRI measurement, while impact-adjusted performance could enable investors to understand companies' activities in the round.

The telecoms industry has assumed a pioneering role in addressing socioeconomic challenges, pledging to fulfil the UN SDGs and achieve net-zero carbon emissions. Orange has launched its Engage2025 initiative, under which it will increase focus on ESG matters while aiming to deliver solid financial results. The company is convinced that "in the years ahead strong economic performance will not be possible without exemplary performance on social and environmental issues". As many operators are regularly measuring and reporting factors such as emissions and energy consumption, the mobile sector is well placed to capitalise on future SRI market growth.

> **"The mobile sector is well placed to capitalise on future SRI market growth.**

To that end, more operators are following the GSMA's Sustainability Assessment Framework, which examines social and environmental sustainability efforts across the mobile sector. The framework is constructed to assess not only the performance of the operators themselves, but also their interactions with society and response to global challenges and opportunities. It builds on existing guidelines, including the GRI, SASB and Integrated Reporting, with three distinct pillars, and is designed to provide operators with clear analysis of how they can improve, tackle gaps in their approach and inspire action through sharing best practice.

Source: GSMA[14]

5 Pillars of the GSMA/Yale/Sida framework



Operating responsibly

Managing the material issues

- Customer and society
- Employee and supply chain
- Environment

Delivering value for society

Creating shared value

- Connecting business and social outcomes
- Operating context and regionality
- SDGs

Values-led leadership

Innovation on behalf of the sector

- Multi-stakeholder leadership
- Industry leadership
- Incentive alignment leadership

With regulatory expectations set to escalate over the coming years, there is an opportunity to enhance transparency and the presentation of mobile's sustainability credentials, and manufacture a leadership position. Building evidence and communicating the social impact operators can deliver raises awareness and confidence in SRI with investors and policymakers. Operators should also be active participants in any process to develop a suite of accepted ESG metrics that provides visibility for investors and markets on firms' efforts in social and environmental sustainability, and helps them make well-informed financial choices.

For mobile operators, the opportunity extends beyond measurement and disclosure, however. As the global transition to a low-carbon economy begins, leading operators are using structured financial mechanisms, which link financial outcomes to ESG factors. In January 2019, Telefónica issued the telecoms sector's first green bond, with the proceeds obtained earmarked for energy efficiency schemes. In addition, Vodafone has designed a Green Bond Framework under which it can issue green bonds to finance or refinance projects for the purpose of meeting environmental objectives. With demand for green bonds growing sevenfold between 2014 and 2019, strong ESG performance could attract a raft of new investors.

There is also the potential to help firms in adjacent sectors meet ESG priorities – from reducing environmental impacts to advancing supply-chain processes. In this respect, operators can leverage their strengths to deliver distinct solutions that tackle industry-specific sustainability issues. The coming decade also affords mobile operators the chance to use their unique combination of connectivity, customer base and technological capabilities to innovate and diversify, taking them into new markets and untapped sources of growth. A bold ESG-centric vision would be needed, but the huge revenue potential and green finance opportunity indicate there is scope for operators to do well by doing good.

14 Integrating sustainability into core business: Summary results of the GSMA Sustainability Assessment Framework 2019, GSMA/Yale/Sida, 2020

5

Private networks: back in vogue and here to stay

5.1 Executive summary

The 5G era will bring about a paradigm shift in how networks are structured, namely from purely national builds to more localised deployments. Private networks (PNs) represent a significant part of the move to these localised deployments, as they offer reserved connectivity at a given quality of service to a specific business or public sector customer.

PNs are not new, having been deployed on LTE spectrum for several years in sectors such as manufacturing. Installations so far, however, have been low profile niche offerings that lack the low-latency capabilities that 5G now offers. These capabilities are the main reason PNs have come back in vogue, as they are a means for monetising 5G in the enterprise segment.

The initial addressable market for PNs is companies with location-specific coverage requirements. City-wide installations would be the next source of demand, either from private firms or municipal authorities. An upper estimate would be that PNs could potentially serve 25–40% of SMEs and corporates, starting with high-priority sectors before transitioning into other areas with more complex layout and delivery requirements over the next three to five years.

How much new revenue can realistically come from PNs in enterprise deployments is, however, an altogether different question and will depend on a number of factors, including capital investment levels and the sector knowledge and expertise of the supplier. In the UK, at least seven sectors spend over £3 billion per year on capital investment. Even if a small share were to be allocated to 5G connectivity and services, the returns are potentially sizeable. If 0.1% of capital investment (approximately £200 million) in the UK were spent on PNs, it would translate into a 1.1% uplift to UK telco revenues, rising to 11% for an investment contribution of 1%.

However, this assumes telcos capture 100% of PN revenue – an unlikely scenario. Early deployments in Germany and the US suggest equipment vendors and cloud companies are likely to participate as partners, separate contractors or even lead contractors. But if telco revenue equated to 50% of the total, the impact would still be material and this should rise over time as more enterprise verticals commit to digital technology investments that serve automation and low-latency requirements.

The lines of competition between telcos, vendors and cloud companies have blurred. For operators, the main risk is of their influence waning if commercial 5G networks are built and operated by verticals with their own spectrum holdings (particularly mmWave for high-burst, short-range signals) or by the likes of AWS as extensions to their cloud footprints. There will, however, be a very real and tangible capex allocation across multiple enterprise sectors that can be capitalised on, with the potential to establish recurrent revenue streams. PNs will be a central product – whoever operates them – but for operators (as incumbent providers) to succeed, a nuanced approach is needed – one that will depend as much on operators taking on the role of an IT consultancy as that of a connectivity supplier.

5.2 Private networks exemplify the opportunity in local-scale network builds

For most of the last 30 years, mobile operators have run a vertically integrated network model, maintaining ownership and control of all passive (e.g. sites and towers) and active (e.g. RAN and core) elements. Such a full stack model carries the principal advantage of scale economies by spreading revenues over a (mostly) fixed cost business.

When times are good and revenue growth is rising, this translates into positive operating leverage and higher margins, especially for the largest telco groups given that cash flow margins are logarithmically related to market share. Unfortunately, the opposite is also true: when times are tough and revenue growth is flat or declining, negative operating leverage takes hold and pressures on margins grow, with cost cutting needed to counteract the trend. For much of the past five years, this latter scenario has been the prevailing environment for US and European operators.

The 5G era will bring about a paradigm shift in how networks are structured, namely from purely national builds to more localised deployments. This marks a major change from the past. National 5G networks will increasingly depend on sharing models to be economically viable, either between operators or in partnership with third-party infrastructure companies, where operators maintain control of the radio network while jointly operating or leasing access to towers or small cells in dense urban areas. Most operators will use a hybrid model balanced between macro and localised deployments for national-scale rollouts (see Figure 1). The growing number of infrastructure spin-offs from operators – such as Telxius from Telefonica, TowerCo from Vodafone, and China Tower – reflects this shift.

Source: GSMA Intelligence

1 New network models in the 5G era unbundle the traditional national build

		Full stack (traditional)	Hybrid	Private network	Neutral host
Active	**VAS** **Billing** **Core** **Backhaul** **RAN**	MNO	MNO	• Enterprise • MNO • Cloud	• MNO • Hotspot operator • Equipment vendor • Other
Active	**Spectrum**	Licensed	Licensed	• Licensed • Dedicated • Unlicensed	• Licensed • Unlicensed
Passive	**Ancillary (power, cooling)** **Macro or small cells**	MNO	• MNO • Tower company	• Enterprise • MNO • Cloud	• MNO • Hotspot operator • Equipment vendor
Passive	**Sites**	MNO	• MNO • Tower company	• Enterprise	• Land or venue operator

In contrast, PNs are local in nature, offering reserved connectivity at a given quality of service to a specific business or public sector customer. PNs are not new, having been deployed on LTE spectrum for several years in the manufacturing and port industries, for example. Hitherto installations have, however, been low profile niche offerings that lack the low-latency capabilities that 5G now offers. These new capabilities are the main reason PNs have come back in vogue.

