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2018 – Middle East Edition

Technology, Media and Telecommunications Predictions

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Foreword

We live in a time of relentless change yet stubborn continuity.

The technology, media and telecommunications sectors remain as fascinating as ever in 2018. Many milestones will be reached this year. Progress will be exponential in some fields. But in other areas the way in which we live and work may shift imperceptibly.

Technology's progress can seem daunting at times: reports of technological advances' negative impacts abound, disseminated at the speed of light by ever faster networks. Machines are perceived by some as threats to the human race: they are stronger, faster, more responsive and even better at playing board games. Are our jobs and very way of life at stake or is this the start of one of the greatest enhancements to the human experience?

Machine learning (ML), a core element of artificial intelligence, will progress at a phenomenal pace this year. But this will be from a low base. As impressive as it is today, in 50 years' time the ML abilities of 2018 will be considered baby steps in the history of this technology.

Over the coming year, ML will become more commonly deployed in enterprises, but will remain far from ubiquitous. Almost every high-end smartphone will have a machine learning chip, but those chips will not yet be fully utilized. Nearly a million ML chips will be installed in data centers, but this quantity will seem small within a decade.

ML is being deployed to make existing technology work better and augment services for customers, but in 2018 almost none of it is replacing human labor.

Indeed, technology remains a human creation with (for better and worse) human traits – the point at which it attains autonomy from human control is far away. Sentient machines still only exist within science fiction, at present.

Technology is leaping forward, but humans hold the reins. It is being applied for the betterment of people, not their belittling.

Technology empowers people to consume content where, when and with (or without) whom they want. Despite this technology-given capability, people will choose to spend over half a trillion dollars in 2018 on consuming content live, often with other people and not on-demand.

People are using digital to augment their live experience – be this in buying and distributing tickets via their smartphones, or streaming events on ever faster mobile networks.

And the pace and reach of those networks is likely to get steadily faster. The majority of voice calls have already moved to mobile networks. Now it is the turn of home broadband, thanks to the ever falling cost per gigabyte of data carried.

Communicating at 35,000 feet has historically been a niche service, constrained by bandwidth and cost, often funded by expense accounts. But a rise in the supply of connectivity is likely to democratize in-flight connectivity, spurring a surge of selfies from 35,000 feet.

Most successful technologies – from the radio to the eReader, from the steam engine to the fitness band – undergo a period of rapid progression before reaching an inexorable plateau.

In 2017, the smartphone had its tenth birthday. On this occasion many smartphones looked as they did on their prior anniversary. This has raised the question as to whether the smartphone's zenith had already been reached.

Superficially the smartphone is unlikely to change markedly in 2018, or indeed through 2023. But on the inside, it is likely going to continue to undergo a massive sequence of upgrades that will steadily widen the device's capability, in 2018 and for years to come. Companies that understand best how to harness these invisible innovations are likely to profit most from forthcoming innovations – for example, via ever more compelling augmented reality on smartphones.

The smartphone is likely to be used by more people, with increasing frequency, and for a wider scope of activities, spanning the practical, informative and entertaining. This trend may well raise the question of whether smartphone usage is excessive: the reality is that the smartphone, like any technology, is a tool whose appropriate usage will be determined by society and individuals.

It has always been our pleasure to work with the world's technology, media and telecommunications companies. We hope you find this year's edition of Predictions to be a stimulating and informative read.

We look forward to the discussion.

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Augmented reality: on the cusp of reality

Deloitte Global predicts that over a billion smartphone users will create augmented reality (AR) content at least once in 2018, with three hundred million being monthly creators and tens of millions making and sharing content weekly.

We further predict that tens of thousands of apps incorporating AR capability will become available during the year, and that by year-end billions of smartphone users will have downloaded an app or an app update, or an operating system (OS) update, that incorporates AR content creation capability.[1] We expect billions of people are likely to view – on smartphones and other screens – AR content created on a phone.

While AR is likely to drive device usage, app downloads and smartphone sales, we expect discrete app revenues for AR content to be less than $100 million globally in 2018. This should not, however, be interpreted as meaning that AR will add just $100 million in value. We expect AR capability will be a key differentiator for some genres of apps (social networks, messaging, shopping, games) and operating systems, and will be an important driver of smartphone upgrades.

While 2018 is likely to be a significant year for AR, subsequent years will be equally important. The core enabling technologies, particularly cameras, sensors and processors, for AR should continue to improve, and the range of applications will grow rapidly.[2] This is likely to increase the number of users making and sharing AR content regularly, and to grow direct AR revenues beyond $1 billion by 2020.

At its core, AR is a special effect that enables digital images to be superimposed on real ones. The technology has been deployed in various forms for decades, but it is only recently that AR content creation capability has gone mainstream, albeit in a simplistic form.[3] Over the past three years, AR has become an increasingly popular smartphone application, often for entertainment applications such as face swapping and adding facial hair and live face filters. Thus far, smartphone AR creations typically have been photographs or primitive animations that are proudly artificial and cartoonish.

Starting in 2018, AR content created on a smartphone will look increasingly photorealistic – viewers of AR content may perceive it to be real when they view it on a smartphone – and will often be recorded and shared as video. The more realistic the digital image, the greater the "wow" factor of the resulting composite.[4] We predict that while almost all AR (more than 95 percent) in 2017 was cartoon style, AR will be over 50 percent realistic in 2018.

The majority of AR usage in 2018 is likely to involve the now-mainstream practice of creating content using smartphone cameras. In the medium term, the technology is likely to be used increasingly by enterprises and government for a variety of applications, with instruction manuals, technical support and public service announcements being possible applications.[5]

Photorealistic AR is being enabled by a combination of software and hardware advances, one of the most significant of which is the launch of dedicated AR frameworks in smartphone operating systems. Apple Inc.'s framework, ARKit, was launched with iOS 11 and works with the iPhone 6s mobile device (launched in 2015) and later models. Google's framework is called ARCore and works with premium Android devices.[6] These frameworks are visual inertial odometry systems (VIOs) with some simple two-plane detection.[7]

The VIO enables the device user's physical position to be tracked in real time by combining inputs from the camera at 30 times a second with the inertial measurement unit (IMU, which combines the accelerometer and gyroscope),[8] which takes readings at 1,000 times a second. Plane detection enables flat surfaces such as a floor or table to be identified, enabling an object to be placed where the viewer would expect it.

By the end of 2018, we expect about 800 million smartphones to have both an OS with dedicated AR support and sufficiently powerful hardware – central processing units (CPUs), graphics processing units (GPUs), digital signal processors (DSPs) and neural chips – to power them. Creating AR content requires significant computing power. The more powerful and energy-efficient the processors and the GPUs inside the smartphone, the smoother the resulting videos and the lower the battery drain. Over time, as the hardware gets more power-efficient, AR content creation will not be limited to only the latest, most powerful devices, although the latter are likely to continue to offer the best user experience and results.

The most significant impact of the availability of AR frameworks is on content creation. Dedicated AR support within a standard OS lowers the cost of developing AR apps. It removes the need, for example, for third-party tools to create the AR effect. It means that a developer's resources can be focused on creating compelling content, and that more junior staff can work on the technical implementations. Furthermore, smaller developer teams, and even individuals, can develop apps with AR functionality. Lower barriers to entry should increase the supply of apps that feature AR throughout 2018.

The introduction of these frameworks has moved in tandem with major advances in some of the smartphone's hardware components.

Recent advances in IMU technology enable the device to sense, with a greater degree of precision, how much it has moved relative to where a camera is being pointed. This way, it is possible to extract stereoscopic 3-D information using just one camera on the phone, lowering the bill of materials for the device.

If the user is moving his or her hand together with the smartphone, the camera takes 30 or more photos per second and calculates how far apart they are based on an accurate estimate from an IMU that contains an accelerometer and the gyroscope. Accurate measurement has required making certain hardware changes, particularly clock synchronization of all the sensors involved. The camera and IMU can work together to estimate precisely the 3-D space only when the precise time each measurement was taken is known.

Semiconductor manufacturers are incorporating these technologies into their latest chips; older smartphones lack the hardware required to support accurate AR frameworks.[9]

But the hardware improvements are only part of the story; algorithms are also critical to creating and displaying compelling AR content. Better algorithms assist in multiple ways.

One of the most important developments is greater precision when identifying edges of surfaces. Identifying surfaces – of a table, floor, pavement or other flat surface where an object might rest – helps position the digital image automatically and means that the object does not appear (unconvincingly) to be hovering in midair. Historically, positioning AR content was effected by placing printed trackers resembling large bar codes on the floor; this required the user to have access to a printer, reducing the addressable market. Now AR delivers the same sort of experience without requiring any physical printed image-based trackers, vastly increasing the base of people willing to try out AR.

Superior algorithms also enable shadows in scenes lit by the sun or artificial light, again making the illusion look more real. Animated AR characters can "react" to the changes in environment (such as a light being switched off), further creating the illusion that the digital objects are real.

In recent years, with custom AR technologies, feature tracking has been applied within face-tracking and face-filter apps, allowing users to augment faces, both comically and also practically (for example, showing how a face would look with a particular hue of lipstick applied). In 2018, software enhancements also will offer improved feature detection, going beyond the face and enabling detection of and interaction with a wider range of objects, from bicycles to buildings. These enhancements should enable AR to be used in a wider range of applications, such as self-service technical support. For example, when assembling flat-pack furniture, AR could be used to stick a virtual arrow next to the part of a shelf where a bolt needs to be inserted.

Smartphones that include depth sensors – of which over 100 million may be in the market by the end of 2018 – will enable devices to work with depth information, providing more accurate augmentation and scanning of 3-D objects using the front-facing camera. Infrared (IR) sensors are also needed for augmented reality to work in low-light environments. This sort of depth information will further enhance augmented reality capabilities once IR sensors are incorporated on both sides of smartphones.

As stated earlier, AR is not new to 2018; what differs is quality, especially with regard to photorealism. Prior to 2018, AR was more rudimentary, as that was all the technology permitted. There have also been practical applications, such as positioning items of furniture in a room to see how they might look in a prospective customer's home, but the bulk of regular usage of AR has been for selfies with face filters.

As of 2018, AR should enable users to appear to be singing along with their favorite singer, interacting with a tiger, juggling balls with a star footballer, or indeed being in the same space as any other person, animal or object they may want to incorporate. This is behavior akin to having one's photo taken with a waxwork model or cardboard cutout of a celebrity, but the AR artifact should look far more convincing – and will also likely move.

In most cases, AR will be used to create short videos designed for sharing. The more convincing the simulation, the more fervent is likely to be the reaction from those receiving the content and thus the more rewarding the activity.

The use of AR in photography will probably be the most commonplace application of AR video, simply because the camera app is one of the most-used smartphone features. There will be other applications, both useful and frivolous, that feature AR, but they are unlikely to be used as frequently.

One major genre is likely to be games, which is the largest category of apps available. Games developers are likely to use AR as a differentiator that could encourage new downloads. AR is also likely to be integrated into existing popular game apps and distributed when the app is updated on a user's device.

Over the course of 2018, we expect a growing number of games to incorporate an AR element, but we expect few AR-only games. One reason for this is that the most advanced AR platforms work only where lighting is good and the device can readily recognize a surface on which to place content. AR objects can be hard to place in rooms with variable lighting or where there are no obvious surfaces; carpet, too, is difficult. AR games cannot be played in the dark and may not work well for users in planes, trains or automobiles, again due to the lack of a surface onto which they can project. This is problematic, as a large part of mobile games' appeal is the ability to play anytime and anywhere.

Furthermore, as AR requires the camera to be operational, battery usage is high. Pokémon Go was the first mainstream smartphone game to feature AR, but it also offered the option to turn the camera off to save battery life. Many regular players rapidly turned off AR when capturing Pokémon, to conserve battery and extend playing time.

A further constraint on the use of AR in games is user fatigue, particularly if AR requires the user to hold the device at an uncomfortable angle. Smartphones are often held nearly horizontal; while one is using a camera, the device often is nearly vertical, and maintaining this position may tire out users. This variation in angle may seem trivial, but mainstream users tend to opt for comfort and abandon games that cause physical fatigue.

Social networks are likely to compete on the strength of their AR functionality, and users' feeds are likely to receive increasing numbers of short videos that incorporate AR animations. Some celebrities may start selling packs of 3-D animated content that can be integrated into their fans' AR videos, similar to the emergence of celebrity-specific emojis and mobile games. Social networks are likely to offer increasingly sophisticated AR effects and bespoke images[10] from their apps.[11]

During 2018, we also expect an abundance of home decoration apps to launch (and relaunch, taking advantage of better technology), enabling prospective customers to visualize how a piece of furniture would look in their homes. This type of application has been developing for many years.

However, in most instances, such AR apps are likely to complement rather than replace a visit to the showroom. These apps enable someone to see – with varying degrees of accuracy– how a sofa with a certain fabric might look in their living room, and even to walk around it. In 2018, these apps should have more accurate scaling, and a visual of the couch in different lighting conditions may be possible. But such an app is unable to indicate how firm or springy the couch is or the quality of its construction, and for that reason, an app is likely to remain just one of many inputs in the final purchase decision.

Also in the home, AR has been suggested as a replacement for the tape measure. The latest AR technology enables the most accurate measurement ever – but it still retains a margin of error of a few percentage points, which would not be tolerable in many cases. Inaccurate measurement of a doorframe by even a few millimeters could mean the couch that the AR app had helped a user visualize would not fit through a doorway.

This prediction has focused predominantly on AR usage via smartphone, as this is how we expect most of AR's value to be generated in 2018. Every premium smartphone sold in 2018 should be capable of video AR at no additional cost to the consumer, whereas dedicated AR headsets may cost hundreds or even thousands of dollars, and it might be two to three years before they're available in the consumer market at accessible pricing.

Further, based on limited uptake of dedicated virtual reality headsets, it is less clear that mainstream consumers will want to wear dedicated AR headsets.

AR on a smartphone will not be as impressive as AR with a head-mounted display, but it will certainly be more accessible.

The bottom line

2018 is likely to be a year of progress and experimentation for AR. The quantity of premium AR devices will swell. There will be tens of thousands of AR apps. The photo app on smartphones may soon start offering an array of people or objects that can be inserted into a shot. App stores specific to AR content may be launched, similar to the instant messaging (IM) stores now available. But it won't be plain sailing. Inevitably, mistakes will be made.

There may be disdain in some quarters for the apparent triviality of AR apps, but this fails to take into account the history of content created for consumers over the past few decades.

And 2018 is far from the endpoint for AR; many further years of evolution are likely to enchant users and enhance their creations. Over the medium term, AR will merge into camera-based apps; we will struggle to recall a time when AR was a mere novelty. And at some point in the future, it may become increasingly hard to tell reality from AR-enabled fiction.

This year, one of the tasks for developers will be to determine when AR adds to an experience and when it is superfluous. For example, with navigation apps, AR could be used to superimpose an arrow on a live image of a street, guiding the user more precisely than would be possible with a 2-D map. Using AR throughout the journey, however, might be superfluous, and this functionality should arguably be deployed only in the final few meters of the journey or even to help identify a friend within a crowd.

Enterprises should experiment enthusiastically but pragmatically with possible applications. Aside from marketing opportunities (such as the ability to place an AR-generated animated company logo anywhere or to superimpose a branded mask on a user's face), there are also possibilities for AR to assist with sales, technical guidance and aftermarket support. Enterprises should be careful, however, not to start off with AR as an answer and then look for solutions it could address.

As mentioned earlier, we would expect tens of thousands of apps that include an AR element to be available by the end of 2018. As with most content, a minority of content drives the majority of usage. Based on the history of most apps, we would expect the majority to be abandoned within a month and a minority to remain in frequent use.

Middle East perspective

We predict that Augmented Reality (AR) adoption from 2018 in the Middle East will be driven by two major factors: m-commerce and user experience in cultural and mega events.

Slowly moving away from a mall-only shopping culture, more e-commerce companies will offer applications equipped with AR capabilities, which will enable consumers to mimic the "see & buy" behavior in brick and mortar shops and visualize the product before purchasing. Another key friction point that could be addressed by AR within the Middle East e-commerce journey is the delivery of the products. With the lack of structured addressing systems in most countries (or a majority of suburban areas), failed or delayed delivery is a major barrier to efficient logistics operations. AR enhanced solutions can tackle this problem by improving accuracy and duration of last mile delivery.

Amongst the early adopters of innovative technologies, we expect governments in the Middle East to experiment with AR solutions in the short term. With many public sector leaders in the Middle East developing ambitious visions for 2030 to harness the power of digital for the economy and society, we will see practical uses of AR as part of smart city initiatives or innovative solutions to improve the citizens' quality of life. We predict that initial examples will be seen in mega events such as Expo 2020 and cultural spaces such as the Louvre Abu Dhabi, playing a major role in enhancing the guest experience. Museums and cultural spaces in the region, with a new wave being planned in the Kingdom of Saudi Arabia (KSA), will embrace the technology to enrich the experience by visualizing the history behind artifacts in display. Guest experiences in mega events, on the other hand, can be enhanced via gamification, which will enable displaying products in action or helping guests to network better.

Next on the agenda and considering the priority sectors across the region we believe Middle East markets will further experiment with use cases of AR across education, transportation and social well-being. Examples will include AR assisted public transportation maps, AR courses in partnership with foreign universities, and instant language translation for the diverse expat community.[i] Yet, 2018 will be remembered as the year when AR took off in the Middle East, with a variety of experimental elements that enhance user experiences, complement efficiency efforts across growing industries, and improve public service solutions.

The future of the smartphone: the era of invisible innovation

Deloitte Global predicts that by the end of 2023, penetration of smartphones among adults in developed countries will surpass 90 percent,[12] a five-percentage-point increase over 2018. Smartphone sales will be 1.85 billion per year in 2023, a 19 percent increase over 2018 and equivalent to over five million units per day.

The main driver of higher adoption rates in each market will be take-up among older age groups. We would expect ownership among 55-to-75-year-olds to reach 85 percent in developed countries in 2023, a 10-percentage-point increase over 2018.[13]

We further predict that owners will interact with their phones on average 65 times per day in 2023, a 20 percent increase over 2018.[14] This will reflect the wider range of applications used by the mainstream smartphone owner, such as enterprise applications and in-store payment options, and more intensive use of existing applications such as photography.

We expect the percentage of smartphone owners who use their devices daily to increase from 93 percent in 2018 to 96 percent by 2023.[15] This implies that 86 percent of all adults will use a smartphone on any given day in 2023, versus 79 percent in 2018.

This usage frequency is likely to be significantly higher than for any other digital device, and it is likely to drive upgrades and, ultimately, total sales and the rising value of those sales. The frequency of smartphone usage is likely also to spur an ever-greater degree of smartphone-centric content creation and process redesign.

We expect about 180 million units to be sold in retail for $1,000 or more. This category alone will generate over $200 billion in revenue and, in unit and dollar terms, will be significantly larger than the entire tablet market.[16] In Q3 2017, one-eighth of smartphones in Western Europe sold for $900 or more, double the proportion a year prior.[17]

We forecast an average selling price (ASP) for smartphones of $350 in 2023, implying a total market value of $650 billion. Global smartphone revenue increased by 10 percent between 2016 and 2017, from $434 billion to $478 billion.[18] Smartphone ASPs rose from $302 in 2015 to $324 in 2017 (ASPs had declined between 2012 and 2015).[19] We expect ASPs to continue to rise as users' valuation of their handsets increases (see Figure 1).

Figure 1. Evolution of smartphone ASP, 2012-17
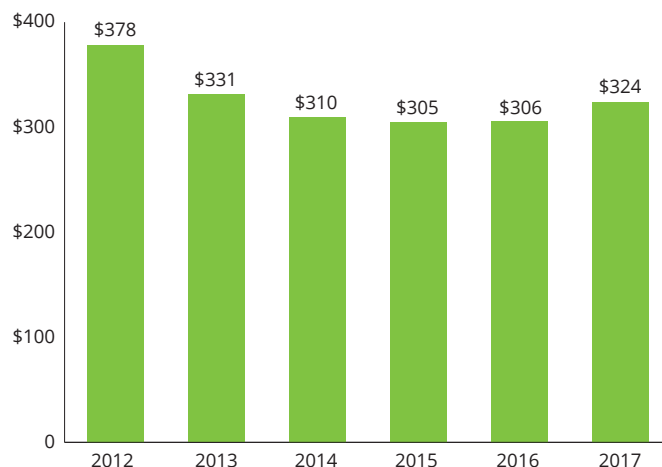
Source: GfK (for further information on the sources, see endnotes)

In short, we predict that over the next five years, the smartphone market should continue to grow in penetration, usage, unit shipments, total value and ASP.

Additionally, the smartphone will consolidate its position as the primary access to digital service and content. This is despite the fact that a 2023 smartphone is likely to look, on the outside, very similar to a 2018 model.[20] The majority of the models shipped in 2023 are likely to feature a single 5- or 6-inch high-definition rectangular touch screen, have two cameras, weigh 130 to 200 grams, and have a lithium-ion battery with a capacity roughly similar to that of today's smartphones.

The secret to the smartphone's success over the next five years is likely to be the introduction of an array of innovations that are largely invisible to its users but whose combined impact should feel tangible in the form of greater ease of use (such as facial recognition based on depth maps) or improved functionality (for example, for maps and photos).

Deloitte Global predicts that by the end of 2023, penetration of smartphones among adults in developed countries will surpass 90 percent, a five-percentage-point increase over 2018.

The smartphone's invisible upgrades
The 2023 smartphone should offer superior performance across a range of business and consumer applications, thanks to enhanced connectivity, processors, sensors, software, artificial intelligence and memory.

By 2023, 5G networks should have launched in most developed markets, offering much greater capacity and connectivity speeds. Over a billion 5G users are forecast for China alone by 2023.[21] Furthermore, advanced 4G networks, which can also support peak download speeds of over 1 Gbit/s, should have rolled out in most of the remaining markets.

Dedicated artificial intelligence (AI) chips are likely to have become standard across smartphones by 2023 and will be most commonly used to assist machine-learning (ML) applications, and in so doing take load off the main CPU for these tasks. 2017 was the first year in which premium smartphones (about 300 million, or 20 percent, of shipments for that year)[22] started incorporating AI chips.

According to Deloitte's research, about two-thirds of adult smartphone owners in developed countries are using at least one application that features ML, and 79 percent are aware of applications with ML (see Figure 2). Through 2023, dedicated AI chips are likely to become standard in smartphones at all price points, as happened with fingerprint readers; these were initially included in only flagship models but are now available in $100 phones. Over time, and as the base of smartphones with dedicated AI chips increases, the range and utilization rate of ML applications should steadily increase.

Premium handsets are always likely to have the latest AI chips in the same way that they include the most powerful CPUs and GPUs.

Field-programmable gate array (FPGA) chips are also likely to have become standard (an FPGA chip can be programmed multiple times to undertake specific tasks after manufacture). An FPGA takes the load off the main processor for certain tasks, such as optimizing reception on a cellular network, particularly in congested areas.[23]

The CPUs and GPUs in smartphones are likely to be upgraded on a regular basis over the next five years, in tandem with developments with other more specialized chips.

There is likely to be an increased range of sensors included on smartphones in 2023, and existing sensors are likely to be upgraded. One additional sensor that may become mainstream over coming years is a forward-facing infrared camera, which is likely to be rolled out on a range of devices in 2018 and may end up usurping the fingerprint reader as the primary biometric authenticator.[24] Smartphones that retain a fingerprint sensor are likely to feature upgraded components, and by 2023 these may be ultrasonic, enabling them to work through glass and metal and even when fingers are wet or greasy.[25] The GPS receiver in smartphones may also be upgraded to enable it to deliver more precise location information – to within 30 centimeters, versus 5 meters in 2017.[26]

AI delivered via better software is likely to become increasingly used across all smartphone applications by 2023, and it will be an ever more prominent differentiator. The main benefit of AI will be to make applications work more slickly, delivering, for example, better recommendations on routes, more realistic augmented reality or more compelling photos. AI, while not tangible per se, is likely to be a heavily marketed core feature.

As of mid-2017, usage and awareness of applications featuring ML were still quite modest, but we expect both indicators to improve through 2023 as AI capabilities steadily improve (see sidebar: AI and smartphones).
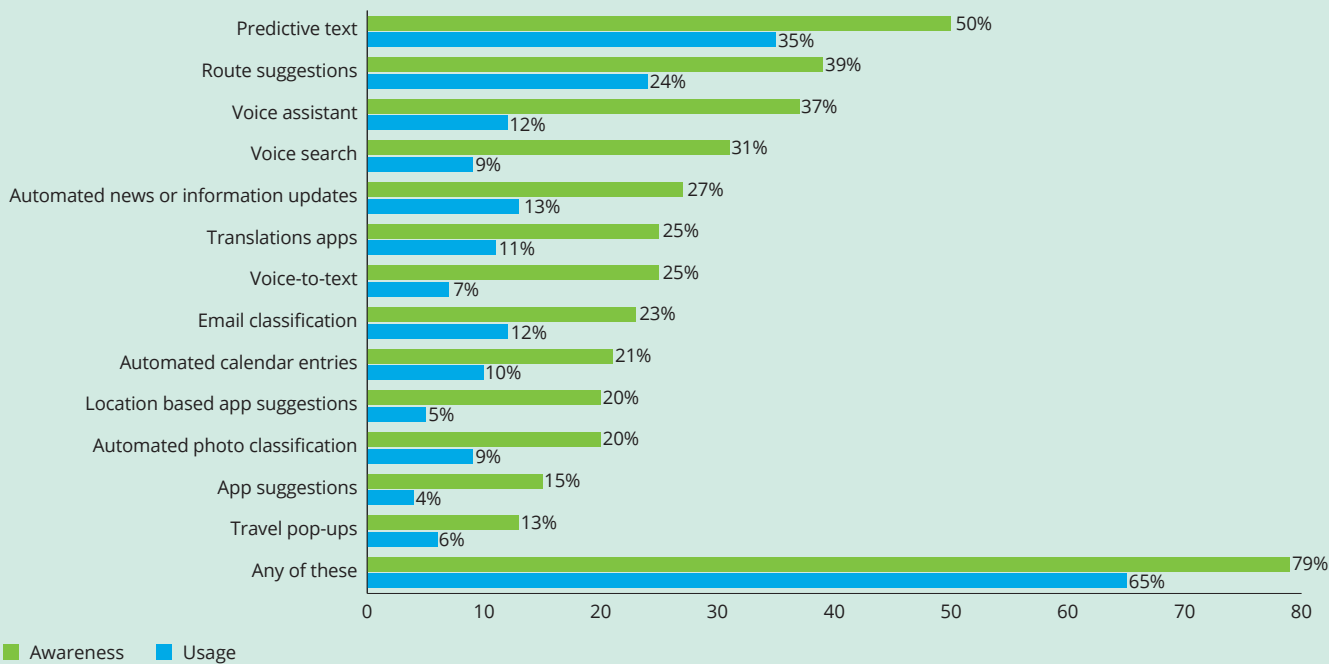
By 2023, 5G networks should have launched in most developed markets, offering much greater capacity and connectivity speeds.

AI and smartphones

According to Deloitte's research, in which we asked respondents about their awareness and usage of a range of AI-enhanced applications, the most commonly used application was predictive text, followed by route suggestions (see Figure 2). Voice recognition applications saw a large cleft between awareness and usage. We expect that as the quality of applications improves, thanks to better algorithms, data sets and AI hardware, users will increasingly depend on AI-infused tools.

For example, in 2017, a quarter of smartphone owners used route suggestions. We expect the proportion to exceed 60 percent by 2023, thanks to more personalized and faster suggestions (due in part to the onboard AI chip, which can learn, for example, the device owner's walking pace according to the time of day) and more accurate recommendations (courtesy of better data sets and better location-tracking capability).

Figure 2. Awareness and usage of applications featuring ML (developed markets)

Application	Awareness	Usage
Predictive text	50%	35%
Route suggestions	39%	24%
Voice assistant	37%	12%
Voice search	31%	9%
Automated news or information updates	27%	13%
Translations apps	25%	11%
Voice-to-text	25%	7%
Email classification	23%	12%
Automated calendar entries	21%	10%
Location based app suggestions	20%	5%
Automated photo classification	20%	9%
App suggestions	15%	4%
Travel pop-ups	13%	6%
Any of these	79%	65%

■ Awareness ■ Usage

Weighted base: Smartphone owners in 16 developed markets (24,563 respondents). The figure is the average of 16 countries in our study, namely Australia, Belgium, Canada, Denmark, Finland, Germany, Ireland, Italy, Japan, Luxembourg, the Netherlands, Norway, Spain, Sweden, the UK and the USA.
Source: Deloitte's Global Mobile Consumer Survey, developed countries, May-July 2017

The average smartphone sold in 2023 will have 128 GB or more storage, compared with about 32 GB in 2018. Most of this space will be occupied by photos and videos, but greater memory capacity will provide more space for apps, some of which will be many gigabytes in size. RAM memory is likely to range from 2 GB to 16 GB.[27] Both upgrades should make smartphones more useful and valuable.

One upgrade unlikely to come through is a new and better battery formulation. By 2023, lithium ion is likely to remain the basis of almost all batteries used in smartphones. As of late 2017, there were no battery technologies on the horizon that appeared to be sufficiently stable and mature to be tested and factored into supply chains that could displace lithium ion.

However, all is not lost. Processors are likely to become more efficient. Splitting off processing tasks to other chips aside from the CPU helps reduce battery usage. Using multiple processors of varying power, some optimized for power and others for efficiency, also improves power usage.[28] Second, wireless battery charging should help users top up devices when they're out and about. The major smartphone vendors have agreed on a wireless charging standard known as Qi that is likely to be rolled out in multiple environments, from coffeehouses to office waiting rooms and from bedside tables to cars. Qi is used in smartphone brands that are likely to represent collectively over a billion smartphones shipped in 2018.[29]

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The smartphone's lengthening list of applications

These invisible innovations should enable the smartphone to continue "absorbing" the functionality of an ever-broader array of physical objects, and to displace further the PC as the preferred device for a growing range of digital applications.

The smartphone's expanding scope among smartphone users in the UK can be seen in Figure 3. Between 2016 and 2017, the smartphone became the preferred device for video calls across all users, the preferred device for search among 18-to-34-year-olds and the preference among 45-to-54-year-olds for reading news. It was not all one-way traffic; the games console became the preferred device for playing video games among males, possibly reflecting the rising market penetration by latest-generation consoles.

Figure 3. Device preference for various activities, UK (2016 versus 2017)

Question: Which, if any, is your preferred device for each of the following activities?

	Total	Male	Female	18-24	25-34	35-44	45-54	55-64	65+
Browse shopping websites	Laptop	Laptop	Laptop	Laptop	Laptop	Laptop	Laptop	Laptop	Desktop
Make online purchases	Laptop	Laptop	Laptop	Laptop	Laptop	Laptop	Laptop	Laptop	Desktop
Online search	Laptop	Laptop	Laptop	Phone (was laptop)	Phone (was laptop)	Laptop	Laptop	Laptop	Desktop (was laptop)
Watch short videos	Laptop	Laptop	Phone (was laptop)	Phone	Phone	Phone (was laptop)	Laptop	Laptop	Desktop
Check bank balances	Phone	Phone	Phone	Phone	Phone	Phone	Laptop	Laptop	Desktop
Video calls	Phone (was laptop)	Phone (was laptop)	Phone	Phone (was laptop)	Phone	Phone	Phone (was laptop)	Laptop	Laptop
Check social networks	Phone	Phone	Phone	Phone	Phone	Phone	Phone	Laptop	Tablet (was laptop
Read the news	Phone	Phone	Phone	Phone	Phone	Phone	Phone (was laptop)	Laptop (was tablet)	Tablet (was laptop)
Play games	Phone	Game console (was phone)	Phone	Phone	Phone	Phone	Phone	Tablet	Tablet
Voice calls using the Internet (VoIP)	Phone	Phone	Phone	Phone	Phone	Phone	Phone	Phone	Phone
Take photos	Phone	Phone	Phone	Phone	Phone	Phone	Phone	Phone	Phone
Record videos	Phone	Phone	Phone	Phone	Phone	Phone	Phone	Phone	Phone
Stream films and/ or TV series	TV	TV	TV	TV	TV	TV	TV	TV	TV
Watch TV programs via catch-up services	TV	TV	TV	TV	TV	TV	TV	TV	TV
Watch live TV	TV	TV	TV	TV	TV	TV	TV	TV	TV

Weighted base: UK smartphone owners aged 18-75 years, 2016 (3,251), 2017 (3,393)
Source: Deloitte Global Mobile Consumer Survey, UK edition, May-Jun 2016, May-Jun 2017
Note: The laptop category excludes hybrid laptops

By the end of 2023, the smartphone is likely to have assimilated various additional non-PC functions, serving as keys; office entry cards; and credit, debit and other stored-value cards (including for transport). This will lead to smartphones being increasingly used to authenticate access to physical and digital environments, including homes, offices and hotel rooms,[30] cars,[31] buses,[32] trains and planes; corporate information systems; and e-commerce and banking sites.

