About the GSMA
The GSMA represents the interests of mobile operators worldwide, uniting more than 750 operators with nearly 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.

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.
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New disruptions on the Radar
As we look to the new opportunities and challenges of 2020, we can be certain that many industry verticals will once again experience disruption, while currently accepted schools of thought will be questioned and potentially turned on their heads. As with every edition since its inception, this Radar examines the possible sources of such disruption and the implications for an increasingly diverse range of industry players.

- In this edition we look at the disruptive potential of satellites to the communications market, following the Federal Communications Commission’s regulatory approval of SpaceX and OneWeb’s deployment plans and the entrance of Amazon in this field. While the competitive landscape in developed economies may see some activity, it is in emerging markets where we expect to see the largest changes. In particular, we examine how the disruptive potential of low Earth orbit (LEO) satellites could bring interesting opportunities for satellite providers to redefine market offerings for industrial IoT deployments in rural and remote areas.

- Improvements in fitness applications and analytics capabilities have caused a revival in the wearables market, especially among health-conscious millennials. Aided by insurer subsidies, consumers are helping to drive digital disruption in healthcare. A clear shift is underway to digitise healthcare access and enable individual empowerment through the widespread use of AI to analyse health information. We look at the data behind this trend to study the importance of digital consent and the compatibility of the differing motives of profit and social good.

- Finally, our infographic chapter looks at developments within the gaming industry and its potential shift to cloud as old and new players look to bring the format into the mainstream in order to capture surging market growth.

I hope you find the topics covered in this Radar to be stimulating and that they provide you with much to consider for the road ahead this year.

Laxmi Akkaraju
Chief Strategy Officer
GSMA
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Key takeaways
Satellite wars relaunched: a new network in the sky

• 2016 marked a decisive moment for the satellite communications market with the arrival of SpaceX and OneWeb. Since then, two significant events have occurred. The first is that proposed deployments from both companies have received regulatory approval from the US Federal Communications Commission. The second is the emergence of Amazon at both the satellite terminal (Project Kuiper) and ground station infrastructure levels of the value chain. If SpaceX, OneWeb and Project Kuiper’s initial deployment plans progress to completion, the combined constellation would effectively cover 100% of people who do not yet have internet access.

• Both SpaceX and Amazon have indicated their intentions to compete in the US fixed broadband market with a focus on rural households and premises. However, rural internet provision and backhaul capacity in emerging markets are more tangible opportunities, especially for low Earth orbit (LEO) deployments if partnerships can be formed with mobile operators to overcome technical difficulties and the lack of sales and distribution infrastructure.

• Industrial IoT deployments in rural and remote locations are the most interesting area of opportunity for satellite connectivity. The disruptive potential of LEO satellites comes from the prospect of undercutting high existing prices, better coverage, and enhanced analytical capabilities in the cloud.

• For these reasons, Amazon’s entry is game changing. The move into satellite ground stations will pose a major challenge to existing players in the market and provide a ready-made solution for rural enterprise customers seeking connectivity, compute and analytics. After a history of false dawns, a new viable model of aerial networks is now firmly on the horizon.

Has tech exceptionalism come to an end?

• Tech exceptionalism is the concept that technology companies operate in their own unique environment, free from the various operational, regulatory and financial constraints faced by more traditional businesses. The concept has helped underpin the rise of a range of disruptive telecoms companies. Indeed, a ready supply of capital chasing a diminishing pool of startups has led to companies staying private for longer while attracting ever higher valuations.

• However, with a number of high-profile tech IPOs either performing poorly or being delayed, public markets are increasingly sceptical not only of the valuations being asked but, more crucially, of some of the fundamentals underpinning these businesses. At the same time, regulators and governments are belatedly addressing the challenges posed by the digital disruptors. This, combined with the various scandals around the use of consumer data that have led to many companies forfeiting users’ trust, has put the basic tenets of the tech sector under threat.

• The sheer volume of capital in the global private equity markets is not about to disappear, but investors in both public and private markets will need to be more discerning about where they invest and to shun the growth-at-any-cost model.

• If the current tech model is showing signs of wear, what then does the future hold? It seems increasingly likely that the focus of innovation will shift from software to hardware, as new form factors and hardware functions will be required to capture the vast amounts of data produced by connected devices. This could provide an opportunity for new disruptors to emerge or indeed for some of the established old-economy (or old-tech) companies to have their own period of dominance.
Analytics on steroids: digitisation in healthcare intensifies

- Through a vastly improved set of fitness applications and analytics capabilities, wearables are experiencing a revival. The activity in this space also reflects a broader push to digitise healthcare access, as AI and machine learning (ML) are being used across a range of institutional and personal health sectors. This is well established in the institutional (or enterprise) space, but the consumer segment has a much higher perceived risk from the public considering the sensitive nature of personal health data and the worry of ceding control to profit-led companies.

- If the current early-adopter phase is essentially about people taking greater control of their fitness through the use of dashboards, we can imagine the next step being one where Google and Apple integrate electronic medical records data – through sharing agreements with hospitals – to provide a richer set of information to users in a single user interface. Phase three would then involve deeper use of digital assistants in a health context, aided by a step up in the level of data inputs from public health bodies and research institutions to train neural networks. This could eventually give way to a scenario where platform companies become a hub for medical services, enabled by highly sophisticated AI engines.

- The transformation of healthcare will be a long game. Companies targeting the health sector will need tactical nous to adjust the traditional modus operandi of bringing digital disruption to an industry for financial gain. Apple, Google, Facebook and Microsoft have made careers out of vanquishing incumbent competitors in multiple sectors through classic innovation, but the same model is not possible in healthcare, as evidenced by the public backlash to the growing list of data scandals. This is as much about corporate identity as it is pursuing new business.

Gaming: the shift to cloud is on

- With surging revenues, the global gaming market could be generating upwards of $200 billion in only a few years’ time. Relatively new formats and technologies are typically not priced into such estimates, though, and could drive revenues even higher.

- New entrants have emerged in the cloud-gaming space, as old and new players alike attempt to bring the format into the mainstream – most notably with Google’s launch of Stadia.

- Startups are also pushing the shift to cloud, in addition to other innovative formats such as VR and e-sports.

- However, as cloud-gaming and VR take-up remains relatively low, it brings into question when (or if) their potential will be realised.

- These services require high processing power and ultra-low latencies; the possible success – or failure – of such formats will therefore have implications for supporting technologies such as edge computing and 5G.
Satellite wars relaunched: a new network in the sky
3.1 Executive summary

The arrival of SpaceX and OneWeb in 2016 revitalised the stagnant satellite communications market. Since then, two significant events have occurred.

The first is that proposed deployments from both companies have received regulatory approval from the US Federal Communications Commission (FCC). The second is the emergence of Amazon at both the satellite terminal (Project Kuiper) and ground station infrastructure levels of the value chain. If initial deployment plans progress to completion, SpaceX, OneWeb and Project Kuiper would collectively have roughly 8,300 satellites in orbit by 2027 – just under four times the number of active satellites currently in orbit for any purpose. Their combined constellations would effectively cover 100% of people who do not yet have internet access, compared to the 80–90% coverage of mobile broadband networks.

Both SpaceX and Amazon have indicated their intentions to compete in the US fixed broadband market with a focus on rural households and premises. As we argued in a previous edition of the Radar, the broadband challenger scenario is eye-catching but low on substance without considerable price reductions on existing satellite tariffs. Even if such price reductions materialised, the revenue opportunity is low.

Rural internet provision and backhaul capacity in emerging markets are more tangible opportunities. Some 900 million people worldwide live out of range of a mobile broadband network (3G or 4G), mostly in Africa and India. This is potentially a strong opportunity for low Earth orbit (LEO) deployments if partnerships can be formed with mobile operators to overcome technical difficulties and the lack of sales and distribution infrastructure. Satellite companies would take a wholesale connectivity revenue fee, while the operator would take charge of the retail-customer relationship.

Industrial IoT deployments in rural and remote areas are the most interesting area of opportunity for satellite connectivity. A number of established companies already operate in this space, providing services for logistics and maritime use cases. The disruptive potential of LEO satellites comes from the prospect of undercutting high existing prices, better coverage, and enhanced analytical capabilities in the cloud. For these reasons, Amazon’s entry is game changing. Its satellite constellation would serve as the final piece to a value chain Amazon has, for the most part, already assembled with Amazon Web Services (AWS) infrastructure. The move into satellite ground stations will pose a major challenge to existing players in the market and provide a ready-made solution for rural enterprise customers seeking connectivity, compute and analytics. After a history of false dawns, a new viable model of aerial networks is now firmly on the horizon.
3.2 FCC greenlights SpaceX and OneWeb, as Amazon joins the fray

2016 marked a decisive moment for the satellite communications market with the arrival of SpaceX and OneWeb. Prior to this, the market had been largely static for 20 years with a selection of incumbent operators offering expensive connectivity services for maritime and remote land-based customers or assets.