> **Hitherto installations of private networks have been low profile niche offerings that lack the low-latency capabilities that 5G now offers. These new capabilities are the main reason private networks have come back in vogue.**

For operators, PNs are a means of monetising 5G in the enterprise segment. The extensive outlay of capital for 5G network builds continues to offer an uncertain consumer return on investment. For example, in Europe we forecast €177 billion to be spent by operators on network capex over six years to 2025, 80% of which will directly or indirectly (such as via fibre) support 5G; however, consumer adoption of 5G is expected to reach just 30% by 2025. In addition to an already low-revenue growth environment, consumer enthusiasm for handset and tariff upgrades will be muted because of economic uncertainty (which has been made worse by the Covid-19 crisis).[1]

Meanwhile, industrial digitisation continues apace. The primary targets for PNs are private enterprises and public sector customers seeking to modernise their IT stacks and/or overhaul operations to be remotely or digitally controlled – this is now well understood. The bigger questions are as follows:

- Which sectors are most suitable for PNs?
- How much revenue can actually be earned from the PN model?
- What financing and business models would work?
- How sustainable is the PN model given the high levels of competition?

This last point should not be overlooked. Amazon, Microsoft and Google have all made significant advances in pushing their clouds to the edge, which have involved a raft of system integrators, IT consultants (e.g. Accenture and Tata) and telco equipment makers.

1 For more information, see Covid-19 impact: testing the resiliency of mobile networks, GSMA Intelligence, 2020

5.3 Supply and demand: the key verticals for private networks

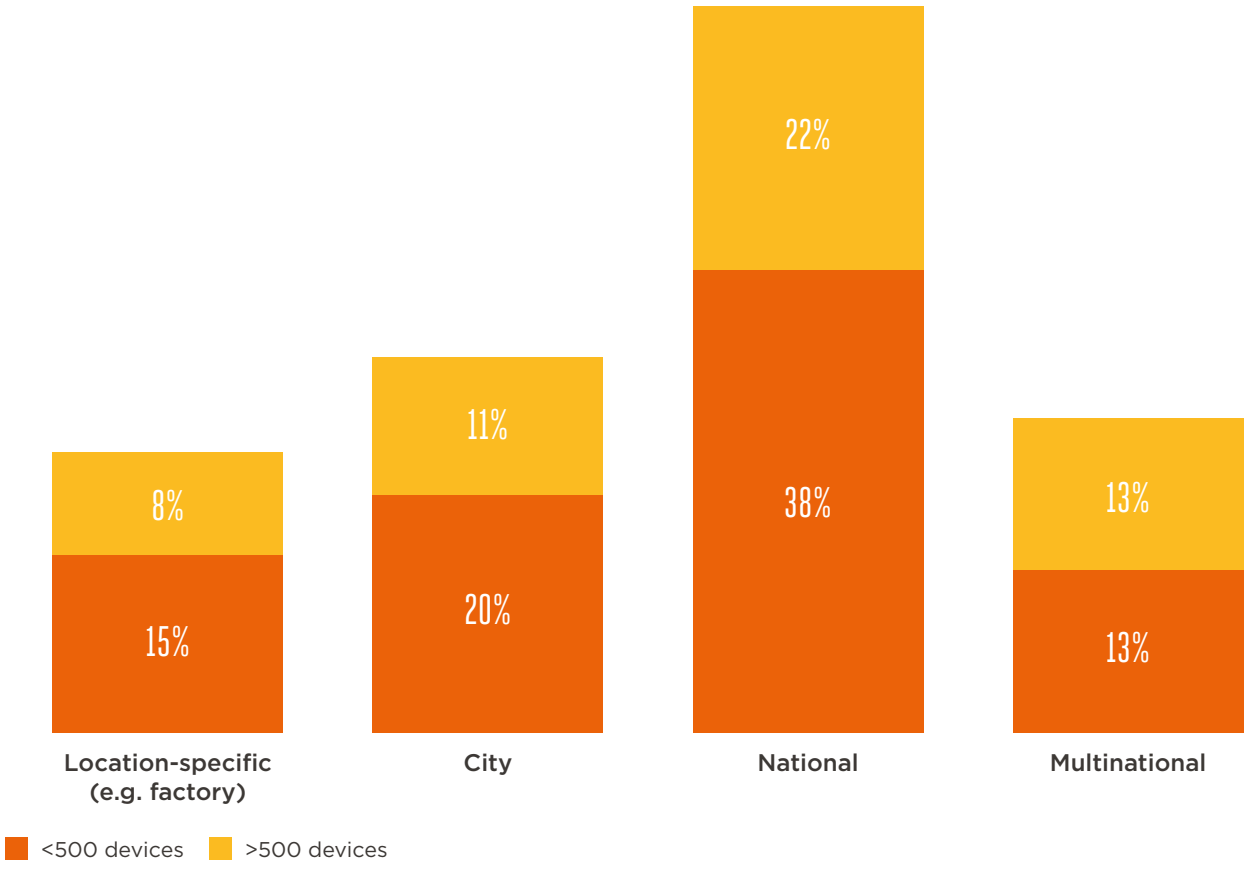
Given the pervasiveness of digitisation across the economy, an important question is which sectors and sub-sectors are the most suitable for PNs. To gain an indication of this, we draw from the data from our enterprise and operators surveys.

Demand: driven by location-specific requirements

While two thirds of companies claim to have deployed an IoT solution, many of these are nationwide in scale e.g. remote water monitoring, home gas and electricity smart meter readings, and point-of-sale terminals in retail outlets. The initial addressable market for PNs are companies with location-specific coverage requirements, such as for a factory, industrial park or campus. Approximately a quarter of companies fall into this category, around a third of which plan to have larger-scale deployments (more than 500 devices). City-wide installations would be the next source of demand, either from private firms or, if early evidence is any guide, municipal authorities in areas such as public transport and road signage.

Source: GSMA Intelligence IoT Enterprise Survey 2018

2 Scale of planned enterprise IoT deployments (global)



Note: respondent companies could enter multiple responses so figures add to more than 100%.

Base: all enterprises planning a future IoT deployment

Manufacturing and other production sectors would be the primary location-specific customers. Multiple use cases involving automated assembly lines are currently in testing or live operation. This includes stationary and mobile robotics, automated guided vehicles, drones (site surveying and security), and robotic exoskeletons.

AR-based software is also in consideration because of its latency demands (sub-20 ms). Training, maintenance, and visualisations and remote demos (e.g. of an oil rig) are further use cases and offer obvious cost savings relative to a human.

Examples of private network deployments

Lufthansa has recently established PNs in collaboration with Nokia and Vodafone. These allow, for example, engineers in Munich to remotely visualise aircraft internal fuselage compartments based at a hangar in Bonn.

Similarly, BMW – in partnership with Deutsche Telekom – has recently deployed a dual-slice LTE campus network at a plant in Leipzig.

