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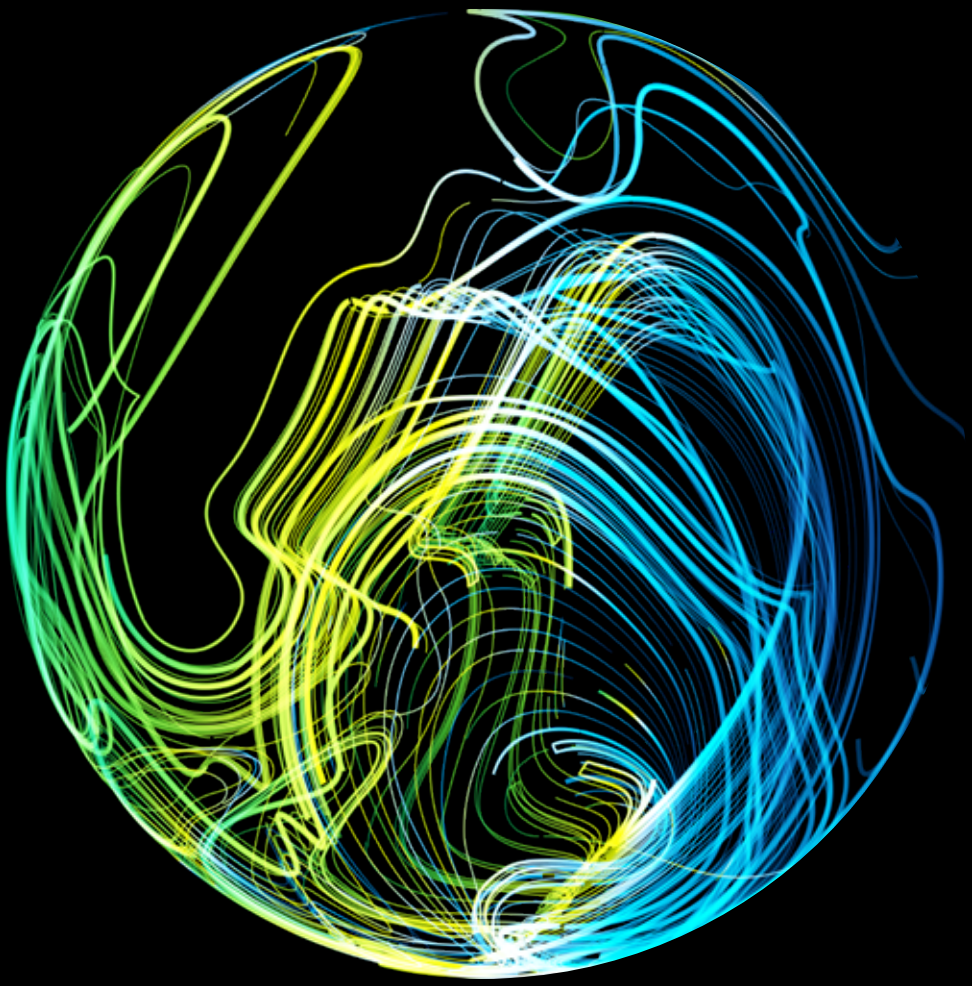


Technology, Media and Telecommunications Predictions

2018 - India edition

Contents

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 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. 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.

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.

It has always been our pleasure to work with the world's technology, media and telecommunications companies. Like last year, this is a combined report on global (which are 11 in number) and India (which are 5 in number) predictions with India perspectives shared on 6 of the global topics as well. Deloitte hopes you find this year's edition of Predictions to be a stimulating and informative read.

Hemant Joshi

Analytics (finally) travels beyond back office

Technology landscape in the domain of Analytics is going through a transformation. Newer technologies help integrate unstructured high volume data with relative ease, and enable faster processing of such data. Platforms and technologies offering a combination of speed and flexibility enable users to manipulate data with relative ease, 10x faster than other existing tools. Sample platforms of this nature include SAP HANA, Microsoft Azure Big Data & Analytics, Google Cloud Big Data & Analytics Platform and Amazon Web Services Big Data & Analytics. For a price conscious market such as India, economics is of paramount importance, and such platforms can provide a cost advantage of 25-30% than that of a dedicated computing platform, from a capital expenditure point of view.

Indian analytics landscape is expected to change significantly in the immediate future enabled by these technology levers and other macro level changes, as data assumes center stage in decision making at the ground level.

Enterprises will combine social inputs with internal data sources to improve customer service

Deloitte predicts technologies will emerge and evolve to enable faster (not necessarily real time) integration of data from social media along with the information contained in internal CRM systems to create a more robust customer profile. With blending of external and internal perspectives, enormous insights can be generated, and businesses will increasingly use these insights to broaden their revenue base and provide a better quality of experience for customers.

Consider the example of tax administration. Authorities around the world, including our country have an objective to widen the tax base and to detect wilful defaulters early on, at the same time provide a hassle free administration for taxpayers. Indian tax authorities in collaboration with a number of technology service providers have embarked on "Project Insight" to improve efficiencies in tax administration and the ease of doing business. Analysis of data from multiple data sources such as income and tax declarations and social media help create a better profile of taxpayers and improve effectiveness at the same time reduce unwarranted demands.

Applied in business context, enterprises finding a way to integrate external perspectives (surveys, social media comments, response to a feedback questionnaire) to the internal data sources such as ERP, Customer Relationship Management (CRM) and Supplier Relationship Management (SRM) have enormous applications for such data[1]. Telecommunication industry with its rich repertoire of customer information is uniquely poised to explore interesting use cases. Similarly, media databases with rich unstructured data like news feeds, videos and audio clips provide a significant source of rich information to drive this new world!

Device data will be integrated faster and on-demand to answer immediate field needs

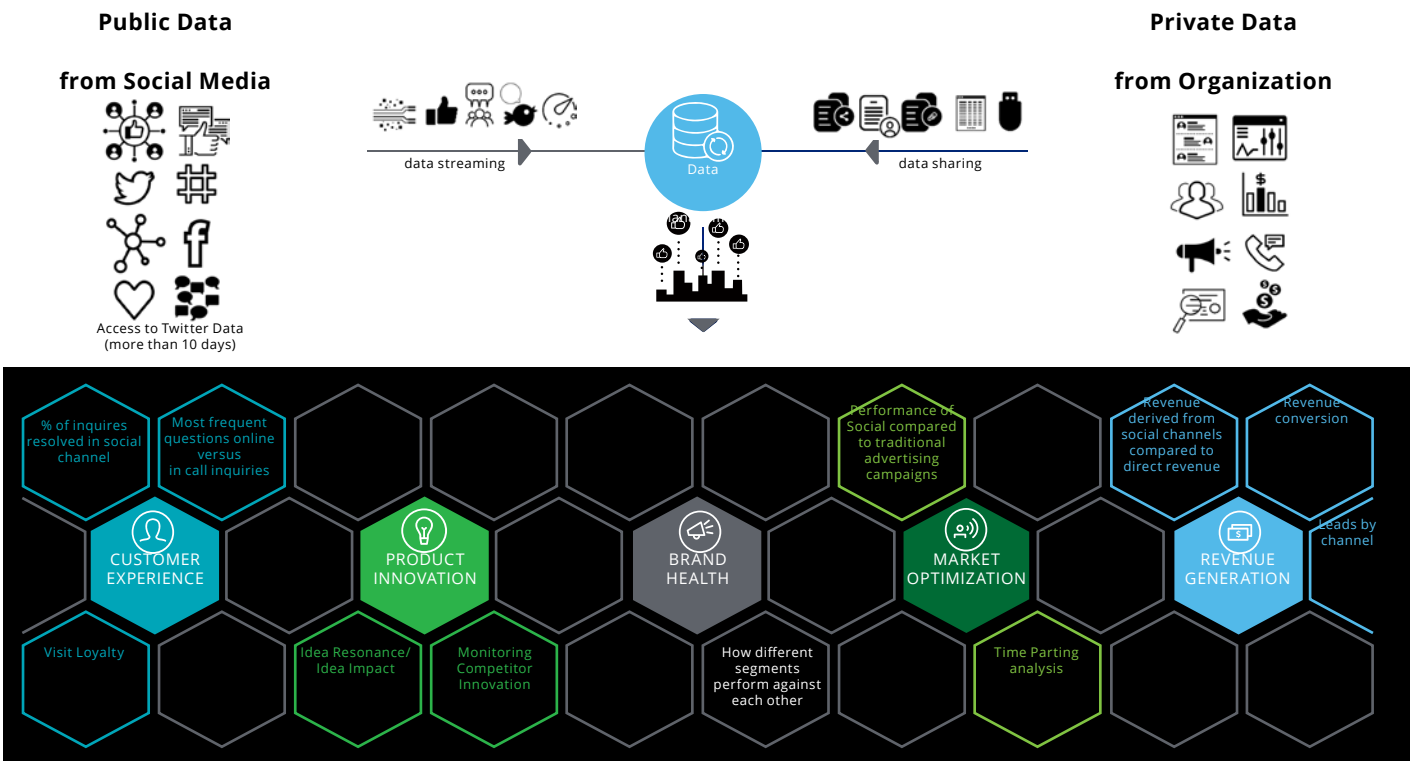
Deloitte predicts platforms and mash-up technologies to integrate data from devices will gain significant speed and traction in the coming year. Proprietary platforms as well as open source/ bespoke platforms providing near real time insights from devices to address immediate issues at the edge network is expected to witness increased adoption across Manufacturing, Oil and Gas, Chemicals and other process industry segments. Data from the devices will be increasingly used for achieving business outcomes (e.g. immediate needs to address potential maintenance failures based on signals and combining the same source with external and past maintenance records to find long term root cause of failures). Such machine data could also be used to dynamically align production schedules based on the demand environment[2].

Almost all process industry players have MES (Manufacturing Execution Systems) as the first level of solutions, which is being augmented with the ubiquitous implementation of sensor or sensor based technologies like bar codes, RFID and other forms of sensors. Media and Technology sectors also have enormous potential in using sensor-based data to create context specific news stories. Any major event coverage that's widespread and signal based is deeply influenced by local sources. One way to increase the same is by deploying more reporters, a surely more pervasive way is to have more sensors collecting this information and optimizing the resources based on the most impactful event.

Information dissemination for decision-making will be lot faster and simpler using digital delivery

Deloitte predicts that newer tools will have significantly better ability to extract insights, both visual as well as readable texts with data mashups. Tools will enable better visualization and integration of data from multiple sources and deliver information to end users in a seamless manner. Indian industry users across sectors will look beyond dashboards and reports to better insights and presentation.

An example of on-demand visualization is already being used by major technology companies. A large services cloud and application environment provider organization uses a combination of big data technology components to continuously watch the sales channel on web, mobile apps, as well a voice assistants deployed to create a monitoring application where they can detect any abnormal customer behavior such as abandoning a cart at the last minute, to security breaches on a real time basis.



Paying for results and provisioning on demand is the new normal (on cloud)

In developing markets such as India, which stands number 3 in the International Price Parity (IPP) index[3], economics and cost optimization is a key driver for technology adoption. Deloitte predicts an accelerated adoption of flexible business models such as pay per use, and the corresponding value enhancement will certainly be visible beyond the initial signals witnessed in the market.

As cloud becomes more pervasive and thereby more affordable, Deloitte predicts all the branches of artificial intelligence will gain moderate to significant momentum in the next year. Following trends will be observed across five major strands of data powered artificial intelligence technologies. These trends are contextual to India and thereby wide range of adoption is expected from overall TMT industry perspective.

AI Technology Component	Adoption Probability	Remarks
Physical AI (a.k.a. IoT based Intelligence)		With renewed focus on infrastructure, manufacturing and other core sectors enabled by telecom and technology growth catalysts, physical artificial intelligence assisted by a machine learning algorithm to solve a specific business question and/or opportunity will have significant adoption. Services infrastructure, rail driven growth corridors and downstream distribution of oil & gas are poised to develop the networks and reap the intelligence. Telecom players will have critical role to get the backbone ready. Along with devices, product technology players will also build contextual algorithms for local issues.
Machine Learning		Machine learning is already seeing a widespread adoption in specific areas of sales and distribution, marketing as well as HR. It is expected to become more pervasive with a continually increasing usage of suitable algorithms.
Voice/Chat Assistant		With a large base of domestic consumers and a consumer industry poised to grow in a significant manner, adoption and large-scale deployment of voice and chat assistants to assist consumers is expected to grow. Increasingly, these assistants are also expected to become more intelligent with embedded algorithms to guide their responses.
Natural Language Processing (NLP)/Natural Language Generation (NLG)		Wide base of finance back office as well increasing need for regulatory and text based management reporting will make natural language generation technology a sure candidate for adoption with an easy pace. NLP is expected to be a clear source to develop an intelligent algorithm.
Computer Vision/Deep Learning		While there may be embedded deep learning algorithms used occasionally or as part of a platform, it is not likely to gain mainstream position in short term.

Large ERP database will finally start generating value in the form of decisions for business

Currently, 87% of Indian large and medium enterprises have at least one ERP in operations. Average age of the ERP in action is around 7.5 years, and almost all core back office business data exists in digital form, on a per transaction basis. ERP application providers are also increasingly allowing the enterprises to export data from captive database and combine with other sources to generate insights. Deloitte predicts that this trend will catch on significantly in the coming years with Indian companies deploying a bespoke or a package tool to get actionable insights from ERP. Deloitte predicts following sequence of business processes to bring this trend into decision-making cycle:

- **Record-to-report (R2R) and the areas of Risk and Controls:** Regulatory pressure, stringent audit and compliance requirements and the increasing need to identify early warning indicators from the systems will drive organizations to use ERP and other sources of control information to drive decision-making. Deloitte predicts this set of applications to be Wave 1 of ERP liberation.

- **Sales & Marketing and Customer growth:** In the era of digital enterprises, customer lifecycle management will be next to get the life shots from data driven insights. Deloitte predicts data driven insights such as "the next best action for a customer" to be mainstream in the next wave.

- **Operations and Supply Chain Enablement:** Currently, the lack of infrastructure and methods to collect stage-wise data is hindering the adoption in operations area. This is also moderating the otherwise significant opportunity area of Supply Chain optimization. As infrastructure modernization peaks up in next 3-5 years with anticipated capital infusion, data from various sales and distribution ERP modules will be extracted and curated through rich statistical models to generate insights.

Addressing the data conundrum

Deloitte predicts the organizations to put in place a well-deserved yet long overdue focus back on data organization, quality and management. Data quality related initiatives are already on the rise in 2017-18 with around 50% of telecom organizations focusing exclusively and deeply on data quality improvement initiatives, which is expected to gain further momentum. Large organizations will also invest in establishing a standard and organizations norms to maintain the data sanctity in the backdrop of further appreciation of data assets.

The bottom line

Analytics and intelligence from data is expected to go mainstream in India, both among Indian arms of Global organizations as well as organization incorporated in India. After a brush with back office optimization and a hiatus in the growth of analytics business, factors and variables seem to be favorably disposed for a catalytic growth in the space. Main drivers for this will be technological advancements to rapidly integrate field data with backoffice, and rich and intuitive visualization tools to bring insights and embedded statistical models to solve business issues. Speed of computing and availability of an on-demand cloud infrastructure is expediting this growth. ERP data captured from multiple back office activities that was otherwise captivated in the proprietary databases will be extracted and combined with other sources to generate data driven insights in the areas of risk and regulatory compliance, sales and marketing and eventually operations.

