About the GSMA

The GSMA represents the interests of mobile operators worldwide. Spanning more than 220 countries, the GSMA unites nearly 800 of the world’s mobile operators with 250 companies in the broader mobile ecosystem, including handset and device makers, software companies, equipment providers and Internet companies, as well as organisations in industry sectors such as financial services, healthcare, media, transport and utilities. The GSMA also produces industry-leading events such as Mobile World Congress, Mobile World Congress Shanghai and the Mobile 360 Series conferences.

The Global Mobile 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 Global Mobile Radar for Q1 2017
This edition of the Global Mobile Radar comes as we look forward to Mobile World Congress 2017. Thought leaders from across the mobile ecosystem will meet in Barcelona to discuss key enablers for the successful digital transformation of the industry.

Mobile World Congress is certain to showcase plenty of examples of the rapid rate of innovation in our industry and how it is becoming increasingly dynamic and disruptive. Keeping pace with new sources of growth and opportunity, as well as the challenges ahead, remains top of the agenda for all in our ecosystem. The Global Mobile Radar continues to cast light on the evolving mix of disruptions and innovations ahead to help you make forward-looking strategic decisions.

In this edition we look at how chatbots are set to revolutionise the e-commerce arena; how digitisation in healthcare is fast evolving but a long-term game for cost savings; how the ‘videofication’ of everything in the digital world looks set to have profound implications for a range of existing industries; and how collaborative, flexible robotics is finding new use cases but raising ethical and regulatory questions.

I hope the topics featured in this edition of the Global Mobile Radar spark plenty of debate within your organisations and help you take actions now for the future ahead.

Best regards,

Hyunmi Yang
Chief Strategy Officer
GSMA
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Key takeaways
Conversational commerce: how chatbots and AI will power the digital economy

• Chatbots have gained significant attention over the last year, helped in part by Facebook’s announcement in April 2016 that it was opening its Messenger platform to third-party developers.

• Chatbots are not a new technology; their origins can be traced back to the mid-1960s. Their new prominence and emergence as a driver of e-commerce is driven by two key factors: the rise of the dominant messaging platforms where billions of individuals are used to communicating through chat; and advances in artificial intelligence (AI) that allow machines to interact more easily with humans.

• The rise of chatbots offers new opportunities for companies in how they engage with customers, promising increases in efficiency, effectiveness, productivity and sales. For the individual, chatbots offer a more intuitive and user-friendly way to interact with companies, whether for 24×7 customer service or e-commerce. Chatbots can provide a more focused and tailored experience than websites or apps.

• Chatbots as a technology today are still in their infancy, but the rapid pace of development in AI means they will deliver much greater functionality over the next five years. The rise of chatbots represents a significantly bigger paradigm shift than that from websites to apps.

• The value of messaging bots often lies in the integration with a broader platform and user data, so that the bot can easily access information around the user’s identity, past purchasing information and payment details. Bots are therefore emerging as another key battlefront in the ongoing war between the internet players and competing platforms for consumer engagement.

Healthcare: big, inefficient and ripe for disruption

• Digitisation is not a new phenomenon in health but it is fast evolving from humble roots in telemedicine. Cloud ubiquity, open APIs and, crucially, the incipient rise of machine learning (AI) have changed the game of what is possible.

• The AI story is starting to play out on top of the open platform model across a range of disparate use cases including cancer screening and genomics, mental healthcare, lifestyle and stress management, medical imaging and diagnostics, and insurance models.

• Some applications target consumers directly but the transformative power of AI is as a surrogate resource for front-line medical professionals – in effect, a partner human resource for doctors minus the cost.

• Healthcare faces several forces acting in parallel – rising costs, ageing populations and inefficiency – that make changes in provision and funding models a ‘when’ rather than ‘if’ question for governments.

• The cost-saving potential from digital health is significant (5–10× revenues) and plays to the inevitable public funding shortfalls. Combined with increasing acceptance in the medical community, the sector outlook is therefore positive, but it should be seen as a long-term game with two major challenges.

  – Digital health is predicated on collaborative innovation between the private and public sectors. Venture-backed start-ups developing niche commercial products are unlikely to survive in the absence of incubation alongside or within national health services.

  – There are the wider ethical and Orwellian issues of power and control. Governments face a catch-22 situation in that health costs must be reduced but safety must be ensured at all costs. In this respect, AI should be seen as a complement to physicians, not a replacement.
How video ate the digital world

- Video is now everywhere: it is increasingly becoming the default format for communication, collaboration, education, marketing and entertainment. Video already looks certain to be the future of social, with Facebook commenting that the social network could become “all video” within five years.
- There has been a paradigm shift in the very nature of video – from something that is highly scripted with a linear run time to increasing amounts of user-generated video.
- Mobile has become the key platform for the consumption of video and is a key driver of the forecast that global IP traffic will more than double by 2020. Mobile has driven the democratisation of video and is fuelling the growth of live streaming and video sharing, with the rise of short-form and vertical video.
- Advances in AI are delivering the reality of searchable video. As video analytics improve, much more value will be extracted from video metadata, offering new routes to monetise video content. Beyond 360-degree cameras, the next phase of technological development will deliver truly immersive video, based on the growing adoption of virtual and augmented reality, and perhaps ultimately holographic video.
- We are now entering a golden age of content production, with the rapid growth of self-generated content and new industry players investing in scripted content. Viewership and revenues are shifting rapidly to these new online platforms, though it may be too early to identify the longer term winners.
- These developments will continue to disrupt the media and content industries, for both traditional and new digital players. There is likely to be a new era of industry consolidation, with the potential for many of the larger players to become vertically integrated as part of a new wave of bundling.

Robotics: the rise of service robots

- Market analyst IDC estimates that spending on robotics and related services will more than double by 2020, growing from $91.5 billion in 2016 to more than $188 billion in 2020. This growth is being driven by various complementary elements, including technology improvements, expanded use cases and a more general acceptance in the market.
- A fundamental shift is underway in robotics, from its historic deployment in heavy industry to a broad range of use cases. Through advances in autonomous learning and artificial intelligence, service robots are increasingly capable of more complex and specialised tasks.
- Funding of startups in the robotics space has risen sharply since 2014, more than doubling to nearly $1.2 billion in 2016. As a lot of robotics is both designed and operated by established companies, the funding is still a relatively small portion of the $130 billion of venture funding in 2016.
- Use cases exist in both the enterprise and consumer spaces. A growing focus for service robots is the consumer, with many highly publicised launches and prototypes at this year’s Consumer Electronics Show in Las Vegas. There was a focus on care and companionship for children and the elderly.
Conversational commerce: how chatbots and AI will power the digital economy
3.1 Executive summary

Chatbots have gained significant attention over the last year, helped in part by Facebook’s announcement in April 2016 that it was opening its Messenger platform to third-party developers, and comments by Chris Messina of Uber that helped coin the phrase ‘conversational commerce’

Chatbots though are not a new technology; their origins can be traced back as far as the mid-1960s and the launch of Eliza, a chatbot psychotherapist. Chatbots’ new prominence and emergence as a driver of e-commerce is driven by two key factors: the rise of the dominant messaging platforms, with billions of individuals used to communicating through chat, and advances in AI that allow machines to interact more easily with humans.

Chatbots are particularly well suited for mobile – perhaps more so than apps, given issues such as screen size and app discovery – with messaging (and the dominant messaging platforms) at the core of the mobile experience. Voice is also now emerging as an alternative conversational interface and may become the interface of choice in settings such as the home or even the car. However, with the installed smartphone user base approaching 4 billion, there is a huge user base for whom chat and textual messaging have become, and are likely to remain, second nature.

The rise of chatbots opens up new opportunities for companies in how they engage with their customers, promising increases in efficiency, effectiveness, productivity and sales. Use cases include automating functions such as customer service and providing new opportunities to target services and promotions at customers through conversational interfaces. For the individual, chatbots offer a more intuitive and user-friendly way to interact with companies, whether for 24×7 customer service or e-commerce. While apps and websites target the mass market, chatbots promise a more focused and individually tailored experience.

Beyond improving the capabilities of the underlying AI, challenges include the need to address market fragmentation (through cross-platform support) and the need for self-regulation to prevent messaging platforms being deluged with poorly targeted marketing campaigns. In the consumer market, chatbots may prove best deployed as guideposts, informing and guiding customers to the appropriate location. The enterprise market offers clearer uses cases, particularly to enhance productivity and manage workflow.

The value of messaging bots often lies in the integration with a broader platform and user data, so that the bot can easily access information around the user’s identity, past purchasing behaviour and payment details. Bots are therefore emerging as another key battlefront in the ongoing war between the internet players and competing platforms for consumer engagement.
3.2 The rise of chatbots and conversational commerce

Defining chatbots and conversational commerce

A chatbot is a computer program that simulates human conversation or chat through artificial intelligence.