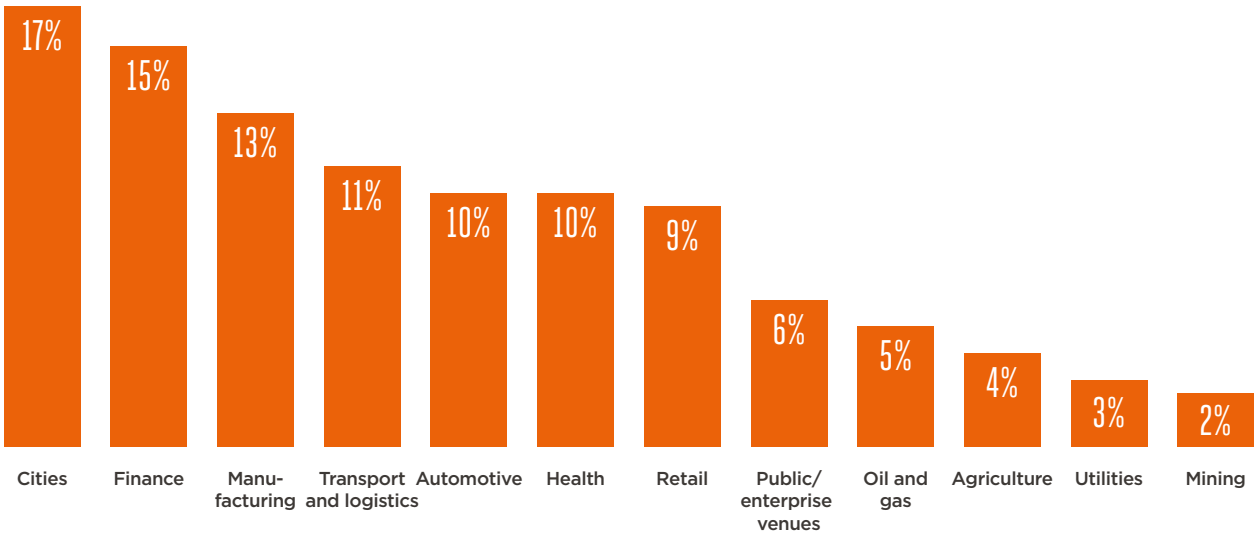
For more information, see Private networks unwrapped: find your role and own it, GSMA Intelligence, 2020

Supply: mirroring the demand

The perspective from operators broadly reflects the demand for location-specific requirements. Figure 3 highlights the top sectors being earmarked by operators that intend to deploy a PN. Manufacturing companies, municipal authorities, banks (potentially because of high-frequency trading), auto makers and healthcare groups are seen as the most suitable targets for PNs. Operators have a lower preference for sectors with more distributed operations (such as oil and gas or mining); however, there is regional variation here (e.g. mining is more prevalent in Latin America and Africa) and we expect there to be opportunities for operators given the heavy capital outlays of firms in such sectors.

Source: GSMA Intelligence Network Transformation Survey 2019[2]

3 Verticals that telcos plan to deploy private networks for (or with)



Note: sampling included 100 groups worldwide

2 For more information, see Network Transformation 2020, GSMA Intelligence, 2020

The nascent e-sports industry would also be under consideration, as live e-sports venues demand ultra-high bandwidth and ultra-low latency connections. While popular perception of e-sports is that it has a limited following, the fact that 200 million people watched an event at least once per month in 2019 puts this notion to rest. The prize money for marquee tournaments such as The International (Dota 2) and the Fortnite World Cup are now on a par with the prize money of some major sporting events, such as the Grand Slam tournaments, indicating a well-financed and attended set of events.

Taken together, an upper estimate would be that PNs could potentially serve 25–40% of SMEs and corporates, starting with high-priority sectors (e.g. manufacturing, cities, logistics) before transitioning into other areas with more complex layout and delivery requirements (e.g. grids, oil and gas, mining) over the next three to five years. This does not include public sector organisations such as transport authorities and airport and train station operators – all of which could be additional buyers.

However, the next two years in particular will be critical for reasons related to capital investment cycles and the availability of standalone (SA) networks, both of which are discussed in the next section.

> **“ An upper estimate would be that private networks could potentially serve 25–40% of SMEs and corporates, starting with high-priority sectors before transitioning into other areas with more complex layout and delivery requirements over the next three to five years.**

5.4 How much revenue can be earned? How long is a piece of string?

Consumer price rises linked to upgrades to 5G tariffs will happen, but their effect will be temporary and eventually competed away. Combined with the need to recoup the capex associated with network rollouts, enterprise verticals are now regularly cited as the main incremental revenue opportunity with 5G.

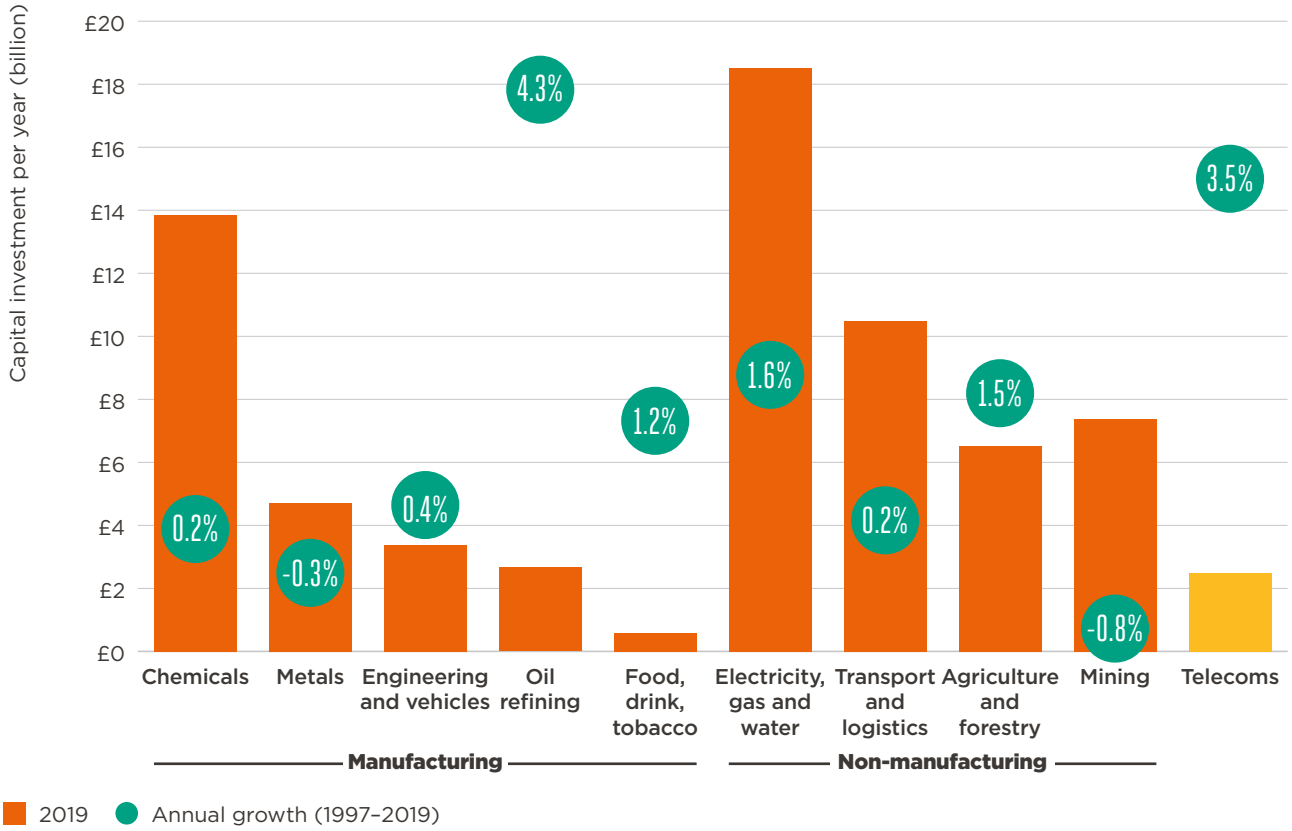
How much new revenue can realistically come from 5G PNs (or LTE PNs with in-built software upgrade capability) in enterprise deployments is, however, an altogether different question and will depend on a number of factors:

- Capital investment levels of a given sector
- The rate and progress of digitisation of existing production or assembly lines
- The physical nature and location of the client premises being earmarked for PN support
- The sector knowledge and expertise of the supplier
- Competitive intensity in the sector (between operators) and outside of it
- First-mover advantage.