Deloitte predicts social data will also be combined with internal insights to generate invaluable rounded views around entities. This will be done on the backdrop of advanced data integration and combination techniques. Device data is expected to be integrated quicker and almost close to the actual occurrence. Statistical techniques and models will then be deployed to predict a multitude events saving precious resources due to disruption. Above all, advancement of technologies will ensure information delivery at a simple and elegant way. At the core of the activities, there will be renewed focus on data assets, creating and maintaining a persistent process and organization.

Internet of Things: realizing the potential

Organizations will take significant steps to realize the potential of Internet of Things (IoT) for their businesses in the coming year. At one end of the spectrum, IoT driven point solutions will be adopted to solve a specific business issues, and at the other end of the spectrum, IoT driven enterprise solutions would help organizations redefine their business models and provide innovative services for their customers. To this effect, the benefits derived from IoT solutions will be commensurate with the level of maturity of such solutions.

IoT units in India are expected to see a growth of 31 times to reach 1.9 billion units in 2020 from its current base of 0.06 billion. In terms of revenue, this opportunity could represent $9 billion by 2020 from the 2016 number of $1.3 billion - a growth of 700%[4]. Government of India aims to create a $15 billion IoT industry in India by 2020[5].

Trends indicate that IoT investments in India in 2018 and 2019 will be led by organizations in the infrastructure domain such as Industrial manufacturing, logistics[6], agriculture, etc. and govt. initiatives such as smart cities[7]. Generally, capital-intensive industries will view IoT as a significant lever to achieve operational efficiencies and hence the focus of investments will typically be on costs, asset visibility and operational flexibility.

IoT for point solutions

At the first level, most organizations will adopt this approach to validate the impact of IoT in their businesses. Investments in this track are likely to be made by Chief Digital Officers (CDO), and Chief Information Officers (CIO) with production and sales heads as the business owners. Such investments will be for a well-defined use case to address a specific business issue. For example, a continuous monitoring solution with an insight engine, to improve operational efficiency of assets. Most of these investments will likely deliver the desired KPIs and achieve desired business outcomes in the first year of operation, but they are unlikely to have a transformative impact on the business. Organizations will also start building internal talent pool within their technology departments to support such initiatives.

Most organizations assessing digital solutions to optimize their core business will start IoT platform investments in 2018. They are likely to consider 2-3 business areas, most likely in core manufacturing, supply chain including inventory and sales management for pilot programs to validate IoT solutions. These projects are likely to be supported by solutions providers who might also co-invest with the organizations to introduce point solutions for use cases such as supply chain, asset management and smartphone/wearables based workforce safety systems.

A few use cases and application areas that could see investments in the immediate future include:

Infrastructure

- GIS and imaging based solutions for supply chain planning. These are mature technologies with an evolved ecosystem, and are likely to deliver value in the immediate future, subject to imaging systems being adapted to operate in Indian conditions
- GPS based real-time tracking of commercial vehicles will see widespread adoption, enabled by cost effective bandwidth. Emergence of new age startups in the logistics industry that are building such technology driven solutions is also catalyzing the adoption of such use cases
- Using drones for real-time inventory tracking, and site surveys by infrastructure, resource based industries. However absence of a strong OEM network in India and an evolving regulatory landscape for drones will likely act as a moderating factor, and the maturity of these initiatives will take a longer time to fructify

Industrial manufacturing

- Industrial manufacturing has visibility of control data to some extent via the Supervisory control and data acquisition (SCADA) and distributed control systems (DCS), and 2018 will be the year plant engineers start demanding IoT platforms capable of performing streaming analytics. Deloitte India predicts that the initial use cases to be implemented could be as under:
  - Sensor based asset monitoring and predictive maintenance
  - Movable asset tracking via GPS / radio systems
  - Creating automatic safety alerts and area-bans based on network of worker and equipment trackers, as well as environmental sensors
  - Sensors and analytics based tracking effectiveness of parts and machines in the production process through their lifecycle
  - Imaging and sensors based quality control
- However, in the absence of an end-to-end digital operating model, the successes of such technology investments will not be exponential and will likely accrue over a period.

Logistics

- Fleet monitoring and management, for passenger as well as commercial vehicles will see increased adoption.
- Cold chain solution providers will be one of the early adopters of this technology, and fleet management for passenger vehicles

will see increased adoption with transportation service providers offering smartphone based tracking for end users.

- Availability of cost effective bandwidth will also contribute to widespread adoption.

Healthcare

- Govt. Of India's 'Tele-medicine' network for e-healthcare services delivery aims to promote accessibility in remote parts of the country with the following use cases:
  - Monitoring various vital parameters of patients like subtle changes in pulse, respiration, heart condition, temperature.
  - Doctor-patient interaction in telemedicine centers, with patients' health records automatically wired to doctors for reference.
- OEMs and technology service providers could provide the technology infrastructure as a managed service and this model is likely to enable faster adoption.
- In our view, adoption of such point solutions in 2018 will likely prepare the path for technology driven transformation of healthcare service delivery in India.

While IoT implementation of point solutions provide the desired incremental benefits in the near term, a more integrated approach is required to fully realize the potential of IoT driven solutions, to help transform the entire industry value chain, moving beyond cost optimizations.

IoT for business model innovations

IoT could also be leveraged by organizations to transform their business operations and enter adjacent areas of business. While such investments could bring extraordinary returns, they are also more risky in nature. In our view, fewer organizations will actively pursue such investments in the near future. These investments will largely be led by the office of the CEO, and executed by the office of the CMO, supported by CDOs. The investments will be assessed not only on KPIs, but also will involve new product launches, new supply chains and a new operating model that enables organizations to monetize their services across value chains, leveraging IoT. Such investments are unlikely to generate immediate returns, and the real returns will start accruing once the proof of concepts are industrialized and workforce transition to a digital mindset is completed. These organizations will be the eventual digital winners[8].

Digital first organizations having an integrated approach towards technology driven business operations are more likely to focus on new and emerging business opportunities using IoT. Such implementations will be fewer in 2018, and the firms taking this path will likely be the nimble players, challenging the market leaders for the mind share of premium customers. They will focus on "being digital" and will increasingly work with a multitude of technology solution partners in their transformation journey.

A few use cases and business applications of IOT for business model innovation include:

Digital supply networks

As integrated logistics networks takes shape in India, catalyzed by investments from both domestic and global enterprises, innovations in supply chain digitization will see increased adoption. Retail and infrastructure sectors will be the early adopters and key investors in such digital supply networks. IoT based solutions for intelligent automation and inventory management will be key focus areas.

Enterprises like industrial manufacturers and utilities are likely to install systems to integrate

- GPS based real time tracking of goods throughout the supply chain to shape demand planning
- Sensors based real time in-house inventory tracking
- Partner system integration to get advance capacity availability information
- Using outside market information to improve pricing decisions and engage the market proactively

Faster implementation and roll out is likely to create positive network effects and will be a key success factor for such investments. This also implies that firms where such initiatives are driven top-down, right from the CEO's office would be more successful than firms where digital is a CFO/CIO agenda.

Agriculture

In India, agri-economy will see increased adoption of IoT use cases to help maximize farm yields with efficient use of inputs such as seeds and fertilizers. Various estimates indicate that out of about 280 IoT start-ups in India, around 40 focus on providing smart agriculture solutions[9].

Areas like soil conditions monitoring, weather monitoring and mobile based agri-consulting will be key focus areas in agri-IoT. Government push towards IoT in agriculture[10] coupled with the niche solutions from the evolving startup up ecosystem could transform the agri-value chain from efficient monitoring

mechanisms for weather, soil, and crop to managing effective cold chains and markets.

The typical uses cases that are likely to be invested in first in India are likely to be around:

- Smart sensors for recording the storage parameters of temperature and humidity
- Real-time alert notifications for storage conditions SLA breach[11]
- GPS tracking of cold chain shipment in transit

Building the IoT ecosystem in India

The ecosystem in India is evolving, with support from industry bodies and govt. initiatives such as 'Make in India', which aims to create a robust manufacturing ecosystems in the country. Such integrated approaches will provide the necessary incentive to build domestic ecosystem of IoT OEMs and solution providers.

Government Initiatives[12]

Centre of Excellence for IoT in Bangalore by Government of India and NASSCOM	• Earlier this year, the Indian government in partnership with NASSCOM, DEITY along with various technology service providers launched a Centre for Excellence for IoT in Bangalore.
Andhra Pradesh IoT policy	• Andhra Pradesh plans to turn into an IoT hub by 2020 and create 50,000 jobs in IoT sector. • Reportedly, Andhra Pradesh government proposes to set up 10 IoT hubs and wants to attract 100 IoT companies to set up operations thereby creating a first of its kind IoT ecosystem in India.

Such initiatives will help develop the ecosystem and enable home grown startups providing localized solutions for the domestic market.[13]

Evolving supplier ecosystem

The supplier ecosystem in India is still evolving, with OEMs and service providers building end-to-end solutions for industry use cases, often in partnership with each other. As global OEMs build edge-computing devices, Indian IT service providers are providing platform driven solutions, including system integration and managed services to help organizations adopt IoT faster. Such investments in technology frameworks and solution accelerators, along with domain specific knowledge and expertise will help Indian IT service majors to create their niche in this evolving market.

Looking at the size of the IoT ecosystem in India today, there are about 120 IoT focused organizations with 60-65% being startups. Venture capital firms have invested over $60 million in Indian IoT startups since 2014[14]. The opportunity is spread across hardware, software platform and applications providers. Application providers are expected to have 50% share of the market in India[15].

Deloitte India believes that alliances and partnerships between OEMs, consultants, and IT system integrators will accelerate adoption of IOT use cases, as the collective experience and expertise in providing domain specific solutions will be help enterprises realize the benefits faster.

Deloitte India predicts that 2018 will also witness India specific IoT solutions and the emergence of domestic OEMs in sensor space, as the market evolves to support localized solutions.

The bottom line

Digital first organizations that use technology as a key tool to optimize business operations will increasingly adopt IoT as a part of their comprehensive digital roadmap. Success in IoT will accrue more to organizations that view IoT as a lever that connects digital and physical systems in a closed loop where physical systems provide data to digital systems that in turn provide information to physical systems on next steps. Enterprises that invest in IoT only as a tool to provide operational visibility will be underutilizing the power of IoT systems.

Enterprises should evaluate how IOT could enable them to become more responsive and agile organization as part of their comprehensive digital strategy before investing in specific platforms.

VoLTE: enabling next-gen voice services

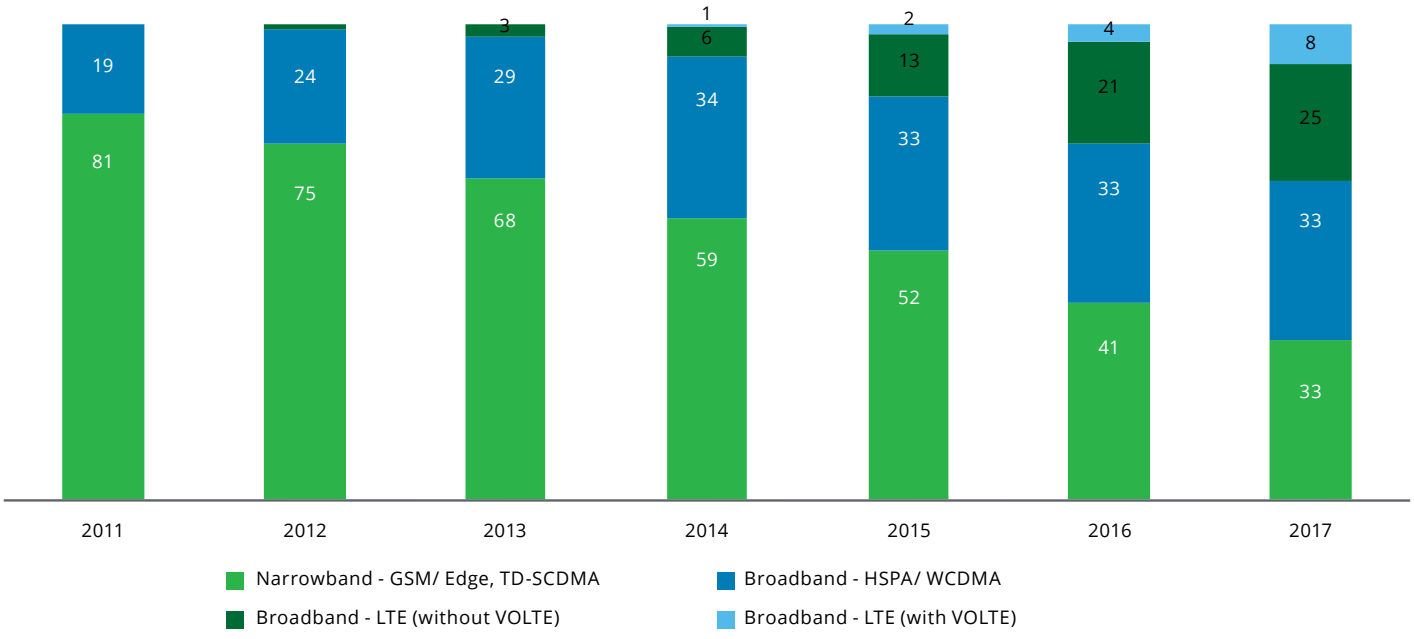
Deloitte predicts that more than 60% of all broadband subscribers would be utilizing Voice over LTE (VoLTE) technology for voice services by 2023 surpassing 5 billion subscribers globally. It is estimated that more than 90% of all mobile subscribers will constitute of broadband subscribers by 2023 thereby making VoLTE the most prevalent voice technology in the future.

VoLTE subscriptions already constitutes 8% of the total mobile subscriber base and has been doubling up year on year since 2014, with the number of service providers offering the voice service through VoLTE increasing at even faster rate. The number of commercial VoLTE networks globally have increased to 125 recently and have more than doubled since end of 2016. With 644 operators offering LTE services, more than one-fifth already have VoLTE deployed.[16]

It would be important to understand what has transpired since the launch of 4G/ LTE by telcos. Circuit Switched Fall Back (CSFB) on 2G/3G legacy technologies for providing voice services; due to ease of implementation and lower costs was the prevalent choice amongst most incumbent carriers embarking on the LTE journey.

Data explosion with 4G/ LTE: The data traffic globally has grown 65% year on year and had almost reached 14 EB (10^{18}) per month by end of 2017.[17] The data explosion is causing capacity constraints with operators focusing on capex deployment to enhance coverage and capacity of LTE networks. VoLTE offers more efficient use of spectrum than legacy 2G/ 3G networks for voice transmission and provides operators an opportunity to retire their 2G/ 3G networks. The spectrum freed up as a result of retirement of legacy technology can be used for IoT and M2M communications there by

Figure 1: Global Mobile Subscriptions by Technology (%)



Source: Ericsson Mobility Report 2017

adding to the operator services bouquet and additional revenue streams.

Degraded Quality of Service (QoS): VoLTE specifications defined for voice services improve on voice quality as compared to current circuit switch-domain voice services. Telcos utilizing CSFB have been facing challenges with the following hampering customer experience and in turn resulting in movement of voice traffic to OTT apps.