Deloitte Global predicts that by 2023, over three-quarters of all smartphone owners in developed countries will use some form of biometric authentication, and 80 percent of smartphones will have at least one dedicated biometric sensor, such as a fingerprint reader or a 3-D facial scanner.[33] This compares with about 29 percent of owners who will use fingerprint authentication in 2018, and a base of about 42 percent of devices with a dedicated fingerprint sensor.

The smartphone's deepening applications

In addition to being used for new functions, smartphones are likely to be used by more people and more often for functions they have already absorbed: as MP3 and CD players, GPS navigation systems and maps, fitness bands and pedometers, compact and single-lens reflex (SLR) cameras,[34] handheld game players and puzzle books, boarding passes, and entertainment tickets.

The caliber of photos and videos captured on a smartphone should steadily improve through 2023 (see sidebar: The evolution of the smartphone camera), increasing device usage and utility in both consumer and business contexts. In the medium term, a major – and for some, a principal – factor in choice of phone, whether premium or budget, new or used, is likely to be the quality of its photo app and hardware.[35] As of mid-2017, 18 percent of smartphone owners in developed countries took photos at least daily, and an additional 44 percent took photos at least weekly (see Figure 4).[36] This proportion should rise over time as the photo capability of a smartphone steadily increases and the possibility of taking a low-quality snap (one not worth sharing) falls.

Figure 4. Frequency of taking photos and recording videos (developed markets average)
Question: Please state how often you do each of these (take photographs/record video). Do you do this...?
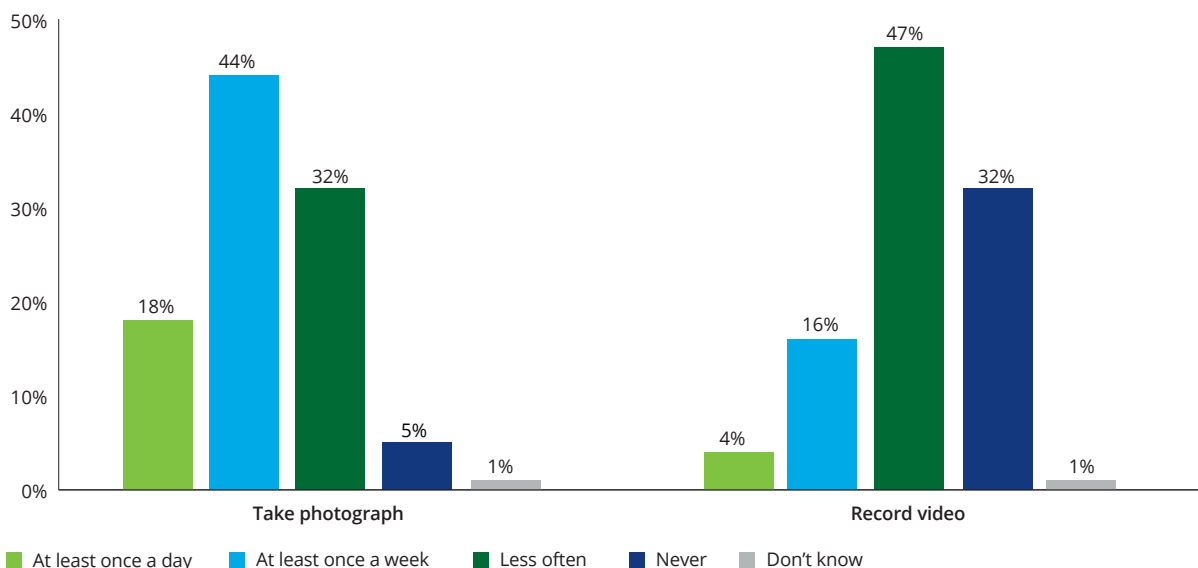
Weighted base: Smartphone owners in 16 developed markets (22,929 respondents). The figure is the average of 16 countries in our study, namely Australia, Belgium, Canada, Denmark, Finland, Germany, Ireland, Italy, Japan, Luxembourg, Netherlands, Norway, Spain, Sweden, UK and USA
Source: Deloitte Global Mobile Consumer Survey, developed markets, May-July 2017

As the range of travel options (such as walking and public transport, in addition to driving) on a smartphone's maps app expands, this function is likely to be used, and relied upon, even more. Over the next five years, we expect smartphone map apps to integrate more large indoor locations (such as shopping malls, office blocks and transport hubs) and become more accurate (thanks to additional location data points from Wi-Fi hotspots, beacons and cell towers). Machine learning, too, is likely to play a major role in generating better routes for each individual.

The smartphone transforms the workplace

A further major driver of increased smartphone usage and value is its wider and deeper usage in a business context.

Over the past 10 years, smartphones have redefined how people live and interact with each other; over the next five, it is likely to be enterprises' turn to use mobile even more than they already do to transform the way work gets done in settings from retail store operations, health care, restaurants, sales and field maintenance to dozens of other services and processes.

We estimate that in the European Union alone, 45 percent of the workforce (about 100 million people) could use a mobile device as a primary (or only) work device (see Figure 5).

Figure 5. Number of tasks that can be done primarily on a mobile among people in work in the European Union, by type of role

Type of role	Employees (thousands)	Total amount of tasks that can be done primarily on mobile (average)	Amount of work that can be replaced by mobile					
			Timesheet management	Job allocation	Office software suite processing	Communication (with peers, employer, clients)	Access to information (job-related or company data)	Stock and third party suppliers management
Lower status employees	42,479	●	●	●	N/A	●	●	N/A
Skilled industrial employees	35,999	◕	●	●	N/A	●	●	◕
Clerks and skilled service employees	32,009	◕	●	●	◕	◕	◔	◕
Small entrepreneurs	24,442	◕	●	●	◕	◕	◕	◔
Technicians and associate professional employees	32,227	◔	●	◕	◔	◕	◔	◑
Professionals	42,912	◔	●	◕	◔	◑	◔	◕
Managers	13,502	◔	●	◑	◔	◕	◑	◕

Source: Deloitte analysis 2017, based on European union employment data as of 2016

Note: To arrive at the average for the total amount of tasks that can be done on mobiles, we have taken into account the importance of certain tasks to the role and the amount of people in work within the category

As of mid-2017, about half of workers in developed countries used their smartphone to email and make calls, yet only 7 percent submitted a timesheet, only 5 percent posted expenses using their phone,[37] and only 10 percent accessed their company's intranet via their phone.

This lack of smartphone usage for work purposes is not due to a lack of scope.

Workers whose job requires them to walk a lot or does not require them to be tethered to a desk – from retail sales staff to traffic officers – would be encumbered by carrying a laptop or a tablet and would probably not need a full keyboard or a PC's processing power.[38] In most markets, at least half of the employees are rarely or never at a desk.

Hundreds of millions of workers around the world do not need to process or analyze information, but they do need to receive contextual information on a timely basis so they can respond to it rapidly based on better information. The smartphone is the ideal device for this.

The enterprise app or mobile-optimized website would appear to offer a huge opportunity that may have been overshadowed by the allure of developing consumer smartphone apps or websites. Yet there are significant dividends in making the world's workforces more productive by making relevant business processes available via a smartphone.

In some regards, 2018 is reminiscent of the early days of the internet era, when enterprises started adopting browser solutions to transform how employees work and changed how they engaged with core enterprise applications – thereby improving substantially the speed and quality of their access to data.

As the underlying nature of work for many professions is unlikely to change fundamentally over the next five years – roofers will fix roofs, chefs will cook – technology's role may be more about improving existing processes than about redesigning them. For roofers, one benefit of a well-designed mobile app would be being able to submit invoices faster and with more information (such as photos showing work done) rather than waiting until they are back in a PC-equipped office. In a small restaurant, one of the most common needs for a chef may be to order ingredients; again, this could be done via a well-designed website or app, and does not require a PC.

However, there are even deeper opportunities for mobile, as has been shown in some professions such as delivery services. Hundreds of businesses and processes are operating under old models, with some employees unnecessarily tethered to workstations or point-of-sale devices, or disconnected from real-time information. In most cases mobile should, through better efficiency, make companies more competitive, but in a few cases mobile will enable entire business models to be reinvented and industries to be disrupted fundamentally.

Workers whose job requires them to walk a lot or does not require them to be tethered to a desk – from retail sales staff to traffic officers – would be encumbered by carrying a laptop or a tablet and would probably not need a full keyboard or a PC's processing power.

The evolution of the smartphone camera

One of the primary differentiators for all smartphones is the camera or, more precisely, the image displayed on a phone's screen once an array of post-processing actions – often using proprietary hardware and software – have taken place.

Improvements in photo quality over the next five years are likely, thanks to better, highly integrated software and hardware, with the role of software becoming increasingly significant. This should enable smartphones to get closer to the quality and characteristics of images captured by much larger, heavier and bulkier traditional cameras.[39]

One type of photographic effect that had been unique to traditional SLRs was "bokeh," where the subject is in focus and the background is blurred, highlighting the subject more prominently.[40] On a standard smartphone, the entire image ordinarily would be in focus.

The bokeh function in smartphones was first introduced in 2016, but it has since advanced markedly, and as of late 2017, most vendors' flagship models supported this effect.[41] The first phones with a bokeh capability blend images from two lenses taking a photo at the same time. Software is then used to create a composite image, with the major challenge being to distinguish and separate precisely the subject from the background. Over time, the quality of the bokeh effect should steadily improve; ML enables more refined algorithms that become more accurate at splitting foreground from background. And more powerful and dedicated processors should enable these composite images to be generated ever faster.

By 2023, convincing bokeh effects should be attainable with a single lens. The first model with this capability was launched in 2017.[42] The device distinguishes between the foreground and the background and creates the composite image from multiple images taken at the same time.[43] This advance is significant, as in a smartphone size is paramount, and the removal of a lens leaves room for other components or a larger battery.

Another innovation that is likely to become ubiquitous in smartphones over the next few years is optical image stabilization, which integrates hardware (the lens), sensors (the gyroscope) and processors to mitigate the impact of the device shaking when a photo is being taken. If the gyroscope detects the phone is moving (perhaps due to the press of a finger on a shutter), it adjusts the direction of the lens slightly to counteract the device's movement.[44] The result is no or reduced blur in a photo.[45]

The smartphone's camera is likely to be increasingly used in work contexts, again with software at the fore. A common administrative task in a work context is capturing information, which may be in the form of business cards, receipts or brochures. Any camera can copy these images; software can remove excess content (such as the underlying table surface when photographing a business card)[46] or shadows.

One type of camera that may be integrated into some handsets used in a work environment is a back-facing IR camera, which detects heat (IR energy). A camera with integrated IR would be compact and portable, and could readily be carried by tradespeople, including in confined spaces or up ladders. Thermal imaging can be used in a wide range of contexts, such as tracing the source of leaks in a home, analyzing faulty motor engines or checking home appliances.[47]

There are likely to be many more techniques incorporated into smartphones that increase the proportion of quality photos, with the benchmark for quality likely to be photographs that elicit a positive response when shared. There are likely to be many more techniques deployed to increase the likelihood that the image that appears on a phone's screen after the shutter has been pressed is the one you wanted to take, even if it was not the one that you actually took.

The bottom line

The role of the smartphone in society, for tech vendors, screen manufacturers, enterprises and government, is likely to become ever more central. There are multiple implications for all; the smartphone is a once-in-a-generation innovation whose full potential is far from realized yet.

The scale of the market, overshadowing any other device currently available or likely to be available, is likely to have multiple ramifications for all device manufacturers. For one thing, vendors will need to remain relentlessly focused on identifying and acquiring the next big idea or differentiator for smartphones. Adopting a technology too early – be it a new battery technology or screen formulation – could prove very costly. Integrating niche functionality, whether in the form of projectors or IR keyboards, should be avoided. Making a commercial success of modular phones is likely to be challenging. Failing to allocate sufficient resources to improving a specific feature, such as the photo capability, could also be significantly detrimental. Given that the camera is so critical, vendors should consider doubling the size of their teams and deploying thousands to the task.

The smartphone's trajectory looks strong through 2023. But should vendors also be developing a new growth engine for when the smartphone's momentum eventually peters out? Or might a focus on a new device distract resources from the smartphone?

Many vendors have bet on the emergence of new form factors, from smart glasses to virtual reality, but the smartphone has so far remained dominant. It has steadily absorbed more digital and physical functionality. Attempts to launch adjuncts to the smartphone have had only modest success.

Members of older generations are rapidly adopting smartphones and may start to rely on them as more processes, from access to public transport to paying for parking, shift to smartphones. Industry and government should create training programs to enable this age group to take full advantage of smartphones. School curricula should place as much focus on familiarity with creating content and coding for smartphones as is currently done for PCs.

IT departments at companies should evaluate how best to integrate smartphones into their IT strategies and their way of thinking. They should consider which device is best for each type of employee and how best to utilize smartphone biometric authentication to improve security.

Middle East perspective

In 2017, Middle Eastern mobile users elected social networks interaction, TV streaming, and sharing of short videos and photos as their most preferred activities after subscribing to 4G services. Looking further ahead, in 2018 we expect that adopted usage behaviors will trigger adoption of innovative smartphone features. We predict that 4G subscribers will transition from their current state of AI technology awareness to effective usage of embedded predictive texting and route functionality in social media applications. This will happen in parallel with subscriber adoption of hardware upgrades such as additional memory capacity for storage of photos and videos, and optical image stabilization cameras for improved photo quality.

Despite lagging in digital adoption ranks, governments in the Middle East will continue to leverage widespread smartphone adoption and evolve to mobile enabled digital models. Inspired by flagship initiatives such as "Dubai Now", an app that integrates more than 50 services from 22 institutions, we predict that the proliferation of one-stop-shop e-service centers and mobile apps across the public and private sectors will enhance customer experience.

Emerging industries such as tourism will also capitalize on smartphone innovations to enhance a visitor's overall experience. In 2018, we predict that millions of visitors in the region, from holiday makers in Dubai to pilgrims in Mecca, will start leveraging upgraded GPS receivers and facial recognition software embedded in their smartphones to access contextual real-time information in enhanced interactive visitor maps. Border control is another key improvement domain. In the UAE, we expect that Dubai's new "Smart Wallets" and "One Gate" initiatives will allow a myriad of travelers to use smartphone-automated biometric facial recognition technology to move through immigration and access lounges seamlessly, progressively replacing immigration control touch-points with automated systems.

Progressively moving away from traditional pin authentication methods, 71 percent of UAE mobile subscribers with biometric functionality already use fingerprint readers to unlock their devices. With a lack of seamless integration between core operational systems and biometrics databases across key industries, and an increase in skimming technology devised by sophisticated hackers, smartphone-based biometric recognition will gain significant traction in 2018. By 2023, we predict that mobile devices will emerge as the preferred authenticator platform for validation of M2M transactions.

In 2018, consumers in the Middle East will continue to embrace new use cases, blending physical environments and upgrading smartphone technology, as well as unlocking digital value beyond personal digital experiences. Progressive digitization of enterprise processes and the provision of hyper-personalized e-services in tourism, transportation, healthcare, and education in GCC nations are expected to drive effective usage of AI driven functionalities in mobile for the next five years.

Smartphones are useful, but they can be distracting

Deloitte Global predicts that 45 percent of global adult smartphone users in 2018 will worry they are using their phones too much for certain activities, and 45 percent of all adult smartphone users will try to limit their phone usage in various ways – from employing high-tech apps that measure or limit usage to sticking their device in a drawer.[48] Further, Deloitte Global predicts this concern will be highest for young people who have smartphones, with nearly two-thirds of 18-24 year olds around the world feeling they are using their devices too much, and with over half trying to control usage. (Throughout the rest of this prediction, all references will be to those who own or have access to smartphones rather than to the total population.)

Finally, Deloitte Global predicts that most adults of all ages are actually quite happy with using their phones a lot – even hundreds of times per day. Instead, they are focusing on controlling usage when it is distracting them from activities they would prefer to concentrate on. The dangers of distracted driving are well known. But many will also be concerned in 2018 about distracted sleeping, distracted walking and distracted talking.

As can be seen in Figure 6, although concern about smartphone use and attempts to limit it both average about 40 percent globally for smartphone owners, there is significant variation by country. Fewer than one in five Japanese smartphone owners surveyed thought they used their smartphone excessively,[49] while nearly three in four Mexicans with smartphones were concerned and nearly two-thirds were actively trying to limit usage. In most countries, the percentages of those worried about overuse and of those trying to cut back were very similar.

There are few obvious regional trends. In the Nordic countries, for example, the proportion of Finns worried about phone usage was about half that of Norwegians.[50] One pattern that did apply was that English-speaking countries were roughly in line with one another for both metrics. Deloitte Global expects that the percentages in 2018 will be slightly higher than in 2017, but by no more than one or two percentage points.

Figure 6. Concern about phone use and attempts to limit use; adults with smartphones in 2017
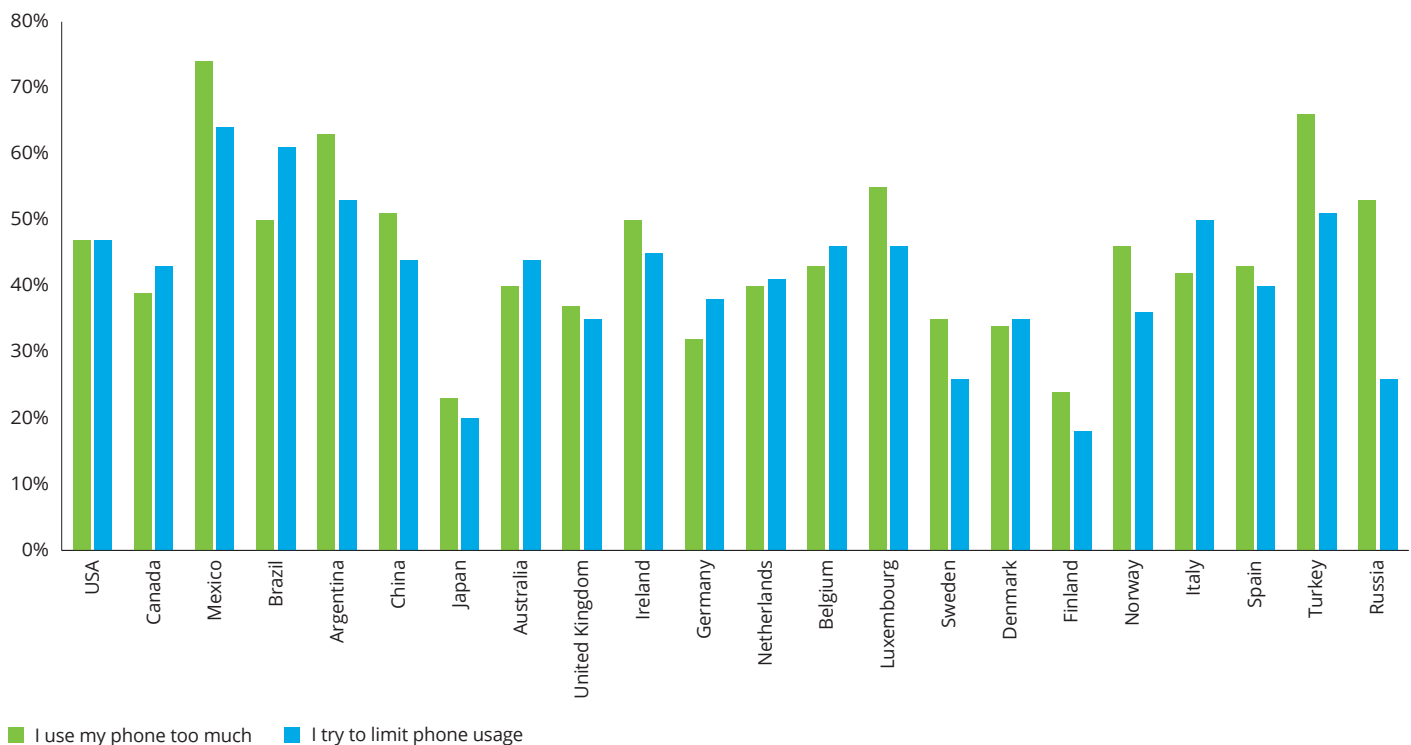
■ I use my phone too much ■ I try to limit phone usage

Weighted base: All adult smartphone owners Argentina (1,811), Australia (1,762), Belgium (1,593), Brazil (1,743), Canada (1,589), China (1,778), Denmark (860), Finland (857), Germany (1,708), Ireland (933), Italy (1,782), Japan (1,194), Luxembourg (913), Mexico (1,789), Netherlands (1,796), Norway (925), Russia (1,976), Spain (1,832), Sweden (1,792), Turkey (927), UK (3393), USA (1,634)
Source: Global edition, Deloitte's Global Mobile Consumer Survey, May-June 2017

Although the term is used frequently in the media, the number of people who are truly "addicted" to their phones is probably very low, less than 3 percent.[51] Addiction and dependence are defined medical terms,[52] and very few adults suffer from genuine addiction to their smartphone.[53] Recent articles have called tablets, phones and gaming consoles "digital heroin" because they all raise dopamine levels,[54] but while it may be true, this happens on a completely different scale for electronic devices and food compared with addictive drugs,[55] as Figure 7 shows.

Figure 7. Relative increases in dopamine: food, video games and drugs
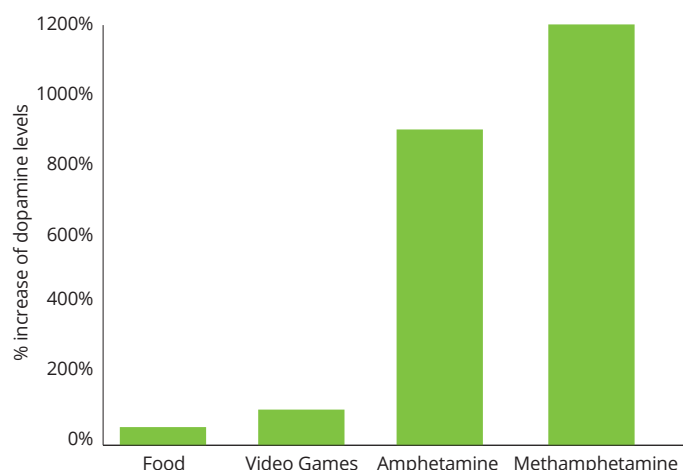
Source: Smartphones aren't addictive – but their increasing usage points to bigger problems, Medium, 21 April 2017

Just as we need to be careful in describing phones as addictive, we also need to be cautious in saying they are being used "too much." Smartphones in 2018 are the Swiss army knife of devices, replacing tens of devices of a decade ago. They now act as wristwatches, radios, TVs, computers, cameras, video recorders, maps, newspapers, gaming devices, magazines and much more. Placed in that context, glancing at a phone 50 or more times per day is not, in and of itself, a sign of excessive use; rather, it shows what an exceedingly useful device the smartphone is. Categorizing these activities as useful or not useful is difficult; any instance of checking the time, taking a picture, and engaging with social media or email could be either useful or not useful.

In 2017, people with smartphones estimated they looked at their phone an average of 50 times per day, according to our Deloitte Global study. As can be seen in Figure 8, about 25 percent of adults worldwide estimated this number at 50 or more times per day, with 40 percent of 18-24 year olds saying they used their devices that often. Meanwhile, 45 percent of adults and 58 percent of 18-24 year olds said they thought they were using their phones too much, and out of those, 42 percent of adults and 47 percent of 18-24 year olds were actively trying to limit their usage. An additional 10 percent of adults and 20 percent of 18-24 year olds were thinking about trying to control their usage but were not yet doing so. Deloitte Global predicts that all these percentages will be slightly higher in 2018.

Figure 8. Phone use and possible over-use in 2017, by age
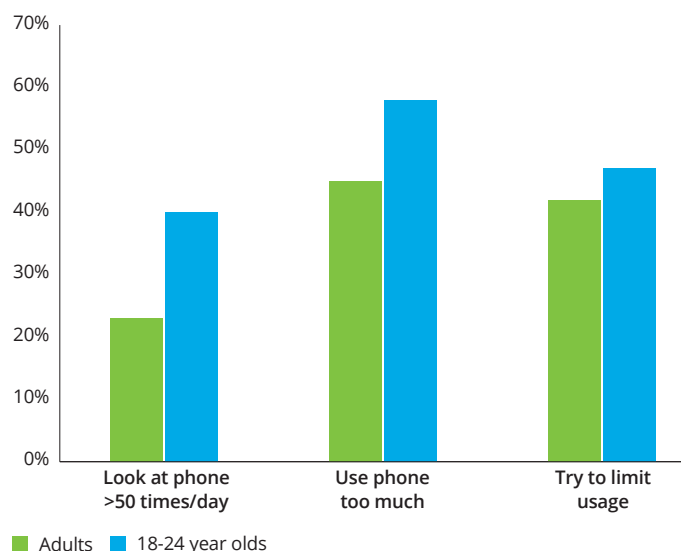
Weighted base: All adult smartphone owners (34,588), 18-24 (5,351)
Source: Global edition, Deloitte's Global Mobile Consumer Survey, May-June 2017

There are some large differences in usage and perception of overuse, not just by age but also by gender. Based on data from 2017, 49 percent of adult women with smartphones think they use their phones too much, while only 41 percent of men think the same. We expect that gender gap to persist in 2018.

Not all usage is equal. Checking one's phone while watching TV or a film, commuting on public transit, or out shopping is probably not harmful or negative in any way, and it seems likely that when people talk about cutting back on phone usage, they are not talking about these instances. Figure 9 shows Deloitte Global data for adults and for 18-24 year olds on phone use for activities when the phone is not distracting users from something they think they should be doing instead.

Figure 9. Phone use that is not distracting; percentage of smartphone owners in 2017 who almost always/very often/sometimes use their phone during different activities
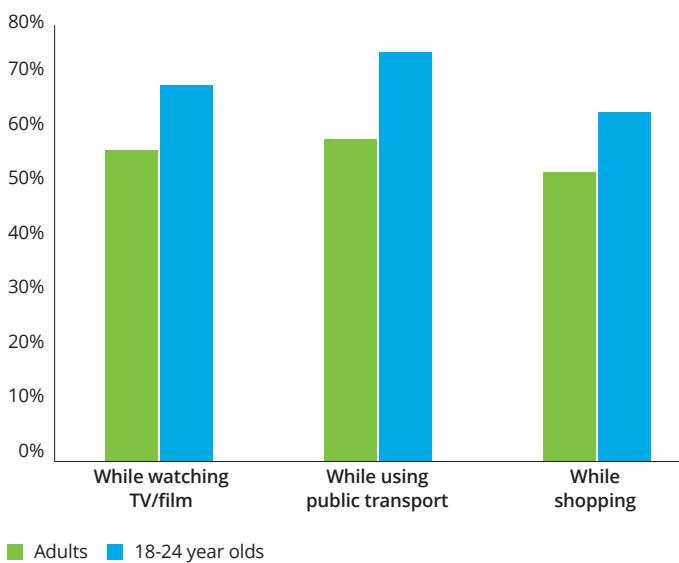
■ Adults ■ 18-24 year olds

Weighted base: All adult smartphone owners (34,588), 18-24 (5,351)
Source: Global edition, Deloitte's Global Mobile Consumer Survey, May-June 2017

But other smartphone behaviors are distracting users, harming their relationships with others, and even potentially endangering their health or that of other people's. See Figure 10 for the Deloitte Global data on these activities in 2017.[56] Once again, there are likely to be differences between age groups, with younger smartphone owners more likely to be using their phones when perhaps they should not. But other demographic splits emerge as well. Men with smartphones were more likely to engage sometimes in distracted driving, with a figure of 15 percent for men, compared with 11 percent of women. Nearly 60 percent of women with smartphones interrupt sleep and check their phones at night. And while over 60 percent of people in the UK, Germany, Netherlands, Italy, Canada and Luxembourg never check their phones at night, more than 80 percent of respondents in China and Turkey do.

Similarly, there are considerable country-specific variations in smartphone use while driving (or at least in the percentages of people who admit to phone use while driving). In the UK and Argentina, only 6-7 percent of smartphone owners said they regularly used their phone while driving, but in the US, China, Finland and Turkey, the figure was three times higher, at over 20 percent.

Figure 10. Phone use that is distracting; percentage of smartphone owners who almost always/very often/sometimes use their phone during different activities
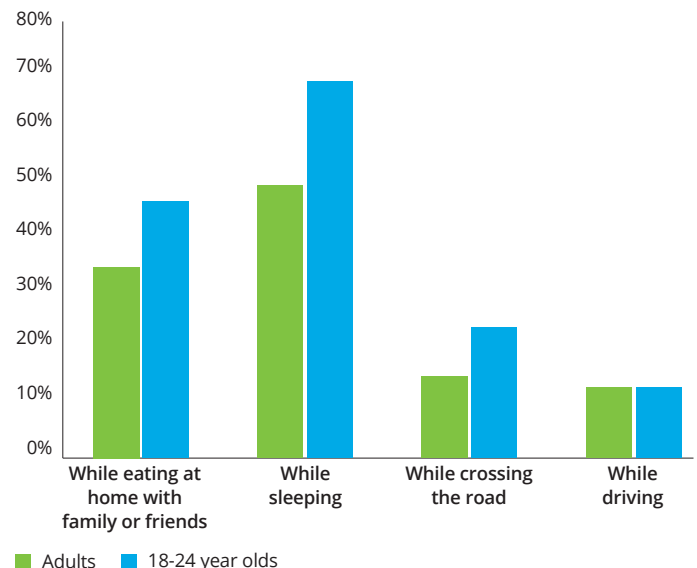
■ Adults ■ 18-24 year olds

Weighted base: All adult smartphone owners (34,588), 18-24 (5,351)
Source: Global edition, Deloitte's Global Mobile Consumer Survey, May-June 2017

There are likely to be differences between age groups, with younger smartphone owners more likely to be using their phones when perhaps they should not.

The bottom line

Both for the telecom industry and for individual users, the goal should not be to strive for some arbitrary number of glances at their phone each day. In fact, as consumers watch ever more video on smartphones instead of TVs, as they perform work tasks on smartphones instead of computers and as e-commerce continues moving to the smartphone, Deloitte Global believes that the number of daily glances will continue to rise and that this may or may not be a bad thing.

Instead, the goal for 2018 should be to help consumers gain control of the specific cases where looking at their phone is something they should do less. Phone manufacturers, software and app developers, and network operators all should work together to assist consumers in enjoying less distracted sleeping, driving, walking, and time with family and friends. Some of these initiatives will improve quality of life; others will save lives. In the US, for example, the Department of Motor Vehicles website provides a list of apps to help prevent distracted driving.[57]

But as Figure 11 shows, those who are trying to limit usage in general (rather than during a specific activity such as driving) tend not to use advanced software technology – or technology of any kind – to limit usage. Only 4 percent of respondents said they were using apps to measure or constrain usage, while the most popular techniques involve turning the phone or notifications off. The single most common technique is putting the phone in a bag or pocket.