Chatbots allow machines to interact with humans on closed domains via written text, and increasingly voice interactions too, either with or without human assistance. This has been termed a conversational user interface, following on from the graphical user interface that most people are familiar with.

The specific use case of using chatbots to allow companies to communicate directly with customers on messaging platforms such as Facebook Messenger, WhatsApp and WeChat has been termed ‘conversational commerce’.

Chatbots can work in two different ways:

- Scripted chatbots deliver simple responses based on a specific command. These are effectively decision trees with only limited AI presence. These chatbots are only as good as their programming and are likely to struggle with more complex questions or situations.

- Artificially intelligent bots can answer contextual questions by learning from previous interactions, carrying on a pseudo-conversation. These AI bots are built on the twin capabilities of natural language programming (NLP) and machine learning (or more specifically, the use of neural networks that mimic the human brain).

The growth in scale and use of a number of key messaging apps means these platforms now boast larger user bases than the social network apps. The big four messaging apps (WhatsApp, WeChat, Facebook Messenger and Viber) have user bases around the 3 billion mark, while the four largest social network apps (Facebook, Twitter, Instagram and LinkedIn) are around the 2.5 billion mark. Messaging apps have typically shown higher user retention and engagement rates than other apps.

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1 Messaging apps are now bigger than social networks, Business Insider, September 2016
While social media is effective as a broadcast channel to reach mass audiences, messaging apps are more focused and personal, essentially offering a one-to-one experience. Consumers are moving beyond using messaging apps just to communicate with their friends and associates, and are increasingly communicating and interacting with companies. There are a range of options available, from using chat to access content and information, to browsing goods and making purchases.

These developments represent the emerging use cases of chatbots, enabled by the rapid pace of developments in artificial intelligence (as explored in more detail in the previous edition of the Global Mobile Radar2). Chatbots are not a new technology though; their origins can be traced back as far as the mid-1960s and the launch of Eliza, a chatbot psychotherapist.

Source: GSMA Intelligence

History of chatbots

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1966</td>
<td>Eliza</td>
<td>Mimicked human conversation by matching user prompts to scripted responses</td>
</tr>
<tr>
<td>1995</td>
<td>Alice</td>
<td>Artificial Linguistic Internet Computer Entity – a natural language processing chatbot</td>
</tr>
<tr>
<td>1997</td>
<td>Jabberwacky</td>
<td>Launched on the internet, its aim was to “simulate natural human chat in an interesting, entertaining and humorous manner”</td>
</tr>
<tr>
<td>2001</td>
<td>SmarterChild</td>
<td>Distributed across SMS networks</td>
</tr>
<tr>
<td>2014</td>
<td>Slackbot</td>
<td>A bot running on Slack that can be programmed to respond to comments</td>
</tr>
<tr>
<td>2016</td>
<td>Bots for Messenger</td>
<td>Facebook announced in April 2016 that it would open its Messenger platform for commercial use of third-party chatbots</td>
</tr>
<tr>
<td>2016</td>
<td>Microsoft Tay</td>
<td>Designed to mimic the speech of a teenage girl but was unable to cope with online trolls</td>
</tr>
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Chatbots have gained particular prominence over the course of the last year, with the Facebook announcement in April 2016 that it would open up its Messenger platform for the commercial use of chatbots a key catalyst.

“No one wants to have to install a new app for every business or service that they want to interact with,” Mark Zuckerberg said at his company’s F8 developer conference. “We think that you should just be able to message a business in the same way that you message a friend.”

There are now a host of start-ups in the chatbot space and growing amounts of venture-capital investment. Microsoft has recently announced its own ‘bots as a service’ platform, the Azure bot service. This allows companies to build bots on Microsoft’s Azure cloud platform, which includes developer tools to help companies better harness the capabilities of natural language understanding and so create more effective bots. As a company that largely missed out on the mobile opportunity, Microsoft has been investing heavily in AI and is now looking to play an active role in the emerging bot ecosystem.

Although Facebook’s announcement attracted significant attention and pre-empted a host of similar moves, Chinese messaging platform WeChat had in fact been offering a bot platform for several years. These bots are referred to as ‘public accounts’, and most businesses have their own account. Indeed, many new ventures in China use one of these public accounts in favour of having their own website.

This highlights the particular application for chatbots around conversational commerce: the intersection of messaging apps and shopping. Consumers are using chat to find and select products and services, and complete the payment process, all without having to call, email or even visit a brand’s website. As well as messaging apps, conversational commerce can occur through other interfaces such as voice – using an Amazon Echo or similar device, for example. The rise of voice interfaces was discussed in more detail in a previous edition of the Global Mobile Radar, and the focus here is more on textual interfaces (although many of the same principles and use cases apply).

See Beyond smartphones: the rise of the super platform, Global Mobile Radar, October 2016

Conversational commerce: how chatbots and AI will power the digital economy

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3.3 Use cases for chatbots in conversational commerce

A number of central use cases have been developed for chatbots in the area of conversational commerce:

**Marketing:** bots provide a route to offer tailored information and offers to users.

**Customer service:** a growing range of companies from different verticals are now deploying chatbots to enhance customer service.

**E-commerce:** many companies are using chatbots (and messaging platforms) to drive business rather than rely on their own websites or apps. Early examples include Facebook and online shop Spring, and fastfood outlet Wingstop on Facebook Messenger.

Many companies are already talking to customers on social networks such as Twitter, but the response times there can often be a source of frustration. Existing efforts to provide automated customer response have also seen high levels of consumer frustration, such as with interactive voice response (IVR) technology. IVR can be intrusive and clumsy in its interaction. With the advantage of AI, chatbots could offer a more personalised and effective response than the limited range of menu options that people are used to with IVR.

The field of customer service is therefore ripe for further innovation (and automation). Data from IBM shows that there are 270 billion service calls annually, and roughly 50% of first calls remain unresolved. Gartner has previously projected that more than 85% of customer interactions will be managed without a human by 2020. Research has also demonstrated a clear preference among consumers for using live chat as a medium for customer service.

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**Source:** Customer Service Benchmark Wave 1, eDigitalResearch, November 2013

3 Live chat currently has the highest satisfaction levels

- 73% Live chat
- 53% App
- 48% Social media
- 41% SMS
- 61% Email
- 50% Post
- 44% Phone

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4 IBM Institute for Business Value Global C-Suite, 2013
5 Gartner Customer 360 Summit 2011
As well as allowing a direct and personalised customer response, chatbots have the advantage of simplicity. People are used to messaging, even those who may not be keen on using apps. In emerging markets in particular large proportions of the population may be on messaging platforms but are not used to online transactions and have limited exposure to apps.

Some high-profile bots in a conversational commerce context today include the following:

- **ACE**: a bot on Slack that aims to increase productivity. It can be used for reporting expenses and managing to-do lists, as well as managing polls and rating policies. New functionality is being added, including sales leads management (currently in beta mode).

- **KLM bot**: KLM was one of the first airlines to release a bot, available on Facebook Messenger and other chat platforms. KLM uses its existing customer database and can recognise when a customer contacts them via any medium, including messaging platforms. Users in Messenger are sent booking confirmations, flight status updates and a boarding pass.

- **H&M’s Bot on Kik Messenger**: the bot provides consumers with fashion tips. It asks questions to learn about what they like and uses product pictures to find out more. It then suggests style choices based on the answers. If users like what they see, the bot sends them a link to its mobile website, from where they can make purchases.

- **Firstjob ‘Mya’**: Firstjob is an online recruitment firm that uses an AI chatbot to help match graduates with job opportunities, talking to candidates through a range of channels (SMS, Facebook etc.). Mya can help to screen candidates pre-interview, post updates on the progress of an application, and provide additional insights to recruitment managers.
3.4 The upside case: for consumers and companies

Conversational commerce is simpler for consumers who, thanks to messaging apps, no longer need to toggle back and forth between text conversations and websites to gather information and make purchases. It is also an experience that feels closer to the individual attention received from a sales assistant in a store. When ordering from a website, a consumer can browse reviews to understand a product, but using chat allows the user to ask more specific questions, to consider different options and make a more informed choice – more like the advice received in-store.

The growth of conversation platforms means that going forward companies will become less reliant on websites and apps for consumer interactions and e-commerce. Most leading retailers and consumer service providers have developed their own apps, but very few have succeeded in gaining significant user bases. The equation for success on an e-commerce site is relatively straightforward:

\[
\text{E-commerce success} = \text{number of visitors} \times \text{conversion rate} \times \text{average basket value}
\]

However, even for sites that attract significant visitor numbers, conversion rates remain low, typically under 2%, which compares poorly to typical in-store conversion rates which are closer to 40%. The use of chatbots to engage with customers can help improve these conversion rates, enabling closer engagement and deeper interaction with customers.