- **Handover failures:** Failures between the LTE and 2G/ 3G legacy networks for voice calls resulting in call drops.
- **Slower call set up times:** In CSFB call set up times are sometimes greater than 4 seconds as opposed to sub-second call setup times in case of VoLTE[18].
- **Termination of data session:** CSFB does not allow users to continue with data session whilst the voice call is established terminating the data session. VoLTE allows for data session and voice calls to be run in parallel.
- **Delayed re-establishment of data sessions:** Handover back to the 4G networks failing resulting in delayed re-establishment of the data session that was previously in progress prior to the voice call.

Free unlimited voice plans: The carriers providing voice services through VoLTE have come up with unlimited voice tariff plans utilizing the packet core and transmitting voice as data packets. Whilst such plans have put the incumbents' (operating CSFB on legacy networks) topline under more pressure with already declining voice revenues; from a customer standpoint this is a positive change in the way subscribers are charged for voice services.

Demand for richer, more reliable services: With the growth of OTT, demand for Rich Communication Services (RCS) which includes video sharing, multimedia messaging, chat and file transfer, location services, group conversations, etc. has increased. This demand from subscribers is fueling the growth of OTT and cannibalizing the service provider voice revenues. Moving to an IP Multimedia Subsystem (IMS) core-based all-IP voice and data communication enables RCS without the need for switching on to an OTT app for RCS. WebRTC initiative to enhance browsers and mobile applications with RCS through simple APIs is further boosting endeavors to provide such features on VoLTE.

Customer dissatisfaction because of poor battery life of smartphones: Extensive use of data, OTT apps, etc. takes a toll on the smart phone battery life, VoLTE is expected to save 40% more battery life than VoIP and OTT apps[19].

In addition to empirical evidence to the benefits of VoLTE with more efficient use of spectrum, resulting in additional capacity whilst providing RCS catering to subscriber needs, with improved QoS and clear calling experience; VoLTE is benefiting from constant improvements on the open source technology as LTE evolves to lay genesis to 5G.

HD voice and beyond: VoLTE users already were experiencing HD voice on the Adaptive Multi Rate Wideband (AMR-WB) codecs and whilst this roll out was gaining pace globally, Enhanced Voice Services (EVS) codecs have been standardized by 3GPP with bitrates ranging from 5.9-128kbps. The enhancement promises voice quality beyond HD[20].

Support for supplementary services: All supplementary services as experienced in normal voice calls such as call forwarding, call barring, origination identification, call waiting, ad-hoc multi-party conference, etc. have been specified in GSMA IR.92 as defined by 3GPP. Hence, in addition to improved voice quality, full scale of features on voice services as available on legacy networks can be provided through VoLTE.

Video capabilities: VoLTE offers fully capable video capabilities without having the need to utilize any OTT app and is fully interoperable across operators. Video over LTE (ViLTE) which is an extension of VoLTE enabling high quality video services along with the voice channel, has deployment of VoLTE as a pre-requisite. ViLTE is also enabled on Voice over Wi-Fi (VoWi-Fi) and when complemented with RCS can help provide a more complete service offering for customers. Hence, this presents a revenue opportunity for the service provider. From a customer standpoint unified billing for all IMS based services would be the benefit.

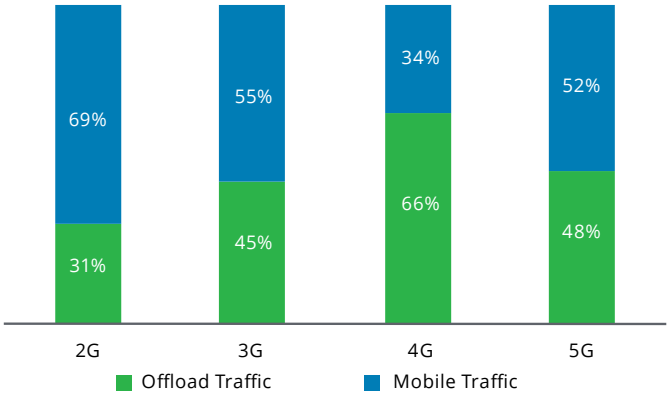
With the growing demand for Video calling with Video contributing to 55% of all data consumption per month globally and slated to contribute to 75% of all mobile data traffic by 2023, this capability provides service providers an opportunity to meet the OTT challenge and offer RCS and video calling services as part of their core service bouquet.

Suitable for Enterprise services: VoLTE with the high quality voice and video capabilities is ideal for enterprise users with carrier grade service definition of VoLTE and improved throughput (VoIP OTT apps require 20-40% more throughput to achieve the same voice quality) and signaling load (100-200% higher) characteristics as opposed to VoIP[21].

Support for Public Protection and Disaster Recovery (PPDR) communications: With LTE slated to be the broadband technology most suitable to support PPDR communications, VoLTE adding voice capabilities to LTE would help enhance situational awareness in PPDR operations. VoLTE providing features like ViLTE, Push-to-talk over LTE (PTToLTE) & High Definition (HD) voice, mission critical capability enhancements in LTE latest releases, in addition to the ability for large file distribution through integrated databases due to enhanced bandwidth data capacity would help improve effectiveness and efficiency during incidents. This also provides opportunity for a unified PPDR communication network inter-operable across geographies.

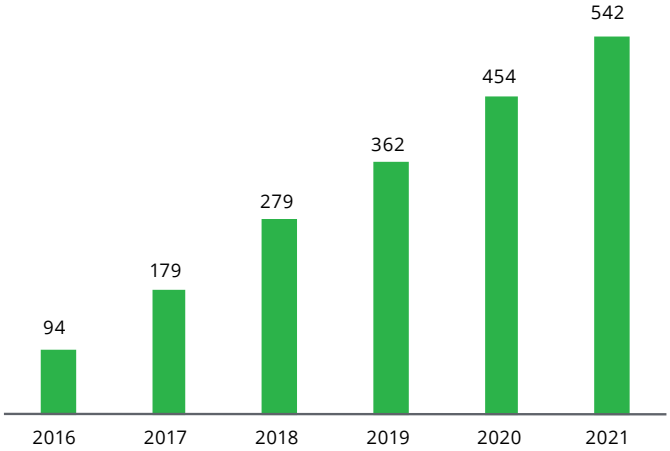
Integration of VoLTE with Voice over Wi-Fi (VoWi-Fi) service: VoLTE supports VoWi-Fi (Wi-Fi calling). With extensive Wi-Fi hot-spot deployment by telcos, this would be an opportunity to monetise the hot-spots as well as off-load the traffic on to the Wi-Fi network. Globally, total public Wi-Fi hotspots (including homespots) will grow six-fold from 94.0 million in 2016 to 541.6 million by 2021[22]. Wi-Fi would be essential part of service provider network strategy to enhance access and extend coverage of cellular networks especially in case of indoor coverage. Especially relevant in the Asia-Pacific region constituting to 45% of all the global hot-spots.[23]

Figure 2: Offload traffic vs. Mobile traffic, 2021



Source: Cisco VNI Report

Figure 3: Number of hotspots (in million)



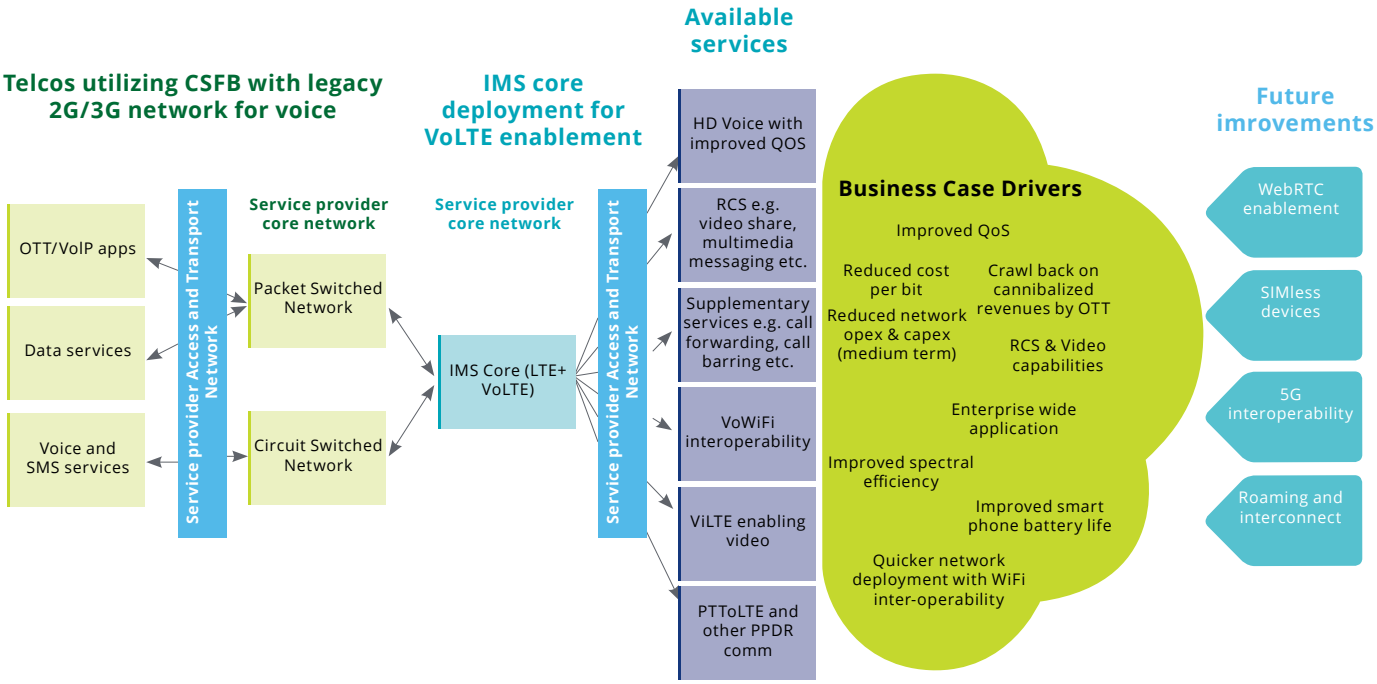
Source: Cisco VNI Report

Wi-Fi offload traffic for 4G technology which was 63% in 2016 is expected to rise to 66% in 2021[24]. Because of significantly higher consumption of data, the need for offloading would be higher in case of 4G. Radio access technology inter-operability with Wi-Fi becomes critical especially for LTE and VoLTE enablement would help service providers improve voice coverage in conjunction to data.

IoT enablement: VoLTE support in Cat-M1-capable Internet of Things (IoT) devices means that those IoT devices will have the ability to make voice calls to other devices and applications. At the last Mobile World Congress, telcos demonstrated VoLTE Cat-M1 use cases of fire trigger panel and GPS emergency tracking device. IoT appliances can be enhanced with VoLTE improving the productivity and efficiency of applications and especially effectiveness in emergency situations, one example is a smartwatch with feature to automatically dial an emergency contact in case of abnormal heart rate. Adding voice capability also presents new revenue opportunities for service providers.

Voice technology for 5G services: With advent of 5G inevitable, telcos deploying CSFB would be faced with the dilemma of managing multiple technologies. Managing three to four technologies in parallel with separate voice and data networks would have cost implications with growing costs of managing legacy networks in addition to challenges on quality, limited services, and spectrum constraints. In this context, adoption of the voice technology suitable for current and future generation networks i.e. 5G networks would reduce the complexity and costs of further modernization.

Figure 4: Ever-expanding service bouquet for VoLTE



Source: Deloitte Analysis

Even with the ever improving business case there are certain challenges which slowed the initial deployment of VoLTE. One of the biggest challenges for VOLTE was inter-operability amongst operators. Due to the lack of interconnect and roaming pacts between service providers in the initial phases of 4G launches, operators needed to rely on CSFB on legacy 2G/ 3G networks. Huge strides have been made to improve VoLTE inter-operability.

Another critical aspect is the device ecosystem. There are more than 1,300 VoLTE enabled device models currently available and with the device ecosystem developing affordability of devices would be a key aspect driving uptake of LTE/ VoLTE enabled devices specifically in the Asia-Pacific region which is seeing the fastest uptake of VoLTE[25]. This upsurge has been caused by new entrant in the Indian market acquiring more than 100 million subscriber since launch in 2016 and fast paced adoption of VoLTE in China. The other service providers in the region have seen the clear benefits of an all-IP network and are fast pacing their IMS deployment and VoLTE enablement. Affordable device bundled offers could further improve adoption.

Technical challenges in complex network environment of service providers with multiple technologies in play, only get enhanced further with requirement of IMS and Evolved Packet Core (EVC) implementation in the network for VoLTE enablement. Radio optimization to meet the carrier grade QoS defined for VoLTE service, software and hardware upgrades required, also add to the complexity.

There are more than 1,300 VoLTE enabled device models currently available and with the device ecosystem developing affordability of devices would be a key aspect driving uptake of LTE/ VoLTE enabled devices specifically in the Asia-Pacific region which is seeing the fastest uptake of VoLTE.

The bottom line

In addition to the advantages of improved spectral efficiency, reduced cost per bit, improved QoS; application across retail and enterprise and ever increasing VoLTE bouquet of services is allowing telcos to compete against the OTT challenge. Video capabilities which would comprise bulk of the traffic in the future enhance the VoLTE business case. As a result, most telcos are advancing their plans and commencing trials/ deployment of VoLTE. GSMA is taking steps to ensure consistent approach industry wide for delivery of VoLTE services.

With all efforts being made to have LTE and VoLTE as the standard globally accepted technologies not hampered by fragmentation and diversity, to enable one community multi-billion connections, the rationale for adoption of these technologies by service providers' further gets improved. If not for the unforeseeable, such as, advent of a path-breaking technology to supersede existing VoLTE features, VoLTE is likely to prevail as the dominant voice technology over broadband networks in the future.

Sports media in India set to unlock new horizons

Deloitte predicts, due to the potential of the Indian Sports market, more and more global players will be investing in the Indian sports business and this sector will continue to attract global investments.

The sports media landscape is evolving rapidly, especially in terms of who creates content and who has the right to distribute it. The last two years saw some significant transactions in the sports broadcasting business. A major Indian Broadcaster sold its sports business brand umbrella to a large global television network for approx. INR 250 billion ($385 million)[26]. This was a significant consolidation in the sports broadcasting space in India in this segment. The size of the transaction also showed the potential of growth in this segment envisaged by a large global player which was further evidenced by high value telecast rights acquisitions.

Cricket

The television and digital broadcasting rights for the Indian Premier League (IPL) were up for grabs after completion of 10 years of telecast agreement. A leading sports broadcaster in India won the IPL global media rights for the period from 2018-2022 with a consolidated bid of INR 1,634.75 billion (Approx. INR 326.95 billion annually). Initially, there were 24 companies contesting for the several rights being auctioned by the Board of Control for Cricket in India (BCCI), which included several global technology giants, telecommunication companies and media companies. These entities are not primarily in the sports broadcast business but had put value on the table to acquire IPL digital broadcasting rights. This proves the global appeal of Indian sports which is now identified as a potential growth area by global giants.

Other Sports

The success of IPL showed that there is a significant place for domestic sporting leagues in many other sports in India. Based on this model leagues have been formed for various sports in India like football (Indian Super League), Hockey (Hero India League and Premier Hockey League), Kabaddi (Pro Kabaddi League), Badminton (Premier Badminton League) etc. These leagues have made a few dormant sports in India like Football and Kabaddi popular again and given the players new inspiration and ambition.