For the purposes of the current exercise, it is helpful to compare sectors on capital intensity. In the UK, at least seven sectors spend over £3 billion per year on capital investment, with grid operators, utilities and chemicals at the top of this list. Investment levels are strongly correlated with the economic cycle, with major drops being precipitated by the 2008 financial crisis, Brexit (UK- and EU-specific) and, inevitably, the Covid-19 crisis. The pandemic will trigger a recession but with the potential for a sharp recovery in 2021 rather than permanent structural changes to the nature of the economy and factors of production. There will likely be a pent-up and sharp release of capital once lockdown restrictions are lifted, a vaccine is released and economic activity recovers. The average annual growth in business investment of 0.3% for manufacturing and 0.9% for other production sectors will therefore likely shoot up in 2021–2022 in China, Japan, South Korea and most western countries.

Source: UK Office of National Statistics, GSMA Intelligence

4 Even a small share of capital investment in many sectors is a big number (UK data)



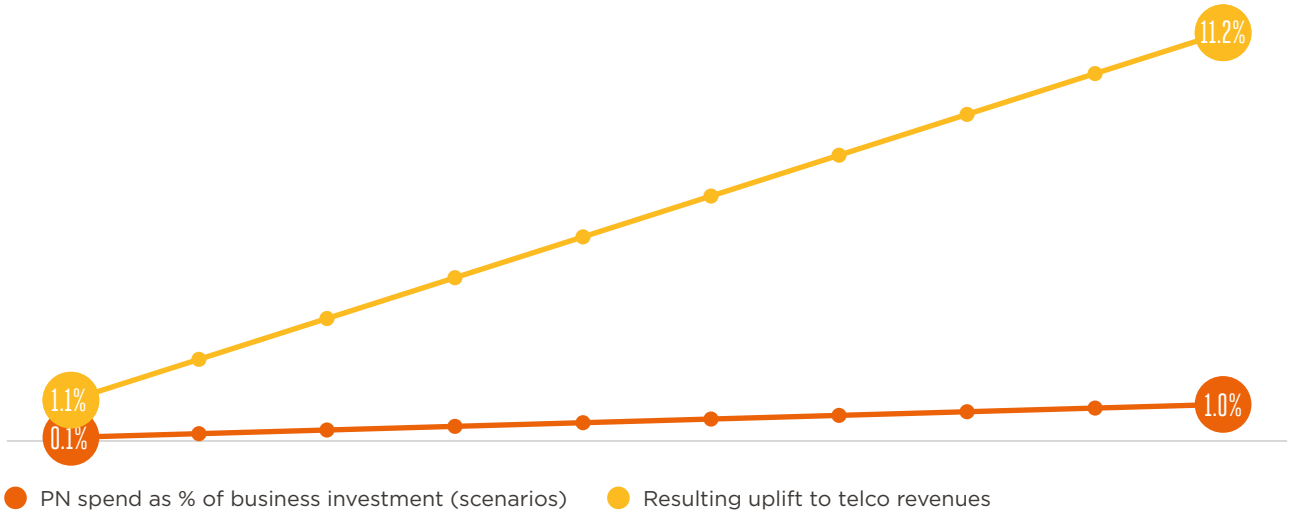
Capital investment across these sectors covers a wide range of uses and the majority of these have nothing to do with digital upgrades. But even if a small share were to be allocated to 5G connectivity and services, the returns are sizeable in relation to telco revenues. If 0.1% of capital investment (approximately £200 million) in the UK were spent on PNs, it would translate into a 1.1% uplift to UK telco revenues, rising to 11% for an investment contribution of 1% (see Figure 5). For reference, existing business-to-business services (connectivity, security and IoT) sold into SME and corporate segments account for around 30% of operator revenue (the other 70% being consumer).

Of course, the below projections assume that operators capture 100% of the PN revenue – a highly unlikely scenario, as early deployments in Germany and the US suggest that equipment vendors and cloud companies are likely to participate as partners, separate contractors or even lead contractors (potentially excluding operators entirely). However, if telco revenue equated to 50% of the total, the impact would still be material and this should rise over time as more enterprise verticals commit to digital technology investments that serve automation and low-latency requirements.

> **Even if a small share of capital investment were to be allocated to 5G connectivity and services, the returns are sizeable in relation to telco revenues.**

Source: UK Office for National Statistics, GSMA Intelligence

5 Even PN spend at 0.1% of business investment equates to a 1% telco revenue uplift (illustrative scenarios in the UK)

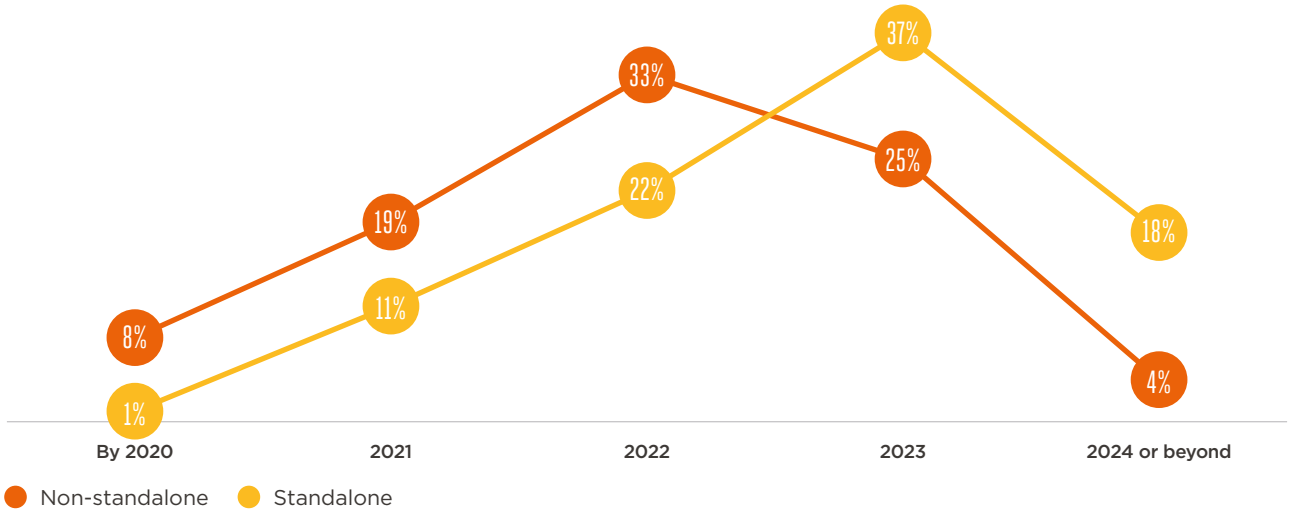


The other major – and largely underappreciated – factor is the availability of SA 5G networks. Most of the initial 5G builds outside of China follow a non-standalone (NSA) architecture that utilises LTE masts and a 5G radio. NSA can support enhanced mobile broadband (faster speeds) but not ultra-low latency, which requires SA. Our survey of operators suggests that most operators (around 60%) intend to launch SA networks in 2022–2023. This represents a two-year lag on NSA, which in part reflects the higher costs associated with SA and the fact that new standards from 3GPP will not be available until 2021. This puts operators at a potential disadvantage given that many enterprises are releasing IT upgrade tenders *now*, rewarding first movers. It is notable that a majority of enterprise clients from our survey view telco equipment vendors (such as Nokia and Ericsson) as preferred suppliers over operators. We expect some operators to fast-track their SA deployments or to launch micro deployments on custom specifications before international standards are agreed.