Figure 11. Steps taken by smartphone owners who are trying to limit their usage
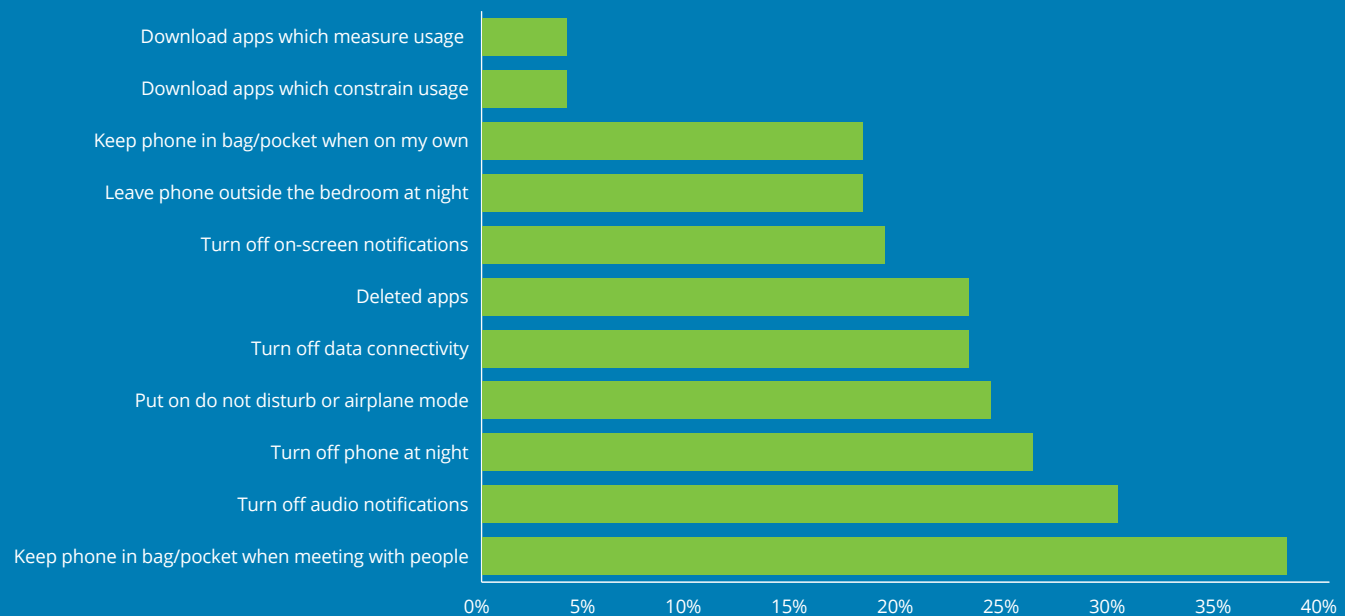
Weighted base: All smartphone owners who try to limit their phone usage (14,410)
Source: Global edition, Deloitte's Global Mobile Consumer Survey, May-June 2017

These lower-tech techniques seem to be working, at least for some. As can be seen in Figure 12, of those who were actively trying to limit usage, most thought they were succeeding. Across all countries, by five percentage points, more people on average thought they were controlling usage successfully: 23 percent compared with 18 percent. In seven countries, the number of those succeeding in cutting back was more than 10 percentage points greater than those failing, with people in Brazil (19 percent) and Belgium (20 percent) enjoying the largest success differential. In some countries, however, users felt they were failing to cut back usage. In China, notably, those who felt they were failing to limit their usage exceeded those succeeding by 10 percentage points.

Figure 12. Limiting mobile usage: success versus failure for smartphone owners
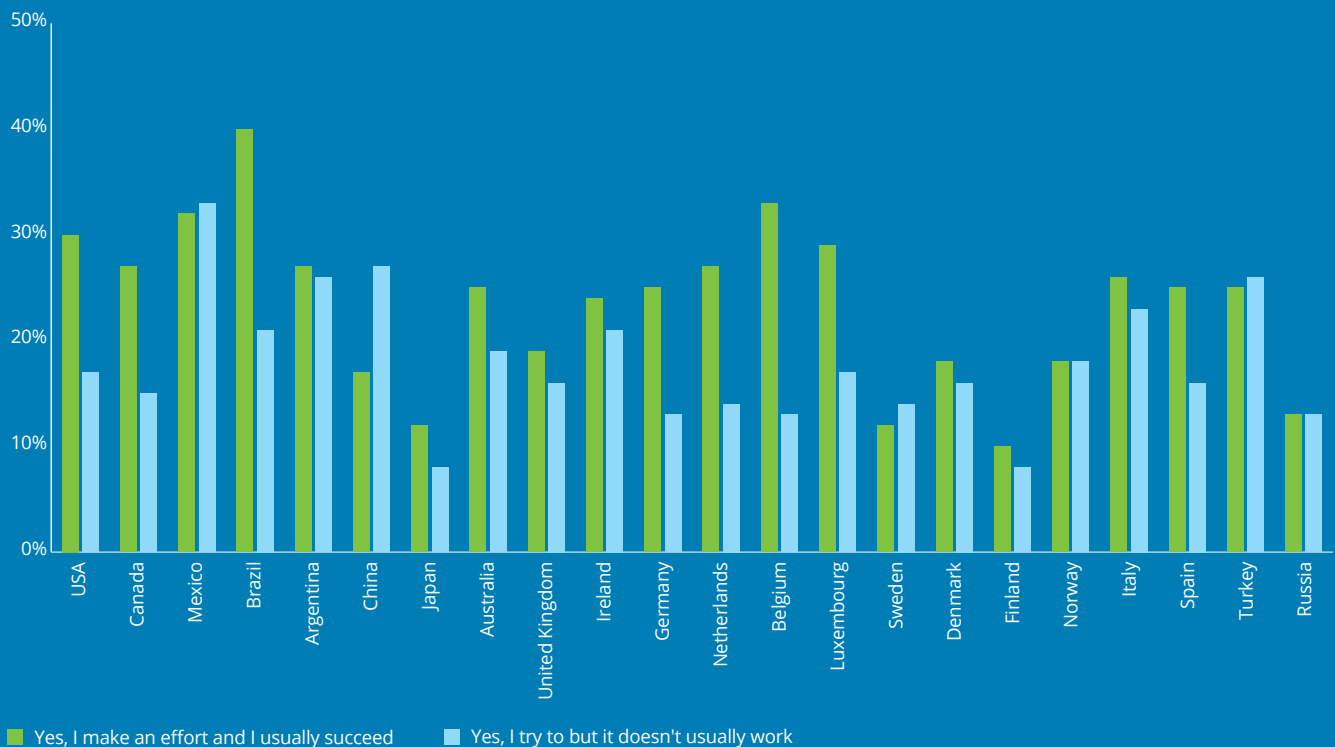
■ Yes, I make an effort and I usually succeed   ■ Yes, I try to but it doesn't usually work

Weighted base: All adult smartphone owners Argentina (1,811), Australia (1,762), Belgium (1,593), Brazil (1,743), Canada (1,589), China (1,778), Denmark (860), Finland (857), Germany (1,708), Ireland (933), Italy (1,782), Japan (1,194), Luxembourg (913), Mexico (1,789), Netherlands (1,796), Norway (925), Russia (1,976), Spain (1,832), Sweden (1,792), Turkey (927), UK (3393), USA (1,634)
Source: Global edition, Deloitte's Global Mobile Consumer Survey, May-June 2017

Although many people worry that smartphones are being used too much, the loudest voice in the debate in recent years has been the one saying that young people use phones too much – and with dramatically negative consequences, ranging from social isolation to depression and even death (a small number of people die taking selfies every year, for example).[58] In September 2017, *The Atlantic* magazine published a lengthy article that summarized the zeitgeist on this issue: "Have Smartphones Destroyed a Generation?"[59]

However, the warnings may be exaggerated. The author, Douglas Adams, wrote this description of how people of various ages react to new technologies.

01. *Anything that is in the world when you're born is normal and ordinary and is just a natural part of the way the world works.*

02. *Anything that's invented between when you're fifteen and thirty-five is new and exciting and revolutionary and you can probably get a career in it.*

03. *Anything invented after you're thirty-five is against the natural order of things.*[60]

In recent years, we have seen warnings that social media was ruining kids, and 10 years before that it was search engines that were to blame. Prior to that, the internet, video games/computer games[61] and computers themselves were all labeled as harmful. The US Senate Judiciary Committee investigated the effects of comic books on young people[62] in 1954 and of rock-and-roll music in 1956.[63] Before that, there were alarms sounded over (in reverse chronological order) TV, radio, gramophones, schools, novels and printed books in general (in the 1500s). Even Socrates in ancient Greece is said to have warned that children should not rely on writing things down, since it would harm their ability to memorize.[64]

As we say in another prediction, it may be that the kids are alright.

In recent years, we have seen warnings that social media was ruining kids, and 10 years before that it was search engines that were to blame.

Middle East perspective

In the Middle East, we predict that high smartphone usage will persist, if not increase in 2018 leading to elevated concerns amongst government authorities who will in turn enforce corrective measures to curb the harmful effects of smartphone distraction.

Middle Eastern countries have some of the highest smartphone adoption and usage rates in the world. 72 percent of GCC mobile connections are smartphone connections versus 65 percent globally. In Saudi Arabia, 68 percent of survey respondents use their phone within the first five minutes after waking up,[ii] almost double the 35 to 45 percent of users that do so globally.[iii] Studies have also found about 30 percent of Saudi university students are using their smartphones as much as 8 hours per day,[iv] and about 70 percent of UAE students are using theirs for around 5 hours or more per day.[v] Compared to global average usage of just over 4 hours a day, regional usage stands out as much higher.[vi]

Such statistics are typically celebrated as an advancement in technology adoption, but have also given rise to behavioral shifts, igniting fresh concerns in the region on the appropriate level of smartphone use. With the lack of data in this area, many regional authorities from traffic police to health professionals and educators are calling for more detailed studies in order to diagnose the level of smartphone distraction.[vii]

When comparing smartphone usage levels during certain activities against the global average, Middle East users actually tend to be less distracted. As can be seen in Figure 13, smartphone usage levels during surveyed activities are lower, typically by at least 10 to 20 percent, except (worryingly) for usage while driving. For example, 29 percent of Arab adults and 16 to 24 year olds tend to use their smartphone when eating at home with family and friends, 13 percent less than 18 to 24 year olds globally.

Figure 13. Phone use that is distracting: percentage of smartphone owners in 2017 who tend to use their phone during different activities – by age
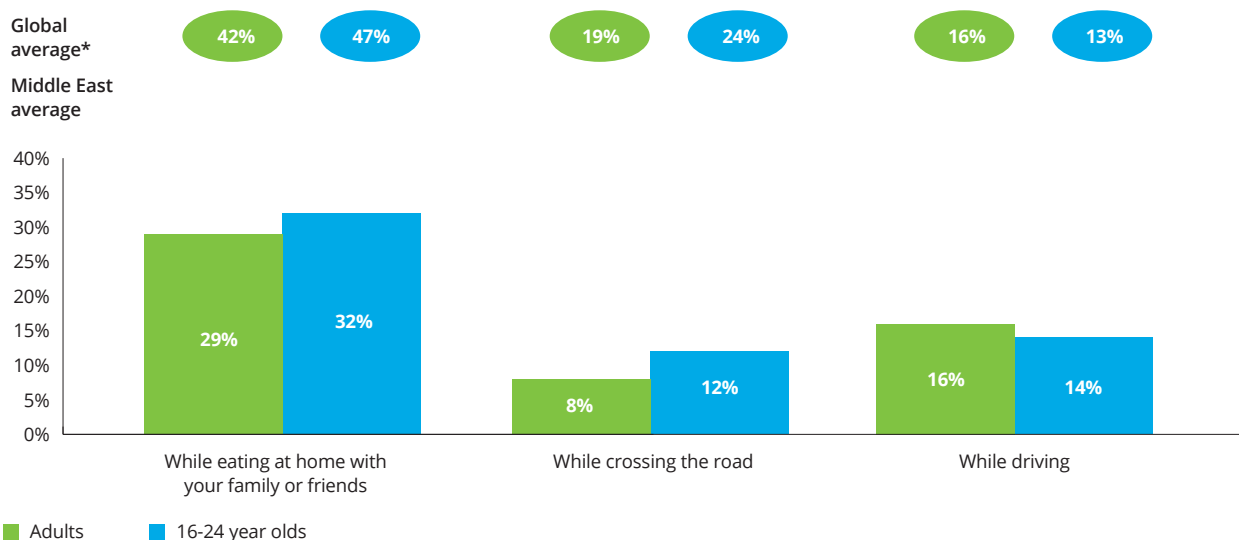
Global average*

| 42% | 47% | | 19% | 24% | | 16% | 13% |

Middle East average

| 40% |
| 35% |
| 30% |
| 25% |
| 20% |
| 15% |
| 10% |
| 5% |
| 0% |

While eating at home with your family or friends	While crossing the road	While driving
29% / 32%	8% / 12%	16% / 14%

■ Adults ■ 16-24 year olds

Weighted base: All adult smartphone owners UAE (1,000), KSA (1,000)
Source: Deloitte's Global Mobile Consumer Survey, May-June 2017
Note: Global average data is a close indicative proxy, representing smartphone owners who use their phone always, very often or sometimes during different activities

While regional usage is similar for youth and adults, there is a marked difference between genders for certain activities as shown in Figure 14. When at home, females in the region use their smartphones significantly more than males while eating a meal with family or friends. However, seemingly better manners will not alleviate a much bigger concern: 1 in 5 men in the region admit to using their phones while driving. This is seven basis points more than female respondents in the region and 4 basis points above global benchmarks.

Figure 14. Phone use that is distracting: percentage of smartphone owners in 2017 who tend to use their phone during different activities – by gender
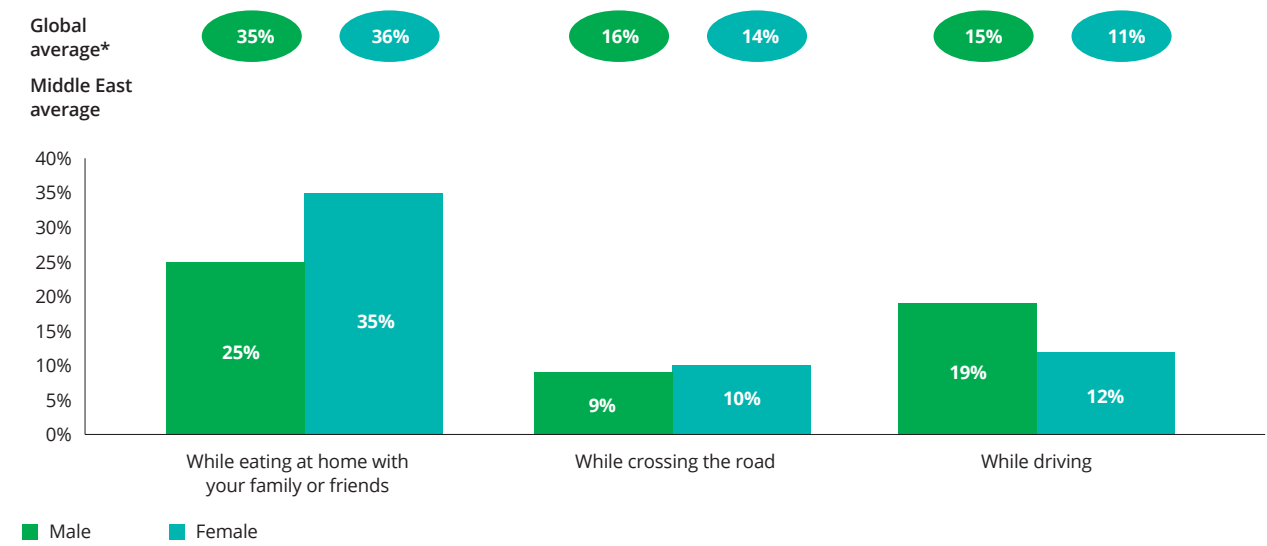
Global average*: 35% 36% 16% 14% 15% 11%

Middle East average

| Male | Female |

Weighted base: All adult smartphone owners UAE (1,000), KSA (1,000)
Source: Deloitte's Global Mobile Consumer Survey, May-June 2017
Note: Global average data is a close indicative proxy, representing smartphone owners who use their phone always, very often or sometimes during different activities

Local society is recognizing these concerns, reporting the negative effects of smartphone distraction. In the UAE, traffic and police studies found smartphone usage while driving increases accident risks by 23 times.[viii] At home, 77 percent of UAE parents admitted their children complain they spend too much time on smartphones,[ix] and many Arab couples voiced similar complaints.[x] In Saudi Arabia, 43 percent of university students reported decreased sleeping hours due to high smartphone usage, 30 percent reported unhealthier lifestyles and 25 percent reported it led to poorer grades.[xi] Regional employers also raised concerns of excessive smartphone usage affecting workforce productivity.[xii]

In response, the region is experiencing a rise in the number of self-control measures taken by local users, as well as more regulatory measures taken by social affairs organizations, influencers, and government authorities to tackle the issue.

Local authorities have been taking the lead so far, employing a mix of traditional and new technology-enabled methods. For instance, one professor in the American University of Sharjah, among many, banned the use of smartphones in lectures,[xiii] as is also the case across UAE's schools.[xiv] Marriage and family counsellors have stepped in to impose smartphone limitations on affected families[xv] and proposals for employers to create a smartphone policy limiting personal smartphone use during office working hours are also being considered.[xvi] UAE traffic laws have been recently modified to double penalties for mobile usage while driving,[xvii] and Dubai Police are now seeking signal-jamming technology solutions to block phone usage on cars in motion.[xviii] Even measures such as fining pedestrians using smartphones on road-crossings are being debated.[xix] Social media campaigns such as UAE and Lebanon's recent #ParkYourPhone campaign are raising awareness and educating users.[xx]
Influential figures, including international artists and comedians soon to be touring the region have also started a trend of "phone free" concerts.[xxi]

Users are exploring ways to self-regulate smartphone usage as well, in some cases working with authorities to do so. Forums and blogs show users considering technology detox (i.e. phone-less, computer-less) weekends[xxii] and even fasting, not just from food and drink, but also from smartphones during Ramadan.[xxiii] And while users reportedly are using mobile phones while driving, a UAE traffic survey also shows that 60 percent of them use their hands-free in 50 percent of drives or more.[xxiv]
As part of the "We are All Police" initiative in the UAE, users are also encouraged to report non-hands-free mobile offences while driving via a mobile app.[xxv]

Data on the success of these measures is limited, although early reports suggest there is still much work to do. One survey showed over 55 percent of students in the UAE had tried to quit smartphone and social media usage in the past 12 months, but were unsuccessful.[xxvi]

As more studies on smartphone usage are undertaken and awareness levels increase, we believe that in 2018 users and authorities will be more mindful and will continue striving towards curbing distracting smartphone usage. Ultimately, we expect Middle East users' and authorities' collective efforts to pay-off, trading down inappropriate and dangerous smartphone usages towards more effective, efficient, safer, and smarter usages. The findings so far at least provide good food for thought.

Hitting the accelerator: the next generation of machine-learning chips

Deloitte Global predicts that by the end of 2018, over 25 percent of all chips used to accelerate machine learning in the data center will be FPGAs (field programmable gate arrays) and ASICs (application-specific integrated circuits). These new kinds of chips should increase dramatically the use of ML, enabling applications to consume less power and at the same time become more responsive, flexible and capable, which is likely to expand the addressable market.

This is a dramatic shift; in 2016, almost all ML involving the artificial neural network (ANN) approach used a combination of standard GPU chips (graphics processing units) and CPU chips (central processing units) in large data centers.

We estimate that about 100,000 to 200,000 GPU chips were sold for ML in 2016.[65] We predict the market for GPUs will be larger in 2018, at over half a million chips. There will also be over 200,000 FPGA and 100,000 ASIC chips sold for ML applications. The dollar value of each kind of chip is different, so Deloitte Global is making a prediction not on the monetary value of each portion of the ML chip market, but merely on the number of chips. One analyst has forecast that the 2022 market for ML accelerator products will be in the admittedly wide range of $4.5 billion to $9.1 billion.[66]

Deloitte Global expects that GPUs and CPUs in 2018 will still be the largest part of the ML chip market, measured by chip units, and will still be growing. But the new kinds of chips may dramatically increase the use of ML, enabling applications to use less power and at the same time become more responsive, flexible and capable, which is likely to expand the addressable market, as can be seen in Figure 15, with chip sales for ML tasks predicted to at least quadruple in only two years.

Growth should be able to continue beyond 2018. The current leader in GPUs for ML in the data center has publicly stated that it anticipates the total available market (TAM) for both training and inference acceleration to be $26 billion by 2020,[67] which would be many millions of chips of various kinds per year, though probably not tens of millions.

Figure 15. Annual minimum sales of ML chips in global data centers (units)
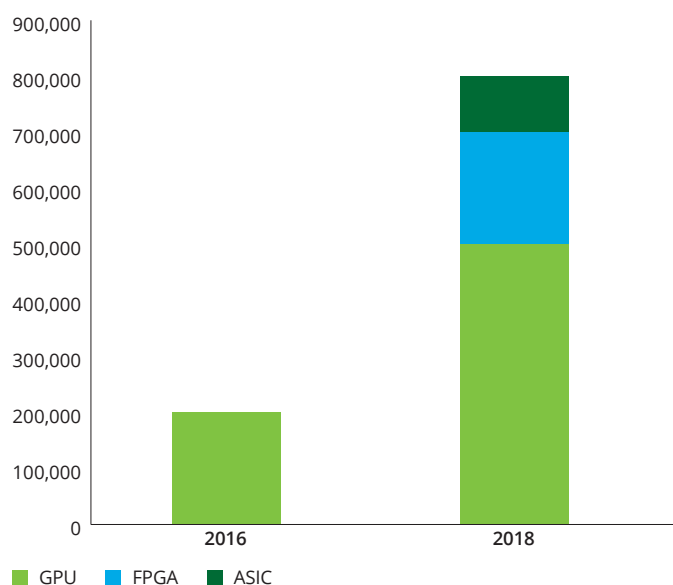
Source: Deloitte Global estimates, 2017, based on publicly available information. See endnotes for full methodology.

Artificial neural networks, machine learning and the associated hardware

Serial processing binary computers, whether made up of tubes or transistors, are capable of many tasks, but there are other computational challenges for which there are better alternatives. Image recognition, for example, is very hard to do using rule-based programming. Inspired by how biological neurons work, scientists in 1943 created a computational model for an artificial neural network.[68]

In subsequent decades, researchers built ANNs in many forms. In the early days, they mostly ran on mainframes and minicomputers, but by the 1980s, they were largely implemented on machines powered by PC-style CPUs.

It is critical to note that ANNs are not exactly like biological neurons; they are merely inspired by certain aspects of how real neurons work. Some chips do work more in the way neurons do, as discussed below, but they should not be confused with ANNs themselves.

In 2009, researchers found that GPUs, the chips that were so good at rendering computer game scenes using highly parallel processing at a reasonable price and great speed, were also very good at machine learning via ANNs. Originally these chips were called not GPUs but "graphic accelerators," and they had an architecture fundamentally different from that of CPUs, with many independent small processing cores. They excelled at parallel processing tasks, while CPUs were better at serial processing. Not every computing problem was done better in parallel, but rendering video game graphics faster was inherently improved with parallel processing.

For ML tasks, GPUs (with some CPUs in the mix) were found to be between 10 and 100 times as fast as CPU-only ML solutions, depending on the exact task.[69] This acceleration was revolutionary and dramatically expanded the market for ML hardware and solutions. CPUs were still used, but the virtues of GPUs increased the size of the pie, with ML being used much more widely than it had been before 2009.

Machine learning using ANNs can be broadly broken into two primary tasks: training and inference. For example, when trying to develop an image-recognition system to recognize cats, the system is shown hundreds or thousands or millions of images. Some of the images are labeled by humans as "cats," and others as "not cats." As the computer is exposed to these labeled images, it generates an algorithm that allows it to detect the presence of a cat in a new image; this is the training portion. Once that algorithm has been created, however, the actual cat-recognition process for a given image is performed through a process called inference. Up until 2016, both training and inference were performed on the same hardware: racks of GPUs and CPUs, usually in large data centers. Although some of the first examples of ML using non-CPU and non-GPU chips were for inference rather than training, it is unclear what the mix will be going forward. As of now, some companies are using FPGAs and ASICs for inference only, and others, for both training and inference.

What follows is an overview of the various kinds of chips that are likely to be used for ML in data centers and even outside them.

ML-optimized GPUs: From 2009 to 2016, the GPUs that were sold to data centers and used for ML were essentially the same chips and boards used for computer gaming. As mentioned above, these gaming GPUs, although not designed for ML, were by orders of magnitude better at running ANNs than the CPUs of that era. In 2018, the makers of GPUs are releasing special versions of GPUs that are optimized for ML; for example, Nvidia's Volta architecture is said to be 12 times better at deep-learning training and six times better at inference than the preceding Pascal architecture. We expect these new chips to sell hundreds of thousands of units per year.

ML-optimized CPUs: Meanwhile, we are also seeing CPU companies introduce variants of their standard chips that are specialized for ML. Intel's recent Knights Mill chip offers ML performance[70] four times superior to that of data center CPUs that were not optimized for ML.

ML-optimized FPGAs: FPGA chips are integrated circuits that can be dynamically programmed for applications or functionality. They are currently manufactured by a number of companies in many configurations. The market for these devices represents millions of chips annually and over $4 billion in sales in 2016.[71] A paper published at the beginning of 2017[72] showed that for a subset of deep neural network tasks, FPGAs were able to outperform GPUs by varying degrees in speed and/or power efficiency. Some tasks were only 50 percent faster, while others were 440 percent faster, and some were only slightly faster but 130 percent better in terms of performance per watt (heat often becomes a limiting factor, and so performance per watt can sometimes be critical).

Yet FPGAs are being used well beyond academic circles. One large cloud provider, Microsoft, has said it is using FPGA chips for inference purposes as part of its hosted ML offering, and has publicly disclosed that as of summer 2017, "hundreds of thousands" of the chips were already being used.[73] Amazon Web Services (AWS) and Baidu are also said to be using FPGAs in their data centers for machine learning purposes,[74] although chip volumes are unknown. And of course it matters that Intel, the world's largest maker of CPUs for data centers, purchased the second-largest FPGA company with its 2016 acquisition of Altera. Total 2018 FPGA chip volume for ML would be a minimum of 200,000. The figure is almost certainly going to be higher, but by exactly how much is difficult to predict.

ML-optimized ASICs: ASICs are single-purpose chips and are made by many large manufacturers. Industry revenues are about $15 billion in 2017. CPUs and GPUs are fairly general-purpose chips, manufactured by the millions each year. CPUs and GPUs tend to be fairly expensive on a per-chip basis, and they often use a lot of power. FPGAs tend to be used only when hundreds of chips are needed. They are fast to market, usually better at power efficiency than GPUs and CPUs, and often a good choice if neither the time, budget or volume requirements for an ASIC nor the ability to reprogram the chip dynamically is needed.

In the history of integrated circuit technology, it has been common for certain tasks to be done first on general-purpose processors, then on FPGAs and then on custom ASICs. ASICs often have the best performance, power and therefore efficiency, but designing an ASIC and getting it to the point of manufacturability can cost tens of millions of dollars. Therefore, ASICs are usually used only when a market application has reached a certain critical size at which the advantages of the ASIC solution become compelling. In terms of ML and ANNs, various ASICs seem set to play important roles in 2018 and beyond.

One example of an ASIC designed for machine learning is the Tensor Processing Unit (TPU – see below), and others, such as the Nervana chip from Intel, are expected to be available by the beginning of 2018.[75] Fujitsu also plans to launch a chip called Deep Learning Unit (DLU) that will be available in 2018.[76] Unit volumes are difficult to predict; they could be in the tens of thousands or hundreds of thousands.

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TPUs: Google has developed a series of ASICs for machine learning, called TPUs. TPUs are optimized to run the open-source ML software TensorFlow (also developed by Google).[77] The first-generation TPU was announced in 2016, and the second-generation chip was introduced in May 2017.[78] As is common in the evolution of chip markets, debate continues about the relative performance of TPUs compared with GPUs. But in tests performed in Google's own data centers on inference tasks, TPUs have shown performance gains over certain GPUs, just as GPUs did compared with CPUs, where the gain was 10 to 50 times. Critically, even when the absolute performance advantage of the TPU over the GPU for a task was not as large, the performance per watt was always considerably superior. For power-constrained applications such as the large server farms where companies do most of their inference, this is likely to be important. The first-generation TPUs appear to have been used only for inference, not for training, although the second-generation devices may be able to do training as well. It is unclear at this time whether the relative performance advantage of TPUs over GPUs for certain inference tasks will be comparable for training tasks. Actual chip volumes have not been disclosed by Google, but estimates suggest around 100,000 units seems likely.[79]

Lower-power ML accelerator chips: Over time, Deloitte Global believes that other chips, optimized for machine learning at even lower power, will see increased deployment in non-data-center markets, specifically for sensor networks, Internet of Things devices and gateways, and medical technologies. Deloitte Global predicts there will be over half a billion mobile chips running ML inferences on smartphones, tablets and other devices in 2018.[80] One example outside the smartphone world would be the Movidius chip from Intel, which is specifically used for ML acceleration for vision processing.[81]

When looking at Internet of Things applications that are mobile or not connected to the power grid, power requirements need to be measured in milliwatts at most. By contrast, GPUs for machine learning frequently consume over 250 watts per chip, and even TPUs require around 75 watts. Inside a data center, on a rack of cards cooled with fans connected to massive power lines and in a building with an air-conditioning plant capable of cooling kilowatts of heat, the energy consumed and the heat produced are difficult challenges.

For applications such as sensor networks, power draw would likely need to be below 10 milliwatts. Equally, any ML chip that needs to work inside the human body cannot use much power or produce much heat; its power consumption may need to be measured in microwatts or less. While there are commercial chips in smartphones and other mobile devices that are at the high end of the range, there is nothing that works at the low end. That is unlikely to change in 2018, but over the next year or two, there may be significant progress in low-power ML chips; in early 2017, one university laboratory produced an ML chip that consumes only 288 microwatts.[82]

Other ML accelerators: There are a number of companies looking to develop their own ASICs (or new computing architectures) that will be optimized for artificial intelligence and machine learning. At the time of writing, these companies have received hundreds of millions of dollars in funding, and have written papers claiming their solutions will be better than the current GPU/CPU solutions, especially for low-precision arithmetic. None seems to be selling these solutions in commercial volumes yet, so the impact in 2018 is unlikely to be large. But in 2019 and beyond, these devices may capture some part of the market.

Neuromorphic chips: There is an additional class of chips that do not fit into the conventional classifications above. IBM's True North chip is one of a class called neuromorphic chips, which are potentially capable of accelerating ML tasks and being very energy-efficient.[83] At this time, there do not appear to be any commercial-scale uses of these chips in data centers, although the US military has stated that it is exploring the technology for ML applications.[84] It is difficult to predict neuromorphic chip volumes for 2018, but it seems likely to be below 100,000 units and possibly even below 10,000.

The bottom line

When it comes to machine learning, big changes to the machine (in this case, the chips) are likely to cause big changes in the industry. After moving from CPU-only to CPU-plus-GPU solutions, the industry exploded in usefulness and ubiquity; using chips that are 10 to 50 times better will do that. If the various FPGA and ASIC solutions offer similar order-of-magnitude improvements in processing speed, efficiency, price or any combination thereof, a similar explosion in utility and adoption seems probable.

That said, there are certain tasks that ML is good at and others where it has its limitations. These new chips are likely to allow companies to perform a given level of ML using less power at less cost. But on their own, they are not likely to give *better* or more accurate results.

If the only accomplishment of these new chips is to make machine learning 10, 100 or 1,000 times less expensive, that could be more revolutionary than it seems. Famously, when aluminum was first purified and produced, it was so expensive that it was used instead of gold on the Washington Monument, and a French emperor had cutlery made out of the new and almost priceless material while less-important guests had to make do with solid-gold utensils.[85] In the 1880s, new processes for refining aluminum from bauxite ore were invented, and the price dropped by orders of magnitude.[86] Nothing about the metal itself had changed; it was the same, but much cheaper. As a result, it became not an object of ostentatious display but an extremely useful and much-used material in many industries. A change in the price of machine learning seems likely to produce similarly disruptive effects.

However, it isn't just the chips that are getting better. Deloitte Global has identified what we believe are important vectors of progress that promise to unlock more intensive use of ML in the enterprise. Some of these advances make ML easier, cheaper or faster (or a combination of all three). This will have the effect of expanding the market for ML, just as Economics 101 would predict. Other advances enable applications in new areas, which will also expand the market.

The key improvements are found in the companion prediction *Machine learning: things are getting intense* and include (in addition to the chip improvements we discuss above) automating data science, reducing the need for training data, explaining the results of ML better and deploying local ML. Taken together, these improvements will double the intensity with which enterprises are using ML by the end of 2018, and they promise over the long term to make it a fully mainstream technology, one that will enable new applications across industries where companies have limited talent, infrastructure or data to train the models.

Machine learning: things are getting intense

Deloitte Global predicts that in 2018, large and medium-sized enterprises will intensify their use of machine learning. The number of implementations and pilot projects using the technology will double compared with 2017, and they will have doubled again by 2020. Further, with enabling technologies such as ML application program interfaces (APIs) and specialized hardware available in the cloud, these advances will be generally available to small as well as large companies.

ML is an artificial intelligence (AI), or cognitive, technology that enables systems to learn and improve from experience – by exposure to data – without being programmed explicitly.