Teams in these leagues are owned by large corporate houses including the biggest names in the India corporate world. Recently a large steel manufacturer won the bidding rights for one of two expansion spots in the Indian Super League (ISL) and formed Jamshedpur FC which now competes in the ISL. Apart from corporate houses, Bollywood actors like Abhishek Bachchan and Ranbir Kapoor as well as current and past cricketers like Virat Kohli, M.S. Dhoni, Sachin Tendulkar, etc. also own or co-own teams in these leagues. The involvement of such celebrities makes these leagues attractive for the views and creates interest in the public for such sports. This results in not only high TV/digital viewership but also big crowds at the stadium.

There are new leagues that have been launched like the Karnataka Premier League and the Tamil Nadu premier cricket league which are cricket league which promotes teams and players in specific States. These have become popular among the tier 2, tier 3 cities and rural areas of such States. This has created a distinctive and a new market for broadcasters, advertisers and team owners. Both viewership and stadium attendance for these leagues is quite high.

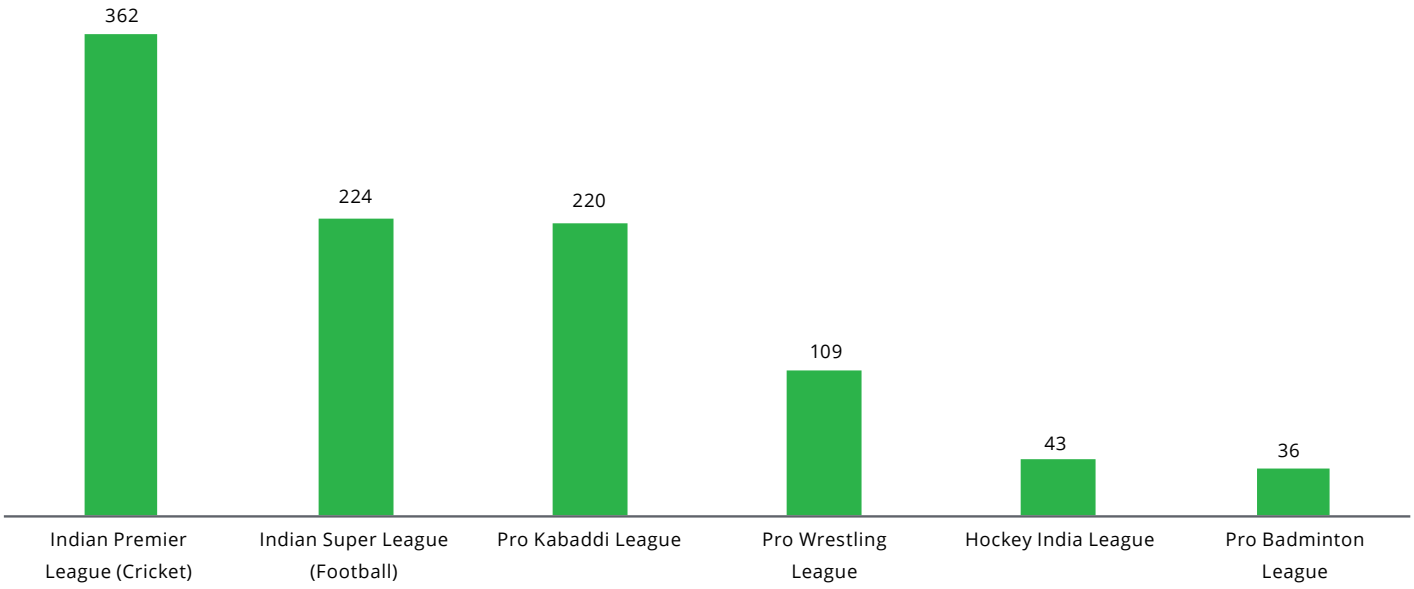
Deloitte predicts that due to the success of the existing domestic sports leagues, other sporting bodies will be inspired to come up with similar leagues.

On the other hand, as the frenzy of buying sports team is settling, there are news that some of the initial investors may be looking for an opportune time to exit from the sector. While the high player transfer cost has been identified as one of the major reasons for most of the teams not making profits in the European Football Circuit, the fact that only few teams have been able to make money in a developed market where the popularity of the game cannot be questioned – is not encouraging and does not help. Deloitte predicts, with moderation of vanity value in owning a sports league team, we could also see some of the old investors exit the sector - courtesy realistic valuation of teams and realisation of ground level challenges of running a sports team.

The broadcasters of these leagues also put their heart and soul in marketing and promoting such leagues and as a result these leagues have become very popular not only in tier 1 and tier 2 cities but also in tier 3 cities and in rural India. In rural India sports like Kabaddi and Wrestling are getting popular. For example, 64% of ratings for both Pro Kabaddi League Season 3 and Pro Wrestling League Season 1 came from rural India.[27]

The viewership of domestic leagues is increasing consistently and in many cases exponentially. Television viewership also scaled new heights, especially for IPL with nearly 46% of its viewership coming from rural India.[28]

Figure 5: Viewership (in millions)



Source: Season 2016 –BARC COVs

The ever increasing popularity of these leagues among the viewers drives the advertising space on television and digital planforms and makes them all the more attractive. Deloitte predicts increase in advertisement rates in the range of 5% to 15%, as the relevant sports and sports league matures.

Data and analytics

Globally, data analytics discussions in sports has been typically concentrating on scouting and player development, but these conversations miss other aspects of a team's or league's operations. One of the most significant trends in sports is the transformation on the business side as a result of big data. Having the best players is critically important, but so is having key insights to create better fan experiences, drive more revenue, and create more value. Business functions, such as finance, marketing, and sales, are seeking ways to better understand the sources of data they have access to and to improve their strategy and operations as a result. Deloitte predicts increase in use of data analytics in sports in India especially in:

- **TV viewership and viewership over digital platforms:** Analysis of data of viewership will enable advertisers and broadcasters to understand which sports are popular in which part of the country, popularity among gender, among various age groups etc. This would result in better placement of advertisements in various sporting programs. Advertisers can decide which products to advertise in which sport, in which geography and at what time. Broadcasters can decide the advertisement rates to be charged advertisers demand patters. With increasing rates, placement of the right advertisement, at the right time and in the right sport is a crucial decision in which data analytics can play a pivotal role.

- **Fan interaction through social media platforms and team and league websites:** Broadcasters as well as franchise owners of teams of sports leagues may be able to obtain actionable insights by analysing social media interactions between players and their fans as well through analysis of traffic on websites of teams and leagues. Owners can understand which players are more popular with the fans which will help them tap revenues other than traditional avenues. Popularity in social media is one of the considerations affecting the valuation of sporting leagues and in valuation of franchises participating in these leagues. Therefore understanding of how to attract interest in social media is an important and strategic decision for the stakeholders. Data analytics can help significantly in this area.

Fantasy Sports & Legalising betting in Sports

Currently, there are approximately 20 state legislations on the subject of betting and gambling in India with certain states

still applying provisions of the Public Gambling Act, 1867. As on date betting is allowed only in horse racing in India[1], while certain other forms of gambling are allowed in states of Goa[2] and Sikkim. Sikkim is the only state in India which permits online betting in Sports (subject to holding licenses granted by the State Government of Sikkim[3]) through websites whose servers are based in Sikkim.

In spite of betting being illegal in major parts of the country, the business of betting has continued to thrive. As per the Lodha Committee report released last year, the business of betting globally is estimated to be close to $400 billion. The committee goes on to refer betting as a general malaise which can be effectively dealt with by providing a legal framework.

While there are set of perceived advantages and obvious repercussions of legalising betting in Sports, Deloitte predicts that there may be enhanced action or movement to suggest legalising betting as an option to curb some of the malpractices in Sports in the country. These could include introducing a separate regulator for sports betting, provide options to individuals to set up limits for betting and providing for responsible conduct while betting and rehabilitation for those who are addicted to betting etc. Some of industry bodies too have been advocating the legalization of betting in sports in India, the legislature would do well to proliferate the advantages of legalizing sports betting while providing for adequate safeguards to ensure that in our eagerness to win the game we do not lose the match.

Another noteworthy development is the rise of Fantasy Sports, the principal legislation governing gambling in India the PGA criminalizes the act of 'gambling' in a public forum and the keeping of a 'common gaming house'. The PGA, however, creates an important exception in favour of games of skill, by stating that the provisions of the PGA shall not be held to apply to any 'game of mere skill' wherever played. Games of skill mean, where, skill plays the dominant role and the result depends primarily upon the relative knowledge, training, attention, experience, and/or adroitness of the participants. Generally, such games are not deemed to constitute 'gambling' and do not fall foul of the laws prohibiting gambling. The 'skill' element of the fantasy Games is generally measured in two aspects: drafting and playing.

The fantasy games segment has also seen spike in acquisitions with Clairvest Group, a Canada based Private Equity firm, investing ~ INR 5 billion[29] ($78.75 million) for a majority stake in a Hyderabad based company which saw increase of 61% in profits for the year ending March 2017. Other multinationals like Stride Gaming, Delta Corp, Tiger Global etc. have also entered the fantasy games space in India. With the rise of the leagues in various sports and ease of access to internet for masses, Deloitte predicts steady gain in popularity of fantasy games in the country.

The bottom line

- Global players will try to invest in the Indian sports business and this sector will continue to attract global investments.
- With broadcasters paying as much attention to rural segment, these geographies will continue to lead the way for Sports sector in India especially with Tier 2 leagues also starting to make a mark.
- Some of the celebrities/corporate houses which made huge investments in initial stage to own teams, will now start to look for disinvesting options.
- Data analytics will increasingly play a significant role in managing all aspects of sports business especially fan engagement and viewership on digital platforms.
- Governance related matters will continue to hog limelight in Indian Sports and matters like legalizing betting will be discussed more than before.

[1] In 1996, the India Supreme Court ruled that wagering on horse races is a game of skill, not just luck, and as such does not constitute an illegal form of "gambling"

[2] Please refer to Goa, Daman & Diu Public Gambling Act, 1976

[3] Please refer to Sikkim Online Gaming Regulation Act, 2008 as amended on 1 August 2009

OTT in digital world soaring high

Deloitte predicts that the original content will be a key driver of Over the Top (OTT) growth and regional content library is expected to increase its share on OTT platform. It is predicted that production houses may use the OTT route to release content, such as, movies before their television premiers. Advertising revenue share from the digital platforms will increase as a fall out and the pace of growth will be exponential.

Digital evolution

The world is changing and so are peoples' choices and perceptions. Thus, media and entertainment sector is ever evolving and has depicted an impressive growth over the years. There are some steady rulers in this sector like television and print but digital media is soaring like a dark horse and making it way ahead by changing the dynamics of this medium.

Digital revolution is expected to generate new market growth opportunities, jobs and become one of the largest business opportunity for businesses in the coming years.

India has nearly 432 million internet users and this number is growing at a rate of 4-8%.[30]

India has biggest market potential for global players. At present, India has probably one of the most liberal investment regimes amongst the emerging economies with a conducive foreign direct investment (FDI) environment. The Media and Entertainment (M&E) industry has significantly benefited from this liberal regime and most sectors of the M&E industry today allow foreign investment. For example, Balaji Telefilms Limited has raised INR 1.5 billion ($ 22.09 million) through allotment of equity shares on preferential basis to catapult the launch and growth of ALT Digital Media, a Business-to-Consumer digital content business segment of Balaji Group[31].

Demonetisation, Jan Dhan, Aadhaar, mobile penetration have changed digital payments landscape in India. Digital payments has also witnessed a massive growth with a shift in behaviour change as more people adopt digital payments in daily life.

The government has taken the "Digital India Initiative" and as a part of this the plan is to connect the remote parts of the country. 8,621 villages are already boarded and there is a plan to onboard over 55,000 villages by 2019. About 112,871 km of optical fiber cable has already been laid under BharatNet for high connectivity[32]. Bharat Sanchar Nigam (BSNL) has built over 2,500 free Wi-Fi hotspots across the country.

OTT

The changing multi-screen consumption pattern and demand for more choice of content is compelling the M&E companies to take the route of OTT. OTT is witnessing 35% growth year on year[33]. Currently, there are about 30 OTT players in India. Many media companies have begun offering OTT video on demand (VoD).

100% jump was noted in the subscriber base of Hotstar from 33 million in August 2016 to 67.5 million in August 2017. In August 2017, the user base of Netflix and Amazon Prime Videos grew to 5.37 million and 12.64 million, respectively[34].

India's OTT video viewers are expected to grow to 355 million by 2020[35] but considering the rate at which the broadband connectivity is growing currently, the number of OTT video viewers may grow at a faster pace. Trend has shown that the people are willing to spend on original content. This is driving OTT service providers to invest in original content programs. OTT players are heavily investing in creating and distributing original programming in Hindi and regional languages. Currently, about INR 25,000 - 33,000 million ($400- $500 million) has been set aside for OTT services in India especially for original content production with a significant stake committed by Amazon Prime[36].

It is expected that the vernacular users will be more than 2.5 times of English Internet user base by 2021. Currently, the viewership of OTT platform is 40% from regional content[37].

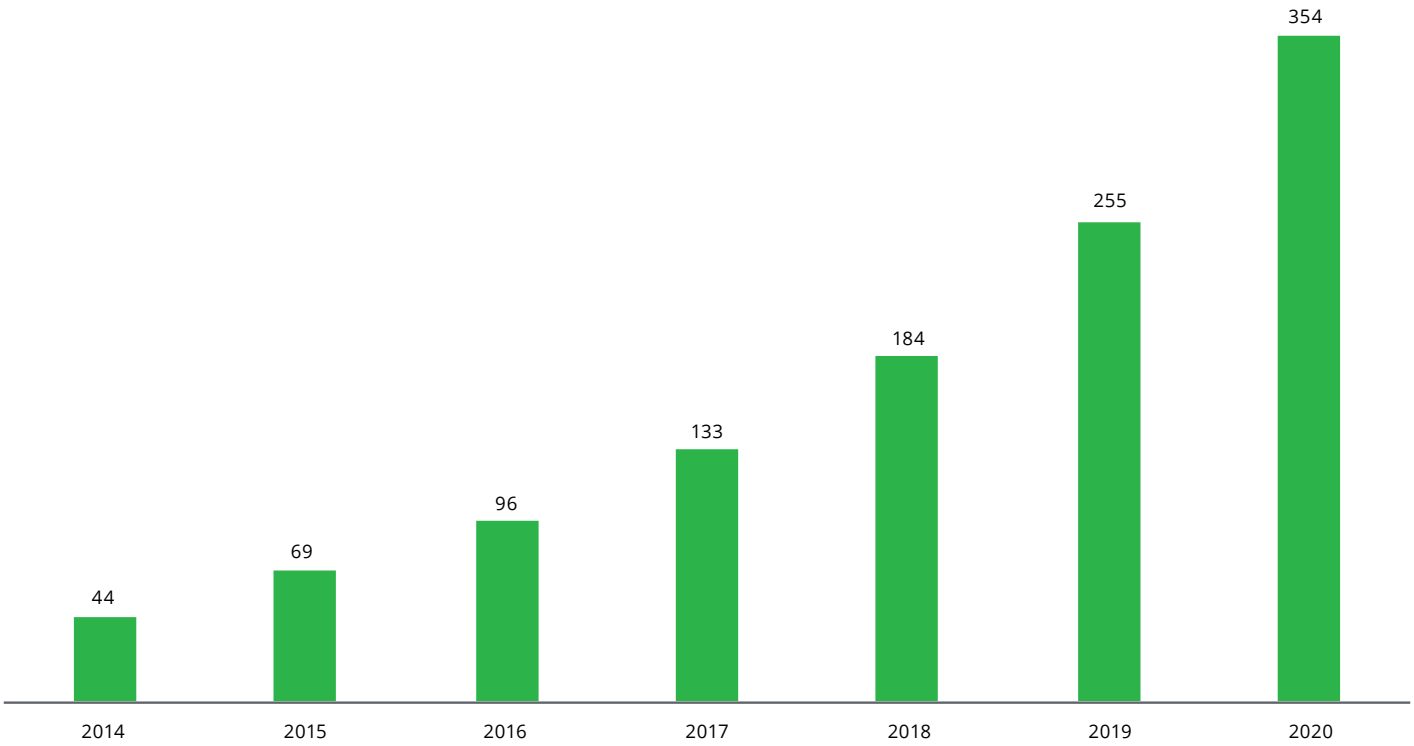
Few companies going the OTT route are:

ALT Balaji	Balaji Telefilms has launched its OTT platform called "ALT Balaji". They have eleven original shows which have initiated 5 million downloads since its inception in April[38]. They launched its first regional Tamil show "Maya Thirrai" in May. They are expanding by introducing regional shows in Hindi, Tamil, Bengali, Telugu and Gujarati.
Voot	Viacom18's Voot has launched seven original shows in Hindi and English with 6-10 episodes in each web series. Voot's active subscribers is about 22 million which is spread across 1,500 cities in India[39]. Their plan is to offer content in Kannada followed by Marathi and Tamil in the next few months.
SonyLiv	SonyLiv has launched Marathi web series called "Yolo" and Gujarati web series. Next on their cards is to have regional short films.