Source: GSMA Intelligence Network Transformation Survey 2019

6 When do you plan to launch standalone versus non-standalone 5G?

(% of respondents)



5.5 Revenue models revolve around partnering for a slice of the pie

Beyond the question of how much money PNs could generate, there is also the issue of project structures and business models. We see three broad options for deploying PNs but with shades of grey in between since companies have highly customised requirements that may well evolve over time.

Three broad approaches for deploying private networks

- **Single provider, end-to-end control:**
  - Operator builds and manages a PN for the enterprise client
  - Traditional project structure of sub-contracting network kit to equipment vendors (Nokia, Ericsson, Huawei, Cisco, ZTE etc.)
  - Operator owns end client and assumes overall responsibility for meeting agreed performance metrics (e.g. throughput, latency, uptime).
- **Single provider, co-investment with enterprise:**
  - Similar to above, but the cost of the network is jointly funded by the customer and operator to spread the capital costs burden to ensure mutual buy-in.
- **Multi-stakeholder:**
  - Operator takes a specific role within a larger project team, which may include equipment and/or cloud vendors as well as other specialists
  - Enterprise customer may contract with each supplier separately or through a joint agreement.

While each model will be utilised to a certain extent, our expectation is that the multi-stakeholder approach will be the default. The single provider models would be the preferred outcome for operators, as they extend the current sub-contracting structure with equipment vendors and ensure operators retain the customer relationship in the 5G era. But given that more enterprises see vendors – not operators – as their preferred suppliers, this hampers such prospects. There is also the issue of complexity in servicing what are highly technical industrial settings; end clients will likely want to hedge their risk by having multiple suppliers. Finally, for enterprises in possession of their own spectrum (in countries such as Germany, Sweden and the US), there is less reliance on operators. The recent deal between Nokia and the Polish electricity grid operator highlights this issue, as power grid operations across the EU have the ability to use the ring-fenced 450 MHz band. Where single provider models prevail, we expect such situations to increasingly involve joint investments with the enterprise customer on a small number of high-value deals.

The multi-stakeholder approach solves the expertise and investment risk problems by bringing in multiple providers to perform specific functions (comparative advantage). It's also in line with the reality that if 5G is to work in enterprise settings, it will require increased processing power at the edge, which will largely depend on working with hyperscale cloud companies (i.e. AWS, Microsoft, Google and Alibaba). Microsoft recently announced Azure Edge Zones for precisely this purpose. AT&T has signed on as an operator partner in Dallas (with plans to expand to Los Angeles in mid-2020). Seven international operators – Vodafone, SK Telecom, NTT, Telstra, Etisalat, Proximus and Rogers – are also listed as partners. Amazon continues to push a similar approach to Microsoft with AWS IoT Greengrass. Ericsson's recently released turnkey solution for PNs in industrial settings ('Industry Connect') is a further sign of things to come.

> **"The lines of competition between operators, vendors, cloud companies and the host of other participants in the IoT value chain have permanently blurred.**

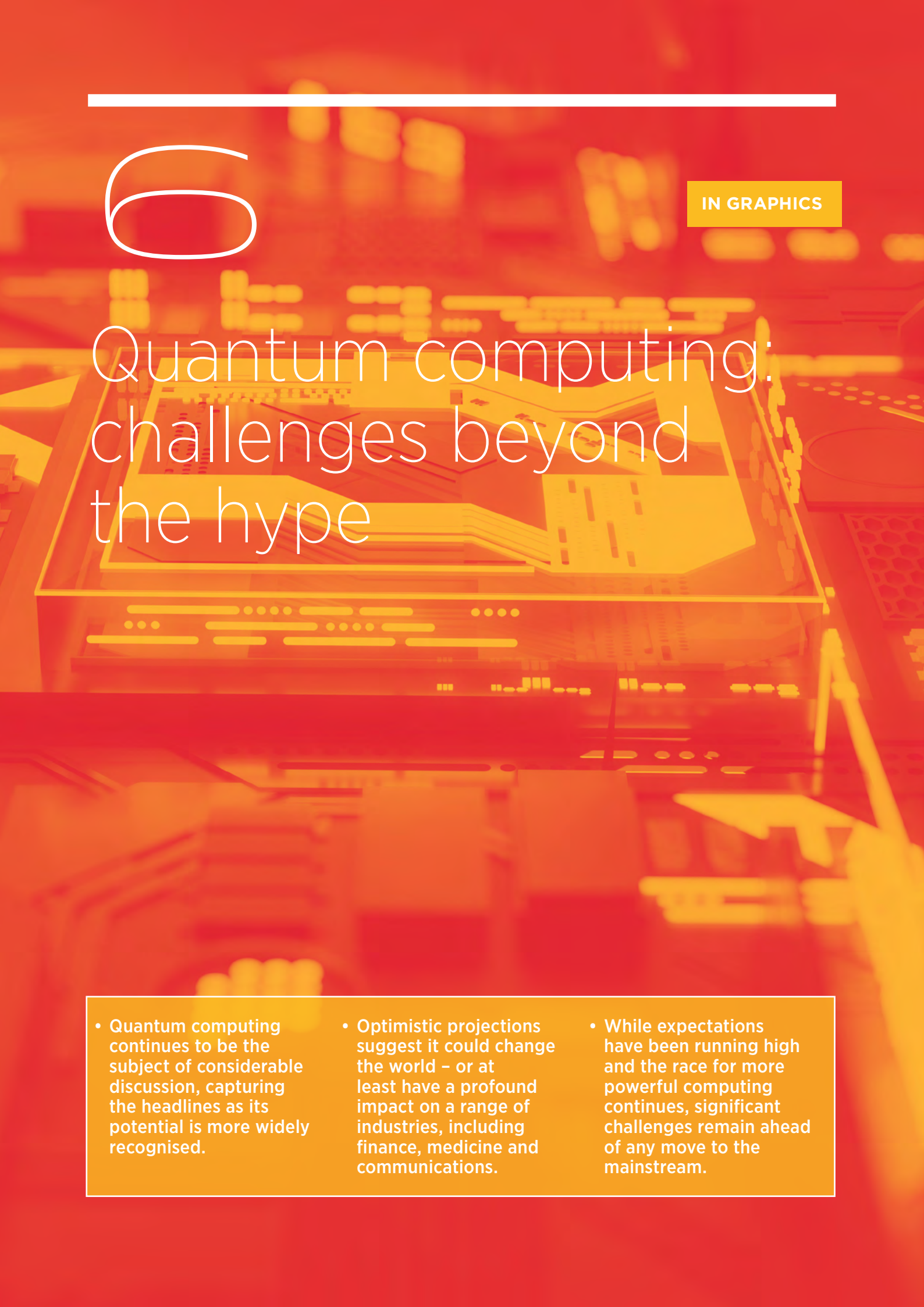
The lines of competition between operators, vendors, cloud companies and the host of other participants in the IoT value chain have permanently blurred. For operators, the main risk is of their influence waning if commercial 5G networks are firmly established by companies with their own spectrum holdings (particularly mmWave for high-burst, short-range signals) or by the likes of AWS as extensions to their cloud footprints. This would put a damper on the grand vision for 5G in the enterprise segment.