As the intelligence behind bots becomes more sophisticated, so the potential for conversational commerce will grow. One impact is on cost savings and the benefits from automation; customer service and direct selling functions can be powered by AI rather than employees. Beyond the simple cost-saving opportunity, chatbots may offer revenue upside as they provide new sales models and offer incremental revenues at lower cost. For example, any customer-service interaction can seamlessly become an opportunity for upselling or cross-selling other products.

Chatbots are likely to be widely deployed in the enterprise space to improve productivity and manage complex processes, accelerated by the focus of major software providers such as Microsoft. IT functions and software support are one potential area, as chatbots are available 24 hours per day and can scale rapidly to deal with critical issues.

Major benefits are likely in the area of operational efficiency. Advances in analytics mean that chatbots will be able to access vast amounts of information and technical resources, enabling them to highlight production issues or operational problems before they become critical. This allows, for example, precautionary maintenance or the rescheduling of production. These developments could also improve general business decision making, allowing faster and more informed decisions.

At the same time, the range of consumer use cases is likely to expand, so that individuals may be willing to pay to have conversations with bots that can help them with various situations beyond the typical customer support or direct selling situations. For example, personal life coaching from an appropriate coaching bot, or DIY advice from a bot with the relevant programming and knowledge base.
3.5 Sizing the market opportunity

Business models and revenue opportunities remain relatively opaque at this stage, though examples from Asia and indeed the mobile operator application-to-person (A2P) SMS messaging market can provide some context.

WeChat has been one of the most successful of the new messaging platforms in monetising its user base, with a focus on payments rather than advertising and ARPU levels that are estimated at around $7. While WeChat has become an important platform for digital commerce, its merchant accounts deliver most of their functionality through a browser interface rather than a true chat interface.

In addition, although a large proportion of the user base make purchases on WeChat, individual purchases are relatively small and its overall share of e-commerce lags well behind the market leader, Alibaba. Alibaba has several commerce platforms, including the eBay-like Taobao, which gains more traction for digital commerce with users than WeChat does. Alibaba’s sites in aggregate give the company around an 80% share of China’s e-commerce market.

A2P SMS messaging is a significant market that has seen strong uptake in certain geographies, such as India. Unlike the current fragmentation of messaging platforms, SMS is a global platform that has access to all mobile subscribers. A survey by Ovum indicated that SMS is still the main mobile-specific route through which enterprises engage with their customers, although there is increasing use of other messaging platforms.

A2P messaging has seen widespread adoption in India, with the average person receiving 12 messages per day. More than 10 billion messages per month are sent in the country as a whole, and use cases have evolved from simple notifications (such as of a booking or cash withdrawal) to marketing messages to more interactive ones (requesting notification of the most recent transactions). Attempts to use A2P for marketing have received pushback from customers and highlight the challenge when using a highly personal messaging platform for general marketing.

These two market examples highlight both the opportunities and challenges associated with the wider adoption of chatbots. Many larger companies in China do not sell directly on WeChat, but use chat interfaces to inform customers and then guide them onto their own online platform, reflecting the potential of chat to inform and guide rather than execute transactions. Other challenges include those around cross-platform integration and the need for self-regulation to prevent users of messaging platforms being deluged with poorly targeted marketing campaigns.

Potential global annual revenue generated by chatbot transactions on Messenger ($ billion)

| Source: App Annie, Jackdaw, Apple, BI Intelligence estimates |

| Messenger low-end estimate | $6.3 |
| Google Play store | $12 |
| iOS App Store | $21 |
| Messenger high-end estimate | $32 |

7 White Paper: Application-to-Person Messaging, Ovum, April 2016
8 “Are chatbots an evolution or a revolution?” Venturebeat.com, September 2016
3.6 Future outlook

Chatbots as a technology today are still in their infancy, but the rapid pace of development in AI means they will deliver much greater functionality over the next five years. The rise of chatbots represents a significantly bigger paradigm shift than that which occurred from websites to apps, with apps merely a packaged better website for a native smartphone experience.

Chatbots are set to revolutionise the e-commerce arena, promising companies increases in efficiency, effectiveness, productivity and sales. The near-exponential growth in the number of active chatbots will only reinforce the rate of progress, as well as empowering a growing range of new cases. A number of key questions remain unanswered though:

- Will a single dominant conversational interface emerge (voice or text/chat), or will specific interfaces dominate in certain contexts?
- Will chatbots and apps/websites be able to co-exist as they do today, or will the increasing overlap in terms of functionality lead to a clear winner?
- How significant will the shift in online commerce and even digital advertising to chatbot channels be?
- What will be the impact of the evolution of AI-driven personal assistants?
- More generally, how will the evolution of AI and its various applications impact the broader battle for consumer engagement and data: a battle between the OS providers (Google and Apple), the new messaging giants (Facebook, WeChat) and others (Microsoft, Amazon etc)?

The near to medium-term outlook is that conversational interfaces will gain increasing traction, but the exact nature of the interface will likely depend on the specific situation. Practical or safety considerations mean that voice interfaces could emerge to dominate in the home and car, while messaging is likely to remain the main interface for smartphone users in other situations.

The most difficult question to answer is whether a super-AI assistant will emerge and dominate the user interface, with the capability to communicate via messaging or voice depending on the user’s location or preferences. The AI-driven personal assistants such as Siri, Amazon Echo, Facebook M or Google’s Assistant will have access to all the bot services that any individual uses, as well as information on personal preferences, location and so on. The super assistants will then be well placed to handle any question or request that arises and deal with it seamlessly. In other words, you will tell your personal assistant what you want, the assistant will find it and provide the relevant information, and you will be able to use the information/order the service as appropriate. The personal assistant will command and coordinate the activities of other bots.
Healthcare: big, inefficient and ripe for disruption
4.1 Executive summary

Across most advanced economies, healthcare faces a number of forces acting in parallel that make changes in the provision and funding models a question of ‘when’ rather than ‘if’.

Across the OECD, national health spend ranges between 9% and 12% of GDP, but this has increased 1–2 percentage points since 2010, implying growth faster than the wider economy. Ageing populations are the biggest driver of cost pressure given the increased rates of disease incidence. Inefficiency remains rife in healthcare provision, with a preponderance of legacy IT systems and lack of interoperability remaining a major barrier to free exchange of data and therefore analytics.

Digitisation is not a new phenomenon in health, having evolved in stages from telemedicine and consumer (mostly wearables) to cloud solutions for enterprise and most recently AI/machine learning. Our focus in this analysis is on the latter two categories targeting large-scale public health institutions and enterprises that have the largest cost and inefficiency burden and greatest scope for change. To illustrate this, we have adopted a recent estimate from Deloitte for the market size of digital health at $25–30 billion worldwide. The value of cost savings from digital solutions has the potential to be 5–10× that of revenues because of the multiplier effect on time and productivity. This is a major incentive for health institutions, governments, insurers and other payers in promoting and adopting digital solutions.

The combination of cloud ubiquity, open APIs and, crucially, the incipient rise of AI and machine learning has changed the game of what is possible in the healthcare space. The AI story is starting to play out on top of the open platform model across a large range of disparate use cases. Start-ups are targeting niches within broad segments including cancer screening and genomics (Flatiron, Pathway Genomics), mental healthcare (iCarbonX, Your.MD), lifestyle and stress management (Biobeats), medical imaging and diagnostics (Bay Labs, Zebra) and insurance models (Welltok, Evolent). Even more than platform functionality and scalability, the transformative power of AI is as a surrogate resource for doctors and clinicians – in effect, a partner human resource for doctors minus the cost. DeepMind’s partnership with the NHS in the UK and IBM Watson with a range of institutions show significant promise.

We believe the outlook for digital health is increasingly positive, but it is a long game, 20–25 years instead of 5–10. Experiences from past ventures should temper short-term exuberance (granted there is always the potential for an as-yet unknown singular invention that catalyses S-curve growth into the mass market).

Firstly, cost savings will take time to realise. AI is a key vehicle for this, but only a minority of hospitals currently invest in it. A critical-mass effect for health institutions and regulators will be at play to convert the growing range of partnerships and trials into commercial agreements. Secondly, cross-industry partnerships are essential; few medical companies have digital expertise or connectivity infrastructure. Thirdly, digital health requires joint innovation between private and public sector; venture-backed start-ups developing niche commercial products are unlikely to survive in the absence of incubation alongside or within national health services (Theranos is a cautionary tale). Fourthly, wearables as a fitness craze misses the wider point of distrust in the efficacy and privacy of using technology to manage medical conditions. Lastly, the wider ethical and Orwellian issues of power and control. Governments face a catch-22 situation in that health costs must be reduced but safety must be ensured at all costs. In this respect, AI should be seen as a complement to physicians, not a replacement. CRISPR and other gene editing solutions sit on a slippery slope where technology improves the ability to avoid or treat disease but is never far from the Pandora’s Box of genetic modification for ulterior motives.
4.2 The trifecta of rising costs, ageing populations and inefficiency

Across most advanced economies, healthcare faces a number of forces acting in parallel that make changes in the provision and funding models a question of ‘when’ rather than ‘if’. Rising costs, ageing and more disease-prone populations, and inefficiency are collectively exerting pressure on nationally funded health systems, and this is only set to increase.