Amazon Prime	Amazon Prime is likely to invest around $300 million in the Indian market for acquiring rights of Bollywood films and also producing original content[40]. Amazon Prime Video has entered into a five-year deal with Salman Khan Ventures, which gives it exclusive digital rights to stream films of the actor even before their television premiere.
Netflix	Netflix is also competing and investing big to grow in India. They have approached Hindi film actor Saif Ali Khan to appear in its upcoming original series "Sacred Games" based on author Vikram Chandra's novel.
Eros Group	Eros Group, is planning to sell its entire content library of films and music for around $1 billion to Apple Inc. This deal includes Eros Group's digital OTT platform Eros Now, which has the rights to over 10,000 films. It has close to 2.9 million paid subscribers and over 100 million registered subscribers as of June 2017[41].
Z5	Zee TV is has announced the launch of "Z5". Zee is integrating all its VoD content and putting it onto a single platform called "Z5".

As more and more consumers are adopting this medium, advertisers are following them. In the forefront is the consumer durables, electronic and automobile industries, as well as premium FMCG companies, who are booking slots and overlays on the OTT platforms. Expectation for the overall digital advertising market in India includes probable cannibalization of advertisement revenues from other traditional segments like TV, radio, and print media. The indications are that the digital advertisement market size will be INR 354 billion ($5580 million) by 2020.[42]

Figure 6: India - Digital Ad Revenues (INR billion)



Source: Deloitte report

OTT platform has been benefited as telecom players offering affordable 4G data. Data rates have dropped drastically across the board with the launch of broadband services by new telecom player in the country.

The bottom line

- Original content will be the game changer for OTT platform in the coming years.
- OTT's focus would be driving towards expanding regional content library in order to increase its market share. It is expected that the vernacular users will be more than 2.5 times of English Internet user base by 2021[43]. This increase can be credited to the improvement in mobile devices technology and internet connectivity, which has provided the viewers with the option of accessing digital media content on the go.
- OTT will slowly be a preferred medium for film premiers over the television.
- As digital penetration increases, there will be an increase in the amount of time spent on digital platforms through mobile devices. Thus, this will soon be a chosen platform for advertising.

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.[44] 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.[45] 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.[46] 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.[47] 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.[48]

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.[49] These frameworks are visual inertial odometry systems (VIOs) with some simple two-plane detection.[50]

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),[51] 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.[52]

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[53] from their apps.[54]

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.

India Perspective

As feature rich smart phones and photorealistic content drive the global adoption of Augmented Reality (AR) content and applications, the ecosystem in India is still evolving, largely driven by business use cases across industries. Among the many use cases that are being explored, retail and consumer industries are among the frontrunners in using AR for improving customer experience and engagement. Consumer companies across categories such as fashion & lifestyle, real estate, food & beverages are among the early adopters, having incorporated AR content in their mobile applications for helping customers navigate the online catalogues, and to virtually assess products before making the purchase. Online education is another important domain that that is witnessing increasing adoption of AR in India. Going by growth achieved by such companies and the investor interest in such platforms, AR is fast emerging as an important tool for Education Technology (Ed-Tech) companies to provide an experiential learning ecosystem that can help improve learning outcomes.

The market is also witnessing the emergence of AR service providers who are helping enterprises and brands across the world embrace AR as part of their digital experience strategy. For service providers with strong capabilities in traditional Enterprise Mobility solutions, AR is becoming an important tool in their portfolio to design an augmented experience for their converged mobility platforms. India's IT services majors are also building capabilities in AR through a mix of technology alliances, partnerships, and dedicated lab infrastructure. India's technology services industry, through their strong supply of AR talent, can play an important role in helping enterprises across industries embrace AR use cases faster, thereby helping in the mass adoption of AR.

Another important application of AR in India is in public sector use cases, in domains such as e-governance, public safety & emergency services, public health & wellness, education, tourism, and sustainability. In India, technology adoption in public sector is at an inflection point, enabled by the government's vision for mass digitization through Digital India program. Increasing adoption of smart phones, mobile internet penetration, govt. interventions such as Jan dhan, Aadhaar, and Mobile (JAM) trinity, along with advancements in mobile payments ecosystem have created a generation of "mobile first" population that uses mobile phones as a primary interface for information and transactions. This can be leveraged for improving the delivery of public services through augmented content and workflow platforms for various citizen touch points. A few use sample cases below:

- Health care – AR simulations to train medical students in surgical procedures, enhanced diagnostics and patient care using 3D modeling
- Education – interactive content for experiential learning and assessments. Job specific trainings
- Public safety –AR simulations for training law enforcement personnel, crime scene investigations
- Public transportation and mobility – real time updates on the traffic situation, vehicle health and maintenance displays and alerts, interactive route maps
- Tourism – travel guides and maps enhanced with augmented content to provide additional information and identify places of interest

India's dynamic market for technology enabled services provides an interesting opportunity for startups to provide localized, mobile first solutions, and AR will be an important tool in their repertoire to improve customer experience and engagement. India's $150 billion technology services industry has the potential to play a key role in increasing the adoption of AR for global businesses by building a robust supply of talent, business models, and frameworks for accelerating deployments. In addition to the business use cases, public sector can also leverage the product and talent ecosystem in the country and adopt AR for improving the quality of experience in citizen services.

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,[55] 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.[56]

We further predict that owners will interact with their phones on average 65 times per day in 2023, a 20 percent increase over 2018.[57] 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.

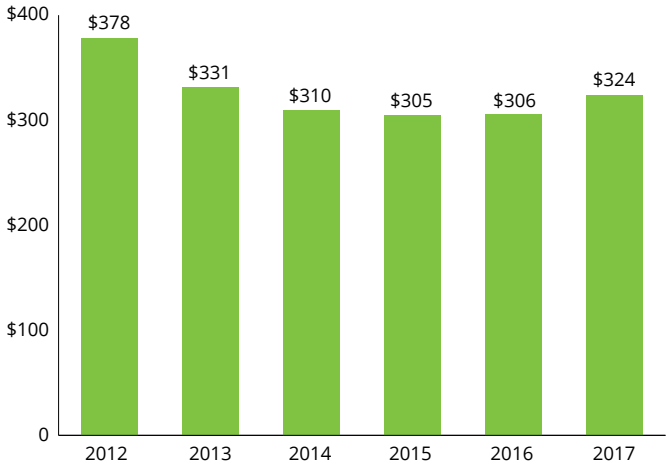
We expect the percentage of smartphone owners who use their devices daily to increase from 93 percent in 2018 to 96 percent by 2023.[58] This implies that 86 percent of all adults will use a smartphone on any given day in 2023, versus 79 percent in 2018.

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.[59] In Q3 2017, one-eighth of smartphones in Western Europe sold for $900 or more, double the proportion a year prior.[60]

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.[61] Smartphone ASPs rose from $302 in 2015 to $324 in 2017 (ASPs had declined between 2012 and 2015).[62] We expect ASPs to continue to rise as users' valuation of their handsets increases (see Figure 7).

Figure 7. 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.[63] 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.[64] 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)[65] 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 8). 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.[66]

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.[67] 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.[68] 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.[69]

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).

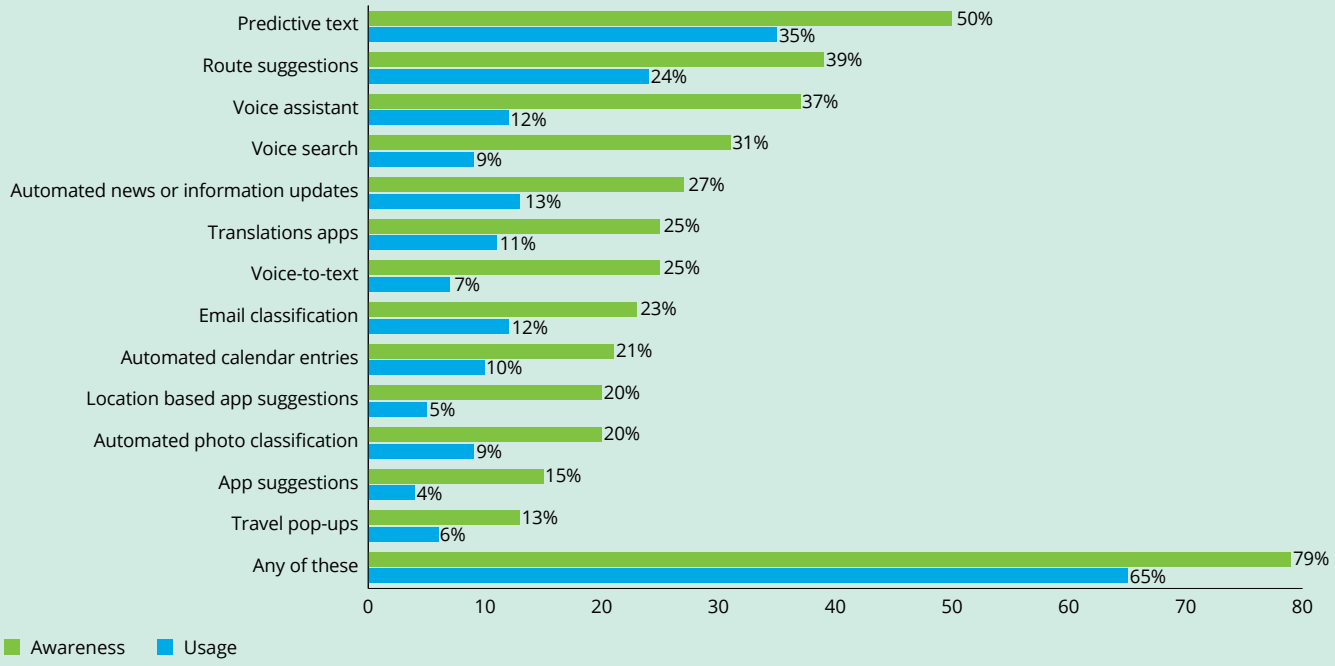
By 2023, 5G networks should have launched in most developed markets, offering much greater capacity and connectivity speeds.

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



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.[70] 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.[71] 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.[72]

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.

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

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

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's Global Mobile Consumer Survey, developed markets, May–July 2017

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,[73] cars,[74] buses,[75] trains and planes; corporate information systems; and e-commerce and banking sites.

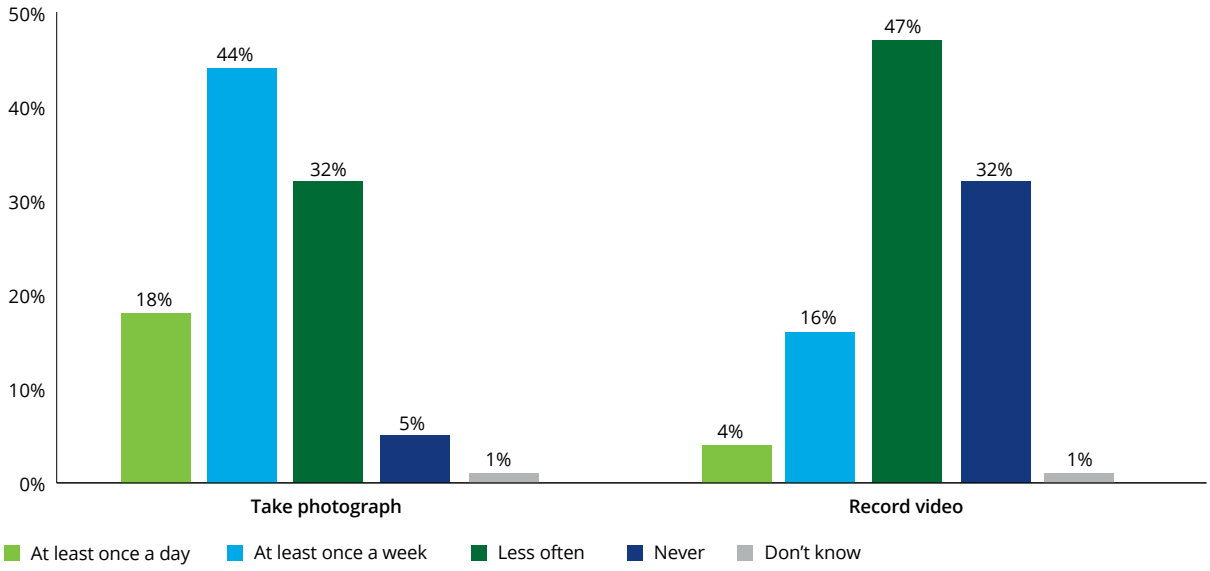
Deloitte Global predicts that by 2023, over three-quarters of all smartphone owners in developed countries will use some form of biometric authentication, and 80 percent of smartphones will have at least one dedicated biometric sensor, such as a fingerprint reader or a 3-D facial scanner.[76] This compares 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,[77] 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.[78] 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 10).[79] 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 10. 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 11).

Figure 11. 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,[80] 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.[81] 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.[82]

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.[83] 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.[84] 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.[85] The device distinguishes between the foreground and the background and creates the composite image from multiple images taken at the same time.[86] 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.[87] The result is no or reduced blur in a photo.[88]

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)[89] 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.[90]

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.

India Perspective

The mobile industry's contribution to the country's GDP currently stands at 6.5% ($140 billion) and is likely to become 8.2% by 2020[91]. Deloitte predicts that India would be leading the smartphone revolution in the coming years as the largely untapped market slowly gets included into the realms of digital services. In early 2016, India became the second largest smartphone market in the world, trailing China and overtaking the US with about 250 million smartphone users[92]. India currently has around 300-400 million[93] smartphone users and is expected to lead the smartphone growth reaching 810 million by 2021[94].

The telecommunications market in India is characterized by an urban-rural divide which is manifested by an urban tele density three times higher than that of rural. This explains the high smartphone user concentration in urban cities and an overall low smartphone penetration in the country. The current smartphone penetration in the country stands at as low as ~35%[95]. The top 30 cities make up 51% of the entire smartphone market in India[96]. However, the scenario will change soon with the increasing availability of affordable telecom services and handsets in the market and the numerous Government initiatives to connect the unconnected. Deloitte predicts that India is poised to be at the forefront of the global data revolution with the introduction of bundle-based sales of smartphones with net effective price less than $25 and data rates slated to reduce to less than $1 per GB by 2020[97].