Despite the excitement over ML and cognitive technologies, and the aggressive forecasts for investment in these technologies, most enterprises using ML have only a handful of deployments and pilots under way. According to a 2017 Deloitte Consulting LLP survey of executives in the US who said their companies were actively using cognitive technologies and were familiar with those activities, 62 percent had five or fewer implementations and the same number of pilots under way.[87]

But progress in five key areas should make it easier and faster to develop ML solutions while also removing some of the barriers that have restricted adoption of this powerful technology. Progress along these vectors should lead to greater investment in ML and more intensive use within enterprises. This in turn should cause enterprises to double the number of ML pilots and deployments by the end of 2018. By then, over two-thirds of large companies working with ML may have 10 or more implementations and a similar number of pilots.

Analysts are predicting strong growth in investment and adoption of ML globally. International Data Corporation (IDC) forecasts that spending on AI and ML will grow from $12 billion in 2017 to $57.6 billion by 2021.[88] But adoption of ML is still in its early phases.

Deloitte Consulting LLP recently surveyed "cognitive-aware" executives in the US at companies that are active in cognitive computing with at least 500 employees. Half of the respondents worked for companies with 5,000 or more employees. Qualifying respondents had a moderate or better understanding of the technology and were familiar with their company's use of it.

While respondents were highly enthusiastic about the potential of cognitive technologies, the majority (60 percent) had just a handful of implementations and pilots per company under way.[89]

What has held back the adoption of ML? Qualified practitioners are in short supply.[90] Tools and frameworks for ML work are immature and still evolving.[91] It can be difficult, time-consuming and costly to obtain the large data sets required by some ML model-development techniques.[92] Even when they work well, some ML models are not deployed in production, as their inner workings are inscrutable and some executives will not run their business on systems they do not understand. Others may be constrained by regulations that require businesses to provide explanations for their decisions or to prove that decisions do not discriminate against protected classes of people.[93] Black-box models, no matter how accurate or useful their outputs, cannot be deployed in such situations.

However, Deloitte Global has identified five key vectors of progress in ML that should unlock more intensive use of the technology in the enterprise.

Three of these five advancements – automation, data reduction and training acceleration – make ML easier, cheaper or faster (or some combination thereof). They will have the effect of expanding the market for ML. The others – model interpretability and local ML – enable applications in new areas, which should also expand the market.

ML continues to improve in other ways as well and is evolving so rapidly that another key improvement is likely to arise over the course of the year.

Our top five vectors of progress – ordered by breadth of application, with the widest first – are detailed below.

1. Automating data science. Time-consuming ML tasks, such as data exploration and feature engineering, which typically take up as much as 80 percent of a data scientist's time, can increasingly be automated.[94]

Data science, an often misunderstood, specialist discipline, is in reality a blend of art and science. Much of what data scientists spend time on – from data wrangling to exploratory data analysis, feature engineering, feature selection, predictive modeling, model selection and so on – can be wholly or partially automated. For instance, while building customer lifetime value models for guests and hosts, data scientists at Airbnb used an automation platform to test multiple algorithms and feature engineering steps – which they would not otherwise have had the time to do. Automation enabled them to discover changes they could apply to their algorithm that increased accuracy by more than five percent – a significant impact.[95]

A growing number of tools and techniques for data science automation, offered by established companies as well as venture-backed start-ups, should help shrink the time required to execute an ML proof of concept from months to days.[96] Automating data science means data scientists can be far more productive. It thereby helps overcome the acute shortage of data scientists, enabling enterprises to double their ML activities.

2. Reducing the need for training data. Training an ML model can require up to millions of data elements. This can be a major barrier. Acquiring and labeling data to be used for training can be highly time-consuming and costly. Consider, as an example, a project that requires MRI images to be labeled with a diagnosis. It might cost over $30,000 to hire a radiologist to review and label 1,000 images at a rate of six images an hour. Privacy and confidentiality concerns can also make it difficult to obtain the data in the first place.

But a number of promising techniques are emerging that aim to reduce the amount of training data required for ML. One involves the use of synthetic data, generated algorithmically to mimic the characteristics of the real data.[97] A team at Deloitte Consulting LLP tested a tool that was able to build an accurate model with only a fifth of the training data previously required; it synthesized the remaining 80 percent of data.

Synthetic training data can also open the door to the crowdsourcing of data science solutions. A number of organizations have engaged third parties to devise ML problem-solving models and are posting data sets appropriate for sharing that outside data scientists can work with.[98] Researchers at MIT used a real data set to create synthetic alternatives that could be used to crowdsource the development of predictive models without needing to disclose the original data set. In 11 out of 15 tests, the models developed from the synthetic data vault performed as well as those trained on real data.[99]

Another technique that could reduce the need for training data is transfer learning. With this approach, an ML model is pre-trained on one data set as a shortcut to learning a new data set in a similar domain, such as language translation or image recognition. Some ML tool vendors claim their use of transfer learning can cut the number of training examples customers need to provide by several orders of magnitude.[100]

3. Accelerating training. As detailed in the prediction *Hitting the accelerator: the next generation of machine-learning chips*, established and start-up hardware manufacturers are developing specialized hardware (such as GPUs, FPGAs and ASICs) to slash the time required to train ML models, by accelerating the calculations required and the transfer of data within the chip. These dedicated processors can help companies speed up ML training and execution manyfold, which in turn brings down the associated costs.

For instance, a Microsoft research team using GPUs completed a system in one year to recognize certain conversational speech as capably as humans could. With CPUs, it would have taken five years.[101]

Google stated that designing its own AI chip, a TPU, for neural networks execution and adding TPUs to CPU and GPU architecture helped the company save the cost of building a dozen extra data centers.[102]

Early adopters of these specialized AI chips include major technology vendors and research institutions in data science and ML, but adoption is spreading to sectors such as retail, financial services and telecom. With GPU cloud computing offered by all the major cloud providers (IBM, Microsoft, Google, AWS), accelerated training should become mainstream, increasing the productivity of teams working on ML and multiplying the number of applications enterprises choose to undertake.

4. Explaining results. ML achievements get more impressive by the day. But ML models often suffer from a critical flaw: many are black boxes, meaning it is not possible to explain with confidence how they make their decisions. This makes them unsuitable or unpalatable for many applications, for reasons ranging from trust in the answers generated by a model – as when customers are offered incentives – to regulatory compliance. For example, the US financial services industry adheres to the Fed's Supervisory Letter, SR 11-7, Guidance on Model Risk Management, which among other things requires that model behavior be explained.[103]

A number of techniques have been created that help shine light into the black box of certain ML models, making them more interpretable and accurate. MIT researchers have demonstrated a method of training a neural network that delivered accurate predictions and the rationales for those predictions.[104]

Some techniques are finding their way into commercial data science products, such as H2O Driverless AI, a data science automation platform;[105] DataScience.com's new Python library, Skater;[106] and DataRobot's ML-powered predictive modeling for insurance pricing.[107] As it becomes possible to build interpretable ML models, companies in highly regulated industries such as financial services, life sciences and health care can be expected to intensify their use of ML and significantly expand the number of pilots and deployments over coming years.

Some of the potential applications include credit scoring, recommendation engines, customer churn, fraud detection, and disease diagnosis and treatment.[108]

5. Deploying locally. ML use will grow along with the ability to deploy it where it is needed. As we predicted last year, ML is increasingly coming to mobile devices and smart sensors, expanding the technology's applications to smart homes and cities, autonomous vehicles, wearable technology, and the industrial Internet of Things.[109]

Technology vendors including Google, Microsoft, Facebook and Apple are creating compact ML software models to undertake tasks such as image recognition and language translation on portable devices. Google is using TensorFlow Lite, Microsoft has an embedded learning library, Facebook has Caffe2Go and Apple Inc. is using Core ML for on-device processing.[110] Microsoft Research Lab's compression efforts resulted in ML models that were 10 to 100 times smaller.[111]

Semiconductor vendors including Intel, Qualcomm and Nvidia, as well as Google and Microsoft, are developing their own power-efficient AI chips to bring ML to mobile devices.[112] With smartphones an increasingly viable deployment option for ML, the number of potential applications is growing, and the number of enterprise ML pilots and deployments will rise too.

Definitions and explanations – a layperson's guide

Data science: An interdisciplinary field that generally employs data management, analytics modeling and business analysis to gain insight from complex data sets that are often very large or unstructured.

Training data: Used to discover and model a relationship between a set of data inputs and a corresponding set of data outputs, or labels. For example, records of home sales might include three attributes, such as square footage, year of construction and school district, as the inputs, and the sale price as the output. An algorithm would be used to discover a relationship between those three attributes and the sale price. Capturing that relationship in a model might make it possible to predict the sale price for other homes when only those three input attributes are known. The use of training data to create or learn such a model from training, or labeled, data is known as supervised machine learning.

Black box: Anything with inner workings that are not apparent. A black-box ML model produces answers – such as medical diagnoses or credit underwriting decisions – without explaining the rationale. A white-box model, by contrast, would reveal its inner workings, making it possible to understand how it arrives at its results.

Interpretability: In this context, the ability to explain why and how a system makes a decision.[113]

Data wrangling: The process of cleaning and sorting complex, unstructured data sets for ease of use and analysis.

Data exploration: The first step in data analysis to understand the data set and to summarize key characteristics of the data.

Feature engineering: The process of using domain knowledge to create relevant features of the data in a tabular format, from the existing raw features, for an ML model.

Neural networks: Includes layers of interconnected nodes, inspired by neurons in the human brain, to perform a form of ML in which the system learns to perform a task by analyzing training data on its own.

The bottom line

Collectively, the five vectors of ML progress should double the intensity with which enterprises are using this technology by the end of 2018. In the long term, these vectors should help make ML a mainstream technology. Advances will enable new applications across industries where companies have limited talent, infrastructure or data to train the models.

Companies should:

• Look for opportunities to automate some of the work of their oversubscribed data scientists, and ask consultants how they can use data science automation.

• Keep an eye on emerging techniques, such as data synthesis and transfer learning, that could ease the bottleneck often created by the challenge of acquiring training data.

• Find out what computing resources optimized for ML are offered by their cloud providers. If they are running workloads in their own data centers, they may want to investigate adding specialized hardware to the mix.

• Explore state-of-the-art techniques for improving interpretability that may not yet be in the commercial mainstream, as interpretability of ML is still in its early days.

• Track the performance benchmarks being reported by makers of next-generation chips, to help predict when on-device deployment is likely to become feasible.

Middle East perspective

As Machine Learning (ML) is on its way to becoming a game changer in the global economy, we expect the Middle East to accelerate its investment in ML solutions to become part of this technological disruption. The International Data Corporation (IDC) *Spending Guide*[xxvii] forecasts spending on cognitive and AI systems in the Middle East and Africa (MEA) region to grow from US$37.5 million in 2017 to over US$100 million by 2021, representing a growth rate of 32 percent annually.

A unique characteristic which differentiates the Middle East (particularly the GCC countries) from the rest of the world is that governments are amongst the early adopters of innovative technologies. Governments, on the back of ambitious national strategies to reduce dependencies on hydrocarbons, have taken a very active look at the use of exponential technologies to foster national competitiveness – AI is at the core of these plans. A number of regional ministries lead the region's efforts in driving investment, taking political and regulatory actions, and creating proof-of-concepts (POCs) to keep up with disruptive trends. For example, in October 2017, the UAE Government launched the UAE Strategy for *Artificial Intelligence*[xxviii] to build a next generation government, with the goal of boosting the country's GDP by 35 percent and reducing government costs by 50 percent within the next fifteen years. To demonstrate further devotion, government announced the appointment of a Minister of Artificial Intelligence,[xxix] who will be responsible for investing in technologies such as machine learning. Furthermore, Dubai Electricity and Water Authority (DEWA) has announced the running of its AI "chatbot" that uses ML technology to analyze customers enquiries based on available data, and is able to accurately answer most queries.[xxx] Recently, Saudi Arabia has revealed Sophia, its first robot that uses ML to match facial expressions, which is a display of conversational Machine Learning.[xxxi]

In the medium term, increasing government support will enable enterprises to justify greater investments and we should see a larger number of POCs and innovative solutions coming out of the region. Private enterprises in the region that are developing digital strategies in which ML plays a major role will contribute to this trend and fuel progressive ML adoption through cloud implementations, cloud adoption, AI applications, robotics, and other technologies.

We believe that three ML domains (automating data science, reducing need for training data, and accelerating training) will significantly contribute to enterprises' use of machine learning technology and increase the number of use cases for this technology. Application of ML to enterprise data is a critical step that produces the benefits discussed. A number of tools like DataRobot, PurePredictive, XpanseAnalytics are being leveraged to deliver these data sorting capabilities on ML.[xxxii, xxxiii, xxxiv]

In the Middle East, we expect financial services, healthcare, and retail industries to be the most impacted by ML. Machine learning will help financial service providers detect fraud, assign risk more accurately, and provide more curated offers. The industry's access to more and better-structured data, compared to other industries in the region, as well as banks' willingness to enhance productivity, will allow financial services to take the lead. Healthcare and retail, on the other hand, will reap the benefits of automation due to their labor-intensive nature. We may witness, for example, early diagnosis capabilities and smart electronic health records for healthcare, and predictive sales, automated customer engagement, and optimized supply-chain for retail.

Overall, 2018 will be a year of acceleration for government-led investments in Machine Learning in the Middle East. Increasing collaboration between digital disruptors, corporations, businesses, and governments, combined with leading practice regulations should help the region to realize the benefits it can incur by adopting and promoting ML technologies.

Live thrives in an online world

Deloitte Global predicts that live broadcast and events will generate $545 billion in direct revenue in 2018, a one percent increase over the previous year.[114] The vast majority ($537 billion, or 98.5 percent) of live revenues are forecast to come from traditional sectors (see Figure 16), with the remainder from live streaming and eSports.[115]

Live broadcasting has remained vibrant despite consumers' ever-improving capability to consume content on demand or, in the case of events, to attend remotely. Even in an age in which the mantra for media is often "what you want, when you want it, where you want it," the way we want to consume is often "now" because of the thrill and convenience of live delivery. And in many regards, digital has actually made live content more productive and profitable.

Live TV and radio broadcasting is expected to generate 72 percent of all live revenues in 2018 (see Figure 16), with the largest component being broadcast TV, with $358 billion from advertising and subscriptions. TV advertising is forecast at $188 billion in 2018, and live viewing's share of pay TV revenue is estimated at $170 billion.[116] We have allocated 85 percent of pay TV's forecast $200 billion revenue to live consumption based on our estimate of the share of TV that is watched live in homes with a digital video recorder (DVR) in selected markets.[117]

Figure 16. Live revenues, 2018 ($ billion)
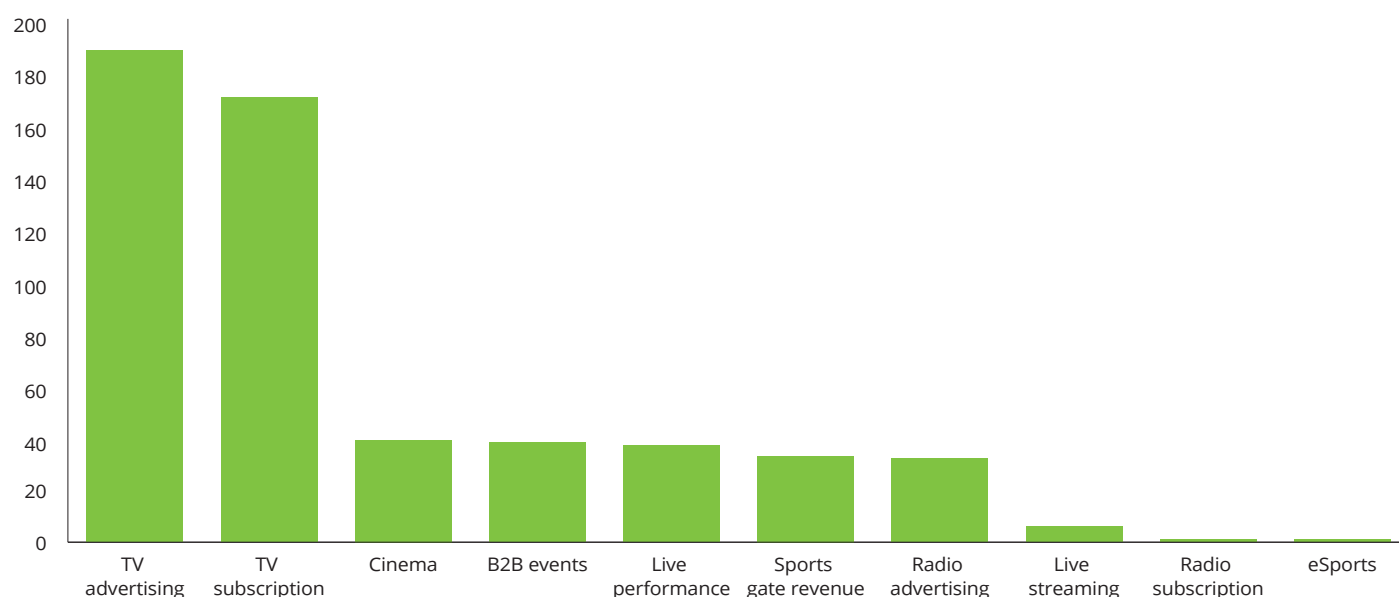
Source: Deloitte Global analysis, 2017

Even in an age in which the mantra for media is often "what you want, when you want it, where you want it," the way we want to consume is often "now" because of the thrill and convenience of live delivery.

Live TV

While consumption of daily minutes of live TV has dropped consistently among younger age groups in some markets (see the prediction *The kids are alright: no tipping point in TV viewing trends for 18-to-24-year-olds*), live viewing remains significant overall. This is despite the steady growth in subscription video-on-demand (SVOD), forecast at 375 million globally in 2018;[118] the availability of DVRs, now owned by the majority of households in some markets, including the US, the UK and Belgium; and the rising reach of smart TVs, which have video-on-demand support built in.

In the US – a market in which two-thirds of the viewing population has access to a DVR[119] – average live TV consumption among adults in Q1 2017 fell by 10 minutes year-on-year to 261 minutes, an aggregate reduction of 2.5 billion minutes (41.6 million hours) for all 250 million adults. But US TV viewers still watched 65.1 billion minutes (1.1 billion hours) of live TV daily and 101 billion hours over the quarter,[120] a quantity that may help explain TV's enduring appeal to advertisers.[121]

Digital platforms enable content to be viewed on demand but can also be used to distribute live content. In 2018, we expect digital platforms to continue to offer live programming, as was the case in 2017:

- Amazon purchased the rights to stream ten Thursday night National Football League (NFL) games in the US market.[122] These will be available to Prime subscribers and also broadcast on TV. In the UK, Amazon launched Amazon Channels, a suite of live TV channels featuring content from Discovery, ITV, Eurosport, MGM and others. This programming is in addition to (and with an additional charge for) the on-demand content included with Amazon Prime.[123]

- Twitter, which live streamed 10 NFL games in 2016,[124] announced in May 2017 that it had signed 16 live-streaming deals spanning concerts, sport and drama.[125] Twitter also partnered with the BBC in the UK to live stream five election specials.[126]

- YouTube has offered, in conjunction with BT Sport, several Champions League football (soccer) matches, including the final.[127]

- In the coming 2017 season, Facebook will broadcast 20 live baseball games and 46 live Mexican football (soccer) matches to US audiences via the Facebook Live platform.[128]

- In the US, Hulu, which has offered SVOD services in the US since 2006, recently launched a streamed live TV service. The SVOD service starts at $7.99 per month; the live TV service starts at $39.99 a month.[129]

Radio

The next-largest broadcast sector by revenue is likely to be radio, with almost all revenue coming from advertising; only the US and Canada have managed to nurture a commercially significant subscription radio market so far.[130] Live radio has remained popular despite the increasing availability of on-demand alternatives, such as personal and portable music collections, streaming music services, and podcasts.

In the UK, time spent listening to the radio has varied little in recent years, at about 20 hours per week,[131] with 90 percent of the population listening to the radio at least weekly. Online has made live radio easier to listen to wherever connectivity is available. In the US, advertising revenues from online radio alone are forecast to rise to $2 billion by 2021, a significant rise from $1.4 billion in 2016.[132]

Live events

Live events – spanning live performances such as concerts and shows ($36 billion),[133] exhibitions and conferences ($38 billion),[134] sports gate revenue ($33 billion)[135], and cinema ($39 billion) – are forecast to grow collectively by $5 billion, to $146 billion in 2018.

Events are also likely to generate significant incremental revenues from food and beverage sales, merchandising, and travel. In some cases, this ancillary spend may exceed direct revenue from ticket sales. For example, in the UK, more than 750,000 overseas visitors attended music concerts or festivals as part of a trip in 2015; these visitors have spent money on accommodations, travel, food and other attractions.[136] In the US, 63 percent of admissions to Broadway shows were from people who came from outside New York and its suburbs and likely stayed overnight.[137]

Live performance

The largest component of live performance is concerts, which represent just over half of the subsector's revenue. The next-largest component is theater, with major hubs such as Broadway in the US (13.3 million admissions in 2015-16) and the West End in London (14.3 million tickets in 2016) each generating significant revenue.[138]

In 2018, the largest concert tours may gross over $200 million from ticket sales. U2's The Joshua Tree Tour 2017 earned $62.7 million in its first month on the road and sold 2.4 million tickets in the Americas and Europe alone.[139] Guns N' Roses generated $151.1 million in the first half of 2017, with $17.1 million generated from just two nights at one venue.[140]

The live performance market could grow considerably over the next few years, with the Chinese market offering significant potential. Live music was worth $219 million in China in 2015 and has been forecast at $290 million by 2019,[141] but there is scope for much greater growth.

B2B events – exhibitions and conferences

The biggest trade exhibitions and conferences are likely to gather hundreds of thousands of attendees in the same venue. In 2017, the Canton Fair, a marketplace for textiles, garments, consumer goods and appliances held in China, hosted 196,490 buyers.[142] One of the largest technology events in Europe is the Mobile World Congress, held in Barcelona. In 2012, there were 67,000 attendees;[143] by 2017, there were 108,000. CES is one of the largest electronics shows, with 180,000[144] attendees in 2017[145], a 17 percent increase over the 153,000 attending in 2012[146].

It is worth recollecting that a decade ago, the prevailing wisdom was that businesses would eschew in-person meetings for virtual ones. Businesses would gather in virtual worlds such as Second Life, and indeed, by 2009, more than 1,400 companies had held conferences and other meetings within its virtual space.[147] Enterprise users were offered various business-oriented amenities, including an auditorium and two conference centers.[148] But Second Life's Enterprise platform closed in 2010;[149] global trade show revenue has risen every year since.[150]

Each of these major events is likely to have significant associated revenue, with the majority of attendees arriving from out of town. The 2017 Mobile World Congress hosted visitors from 207 countries, and the event is estimated to have contributed more than €465 million (US$541 million).[151]

Live sports

Watching sports live remains a significant market, despite the widespread availability of televised sport and the proliferation of results available online. There are now 50 sports leagues and events that have an aggregate attendance of over one million people. Football (soccer) leads, with 29 events, followed by rugby with seven and baseball with four.[152] Seven of these leagues are in Asia and are among those growing the fastest.[153]

Attendance at football matches in Europe (domestic and regional championships) exceeded 170 million in 2015-16 and grew by 2.6 million year-on-year. German and English clubs attracted 55 million spectators between them.[154]

Increases in the value of broadcast rights enable a larger spend on talent[155], which itself can create a larger draw for match-day attendance.

Cinema

Cinema, a live entertainment format that is over 100 years old, remains in strong commercial health, albeit with rising ticket prices balancing out declining ticket sales. Over the past decade, box office revenue has varied little year-on-year, and this is likely to remain the case for 2018. In 2016, the global box office rose 1 percent, to $38.6 billion.[156]

The shape of the global cinema market has changed markedly in recent years, with China now generating almost half of all box office revenue. In the first part of 2017, the Chinese box office represented almost exactly half of the takings for the top seven movies.[157]

Ancillary revenues can be substantial; at one movie theater chain, for every dollar spent on admissions, patrons spent another $0.60 on popcorn and other concession items.[158]

Live streaming and eSports

Almost all revenue from live events is being generated by traditional formats, but new genres, primarily live streaming and eSports, are enjoying surging revenue, albeit from a low base. We forecast a 46 percent rise in revenues for new formats to $8.4 billion in 2018, equivalent to 1.5 percent of all live revenue.

Live-streaming revenue should reach $7.4 billion in 2018, a 47 percent increase over the previous year. The primary revenue model for this market is likely to be tipping, whereby viewers donate money to performers.

China is likely to remain the largest market for live streaming in 2018, with forecast revenue of $4.4 billion, a 32 percent increase over 2017, 86 percent higher than in 2016.[159] Viewers are likely to reach 456 million.[160] One of the largest platforms is YY, with 117 million monthly users and 10 million channels.[161] YY had net revenue of $384.8 million in Q2 2017, a 31.7 percent increase over Q2 2016.[162]

Donations are in the form of virtual gifts, such as virtual flowers, lollipops or even cars. These tokens are priced on one platform, UpLive, at between $0.30 and $148.[163]

The Chinese model for tipping is likely to be exported to other markets via Chinese-owned companies. According to one analyst, the UpLive app was the number one download in Japan and the second in a dozen other countries.[164] Another app, Live.Me, owned by Cheetah Mobile, a company headquartered in China, is focused on the US, the UK, Canada and Australia.

Donations are also an emerging element of the business model for other live-streaming platforms, including platforms used for streaming video game play. On YouTube, the viewers contribute via a feature called "Super Chat," whereby a comment posted remains on screen for longer and in a different color, depending on the sum contributed.[165] On Twitch, the equivalent feature is called "Cheering."[166]

The eSports market generates revenue from live viewing and events. The market has grown rapidly in recent years. It was worth $325 million in 2015 and is expected to reach close to $1 billion in 2018.[167] Viewing hours leapt to an estimated six billion hours globally in 2016, five times the volume of 2010, but were only 19 percent higher year-on-year and still equivalent to only 5.33 days of live TV viewing in the US. China represents half of all viewing hours and generated 11.1 billion streams in 2016, significantly more than the 2.7 billion for North America.[168]

eSports revenue should continue growing over the years. One boost could come from the adoption of eSports complements to traditional events:

• The finals of the first Formula 1 Esports world championship will take place in Yas Marina (Abu Dhabi) as part of the final Grand Prix of the 2017 season.[169]

• The first FIFA eWorld Cup will take place in 2018, with the grand final in August of that year.[170]

• eSports will be a medal event at the 2022 Asia Games in Hangzou, China.

Live-streaming revenue should reach $7.4 billion in 2018, a 47 percent increase over the previous year. The primary revenue model for this market is likely to be tipping, whereby viewers donate money to performers.

The bottom line

Live content and events are thriving in a digital world – they are as relevant as ever for enterprises and consumers. The sector is vibrant both despite and because of digital.

There are several core reasons why live content – across broadcast and events – will remain compelling and lucrative in 2018, and there are multiple ways in which digital tools can be used to enhance the appeal of live content and events.

Convenience and inertia: It is easier, for the majority of viewers, to watch at a scheduled time than to make their own schedule. Content owners should use data analytics to refine schedules; data should be used in conjunction with a scheduler's instinct about what people are going to watch or listen to and at what time.

Fear of missing out: People enjoy being part of a conversation, and social networks make it easier to be reminded of upcoming live events and more galling to have missed them. It is now becoming commonplace to see a few eventgoers live streaming a concert they may have paid hundreds of dollars to attend, but one consequence of live streaming is to raise awareness, with the potential knock-on effect of encouraging the streamers' social network group to purchase tickets.

Shared experiences: Whether it is the final of a reality TV show, a concert, a trade show or the first people landing on the moon, most people relish experiencing events that connect them to other people. Communal voting is one trusted way of making viewers feel as though they're part of a show; with today's technology, voting and other forms of participation can take place on a massive scale. Some members of the audience are always likely to contribute by sending messages. With current technology, these messages could be overlaid on a TV screen but seen only by the viewer's social network circle.

Exclusivity: Live performances are accessible to only a few, and those lucky enough to attend have a treasured experience to which most others may not have access. Encouraging people to trumpet, via social media, their attendance at an exclusive enclave or event is likely to goad others into purchasing premium access next time around. Technology can also be used to improve the match-day experience, starting with slick mobile commerce sites, smartphone ticketing, automated ticket barriers, in-stadium connectivity and more.

Live appears to be still alive in the digital era. And it may always be the case that people use technology to enhance live consumption rather than avoid it.

Middle East perspective

We predict that three of the main live markets (Live TV, Cinema and Music) will see renewed growth in the Middle East from 2018 on the back of a number of catalyst events, particularly in the Saudi market. In addition convenience and inertia, fear of missing out, shared experiences, and exclusivity will remain relevant drivers for the live market in the region for 2018 despite historic challenges.

Live TV revenue streams such as advertising and subscriptions are impacted by device choices and content being offered. In the region, consumers have been 'leap frogging' for some time now to smartphone viewership due to privacy preferences. Globally, larger screens are favored for long-form content, but not in this region, where, for example, 69 percent of the respondents in UAE listed smartphones as their preferred device for watching videos,[xxxv] whereas globally the average was 41 percent.[xxxvi] In fact, the number of users consuming on-demand content on tablets is set to rise by 77 percent[xxxvii] every year until 2020. Still, a high affinity towards devices other than TVs does not necessarily translate into decline in the live TV market as broadcasters with a platform agnostic delivery of content (e.g. OSN play) still benefit from live viewership on other devices. What definitely does affect this market is the content it offers in comparison to non-live TV. Live TV content in the region is limited due to relatively stringent content regulation by governments and in general lesser quality of local live premium content (e.g. local football leagues). In contrast, with one of the highest number of Free-to-Air channels in the world, the region has a plethora of free (or cheap) non-live, quality content. An important game changer for Live TV content for the region will be the recent acquisition of the Saudi Premier League rights for 10 years by STC. This acquisition represents a unique opportunity for the League and STC to create a virtuous circle for the League and STC's TV operations similar to the symbiotic relationship that Sky and the BPL have enjoyed for years. This could turn the most valuable live sports property in the Middle East into an even more significant opportunity for the enhancement of the league, the growth of the rights in the long term and the value of the live TV revenues in the Kingdom.

Similarly, the cinema market in the region is set to experience a new wave of growth in 2018 and beyond. It is well known that the cinema market in the Middle East has inherent flaws. The region has one of the lowest cinema screens per million inhabitants in the world, with the UAE having the highest at around 40,[xxxviii] which is extremely low compared to the United States' 120.[xxxix] This, coupled with low GDP per capita in many non-GCC countries of the region, also reduces propensity to pay for tickets. For example, Egypt accounts for about 30 percent[xl] of the region's population and a good share of the total Arabic movies production but only accounts for 6 percent[xli] of box office revenue share. On the contrary, the UAE accounts for only 3 percent[xlii] of the region's population, but brings in 22 percent[xliii] of its box office revenue. However, the biggest gap in the market has clearly been historically the absence of cinemas in Saudi Arabia. With the lifting of the ban in late 2017, the government has confirmed it would begin licensing cinemas immediately and is expecting to have first movie theatres to open in Q1 2018. Given the size of the market, this is a game changer for the Middle East cinema market.

Lastly, we believe that live music performance will be another key beneficiary of the promotion of entertainment by the Saudi Government as part of its broader National Transformation Plan. Historically, as a percentage of overall music revenue, live music's share is approximately 90 percent[xliv] in the Middle East, compared to 65 percent[xlv] globally. The primary reason for this is the high-level of unpaid music consumption in the region, partially due to the lack of performance rights organizations. However, this does not necessarily mean that in the absolute sense, live music is doing well in the region. Apart from the effects of the availability of new and easily accessible content, there are also geographical and cultural constraints. With the exception of the UAE, there are very limited large-scale venues available in the region. Today, the UAE hosts over 90 percent[xlvi] of the region's overall concerts. This limited geographical reach makes the region less attractive to global artists and musicians, as they would ideally like to cover several cities and countries on their tour to a specific region. However, the opening of the KSA market to live music events, which has already been seen last year the organization of music concerts, a Comic-Con pop culture festival and a mixed-gender national day celebration, is likely to boost the prospects of the industry in the region.

Overall, we believe that 2018 will be the start of a new age for live in the Middle East, boosted by the combination of policy changes (cinema and music) and commercial ventures (STC's SPL rights) in the largest untapped market, KSA. In this context of rapid growth, live will be far from a zero sum game for traditional broadcasters and digital new entrants. We believe that there is plenty of room for a range of players and delivery platforms in the Middle East to thrive off the expected boom of live content in the coming years.