There were two turning points to this uneconomic mode of connectivity provision: the reduction in satellite vehicle sizes and the shift to constellation deployments at significantly lower altitudes. Both SpaceX and OneWeb had, at the time, amassed strategic investments from multiple partners to fund R&D efforts to miniaturise components, decrease power consumption and invest in automated production lines. Interest was being further fuelled by Elon Musk, SpaceX’s charismatic (if mercurial) founder and CEO, who was also declaring the company’s broader ambition to put humans on Mars.

Since 2016, there have been two critical developments. The first is that SpaceX and OneWeb’s constellations have received regulatory approval from the FCC. For SpaceX, 4,425 satellites were initially approved, followed by an additional 7,518, in spite of fierce opposition from existing satellite operators and broadcast companies. OneWeb will initially launch a more modest 650 satellites, although its deployment timeline is more aggressive with commercial services planned for 2021 (the company also has the option to build an additional 1,330).

The second major event is the emergence of Amazon as a new competitor, entering the market at both the satellite terminal (Project Kuiper) and ground station infrastructure levels of the value chain. Project Kuiper is branded as a partnership looking to extend internet access to the unconnected, which the company quantifies in the “tens of millions”. So far, few details have been released, which leads us to believe Amazon will likely provide financing and support, as opposed to taking on a lead build role. Perhaps more importantly, AWS has expanded into the satellite ground station market (ground stations are the equivalent of internet routing or switching centres). At present levels, this is set to increase the scale of routing facilities by orders of magnitude. Combined with latency reductions, satellite signal strength and quality are on course for dramatic improvements.
# The constellation model explained

The architecture and performance of communication satellites are determined by three major characteristics: geopositioning, orbit/altitude and satellite density.

## Geopositioning

Every satellite in orbit is designated based on longitudinal positioning. This is measured in degrees, with coordinates moving either westward or eastward from the Prime Meridian (0°, running through Greenwich, London). It is possible for multiple satellites to share the same longitude by occupying different orbit inclinations (higher inclinations move closer to the polar regions).

## Orbits and the altitude/signal strength trade-off

This is the most important element of satellite topology. There are multiple types of satellite orbits, which are distinguished by their altitude and inclination (angle from the equator). The key trade-off is that with increasing altitude, ground coverage is improved while signal strength to ground is reduced.

### Low Earth orbit (LEO)

Satellites at LEO are nearest relative to Earth, with an altitude of 2,000 km or less above sea level (for context, commercial aeroplanes fly at an altitude of 10 km). The rotational period around the Earth takes 225 minutes, which means satellites at LEO circumnavigate the globe approximately six times per day. Lower altitudes mean it takes less time for signals to make a round trip from satellite to Earth, so LEO satellites also have the lowest latency. LEO satellites are ideal for weather and other observational purposes, such as high-resolution imaging for the defence sector.

### Geostationary Earth orbit (GEO)

These satellites are furthest away from Earth, occupying an altitude of 35,800 km directly above the equator. The orbital period of this altitude matches the Earth’s rotation (24 hours). This means that for a person on the ground, the position of a GEO satellite remains the same throughout the day, preserving line of sight and reducing the risk that coverage is lost. For this reason, the majority of communication satellites up to now have been stationed at GEO. However, GEO satellites have a latency of 250–280 ms, 10 times greater than that of LEO satellites.

### Medium Earth orbit (MEO)

Satellites at MEO occupy a broad range of altitudes between LEO and GEO.
The new constellation deployments from SpaceX, OneWeb and Project Kuiper will sit in LEO rather than GEO. The advantage of lower altitudes is a higher data throughput capacity and lower latency due to the shorter distances signals are required to travel. While this is a trade-off with surface area coverage, operators can compensate for this by having a higher density of satellites in the constellation to create overlapping cells. If initial deployment plans progress to completion, SpaceX, OneWeb and Project Kuiper would collectively have roughly 8,300 satellites in orbit – just under four times the total number of satellites currently in use worldwide for any purpose. Their combined constellations would, in theory, effectively cover 100% of people who do not yet have internet access, compared to the 80–90% coverage of land-based mobile networks.

Source: Company reports, FCC

### Constellation deployment plans for new satellite operators (committed rollouts by 2027)

![Diagram showing constellation deployment plans for new satellite operators](image)

Figures in the bubbles represent the planned number of satellites at a given altitude.
3.4 Scenario analysis: the new target markets for satellite

We envision three broad market segments for satellite entrance (these are not mutually exclusive): fixed broadband; rural/remote broadband in emerging markets (and backhaul); and IoT.

In a previous edition of the Radar we argued that the fixed broadband challenger scenario is eye-catching but low on substance in the absence of considerable price reductions on existing satellite tariffs. In contrast, rural broadband and IoT have larger addressable markets and both are now more attractive options, following the FCC’s decision to permit the increased constellation sizes for SpaceX and OneWeb, along with the entrance of Amazon.

### Three market segments for satellite

<table>
<thead>
<tr>
<th></th>
<th>Fixed broadband</th>
<th>Rural/remote internet</th>
<th>IoT (greenfield)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenue potential</td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>Markets</td>
<td>Fixed and mobile broadband</td>
<td>Internet access in remote locales, backhaul services for mobile operators</td>
<td>Connectivity for remote objects and sensors</td>
</tr>
<tr>
<td>Geography</td>
<td>US, Canada, Europe</td>
<td>Africa, India, Latin America, South East Asia</td>
<td>Global</td>
</tr>
<tr>
<td>Incumbents</td>
<td>Cable, fibre, ADSL, legacy satellite (e.g. Sky, DirecTV)</td>
<td>Covered areas: legacy satellite Uncovered areas: vacant</td>
<td>Legacy satellite, Wi-Fi, mobile operators (LTE-M, 2G)</td>
</tr>
<tr>
<td>Distribution</td>
<td>Retail (direct to consumer)</td>
<td>Retail, wholesale (partnership)</td>
<td>Retail, wholesale (partnership)</td>
</tr>
<tr>
<td>Pricing model</td>
<td>Contract subscription</td>
<td>Contract subscription, PAYG, community-based, data brokerage</td>
<td>PAYG</td>
</tr>
<tr>
<td>Addressable size</td>
<td>Households with no fixed broadband: 120 million (US and Europe)*</td>
<td>Population out of 3G/4G coverage: 900 million</td>
<td>Connected objects in industrial verticals: 13.7 billion (2025)</td>
</tr>
</tbody>
</table>

*As of March 2019

Source: GSMA Intelligence
Fixed broadband – a prohibitively expensive endeavour

Both SpaceX and Amazon (via Project Kuiper) have indicated their intentions to compete in the fixed broadband market with a focus on rural households and premises. The US would be the initial launch country, with FCC stipulations requiring satellite operators to provide continuous coverage of the continental US for 75% of a 24-hour period. The US has a polarised distribution of broadband access: while roughly 60% of households are on cable or fibre subscriptions, 17% remain on legacy copper lines and 21% have no broadband at all (see Figure 2). This final group, mostly dispersed in rural locations, is the target of the planned LEO constellations.

Viasat and Hughes are just two names in a long list of satellite communication companies that have been trying to reach this band of households for 20 years; this has been a largely unsuccessful endeavour because of high costs and poor satellite signal quality. Current entry-tier tariffs max out at 20 and 25 GB data allowances in peak hours (08:00–02:00). Viasat offers an unlimited plan at 30 Mbps, but this must be weighed against the problem of high latencies, which seriously undermine the user experience for time-sensitive applications like video calling, gaming and HD video streaming. Speeds from the new LEO constellations will almost certainly be higher due to the mesh architecture and because the satellites, at 1,000 km, will be 35× closer to the earth than existing GEO terminals. Latencies are harder to predict because they depend on the proximity to ground stations. SpaceX contends it will be able to offer a broadband service at latencies of 30 ms – 20× better than anything currently in operation – but this has yet to be demonstrated in practice under live conditions.

Source: GSMA Intelligence

21% of US households lack any type of fixed broadband...

<table>
<thead>
<tr>
<th>Percentage of households</th>
<th>UK</th>
<th>France</th>
<th>Portugal</th>
<th>Spain</th>
<th>US</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>75%</td>
<td>78%</td>
<td>13%</td>
<td>20%</td>
<td>21%</td>
</tr>
<tr>
<td>FTTx</td>
<td>19%</td>
<td>5%</td>
<td>14%</td>
<td>22%</td>
<td>17%</td>
</tr>
<tr>
<td>Cable</td>
<td>6%</td>
<td>17%</td>
<td>37%</td>
<td>43%</td>
<td>51%</td>
</tr>
<tr>
<td>Copper</td>
<td>36%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No fixed broadband</td>
<td>11%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Source: whistleout.com, company websites, GSMA Intelligence

3 ...but satellite has remained prohibitively expensive (US broadband tariffs)

<table>
<thead>
<tr>
<th>Speed (Mbps)</th>
<th>12-month cost ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viasat 12</td>
<td>$999.99</td>
</tr>
<tr>
<td>Hughes 25</td>
<td>$1,289.86</td>
</tr>
<tr>
<td>Viasat 30</td>
<td>$1,899.99</td>
</tr>
<tr>
<td>Comcast 60</td>
<td>$569.87</td>
</tr>
<tr>
<td>Comcast 150</td>
<td>$749.87</td>
</tr>
<tr>
<td>Comcast 250</td>
<td>$929.87</td>
</tr>
<tr>
<td>AT&amp;T 300</td>
<td>$480.00</td>
</tr>
<tr>
<td>AT&amp;T 400</td>
<td>$1,433.39</td>
</tr>
<tr>
<td>Viasat 400</td>
<td>$1,000.00</td>
</tr>
</tbody>
</table>

Tariffs accurate as of 29 May 2019. 12-month cost includes monthly tariff plus any fees for CPE and installation.