The days of feature phones are far from over

Over 85% of the urban Indian population now owns a mobile phone, while smartphones get most of the attention, 56% of this user base actually uses feature phones[98]. In a price sensitive Indian mobile market, the term 'feature phone' stands for an affordable device with basic features like call, SMS and USSD. When telecom service providers in India started offering 4G data services at low prices and OEMs reduced entry level smartphone prices, a large number of feature phone users were expected to upgrade to smartphones. However, the "smart feature phones" introduced by a new entrant (telecom service provider) in the market proved to be a game changer. These phones would potentially bridge the digital divide by reaching out to the bottom of the pyramid with several data-driven functionalities bundled into a device.

Shifting dynamics of the Indian Smart Phone market

Although India continues to be a price sensitive market, there is a growing section of the new-age buyers who are willing to pay a premium for better technology. The access to low cost 4G data services, digital infrastructure, growing middle class and content ecosystem are key contributors to the smartphone market expansion in Indian cities.

The smartphone prices in the country have started to witness an upward trend with 25% increase in average selling price in the current year[99]. OEMs are now focusing on India as a key growth market and are introducing smartphones focused on higher memory, better camera, more battery and bigger LCD screens.

Two years ago, local smartphone OEMs had more than 54% market share but the Chinese smartphone OEMs gained ground in the country very quickly and have surpassed 50% of the market share in the current year[100]. Moreover, currently the top 4 players have more than 62% of the total market share[101]. Deloitte India predicts that it is quite likely the overcrowded Indian smartphone market will undergo consolidation in near future via market exits rather than mergers.

The key drivers behind the smartphone revolution in India are as discussed below:

'Digital India' initiative – A boon for smartphone ecosystem

In order to bring the 750 million rural India users into the realms of digital services, the Government of India (GoI) has embarked on the 'Digital India' initiative focussed on converting ~100 towns and cities into 'Smart Cities' across India and implementing 'BhratNet' which involves roll out of 'National Optical Fibre Network (NOFN) across India. 77% of urban users and 92% of rural users consider mobile as the primary device for accessing the Internet and rolling out of BharatNet across 2,50,000 gram

panchayats in the country by December 2018 will enable high speed Wi-Fi and broadband services to these users and this will steer the rapid uptake of smartphones in India[102]. Deloitte also predicts a significant drive in smart phone usage over next 5 years to enable access to smart cities features viz. smart parking, smart home metering, digital libraries, smart homes (control lighting, AC et al.).

Proliferation of smartphone applications to device solutions to social issues

The increased availability of smartphones is enabling increased access to a wide variety of digital solutions helping to improve healthcare, women safety, smart education, micro financing opportunities etc.

Mhealth opportunities are being harnessed by a number of social organizations to improve health services to underserved populations, help educate and inform patients, and assist community-based health workers diagnose, treat and monitor a broad range of conditions.

The growing adoption of smartphone has also prompted various entrepreneurs to come up with social security apps particularly targeted towards improving women safety in the country. The Department of Telecom (DoT) in April necessitated all new feature phones and smartphones sold in the country from January 2017 to have a panic button feature that will allow women in distress to seek help. It also mandated all new phones from January 2018 to have GPS installed.

Smartphones are also empowering students to learn anywhere and parents to promote education through alternate interactive mediums. Coupled with low cost devices as compared to PCs and Laptops, availability of cheap and fast data, knowledge and education can now reach remote areas of semi-developed India. Online educators have realized this potential, and the online education market is expected to hit $1.96 billion by 2021[103].

Digital content providers as YouTube have substantially increased their education content by up to 75% Y-o-Y. This has resulted in projections of CAGR 60% annually in the online education market just for India[104].

The app economy has also boomed in India due to cheaper mobile data plans and better internet speeds: 97% of Indians rely on dedicated APPs over browsers and websites. Moreover India has witnessed a massive surge in demand for “On the go” content and seamless video streaming during the past year[105]. Streaming through smartphones offers ease of consumption with anytime, anywhere access and no storage requirement. Deloitte predicts as more and more Indians continue to opt for smartphones, on demand content consumption will experience a rapid uptake in the tier 2, tier 3 cities. The supply side eco-system is evolving too with local content providers ready to innovate and help audience discover more of their favourite content.

E-commerce is the present boom, but M-Commerce will soon overtake it

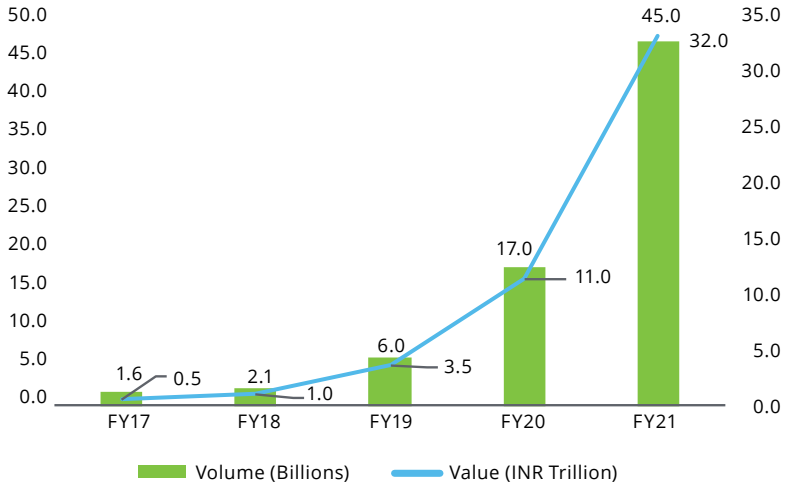
Over 83% of Indians prefer shopping online on their Smartphones as compared to PCs[106]. The m-commerce market is expected to be $30 billion by 2020 which would constitute over 85% of all e-Commerce sales[107]. Mobile phones, electronics, and apparel are currently the most popular segments for online shoppers in India. But going forward, groceries, personal and beauty products, furniture, and food delivery will also have a larger number of takers with FMCG based industries contributing to over $6 billion in sales[108].

Drive for digital payments

The Indian digital payments industry is poised to grow to $500 billion by 2020[109]. The National Payments Corporation of India, together with the RBI, has launched UPI (“united payment interface”), which powers multiple accounts from participating banks, and offers several banking services all in a single mobile application. 23% of connected Indians are currently using mobile payments at least once a week with one third of connected Indians preferring to pay for everything with their mobile in the future[110].

The demonetization of all INR 500 and INR 1,000 banknotes in November' 2016 moved the country's unbanked population and offline merchants onto digital payment platforms. The mobile wallet space saw an immediate surge. As the penetration of mobile internet and smartphones increase, mobile wallets with their ease of use & convenience are expected to continue to see an upward trend.

Figure 12: Value and volume forecast for the mobile wallet industry (FY17-FY21)



Source: Reserve Bank of India

Furthermore, large financial banks and institutions today have their own smartphone based payments with Samsung, Google and Apple either having launched or in process of launching smartphone-based payments.

Internet of things (IoT) – Smartphone transforming our daily cadence

The IoT market in India is currently growing at a compounded annual growth rate (CAGR) of 41% and will continue to grow at the same rate till 2020. With increased adoption, the growth rate will increase to around 54% CAGR between 2020 and 2025[111]. This can be attributed to increasing adoption of the internet of things (IoT) by Indian consumers owing to increasing internet penetration, rising smartphone usage and expanding social networks

The government plans to heavily invest in smart city projects and make 100 cities more sustainable. India currently has some 60 million IoT devices, and the number is forecast to reach almost 2 billion in the next three to four years[112]. Much of the IoT growth is currently driven by industrial automation, primarily in sectors like healthcare, housing, agriculture and engineering. However, the consumer IoT market is slowly evolving with increasing awareness among people.

India is on the cusp of a digital hyper-revolution and smartphone is at the center piece of this technological blitz. Each and every stakeholder in the telecom value chain will have to harness the potential to help drive transformational changes that go well beyond their core businesses.

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.[113]

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.[114] 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.[115]

What has held back the adoption of ML? Qualified practitioners are in short supply.[116] Tools and frameworks for ML work are immature and still evolving.[117] It can be difficult, time-consuming and costly to obtain the large data sets required by some ML model-development techniques.[118] 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.[119] 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.[120]

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.[121]

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.[122] 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[123] 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.[124] 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.[125]

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.[126]

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.[127]

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.[128]

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.[129]

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.[130]

Some techniques are finding their way into commercial data science products, such as H2O Driverless AI, a data science automation platform;[131] DataScience.com's new Python library, Skater;[132] and DataRobot's ML-powered predictive modeling for insurance pricing.[133] 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.[134]

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.[135]

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.[136] Microsoft Research Lab's compression efforts resulted in ML models that were 10 to 100 times smaller.[137]

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.[138] 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.[139]

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.

India Perspective

In the Indian context, the public discourse on machine learning (ML) and artificial intelligence (AI) has largely centred on the prognostications of large-scale job losses driven by automation, especially in low-end services. While it is natural for technology progress to realign industry value chains and alter the workforce mix, India's core advantages in talent ecosystem along with the evolving domestic market opportunities for technology services will enable us create jobs in newer areas and navigate the shift better.

At the core, machine learning helps create a prediction engine for business applications that maximizes accuracy and minimizes errors. This is achieved through experience (as the algorithms get exposed to more and more training data) and feedback. ML could be beneficial for any application that involves prediction, such as medical diagnostics, image recognition, autonomous driving, predictive maintenance, drug discovery, etc.

For India to take advantage of advanced tools such as AI / ML, it requires a) availability of large-scale actionable data to train the algorithms, and b) capabilities, expertise, and the talent ecosystem in AI/ML tools to build custom applications at scale. While the on-going digital transformation of public and private sector enterprises transforms the economy from bring data poor to data rich, India's strong talent ecosystem in science and engineering skilled in advanced tools such as AI/ML can help accelerate the adoption.

Towards a data rich economy

Technology adoption in India is going through a fundamental shift, due to the evolving market dynamics and favorable policy environment. For businesses across industries, technology is becoming a core element of business strategy due to changing consumer preferences and competition from new age enterprises and startups that are adept in using technology for optimizing business operations. In addition to the market driven changes, government initiatives such as Digital India and Smart Cities recognize information technology as an important tool for governance, and aim to streamline the procurement, implementation, and the program management functions of IT projects in the public sector. According to a forecast by Gartner[140] , IT spending in India is projected to reach $87.1 billion in 2018, which is 9.2% increase over 2017 numbers. While devices ($31.4 billion) and communication services ($32.4 billion) contribute majority of this spending, IT Services ($14.3 billion) and Enterprise Software ($5.7 billion) are expected to grow at a faster rate, at 13.8% and 15.3% respectively.

As enterprises embrace technology to bring transparency and efficiency in business operations, data assumes center stage in decision-making, setting stage for tools such as advanced analytics and machine learning to bring efficiencies across the value chain, and improve productivity in the economy.

India's manufacturing sector for example is going through a technology led transformation, supported by initiatives such as Make In India which aims to improve the share of the sector in the country's GDP from ~16% in 2016 to 25% by 2022, and also create 100 million new jobs by 2022[141]. According to Global Manufacturing Competitive report released by Deloitte and the Council of Competitiveness in the US[142], India is placed eleventh in the Global Manufacturing Competitiveness Index (GMCI) and is expected to reach fifth position by 2020. Globally, the industry is disrupted by advanced trends such as additive manufacturing, artificial intelligence, robotics, augmented reality, industrial internet of things (IIoT), collectively known as Industry 4.0. According to a survey by Federation of Indian Chamber of Commerce and Industries (FICCI) and Tata Strategic Management Group[143], 80% of Indian manufacturing companies are looking to adopt to such changes by 2020, with IIoT being the most talked about trend witnessing higher adoption. As the industry becomes more data-centric, tools such as advanced analytics and machine learning can help reduce unplanned downtime through predictive maintenance, and also increase production speeds, supply chain efficiencies, and reduce product defects.

Another important application of AI / ML relevant for India is the government / public sector use cases, where AI could augment human intelligence and administrative capacity to achieve desired social outcomes[144]. For an emerging economy like India with

billion plus population and a constrained resource environment, there are unique challenges in managing the economic growth in a sustainable manner with efficient use of resources. This is where mass digitization and tools like machine learning could have maximum impact. A few use cases include:

- Public health – predictive models for population health, empowering primary healthcare workers in preventing disease outbreaks
- Agriculture – advanced weather forecast models, optimizing inputs mix such as seeds, fertilizers and maximizing yields
- Education – personalized learning modules to improve learning outcomes
- Public safety – predictive models for forecasting extreme weather events, improving emergency response
- Public transportation and mobility – predictive models for traffic congestion by analyzing traffic patterns, video / image analytics for traffic violations

Building the talent ecosystem

India's $150 billion technology services industry is increasing investments in digital technologies such as AI/ML, automation, block chain, cyber security, augmented reality etc. as they face headwinds in the traditional services. While Tier 1 majors are providing platform-based services using proprietary products in AI/ML and automation, there are also a host of emerging enterprises and startups providing niche services in decision sciences, and are carving their own niche in the market place. India's technology services and analytics industry can provide the skilled work force required to build business applications using machine-learning tools, and are expected to play an important role in accelerating the global adoption of machine learning across industries.

The benefits of AI/ML for businesses and public sector could be immense, and India has the potential to lead the change in both these fronts. As India's technology services industry is reinventing itself with proprietary automation platforms and the shift towards digital, government could formulate a long-term vision and increase public investments in AI for public goods, by effectively utilizing the digital infrastructure envisaged under the digital India program. Public investments in R&D, along with capacity building initiatives for the workforce could enable India to effectively use modern AI tools for improving efficiencies across industry value chains and improve the overall productivity of the economy.