Digital media: the subscription prescription

Deloitte Global predicts that by the end of 2018, 50 percent of adults in developed countries will have at least two online-only media subscriptions, and by the end of 2020, that average will have doubled to four. The cost of these subscriptions – spanning principally TV, movies, music, news and magazines – will typically be under $10 per month each in 2018. In total, we estimate there will be 580 million subscriptions and about 350 million subscribers this year (see Figure 17).

Figure 17. Global digital media subscriptions (million)
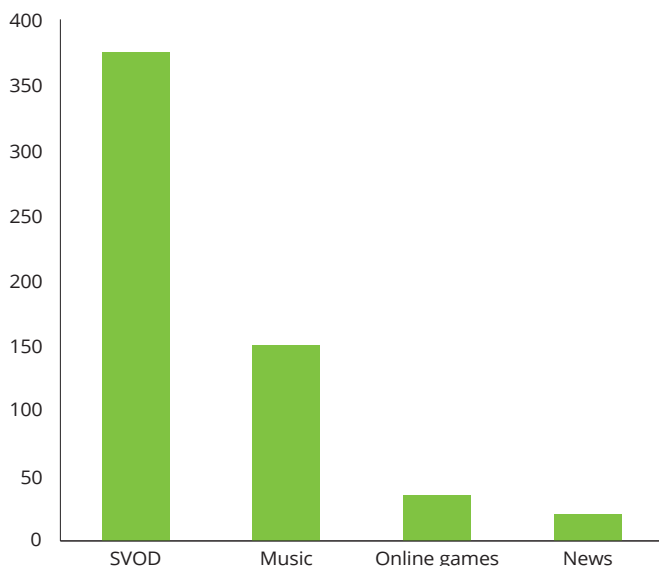
Source: Deloitte Global analysis, 2017

We further predict that a fifth of adults in developed countries will pay for or have access to at least five paid-for online media subscriptions, and by the end of 2020, they will have 10. For these adults, aggregate spend on digital subscriptions they have access to (paid for by themselves or by someone else in the household) is likely to average over $100 per month by 2020, or over $1,200 annually.

These subscriptions will be in addition to traditional media subscriptions that include online access, such as a pay TV or newspaper subscription that often includes one or more digital passes.

While the accumulation of online, digital-only subscriptions across multiple media is relatively new,[171] multiple media subscriptions are not.[172] Online media subscriptions are the digital update and upgrade to behaviors exhibited a generation back, when households would subscribe to multiple media, including newspapers (morning and evening), magazines and books (adults and kids, from fiction to reference), analog cable TV, music, and more recently, DVDs.[173, 174]

Why did people stop subscribing? A major trigger was the online revolution in the mid-1990s and the accompanying belief that online ad-funded content, shown to hundreds of millions and ultimately billions of eyeballs, would be more lucrative than digital subscriptions. As so much content – particularly news – became free, media companies and their investors started to measure success by metrics such as global monthly web browsers (the number of individual web browsers that hit a site), expecting that revenues would follow the eyeballs.

As of 2018, it is possible for a media site to reach hundreds of millions of different web browsers per month, a phenomenal total for a news publisher whose reach would formerly have been restricted to its local market.

But as reach has grown, revenue per viewer, visit, impression, web browser or click has steadily fallen. For some publishers, generating sufficient revenue from online advertising alone has felt like a Sisyphean task.

As traffic volumes have increased, revenue per impression has fallen and the number of intermediaries extracting a commission has risen. To compensate for this, web pages have become ever more cluttered with banner and video ads. In response to the proliferation of advertising, hundreds of millions of online consumers have deployed ad blockers, which in turn has provoked the channeling of ever more advertisements per page to those not blocking ads.

In response, content creators have increasingly started to focus on growing their online digital subscription revenue and on formulating ever more varied and appealing digital subscription packages. As this has happened, consumers have become increasingly willing to pay for digital content – even when the same content might be available for free via another source, legal or not.

Looking across all forms of online media, we find the principal drivers of the rise in online media subscriptions are likely to include:

- Supply side: Steady growth in the number of companies offering online media subscriptions, and fragmentation of content libraries. For example, rights to watch a specific sports team may be split across two or more providers, requiring more than one subscription, or drama fans may need to purchase two or more subscriptions to be able to access all the programs they want to watch. There has also been growth in subscription bundling. Amazon Prime is the best known, and it bundles a range of add-ons to delivery, including video. *The Telegraph* (a newspaper in the UK) has offered Amazon Prime for free with its online subscription,[175] and in the US market, students were offered Spotify Premium with a subscription to Hulu.[176]

- Demand side: Increased willingness among consumers to pay for content online rather than consume ad-funded content. This is partly driven – especially for news – by rising awareness of the variations in caliber of news outputs. Furthermore, the attractiveness of the online model is, for some genres, becoming more compelling than pre-existing traditional alternatives. Music subscriptions offer access to tens of millions of tracks and hundreds of thousands of playlists, some of which are customized to the subscriber, and all are available on demand. For many, this is superior to owning a digital or physical music library. In some markets, consumers are "cord cutting" and "cord shaving" their traditional pay TV bundles – that is, cancelling their pay TV subscriptions outright or else downscaling their package to reduce cost. In some cases, these consumers are replacing all or some of their TV content with SVOD.

There are also several technological enablers that are making online-only subscriptions more viable and easy to use.

- The steady rise in broadband speeds has facilitated the rise of the online subscriber. A decade ago, relatively few households in developed countries had broadband speeds that could reliably deliver online video to TV sets. As of early 2018, however, hundreds of millions of homes will have this capability, and streaming services are now available in 4K or ultrahigh-definition (UHD) resolution. The growth of 4G networks has made music streaming while connected to a mobile network (say, in a car or on a bus) far more reliable. At the end of 2016, about 60 percent of the world's population was in a market with access to 4G. By 2020, about 40 percent of all mobile connections will be 4G.[177]

- There is a growing base of devices that facilitate access to online media subscription services. As of 2018, hundreds of millions of TV sets and set top boxes will have the capability to access SVOD services directly. This contrasts with the early days of SVOD, when consumers would watch on a laptop, which typically meant an inferior video and audio experience relative to that from a TV set. A similar change has happened with music. Premium connected speakers are shipped with fast access to built-in premium subscription services.[178]

- A further enabler has been the ease of sign-up. Users can now subscribe to online media with just a couple of clicks from a mobile browser page, followed by a tap of a fingerprint reader to authenticate payment.[179] Deloitte Global estimates that by the start of 2018, a billion smartphones and tablets will have fingerprint readers, and in some markets, over 80 percent of these are used.[180]

- Smartphone screens have steadily expanded over the past decade, with the majority of models on sale in 2018 offering a screen that is 5 inches or larger, often combined with pin-sharp resolution. News articles displayed on a smartphone are now very similar in dimension to a newspaper column, with about eight to 10 words per line.

Demand dynamics for each medium are likely to vary considerably in 2018 and in years to come. In the next section, we look at trends in television, music, video games and news.

Online TV and movie services

At the start of 2018, we expect there will be about 375 million SVOD subscriptions worldwide. A growing number of individuals will have access to multiple subscriptions – a trend Deloitte Global wrote about in 2014 and called "cord stacking."[181] According to one study, the majority of subscribers to Hulu and HBO Now also subscribe to Netflix.

The number of SVOD services a household may have access to is likely to increase through the end of the decade as more production houses and content owners launch over-the-top (OTT – content delivered over the internet) services.

For example, Disney is launching two SVOD services in 2018-19, one focused on sports under the ESPN brand and the other on Disney and Pixar movies and Disney TV programs.[182] In 2017, Sky launched an OTT service in Spain, following HBO's launch of an OTT service the prior year.[183] The owners of Formula 1 have announced plans to launch an OTT service in markets where they currently do not have distribution.[184]

By the end of 2020, we expect that in mature SVOD markets such as the US, an individual may subscribe or have access to multiple TV services spanning many genres, including drama, comedy, sports and kids. In the US market, a sports fan may want to subscribe to OTT services for each of the major sports (football, hockey, baseball and basketball).

In the UK market, it is already the case that to be able to follow their team, football (soccer) fans need to subscribe to two services, as games are split between two providers. A person who is also, say, a tennis fan might wish to take up an additional OTT subscription, particularly if there is only scant free-to-air TV coverage. Traditional pay TV providers, which have long broadcast in digital, are likely to offer OTT services increasingly as a complement or an alternative to existing services.

In non-English-speaking markets, we expect more local language content to be created to drive demand for OTT services. Netflix has commissioned local language productions in multiple countries, including Mexico, India, Brazil and Germany.[185] HBO is commissioning local language content, such as the Swedish language comedy *Gosta*[186] and the Spanish language drama *Patria*.[187] As more local language content is developed, SVOD services will broaden their appeal; fluency in English or a willingness to consume dubbed or subtitled content will no longer be necessary.

As the cost of programming rises, with several series now costing over $10 million per episode (and possibly heading to $20 million per hour),[188] and with the cost of sports broadcast rights continuing to increase, the number of distinct providers may end up increasing as providers reduce the size of their program portfolios and focus on fewer "tentpole" productions.

Online news

By the end of 2018, we expect there will be about 20 million digital-only news subscriptions worldwide. This is a seemingly modest total relative to SVOD television and movie services. However, online news services tend to be among the most expensive individual services, often costing tens of dollars per month, and there are also many tens of millions more subscribers to printed newspapers and magazines.

We expect news providers to focus increasingly on generating revenue from subscriptions, typically as a complement to advertising, given the challenges they have encountered during years of reliance on ad revenue alone. Whereas certain titles had a 10:90 ratio of subscription to ad revenue in 2012, we predict it may be 50:50 by 2020.

This increased focus on subscriptions has also coincided with a growing awareness among some readers of the variability of the quality of news. In 2017, the market with the biggest surveyed willingness to pay for news was the US. The desire was strongest among 18-to-34-year-old millennials. According to one study, the number of people willing to pay for online news jumped to 16 percent in 2017 from 9 percent in 2009. Multiple US-based news publications, including the *New York Times* and the *Washington Post*, have reported a surge in subscriptions from 18-to-34-year-olds.[189]

Publishers have also become more adept at identifying trigger points that can cause readers to become subscribers and at recognizing what type and proportion of content to place behind the paywall. For example, on big news days, paywalls may be lowered to encourage people to access content. Some of those who view the content then become subscribers once the paywall is reinstalled.[190] Periods in which there is major breaking news have been found to be optimal occasions for publications to request contributions.[191] In some cases, the offer of live video has helped trigger subscriptions.[192]

As mentioned earlier, the past two years have seen a marked increase in the number of publications earning regular income from subscribers – digital as well as physical.

In the US, the *New York Times* had nearly 2.5 million digital-only subscribers as of the third quarter of 2017.[193] Digital subscription revenue, including revenue from those subscribing to the crossword and to its cooking app, rose by 46 percent, to $85.7 million.[194] The *Washington Post* surpassed one million digital subscribers in 2017;[195] as of mid-2016, the newspaper had grown its digital subscriber base by 145 percent year-on-year.[196]

The *Financial Times*, which has always had a paywall, ended 2016 with 650,000 digital subscribers, a 14 percent increase over the previous year.[197] As of the end of June 2016, the *Times* and the *Sunday Times* had 413,600 subscribers, of which 182,500 were only digital.[198] *The Guardian* offers subscriptions as well as memberships. In July 2016, there were 50,000 members, each paying between £5 ($6.5), equivalent to 111 unique web browsers, and £30 ($39.3), equivalent to 666 unique web browsers per month.[199] As of March 2017, there were 200,000 members[200] and a further 185,000 subscribers.[201] In November 2016, the *Telegraph* replaced a metered paywall with a range of subscriptions, with digital-only service starting at £2 ($2.60) per week.[202]

Publications are diversifying into a range of subscription services on top of online and physical copies. For example, *Business Insider* offers subscriptions to its BI Intelligence service, which is priced at $2,500 per year and has an estimated 7,500 subscribers. Enterprise-level access costs up to $150,000. One reason *Business Insider* diversified was its recognition that it could not keep growing solely via unique users, which numbered 54 million in March 2017.[203]

CNN will also start offering tiered subscription packages for its digital news business in the first half of 2018. The premium offering will be for topic-specific news, such as CNN Money and CNN Politics.[204]

Condé Nast has diversified into offering subscriptions to gift boxes with themes of magazine titles, including *GQ, Teen Vogue, Condé Nast Traveler* and *Brides*.[205] These boxes contain a gift, usually with a retail value greater than the monthly price of the magazine; for example, *Teen Vogue* shipped an eyebrow crayon and a vibrating face-washing implement. The logic behind this venture is that it can bolster circulation and drive direct e-commerce revenue.[206] There are currently tens of thousands of subscribers. Each subscription costs a few tens of dollars per month (for example, the *Teen Vogue* box costs $39 per month).[207] The publisher has a wholly owned subsidiary that sources, packages and dispatches each box.

Music

By the end of 2018, we expect there will be about 150+ million music subscriptions. We expect that unlike video, music will attract relatively few subscribers to more than one service, as each boasts tens of millions of tracks. However, if some major artists become exclusive to individual platforms, services could become specialized, which may force some fans (perhaps begrudgingly) to pay for multiple subscriptions.

Subscriptions for music services are about $10 per month in the US, €10 in Europe and £10 in the UK – about the price of a CD. In 2015, the average per-stream rate for online music videos worldwide was $0.001, half as much as in the previous year. $10 is equivalent, in revenue terms, to the royalties for 1,000 streams.

The music industry has attained this milestone by creating a product that is built with existing mainstream digital tools: the smartphone, fixed and mobile broadband connectivity, search, hyperlinked messaging, and cloud storage. Subscription blends ease of use, portability, instant access, social features and more, in a way that is superior to the music formats that preceded it.

Growth should continue to increase for years to come – the number of subscribers is still a fraction of the number of ad-funded consumers, and any smartphone can be a repository of or a conduit to music services. However, there may need to be more tiers of service, including cheaper options costing half or less of current prices, to encourage greater adoption.

In some cases, music subscriptions may be bundled with other services, with one common combination being music included at no cost with mobile data packages.[208]

Video games

At the start of 2018, we expect there will be about 35 million subscribers to video game networks that enable online play.[209] We expect very few people to subscribe to more than one online games network, as most players would have just one brand of console, and the networks are platform specific.

The number of subscribers may appear quite small, but it is worth bearing in mind that the number of latest-generation consoles is likely to remain under 100 million at the end of 2018, so 35 percent penetration is quite respectable. Furthermore, at $5 per month, 35 million subscribers are worth an additional $2.1 billion in annual and predictable revenue on top of the money made by selling the games and consoles in the first place.

Growth in the number of online subscriptions is likely to be driven by an increased emphasis on online multiplayer, rather than individual, games. The latest version of the Gran Turismo series, which has sold 70 million copies over the past two decades, is optimized for online play, and offline play options are relatively limited.[210]

The bottom line

The total number of online media subscriptions, as well as the average number of subscriptions per individual and household, should grow by at least 20 percent in 2018 and continue to increase in the medium term. This is a positive development for the media industry.

But this estimate must be put in context. Aside from SVOD (TV and movie) and music services, the number of online-only subscribers is modest. There are only tens of millions of news, magazine and video game subscribers.

The revenue is certainly welcome, but it is, for individual media, quite modest still – in the low tens of billions globally. This contrasts with US TV ad revenues alone of over $70 billion. There is still much more work to do to increase the number and to enable the media industry to exploit digital opportunities fully.

One balance that suppliers should consider is how best to make online-only services tangible. Interestingly, demand for printed books remains far higher than for eBooks, partly because of the signal to those in the vicinity that this conveys. One's character can be signaled by the cover of a book but is invisible with an e-reader. Choice of newspaper has always been an important signal, and news organizations should consider what tangible objects (such as tote bags, pins and notebooks) could be bundled into a digital subscription to signal a reader's preferred news supplier.

It is also the case that the media industry cannot rely on online subscriptions alone, even if for some media companies this option does bring in the majority of their digital revenue. The sector should also remain focused on advertising – but with ad formats and an ad load appropriate to its customer base.

The media industry should also consider how best to sell content on an individual article, track or edition basis. In this regard, blockchain technologies may be an efficient approach to tracking supply and demand.[211]

Furthermore, other revenue models, including tips and contributions, should also be considered. As discussed in the 2018 prediction *Live broadcast thrives in an online world,* live-stream tipping revenue is now in the billions of dollars.

Middle East perspective

Subscriptions to online media in the Middle East will continue to see sharp double digit growth, higher than the global average in the near term. The region has been catching up with mature markets in terms of digital adoption and usage, despite the various levels of digital maturity across the region. Accordingly, we expect online media subscription to closely follow this trajectory. Multiple factors will underpin this transition and catalyze growth of online media subscription from both the demand and supply side.

· From the demand side: A population composed of 30 to 50 percent of millennials[xlvii] who are increasingly spending time on digital devices to browse and access media content. Moreover, while consumer expenditure per capita in certain countries (mainly GCC) is comparable to developed countries, the proportion of this spend going to media is currently less important but growing and we see potential to gradually catch-up.

· From the supply side: On the network side, high-speed broadband infrastructure is readily available in select markets within the region, the government is also taking a leading position in terms of installing next generation broadband infrastructure (5G, IoT network, etc.). [xlviii] On the service side, the region has seen a proliferation of Over-The-Top (OTT) players, most recently in the Subscription Video on Demand market (Netflix, icflix, WAVO etc.).

Among all media subscriptions, online TV and movie services are expected to witness the highest growth rate, with double-digit growth predicted for 2018. However, these services still make up a relatively small share of overall TV subscriptions. Historically, there has always been a tendency in the region for a minority of households to own multiple pay TV subscriptions (e.g. OSN and Bein) and this is being now replicated in the digital space, but at a larger scale.

Figure 18. MENA OTT TV subscriptions ('000)

2017	2018P	2019P	2020P
849	1,306	1,931	2,416
	+54%	+48%	+42%	+25%
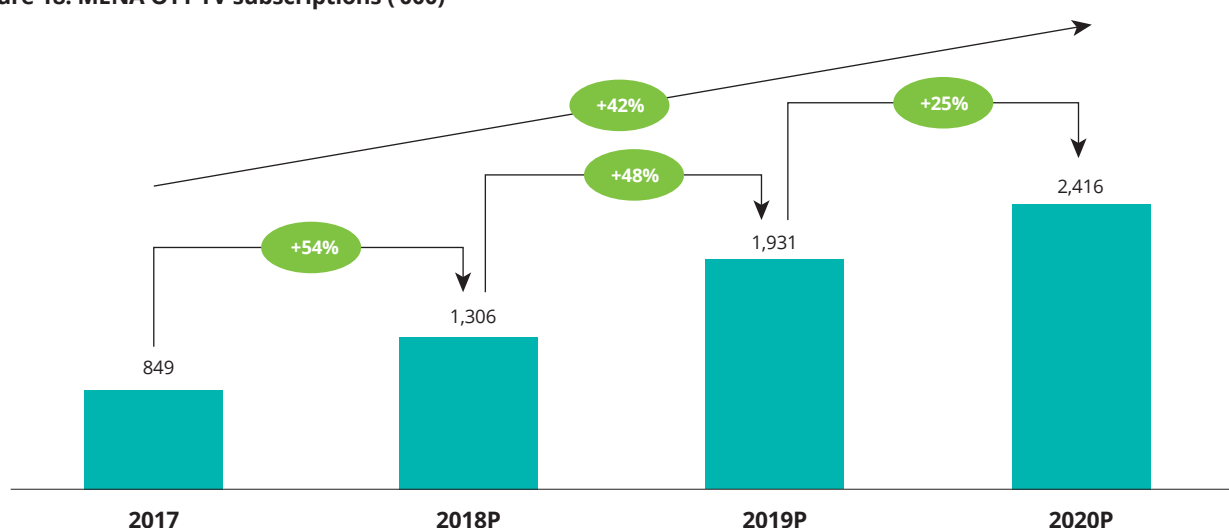
The arrival of Netflix in 2016 had a transformational impact in terms of expanding the subscription video on demand (SVOD) subscription base and compelling local players to introduce their own SVOD offerings, while bearing the risk of cannibalizing their own product base. For example, OSN launched its own Over-The-Top (OTT) service called *Wavo* in 2017.

In the near future, SVODs will increasingly establish partnerships with players across the value chain to drive subscription growth. Partnerships may take the form of, for instance, joint offers with telecommunication operators. *E-Vision*, an Etisalat subsidiary, and *Starz Play* recently signed a five year deal to broadcast content on Etisalat's IPTV box.[xlix] In addition to this, SVODs will start producing & broadcasting localized content tailored to the region. Netflix started to produce its first Middle Eastern content – "Jinn" its first Arabic original series will follow its Arabic stand-up comedy "Adel Karam: Live from Beirut" due to launch in March 2018.[l] As more content owners and production houses launch SVOD services, we also expect a minority of users to have multiple SVOD subscriptions mimicking behavior observed in Pay TV subscriptions.

Other media, such as gaming, music, and online news will follow this upward growth pattern, though at a slower pace.

- Music streaming appeared in the region many years ago with the launch of localized streaming platforms such as *Anghami*, which has over 5 million monthly active users,[li] as well as the adoption of international platforms such as *Deezer*. The recent arrival of new players in the region like Apple Music is putting increased pressure on local platforms to bring further innovation through enhancing their catalog selection, launching bundled offers (i.e. bundling a postpaid plan with a music streaming subscription), and collaborating with artists to produce content.

- Although online gaming subscription numbers are fairly limited, the Middle East remains an important consumer of video games. Nearly four in ten nationals in the region play video games (36 percent) and six in ten nationals who own a smartphone play games on their phone (59 percent).[lii] Regional gamers tend to subscribe to game networks such as *PlayStation Network*, as well as targeted smartphone games. The launch of popular multiplayer games on smartphones and the introduction of new console innovations such as virtual reality technology will be two important factors driving subscribers growth in the region.

- As consumers lack a willingness-to-pay for news content, and the total number of hours spent reading in the region remains below the global average, online news subscriptions will most likely lag behind growth of other media in the region. Leading publishers across the world launched online subscriptions models to diversify their sources of revenue and this has yet to happen in a meaningful way in the region, as a limited number of publishers propose digital subscription offers. However, as publishers face increasing pressure to manage their bottom lines, selected newspapers especially in Lebanon such as *L'Orient le Jour* and *An-Nahar* are now offering digital subscriptions. In this respect, we expect a number of publishing houses to increasingly explore these types of offerings in the years to come.

The stars are aligned for online media subscription in the region, with SVODs taking the lead in terms of total subscription numbers and growth rate. Broader choice and content library expansion will be the two main elements responsible for driving industry growth in the region this year. However, this will be restrained to a minority of affluent households having multiple subscriptions and driving overall growth, whilst large parts of the population are yet to subscribe to a digital platform due to affordability, access to free content, and cultural factors.

Is there an #adlergic epidemic? Ad blocking across media

Deloitte Global predicts that 10 percent of North Americans over age 18 will be engaged in four or more multiple, simultaneous advertisement-blocking behaviors in 2018; we call these people adlergic. In a Deloitte Global survey conducted in mid-2017 of 1,096 Americans and 1,090 Canadians aged 18 to 75, we measured ad blocking across various media and devices. We found that while about three-quarters of North Americans engage in at least one form of regular ad blocking, a much smaller subset of about 10 percent blocks ads across four or more types of traditional and digital media channels most of the time. Some forms of ad blocking (such as software on computers and mobile devices, and streaming music and video services) are growing relatively quickly, while other forms of ad blocking (such as ad skipping with personal video recorders [PVRs] or changing channels on TV or radio) are stable or growing slowly. We predict the percentage of adlergic people will be about one percentage point higher in 2018 (see Figure 19) in North America.

The adlergic percentage is much higher for millennials aged 18 to 34, with over 17 percent blocking ads in four or more categories, and we expect this percentage to increase one or two percent in 2018. Nor is age the only demographic factor that seems to affect the tendency to block four or more categories. In all countries studied, people who were employed and had higher incomes and more education were all more likely (by 200 to 400 percent) to be heavy ad blockers than were less-educated people who were not working and had lower incomes (see Figure 22).

Finally, it appears that almost nobody blocks all ads. We are referring not to categories that are inherently impossible to block (for example, a highway billboard), but instead to the fact that across the seven major ways of blocking ads, the percentage who block all seven was zero or nearly zero in all countries surveyed in 2017, and we predict that will be true again in 2018.

While doing research on a different project, we happened to conduct the same survey in Turkey, and we include the findings for those who are interested. Turkish data is shown on all charts, but more detailed data can be found in a separate section below.

Figure 19. #Adlergic population measured by number of ad-blocking behaviors
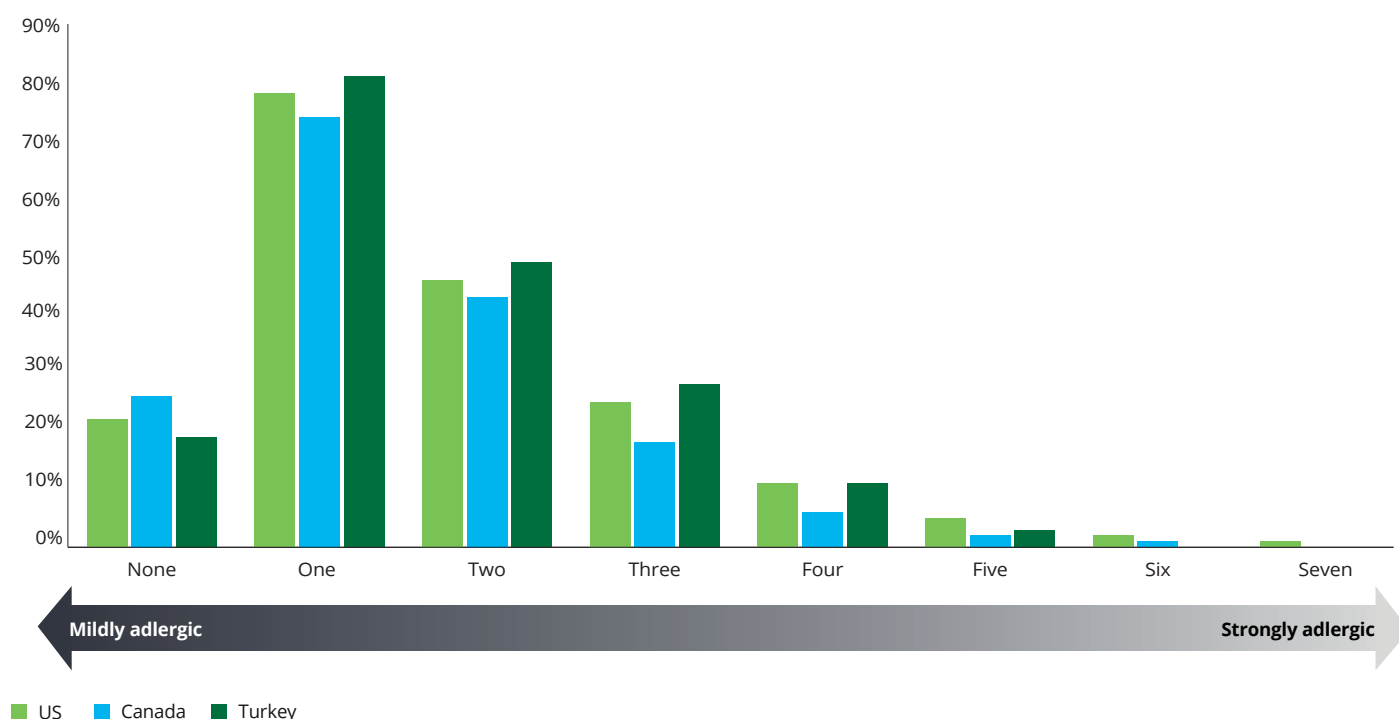
Weighted base: Deloitte Global survey of adults USA (1,096), Canada (1,090), Turkey (1,061)
Source: Deloitte Global survey, Aug-Sep 2017

What are the various ad-blocking behaviors being counted as part of the adlergic population? See Figure 20 for an overview of how the various behaviors occur across the countries studied.

Figure 20. Ad blocking by category
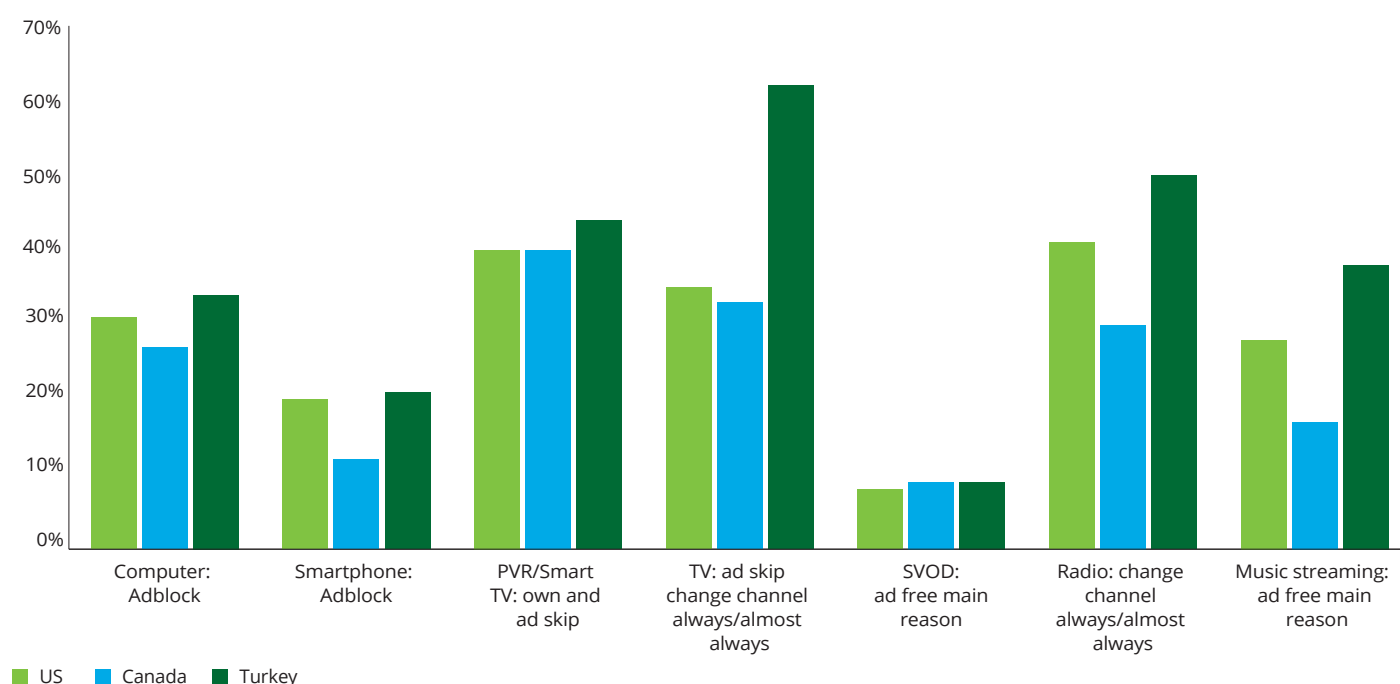
Weighted base: Deloitte Global survey of adults USA (1,096), Canada (1,090), Turkey (1,061)
Source: Deloitte Global survey, Aug-Sep 2017

PC and mobile: Ad-blocking software on computers is not new: 18 percent of users in the US and 24 percent in Canada used the software as of 2016.[212] Deloitte Global's survey found that PC ad blocking was even higher in 2017, with 31 percent of Americans and 27 percent of Canadians using this technology. In both countries, men were over 10 percentage points more likely than women to use PC ad blockers, and also in both countries, 18-34 year olds were over 10 percentage points more likely than were the average of people of all ages. Indeed, 50 percent of 25-to-34-year-olds in the US said they used a computer ad blocker. Given the growth versus 2016 numbers, it seems likely that PC ad blocking will continue to grow and will almost certainly be in place on at least one in three computers in North America by 2018. That number could be even higher, as a popular web browser (both PC and mobile) may soon incorporate ad-blocking software without the need for users to download additional modules.[213] It will not block all ads, but it may block those that do not comply with the Better Ads Standard, such as ads that launch automatically and play loud music, for example.

Mobile phone ad blockers are common in some regions around the world. In one study, 28 percent, 13 percent and 58 percent of smartphone owners in India, China and Indonesia, respectively, used some version of the software. Some studies suggest that mobile ad blocking in North America is minimal – one percent[214] or even zero.[215] Our 2017 Deloitte Global survey showed much higher self-reported rates of mobile ad blocking; 20 percent of Americans and 12 percent of Canadians said they used a mobile ad blocker. The demographic trends in computer ad blocking were seen in both countries. Young people were more likely to use mobile ad blockers, and men were more likely than women; 30 percent of US men, compared with only 10 percent of US women, said they had a mobile ad blocker. It seems likely that the motivations for ad blocking on phones (data consumption, etc.) mean that the percentage of mobile ad blockers is likely to grow in 2018.