**Rising costs**

Across the OECD, national health spend ranges between 9% and 12% of GDP, but this has increased 1–2 percentage points since 2010 (see Figure 1). For reference, telecoms tends to account for 3–4% of GDP.

As costs of healthcare are rising as a share of GDP, growth in health expenditure is outpacing the wider economy. Cost inflation at this rate is unsustainable given that the trends of ageing populations and subdued economic growth in western countries (low single digits) are likely to continue for the foreseeable future (15–20 years).

The US is the glaring outlier, with 17% of overall output spent on health (2015). It remains the only advanced western economy without a universal health system (i.e. free at the point of delivery for the majority of procedures), with rising premiums for private insurance driving up overall spend. In 2014, 41% of adults in the US paid more than $1,000 of their own money to fund health costs over the course of one year. The comparable figures for Europe are fractional: UK (3%), Netherlands (7%), Germany (11%) and Switzerland (24%).

**Health expenditure is rising faster than GDP**

Spend on health (private and public) as a percentage of GDP

Ageing populations

Ageing populations are the biggest driver of the increase in costs.

Across the EU, between 2015 and 2050 the population is forecast to grow at an anaemic 0.1% per year overall but at 1.2% for the 65+ age group. This means the over-65 share of the population will rise from 19% to 28% over the period, with a net increase of 52 million (a net decrease from other age groups). In other words, Europe is much closer to stasis than population growth (as from the 1980s and 1990s driven by the ‘baby boomer’ generation), with most of the movements shifting within the population to older age groups.

Source: Eurostat, US Census Bureau

Population projections for Europe and the US

<table>
<thead>
<tr>
<th>Total population (million)</th>
<th>2015</th>
<th>2030</th>
<th>2050</th>
<th>2015–2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU (28 countries)</td>
<td>508</td>
<td>518</td>
<td>526</td>
<td></td>
</tr>
<tr>
<td>US</td>
<td>321</td>
<td>359</td>
<td>398</td>
<td></td>
</tr>
<tr>
<td>Share of population 65+</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EU (28 countries)</td>
<td>19%</td>
<td>24%</td>
<td>28%</td>
<td></td>
</tr>
<tr>
<td>US</td>
<td>15%</td>
<td>21%</td>
<td>22%</td>
<td></td>
</tr>
<tr>
<td>Net increase 65+ (million)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EU (28 countries)</td>
<td>28</td>
<td>24</td>
<td>52</td>
<td></td>
</tr>
<tr>
<td>US</td>
<td>26</td>
<td>14</td>
<td>40</td>
<td></td>
</tr>
</tbody>
</table>

Inefficiency

A number of factors drive inefficiency in healthcare. This could be a report in itself, but we overview in brief below.

Publicly funded national health systems are perhaps the single most important creation post the Second World War. While this is fundamental in enshrining healthcare as a universal right, the consequential obligation on governments to underpin this right has resulted in expenditure driven off a model where health professionals are incentivised by providing treatments as opposed to achieving measurable positive outcomes. This incentivises treatment even if it is not necessary and disincentivises alternatives with a lower resource/cost burden.

There is a preponderance of legacy IT systems, some of which have been modernised but many of which have not. Interoperability remains a major barrier to free exchange of data and therefore analytics.

Finally, there remains the problem that even as technology has been integrated into health delivery (such as with electronic health records), it has not generally been accompanied by organisational and cultural change.
4.3 Cost savings are multiples of the revenue story in digital health

Digitisation is not a new phenomenon in health; it has evolved in stages to reflect the fact that the main delivery vehicles of health budgets – hospitals, clinics, pharmacies, laboratories – are equipped with legacy IT systems for which there is a morass of complexity in modernising.

At the top level, the digital healthcare market could be segmented into four broad groups: telemedicine, consumer, enterprise and AI/machine learning. See Figure 2. Telemedicine has been in practice since around 2000, with remote diagnostic tools and consultations now complementing previously developed use cases in chronic disease management (e.g. taking a course of medicine for, say, Crohn’s disease). Wearables and health-related apps make up what could be called the consumer segment; this took root in 2013/14, targeting personal wellness. Fitbit and Jawbone’s launches have catalysed a wave of specialist plays, all the while joined by Apple, Samsung and Google bolting on health apps to their service/content ecosystems. Our focus here, however, is on health innovation targeting large-scale public health institutions and enterprise (within the dotted box in Figure 2, e.g. hospitals, medical research centres, insurers). These institutions have the largest cost and inefficiency burden and therefore the largest scope for change.

There are two main reasons for this:

- The first is that, from field and commercial results reported so far, the value of digital healthcare is much more in cost savings and efficiency gains than in a revenue story. Deloitte and Goldman Sachs have recently estimated the size of the digital health market (revenues from companies specialising in digital health plus those from health arms of larger enterprises in the space, such as GE, IBM, Johnson & Johnson). We have adopted Deloitte’s figure of roughly $25–30 billion worldwide. The potential size of a nascent sector is hard to estimate because future disruption is unknowable and so $25–30 billion will grow, probably by multiples. But the value of cost savings from digital solutions has the potential to be 5–10× that of revenues because of the multiplier effect on time and productivity (we discuss this in the last section). This is a major incentive for health institutions, governments, insurers and other payers in promoting and adopting digital solutions.

- The second is that the combination of cloud ubiquity, open APIs and, crucially, the incipient rise of AI and machine learning has changed the game of what is possible in this space. It would not be a stretch to simplify the segmentation of the digital health market into a bifurcation of pre-AI versus post-AI.

Note that this market size excludes traditional medical devices, medical IT systems and pharmaceuticals.
Segmenting the digital health market

<table>
<thead>
<tr>
<th>Description</th>
<th>Telemedicine</th>
<th>Consumer-driven</th>
<th>Enterprise and cloud</th>
<th>AI and machine learning</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>From</strong></td>
<td>2000</td>
<td>2008</td>
<td>2010</td>
<td>2014</td>
</tr>
<tr>
<td><strong>Adapting conditions and procedures to a remote environment.</strong> Includes remote diagnostics, consultations, monitoring, chronic disease management</td>
<td><strong>Includes two broad categories: wearables and health-driven mobile apps.</strong> Focus on end-consumer, although enterprise is becoming a larger sell-in segment as part of fostering health as core element of company values</td>
<td><strong>Solutions that digitise major enterprise systems, often with advanced analytics.</strong> Largest single category is electronic health records (EHRs) but activity expanding into new areas such as procurement and data sharing among clinicians</td>
<td><strong>Newest and fastest growing area of digital health.</strong> Range of use cases being trialled, including interpretation of radiology and topographical scans, behavioural therapy (consumer), genomics</td>
<td></td>
</tr>
<tr>
<td><strong>Target</strong></td>
<td>Heart disease, diabetes, chronic illnesses (e.g. Crohn’s)</td>
<td>General wellness and wellbeing. Preventative measure to development of serious illness</td>
<td>General. Focus is on improving operational efficiency as opposed to specific ailments</td>
<td>General. Focus is on improving operational efficiency as opposed to specific ailments</td>
</tr>
<tr>
<td><strong>Size</strong></td>
<td>$2.8 billion</td>
<td>$3.7 billion</td>
<td>$18 billion</td>
<td>???</td>
</tr>
</tbody>
</table>

Note: market size estimates made by Deloitte in its report, *Digital Health in the UK: An industry study for the Office of Life Sciences*, for the UK government
4.4 Marrying the platform with AI

The AI story is starting to play out on top of the open platform model across a large range of disparate use cases. It is telling that start-ups are targeting many niches within broad segments including cancer screening and genomics, mental healthcare provision, lifestyle and stress management, medical imaging and diagnostics, and insurance models.

Healthcare and wellness account for a relatively small share (4%) of total internet software funding, but this is growing. Venture-capital deal appetite has remained strong through a wider correction in start-up funding; health start-ups are averaging new financings of $1.0–1.4 billion per quarter, with deal volumes growing around 20% in the 12 months to September 2016 (see Figure 3).