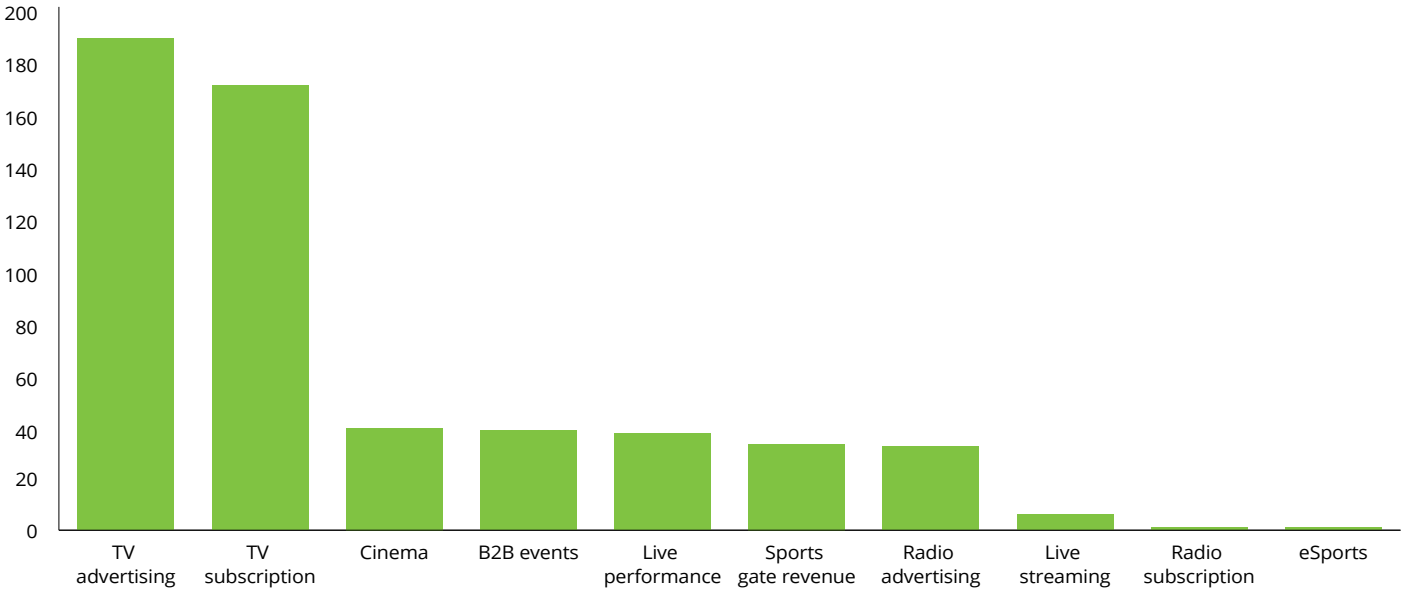
Live thrives in an online world

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.[145] The vast majority ($537 billion, or 98.5 percent) of live revenues are forecast to come from traditional sectors (see Figure 13), with the remainder from live streaming and eSports.[146]

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," 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 13), 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.[147] 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.[148]

Figure 13. 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;[149] 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[150] – 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,[151] a quantity that may help explain TV's enduring appeal to advertisers.[152]

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.[153] 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.[154]

- Twitter, which live streamed 10 NFL games in 2016,[155] announced in May 2017 that it had signed 16 live-streaming deals spanning concerts, sport and drama.[156] Twitter also partnered with the BBC in the UK to live stream five election specials.[157]

- YouTube has offered, in conjunction with BT Sport, several Champions League football (soccer) matches, including the final.[158]

- 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.[159]

- 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.[160]

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.[161] 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,[162] 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.[163]

Live events

Live events – spanning live performances such as concerts and shows ($36 billion),[164] exhibitions and conferences ($38 billion),[165] sports gate revenue ($33 billion)[166], 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.[167] 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.[168]

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.[169]

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.[170] 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.[171]

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,[172] 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.[173] One of the largest technology events in Europe is the Mobile World Congress, held in Barcelona. In 2012, there were 67,000 attendees;[174] by 2017, there were 108,000[175]. CES is one of the largest electronics shows, with 180,000 attendees in 2017[176], a 17 percent increase over the 153,000 attending in 2012[177].

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.[178] Enterprise users were offered various business-oriented amenities, including an auditorium and two conference centers.[179] But Second Life's Enterprise platform closed in 2010;[180] global trade show revenue has risen every year since.[181]

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).[182]

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.[183] Seven of these leagues are in Asia and are among those growing the fastest.[184]

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.[185]

Increases in the value of broadcast rights enable a larger spend on talent[186], 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.[187]

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.[188]

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.[189]

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.[190] Viewers are likely to reach 456 million.[191] One of the largest platforms is YY, with 117 million monthly users and 10 million channels.[192] YY had net revenue of $384.8 million in Q2 2017, a 31.7 percent increase over Q2 2016.[193]

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.[194]

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.[195] 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.[196] On Twitch, the equivalent feature is called "Cheering."[197]

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.[198] 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.[199]

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.[200]
- The first FIFA eWorld Cup will take place in 2018, with the grand final in August of that year.[201]
- 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.

India Perspective

Deloitte predicts in the coming years, live streaming and OTT video content is likely to gain popularity. Live streaming of events like concerts and sports is witnessing an increasing trend. Several brand launch events, music festivals and celebrations have adopted live streaming to allow their fans and followers around the world to be a part of the experience.

Live Sports
In India, Cricket is the main sport followed by the masses. Live streaming of Indian Premier League (IPL), the country's flagship 20-20 cricket tournament, helped Hotstar surpass 100 million users during the 2016 edition. During the tournament, the app was opened 4.5 billion times by its users[202]. As other sports like Kabbadi get more corporatized, live streaming of the various league matches will surge. Various subscription models, like pay-per-use/match may evolve.

Live events
Businesses are increasingly using live streaming platforms for launching their products (e.g. Apple launch event on September 12, 2017).

In India too, it is expected that by 2020-21 the events and activations industry will cross INR 100 billion (~$1.58 billion) mark. Digital (live streaming) will drive the growth and popularity of events industry and average digital events per respondent have grown 9 times since 2013-14[203].

Live performance
Live music concerts is gaining popularity in India. This is evident from an increase in the number of live concerts as well as the audience attending it. Justin Bieber's India concert is one such event in the history of live events and concerts in India, which had an investment value of approximately $4 million[204].

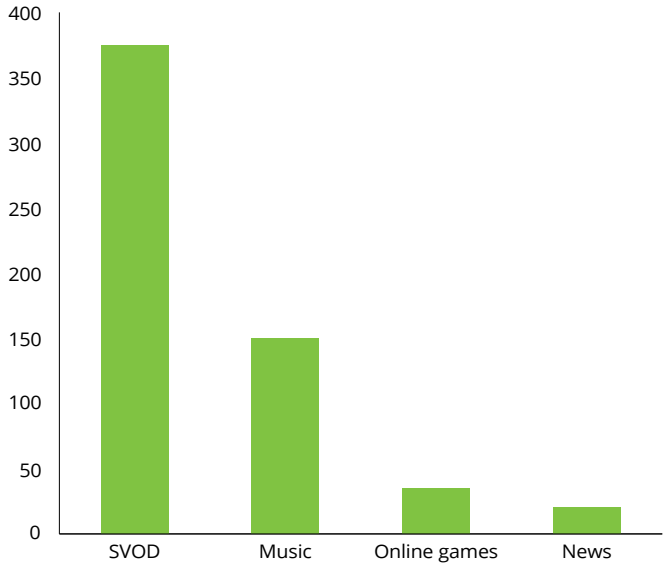
Online video advertising revenue
Online video advertising business is expected to grow to INR 67 billion ($1 billion) by 2020. This would result in 41% growth on an annual basis[205]. Star India's Hotstar, Viacom18's VOOT and MSM's Sony LIV have ad-based revenue models.

Live content and events have appeal to the masses especially to millennials. Evolving revenue models, which include 'pay per use' will further fuel growth in the sun-sector. The demand side pull of watching events on-the-go will help in ensuring health growth numbers which will further boost investments in the sector and in related technology.

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 14).

Figure 14. 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,[206] multiple media subscriptions are not.[207] 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.[208, 209]

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,[210] and in the US market, students were offered Spotify Premium with a subscription to Hulu.[211]

- 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.[212]

- 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.[213]

- 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.[214] 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.[215]

- 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."[216] 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.[217] In 2017, Sky launched an OTT service in Spain, following HBO's launch of an OTT service the prior year.[218] The owners of Formula 1 have announced plans to launch an OTT service in markets where they currently do not have distribution.[219]

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.[220] HBO is commissioning local language content, such as the Swedish language comedy *Gosta*[221] and the Spanish language drama *Patria*.[222] 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),[223] 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.[224]

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.[225] Periods in which there is major breaking news have been found to be optimal occasions for publications to request contributions.[226] In some cases, the offer of live video has helped trigger subscriptions.[227]

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.[228] Digital subscription revenue, including revenue from those subscribing to the crossword and to its cooking app, rose by 46 percent, to $85.7 million.[229] The *Washington Post* surpassed one million digital subscribers in 2017;[230] as of mid-2016, the newspaper had grown its digital subscriber base by 145 percent year-on-year.[231]

The *Financial Times*, which has always had a paywall, ended 2016 with 650,000 digital subscribers, a 14 percent increase over the previous year.[232] As of the end of June 2016, the *Times* and the *Sunday Times* had 413,600 subscribers, of which 182,500 were only digital.[233] *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.[234] As of March 2017, there were 200,000 members[235] and a further 185,000 subscribers.[236] 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.[237]

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.[238]

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.[239]

Condé Nast has diversified into offering subscriptions to gift boxes with themes of magazine titles, including *GQ, Teen Vogue, Condé Nast Traveler* and *Brides*.[240] 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.[241] 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).[242] 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.[243]

Video games

At the start of 2018, we expect there will be about 35 million subscribers to video game networks that enable online play.[244] 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.[245]

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.[246]

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.

India Perspective

Deloitte predicts a significant increase in total number of online media subscriptions, as well as the average number of subscriptions per individual in 2018 and continue to increase at steady pace in the medium term.

In India, paid digital subscription for content based services is increasing consistently. Global industry leaders like Netflix, Amazon Prime, Apple music, etc. have launched their services in India. Domestic market leaders like Hotstar premium, ALTBalaji, Gaana.com, Saavn are gaining popularity with increasing number of paid subscribers.

Across all forms of online media, the principal drivers of rise in online media subscriptions are likely to include:

Supply side: There has been a steady growth in the past few months in the number of companies offering online media subscriptions. Global players too have launched services and compete with their local peers. These services include subscription based TV and content relating to movies. These platforms also offer original content which is produced specifically as well as syndicated content from various global and local television channels and production houses. Promotional offers by the new entrants has also led to increase in interest in these services.

Demand side: Increased willingness among consumers to pay for content online rather than consume ad-funded or pirated content. The use of subscription based premium digital services for content is increasing at a rapid pace especially in tier 1 cities. There are classes of people who have subscribed to more than one such platform (e.g. People subscribe to both Netflix and Amazon prime as both have different content). Music subscriptions offer access to voluminous libraries and also offer customized solutions to the subscriber. There are unique avenues for consuming content, for e.g. by travellers in radio taxis in numerous Indian cities.

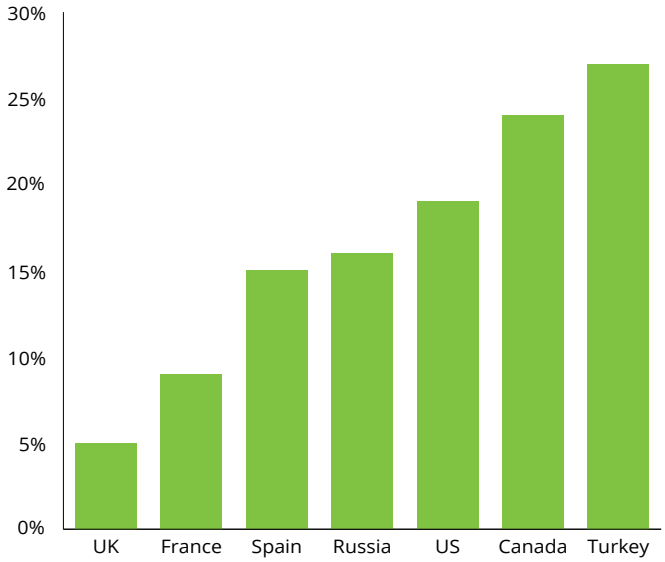
Technology support: The steady rise in broadband speeds has fuelled the success of online streaming and in-turn facilitated the increase in numbers of the online subscriber. A few years ago, relatively few households had broadband speeds that could reliably deliver online video to their devices. 2018 will see increase in number of homes consuming streaming services in 4K or ultrahigh-definition (UHD) resolution. The roll out of 4G networks by telcos has made music and digital content streaming (say, in a car or on a bus) far more reliable. Surge in sale of Smart TVs has helped increased consumption of streaming content on internet. Use of devices like Google Chromecast and Amazon fire TV stick has further enabled consumption of streaming content on conventional television through the USB port on the set.

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.[247] 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 15). 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.[248] 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.[249]

Figure 15. Percentage of data mobile-only homes in selected countries in 2017



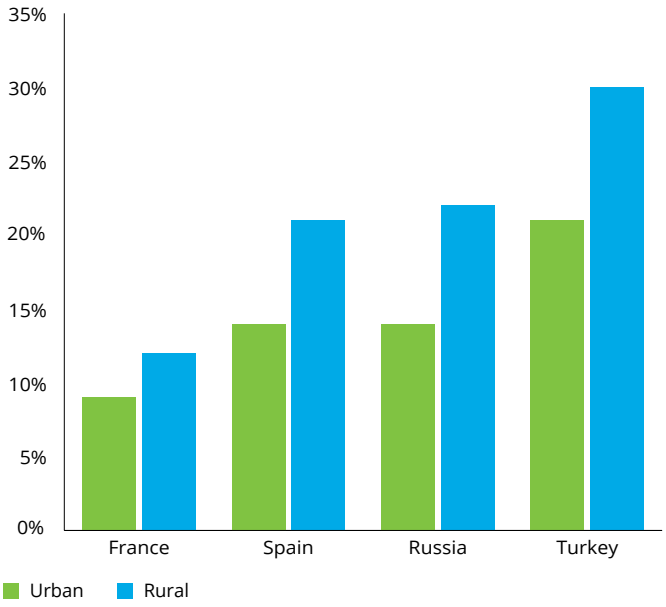
Source: Deloitte Global survey of adults in seven countries – 1,096 in the US; 1,090 in Canada; 1,061 in Turkey; 1,118 in the UK; 1,097 in France; 1,082 in Spain; and 1,097 in Russia (survey conducted Aug.-Oct. 2017)

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.[250] 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 16, in countries for which we have data, rural residents are far more likely than urban residents to have mobile-only service.

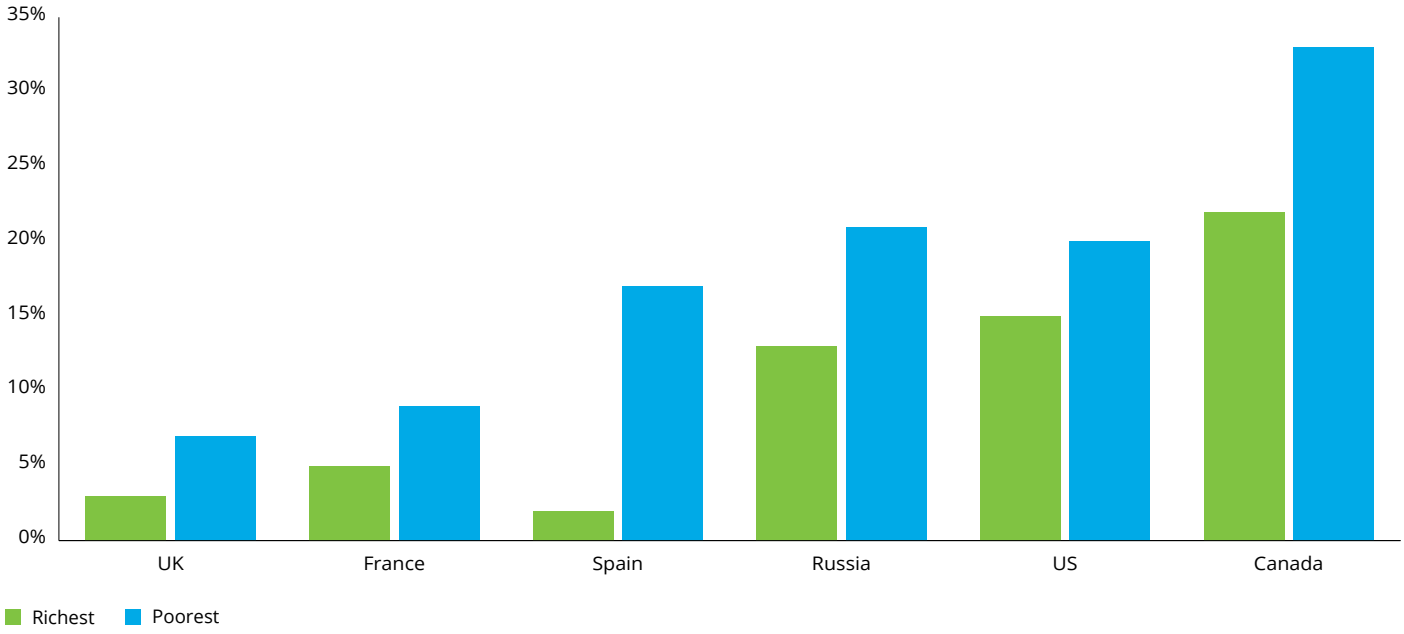
Figure 16. Data mobile-only population for urban and rural, 2017



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 17 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.