Traditional TV: In our survey, 65 percent of Americans and 60 percent of Canadians said they own either a smart TV or a digital video recorder (DVR), and of those, over 80 percent in each country said they watch recorded shows and use the fast-forward function for various reasons, while about 20 percent have the devices but never use that function; therefore, about 50 percent of the total population in each country have a device that permits fast-forwarding and use that functionality. In the US, 61 percent of those who have a smart TV or a DVR said they did it to skip ads rather than for other reasons, while the equivalent Canadian number was 67 percent. In the US, women with devices that allowed fast-forwarding were slightly more likely to skip ads (64 percent compared with 58 percent for men), and ad skipping was relatively consistent by age in both countries.

The more interesting demographic variations related to education and income. Americans who owned a smart TV or a DVR and had more education and the highest incomes were 13 percentage points more likely to skip ads, while those with children were less likely (by seven percentage points) to do so. Canadian data showed little difference by education or presence of children, but 70 percent of Canadians making more than C$100,000 annually who had the devices fast-forwarded to skip ads, while only 55 percent of those making less than C$25,000 did so.

According to the official TV measurement data, only 11 percent of all traditional TV viewing is time-shifted (watched after original broadcast) in the US,[216] and under 9 percent is time-shifted in Canada.[217] These numbers are broadly consistent across ages, with American 35-to-49-year-olds watching the most time-shifted content, at 14 percent; 18-24 year olds watching 10 percent nonlinear programs; and those age 65+ watching nine percent time-shifted shows. There is only slight variation by race in the US as well, with Black and Hispanic Americans consuming 8-9 percent of all TV in a nonlinear way, while Asian Americans are at almost 13 percent.[218] Canadian 18-34 year olds are more likely than average to time shift, at almost 12 percent.[219]

Even those who do not have DVRs or smart TVs can still engage in ad-blocking behavior; they can change the channel, mute the sound, leave the room, or look at their phone, tablet or computer (known as second screening) when a commercial comes on.

See Figure 21 for the US and Canadian data on those who always or almost always engage in these behaviors. Each behavior is slightly more prevalent in the US than in Canada, but the tendency toward each category is roughly similar in both countries. From the perspective of advertisers, not all ad-avoiding behaviors are equivalent. Leaving the room means the target of the advertisement sees and hears nothing; those changing channels probably see bits of ads; those muting may not hear the ads but still see the visual content; and those second screening on tech devices are likely still to hear the audio if not to concentrate on it.

There were important demographic variations in both countries. Those who were younger were more likely, sometimes by only a few percentage points, to do any of the four activities in order to avoid ads, but for second screening, 18-24 year olds were nearly 30 percentage points higher than the average for all ages, at 82 percent. And for all four behaviors, Americans with more education, higher incomes and a job (as opposed to being unemployed) were more likely to avoid TV ads. Not all of the differences were statistically significant, but many are. For example, 40 percent of Americans who were working or had a bachelor's degree or higher changed the channel always or almost always to avoid ads, while only 25 percent of those who were not working or had no college education did the same. The demographics in Canada were approximately similar but more muted, with narrower differences by age, gender, income and education.

In the US, women with devices that allowed fast-forwarding were slightly more likely to skip ads (64 percent compared with 58 percent for men), and ad skipping was relatively consistent by age in both countries.

Figure 21. "To avoid ads when watching TV, I always or almost always …"
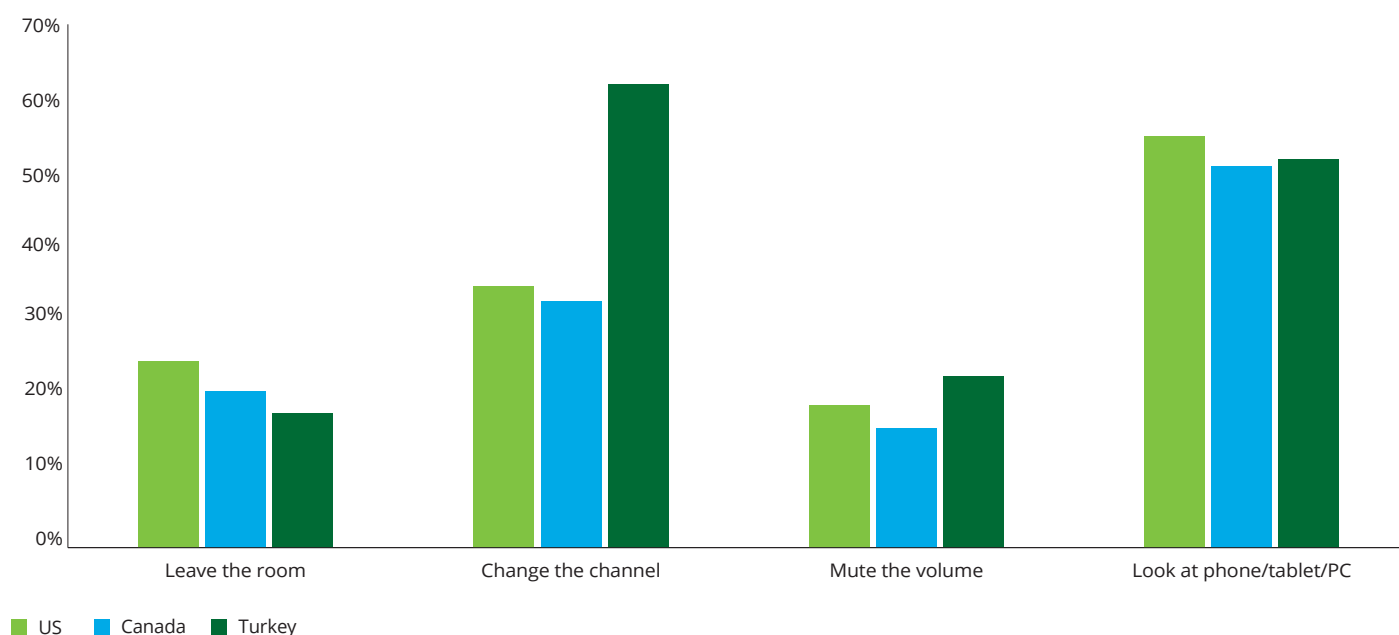
Weighted base: Deloitte Global survey of adults USA (1,096), Canada (1,090), Turkey (1,061)
Source: Deloitte Global survey, Aug-Sep 2017

It seems likely that the percentages using DVRs, smart TVs or any of the four other TV ad-blocking behaviors will remain similar in both Canada and the US in 2018.

Nontraditional TV, aka SVOD: Of course, not all video being watched in 2018 is traditional TV with ads. A number of subscription video-on-demand (SVOD) services are ad-free: 65 percent of Americans subscribe to one or more of these, and 47 percent do in Canada. In Canada, however, it is important to note that language plays a big role. In the mainly French-speaking province of Quebec, SVOD penetration is 34 percent, while the average for the mainly English-speaking other provinces is 53 percent.

The demographics of SVOD customers are unsurprising. In the US, 89 percent of 18-24 year olds subscribe to at least one service, while only 36 percent of 55-to-75-year-olds do. Those who are working are at 70 percent, and those not working are at 56 percent. Those with any college education or degree had a figure of 67 percent compared with 55 percent for those with no college education.

Finally, 71 percent of those with incomes over US$75,000 had at least one SVOD, while those earning under US$25,000 annually were at 49 percent. Canadian demographic splits were about the same, albeit a little narrower.

There are many reasons why someone would subscribe to a paid streaming service; 46 percent of Americans who had SVOD said that the fact they are ad-free was one of the reasons for subscribing, while eight percent said it was the main reason they subscribed. The equivalent Canadian figures were 57 percent and nine percent, respectively.

Looking forward to 2018, it seems likely that the total percentage of homes subscribing to one or more SVOD services will increase, and it also seems likely that the percentage for whom being ad-free is the main reason would be about the same. If 70 percent of Americans have an SVOD subscription in 2018 and it is still eight percent who feel most motivated by being ad-free, then about six percent of all Americans and about five percent of English-speaking Canadians will be using SVOD as a form of ad blocking.

Radio and music: People can also subscribe to ad-free versions of streaming music. In our survey, 33 percent of Americans pay for at least one ad-free streaming music service, while in Canada the number is only 19 percent. In both countries, the familiar demographic trends follow, with those who are higher-income, more educated, employed and younger all being more likely to subscribe to at least one premium ad-free music service. As one example, 41 percent of working Americans subscribe, while only 21 percent of those who are not working do so. Unlike SVOD, where the ad-free nature was the main reason for less than 10 percent of Americans and Canadians, the ad-free nature is a much more important factor in using premium streaming music services. Of Americans who had a subscription, 86 percent said the fact that there were no ads was either an important or an essential reason why they subscribed, and the equivalent number for Canadians was 89 percent.

And just as with traditional TV, there is a lower-tech version of ad blocking for traditional radio, especially when driving; 41 percent of Americans surveyed said they always or almost always change radio stations as soon as a commercial break occurs, with 30 percent of Canadians saying the same. There are unusually strong age-related effects in this behavior; over 60 percent of US and Canadian 18-24 year olds change stations always or almost always, while fewer than 20 percent of those aged 55-75 in either country do so.

Looking forward, Deloitte Global predicts that traditional radio ad-blocking behaviors will be more or less similar in 2018, but we do expect more people to subscribe to premium ad-free music services, with perhaps 30 percent of Americans subscribing to at least one service with the aim of avoiding ads.

The demographic divides within the adlergic population don't apply to just age. It also turns out that those who are more highly educated, have higher incomes and are employed tend to be more adlergic (see Figure 22). The absolute numbers of people in each country who are blocking four or more types of ads are small, so the results need to be interpreted with caution. That said, some of the differences are so large that they merit consideration and further study. These are, of course, demographics that are of particular interest to many broadcasters and advertisers. The percentages do not vary by gender, with women about as likely as men to be adlergic.

Figure 22. The demographics of those blocking four or more types of advertising
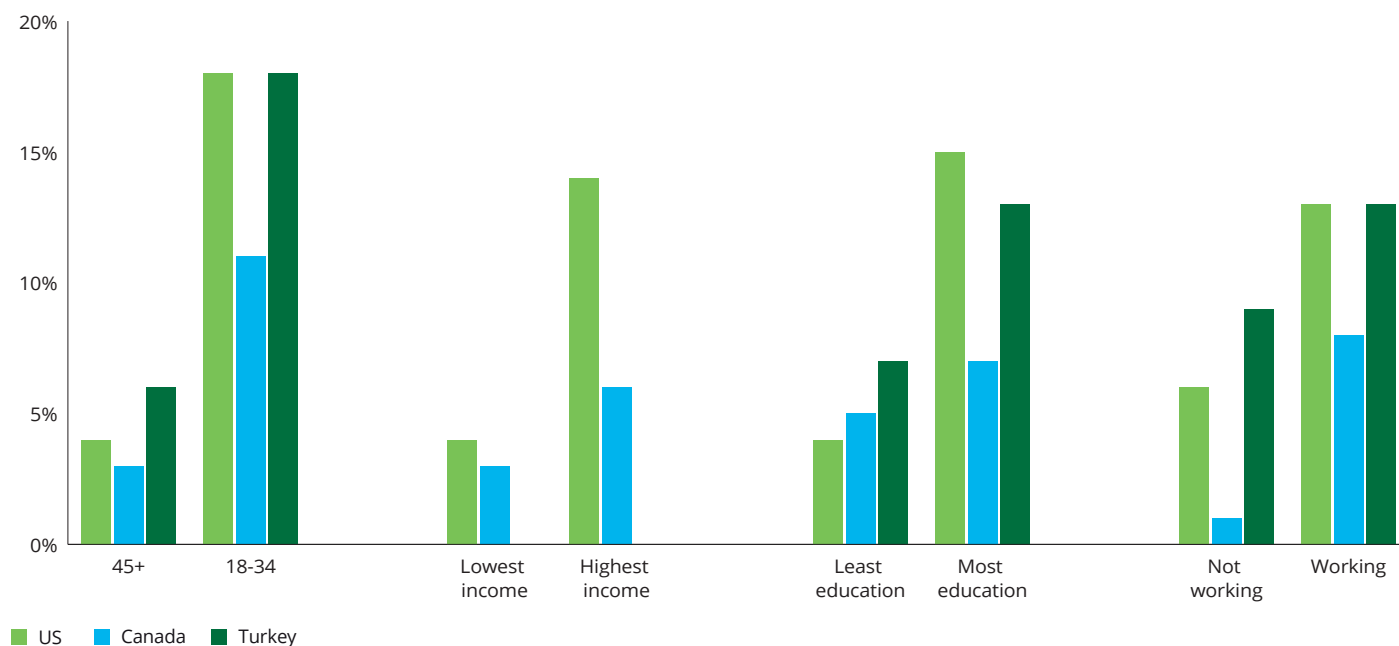
Weighted base: Deloitte Global survey of adults USA (1,096), Canada (1,090), Turkey (1,061)
Source: Deloitte Global survey, Aug-Sep 2017

It should be stressed that with only 10 percent of the US and Canadian population blocking four or more categories of media, the other 90 percent see a lot of ads, depending on the media channel, and do not seem to mind them enough to strive to avoid them. Roughly one in five is not blocking any ads. Further, though the adlergic group blocks many ads, they do not block all of them.

Most ad-blocking software filters out only a portion, and even the most dedicated DVR user usually still watches some TV live (often sports, reality, news, weather or award shows) and is therefore likely to see some, many or all of the ads.

The bottom line

Broadly speaking, it seems that if advertisers want to reach those who are blocking ads, especially those who are younger, employed, higher-income and better educated, then the ad categories that cannot be easily blocked are likely to be the fastest-growing ad categories for the next few years. Mobile and apps are expected to grow in the US in 2018 by 28 percent over 2017, out-of-home (OOH) by 5.5 percent (with digital OOH up 18 percent)[220], and social media ad spend by 14 percent.[221]

Even within social, there are growing subcategories that should be considered. The rise of the social media influencer was worth $1 billion in 2017, and this is expected to double by 2019, which is equivalent to over 40 percent compound annual growth.[222] When targeting the youth market, some advertisers are moving past influencers and sponsoring Slack channels (Slack is a digital workspace, and channels are how users communicate and share) and even festivals.[223]

The most obvious target for advertisers eager to get around the ad blockers should be digital mobile. Although computer (laptop and desktop) ad blocking is fairly common, at around 30 percent, mobile was lower, at a self-reported 20 percent, and we believe that number may be a large overestimate. Further, when ad blocking takes place on mobile, it occurs at the browser level and does not block in-app advertising. But how big is the mobile app market in terms of time spent?

According to an August 2017 comScore report on US habits, adults age 18+ spent 50 percent of digital media time inside smartphone apps and seven percent within tablet apps, for a total of 57 percent inside mobile apps.[224] However, that time split is for all adults. The youngest group, 18-24 year olds, spent 70 percent of their digital time inside mobile apps and only 23 percent on computers, while those age 65+ spent just under 40 percent on mobile apps and 53 percent on computers (see Figure 23 below).[225]

These averages are important, but advertisers need to keep in mind that in-app time spent varies dramatically by category of digital media. For social networking, gaming and dating categories, mobile app time spent is 70 percent, 81 percent and 79 percent, respectively. On the other hand, for all other categories, mobile apps make up less than half of time spent, and for travel and sports categories mobile app time is in fact lower than for desktop, at around 33-34 percent.[226]

Figure 23. Share of platform time spent, by age, 2017

	Desktop	Smartphone app	Smartphone web	Tablet app	Tablet web
Total	34%	50%	7%	7%	2%
18-24	23%	66%	7%	4%	1%
25-34	31%	54%	7%	7%	1%
35-44	32%	53%	8%	6%	1%
45-54	36%	48%	7%	7%	2%
55-64	34%	46%	7%	10%	3%
65+	53%	27%	6%	12%	3%

■ Desktop   ■ Smartphone app   ■ Smartphone web   ■ Tablet app   ■ Tablet web
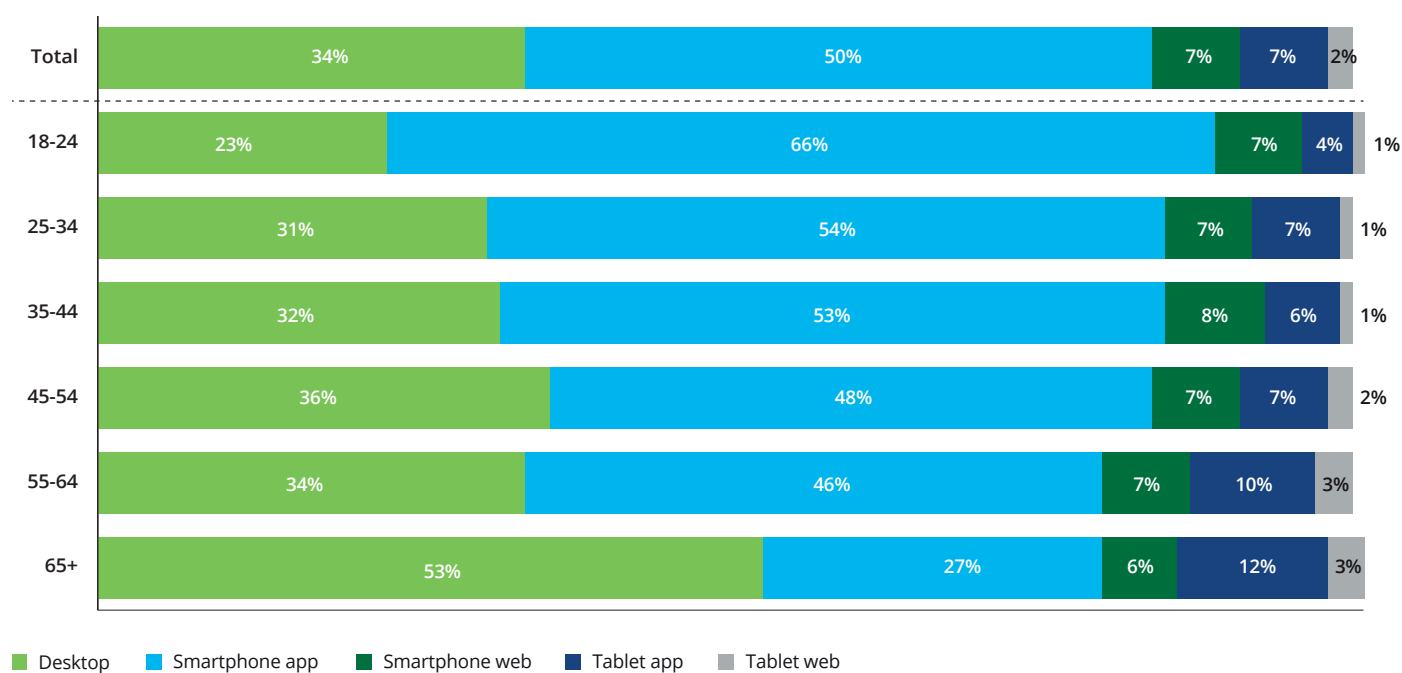
Source: comScore Media Metrix Multi-Platform & Mobile Metrix, US, Age 18+, June 2017

Broadcasters may want to offer versions of their schedules that are ad-free (or largely ad-free) but have a monthly subscription cost. Some networks are already doing this,[227] although subscriber take-up of paid ad-free services has been modest thus far. As one example, the ad-free version of YouTube has an estimated 2.5 million subscribers,[228] while the ad-supported version reaches billions.

Product placement is another category that cannot be ad blocked. It was worth about $6 billion in the US for 2015 and is predicted to grow at over a 20 percent compound annual growth rate, to $11.44 billion in 2019.[229] Given that total US ad spending is over $200 billion annually, product placement is running at about 3-4 percent of total spend. It seems to be a significant factor only in the Americas. The US, Mexico and Brazil product placement markets make up over 80 percent of total placement spending worldwide.

Finally, time to talk Turkey – and other countries that aren't the US and Canada.

Although there are important differences between Turkey and the North American countries, the ad-blocking behaviors are strikingly similar. If anything, it seems that the actions of Turks and Americans are closer to each other, with Canadians being the outliers.

Those surveyed in Turkey seem to be more interested in changing TV channels or radio stations (Figure 20), and the gaps between those working/not working and most educated/least educated are narrower than in North America (Figure 22). But in general, and even in detail in multiple categories, the similarities are much greater than the differences.

This is probably not true for many other markets. In another English-speaking market, we suspect the level of ad-blocking behaviors would be much lower. In the UK, TV ad loads are much lower, and TV and radio commercial breaks are synchronized, for example. Therefore, we think that the motivation for changing channels and the effectiveness of the strategy would be reduced. Similarly, conversations with French audiences in 2017 would suggest that not only are SVOD levels lower, but the use of DVRs to skip ads also is much less common than in North America.

Therefore, caution must be used. The North American results do not apply globally – although, as the Turkish results show, neither are the North American results unique; other countries seem to show similar tendencies at least some of the time.

The kids are alright: no tipping point in TV viewing trends for 18-24 year olds

Deloitte Global predicts that traditional TV viewing (see below for definition) among 18-24 year olds will decline by 5 to 15 percent per year in the US, Canada and the UK in both 2018 and 2019. In each market, this would be a rate of decline similar to that of the past seven years. The decline is neither exacerbating nor improving; there is no tipping point, and viewing is not collapsing. We expect 18-24 year olds in all three markets to watch at least 80 to 120 minutes of TV per day in 2018, with variation by season.

Deloitte Global further predicts that through 2023, annual TV viewing drops in the 5 to 15 percent range should continue. However, we think it is possible the rate of decline may be at the lower end of the range as the impact of the forces that have been distracting young people from traditional TV weaken.

In the past five years, all millennials in general and trailing millennials in particular have been lured by smartphones, computers, social media, YouTube and other short-form aggregators, subscription video-on-demand (SVOD) services like Netflix, and video piracy. All these distractions are reaching saturation (perhaps as early as 2018, but very likely by 2020) in these three large English-speaking markets and are showing flattening annual growth in penetration and usage, meaning that the erosion of TV minutes may well slow, even if it does not stop altogether.

The definition of "TV viewing" has evolved over time and varies by country. When current measurement systems were implemented, TV programs were viewed only on TV sets, and almost all viewing was live, so measurement was relatively straightforward. As of 2017, in the US and Canada, TV viewing includes live and time-shifted viewing of TV content on TV sets, connected TV devices, computers, smartphones and tablets. The scope has changed over time, and data from earlier periods may not include viewing on some of those non-TV devices (tablets were added only in the past year, for example). Further, the period included as live and time-shifted has changed over the years. In the UK, it means programs viewed on a TV set, either live or time-shifted by no more than eight days. Viewing, either live or time-shifted, on other devices is not included. In all three markets, TV viewing excludes SVOD services such as Netflix, online video content such as YouTube or pirated content, regardless of viewing device.

Millennials, also known as Gen Y in some countries, are those born between 1981 and 2000, who will be 18 to 37 years old in 2018. Demographers often split them into two groups, leading millennials being older and those 18-24 in 2018 belong to the category of trailing millennials. However, our prediction is not about trailing millennials per se; it is about the media behaviors of 18-24 year olds, considering past behavior, present dynamics and future outlook. The data we analyze looks at measured consumption of 18-24 year-olds from 2011 (whose cohort is now 25 to 31 years old). This prediction is mainly about the age group, not the cohort. That said, when predicting future behavior of 18-24 year olds, it is also important to consider current behaviors among 10-18 year olds today.

Figure 24 shows the annual changes in traditional TV viewing for similar youth age groups in the US, UK and Canada from 2011 to the present (the blue box at the end of this prediction provides guidance on interpreting this chart). Traditional TV viewing by 18-24 year olds is in structural decline. This is an enduring trend. In the period from 2011 to 2013, annual declines for this age group varied by quarter but were largely in the range of zero to 10 percent. As of 2014, there were sharper drops in viewing, and since then, annual declines have tended to be in a range from about four percent to about 11 percent, with 53 of the 76 quarterly data points in the chart falling into that range. As those in other media businesses disrupted by digital can attest, single-digit declines are far preferable to double-digit ones. The trend does not seem to be accelerating. There have been some quarters in which the annual rate of decline has exceeded 15 percent in the UK and in the 20 percent range in the US in two quarters, but these appear to be outliers.

UK declines look stable, and in both Canada and the US, there seems to be a stable-to-moderating trend in annual drops in TV viewing by this youngest age group. That could change, but the worst seems to have passed.

In the past five years, all millennials in general and trailing millennials in particular have been lured by smartphones, computers, social media, YouTube and other short-form aggregators, subscription video-on-demand (SVOD) services like Netflix, and video piracy.

Figure 24. Yearly change in traditional TV viewing by young people for the US, UK and Canada, 2011-17
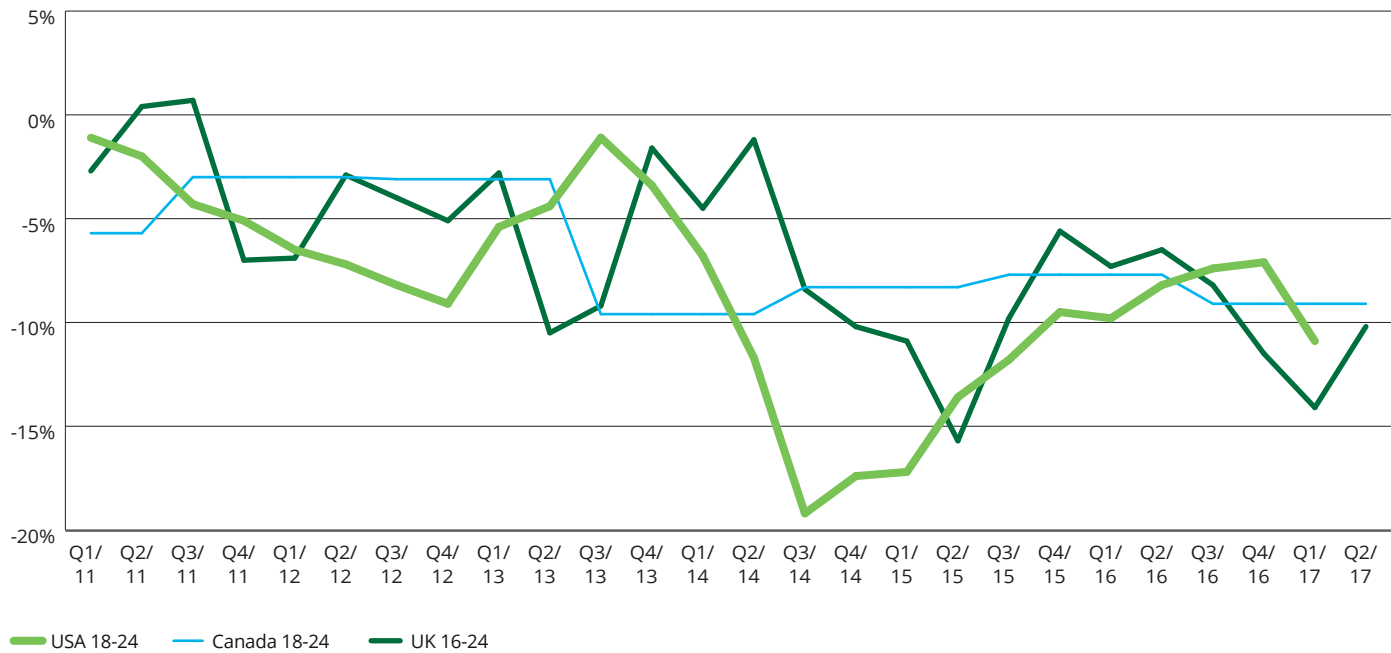
Sources: Nielsen, Numeris and BARB

It seems likely for the rest of 2017 that we will see more severe viewing declines in the US and the UK. The US presidential election caused a spike in TV news viewing by young people.[230] Even in the UK, the US election TV ratings in 2016 were double those in 2012.[231] Therefore, the year-over-year comparisons are likely suffering in 2017 now that the big TV news events are probably over. Young people in the US are still watching over 100 minutes of traditional TV per day as of 2017. We expect smaller declines in 2018 and 2019 than in 2017.

The reason is that it seems recent declines in traditional TV viewing by 18-24 year olds were in large part caused by smartphones, SVOD services, social media, piracy and ad-supported online video, all of which have acted as competitors or substitutes for traditional TV. All of these options existed before 2014, when viewing by 18-24 year olds started declining faster, but entered the steep part of adoption and usage curves more recently and collectively diverted 18-24 year old eyeballs away from TV sets. (Video games are also a distraction, but they have been so for decades, at a constant level.)[232]

None of these factors should become significantly much less or more important going forward.

Smartphones are near ubiquitous among trailing millennials; penetration cannot grow much further.[233] Ownership of smartphones among 18-24 year olds in the US surged from 55 percent in 2012 to 94 percent in 2015 but remained unchanged in 2016. UK and Canadian smartphone penetration for this age group is similar in 2017, at 95 percent and 92 percent, respectively.[234]

Growth in time spent with smartphones may be about to start slowing. In the US, time spent on apps and the web among 18-24 year olds surged from 90 minutes daily in 2015 to 156 minutes per day in 2017, a 73 percent increase.[235] But 18-24 year olds in the US are already spending more minutes per day with their phones than watching TV (156 minutes versus 124 minutes). We expect smartphone time will continue to increase, and TV time continue to decrease, but given the finite number of media minutes in a day, it seems likely that smartphone minutes will not increase as quickly in the future as they have in the past.

Smartphone screen area is unlikely to continue growing. The larger the smartphone screen, the more viable this device is for watching video. In the US, as of September 2014, there were 60 million phones with screens larger than 4.5 inches. The other 120 million phones were smaller. By December 2016, there were only 40 million of the smaller phones and 160 million larger ones.[236] Given new product launches, over half of all new phones may have screens over 5.5 inches, compared with 5 inches in 2016, which is likely to drive a little more mobile video viewing, but the magnitude will likely be smaller than we saw after the increase from 4.5 inches. Bigger smartphone screens have meant that 18-24 year olds have gone from watching 4.6 minutes of video on their phones daily in 2015 to 11.9 minutes in 2017.[237] But phones are unlikely to get any larger going forward, as it seems we are close to the maximum most people will use, given the size of the average hand, a desire by some for single-handed use and the size of the average pocket.

More young people have SVOD services such as Netflix and use them more each day. Netflix access among US 18-34 year olds (not just trailing millennials) almost doubled from 28 percent in 2012 to 50 percent by 2015.[238] Adding other streaming services to Netflix, SVOD penetration in the trailing millennial demographic is much higher. According to a Deloitte Global 2017 survey (see Figure 25), 89 percent of US 18-24 year olds have a subscription to an SVOD service, while the number in English-speaking Canada is about 90 percent.[239] (SVOD penetration in French-speaking Canada is about 20 percentage points lower.) Daily usage for Netflix globally was about 1.2 hours per subscriber per day in 2012 and 1.8 hours in 2017.[240] But that number isn't growing in the way it has in the past. More recent quarters suggest that daily viewing seems to be about flat year-over-year,[241] which suggests that in 2018, streaming will not be subtracting much more from TV viewing. There are other SVOD services, but as Figure 25 shows, they seem likely to have a weaker effect on TV viewing than Netflix due to lower penetration, especially in English-speaking Canada. In that market, although some respondents had more than one SVOD subscription, all of them had Netflix at a minimum.

In the US, time spent on apps and the web among 18-24 year olds surged from 90 minutes daily in 2015 to 156 minutes per day in 2017, a 73 percent increase.

Figure 25. SVOD subscriptions for 18-24 years olds in the US and English-speaking Canada, 2017
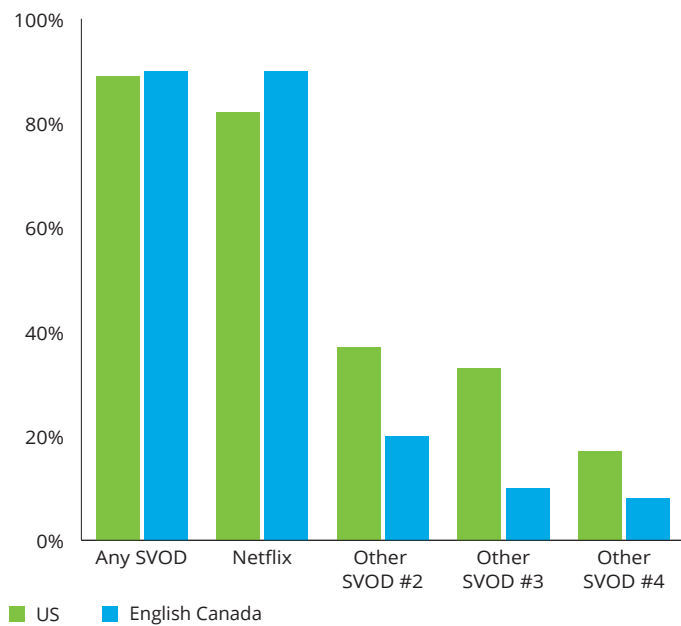
Weighted base: Deloitte Global survey of 18-24 year olds: US (140) and English-speaking Canada (101), Aug-Oct 2017.