However, there will be a very real and tangible capex allocation across multiple enterprise sectors that can be capitalised on, with the potential to establish recurrent revenue streams. PNs will be a central product – whoever operates them – but for operators (as incumbent providers) to succeed, a nuanced approach is needed – one that will depend as much on operators taking on the role of an IT consultancy as that of a connectivity supplier.

6

IN GRAPHICS

Quantum computing: challenges beyond the hype

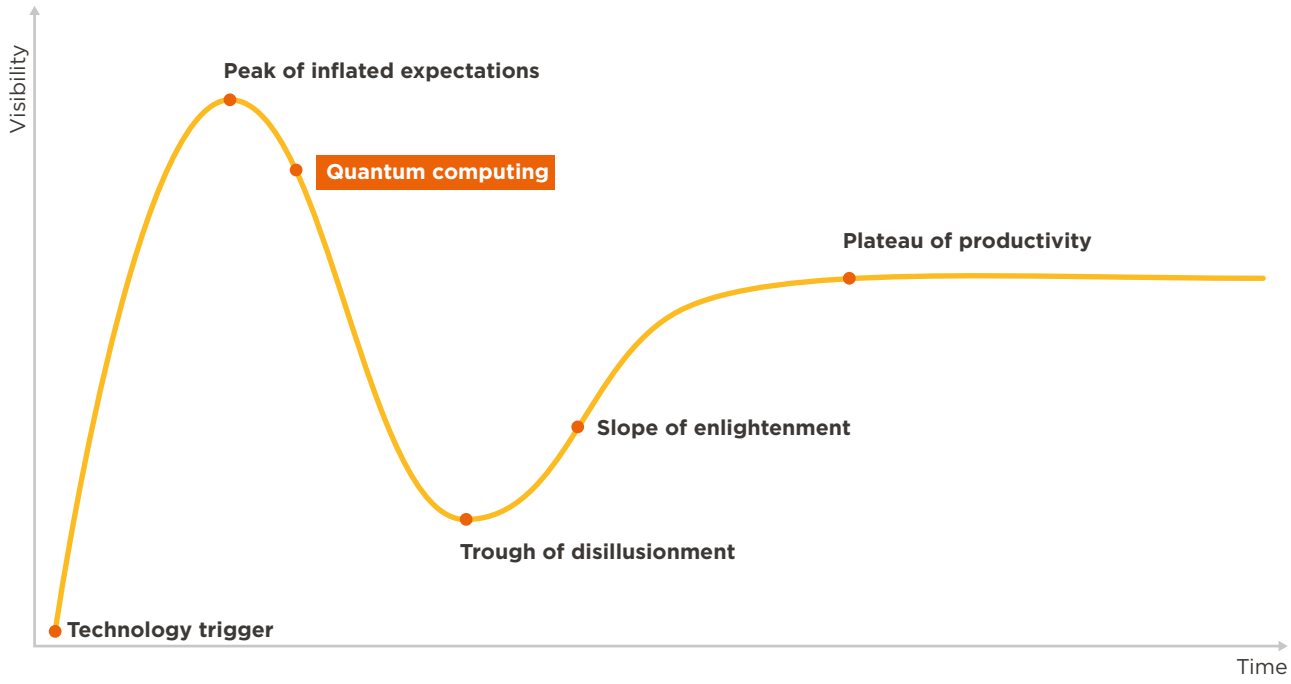


- Quantum computing continues to be the subject of considerable discussion, capturing the headlines as its potential is more widely recognised.
- Optimistic projections suggest it could change the world – or at least have a profound impact on a range of industries, including finance, medicine and communications.
- While expectations have been running high and the race for more powerful computing continues, significant challenges remain ahead of any move to the mainstream.

Expectations running high

Quantum computing currently appears to be moving beyond the peak of inflated expectations in the classic hype cycle. New technology tends to then pass through a period of disillusionment, as it struggles with the challenges of practical deployments. These subsequently begin to be addressed and the tech is more widely adopted.

Moving beyond the peak in the hype cycle

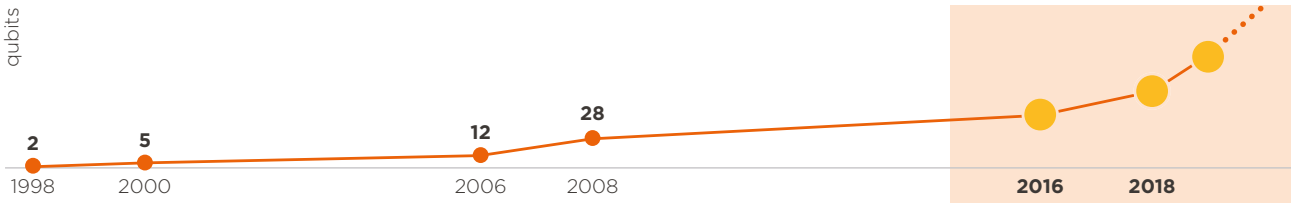


Source: Based on Gartner hype cycle

The race for more powerful quantum computing continues

Since Oxford University researchers announced in 1998 that they had made a breakthrough with the ability to compute information using 2 qubits, the rate of development for quantum computing has generally been slow. It is only in the last few years that this has started to change.

Quantum development ramps up



2016

IBM reaches significant milestone in developing the most powerful computer at **50 qubits**, representing a 25-fold increase in computing power over a 20-year period.

2018

Google demonstrates **72 qubit** processing, reflecting a clear acceleration in the rate of development.

Rigetti announces it is developing its service at **128 qubits.**

2019

Google AI, in partnership with Nasa, claims its Sycamore quantum processor has completed in 200 seconds a task equivalent to one which would take a state-of-the-art supercomputer approximately 10,000 years to complete. This is known as 'quantum supremacy' – namely, the point at which quantum computers begin to do things that classical computers cannot.

IBM's Q experience counts more than 100 customers paying for access to the hardware and expert assistance.

Amazon Braket is available in trial form as part of the AWS offering.

Microsoft's Azure Quantum cloud service is available on a test basis.

Source: Company announcements

Applications are emerging for quantum computing

There are three different types of quantum computing, which differ in the amount of processing power that they require and the time needed before they will be ready for commercial applications:

Quantum annealing – This is most suited to optimisation problems – specifically, how to find the best possible combination of a range of variables.

Quantum simulations – This involves exploring specific problems in quantum physics that are beyond the capacity of classical computer systems. Simulations can be applied in the field of chemistry – for example, folding a protein (a major challenge for biochemistry in endeavours to understand a range of diseases).

Universal quantum computing – This involves the most powerful quantum computers that would require power of at least 100,000 qubits (and potentially significantly more). In theory, a universal quantum computer could rapidly solve any complex problem, with likely application in areas such as artificial intelligence to accelerate machine learning. However, given the rate of progress outlined above, these machines remain some way off.