A comparison of current tariffs suggests that satellite is two to three times more expensive than cable or fibre alternatives despite far inferior speeds. The FCC’s guidelines state that broadband must reach a minimum of 25 Mbps downlink, which only one satellite plan currently offers (Viasat’s 30 Mbps). Amazon made explicit reference to these guidelines in its Project Kuiper application, although it did not provide details on the speeds its own service would offer. Amazon and SpaceX both have the ability to bring prices down, given their vertically integrated cost structures. Amazon can exploit economies of scale through AWS’s data centre infrastructure for routing; there are also potential synergies with the Blue Origin rocket venture backed by Amazon’s CEO, Jeff Bezos, although this could trigger conflicts of interest. Meanwhile, SpaceX should also be able to operate a leaner opex structure because it owns the actual rockets to distribute its payloads into orbit.

However, the revenue opportunity is low. Assuming satellite operators were able to sign up half of the 20% of households currently shut out from broadband access in the US with an ARPU of $48 per month (commensurate with the low end of fibre/cable tariffs), annual revenue would only be $7.9 billion, a fraction of the total fixed line market. But, we argue this is not the point. For mobile operators seeking to extend their reach into areas hitherto uneconomic for laying cell towers, wholesale connectivity without the need for new customer-premises equipment (CPE) is a more viable option. There is also the prospect of taking a share of the backhaul market. In any case, Amazon’s strategic rationale for entering the satellite internet access market – at least in the US – is to drive traffic to its e-commerce platform rather than to grow a retail or wholesale broadband business as such. For SpaceX we believe its ambitions lie further afield in rural and remote locales of developing countries. Therefore, in the context of fixed broadband, the hype around the disruptive potential of satellite to incumbent operators and cable providers is unfounded.
Rural/remote broadband – eyeing those without 3G and 4G

Rural internet provision and backhaul capacity in emerging markets are more tangible opportunities than fixed broadband. The provision of ground-based network coverage from mobile operators to remote regions is constrained by the high cost of towers, backhaul, the lack of grid electricity access and the need for low frequency spectrum to transmit data over very long distances. Moreover, demand is limited by low incomes in remote parts of Africa and India.

The world is split between those who are already internet users, those who have a mobile phone but without internet capability (or have chosen not to take a cellular data tariff), and those with neither (see Figure 4). The number of those without access to either the internet or a mobile phone remains staggeringly large on a global scale, at around 2.6 billion people. The actual addressable market for satellite is lower than this number though, because many people without internet access already live within range of a 3G or 4G mobile signal. This suggests that other factors, such as cost or relevance, are the barriers. Overall, around 900 million people worldwide live out of range of a mobile broadband network, most of whom reside in Africa and India (see Figure 5).

Source: GSMA Intelligence

The internet is still used by less than 50% of the global population...
...but the actual target market for satellite is the 10% with no 3G/4G coverage

Number of people connected to mobile internet and with 3G/4G coverage by region

<table>
<thead>
<tr>
<th>Region</th>
<th>Connected to mobile internet</th>
<th>3G/4G coverage but not connected</th>
<th>No coverage and not connected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub-Saharan Africa</td>
<td>382</td>
<td>1,011</td>
<td>211</td>
</tr>
<tr>
<td>South Asia</td>
<td>211</td>
<td>496</td>
<td>282</td>
</tr>
<tr>
<td>MENA</td>
<td>222</td>
<td>276</td>
<td>86</td>
</tr>
<tr>
<td>Latin America</td>
<td>321</td>
<td>1,239</td>
<td>53</td>
</tr>
<tr>
<td>Rest of Asia</td>
<td>96</td>
<td>207</td>
<td>21</td>
</tr>
<tr>
<td>Europe</td>
<td>517</td>
<td>264</td>
<td>94</td>
</tr>
<tr>
<td>US/Canada</td>
<td>264</td>
<td>1,040</td>
<td>4</td>
</tr>
</tbody>
</table>

This is potentially a strong opportunity for LEO deployments if partnerships can be formed with mobile operators to overcome technical difficulties and the lack of sales and distribution infrastructure. Regarding the technical challenges, very few handsets have the requisite radios to connect with satellites, necessitating CPE to be installed on home premises. This may be acceptable for hospitals, schools or other public buildings, but it is unlikely to be an attractive or affordable option for individuals. Additionally, the current realised speeds are questionable. SpaceX, for example, has claimed that once fully deployed, its constellation network will be able to support an aggregate downlink capacity of 17–23 Gbps per satellite, with end users reaching “up to” 1 Gbps. This would only allow for 17–23 people to be serviced by the cell assuming each uses 1 Gbps. Extrapolating this out, if the company connected 40 million subscribers (5% of the addressable population), it would take 40,000 satellites to give each person even 1 Mbps speeds.

It would therefore be much more economical to pair connectivity with the low frequency LTE spectrum of mobile operators. In this scenario, satellite communication companies would take a wholesale connectivity revenue fee while the operator would take charge of the retail-customer relationship. UbiquitiLink, a US start-up, claims to have 21 mobile operators signed up to a pilot scheme to test seamless roaming between satellite and licensed LTE spectrum. Because UbiquitiLink provides the aerial infrastructure, operators would only bear a minimal incremental capex burden.
IoT – from maritime and aviation to land-based enterprise verticals

IoT is the largest and fastest growing greenfield area of opportunity for satellite connectivity. A number of established companies already operate in this space including Orbcomm, SkyWave, Iridium Communications and Inmarsat. Service is concentrated on verticals that require unit tracking across large distances (e.g. military vehicles, commercial trucking and shipping) or that operate in remote areas out of reach of land-based networks (e.g. offshore oil rigs and mining pits). The disruptive potential of LEO constellations here comes from three factors: the prospect of undercutting extremely high existing prices; the ability to provide continuous coverage by having more satellites in orbit and a larger number of ground stations; and enhanced analytical capabilities in the cloud.

SpaceX, OneWeb, Amazon and Telesat, as well as a host of smaller competitors such as LeoSat and Hiber, have all made it clear that IoT verticals are core to their strategic rationale. Prevailing ARPs for machine-to-machine (M2M) data used by companies in these verticals range from $5 to $10 per month compared to the $1–2 achieved by mobile operators. Maritime, logistics and aviation are among the most targeted IoT verticals, but land-based enterprise IoT deployments are also showing plenty of promise. Regardless of industry, our IoT enterprise survey suggests a fast rising propensity for satellite options. While current deployments mostly rely on Wi-Fi, LTE-M or legacy 2G connections, there is a striking difference when comparing this with planned deployments. For the latter, satellite is now the second most favoured option after 5G (see Figure 6).

Source: GSMA Intelligence IoT Enterprise Survey 2018

Technologies used for enterprise IoT deployments: 5G and satellite up, Wi-Fi down

Most of the interest for satellite-based IoT comes from high-growth emerging economies such as Indonesia, Mexico and India (see Figure 7). Demand is also highest from companies that are planning large-scale deployments in excess of 1,000 objects; this suggests that purchasers will come from the likes of...
utilities, energy and mining, as opposed to aviation and maritime, which will have smaller deployment volumes. In Africa, for example, the current footprint of industrial IoT objects is a vanishingly small share of the global total (1.5%). However, we expect volumes to quadruple to 200 million by 2025, with energy and water utilities alone accounting for an additional 36 million connections (25% of the incremental growth). Some of this could conceivably be serviced by narrowband options, but this would be challenging in rural areas and villages with poor proximity to cell towers, where much of the demand is expected to be concentrated.

Source: GSMA Intelligence IoT Enterprise Survey 2018

<table>
<thead>
<tr>
<th>Country</th>
<th>Size of deployment (number of objects/sensors/devices)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indonesia</td>
<td>48%</td>
</tr>
<tr>
<td>Mexico</td>
<td>43%</td>
</tr>
<tr>
<td>India</td>
<td>43%</td>
</tr>
<tr>
<td>Thailand</td>
<td></td>
</tr>
<tr>
<td>South Africa</td>
<td></td>
</tr>
<tr>
<td>Russia</td>
<td></td>
</tr>
<tr>
<td>Brazil</td>
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<td>1,000+</td>
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Figures are for planned use of satellite connectivity for IoT deployments by country and instalment size. N=525.
3.5 Future outlook: a new network on the horizon

The rise of satellite is part of an ongoing quest to develop a legitimate and economical aerial network infrastructure model. Google (Loon), Facebook (Aquila drone) and O3b (satellite constellation) all established their mission-oriented ventures for this purpose – to plug a market gap in servicing unconnected populations.