Young people are consuming more streaming video from services such as YouTube. Streaming video hours weekly for US millennials rose from 1.6 hours in Q4 of 2013 to 5.7 hours in the same quarter of 2015, more than tripling in two years.[242] Although we expect the number to continue growing, it seems unlikely that it will triple again in the next two years.

Social media apps are ubiquitous and time-consuming. As of December 2016, over 60 percent of US 18-34 year olds were on Snapchat, over 75 percent were on Instagram and 95 percent were on Facebook. Daily use of each platform by those aged 18-34 years averaged 14 minutes, 13 minutes and over 30 minutes, respectively – meaning that between the three, total daily social media usage approaches one hour.[243] Snapchat was used by 38 percent of US 18-24 year olds in December 2013 and by 78 percent in December 2016.[244] However, time spent by 18-34 year olds on social media is growing more slowly (at 21 percent year-over-year) than it is for 35-49 year olds (29 percent) and for those over 50 (64 percent).[245] Social media time for millennials may increase but is unlikely to double again in the near term. Time allocated to social media has been shifting between platforms, and that is likely to continue, but the overall time spent on social media appears to be plateauing at around an hour per day for 18-24 year olds.

Young people may have reached peak piracy levels. Although millennials are now less likely to download, they are still pirating video content, largely via streaming. Of 18-24 year olds in 2016, 42 percent said they illegally streamed video on their desktop/laptop, and 41 percent said they were streaming illegally on their mobile devices.[246] Data for piracy is hard to measure directly, and self-reported surveys are likely to be inaccurate, but based on a series of focus groups with 18-35 year olds in North America, Europe and the Nordics, we believe that although young people are unlikely to pirate less content, it is not the case that piracy levels are accelerating.

The bottom line

The traditional TV businesses – broadcasters, distributors and advertisers – should assume that 18-24 year old viewing minutes will continue to see annual declines in the high single digits. But they should not expect sustained double-digit declines. US TV viewing by 18-24 year olds will, depending on the quarter, probably be 90 to 110 minutes daily in 2018, and 80 to 100 minutes daily in 2019, with UK and Canadian minutes declining to roughly the same levels.

Although traditional TV viewing is declining, the relative proportions that are viewing live and time-shifted TV are not changing much over time. In 2017, 90.8 percent of TV viewing by US 18-24 year olds was live, up fractionally from 90.5 percent in the same quarter of 2015.[247] This suggests that even as younger viewers change some of their video consumption to streaming services or to non-video alternatives, there is a "core" of TV options they continue to prefer to watch live.

What genres of traditional TV are millennials 18-34 years old watching? In 2017 in the US, sports was still a big draw, with six of the top 20 shows and five of the top 10 being American football. Reality shows were also popular, with three of the top 20 from this category, although none were in the top 10. The other top 20 shows for the year were a mix of comedy, drama, police procedurals and animation.[248] It seems likely that these patterns will continue, and TV producers and advertisers will continue to need a balanced mix of genres to reach younger viewers, with no category (except perhaps live sports) dominating.

Although younger viewers may be less likely to watch traditional TV (either through a distributor such as a cable, telco or satellite provider) and over-the-air (OTA) with a digital antenna, they are more likely than other demographics to consume SVOD services. More important, they are more likely to subscribe to multiple services; in a 2017 US study, nearly a quarter of 18-29 year olds who were SVOD subscribers, compared with only 18 percent of the adult subscribing population as a whole, were paying for three or more separate subscriptions.[249] That same age group was also the most willing to pay for live SVOD content, with two-thirds of men in the demographic willing to pay for live TV.[250]

It seems likely the industry should look closely at moving beyond the arbitrary split of watching traditional linear TV (either on a TV or on any device) and watching the same thing but streaming over the internet. Measuring total audience will likely become best practice, with one large US sports network already moving in this direction in late 2017. The shift in measurement is expected to add as much as five to seven percent to younger audiences.[251]

Finally, as mentioned above, it is important to watch the habits of those who are the 18-24 year olds of the future. In both the US and the UK, their traditional TV viewing is declining as well, and often by annual percentages even worse than we have seen from current 18-24 year olds. In the UK, viewing by children (those under 16) has declined by over five percentage points more than viewing by 16-24 year olds since 2010,[252] and in the US, the decline in TV viewing by 12-17 year olds has fallen by two percentage points more than 18-24 year old viewing.[253] If the habits of this next generation persist over the next few years, our projections for stable or even less-severe declines could be wrong.

📊 Details on interpreting the chart

01. Line thickness indicates population size. The age break used in the US and Canada is 18-24 year olds, while the UK age break is 16 -24 year olds.

02. In the period measured, there were about 25 million to 27 million 18-24 year olds in the US,[254] about 7 million 16-24 year olds in the UK, and over 3 million 18-24 year olds in Canada.[255]

03. Data in each country is sourced from the traditional leaders in TV viewing measurement: Nielsen in the US, BARB in the UK and Numeris in Canada.[256]

04. There are multiple important differences in the measurement methodologies used by the three data providers. These are far too many to enumerate, but they almost certainly matter. Some viewing data includes tablet viewing, while some does not. Some is passively measured, others rely on diaries, and the definition of live is different, etc.

05. The Canadian data is annual instead of quarterly.

06. There are important country differences. Just a few examples:

    A. Although used for a small portion of all viewing, BBC iPlayer is a factor in the UK (and appeals to younger viewers), and there is no real equivalent in the North American markets. As of 2017, 44 percent of all iPlayer users were aged 16 to 34, the single largest demographic, and for comparison, that same age group made up only 30 percent of both TV and radio audiences.[257]

    B. In Canada, TV habits of English-speaking and French-speaking (about 22 percent of the population) viewers are sharply different, with French speakers watching more traditional TV each day and annual declines being lower. As of 2017, 57 percent of those in English-speaking Canadian homes subscribed to a video-streaming service, but only 38 percent in French-speaking homes had a streaming subscription.[258]

    C. In the US market, there are large differences within the population in terms of race, with the average 18-24 year old watching about 151 minutes of live and time-shifted TV per day in Q4 2016, while the average Black American of the same age was watching 246 minutes (63 percent more than the composite average) and the average Asian American was watching only 83 daily minutes (45 percent less than the composite).

07. Although younger viewers are moving some of their daily video minutes away from traditional TV comedy and drama, other categories such as sports viewing have remained relatively strong. Therefore, sports viewing now makes up an increasing percentage of total traditional TV viewing for young people. That's great for sports and traditional TV, since it is watched live and with strong ad loads and subscription fees. But it also means that analyzing annual trends is more complicated, volatile and country-specific. Three examples:

    A. Whether in regards to the football World Cup or the Champions League, strong or weak performance by any of the UK teams has a large positive or negative effect on viewing in the UK market. Although some in North America watch these matches, the effect on viewing numbers is much smaller.

    B. Meanwhile, NFL (football) is the dominant TV sport in the US. A period of slightly declining ratings (as was seen in the first half of the 2016-17 season) would have a material impact on TV viewing by young people. Assuming they watch on average 120 minutes of TV per day in that fall football quarter, even a six-minute decline in NFL viewing would cause a drop in younger viewing figures.

    C. In Canada, neither kind of football is as important for traditional TV; instead, it is NHL (ice hockey). A playoff year that saw no Canada-based teams perform well would see much smaller audiences than a year when several Canadian teams (especially those based in larger markets) made it through several rounds. A five-to-10-minute per day impact for 18-24 year olds would be a conservative estimate.

08. Equally, although Figure 24 shows relatively stable, mainly single-digit, annual declines in the US, UK and Canada over recent years, data from other countries shows a different story. Figure 26 shows annual data over the same time span as Figure 24 for a mix of "younger" demographics from the Nordic countries of Sweden, Denmark, Finland and Norway. These countries tend to have high levels of English fluency, and adoption of streaming services and other international content has been rapid. As can be seen, viewing has tended to decline but with rapid year-over-year changes: Danish millennials went from a 14 percent viewing decline in 2013 to a 0 percent decline in 2014 and then plunged to a nearly 18 percent decline in 2016. And although 2016 viewing declines were in double digits in Sweden, Denmark and Norway, Finnish 15-24 year olds saw a moderating decline in the same year of only 3 percent. 2017 data will be needed, but at this time, it seems impossible to predict Nordic millennial viewing for future years; no clear trend is visible.[259]

Figure 26. Yearly change in traditional TV viewing by young people, Nordics 2011-16
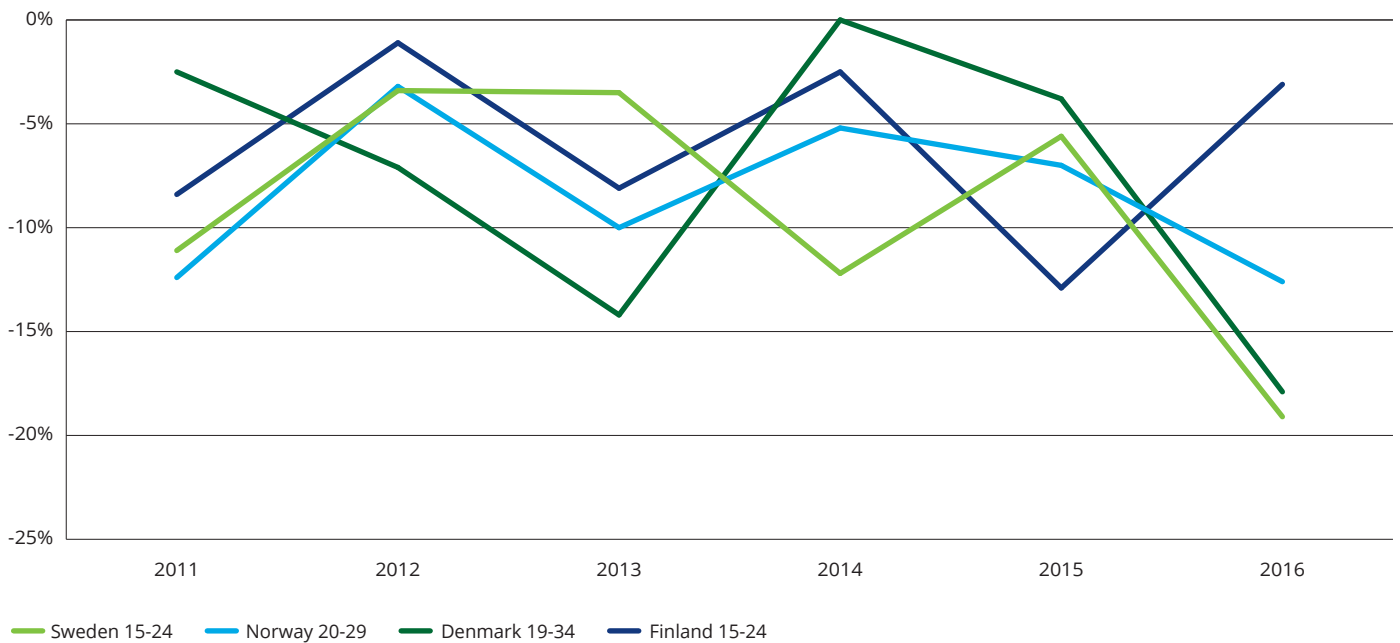
Sources: Kantar Gallup Denmark, Finnpanel, Kantar TNS Norway, MMS.

Middle East perspective

In line with global trends, those between the ages of 18 and 24 in the Middle East will experience a steady decline in TV viewership by 5 to 15 percent in 2018, leading to around 100 minutes of leisure time for TV viewing.[liii] This age group will continue to be lured away from TV and its content, by both other devices such as smartphones, tablets as well as by alternative content. In the Middle East, YouTube channels and short form videos combined with pirated content and to a lesser extent SVOD platforms represent very popular alternatives to highly regulated TV broadcasters, and have yet to hit their saturation point. However, decline in TV viewing will still not hit a tipping point in the Middle East. The key drivers of this will be the fact that TV viewing remains very much a family activity, TV content becoming increasingly available on new devices, and anti-pirating initiatives.

If we look deeper, two main factors are primarily driving declining TV viewing amongst 18 to 24 year olds in the Middle East: rival media content and regulations driving users to that rival content. On the rival media front, short-form aggregators and YouTube channels (particularly comedies in KSA) have shown impressive viewership numbers. Newer to the Middle East media scene, SVOD players such as Netflix, who were latecomers to the region, are now investing to build up a local, relevant content library. Last but not least, social media usage remains prevalent in the region and is taking time away from the finite media minutes in a day. The level of regulation over broadcast TV content, particularly amongst many of the channels affiliated to government, is also far greater than the content curated over open OTT platforms. This increasingly drives the 18 to 24 year old age group to subscribing to SVOD services, resorting to short-form aggregators or using pirated content. As time spent with media for this age group is limited, time spent viewing or interacting with rival content substitutes TV content viewing, leading to a steady decline.

As stated earlier, still, there are forces that will keep this steady decline in check, preventing a collapse in this age group's TV viewing. These forces include the cultural importance of family time around the TV set, new broadcaster device offerings, and anti-piracy campaigns. Firstly, the traditional sense of gathering around a TV set during prime time evening hours is a socio-cultural staple in the region. The family unit is central to Arab culture, and prime time *is* family time. This is evidenced by the repurposed content that dominates this airtime and takes into account the region's cultural sensitivity when broadcasting movies and general interest content, the two most popular genres among Arabs.[liv] Secondly, this age group in the Middle East will increasingly watch TV on mobile devices, which fits the definition of TV viewing, as local viewers are less affected by screen size when viewing long-form content. This is evidenced by the 39 percent that watch long-form on smartphones, compared to 26 percent globally.[lv] Pay TV operators in the region are moving towards a multi-screen offering to support this. Finally, anti-piracy coalitions are active and as many as 28 pirated channels were taken off air.[lvi] Additionally, many governments such as the UAE are outlawing VPNs that are typically used to access foreign SVOD content. All of these forces will work together to counteract the effects rival content will have on TV viewing for this age group.

The kids will be alright in 2018. While there will be continued decline in TV viewership amongst the 18 to 24 age group in the Middle East, we should not expect to reach a *tipping point* due to the cultural importance of prime-time TV viewing, the adoption of new devices by broadcasting companies, and the various measures being taken against pirating.

Mobile-only: wireless home internet is bigger than you think

Deloitte Global predicts that 20 percent of North Americans with internet access will get all of their home data access via cellular mobile networks (mobile-only) in 2018. Deloitte Global further predicts that a mixture of cellular and fixed wireless access (FWA) technologies could lead to 30-40 percent of the population relying on wireless for data at home by 2022, an increase from only 10 percent in 2013.[260] These people will have no active wired data connection to their home – no coaxial cable, fiber-optic connection or DSL copper line. Instead, they rely solely on radio technology for their entire home internet usage. They are likely also to access the internet while at work, in school, in coffee shops and so on, but when they are at home, they have no other data-access technology.

Deloitte Global further predicts significant variation in the proportion of the population that use only cellular mobile for data access by country and by region (see Figure 27). According to our research, less than a tenth of people in France and the UK were mobile-only, but in Turkey the figure was more than three times higher. In Latin America, for example, Deloitte Brazil believes that over a third of all homes in Brazil were mobile data only. And in China, a fifth of the online user base (rather than households) were mobile-only as of 2016.[261] In Tokyo, where fiber-optic connections are widely available, hundreds of thousands of homes (or about five percent) are relying on only mobile in 2017.[262]

According to our research, less than a tenth of people in France and the UK were mobile-only, but in Turkey the figure was more than three times higher. In Latin America, for example, Deloitte Brazil believes that over a third of all homes in Brazil were mobile data only.

Figure 27. Percentage of data mobile-only homes in selected countries in 2017
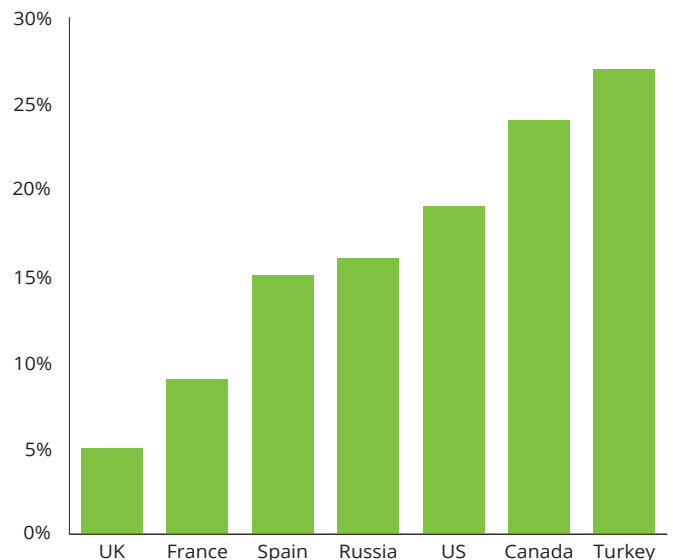
Source: Deloitte Global survey of adults in seven countries – 1,096 in the US; 1,090 in Canada; 1,061 in Turkey; 1,118 in the UK; 1,097 in France; 1,082 in Spain; and 1,097 in Russia (survey conducted Aug.-Oct. 2017)

Why will so many homes be relying on mobile internet service alone in 2018? There will be many different reasons. Sometimes it is because mobile is the only form of data connection available, especially outside cities. Other factors – income, age, living alone, or using better and faster networks with bigger monthly data allowances – also seem to play a role. This tendency also follows a trend; many people have discontinued wired home phones, and the same shift is occurring in internet access.

Part I: the past and present of mobile-only for data

Sometimes you have only one choice. From the edge of cities to remote farms, there are hundreds of millions of people worldwide who live in areas with no fiber or cable connections. Although their homes have copper phone lines, they are too far from the local telephone exchange for DSL technologies to work well.[263] If their homes are more than a mile from a central office and less than four miles from a long-term evolution (LTE) cell phone tower, mobile may be the fastest internet service available. This may be quite rare in the UK and France (and probably many other Western European countries), but is more common in other places. As can be seen in Figure 28, in countries for which we have data, rural residents are far more likely than urban residents to have mobile-only service.

From the edge of cities to remote farms, there are hundreds of millions of people worldwide who live in areas with no fiber or cable connections.

Figure 28. Data mobile-only population for urban and rural, 2017
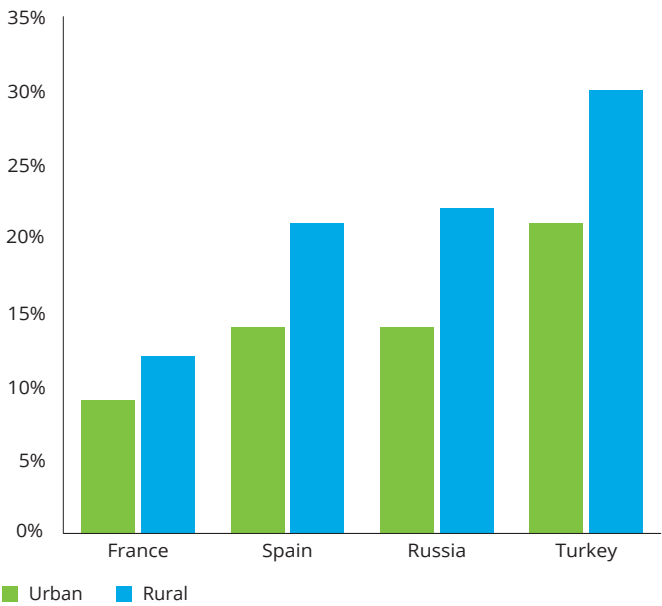
Source: Deloitte Global survey of mobile-only adults: Turkey (290), France (103), Spain (168), and Russia (171), Aug-Oct 2017.

It's about income, but it isn't about only income. In every country surveyed, homes in the lowest income bracket were more likely to be mobile-only than homes in the highest income bracket (the brackets vary from country to country). As Figure 29 shows, the income effect was lowest in the US, where those making less than $25,000 annually were only a third more likely to be mobile-only than those making $75,000 and over. In general, it seems clear that having a low income makes being mobile-only well over 50 percent more likely. Deloitte Global predicts that in 2018 there will be a higher proportion of mobile-only homes among lower-income households, although it should be noted that in some of the countries surveyed, 13 to 23 percent of higher-income individuals are also mobile-only; wireless-only data isn't only for those who can't afford wired service.

Figure 29. Data mobile-only population for highest and lowest income groups, 2017
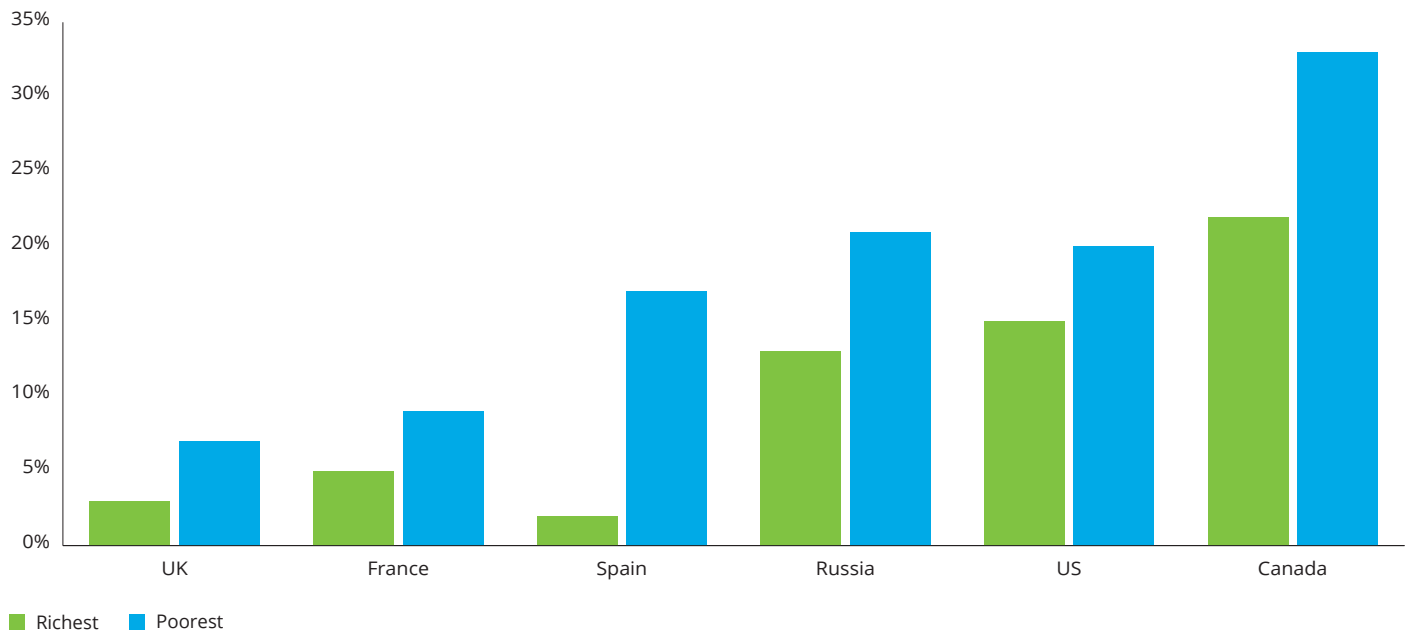
Source: Deloitte Global survey of mobile-only adults – 54 in UK, 103 in France, 168 in Spain, 171 in Russia, 203 in the US and 265 in Canada (survey conducted Aug.-Oct. 2017)

The age effect is pronounced. Younger people are roughly twice as likely to rely on cellular for all of their at-home data. In fact, the single biggest demographic factor pointing to whether someone will be mobile-only is age. As can be seen in Figure 30, the youngest cohort surveyed (the exact ages varied from country to country, but were around 18-24) was almost always more likely, and on average for the seven countries twice as likely, to be mobile-only than the oldest age group (varying by country, but around 55-65 years). The effect was largest in the US, Canada and France; the reasons are unclear.

Figure 30. Data mobile-only population for oldest and youngest groups, 2017
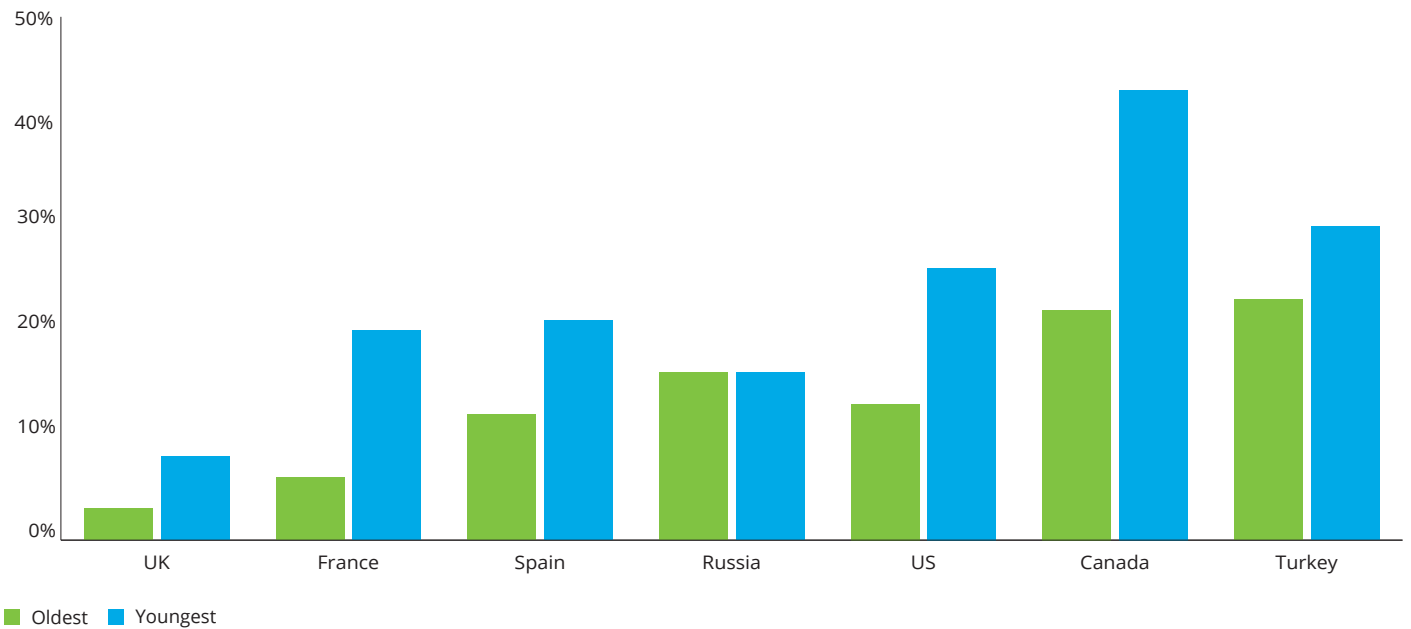
Source and base: Deloitte Global survey of data mobile-only adults: UK (54), France (103), Spain (168), Russia (171), US (203), Canada (265), and Turkey (290), Aug-Oct 2017.

Some people use little data when at home. In 2016, monthly internet usage was 190 GB per household in the US, 145 GB in Canada and 132 GB in the UK.[264] By 2018, usage may be approaching 200 to 300 GB per month in these countries, which may make mobile-only unsuitable for many. These averages are lifted by a minority of households (one to two percent among cable customers in the US)[265] whose usage is approaching one terabyte (TB) per month. Homes with one or two residents who are older or who watch little online video consume much less. Homes where people watch little online video on a TV set would struggle to use

more than 50 GB per month. For these homes, the data packages offered by mobile operators may suffice. In markets where naked broadband (broadband only, without also having to subscribe to a landline) is not available, homes can save hundreds of dollars per year by giving up their landline connection. As can be seen Figure 31, people who are single are more likely to be mobile-only than those who are married or living as married. Although the differences between marital statuses were not statistically significant in all countries, single people were on average over 40 percent more likely to be mobile-only.

Figure 31. Data mobile-only population for married/living as married and single people, 2017
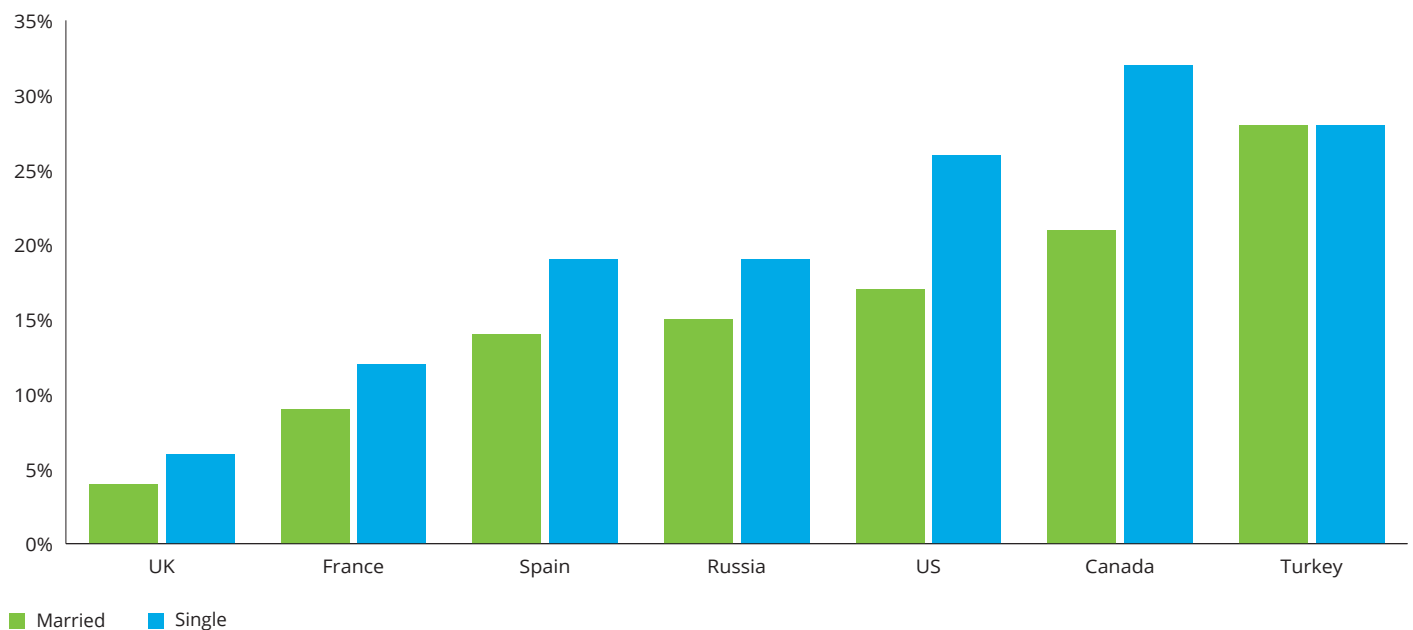
Source: Deloitte Global survey of data mobile-only adults – 54 in UK, 103 in France, 168 in Spain, 171 in Russia, 203 in the US, 265 in Canada and 290 in Turkey (survey conducted Aug.-Oct. 2017)

Better cellular mobile networks means mobile only is enough for some. Since 2013, fourth-generation (4G) LTE wireless networks have become more ubiquitous, and in the past two years, LTE Advanced technologies have been widely deployed in many countries. As a result, those with wireless connectivity regularly see speeds of 10 to 30 Mbps (in 2017, typical download speeds in the developed world were 16.6 Mbps, while 13 countries had speeds of at least 30 Mbps)[266], and monthly data allowances are larger than in the past; in 2014, the US average monthly consumption of wireless data was only 1.9 GB, with 1.2 GB per month typical in Canada.[267]

Faster speeds and higher caps make wireless-only internet an option for more people. This will only increase as we move to next-generation technologies and networks.

Part II: mobile-only turns into wireless-only, aka fixed wireless access

When using the term "mobile-only," up until now we have been talking about a specific kind of usage. Some people accessed the internet at home solely via their phone's cellular radio and viewed the content on the smartphone screen; others used their smartphone radio as a hotspot and viewed the internet on other devices like computers or tablets. The data in either case flowed over a licensed spectrum in certain frequency bands between 700 MHz and 5 GHz and was provided by a short list of cellular operators, and the technology was mobile; the same device that allowed wireless internet in someone's home could be easily picked up and moved somewhere else.