The familiar trend of unbundling can be seen in health as it has been in other sectors disrupted by digitisation (see Figure 4). Flatiron, for example, is a company founded by ex-Google staff that serves as an aggregator of cancer information worldwide. This includes information on diagnostics, real life treatment plans and clinical trials, much of it crowdsourced to stay current. It is two-sided, serving as a reference tool for physicians through a number of products, and as a consultative support for patients in need of rigorous information as a complement to emotional support from family and a tonic to the reams of misinformation from general internet searches. Welltok is a platform that plugs into databases of a range of insurance companies and employer benefit plans, giving employees a simplified view of health insurance options (it also has an AI-driven voice tool powered by Watson). There are many more; Evolent (another intermediary platform between employers and insurers), iCarbonX (consumer stress management) and Biobeats (workplace wellness and stress management) are examples.

Source: CB Insights

Financing in health start-ups

![Financing in health start-ups chart]
Healthcare: big, inefficient and ripe for disruption

Even more than platform functionality and scalability, the transformative power of AI is as a surrogate resource for doctors and clinicians – in effect, a partner human resource for doctors minus the cost. DeepMind (i.e. Google) is a leading player. The company has three partnership trials with the National Health Service (NHS) in the UK.

- One is with University College London, which uses AI to interpret radiology scans of suspected throat and mouth cancers. The scans are used to map intricate anatomical regions in preparation for surgery to excise malignant tumours without damaging healthy tissue, and as such require significant expertise and time (on average, four hours to interpret one scan). The target of the partnership is to use machine learning algorithms to reduce this time to one hour (a 75% time saving).

- A similar objective has been set for a separate partnership with Moorfields Eye Hospital in London. In this case the target is age-related macular degeneration (AMD – a common but potentially damaging condition that can result in blindness) and diabetes-induced blindness. The trial aims to feed 1 million eye scans into machine learning algorithms in recognition of the basic fact that AI itself improves (learns) through pattern recognition over multitudinous rounds of information input.

- The third trial is targeting Acute Kidney Injury (AKI). The NHS estimates AKI to have a role in 20% of emergency admissions and 40,000 deaths per year, 25% of which are preventable. The trial uses a new app (Streams) on smartphones that monitors and interprets a panoply of real-time data to flag the potential of imminent danger (such as sepsis) for individual patients to their doctors before it is too late to act (technically this app uses predictive analytics as opposed to AI, but the company is exploring the possibility of AI in future).
IBM has a range of partnerships with health institutions leveraging the Watson API. One of the most notable is with the Broad Institute (Harvard and MIT). In this case, AI is used to analyse genetic sequences from cancer patients with tumours that have evolved resistance to drugs used in treatment – a result of spontaneous mutations in cancerous cells. The consequences of this resistance can be devastating given the risk of metastasis into other parts of the body. The play here is to feed Watson DNA sequences from such patients so that it can predict with an increasing probability how and where mutations will occur. If successful, the implication is that drug therapies can target alternative regions of cancer cells to mitigate the risk of resistance – something aptly compared to predicting an opponent’s move in a game of chess.

Pathway Genomics is a start-up founded in 2008 built on a similar premise but targeted at consumers. It has also used the Watson API to develop proprietary genetics testing products that allow consumers to self-screen their DNA for genes associated with metabolic problems.

AI-driven platforms are also being developed in mental health for informal diagnoses. Your.MD uses an AI backend to derive the probability of a link between symptoms as verbally described by patients and certain conditions. The company reports that the two largest areas described into its platform by consumers are mental health and sexually transmitted infections. It has not yet reported query volumes, but is in partnership with Samsung, with the app now pre-installed on all Galaxy phones. Neurolex uses AI and voice recognition tools to predict potential cases of psychosis, a key element of schizophrenia (inspired by a recent academic study that used AI to retrospectively predict psychosis with 100% accuracy).
4.5 Avoiding another false dawn

We believe the outlook for digital health is increasingly positive but is a long game that faces challenges, reality checks and experiences from past ventures that should temper short-term exuberance.

Cost savings will take time to realise

Firstly the cost savings potential will take time to realise. Digital health is still at an early adoption phase, with take-up levels relatively low and cost savings immaterial in the context of their potential (see Figure 5). The complexity of modernising legacy IT equipment, overcoming consumer concerns on efficacy and privacy, changing procurement practices that currently favour incumbents in established verticals at the expense of new entrants, and accelerating regulatory reform mean that transformation is more likely a 20–25 year process than a 5–10 year one characteristic of consumer technology. Our assumption is that cost savings will accelerate exponentially once a critical mass of adoption in major health institutions is passed. The share of hospitals investing in AI is still a distinct minority (one estimate from Spiderbook puts it at 1.5%) but this will increase as the many partnerships and trials are converted into product adoption. If this is correct, the most difficult period will be near-term (3–5 years) driven by pressure from incumbents fearful of disintermediation and from regulation that lags technology.

Source: GSMA Intelligence

Benefits from digital health are big but long term

Present
Digital adoption rising but not yet at scale. Cost savings still not seen.

Acceleration
Adoption passes critical mass. Cost savings grow exponentially.

New steady state
Digital fully established and accepted. Health systems operate off structurally lower cost base.

Note: graphic is indicative only (as opposed to actual data) to illustrate the potential cost savings over time.
Sustainable link required between entrepreneurs, institutions and financial backers

The venture-backed start-ups developing niche commercial products are unlikely to survive in the absence of incubation alongside or within national health services. These institutions and their procurement arms represent the vast majority of buying power for digital health (not consumers) so it is vital that new services are developed within their purview and gain their blessing. The UK, for example, has created a national digital health accelerator (NHS Innovation Accelerator). This purposefully accepts only a limited number of start-ups each year (10), providing mentorship, contacts within the NHS, and testing environments. Several European markets are fostering similar innovation accelerators in health, with at least 100 in active operation.

Accelerators are not a panacea – but for digital health to work, there needs to be a sustainable link between entrepreneurs, health institutions and financial backers. Accelerators are well positioned to form it. Theranos, by contrast, is a cautionary tale. Its idea to change the way blood samples were drawn from needles to a pin prick that could be managed by consumers instead of doctors attracted significant investor support and media attention (a $9 billion valuation was estimated in 2014 for a company with zero revenues). In January 2016 the US Department of Health alleged its laboratories posed “...immediate jeopardy to patient safety”. While Theranos refuted the allegations, its key distribution partner Walgreens pulled out of a partnership in June, and regulators subsequently imposed sanctions on lab operations. The company announced in October it would close its labs and blood testing business, effectively wiping out its entire value.

Source: NHS Innovation Accelerator (NHS England)

Selected projects accepted on the National Innovation Accelerator (UK, 2016)

<table>
<thead>
<tr>
<th>Condition targeted</th>
<th>Inefficiency</th>
<th>Description</th>
<th>Projected impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sore throat test and treat</td>
<td>1.2 million GP visits for sore throats each year, with 62% prescribed antibiotics unnecessarily</td>
<td>Simple test that allows end-users to be screened for bacterial infections at pharmacy instead of GP</td>
<td>800,000 GP consultations saved, equivalent to £34 million per year</td>
</tr>
<tr>
<td>Outcomes Based Health (OBH)</td>
<td>Hospitals and healthcare providers rewarded on care delivery model as opposed to positive patient outcomes</td>
<td>Platform that provides benchmarking on realistic outcomes for a range of conditions (e.g. diabetes, mental illness)</td>
<td>To be quantified through scaling service; goal is to cover 10% of England population by 2017</td>
</tr>
<tr>
<td>ARTEMUS-ICS</td>
<td>High strain on health systems from chronic conditions (50% of GP visits and 70% of hospital bed days) when some could be avoided or managed remotely</td>
<td>Data-driven population health platform that uses analytics to pre-empt hospital admissions</td>
<td>Reduction in hospital admissions of 75%, reduced emergency (999) calls 65-70%, 40-50% reduction in GP/nurse visits to residences</td>
</tr>
<tr>
<td>ERAS+</td>
<td>Lack of consumer education pre-operation can increase risk of PPC</td>
<td>Platform that educates and informally trains individuals on the build-up and follow-on to major surgery (e.g. respiratory training, anaesthesia)</td>
<td>Reduced PPC by 50% and post-operative hospital stays by three days</td>
</tr>
</tbody>
</table>

Note: 10 projects are selected each year to be part of the NIA. We show four as part of the 2016 cohort.
Consumers remain reluctant to embrace technology to manage medical conditions

Smartphone adoption has now reached ubiquitous levels (75%+) for the majority of age groups, but willingness to use smartphones for diagnostics or as a tool in managing health conditions is much lower, with priority more on personal wellness than medical conditions. In the UK, 53% of people agree that health tech should be used to target obesity (a good thing given that the annual cost to treat it was last estimated at £4 billion in 2007, equivalent to the entire projected increase in the NHS annual budget by 2020). Only 17% agree for diabetes, 14% for dementia, 10% for cancer and 8% for heart disease. This is likely to skew even lower for older age populations, where smartphone penetration is also lower.