For the most part these have failed or been remodelled with operator partnerships; however, the impending LEO constellations are a genuine break from the past, offering larger scales and superior economics. If total launches progress to completion, the cumulative number of active LEO satellites will surpass 10,000 by 2027, of which 90% will come from SpaceX, Project Kuiper, OneWeb and Telesat. This would provide blanket coverage for virtually 100% of geographic land mass.

Source: Union of Concerned Scientists (UCS), company reports, GSMA Intelligence

Active satellites in LEO versus GEO

![Active satellites in LEO versus GEO](image-url)
While the new constellations will significantly improve coverage, the shift in costs will be the biggest change. By vertically integrating the component supply chain and manufacturing process, a new type of network may be in the making. Amazon’s FCC filing underlines this point:

“Amazon also has global terrestrial networking and compute infrastructure required for the Kuiper System, including intercontinental fibre links, data centres, compute/edge compute capabilities and the tools, techniques, and know-how to securely and efficiently transport data. Amazon will leverage its resources and capabilities to develop, implement, and interconnect the Kuiper System and terrestrial networks to delight customers.”

In other words, the Kuiper partnership is not the start but an end for Amazon. It would be the final piece to a value chain Amazon has, for the most part, already assembled with its AWS infrastructure. The move into satellite ground stations (with plans for nine data centres to be operational by the end of 2019) will further displace existing competition and provide a ready-made solution for rural enterprise customers seeking connectivity, compute and analytics. OneWeb has also installed its own ground stations in at least five locations, with its expansion plans backed by substantial financial resources and strategic investments from Softbank and Virgin Group.

Partnerships between satellite communication companies and mobile operators to translate network coverage into actual end-user connections for unconnected people, businesses and objects may become the norm. In reaching such wide addressable markets, there are few instances where it is economically viable for either to go it alone. Pan-regional groups like Vodafone, Telefónica and Airtel have been at the vanguard of this shift – a decade in the making – which we expect to accelerate from 2020 onwards (if not before through commercial pre-bookings) once the constellations are operational.

Because most of the satellite coverage footprint will not be overlapping, LEO operators are complementary as opposed to substitutive to mobile operators. The main impediments are regulatory based. One issue is the need to establish repercussions in the event of satellite failure and the resultant proliferation of space ‘junk’. Most of the new crop of satellite companies have put in place provisions to shorten the lifespan of vehicles to avoid this problem, but there is no precedent for a national regulator to impose a penalty should this occur in the future.
Has tech exceptionalism come to an end?
4.1 Executive summary

Tech exceptionalism is the concept that technology companies operate in their own unique environment, free from the various operational, regulatory and financial constraints faced by more traditional businesses. This notion has become a mainstay of the corporate world in recent years and dominated discussion on innovation and new business models. The old economy has looked on enviously as new tech companies have emerged and scaled rapidly.

The global liquidity bubble shows little sign of abating, and the ready supply of funding chasing the diminishing pool of startups has led to companies staying private for longer while attracting ever higher valuations. However, there are growing indications that the era of tech supremacy is now coming to an end, or that at least there will be substantial changes. With a number of high-profile tech IPOs either performing poorly or being delayed, public markets are increasingly sceptical not only of the valuations being asked but, more crucially, of some of the fundamentals underpinning these businesses.

Financial market concerns cannot be viewed in isolation from the increased regulatory scrutiny facing the technology sector. Regulators and governments are belatedly addressing the challenges posed by the digital disruptors. This, combined with the various scandals around the use of consumer data that have led to many companies forfeiting users’ trust, has put the basic tenets of the tech sector under threat.

Ultimately, the question is whether digital service companies get their competitive edge from their digital technology or from regulatory and operational freedom.

Is WeWork a technology company or a real-estate broker? As business models converge, it is becoming increasingly hard to distinguish many tech companies from their old-economy peers.

The sheer volume of capital in the global private equity markets is not about to disappear in a world where ultra-low interest rates appear increasingly to be the norm. But investors in both public and private markets will need to be more discerning about where they invest and to shun the growth-at-any-cost model.

If the current tech model is showing signs of wear, what then does the future hold? It seems increasingly likely that the focus of innovation will shift from software to hardware, as new form factors and hardware functions will be required to capture the vast amounts of data produced by connected devices and to allow humans to interpret the new capabilities of AI. However, hardware innovation can be costly and slow, and many established software-focused players have limited experience in this area. This could provide an opportunity for new disruptors to emerge or indeed for some of the established old-economy (or old-tech) companies to have their own period of dominance.
4.2 The longer-term drivers of VC funding growth

In 2008, total global venture-capital (VC) investment stood at just over $50 billion; by 2018, this had increased fivefold to around $254 billion. The drivers of this phenomenal increase have been well covered in many reports. However, it is worth summarising these before exploring more recent trends in the VC markets.

Three developments, in particular, have contributed to the surge in VC investment:

1. **A global liquidity wave** – The widespread implementation of quantitative easing by leading central banks around the world, in response to the global financial crisis, instigated a wave of global liquidity. While quantitative easing has since been scaled back in several markets, interest rates remain close to or even below the post-crisis lows. The European Central Bank recently cut its main benchmark lending rate further below zero, a measure the bank first implemented in 2014. The liquidity wave has spilled into a broad range of asset classes, including private equity markets.

2. **The primacy of a new economic and business paradigm** – This new paradigm was best captured by Marc Andreessen, co-founder of VC firm Andreessen Horowitz, who stated that “software is eating the world”. As Andreessen wrote in 2011, “we are in the middle of a dramatic and broad technological and economic shift in which software companies are poised to take over large swathes of the economy” – a statement which still seems largely relevant today.

3. **An increased tendency to remain private for longer** – Companies are staying private for longer because of the availability of private-market funding (see point 1) and the corporate governance preference for less stringent reporting and regulatory requirements around private-market fundraising.

These factors, paired with accommodative market conditions, have allowed young technology firms to raise more capital in private venues than in previous cycles, both at early (angel, seed and series A) and later stages of VC funding. For example, startups such as Dropbox and Uber have raised funds privately at valuations that would previously have been unachievable while remaining private.

The ready availability of private-market funding has broader implications than just valuations. The reduced oversight in private markets compared to public markets grants new companies greater flexibility in terms of risk tolerance and the ability to invest more heavily to generate growth (whether through acquisitions or spending on research and development). As an example of this reduced oversight, Section 404 of the Sarbanes-Oxley Act requires public companies to provide internal control reports that affirm the ethical and responsible management of their finances, while such reporting is optional for private companies. Similarly, stock market listings require that companies submit a range of documents and that sponsoring investment banks produce detailed reports on a company’s performance and outlook for investors, while private-market fundraising has no such reporting requirements.

This has helped fuel the disruptive potential of new companies, which have the freedom to test new business models and access to sources of capital that established companies do not.

In addition, stock options linked to lofty private-market valuations and the promise of healthy profits on public market listing have enticed many bright and talented individuals to join startups, even though there is often little on which to judge the real worth of these options. The ability to attract the best and brightest was another element that helped establish the supremacy of the tech sector.

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1. Venture Pulse: Q4’18 global analysis of venture funding, KPMG, 2019
Signs of a slowdown: has funding peaked?

There has been significant growth in VC funding for technology companies over the last decade, which has fed the emergence of innovative companies that are disrupting a range of industries. While 2018 was a record year in terms of overall levels of VC funding, the trend in 2019 was more mixed.

Data from Crunchbase suggests that a total of $75.6 billion was invested globally in the third quarter of 2019, a modest $2.8 billion decline on the same quarter in 2018. It may be too early to say that total VC investment has peaked, but there are signs that investment momentum is slowing.

This is perhaps most evident in the US, where investments in dollar terms and number of deals fell in the third quarter of 2019. As shown in Figure 1, deal volumes have been on a declining trend since the fourth quarter of 2018.

The recent drop in the number of deals is part of a broader trend of declining deal activity since 2015, when the volume of deals was at its highest at around 20,000. The number of seed deals in particular is falling, down from 3,000 in the first quarter of 2015 to just 1,000 in the third quarter of 2019.

The amount invested and volume of deals were previously seen to have been positively correlated but have more recently been decoupled from each other. As highlighted by financial analyst Alex Graham,3 a number of factors are driving the fall in deal numbers against a backdrop of rising VC funding:

- There are fewer fundable startups to invest in. This may seem counter-intuitive given the growth in total VC investments in recent years, but Crunchbase data shows that the peak year for startup creation was 2015. As a result, fewer companies are successfully moving from seed to series A funding.
- There is a greater focus among larger funds on more mature startups.
- Startups are raising more funding and staying private for longer.
- As a result, companies are typically generating more growth and attracting higher valuations while remaining privately funded.