Though the benefits of quantum computers are mostly still theoretical, early use cases are already emerging, mostly relying on quantum annealing. For example, truly random number generation can be used to enhance the encryption of messages and transactions. This field of quantum cryptography is perhaps the most promising, though distance – in terms of how far encrypted information can be carried – is still a challenge.

Emerging use cases

Encryption – China's Micius satellite has been testing secure videoconferencing between continents as it seeks to address the distance challenge. It has successfully set up a videoconference between the Chinese Academy of Sciences in Beijing and the Austrian Academy of Sciences in Vienna.

Operations – Delta Airlines is using IBM's Q experience to quickly reschedule flights following significant disruptions.

Manufacturing – OTI Lumionics is using Microsoft's Azure Quantum to accelerate the search for new materials to make OLED screens, which can be used in devices such as TVs and laptops.

Financials – JP Morgan is looking to create a 'quantum culture' as it looks to explore the benefits of the emerging technology. A group of senior computer scientists review the latest research in quantum computing every fortnight. Initial use cases include helping fund managers to improve their investment decisions and financial risk analysis.[1]

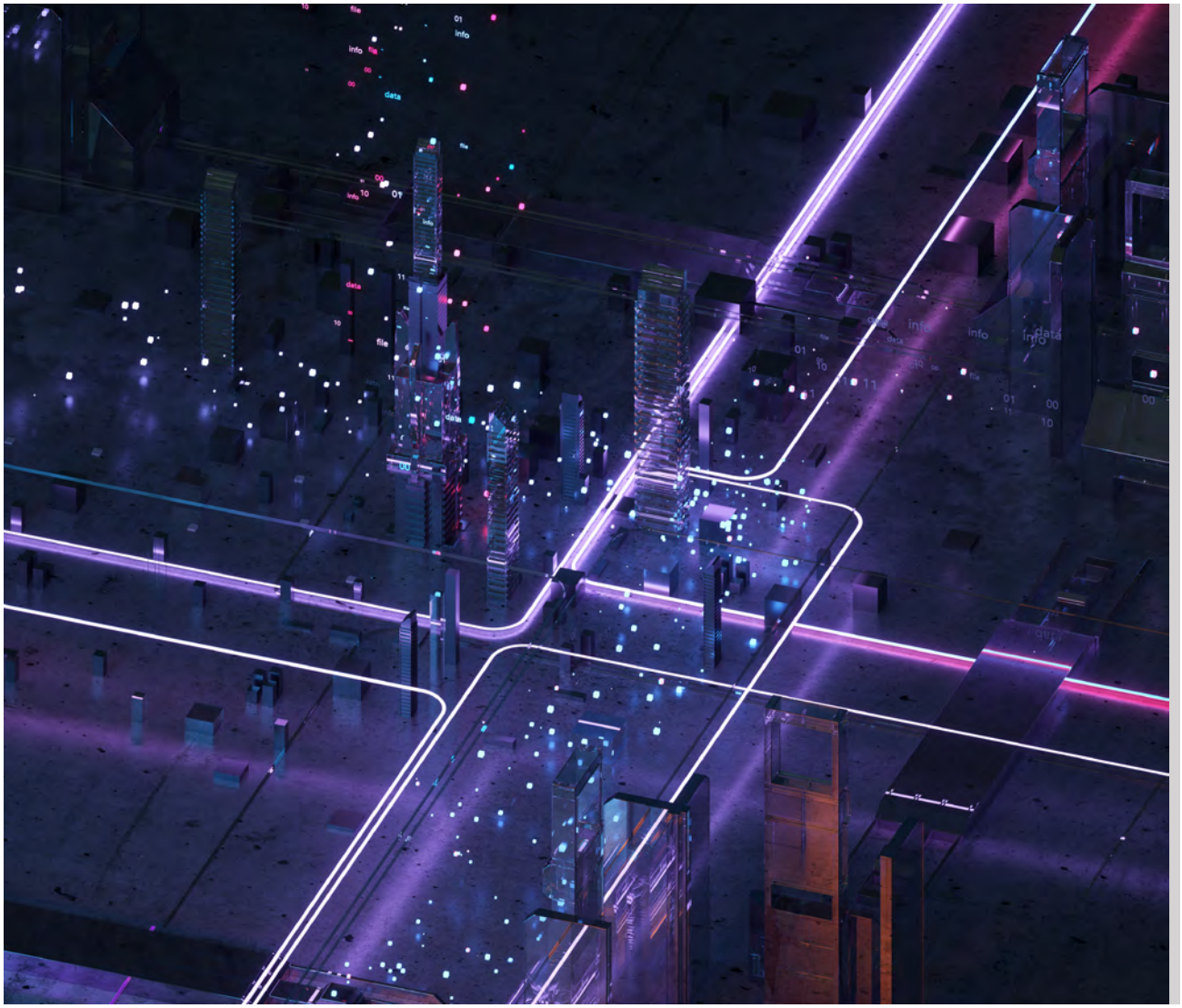
1 "Amazon, IBM and Microsoft race to bring global access to quantum computing" CNET, April 2020

Quantum in telecoms

Quantum annealing could also have applications in the telecoms sector, with network planning a likely use case.

TIM recently claimed to be the first European telecoms operator to implement quantum computing in its network planning. The company has optimised the planning of radio cells, framing the problem within a QUBO (quadratic unconstrained binary optimisation) algorithmic model, carried out on D-Wave's 2000Q quantum computer. This has made it possible to develop radio cell planning that ensures reliable mobile services with high performance.[2]

As quantum computing speeds are expected to improve further as the technology evolves, TIM highlights the ability to configure the network in real time as a key aspect in providing customers with better mobile service.



2 "TIM is the first operator in Europe to use quantum computing live on its mobile networks", TIM, February 2020

Investing in quantum for a strategic advantage

With the emerging potential of quantum computing, nations as well as corporates are looking to invest to gain a strategic advantage.

National initiatives

- The US established the National Quantum Initiative Advisory Committee in 2019, with the goal of spending up to $1.2 billion on quantum research over the next five years.

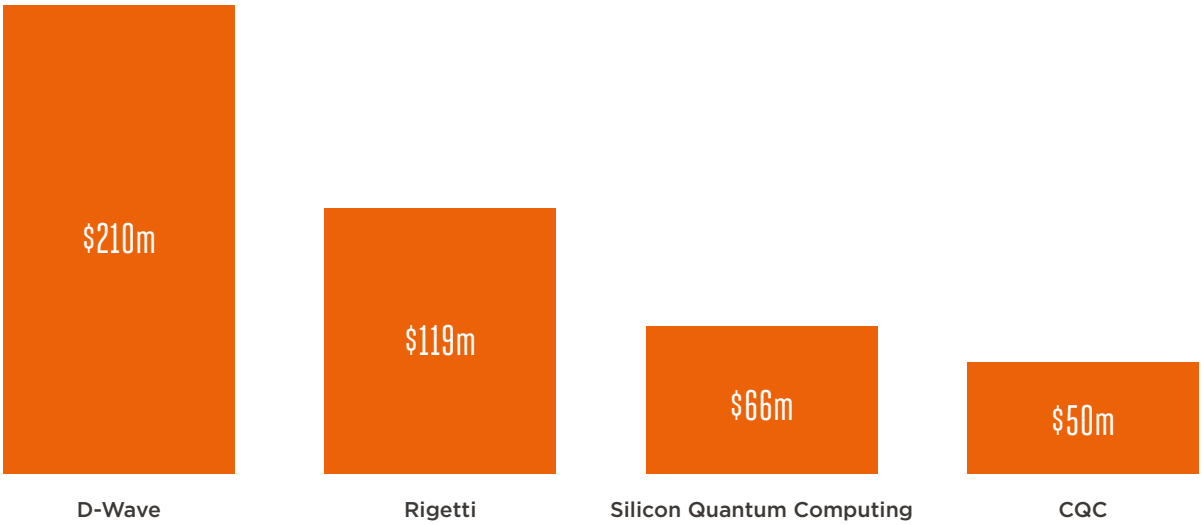
- The Indian government has announced a National Mission on Quantum Technologies & Applications with a total budget of INR8,000 Crore ($1.12 billion) over a five-year period.