Wider ethical and Orwellian issues of power and control persist

Governments in some senses face a catch-22 situation in that health costs must be reduced, but safety must be ensured at all costs. AI should be seen as a complement to physicians, not a replacement, freeing time for doctors by speeding up existing diagnoses and procedures. This may sound boring but at scale is transformational. There is, of course, the potential that AI opens up new treatment methods, but for the foreseeable future the doctor-patient axis is likely to remain paramount. The promise of AI in genetic sequencing is real but mostly for institutions. Companies that have tried to democratise DNA testing to the consumer have had mixed results; 23andMe, for example, has been forced to reduce the number of conditions people can screen for. At a deeper level, CRISPR and other gene editing solutions sit on a slippery slope where technology improves the ability to avoid or treat disease but is never far from the Pandora’s Box of genetic modification for ulterior motives.

Cross-industry partnerships are essential

Few companies in established medical sector verticals also have the digital expertise needed to reinvent legacy products and services. Cloud partnerships have already taken root, with Amazon and Microsoft having the largest scale positions, but the range has widened dramatically to capture the need for connectivity (particularly short range), analytics and AI. A far from exhaustive list includes Novartis with Qualcomm, IBM with Apple, Medtronic and the Broad Institute, Salesforce with Philips, DeepMind with the UK NHS, and Vodafone with AstraZeneca.
5

How video ate the digital world
5.1 Executive summary

Video is now everywhere: it is increasingly becoming the default format for communication, collaboration, education, marketing and entertainment. Video already looks certain to be the future of social, with Facebook commenting that the social network could become “all video” within five years.

Beyond social media, video has now become the key strategic priority for many companies across multiple sectors. It is increasingly the communication tool of choice in the corporate world for internal communications, with videos now being produced not just by marketing departments but increasingly by other departments such as IT and HR. Future use cases will expand and transform sectors such as health and education.

There has been a paradigm shift in the very nature of video – from something that is highly scripted with a linear run time to increasing amounts of user-generated video, including live video feeds and curated collections of video clips from other sources.

Mobile has become the key platform for the consumption of video and is a key driver of the forecast that global IP traffic will more than double by 2020. The near ubiquity of smartphones with advanced cameras has empowered everyone to become a content producer, allowing the true democratisation of video and fuelling the growth of live streaming and video sharing. The growth of apps such as Snapchat has driven the rise of short-form and vertical video, with advertisers increasingly looking to engage in the most appropriate format.

Technological advances are delivering higher quality ultra-HD screens, even for smartphones, though improvements are now approaching the limits of what is meaningful to the human eye. Beyond 360-degree cameras, the next phase of development will deliver truly immersive video, based on the growing adoption of virtual and augmented reality, and perhaps ultimately holographic video.

Advances in artificial intelligence are increasingly delivering the reality of searchable video, allowing for example a user to find exactly what they are looking for (a scene, sentence or topic area) without having to watch hours of video footage. As video analytics improve, much more value will be extracted from video metadata, offering new routes to monetise video content.

We are now entering a golden age of content production, ranging from the rapid growth of self-generated content to new industry players investing in scripted content, including Netflix and Amazon. Viewership and revenues are shifting rapidly to these new online platforms, though it may be too early to identify the longer term winners.

These developments will continue to disrupt the media and content industries, for both traditional and new digital players. There is likely to be a new era of industry consolidation, with the potential for many of the larger players to become vertically integrated as part of a new wave of bundling. AT&T’s impending acquisition of Time Warner may be just the latest manifestation of this process, with both YouTube and Netflix facing (admittedly different) challenges as they look to adapt to the rapidly evolving digital landscape.
5.2 The rise of videoification

The digital age, with the near ubiquity of both connectivity and smartphones/tablets, has been the catalyst for a key trend: the “videoification” of everything. This trend has turned what were previously static photos and graphics into dynamic video and video-like experiences. While the traditional photo still exists, dynamic video is being introduced into more and more digital experiences. Examples range from ‘live photos’ on iPhones, to Twitter Moments and Snapchat Live.

The ubiquity of smartphones with advanced cameras, together with the rise of native advertising, has redefined the concept of what constitutes video content. Unedited and raw video, increasingly live, is gaining traction and viewership. The ease of video production and distribution means that scale or resources are no longer prerequisites to produce video and build user engagement.

Live streaming of video is the latest phase in the evolution of video formats and a clear shift from the world of scripted or episodic content to one that offers an immediate and more unpredictable experience. Ustream, a live video technology provider acquired by IBM in January 2016, has found that consumers spend two to three times as much time watching live videos of an activity as it is taking place rather than after the fact. Smartphones have also made it easier to shoot videos live and share them without delay.

Video has become a key strategic priority for many companies, including leading social media and messaging services. Facebook could become “all video” within five years, according to Nicola Mendelsohn, vice president for the social network in Europe, the Middle East and Africa. On-demand streaming services also mean that video libraries can be viewed almost anywhere and at any time.

1 “Live from Everywhere, It’s video!” Bloomberg, March 2016
5.3 Data traffic is video

The latest forecasts from Cisco show that total IP traffic (both business and consumer) will pass the zetabyte level by the end of 2017 and will reach 2.3 ZB per year by 2020. Video traffic will remain a key driver of overall growth, with IP video traffic set to account for 82% of all IP traffic by 2020, up from 70% in 2015.

Global IP video traffic will grow threefold between 2015 and 2020, a CAGR of 26%. Internet video traffic will grow fourfold between 2015 and 2020, a CAGR of 31%. Key drivers of this growth of video traffic will include internet video to TV traffic (growing 3.6× by 2020) and consumer VoD traffic (growing twofold by 2020), with the increasing uptake of HD (and ultra-HD) screens strongly affecting traffic volumes.

Source: Cisco

Total global IP traffic (PB per month)

Mobile will be a key component of this video traffic growth, with estimates from Ericsson suggesting that more than half of mobile data traffic in 2015 was video, while by 2022 that figure is likely to increase to as high as three quarters. The growth in mobile video traffic is being fuelled by the widespread adoption of smartphones, increasingly affordable data packages, and crucially video content that is more suited to smaller screens.
A key part of adapting video for smartphones has been the shift from horizontal to vertical formats (horizontal video is filmed in a 16:9 ratio, which is reversed for phones with a 9:16 ratio). Data from KPCB indicates that the proportion of mobile video viewed in a vertical format increased from just 5% in 2010 to almost 30% in 2015. YouTube saw a 50% increase in the upload of vertical video traffic in 2015, while all the mobile apps and platforms have been forced to adapt following the growth of apps such as Snapchat, Meerkat and Periscope, which were designed from the outset around vertical video.

Vertical videos are easier to watch on smartphones, with no need to rotate the device from its normal position. Not surprisingly, these videos result in better consumer engagement; Snapchat has reported that vertical video ads have a nine-fold higher completion rate than horizontal ads. A range of content providers, including advertisers but also importantly publishers and other media companies, are embracing the vertical format.

In parallel with the growth of vertical video has been the growth of short-form video. While users are increasingly showing a willingness to watch longer form video on phones, including films and TV series, the fastest growth and key driver of mobile video traffic has been short-form video. For example, data from App Annie shows that Android users spent 45% more time viewing YouTube videos in 2016 compared to the prior year, far outstripping growth for Netflix or Hulu.

Perhaps not surprisingly, the greatest adoption and engagement rates for short-form video are among younger viewers. A recent survey by AOL in the UK found that short-form video has now become the primary news source for 18–24 year-olds, with more than half stating that they preferred viewing news to reading it. The same survey found that users were willing to engage with video ads if they were relevant.

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2 “Vertical Video”, Medium.com - Jon Steinberg, May 2015
3 “5 key trends for short form video success”, Netimperative, November 2016
And so is everything else

Video is becoming of greater strategic importance as well as more pervasive, while at the same time the very nature of video has changed. Video is no longer a fixed format (typically the 16:9 media format) with a clear linear run-time (that you have to “play” and watch from beginning to end). The change in the nature of video extends beyond for example autoplaying clips designed for television. Video is now more an experience, often involving “cheap” and unconventional way to bring video to life. Vertical video, Vine and GIFs are all examples of this trend, with apps such as Snapchat Discover providing a new format where video, animated photos and graphics blend together.

Video already dominates on many of the leading social media platforms; for example, Facebook commented on its Q4 2015 results call that its users watch more than 100 million hours of video each day. Facebook has launched its Facebook Live initiative and is focused on encouraging its user base to both produce and view live video streams. The ability to live stream video was initially restricted to celebrities and other high-profile users, but has now been extended to all its user base.