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3 “State of the Venture Capital Industry in 2019”, Toptal, 2019
As funding rounds have increased in both size and quantity, investors have been able to extract more value from their investments by keeping them private for longer. The flipside of this is that companies are getting older and, as investors are looking to realise their hefty investments, this is driving a need for liquidity, namely exits via initial public offerings (IPOs) or M&A deals.

“Companies are getting older and, as investors are looking to realise their hefty investments, this is driving a need for liquidity, namely exits via IPOs or M&A deals.”
4.3 Struggles in the IPO market and the impact on VC funding

According to CB Insights, there were 180 unicorns (private companies with valuations of more than $1 billion) in the US at the end of the third quarter of 2019 – a new record despite a number of IPO exits over the last year. This represents a large number of companies looking to an IPO, even though 2018 was already a bumper year for listings with more than 80 VC-backed IPOs, the highest since 2014.4

However, the performances of companies that listed in 2019 have been incredibly varied, with several still trading significantly below their initial IPO price. Some companies have performed extremely well, including Beyond Meat, which sells plant-based meat substitutes.

In contrast, ride-hailing platforms Lyft and Uber have performed poorly, with both companies still trading under their IPO prices (despite Uber’s listing taking place at a level far below initial guidance).

<table>
<thead>
<tr>
<th>2019 IPOs</th>
<th>Price*</th>
<th>IPO price</th>
<th>Change from IPO price</th>
<th>Market capitalisation (billion)</th>
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<tr>
<td>Beyond Meat</td>
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<td>$25</td>
<td>368.20%</td>
<td>$7.2</td>
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<td>Luckin</td>
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<td>$17</td>
<td>169.41%</td>
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</tr>
</tbody>
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*Prices as of 15 January 2020

4 "How will venture capital change in 2019? PitchBook makes 6 predictions", GeekWire, 2018
The travails of WeWork, in particular, have attracted widespread coverage. Investors had a number of concerns around the company’s corporate structure and indicated valuations. WeWork had previously been valued at around $47 billion in the private markets, but press reports indicated that the company was considering a public listing at around half that figure. SoftBank, one of WeWork’s main investors, ended up taking an 80% stake in the company as part of a $5 billion financing package after the planned IPO was cancelled. Food-delivery startup Postmates, valued at over $2 billion, was expected to go public in 2019 before it, too, delayed its IPO.

These poor post-IPO performances and pulled listings have been caused by a range of factors:

- **Lower margins** – For a number of recent listings, profitability levels are relatively low compared to listings in previous years. As noted by venture capitalist Fred Wilson, the more successful IPOs this year have had higher gross margins, in the 70–80% range (including Zoom, Cloudflare and Datadog). In comparison, companies such as Peloton, Uber and Lyft have margins in the 30–40% range, with WeWork’s margin being as low as 20%. Gross margin may be a simplistic measure of relative profitability and outlook, but it does help distinguish between companies that are more software focussed and those that are leveraging real-world assets.

- **Macro market conditions** – As we enter the late cycle phase of the current bull market, a number of factors are influencing global markets and contributing to weaker share price performance. These include ongoing trade disputes and lingering fears of recession and/or a sharp global economic slowdown. Equities are generally seen as a relatively high-risk asset class and tend to be heavily impacted during periods of market uncertainty.

- **Unclear paths to profitability** – Companies are now staying private for longer, so private-market investors are capturing more of the growth phase. But it is important for all companies to be able to chart a clear path to profitability, particularly as revenue growth rates begin to slow. High levels of cash burn may be acceptable in private markets, especially when top line trends are still positive, but this may be more challenging to sustain in public markets.

It will be interesting to see what the knock-on effects of the more cautious response from equity markets will be for private-market valuations. While there are few indications yet that there will be a major reduction in valuations, there will likely be some impact on the pricing of later-stage VC rounds and unicorn IPOs.

**Does this mean the end of the current tech model?**

It can be dangerous to read too much into short-term developments, whether in terms of individual stocks or broader markets. But we may be at a tipping point. The boom in startup investments over the last decade has led to a relentless focus on growth, with limited regard for the future. The well-publicised success stories of the likes of Amazon or Facebook have incited a feeding frenzy as VC funds and a host of newer players (including corporate VC arms) have competed to invest in the latest emerging trend.

Consequently, huge amounts have been invested into new companies, but much of this has been wasted or poorly spent and often with limited supervision. Recent market developments suggest companies will need to review their business models and strategies with a greater focus on profitability, as private markets tend to focus on the growth outlook but public markets prioritise a path to profitability and more sustainable growth. Without a clear route to an IPO, VC investors lose one of the main methods to realise their investments.

More generally, these developments bring into question whether we are now approaching the limits of the current tech model and the extent to which digital platforms can be used to disrupt established businesses. Does having an app or digital platform qualify as a foray into the tech space? If so, then it becomes hard to distinguish between old and new economies. This is central to the economics of a company’s model: while a digital product has a near-zero cost of production and can generate enormous scale economies and positive feedback loops, physical products tend to cost more to produce and generate lower economies of scale.
Recent developments bring into question whether we are now approaching the limits of the current tech model and the extent to which digital platforms can be used to disrupt established businesses.

For example, WeWork’s core business model is to lease office space, but this is not immediately apparent based on the description from its IPO prospectus:

“WeWork’s S-1 filing

[“Technology is at the foundation of our global platform. Our purpose-built technology and operational expertise has allowed us to scale our core WeWork space-as-a-service offering quickly, while improving the quality of our solutions and decreasing the cost to find, build, fill and run our spaces. We have approximately 1,000 engineers, product designers and machine learning scientists that are dedicated to building, integrating and automating the complex systems we use to operate our business. As a result, we are able to deliver a premium experience to our members at a lower price relative to traditional alternatives.”](6)

Regulatory pressure builds

Across many major markets (from the typically more interventionist European markets to the more laissez-faire US market) tech companies and their business models are facing increasingly more regulatory scrutiny. Examples include Uber’s struggles to renew its operating licence in London, a new Californian law clarifying the line between contractors and employees, and the potential implementation of GDPR-esque privacy legislation in the US. Combined with various scandals around the use of consumer data that have led to the loss of users’ trust, this has put many of the basic tenets of the tech sector under threat.

As the Wharton Professor of Management John Paul MacDuffie succinctly put it when referring to Uber’s regulatory struggles: “There appears to be a deep belief that, as a technology platform...Uber and its business model exist outside all past transportation business models and rules.”

The threat of greater tech regulation also adds to the valuation challenges we addressed earlier. The revenue growth and valuation premiums attached to tech disruptors have in part been driven by the ability of these companies to operate free from the various operational, regulatory and financial constraints faced by more traditional businesses. However, for many of these companies this competitive advantage will be eroded away as regulatory scrutiny increases. This, in turn, will impact the valuations that investors are willing to pay for growth.

[“There appears to be a deep belief that, as a technology platform...Uber and its business model exist outside all past transportation business models and rules.”](7)

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6 WeWork’s S-1 filing

7 “Can Uber Overcome Its Regulatory Obstacles?”, Wharton School of the University of Pennsylvania, 2019
4.4 The innovation pendulum swings back towards hardware

If the current tech model is showing signs of wear, what then will drive the next decade? It seems increasingly likely that the answer will be a shift from software back to hardware, as new form factors and hardware functions will be required to capture and interpret the innovative capabilities and vast amounts of data of AI. New hardware will range from wearables, cameras and sensors to robots, drones and a whole class of new autonomous devices.

Until recently, the potential of new smart technologies such as AI-powered virtual assistants has been limited by their access points e.g. computers, tablets and smartphones. As such, hardware innovations will become progressively more valuable as the interface for tomorrow’s software. Technology will become much more human-centric, to the point where it will introduce seamless interaction between people, their local environment and objects. This includes newer classes of wearables such as smart glasses or even physical implants.

Discussions about the future of IoT often concentrate on the advanced algorithms that will be needed to interpret the vast amounts of data that will be produced. However, this will also require new hardware
to capture the data through wearables, hearables, cameras and a growing variety of sensors. For instance, new technologies such as smart dust (tiny wireless microelectromechanical sensors) could lead to the development of camera lenses as small as grains of salt.

Hardware innovation will also be needed to realise the potential of manufacturing and, more broadly, Industry 4.0. Much of the focus to date has been on software (AI and security) or the communications layer, but less attention has been given to the vast range of hardware needed to deliver the vision of fully automated factories. Specifically, challenges lie in areas such as energy efficiency, miniaturisation and design flexibility.