- The EU has created the Quantum Technologies Flagship programme, with €1 billion to invest in quantum projects across Europe.

Corporates and financial investors

Notable startups include D-Wave, which has seen the most private capital and is still privately held. D-Wave was the world's first commercial supplier of quantum computers. Organisations including NEC, Volkswagen, Denso and Lockheed Martin are using its quantum systems. Rigetti recently raised a further $71 million in funding, but press reports indicate this was raised at a lower valuation, reflecting the challenges in this still emerging technology.

Quantum computing start-ups with over $50m raised



Source: CB Insights

Challenges remain in quantum computing

While the addition of quantum computing to existing cloud computing offerings is beginning to make the technology accessible to a broader range of users, a number of challenges remain to be addressed before quantum can displace the current reliance on the classical computing model.

These significant challenges will be a factor in driving sentiment towards the 'trough of disillusionment' identified earlier. As some are addressed and more practical use cases are developed, quantum computing should see more widespread adoption. While it is too early to signal the death knell for classical computing, quantum computing's potential is clear.

Main challenges

Lack of knowledge outside core researchers

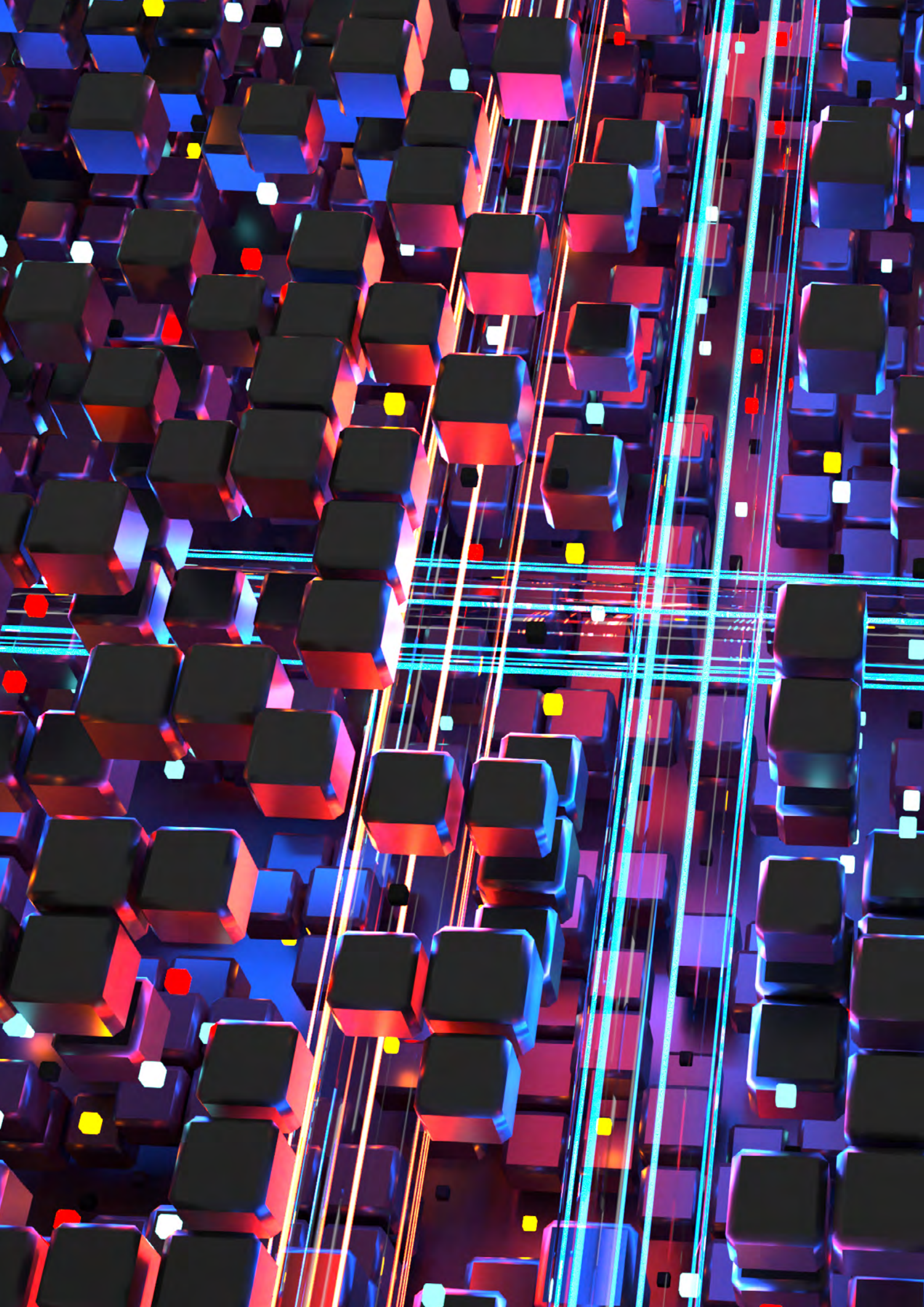
The companies in the race to bring quantum computing to the cloud are the same companies looking to develop the tools to create and run quantum software. A broader range of developers is required to bring quantum computing into the mainstream and make it more accessible to a wider range of users.

Form factor and energy efficiency

Quantum computers in use today are extremely large and custom built. They are very different to the models and form factors seen in mainstream computing; these incorporate miniaturised and mass-produced chips and other key components, lowering costs and increasing accessibility. Many of the existing quantum machines must also be cooled to close to absolute zero, presenting challenges in terms of containment and energy consumption.

Error correction

This is a fundamental challenge for quantum computers, especially for universal quantum computing (some question whether it can be solved at all). All computers correct small random errors, but the inherent instability of qubits means errors can develop rapidly. IBM has set a goal of doubling every year its 'quantum volume' – a measure of several factors including how long the computer can be used before the error rate fouls its output.



gsma.com

Engage with the GSMA Radar suite of products

Access data, trends and insights from the GSMA through the **Radar** suite.

Strengthen your business strategy with our foresight intelligence into the digital ecosystem.

Participate in the global digital ecosystem with mobile operators, start-ups, think tanks, internet players and others.

Voice your opinions and requests in our webinars and events, and be part of the **Radar** community.

Previous editions

gsmaintelligence.com

Contact

Matt Bonsall,
Director of Strategy and Innovation

mbonsall@gsma.com

Authors

Streaming: no standard definition of success
David George
dgeorge@gsma.com

Socially responsible investing: doing well by doing good
James Robinson
jrobinson@gsma.com

Private networks: back in vogue and here to stay
Tim Hatt
thatt@gsma.com

Quantum computing – challenges beyond the hype
David George
dgeorge@gsma.com

GSMA Head Office
Floor 2
The Walbrook Building
25 Walbrook
London EC4N 8AF
United Kingdom
Tel: +44 (0)20 7356 0600
Fax: +44 (0)20 7356 0601