Video is increasingly the communication tool of choice in the corporate world for internal communications, with videos now being produced not just by marketing departments but also increasingly by other departments such as IT, HR and finance. With employees more and more used to video in their home environments, businesses are using the power of video as a medium to help ‘tell their story’. Towers Watson’s ‘Change and Communication ROI Report’ has demonstrated that the most productive and successful companies typically convey a consistent story about their business. Video is being deployed to meet this goal, with for example video updates from senior management and animated films that highlight changes or successful projects.

A recent survey carried out for Buto by Communicate Magazine highlighted the potential for a huge increase in the amount of user-generated video used in corporate internal communications. While only around a quarter of respondents indicated that their organisation currently encourages user-generated video, more than a third of respondents indicated that they plan to move to this form of video content.

However, there are warnings for companies of all kinds as they look to embrace the power of video. Consumer fatigue means that platforms can fall almost as quickly as they rose. Twitter was an early leader in live video but is seeing itself increasingly challenged by other players such as Facebook. Meerkat, another pioneer in live streaming, recently closed due to increasing competition in the live video market.

Source: UBS, eMarketer

### Platforms on which US internet users have viewed live streaming video

- **Facebook Live**: 17%
- **YouTube Live streaming**: 16%
- **Snapchat Live**: 12%

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4 “Opinion: How can video content help solve the UK productivity crisis?” Transform Magazine, December 2016
5.4 Future technology trends: from better screens to immersive video

The focus of development in recent years has been on improving the quality of video from the consumer perspective, whether through advances in screen quality or compression techniques that reduce the overheads (time and money) involved in distributing content to consumers.

Improvements in video codecs help to reduce the amount of bandwidth needed to serve video over the internet. The gains determine the quality of the experience for constrained devices such as smartphones on cellular networks and are key to supporting the business models of cloud-based video services.

Advances in compression technologies are now proving more challenging to deliver, though there are two potential areas of progress as outlined in Table 1.

Source: GSMA Intelligence

Latest developments in video compression

<table>
<thead>
<tr>
<th>Codec name</th>
<th>Advantage</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>High efficiency video coding (HEVC)</td>
<td>Requires half the bandwidth of other codecs</td>
<td>Ratified by ITU and seen extensive hardware and software deployments. Content adoption hindered by uncertainties around patent licensing</td>
</tr>
<tr>
<td>Alliance For Open Media (AOM)</td>
<td>Aim to develop a mainstream, royalty-free codec</td>
<td>Google has led significant development work. AVI codec due to be released imminently</td>
</tr>
</tbody>
</table>

In terms of screen quality, some significant developments are imminent – in particular, the move from high definition (HD) to ultra-high definition (UHD), which promises higher resolution, higher colour accuracy, and higher dynamic range. UHD includes a range of video formats:

- **4K UHD**: "4K resolution" refers to a horizontal resolution of approximately 4,000 pixels. UHD-1 is the specific 4K standard that has been adopted for televisions and PC monitors, as well as content providers such as YouTube. 4K screens are also now being made available on smartphones, with the Sony Xperia Z5 one of the first, and press reports suggesting the Galaxy S8 will be the first Samsung with a 4K screen (expected to launch in 2017). Whether the benefits of UHD translate to such small screens will remain a topic of some debate.

- **8K UHD**: 8K refers to a resolution of $7680 \times 4320$ (33.2 megapixels). The first 8K televisions and computer monitors were released in 2015.

- **HDR**: high dynamic range expands the range of both contrast and colour significantly. For televisions, this means expanding the TV’s contrast ratio and colour palette to offer a more realistic, natural image than possible with existing HDTVs.
A number of streaming services already produce content in 4K resolution, including Amazon, Netflix and YouTube, as well as major broadcasters in many developed markets (although only to date over satellite and cable, with most terrestrial broadcasts in 4K still in the testing phase). Blu-ray players are also now available in 4K resolution, and the growing supply of higher resolution content is fuelling demand for 4K screens. The US Consumer Technology Association expects 4.5 million 4K UHD TV sets to be sold in the fourth quarter of 2016, boosting overall sales for the year by 40% compared to 2015. UHD content is forecast to grow to 20.7% of global IP video traffic by 2020.

In contrast, 8K broadcasts are still hard to achieve with current technology, even when using the latest compression codecs. The benefits of 8K screen resolutions have also been disputed by a number of content providers, given the limitations of increasing the number of pixels in a screen against what the human eye can detect. For example, Neil Hunt, Netflix’s chief product officer, claimed “the future of TV is in better pixels, not just more of them”. Netflix has already introduced two HDR-ready series and is likely to release more going forward.
5.5 Beyond screen quality: searchable and immersive video

The more fundamental shifts of video technology will be far beyond screen quality. Two key areas are worth highlighting:

**Video search:** searching in documents or the web for specific content is now widely accepted as the norm, but searching a video is only now just becoming possible.

**Immersive video:** making video that is almost indistinguishable from reality, in the short to medium term through virtual reality, and in the longer term by holographic video.

There are particular challenges for artificial intelligence in analysing and understanding video data, in areas such as recognising objects and faces. However, rapid progress is being made and a number of new use cases and services are being developed. One immediate use case is to make all video fully searchable, to allow users to find exactly what they are looking for (a scene, sentence or topic area) without having to watch hours of video footage. As video analytics improve, much more value will be extracted from video metadata.

Finnish video analytics company Valossa has launched the Val.ai platform that performs a range of video analytics functions. These include sentiment analysis (on the emotional state of a person in the video, including estimates of heart rate) and video search (to locate specific scenes or actions in a video). The platform promises a voice interface for search and offers new ways of video monetisation, with the ability to scan video in real time to identify concepts such as places and objects. The company recently launched a closed API Beta programme aimed at video creators, advertisers and discovery services.

The second key area of advancement is truly immersive and realistic video:

The big overarching goal is to create something that would make visual communication indistinguishable from reality

Professor Aljosa Smolic

The longer term vision of truly immersive experiences could involve holographic video, long a feature of science fiction. In the short to medium term, more immersive video is being delivered by virtual reality. Despite the limitations of the technology today, with pre-rendered VR unable to match the immersive qualities of 3D video, the uptake of VR is already impressive. Oculus has announced that people have already watched more than 3 million hours of video in Samsung’s Gear VR, with more than 1 million users per month. Netflix and Hulu each launched VR apps to coincide with the Samsung Gear VR headset launch, and the supply of VR content will only increase.

Immersion – the next frontier in video

While mobile video has been particularly effective in meeting user demands for immediacy, the growth of filtered social feeds or curated video lists (often produced by algorithms that find the most popular or relevant content) has affected the authenticity of mobile. New apps such as Beme address this issue, with videos that are shared instantly and without a preview screen. The question is then how quickly VR will address the need for a truly immersive experience. Although producing VR video today is a relatively complex undertaking, at some point VR video capture will become possible on mobile devices, which will then catalyse the demand for VR video with an almost unlimited supply of content from the billions of smartphone users who are now recording much of their lives.
5.6 Emerging use cases for video

Video has already been adopted in the corporate world and is used in areas such as health and education. However, the full potential of video in these two verticals in particular has yet to be fully realised.

As students and educators become more used to video in every part of their lives, the value of it for educational purposes is being recognised in the classroom and beyond. A 2016 survey by Kaltura found that three quarters of higher education students in the US use video in their assignments, with a third of users reporting that video was used to provide feedback. There was also a widespread expectation that video will become much more central to the educational process, potentially taking much of the teaching load to allow for more meaningful face-to-face interactions between teacher and student.

Health uses cases for video may be most relevant in emerging and rural markets, where distance to nearest providers is a significant constraint to receiving care, and particularly relevant for chronic conditions. Video adoption today is being driven in developed markets, with the promise of telemedicine being realised to offer more cost-effective consultations or to monitor chronic conditions. Using some of the emerging video analytic techniques described previously, to help understand a patient’s state of mind or heart rate for example, could further enhance the effectiveness of telemedicine.

The AiCure app supported by The National Institutes of Health uses a smartphone’s webcam and AI to autonomously confirm that patients are adhering to their prescriptions, supporting them to make sure they are managing their condition.
Future implications: dawn of the video wars

The videoification of everything in the digital world will have profound implications for a range of existing industries.

Television broadcasters are already under pressure from streaming services and online content providers, with falling audiences undermining the viability of advertising-based revenue models. Advertising revenues will continue to move, as advertisers question the value of expensive slots on prime-time TV when Facebook can deliver a broader audience through Facebook Live.

The next edition of the Global Mobile Radar will look in more detail at the changing content industry landscape and the implications for the various major players. However, it is already evident that there are significant shifts underway, both in terms of what constitutes video content and who can produce it. While social media platforms and apps allow any individual to become a content producer, new distribution platforms are accelerating the shift of audience attention and revenues.