Three areas of hardware technology require significant evolution for the benefits of Industry 4.0 to be realised: motors and motor drives; robots and robotics; and energy efficiency. New low-power electronics and motor drives that can run at higher operating frequencies and efficiencies will allow motors to have faster response times and higher-precision positioning and control during real-time operation. If successfully addressed, improved energy efficiency and hardware design innovation would provide unprecedented flexibility for factory layouts, as well as material savings in capital and operating costs.

McKinsey believes that advances in AI are also creating new opportunities for semiconductor companies. Developers who are trying to improve training and inference of AI applications often face roadblocks because of hardware limitations around storage, memory, logic and networking. By providing next-generation accelerator architectures, semiconductor companies could increase computational efficiency and/or facilitate the transfer of large datasets through memory and storage. New processors specially designed for edge computing will need to combine high performance with low power consumption and small size.

The latest edition of the AI Index, which summarises the areas of AI seeing the greatest progress, emphasises the move towards hardware leading the advances in the field of AI. In most areas, AI algorithms have been making less progress in recent years, in part because of the significant advances that have already been made. Some of the issues still to be addressed present much greater difficulties; for example, language recognition is showing better progress than image recognition. In contrast, there has been a marked shift in the performance of computing hardware. Prior to 2012, AI results closely tracked Moore’s Law, with compute doubling every two years; since 2012, however, the amount of computation used in the largest AI training runs has been doubling every three to four months.

Hardware innovation can be challenging though, requiring significant investment and, importantly, time. Additionally, because of their origins in software, many successful tech companies today have limited expertise in hardware development. Amazon may be proving itself the exception with a widening range of hardware products, but Google’s ordeals in this space have been well documented, as it has historically struggled with both acquisitions and its own product roadmaps. This could provide an opportunity for new disruptors to emerge or indeed for some of the established old-economy (or old-tech) companies to have their own period of dominance.
4.5 Future outlook: resetting expectations

The last decade was dominated by the ‘FANG’ stocks, originally defined as consisting of Facebook, Amazon, Netflix and Google (but Salesforce, Apple and Microsoft are often included as well). Most of these companies are software focussed and originated in the private equity markets. Investors have spent much of the last decade searching for the next FANG with a fair number of successes.

Attention now turns to what the new decade will bring. Technology will undoubtedly continue to advance, but innovation could instead arise from areas such as hardware. As technology becomes more pervasive, the ability to invest in a pure ‘technology’ company may become more difficult.

This is not to doubt the genuine innovation represented by such companies or the power of the software-based model and its ability to both disrupt more traditional bricks-and-mortar competitors and drive overall enterprise digitisation. However, there is a need to reset expectations around the applicability of the ‘software eats the world’ model and to determine whether better software means a better real-estate company or simply a real-estate company with good software. Increased regulatory scrutiny will continue to erode the competitive advantage of tech companies and the valuation premiums that many of these companies have thus far enjoyed.

The sheer volume of capital in the global private equity markets is not about to disappear in a world where ultra-low interest rates appear increasingly to be the norm. But investors in both public and private markets will need to be more discerning about where they invest and to shun the growth-at-any-cost model. This will necessitate a search for new areas of innovation and more rigorous analyses of a company’s business model and its path to profitability.

“There is a need to reset expectations around the applicability of the ‘software eats the world’ model.”
Has tech exceptionalism come to an end?
Analytics on steroids: digital disruption in healthcare intensifies
Executive summary

Through a vastly improved set of fitness applications and analytics capabilities, wearables are experiencing a revival. Millennials have been the driving force, eager to extend a natural affinity for technology in pursuit of healthy lifestyles. Health insurers are subsidising a significant share of purchases – an important signal of the underlying activity in AI development to shift personal health to a model where consumers are empowered to own their risk profile.

Activity in the wearables space reflects a broader push to digitise healthcare access. AI and machine learning (ML) are being used across a range of institutional and personal health sectors. Institutional (or enterprise) activity is well established and focussed on overhauling legacy IT systems and migrating electronic medical records (EMRs) from on-premise servers in hospitals and clinics to the public clouds of companies such as Microsoft, Amazon and IBM. The consumer segment, by contrast, has a much higher perceived risk from the public considering the sensitive nature of personal health data and the worry of ceding control to profit-led companies.

If the current early-adopter phase is essentially about people taking greater control of their fitness through the use of dashboards, we can imagine the next step being one where Google and Apple integrate EMR data – through sharing agreements with hospitals – to provide a richer set of information to users in a single user interface. Phase three would then involve deeper use of digital assistants in a health context, aided by a step up in the level of data inputs from public health bodies and research institutions to train neural networks. Questions approaching the realm of diagnostics – ‘Could I have cancer?’ or ‘How likely am I to develop diabetes given my mother had it?’ – enter the fold even if filters are set to screen out ML-driven answers. This could eventually give way to a scenario where platform companies become a hub for medical services, enabled by highly sophisticated AI engines refined through rounds of data input over many years.

The hive of investment activity among startups and large tech companies in the healthcare sector is about capitalising on a nascent business opportunity. Healthcare annual spend in the US is equivalent to 17% of GDP or $10,000 per person – more than double that of the European average. Far less clear are the implications of digitising personal health data on a mass scale despite the purported benefits of cost savings and empowerment. This is a highly charged area of competition that goes to the heart of AI ethics and consent.

The transformation of healthcare will be a long game. In part this reflects the complexity of designing commercial products for the health space and the potential for unorthodox business-to-business (B2B) funding models for inherently consumer companies. Babylon is an example. The company is an app-based private healthcare provider selling tiered levels of access to the general population. It recently signed a 10-year partnership with a UK National Health Service trust in which many of its paid-for features such as remote diagnosis will become available to patients in the relevant local area on a free-to-access basis.

Companies targeting the health sector need tactical nous to adjust the traditional modus operandi of bringing digital disruption to an industry for financial gain. Apple, Google, Facebook and Microsoft have made careers out of vanquishing incumbent competitors in multiple sectors through classic innovation: invent something new that people like or do something that already exists but better. The same model is not possible in healthcare, as evidenced by the public backlash to the growing list of data scandals. This is as much about corporate identity as it is pursuing new business.
### 5.2 Millennials, fitness and the wearables revival

The renewed rise of the wearables category has come into sharp focus over the last 12 months. Sales volume growth is estimated to have increased to 80–100% in H1 2019, building on the nascent resurgence from 2018, making it the highest growth segment in consumer electronics.

Apple has been the main beneficiary in the US, Europe and Japan. While it does not report unit sales data, we can infer from revenue and aggregated point-of-sale volumes that sales of Apple Watch (and its derivatives) are growing 20–30% per year. China is the other primary arena, where Huawei and Xiaomi continue to dominate at the expense of low-cost domestic competition.

Wearables contrast to smartphones despite being subject to the same influencing factors as consumer discretionary items. Smartphones continue to languish in the face of saturation in high-income countries, lengthened replacement cycles and innovation fatigue. Adoption of wearables is far lower at 10–20% of adults across high-income countries (based on our Consumer Insights Survey). The current run rate implies adoption levels could rise to 25–40% over the coming 18–24 months.

This follows years of frequent but ultimately erroneous predictions that wearables were a ‘flash in the pan’. High prices, oversupply, and a lack of unique use cases compared to what could be done on a smartphone all figured into this sentiment.

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**Source:** Statista, IDC, GSMA Intelligence

Wearables are experiencing a renewed adoption boost
Things have changed over a short time span, though little of this has been to do with hardware. Instead, it reflects a vastly improved set of fitness applications and analytics capabilities. Millennials have been the driving force, eager to extend a natural affinity for technology in pursuit of healthy lifestyles. Declining retail prices have helped sales but less obvious has been a rise in device subsidies offered by employers and health insurers. Analysis of our survey data indicates that almost a third of fitness trackers owned by 18–34 year-olds were acquired with a subsidy, often with built-in incentives and reward pathways that encourage physical activity (anything from free coffee to discounted air travel). The participation of insurance companies is an important signal of the underlying activity in AI development to shift personal health to a model where consumers are empowered to own their risk profile.

Google’s purchase of Fitbit in November 2019 for $2 billion was based largely on this rationale. Fitbit was once the wearables market leader but since 2015 has been squeezed by Apple at the high end and commodity Chinese models at the low end. As of March 2019, it commanded a mere 5% of global sales. However, the company counted the health profiles of 30 million people that Google can now host on its cloud servers and cross-link with their activities on other Google properties such as search and maps.

All this points to health as the next great frontier of digital disruption. Far less clear are the implications of digitising personal health data on a mass scale – particularly if controlled by a limited number of platforms, principally Google and Apple – despite purported benefits from efficiency, cost savings and empowerment. This is a highly charged area of competition that goes to the heart of AI ethics and consent.