That kind of solution may be adequate for some part of the population in 2018 (depending on the country), but the limitations on speed and capacity mean that it is sufficient only for those who (relatively speaking) do not use much data. As an example, probably more than two-thirds of North Americans need more than 100 GB per month, and as time goes on, that requirement seems sure to climb. By 2020, assuming current annual growth is maintained, the average North American home may be using over 500 GB per month, meaning that only a small percentage of the population would be happy with any kind of mobile-only solution provided today.

Wireless networks are expected to improve dramatically as 5G, or fifth-generation, wireless networks are deployed, with gigabit speeds expected. These networks are predicted to launch in the US by 2020,[268] but exact launch dates will vary by country. 5G is made possible by many different technologies, but a critical one is the use of new radio wavelengths.

Millimeter wave (mmWave) fixed wireless access (FWA)

Historically, although frequencies that were much higher than traditional cellular frequencies theoretically had lots of room to carry data, they were not of much use practically. Technology to transmit and receive these frequencies was expensive and hard to develop, and the radio waves themselves propagated poorly. Although cellular frequency radio waves can travel for kilometers, go around buildings and penetrate windows, people believed that the much shorter radio waves at over 24 GHz – also known as millimeter wave, or mmWave – could travel only two hundred yards before being absorbed by the air, could not penetrate glass or even the leaves of a tree, and worked only in the line of sight.

But Deloitte Global predicts that in 2018 there will be significant further trials in the US of technologies using frequency bands around 28 GHz, 37-40 GHz and 64-71 GHz (11 GHz of spectrum) as laid out in the new rules proposed by the Federal Communications Commission (FCC).[269] These trials will not, at first, be focused on mobile devices (that will likely happen in 2019 and 2020) but will instead be for non-mobile home internet access. The technology uses small digital antennas mounted on the outside of homes, located about a few hundred meters from small microcell transmitters (usually on utility poles rather than on traditional much larger and more expensive cell towers but often connected to high-speed fiber-optic cables as part of ongoing network densification efforts) and with a direct line of sight between the home and the transmitter.

Speeds are potentially much higher than 4G, with 1 to 2 Gbps being the likely minimum and 10 Gbps possible, all with latency of less than 10 milliseconds. This is known as fixed wireless access, and major North American carriers, as well as potential non-carrier entrants in the wireless ISP market, are doing multiple trials in 2017 and 2018.[270] From what we know only from public announcements, this technology is being tried in over 15 US markets, with the first commercial launch from one carrier scheduled for late 2018.[271] Very importantly, the trials are revealing that mmWave technology may be working better than predicted; some trials have seen 1.4 Gbps speeds at distances of about a quarter of a mile and from behind a building.[272] If this proves the case in larger trials, it would make the technology significantly more useful.

It is early days, but Deloitte Global is predicting that this technology will be useful in at least some locations and for some customers and is likely to capture a small but growing portion of the home internet market by 2022. Further, due to the high speeds and small cell sizes, monthly capacity will be very high, and each home is likely to be able to use over a TB per month. Those who already have fiber-optic connections are unlikely to switch, and even those who have DOCSIS 3.1 cable connections and G.fast telco connections (both of which will probably offer 1 Gbps speeds or more by 2022) may not move to mmWave. But as we have seen in our mobile-only predictions for 2018, there are still many people who are not paying for wired access.

By 2022, wireless home internet solutions will continue to occupy the low end of the market (homes using relatively little data), but they are also likely to be competing at the high end of the market and sometimes displacing fiber-to-the-home solutions.

The bottom line

The most obvious short-term implication of the prevalence of mobile-only access is for all firms doing business with consumers over the internet – which in 2018 is likely to be almost every consumer firm. Based on conversations with many large B2C worldwide companies in late 2017, we find most of these companies (depending on the country) did not know that significant parts of their audience lacked access to wired home internet and were mobile-only, often with lower speeds and lower monthly caps.

Any application that involves large images or even medium-quality video might not be feasible for mobile-only customers with low data caps. As mentioned above, consumers may be able to access data-rich services at a coffee shop, work or college, but they do not enjoy this access while at home.

For these situations, e-commerce retailers or online financial services firms will want to consider having low bandwidth versions that can reach the mobile-only audience. This can work well; low-resolution pictures of shoes or text-only versions of bank balances will likely suffice. But for media, it seems impractical to stream large amounts of video, even at lower resolutions, to those in the population who are mobile-only and face low monthly caps.

Some interesting challenges, given the fact that mobile-only is skewed toward lower-income and rural populations, are the public policy issues of distance medicine and education. Education of students online and conversations between patients and doctors both require significant bandwidth; mobile-only populations may be less able to access these services. For example, a distance medicine trial in Uganda was not able to use the hoped-for video conferencing solution due to bandwidth; instead, the connection had to be audio-only.[273]

Access to the internet, especially at higher speeds and with higher monthly caps, is of great interest to regulators worldwide. Often there are programs, initiatives and incentives that aim to provide better internet access to as much of the population as possible, with a focus on rural and lower-income households. Given the predictions above regarding mobile-only, regulators need to consider not only wired solutions but wireless too. The US regulator is already considering making mobile-only internet qualify as mandated minimum coverage by carriers,[274] although this is provoking some debate.[275]

Perhaps the most important question comes not from mobile-only in 2018 but from the choices for mobile data connections with mmWave technologies in 2019 and beyond. Network operators in countries including Singapore (95 percent) and South Korea (83 percent) already have extensive fiber-to-the-premises (FTTP) connections[276] and are likely to see little incentive for mmWave deployments. But in countries such as the US, where only about 10 percent of homes have FTTP, the question of how to deliver gigabit speeds will now have to include mmWave alongside DOCSIS 3.1 cable, G.fast telco and FTTP offerings.

There is unlikely to be a single magic-bullet technology; different markets have different weather, geography, density, digging costs and even extent of foliage. As an example, Phoenix has large numbers of single-family homes far enough apart that laying fiber to each home is not easy. But there are few trees to block mmWave signals, and it never snows – for snow, too, can interfere with radio at these frequencies. The same conditions do not apply in Boston or Paris. Equally, in Taipei, so many people live in 10-to-20-story buildings that running fiber to each building may be easier than using mmWave. In Istanbul, laying fiber is difficult in older parts of the city, since often when ground is broken, archeological finds are unearthed, so a wireless solution may be better.

Over the longer term, the most important market for mobile-only, LTE and mmWave and 5G will probably be the developing world. There, even in the cities, there is often no coaxial cable and few or no fiber-optic lines, and the telco infrastructure tends to be older and less useful for DSL internet services. Wireless data delivery is almost certain to be not just a choice but perhaps the only choice to move citizens into the gigabit age.

Middle East perspective

In many markets of the Middle East, mobile broadband has been for years a de facto substitute to fixed broadband, given the lack of existing wireline infrastructure. The growth in mobile broadband connections in the region over the next three years is expected to be on par with global rates, at just over 10% CAGR. In fact, by 2020, nearly 70 percent of mobile subscribers will have shifted from technologies that provide only voice service (2G) to technologies that provide data services (3G/4G/4.5G). By 2022, mobile data usage per subscriber in the Middle East will increase around 10 fold from over 1GB per month today to close to 12GB1.[lvii]

The adoption of mobile over fixed broadband in the region is largely due to a lack of fixed infrastructure which is most significant in countries with large territories. An additional factor is consumer preferences; customers seem to feel comfortable using mobile devices that provide added security and privacy to the experience, and prefer the low cost. Additionally, telecommunication companies in the region strive to be at the forefront of new technologies such as 5G, and they will go to great lengths to be a first-mover and offer seamless end user experience.

Despite efforts to develop fixed broadband networks in a number of GCC markets (e.g. OBC in Oman, Qnbn in Qatar etc.) fixed broadband penetration in the Middle East is still below many leading international markets such as Korea (South), Switzerland, and the USA.[lviii] In some countries where mobile data rates are very competitive (such as Bahrain and Saudi Arabia), we have witnessed decreasing fixed broadband penetration.

Mobile broadband technology presents an opportunity to provide internet access to the population in a cost effective way compared to fiber deployment. But a broader next generation of fixed wireless technologies could also play a role in the Middle East. New architectures such as WTTx (Wireless to the Home, Building etc.) are being explored by Middle East's telcos, leveraging learnings from previous cases of enterprises and residential applications connecting to 4G, 4.5G, and 5G networks. The higher data throughput of these mobile technologies, in addition to the ability of 5G to use software in order to enable dynamic configuration of the core and radio access network, are crucial factors for the flexibility needed to deploy WTTX solutions on a truly converged mobile infrastructure. Moreover, an advantage of WTTX over fixed deployments is its ability to support very high peak rates, including coverage of areas with multiple clients (1: N approach rather than 1:1 approach of fixed networks).

A final regional factor In the Middle East market is the regional emulation amongst telcos to be the first to launch 5G. Regional telcos are preparing early commercial deployments of 5G: STC in KSA, Ooredoo in Qatar, and Etisalat in the UAE are among the key players competing to be the first to roll out a 5G commercial network in the region, which we expect to be deployed by 2020. With the 4G network already vastly rolled out, and the 4.5G and 5G networks being deployed for businesses (e.g. in high population-density areas, smart cities, and smart places), mobile and wireless will continue to be the dominant access technology for broadband services in the foreseeable future in the Middle East.

Fasten your seatbelts: in-flight connectivity takes off

Deloitte Global predicts that in 2018, one billion passenger journeys on planes (about a quarter of the total) will be on aircraft equipped with in-flight connectivity (IFC).[277, 278] IFC can be used for data and, where allowed, voice communications. This would be a 20 percent year-on-year increase. IFC revenue for airlines should be close to $1 billion, with most generated by airtime sales to about a tenth of passengers who purchase access on routes where IFC is available and charged for.[279, 280]

While IFC has been available for many years in markets such as North America, it should be more popular and lucrative than ever in 2018, thanks to the rising number of routes covered, higher connection speeds and greater data capacity per flight.[281]

This trend implies that within a few years, the airplane may no longer be one of the last remaining connectivity-free zones – in any part of the world.

How IFC works

There are two ways of providing connectivity to planes; on occasion, both approaches are deployed in tandem:

- Air to ground (ATG): A network of specialized ground-based mobile broadband towers relays signals up to antennas located on the underside of a plane's fuselage. As with a terrestrial cellular network, the plane automatically connects to the closest tower. ATG has been cheaper and has lower latency than satellite-based services, but for evident reasons works only while over or close to land. One of ATG's major constraints is the amount of spectrum available for the service.

- Satellite: A constellation of satellites, typically in geostationary orbit, sends to and receives signals from earth via receivers and transmitters. Connectivity is via an antenna on the roof of the aircraft. Satellite-based systems provide coverage across the globe, including over oceans, but have typically been more expensive and have higher latency.

Until recently, many airlines outside of North America had taken a wait-and-see approach to IFC or had only partially equipped their fleets. About a third of commercial planes will be equipped with IFC at the start of 2018. Deployment was partial for a combination of factors, including the inability to offer quality service, the impact of legacy technology on the plane's weight and the costs involved.

But in 2018 and beyond, the business case for IFC should become more compelling due to technological advances in satellite and ATG connectivity. IFC is likely to enjoy better speeds per user and greater capacity, enabling both improved experience and lower prices. Deloitte Global expects an additional 1,600 to 2,000 airplanes to be equipped with IFC in 2018. We also expect upgrades to planes already equipped with prior-generation IFC equipment, delivering better connectivity as a result.

The principal upgrade from satellite providers is the move to high-throughput satellite (HTS), which employs frequency reuse and multiple spot beams to raise throughput. HTS should increase capacity and data speeds substantially and lower costs significantly. HTS increases peak speed to the aircraft to more than 100 Mbit/s.[282] Non-HTS satellite-based services deliver between 10 and 70 Mbit/s to an aircraft. The exact speed realized depends on the combination of equipment in a given system – satellite, antenna, modem – and latitude.[283] This capacity is shared among all passengers who wish to use the service.

HTS deployment, which was introduced to commercial satellite communications within the past decade, is likely to ramp up in the medium term. According to Euroconsult, total HTS capacity dedicated to IFC will increase to 21 Gbit/s by the end of 2018, up fivefold from the end of 2016.[284]

Further growth in the volume of satellite capacity targeting the IFC market is expected beyond 2018 as more HTS systems are launched. NGSO (non-geostationary) HTS constellations such as Space X and OneWeb that promise to deliver large-capacity supply are also being planned. IFC is likely to be one use of this capacity.

In 2018, ATG providers are expecting to be able to deliver peak speeds to the aircraft of up to 100 Mbit/s using solutions based on LTE technology and, in some cases, unlicensed spectrum. This is about 10 times faster than existing ATG solutions and at a much lower cost.[285] GoGo, the main ATG provider today, is expected to launch its next-generation ATG network in 2018.[286] The ATG market is likely to see new entrants, with their services expected to begin to be available at the end of 2017.[287]

The receiving technology on planes has also improved in recent years; the introduction of flat-panel antennae reduced drag. One criticism of legacy satellite antennas was that they made planes less aerodynamically efficient.[288] There will also be improvements to the receiving technology in aircraft. One vendor is using multiple receivers instead of one, enabling a more consistent service. One receiver allows users to stay connected, while a second acquires the new spot beam as an aircraft moves from one beam to another.[289]

Another vendor is expecting to introduce modems that can increase speeds in the aircraft to up to 400 Mbit/s, markedly faster than existing modems which allow for speeds of 15 Mbit/s available on some planes with legacy IFC technology.[290]

One ATG vendor has introduced the use of four antennas to pick up signals more effectively and offer faster speeds.

In 2018, more consumers across the globe are likely to be on planes with IFC. In 2017, 80 percent of flyers in North America traveled on routes with IFC.[291]

However, in other markets such as Europe and Asia-Pacific (APAC), IFC rollout was limited. This is likely to change in coming months as more airlines launch IFC services on more planes and more routes, including in formerly underserved regions.

In Europe, International Airlines Group (IAG), the parent company of Aer Lingus, British Airways, Iberia and Vueling, aims to have 90 percent of its short-haul fleet equipped by early 2019.[292] Initiatives such as the European Aviation Network (EAN) and the deployment of over 300 on-ground base stations specifically designed for IFC should aid the European deployment.[293]

IFC prospects are also picking up in APAC. For example, Virgin Australia and Qantas plan to equip the majority of their fleet with IFC by the end of 2018.[294] Chinese airlines are set to take advantage of the October 1, 2017, lifting of the ban on the use of portable devices on domestic flights.[295] China Eastern, China Southern, Hainan and Xiamen airlines are offering IFC on some of their international routes. Air China will have a number of its Airbus 350 aircraft equipped with IFC by December 2017.[296]

In the next decade, the largest percentage growth is expected across Latin America, where the number of connected aircraft is forecast to increase from 44 in 2015 to 1,529 by 2025.[297]

Demand for the new IFC capacity coming on stream should be significant. Historically, usage has been concentrated among business users, most of whom expense usage. Consumers have always wanted in, but at lower price points and with better quality.

Demand for connectivity is now so strong that consumers would prioritize it over most other amenities. One survey found that if respondents had to select from a range of services, 54 percent would choose Wi-Fi. This is almost three times the proportion (19 percent) that would choose a meal.[298] Another survey, conducted among IFC users, found that almost 90 percent would trade seats, additional legroom or another amenity for a faster and more consistent wireless connection.[299]

Consumers' connectivity motivations will vary. Some may want to remain productive and respond to work emails. Others may want to continue conversations (when permitted), share selfies from the sky or stream their choice of music rather than the airline's selection.

Airlines' motivations are likely to be to meet customer demand, attract and retain customers, and generate revenue. Revenue could come directly, from the sale of airtime, or indirectly, when IFC is offered free, as a way to acquire new customers or improve loyalty. If it proves a revenue generator, IFC will allow airlines to augment the already booming ancillary services market, which has increased more than 13 times between 2007 and 2016.[300]

The most popular charging model is for a certain period of connection time or for a flight (regardless of the route).[301] Some airlines may choose to offer certain, typically low-bandwidth services (such as texting) for free or offer connectivity for free for a certain period of time as a way to increase service awareness and entice further usage.[302]

Other airlines may choose to delay IFC deployment, given the capital cost of between $200,000 and $300,000 per plane[303], the revenue forgone from grounding the plane during the three-day installation[304], and the on going cost for capacity. Some of these costs may be offset by savings if IFC means that existing seatback entertainment systems can be uninstalled or not installed in the first place. Removing seatback entertainment would eliminate a major maintenance cost, remove the capex spend on new hardware or upgrades, and reduce fuel costs by reducing the plane's weight.[305]

Some of the cost savings could be put toward purchasing capacity and media content to be made available for consumption on customers' personal devices. Improvements in compression should enable content (including movies and TV programs) to be streamed at high quality with less bandwidth.[306]

↓ The bottom line

When deploying IFC, airlines have to decide whether to use satellite, ATG or both. Airlines also need to decide which spectrum to use; they must determine which solution is most suited to future as well as current demand and how well it can scale.

There is a trade-off between quality of service, the complexity of the solution and the cost of the installation process.[307] Airlines will need to gauge if the resulting customer pricing, if any, is likely to be affordable to their customers.

Airlines will also need to decide which parts of the IFC service they want to manage on their own. For example, with certain solutions, the vendor supports the costs of installing the connectivity in the planes and can manage the service; the airline receives a share of the revenue but doesn't need to do anything else. Other airlines are taking on the installation of IFC and the development and delivery of services.

IFC can also be used to run parts of the aircraft's operation. American Airlines, the first airline to do this, equipped all its flight attendants with internet-enabled tablets as early as 2012.[308] This enables them to carry out mileage upgrades, read and respond to corporate emails, get real-time access to passenger seat assignments, file reports, and do remote maintenance.

Airlines will need to determine the role that IFC plays in their entertainment program. Some airlines may choose to allow customers to use their own devices to stream content from an onboard library, even at no additional cost. Others may choose to continue to provide seatback entertainment, but mostly on long-haul routes. Airlines will also have to consider whether to give customers full control over which services can be used. Various airlines are forbidding calls on their planes, mostly in response to flyers' feedback.[309]

Mobile operators will need to consider whether they should extend their reach into the sky. One operator has sponsored free access to messaging and one hour's in-flight internet access.[310]

Connectivity can be sponsored by other companies in exchange for customer data; this is currently the model used in many airports that offer free internet.

Regulators will need to ensure that there is sufficient spectrum to meet current and future demand.

For three-quarters of air travelers at present, being on a plane means disconnection from the world, whether or not they want that. In coming years, it may not be an option. As connectivity improves and becomes cheaper, IFC is likely to become standard. The plane, too, will be connected – and the majority of passengers will be delighted by this and will express their happiness on social networks from 35,000 feet up.

Middle East perspective

Within a few years, the airplane may no longer be one of the last remaining connectivity-free zones – in any part of the world. In line with global trends, Middle Eastern airlines are investing heavily in in-flight connectivity (IFC) technologies with the aim of enhancing customer experience and increasing revenue simultaneously. We see this trend continuing in 2018 due to rising customer demand, availability of efficient IFC technologies, and the desire of Middle East based airlines to outperform global competitors. According to a study from the London School of Economics, global-connected ancillary revenue will be worth US$130 billion by 2035, of which the connected ancillary revenue for airlines will be worth US$30 billion, and the Middle East's share will be US$1.3 billion.[lix]

While Dubai gears up for its second Connected Aircraft Conference in 2018, a recent report from 2017 states that 68 percent of Middle Eastern airlines are investing in IoT programs over the next three years, which is up from 57 percent in 2015. Additionally, 37 percent of Middle Eastern airlines operate connected aircrafts, a figure that is projected to reach 66 percent by 2019. According to the same report, the global-connected aircraft market is expected to grow at a CAGR of 14.9 percent during the period of 2015-2020, and the Middle East & Africa (MEA) region has an even a higher predicted CAGR of 18.7 percent for the same period.[lx]

The Middle East's airline industry is already making great headway in the adoption of the latest IFC technologies. The likes of Emirates, Etihad Airways and Qatar Airways, show no signs of slowing down. A few examples of airlines investing in the latest IFC technologies are mentioned below.[lxi]

- Emirates Airlines:
  - Invested US$21.9 million in IFC technology installation and operations
  - Fleet is 70 percent Wi-Fi enabled
  - A multi-million dollar deal with Thales will equip its Boeing 777X fleet with the AVANT in-flight entertainment system, which offers better connectivity and live TV

- Etihad Airways:
- Signed a US$700 million deal in October of 2015 with IT vendor IBM to completely overhaul the airline's ICT infrastructure during next ten years
- Includes cloud-based technologies, in-flight connectivity and enhanced EFB capabilities
- Partnered with Global Eagle Entertainment (GEE) to provide in-flight entertainment (IFE) content aboard six airlines of Etihad Airways Partners

- Qatar Airways:
- Equipping its fleet with GX Aviation technology, which provides next-generation, high-speed in-flight wireless connectivity

Inmarsat, a leading provider of satellite communication solutions to airlines, released its 2017 IFC Survey, the highlights of which are illustrated below. According to the survey, 60 percent of passengers globally believe that inflight Wi-Fi is a necessity, not a luxury.[lxii]

Figure 32. Inmarsat IFC survey 2017

■ Global   ■ Middle East
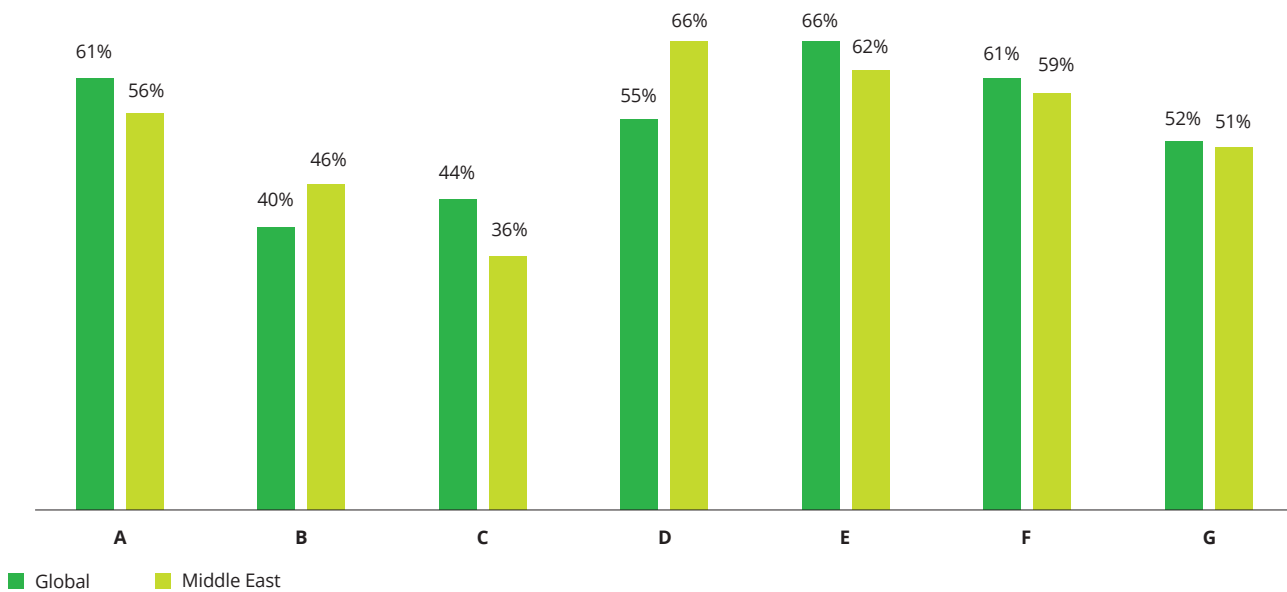
A - Consider Wi-Fi more important than in-flight entertainment
B - Rank IFC as a top 3 driver of airline choice
C - Would stop using their preferred airline if it offered poor quality IFC
D - Have connected more than one device on at least one flight in the past year
E - Of families said inflight Wi-Fi would be a life saver when travelling with children
F - Said Wi-Fi access relieves anxiety
G - Would take advantage of the ability to buy items on a flight and collect them upon arrival

The airline industry in the Middle East has seen huge sums of money being invested in IFC technologies and this will continue to be the case in 2018. Yahsat, a UAE satellite operator and a unit of Mubadala Investment Company has tested a 50Mbps in-flight broadband connection that is considered to be the fastest in the market.[lxiii] Yahsat's third satellite will go online in 2018 and this can potentially lead to faster speeds on board flights. The appetite for cheap and efficient IFC technologies seems to be insatiable in the Middle East and this demand will drive many companies such as Yahsat to continue their research and development in order to pioneer the next disruptive IFC technology for the world to adopt. This combination of customer demand and investment will make the skies of the Middle East some of the most connected in the world.

Endnotes

1. Augmented reality capability is likely to be included as standard across multiple social network platforms, causing AR functionality to be downloaded by default.

2. For examples of applications of AR, see Made with ARKit, Madewitharkit. com, as accessed on 2 November 2017: http://www.madewitharkit.com/.

3. Until five years ago, the AR that most people have experienced was in TV programs in the form of graphics created by professional designers. This would include, for example, charts used in news programs or player-tracking tools used by sports commentators.

4. For more information on the photorealism now available with AR, see Reality, realistically augmented, Max-Planck-Gesellschaft, 24 February 2017: https://www.mpg.de/11073847/augmented-reality-photorealistic.

5. Public service announcements could include augmented reality guides on sugar, salt and fat content in packaged foods. Users could scan a bar code and then have a visual representation of the sugar, salt and fat content in the food. Sugar could, for example, be represented visually via the equivalent number of sugar lumps in a soft drink.

6. For more information on how this works, see ARCore: Augmented Reality at Android scale, Google, 29 August 2017: https://www.blog.google/products/google-vr/arcore-augmented-reality-android-scale/; Introducing ARKit, Apple Inc., as accessed on 02 November 2017: https://developer.apple.com/arkit/. iPhone and ARKit are trademarks of Apple Inc., registered in the US and other countries. Deloitte's TMT Predictions report is an independent publication and has not been authorized, supported or otherwise approved by Apple Inc.

7. This essay is a very useful explanation of the underlying technologies that enable current AR systems in smartphones; see Why is ARKit better than the alternatives? Medium, 1 August 2017: https://medium.com/super-ventures-blog/why-is-arkit-better-than-the-alternatives-af8871889d6a.

8. The camera tracks where you are relative to a point in the real world. The IMU measures the user's movement. A Kalman filter determines which of the inputs (the camera or the IMU) is likely to be giving the more accurate reading.

9. As of October 2017, there was a base of a few hundred million smartphones that had dedicated support for AR. Apple smartphones with an A9, A10 or A11 processor are compatible with ARKit. Samsung S8 and Note 8 are compatible with ARCore. For more information, see Introducing ARKit, Apple Inc., as accessed on 2 November 2017: https://developer.apple.com/arkit/; Google wants to bring augmented reality to your smartphone with ARCore, Digital Trends, 18 October 2017: https://www.digitaltrends.com/mobile/google-arcore-augmented-reality/.

10. Snapchat has launched an augmented reality art platform that enables artwork to be placed within photos. The first artist to collaborate with this initiative was Jeff Koons. For more information, see Artwork All Around You, Snapchat, as accessed on 2 November 2017: https://art.snapchat.com/.

11. A Games of Thrones AR promotion was made available via Facebook. This was delivered by an app update. Game of Thrones rolls out AR camera effect on Facebook, The Drum, 26 August 2017: http://www.thedrum.com/news/2017/08/26/game-thrones-rolls-out-ar-camera-effect-facebook; see Harness the power of Augmented Reality with camera effects platform, Facebook, 18 April 2017: https://developers.facebook.com/blog/post/2017/04/18/Introducing-Camera-Effects-Platform/; Introducing AR studio, Facebook, as accessed on 2 November 2017: https://developers.facebook.com/products/camera-effects/ar-studio/.

12. Adults are, for the purposes of this survey, those aged 18 to 75. In most developed countries, this represents the vast majority of all adults. If we were to include 16-to-17-year-olds as well, the penetration would increase a little. The data is from Deloitte's Global Mobile Consumer Survey across 16 developed markets, with a total sample of 29,056 respondents. The countries surveyed are Australia (2,002), Belgium (2,002), Canada (2,002), Denmark (1,003), Finland (1,002), Germany (2,000), Ireland (1,036), Italy (2,000), Japan (2,003), Luxembourg (1,000), the Netherlands (2,000), Norway (1,002), Spain (2,000), Sweden (2,002), the UK (4,002) and the US (2,000). Deloitte's Global Mobile Consumer Survey (GMCS) refers to individual Deloitte member firms' 2017 GMCS surveys, conducted between May and July 2017. For more details, see https://www2.deloitte.com/global/en/pages/technology-media-and-telecommunications/articles/gx-global-mobile-consumer-trends.html.

13. Ibid.

14. Ibid. The average views for 2017, based on survey responses, were 46. Our view is that people in general underestimate the number of times they interact with a phone, as most people do not count how many times they do it. As of 2016, iPhone mobile device owners unlocked their phones an average of 80 times per day. Apple's Penchant for Consumer Security, Tech.pinions, 18 April 2016: https://techpinions.com/apples-penchant-for-consumer-security/45122.

15. Ibid. As of 2017, this was 92 percent.

16. Deloitte Global estimates that there will be 180 million units of smartphones sold by multiple vendors retailing at $1,000 or more (in US dollars, or when converted into US dollars) in 2023. We estimate that the average selling price will be $1,250 for this category, with the most expensive devices priced at close to $2,000. Deloitte Global's forecast for global tablet sales in 2017 was 165 million, a 10 percent decrease from the prior year, and significantly lower than the 2014 peak of 230 million units. See Deloitte Global's TMT Predictions 2017 – Have we passed peak tablet? Deloitte Touche Tohmatsu Limited, 11 January 2017: https://www2.deloitte.com/uk/en/pages/press-releases/articles/technology-trends-for-2017.html.

17. The figures are obtained by leveraging various press releases by GfK. See Smartphone average selling price sees record year-on-year growth in 3Q, GfK, 24 October 2017: http://www.gfk.com/insights/press-release/smartphone-average-selling-price-sees-record-year-on-year-growth-in-3q/; Global smartphone sales hit a quarterly high in Q4 2015, GfK, 3 March 2016: http://www.gfk.com/insights/press-release/global-smartphone-sales-hit-a-quarterly-high-in-q4-2015/; Strongest Q3 smartphone sales on record driven by demand in China, MEA and emerging APAC, GfK, 25 November 2015: http://www.gfk.com/insights/press-release/strongest-q3-smartphone-sales-on-record-driven-by-demand-in-china-mea-and-emerging-apac/; Global smartphone sales exceed 1.2b units in 2014, GfK, 17 February 2015: http://www.gfk.com/insights/press-release/global-smartphone-sales-exceed-12b-units-in-2014/.

18. Ibid.

19. Ibid.

20. Deloitte Global expects the majority of smartphones shipped in 2023 are likely to feature a single 5-to-6-inch touch screen (measured on the diagonal) and two to four cameras, weigh 150 to 200 grams, and have a lithium-ion battery (the same composition as used in a 2018 model). By 2023, the majority of screens are likely to be OLED; in 2018, about a third are likely to incorporate these screens.

21. China to blaze connectivity trail with a billion 5G users by 2023, TechRadar, 18 October 2017: http://www.techradar.com/news/china-to-blaze-connectivity-trail-with-a-billion-5g-users-by-2023.

22. As of 2017, multiple vendors had launched handset models with dedicated AI chips. These include proprietary chips, which shows the importance being placed on this processor as a differentiator. For more information, see Why are smartphone chips suddenly including an AI processor? Android Authority, 30 September 2017: https://www.androidauthority.com/smartphone-ai-processor-803019/.

23. Huawei boosts smartphone 4G reliability and performance with lattice semiconductor tunable antenna solution, Lattice Semiconductor, 7 July 2015: http://www.latticesemi.com/About/Newsroom/PressReleases/2015/20150707Huawei.aspx.

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For those who view and share photos mostly via a smartphone, the SLR is likely to become increasingly eschewed. This is a trend similar to that for music; traditional hi-fi setups, occasionally including vinyl records, are likely to continue to offer the highest-fidelity reproduction. But smartphones streaming high- or standard-resolution audio files to single box speakers are likely to be increasingly used for music instead of traditional hi-fi. This is because it is convenient and the combination of streaming and single speaker is continuously improving.

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