Facebook’s Live streaming platform is becoming more like traditional broadcast television, with the company recently reported to be in talks with production studios and other content producers to produce a range of proprietary content. This represents a new stage in Facebook’s video content strategy that previously involved paying celebrities and other media outlets to produce video for distribution on the Facebook Live platform. As with its investments in VR content, this appears more a move to seed content onto the Live platform than a fully fledged move into content production and ownership. But as the boundaries in the digital landscape continue to blur, making such distinctions may prove increasingly difficult.

We are now entering a golden age of content production, ranging from the rapid growth of self-generated content to new industry players, including Netflix and Amazon, investing in scripted content. Viewership and revenues are shifting rapidly to these new online platforms, although it may be too early to identify the longer term winners.

Over the next few years there is likely to be a new wave of industry consolidation, with the potential for many of the larger players to become vertically integrated. AT&T’s impending acquisition of Time Warner may only be the start of this process, with both YouTube and Netflix facing (admittedly different) challenges as they look to adapt to the rapidly evolving digital landscape.
Robotics: the rise of the service robot
6.1 Greater collaboration between humans and robots

Robotics are not new, but their use – particularly for industrial and increasingly service applications – has grown significantly over the past decade and will accelerate and broaden into new areas for the remainder of the decade.

The International Federation of Robotics (IFR) reports that almost 70% of industrial robots, as of end-2015, are in three sectors – and nearly 40% are in the auto sector alone. It expects greater growth through to 2019 to come from the electronics industry and from SMEs. It claims “compact and easy-to-use collaborative robots” will drive a “breakthrough” in human–robot collaboration.¹

Market analyst IDC estimates that spend on robotics and related services will more than double by 2020, growing from $91.5 billion in 2016 to more than $188 billion in 2020. This growth is being driven by various complementary elements, including technology improvements, expanded use cases and a more general acceptance in the market. More than half of robotics spend is forecast to come from manufacturing, with other major industry verticals including resource industries, consumer and healthcare.

¹ International Federation of Robotics, IFR World Robotics 2016, September 2016
6.2 Use cases: from industrials to service robotics

A fundamental shift is underway in robotics, from their historic deployment in heavy industry to a broad range of use cases. Through autonomous learning and artificial intelligence, we are seeing the rise of service robots, with more collaborative and flexible robotics deployed into a diverse range of environments. Service robots are easier to train and manipulate and can operate in offices, hospitals and warehouses – all of which are non-standard, real-world environments. Service robots are increasingly capable of more complex and specialised tasks, making them increasingly essential to many businesses.

Source: PWC

Robotics industry moves towards service robots
Enterprise

**Manufacturing**
Robotics is used heavily in many sectors where repetitive tasks are necessary but must be performed with precision; the automotive sector is in fact the largest operator of industrial robots, though other sectors such as electronics are growing faster. At SEW-Eurodrive’s factory in southern Germany ‘cobots’ - robots that assist rather than replace workers - enable workers to be more productive, focus on more advanced rather than repetitive tasks and feel more satisfied with their work.

**Medical/surgical**
Potential applications include remote surgery and robot-assisted surgery, robotic triage, prescription ordering and even patient consultations. At the Children’s National Medical Center in the US, the Smart Tissue Autonomous Robot (or STAR) outperformed surgeons in open bowel surgery for pigs. Equipped with a robotic arm and surgical tools, STAR combines smart imaging technologies and fluorescent markers to navigate and adapt to the complexities of soft tissue.

**Logistics**
Many companies use robots in warehouses and order fulfilment centres. Examples include e-commerce giant Amazon and UK online grocer Ocado.

**Finance**
Applications include payment and transaction processing, accounts reconciliation, risk management, regulatory compliance and other high-volume, low value-added tasks.

**Others**
Robotics is used in a variety of sectors such as agriculture, maritime, construction, security, journalism and public relations.
Consumer

Robots in the home may remind some of science-fiction TV series, but they are becoming a reality. There were many highly publicised launches and prototypes shown at this year’s Consumer Electronics Show (CES) in Las Vegas, with a particular focus on care and companionship for children and the elderly.

Children

‘Gamified’ education, media consumption management, companionship and monitoring. Avatarmind’s iPal serves as a learning and safety companion for children and the elderly. The robot can sing, dance, navigate a maze and interact with people. iPal has touch sensors and microphones as well as an “emotion management system” that enables it to detect and learn emotions. The robot has an interactive touch display mounted on its ‘chest’ that can be used for educational purposes or as a video screen for chat.

Elderly

Robotic companionship and monitoring to help with tasks and challenges such as memory loss, prescription regimens and vital health statistics. Yumii’s Cutii is designed specifically for care for the elderly. It can respond to verbal cues and assist in a variety of daily activities including setting up reminders and assisting with cooking. It can help individuals contact family members and make doctor’s appointments. It was selected as a CES 2017 Innovation Awards Honoree in the ‘Tech For a Better World’ category.

Other

Other use cases around the home include gaming, cleaning and maintenance.

Source: Yumii

Yumii’s companion robot, Cutii
6.3 Sizing the robotics market

Source: International Federation of Robotics

### Global estimated operational stock of industrial robots (thousands)

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Source: International Federation of Robotics

### Industrial robots per 10,000 manufacturing employees, 2015

Global average: +42% over 2016
Sales of service robots for professional use (thousands)

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Source: International Federation of Robotics
6.4 Venture-capital funding

Funding of startups in the robotics space has risen sharply since 2014, more than doubling to almost $1.2 billion in 2016. As a lot of robotics is both designed and operated by established companies, the funding is still a relatively small portion of the $130 billion+ of venture funding in 2016. Many of the best-funded startups are in the medical space. This is indicative of both the size of the potential opportunity – as healthcare is one of the largest sectors in many developed countries – and the inefficiencies that robotics can help address.

Source: CB Insights

Robotics venture funding

[Graph showing venture capital funding from 2012 to 2016]

Source: CB Insights

Market map of 80+ robotic startups

[Market map showing various robotic startups in different sectors]

Source: CB Insights
6.5 Spotlight on selected robotics companies

**Double Robotics** offers a telepresence robot that allows users to remotely navigate around the office and engage with colleagues instead of being stationary at a desk or requiring the use of Skype or other web conferencing software. Its main interface is an iPad positioned at its head.

**Starship Technologies** is a European technology start-up building a fleet of self-driving delivery robots that can deliver goods locally within 30 minutes. Designed using off-the-shelf components, the robots are lightweight and low-cost, enabling the company to bring the current cost of delivery down by 10–15 times per shipment. The company established a partnership with Just Eat and trialled the world’s first takeaway delivery by a self-driving robot in December 2016. In the US, its first partners are the food delivery startup DoorDash, and courier marketplace Postmates, which are beginning pilot tests with Starship’s delivery robots.

**Medrobotics** has developed a platform of flexible medical robots that enable surgeons to access, visualise and perform two-handed surgery in hard-to-reach anatomical places. The technology has already been used to undertake the world’s first robotic-assisted cancer procedures. The company has to date raised more than $130 million in funding, mostly from anonymous private investors.

**Franka Emika** will start shipping its low-cost robotic arm in 2017. The arm is designed to be easy to set up and program – a clear advantage compared to other complex and expensive systems. Safety features and a force-sensing control scheme prevent injury to humans. This makes it effective as a collaborative robot that can work alongside humans in a close and supportive manner. The longer term plan is for the arm to be able to produce copies of itself; it is currently capable of doing around 80% of the necessary work.
6.6 Regulatory and ethical challenges around robotics

The rapid pace of development in robotics and related technologies such as AI means that sentient and self-replicating machines are now close to being reality. As the number of service robots, and their use cases, continues to grow, ethical and regulatory challenges will emerge for society and governments.

The European Union is already investigating the need to set rules for the use of robots and to settle issues around ethics, safety and security. The EU’s legal affairs committee has been reviewing the topic. Its recent publication made a number of recommendations:

• EU-wide rules to exploit the economic potential of robotics and artificial intelligence and also guarantee safety and security.
• A new European agency for robotics and a code of ethical conduct.
• The code should recommend that robot designers include "kill" switches, so that robots can be turned off in emergencies.

• Longer term, the potential to create a specific legal status of "electronic persons" for the most advanced autonomous robots should be explored, which would help to clarify responsibility in cases of injury or damage.

The EU report highlighted that the science fiction writer Isaac Asimov sought to stamp out the prevailing negative Western image of robots through the creation of three fundamental laws of robotics. These could be used today to help draw up a general ethical framework to address the problems associated with robotics and AI.

Asimov’s three laws of robotics

1. A robot may not injure a human being or, through inaction, allow a human being to come to harm.

2. A robot must obey the orders given to it by human beings, except where such orders would conflict with the First Law.

3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

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