Source: GSMA Intelligence Consumer Insights Survey 2019

2 Millennials gravitate to health tech the most, helped by subsidies

<table>
<thead>
<tr>
<th>Fitness tracker ownership</th>
<th>Subsidised</th>
<th>Paid for out of own pocket</th>
</tr>
</thead>
<tbody>
<tr>
<td>18–24</td>
<td>12%</td>
<td>5%</td>
</tr>
<tr>
<td>25–34</td>
<td>13%</td>
<td>5%</td>
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<td>35–44</td>
<td>13%</td>
<td>3%</td>
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<td>45–54</td>
<td>11%</td>
<td>2%</td>
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<td>55–64</td>
<td>10%</td>
<td>2%</td>
</tr>
<tr>
<td>65+</td>
<td>9%</td>
<td>1%</td>
</tr>
</tbody>
</table>
5.3 Health: the last but largest frontier of digital disruption

AI and ML in healthcare are being used across a spectrum of institutional and personal health sectors. Institutional (or enterprise) activity is well established and largely focussed on overhauling legacy IT systems and migrating medical records (EMR) from on-premise servers in hospitals and clinics to the public clouds of companies such as Microsoft, Amazon and IBM. This is rooted in the need for governments to cut costs as the burden of funding patient care rises with ageing populations and a higher incidence of ailments such as diabetes and heart disease.

For the purposes of this analysis, however, our focus is on the consumer domain – specifically, the extent to which personal health data could become digitised in a format and set of circumstances that achieves public acceptance.

Figure 3 outlines an indicative view of the risk profile for digital health services. The big difference lies in a lower perceived risk for institutional use cases. While the migration of EMRs and other hospital operational functions to the cloud was held back by decades of inertia, this is now commonplace in the US (the world’s largest healthcare market) and most of Europe. The fact that most national healthcare systems are publicly funded with stringent regulations preventing private sector control gives tacit public acceptance to the role of digital transformation. By contrast, the consumer segment has a much higher perceived risk given the sensitive nature of personal health data and the worry of ceding control to profit-led companies.

3. Consumer health digitisation has a greater risk/reward trade-off compared to institutional partnerships

Source: GSMA Intelligence

Key participants

**Enterprise**
Microsoft, Amazon, Google, IBM, Salesforce, HPE

**Consumer**
Google, Apple
The scenarios presented below sit along this continuum, with the level of change in health access and risk increasing in each case. The current adoption of wearables (20%) is a rough proxy for the level of public adoption of digital health services. This would place the market in an early-adopter phase, where risk is gradually rising but below where it could reach in the coming three to five years.

### SCENARIOS

1. **Fitness dashboards**
   - Expansion of capabilities of the current generation of analytics dashboards available from mainstream fitness trackers and smart watches (e.g. Apple, Fitbit, Huawei, Garmin).
   - Availability of core health data from work-outs for consumers. Some functionality to plan fitness regimes.
   - May be augmented by pairing data from smart home objects (e.g. sleeping patterns from mattress sensors).
   - Limited cross-linking of fitness tracking analytics with personal data from the same user generated in other settings (such as search engines or from hospital EMRs).
   - Relatively low risk as consumers remain in control, with opt-in consent for onward sharing.

2. **Deep personal**
   - EMR data integrates into fitness dashboards to provide a richer set of information to users in a single interface.
   - Requires platform companies to gain the consent of hospitals and other public health authorities to release EMR data. Apple has, for example, signed agreements with 448 such bodies in the US – a rapid rise from the original 12 signed in 2018 at launch.
   - Limited introduction of personalised recommendations, such as for training or dietary routines.
   - Higher risk profile given the potential unease with tech companies having access to sensitive personal health records – even if barred from using that data. This is the lesson of the Google/Ascension scandal in 2019.

3. **Virtual health assistants**
   - Allows people to ask their preferred assistant (Siri, Google Now, potentially Amazon’s Alexa) health-related questions and receive advice.
   - Third-party developer support grows as APIs are opened up, bringing in a new ecosystem of health services on the major platforms, including DIY-style genomics and risk profiling.
   - Cross-device support gives consumers the ability to view and manipulate health data on multiple form factors (e.g. watch, smartphone, smart speaker, tablet).
   - Significant step up in the level of data inputs from public health bodies and research institutions to train neural networks. Questions approaching the realm of diagnostics – ‘Could I have cancer?’ or ‘How likely am I to develop diabetes given my mother had it?’ – come into the fold even if filters are set to screen out ML-driven answers.
   - Risk profile increases from the likely preponderance of false-positives in DIY healthcare.
4 Is Google your doctor?

- Platform companies become a hub for medical services, enabled by highly sophisticated AI engines refined through rounds of data inputs over many years.
- This would likely work through partnerships with public health authorities such that services remain under their jurisdiction even though a significant operational load would be shifted to the cloud.
- This could include remote consultations, prescriptions and potentially diagnostics, significantly reducing the number of physical appointments. The same concept would apply to insurer-based claims and payments.
- While such a scenario may seem far-fetched given the potential public outcry, innovation is blind to identity, and the pragmatic need to cut costs may force public health authorities to deploy out-of-the-box solutions to preserve physician capacity in clinics and hospitals.
- This would be a dramatic change to the prevailing model of public healthcare delivery and require a new way of ensuring oversight of AI and algorithmic decision engines. It would also face bureaucratic hurdles from things like device procurement. A case in point is the current low take-up of connected health devices (8% overall and less than 3% in the 65+ bracket where demand would be highest) prescribed by doctors to allow remote monitoring of patient conditions.

Source: GSMA Intelligence Consumer Insights Survey 2019

Connected health devices* have grown in popularity but not to where they need to be

*Prescribed by a medical professional; automatically sends measurements to a doctor or nurse. Includes 21 countries with 1,000 respondents per country
5.4 Navigating the slippery slope of consent

Consent is the single most important factor in the eventual success or failure of digital health. Data privacy and consent have risen to the top of the political agenda following the Facebook/Cambridge Analytica data scandal, but there are few new regulations (or even proposals) to curb or mitigate the actions of nefarious actors in the murky world of behavioural analytics.

This problem is compounded by a paradox that exists in how consumers respond to perceived risks about the security of their personal data online. In the US and UK, nearly 80% of adults in our survey claim to be concerned with the privacy and security of their personal data online, with more than half this group indicating those concerns have grown over the last two years. Despite the evident apprehension, very few people are willing (or, more aptly, able) to do anything about it. Changing a password (48%) and altering the privacy settings of web browsers (31%) were the only actions taken by a third or more of adults. More sophisticated modes of bolstering security such as two-factor authentication are far less common, as is the option of simply deleting a social media account.

“A paradox exists in how consumers respond to perceived risks about the security of their personal data online.”

Some 80% of people are highly concerned with the security of their personal data online...

How concerned, if at all, are you with the privacy and security of your personal data online

Not concerned: 21%

Concerned but no more than I was 2 years ago: 33%

Concerned even more than I was 2 years ago: 46%

Figures are for the US and UK, with a sample size of 1,000 adults in each country.
...But most take only basic steps to reduce their risk

Q: In the last two years, have you taken any of the following steps to better secure your online data?

![Graph showing actions taken to mitigate risks](image)

- Changed password: 79%
- Changed privacy settings: 48%
- Disabled location services: 31%
- Enabled second layer of security (e.g. SMS, face ID): 24%
- Declined terms of service agreement for an online service: 16%
- Used password manager for online accounts: 15%
- Used VPN: 8%
- Deleted social media account: 8%

The working assumption must be that security concerns for health data are heightened compared to less sensitive contextual information from, for example, web browsing and watching videos. If consumers are only equipped to take rudimentary measures in protecting their personal data and there is little meaningful regulation to check the onward sharing of such data for purposes not explicitly consented to, the power of scaled platform owners in the digital health era is potentially immense. Google, Apple and Facebook have therefore made user opt-in and controls for how, and in what circumstances, data is shared a core part of the response to the criticism from governments and the general public in the wake of recent privacy scandals. But the practicalities of this in a health context are daunting. Would a Fitbit user, for example, have the option to opt in to their heart-rate data being shared with medical researchers but not with private health insurance companies? Or what about one insurance company but not others? More likely is a simple all-in model of consent with general language that could obfuscate, intentionally or not, the ultimate recipients of a user’s health data. Attempting to police the inevitable data sharing between platform owners and companies seeking access to personal health data for commercial reasons would become impractical. Herein lies the slippery slope of consent.

The power of scaled platform owners in the digital health era is potentially immense.
5.5 The profit motive versus social good

The hive of activity among startups and large tech companies to invest in the healthcare sector is about capitalising on a nascent business opportunity. The compatibility of that profit motive with the imperative of ensuring personal wellbeing is a major fault line.

A view of health spend across advanced countries underpins the scale at stake. Taking a sample of six countries – the US, Switzerland, Germany, France, Japan and the UK – annual health spend ranges from 10% to 17% of GDP. The US is the single highest payer at 17%, equating to $3.3 trillion (six times bigger than the next closest, Japan). But the real measure is health spend on a per-head basis, which in the US is roughly double the average of European countries, with the exception of Switzerland. Even accounting for higher rates of preventable ailments such as obesity, the per-head figures imply a huge amount of inefficiency in the US healthcare system. This represents a large part of the rationale for migration of service provision to digital channels and the general shift to preventative care.

The compatibility of that profit motive with the imperative of ensuring personal wellbeing is a major fault line.

Source: OECD, GSMA Intelligence

The US remains the world’s most lucrative healthcare market

Publicly funded = government spending and compulsory insurance. Voluntary = private health and dental insurance schemes, medical component of automotive and travel insurance, non-profit funding, enterprise financing (e.g. occupational health). Out of pocket = household spend on health services paid from private funds.
The question of how much of this is actually addressable for non-traditional providers – large or small – is complex considering regulation and the fragmented nature of the existing delivery value chain. We can gain an indicative view using granular spending figures from the UK NHS accounts. In 2016 (the most recent figures), total national spend on healthcare amounted to £192 billion or 10% of GDP. Of this, 57% went towards curative and restorative care in hospitals, GPs, dental practices and related services such as physiotherapy. If even 1% of this sum was shifted to digital channels, it would equate to roughly 13% of the combined UK turnover of Apple and Google. This is an indicative comparison rather than a forecast of potential digital health revenue accruing to Apple and Google, but clearly even a small share of health spend is a big amount.

Another potential route to market would be as a health insurer. Both companies have ready-made customer bases to cross-sell into, existing platforms and scaled developer ecosystems. From the same set of figures, voluntary health insurance in the UK amounts to roughly £13 billion per year, a figure that is likely to rise rather than fall as non-traditional digital entrants (such as Vitality) attract others seeking to operate a platform model using third-party underwriters.

The variation in possible business lines in the health sectors is demonstrated by the wide variety of business units and venture investment set up by the major tech companies. Google has the largest footprint; it has invested in 93 health startups using three corporate VC units. Alphabet’s in-house R&D centre for health research, Verily, has largely been staffed from the industry and health regulators. Of its top portfolio segments, genomics has emerged as a key testing ground for ML from Deep Mind, although perhaps most interesting is its increasing shift to invest in new entrants to the health insurance industry. Apple is, by contrast, far more guarded about its strategy. It does not have an in-house CVC arm but buys companies instead, mostly for talent and IP rather than existing commercial business. Microsoft also has an extensive web of health investments and R&D focussed on using ML to improve preventative care and to shift hospital workloads onto Azure.

This experimentation will continue for years to come; digital involvement in the health sector is a long game. In part this illustrates the complexity of designing commercial products for the health space and the potential for unorthodox B2B funding models for inherently consumer companies. Companies targeting the health sector need tactical nous to adjust the traditional modus operandi of bringing digital disruption to an industry for significant financial gain. Apple, Google, Facebook and Microsoft have made careers out of vanquishing incumbent competitors in multiple sectors through classic innovation: invent something new that people like or do something that already exists but better. The same model is not possible in healthcare, as evidenced by the public backlash to the growing list of data scandals – be that Deep Mind’s collaboration with the NHS or Google with Ascension – with otherwise noble intentions. This is as much about corporate identity as it is pursuing new business.
Health VC funding is scattered across many areas

<table>
<thead>
<tr>
<th>Venture investments into digital health</th>
<th>Google</th>
<th>Microsoft</th>
<th>Apple</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>93</td>
<td>35</td>
<td>Not disclosed</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Investment vehicles</th>
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</thead>
<tbody>
<tr>
<td>M&amp;A</td>
</tr>
<tr>
<td>Corporate venture</td>
</tr>
<tr>
<td>Accelerator</td>
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<table>
<thead>
<tr>
<th>Top portfolio segments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genomics</td>
</tr>
<tr>
<td>Clinical research</td>
</tr>
<tr>
<td>Insurance</td>
</tr>
<tr>
<td>Data analytics</td>
</tr>
<tr>
<td>Genomics</td>
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<table>
<thead>
<tr>
<th>Consumer products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Watch or fitness tracker</td>
</tr>
<tr>
<td>Smartphone</td>
</tr>
<tr>
<td>Connected health monitor</td>
</tr>
<tr>
<td>OS</td>
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<table>
<thead>
<tr>
<th>Enterprise products</th>
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</thead>
<tbody>
<tr>
<td>Google Cloud</td>
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</table>
Gaming: the shift to cloud is on

- With surging revenues, the global gaming market could be generating upwards of $200 billion in only a few years’ time. Relatively new formats and technologies are typically not priced into such estimates, though, and could drive revenues even higher.
- New entrants have emerged in the cloud-gaming space, as old and new players alike attempt to bring the format into the mainstream – most notably, with Google’s launch of Stadia.
- Startups are also pushing the shift to cloud, in addition to other innovative formats such as VR and e-sports.
- However, as cloud-gaming and VR take-up remains relatively low, it brings into question when (or if) their potential will be realised.
- These services require high processing power and ultra-low latencies; the possible success – or failure – of such formats will therefore have implications for supporting technologies such as edge computing and 5G.
Gaming has long since moved on from being PC only

The near-future outlook for gaming will be fuelled by smartphones and mobile gaming, as PC’s share of the market continues to decline. However, this does not take into account any potential uplift from cloud-gaming and VR adoption.

Cloud and VR could both drive revenues higher, but this would come years down the line, as take-up remains low and content libraries are still relatively limited.

The global gaming market will generate almost $200 billion by 2022, driven by mobile gaming

Source: Newzoo
For more information, see Newzoo Global Games Market Report 2019
Infrastructure requirements for cloud gaming

Fibre

Top 10 countries (plus the US, Germany and the UK) by FTTP household penetration*

Penetration of fibre-to-the-premises (FTTP) is rising around the world; however, there is a significant disparity between the most and least penetrated nations.

Source: IDATE for FTTH Council Europe, March 2019

<table>
<thead>
<tr>
<th>Country</th>
<th>Household Penetration</th>
</tr>
</thead>
<tbody>
<tr>
<td>UAE</td>
<td>95.7%</td>
</tr>
<tr>
<td>Qatar</td>
<td>94.5%</td>
</tr>
<tr>
<td>Singapore</td>
<td>92.0%</td>
</tr>
<tr>
<td>China</td>
<td>77.9%</td>
</tr>
<tr>
<td>South Korea</td>
<td>76.0%</td>
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<tr>
<td>Hong Kong</td>
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<tr>
<td>Japan</td>
<td>70.2%</td>
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<tr>
<td>Mauritius</td>
<td>63.8%</td>
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<tr>
<td>New Zealand</td>
<td>53.3%</td>
</tr>
<tr>
<td>Uruguay</td>
<td>51.1%</td>
</tr>
<tr>
<td>US</td>
<td>12.0%</td>
</tr>
<tr>
<td>Germany</td>
<td>2.3%</td>
</tr>
<tr>
<td>UK</td>
<td>1.3%</td>
</tr>
</tbody>
</table>

*Household penetration of countries with at least 200,000 households and with more than 1% household penetration

Edge

- Edge computing and the edge cloud are critical to the delivery of cloud gaming services because they enable ultra-low latencies to devices.
- Advances in chip/GPU processing power are integral to satisfying the compute demands of video game streaming.

Source: GSMA Intelligence
VC funding is a strong indicator for future commercial launches

Venture funding for gaming companies

Microsoft and Google are the largest tech investors, but their motivations differ

Microsoft bought ~58% of FAMGA gaming acquisitions

Google made ~81% of FAMGA gaming investments

- With an established consumer base and revenue stream thanks to the Xbox, Microsoft has an advantage in the gaming space among the big tech companies. Moving some of its audience to the cloud would be complementary to its current offerings.

- However, as a new entrant, Google is trying to circumvent the existing model by cutting out the console level of the value chain by leveraging its cloud infrastructure.

Source: CB Insights

Number of deals

<table>
<thead>
<tr>
<th></th>
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<td>Amount of funding (million)</td>
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<td>$4,188</td>
<td>$2,822</td>
<td>$2,560</td>
<td>$1,510</td>
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<tr>
<td>Number of deals</td>
<td>88</td>
<td>147</td>
<td>363</td>
<td>232</td>
<td>250</td>
</tr>
</tbody>
</table>
Beyond cloud, startups are pushing other new formats such as e-sports and VR

Examples of startups in the e-sports and VR spaces

**Esports**

- Cloud9
- Douyu.com
- Twitch
- Wikia
- Razer
- Corsair

**VR**

- Unity
- Oculus
- CCP
- Survios
- Mindmaze
- Virtual Omni
Taking VR mainstream: form factor and content are critical

VR has long been touted as the next big thing in entertainment. However, headset ownership growth has flatlined over the last three years. Gaming is still the major use case, but even then consoles and PCs are the device of choice for most gamers, with VR still a niche.

There is still long-term potential though, if VR headsets can become more ergonomic and content partnerships expand to live sports and music.

VR headsets are stuck in first gear

![Graph showing percentage of households owning a VR headset by country and year.](source: GSMA Intelligence Consumer Insights Survey 2019)
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