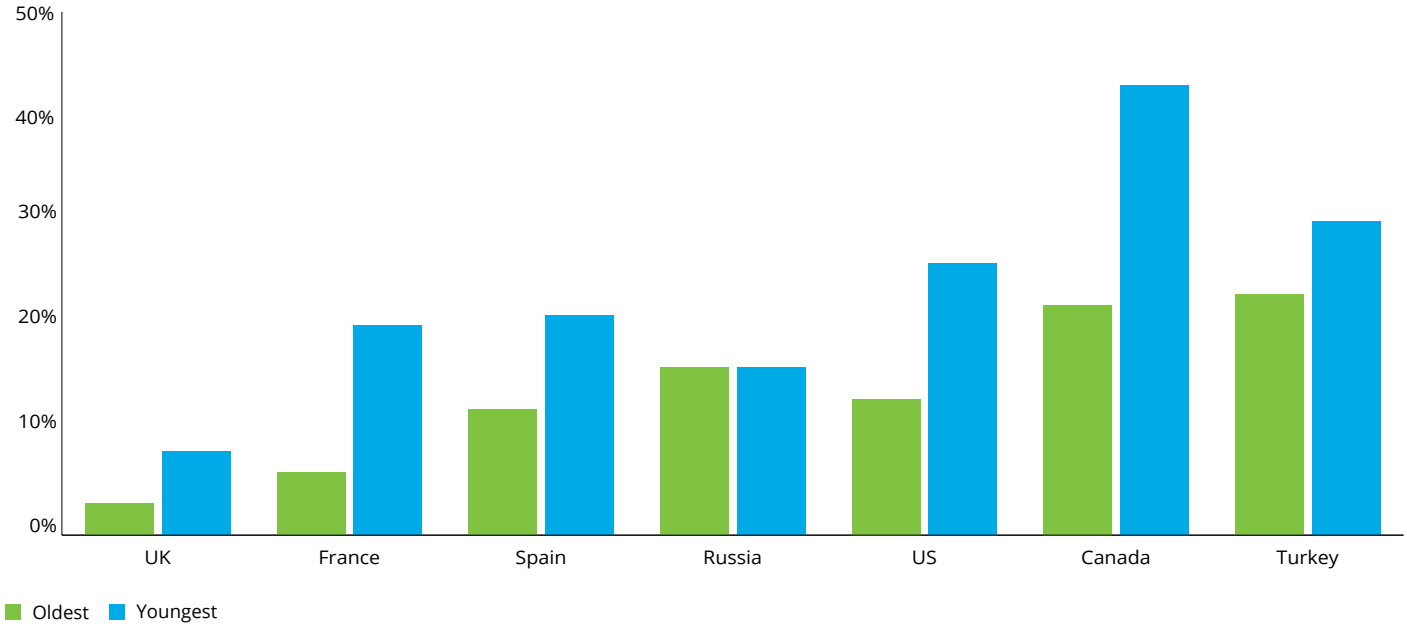
Figure 17. Data mobile-only population for highest and lowest income groups, 2017



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 18, 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.

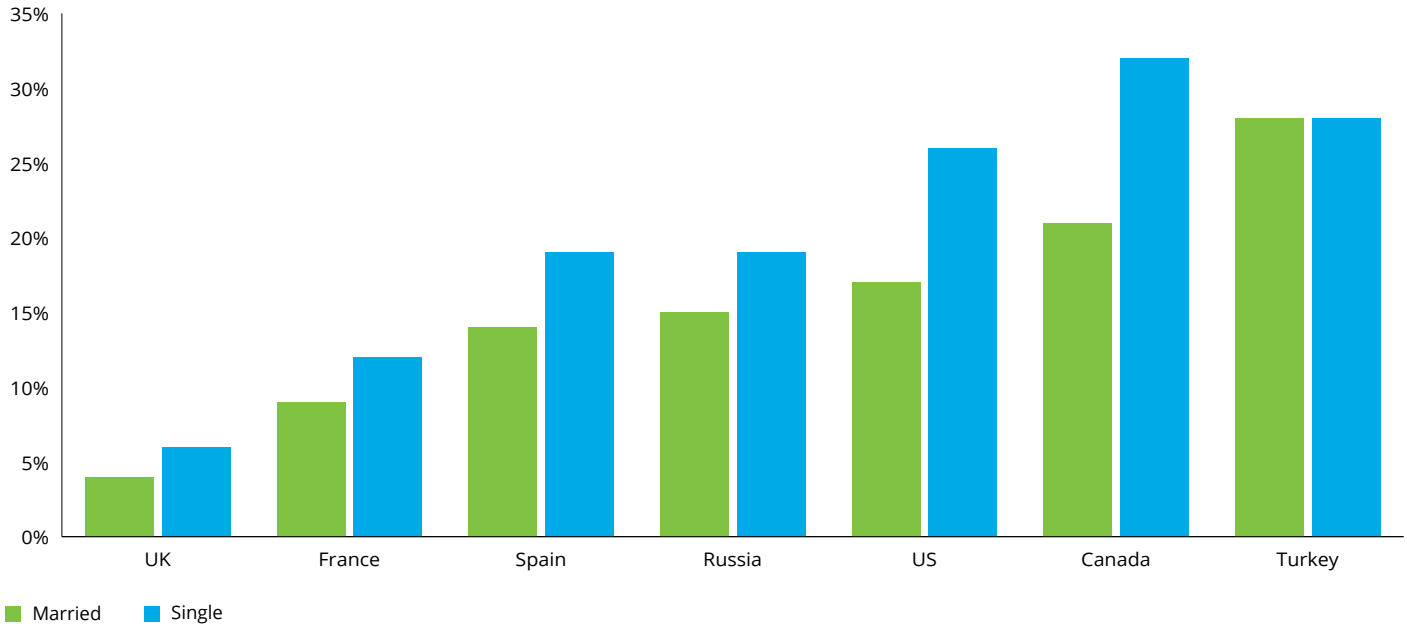
Figure 18. Data mobile-only population for oldest and youngest groups, 2017



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.[251] 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 [252]) 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 19, 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 19. 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)[253], 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.[254] 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,[255] 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).[256] 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.[257] 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.[258] 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.[259] 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.[260]

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,[261] although this is provoking some debate.[262]

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[263] 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.

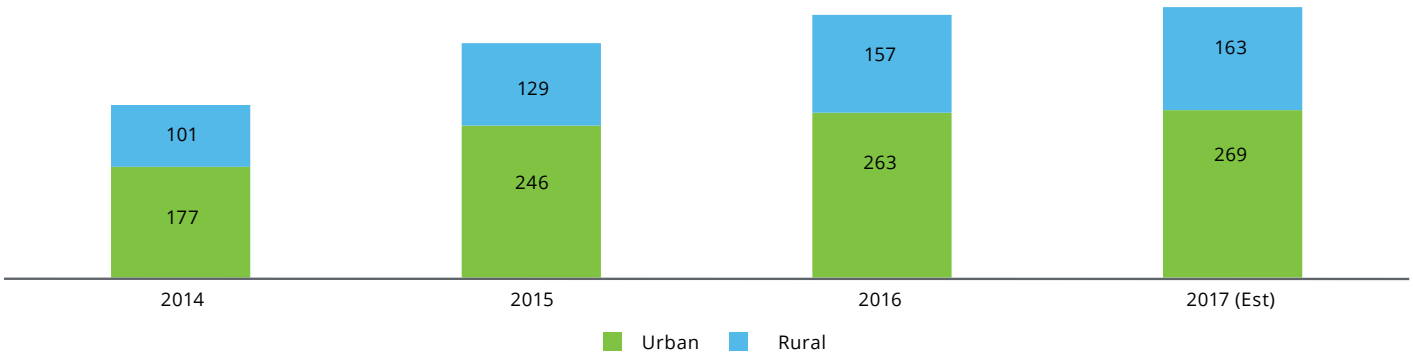
There is unlikely to be a single magic-bullet technology; different markets have different weather, geography, density, digging costs and even extent of foliage. As an example, Phoenix has large numbers of single-family homes far enough apart that laying fiber to each home is not easy. But there are 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.

India Perspective

India has become an epitome of digital transformation, driven by various private and public initiatives. During the last few months, technological advancement and entry of big players with disruptive initiatives has allowed operators to launch economical internet plans, which provided the required impetus for increasing internet usage in India. India currently has over 400 million internet subscribers, making it the second largest online market in the world, ranked only behind China. However, the overall internet penetration is still at 31%, skewed in favor of urban India, which has ~70% internet penetration. Rural India is still underpenetrated with only 17% penetration. With a total rural population of ~906 million, approximately 750 million users still do not use internet[264].

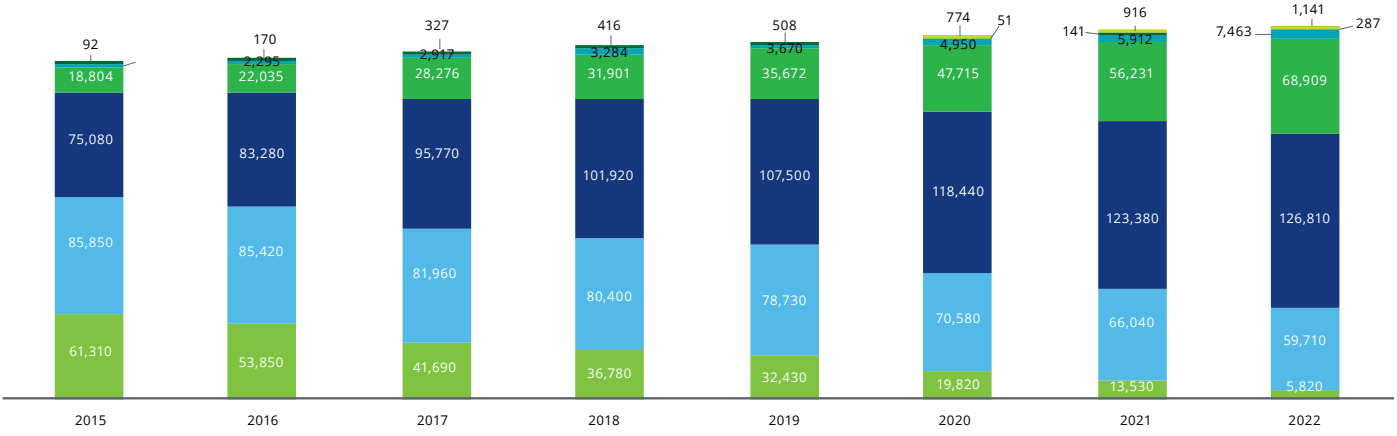
Figure 20: Internet users in India – Urban Rural divide, 2014-17 (in Millions)



Source: Internet in India 2016 – An IAMAI & IMRB report

Assuming average household size to be ~5 person, this represents an opportunity of ~150 million households, which are yet to be connected. Also, Indian households have been witnessing an upwards increase in their disposable income since last few years (Figure 21). Deloitte predicts that rising affluence of households will lead to an increased demand for consumer goods, entertainment systems etc. which will further drive demand for internet services. Hence these untapped households will represent the next wave for internet growth in India.

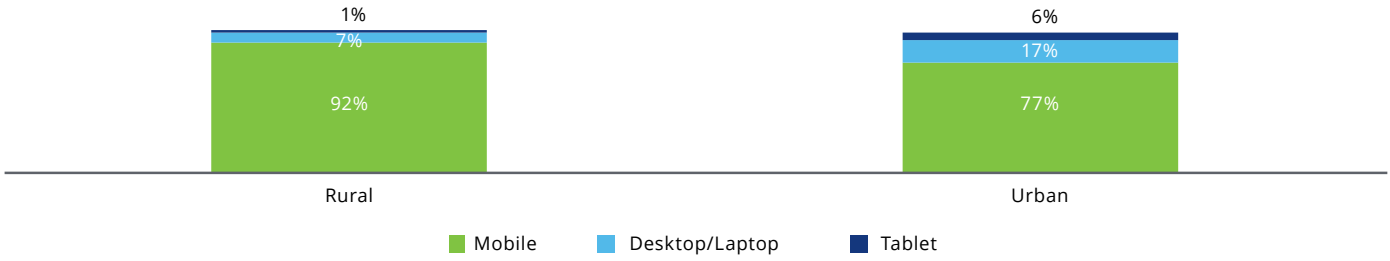
Figure 21: Number of Households by Income distribution, $ per Annum (2015-2022)



Source: EIU Country forecasts – India, 2017

Over the last few years, increase in internet penetration has been driven mostly by availability of cheaper smartphones. More than 92% of rural users and 77% urban users have been using mobile as primary device for accessing internet through cellular data connections.

Figure 22: Internet usage by device, 2017 (% contribution)



Source: Internet in India 2016 – An IAMAI & KANTAR IMRB report

Usage of other devices (laptops, desktops) for internet access is expected to decrease further online communications, social networking, and consumption of entertainment (video/audio content etc.) services on-the-go drive usage on mobile devices without impacting customer experience. In the near future, demand for wireless broadband services would be higher as compared to fixed broadband services. Demand for fixed broadband services would be majorly limited to urban consumers, who have higher bandwidth/QoS requirements for accessing services like gaming, high definition video streaming etc.

From a technology perspective, fixed broadband network deployment poses multiple challenges like capex intensive last mile deployment, competition for access to ducts/poles, longer deployment time, Right-of-way issues etc. which makes it commercially unviable for service provides to provide fixed broadband services in low density areas.

On the other hand wireless broadband networks have lower deployment costs, allows quick deployment and service provisioning and good customer experience. Telcos in India have been providing wireless internet using 2G/ 3G technologies primarily, utilizing licensed spectrum in certain frequency bands between 700 MHz to 5 GHz. Due to limitations around speed and capacity, 2G/3G technologies are good only for consumers with limited data requirements.

In order to cater to higher speed and capacity requirements through wireless access, operators are now shifting to newer wireless technologies like LTE, LTE-A, LTE-A Pro evolving to 5G and also looking at ways to utilize the Millimeter wave bands etc. The on-set of these new technologies with enhanced capabilities in terms of greater capacity, more reliability, support for higher bandwidth and enhanced security will provide a boost to the mobile internet ecosystem in the country. These emerging wireless technologies are making wireless broadband, commercially more viable due to lower cost per MB of usage.

Hence, in the long run, given the challenges in deployment of fixed broadband networks, wireless networks will become the preferred source for internet access. Wireless home internet would drive the next wave of internet growth in India by targeting the large potential of untapped household base.

Smartphones are useful, but they can be distracting

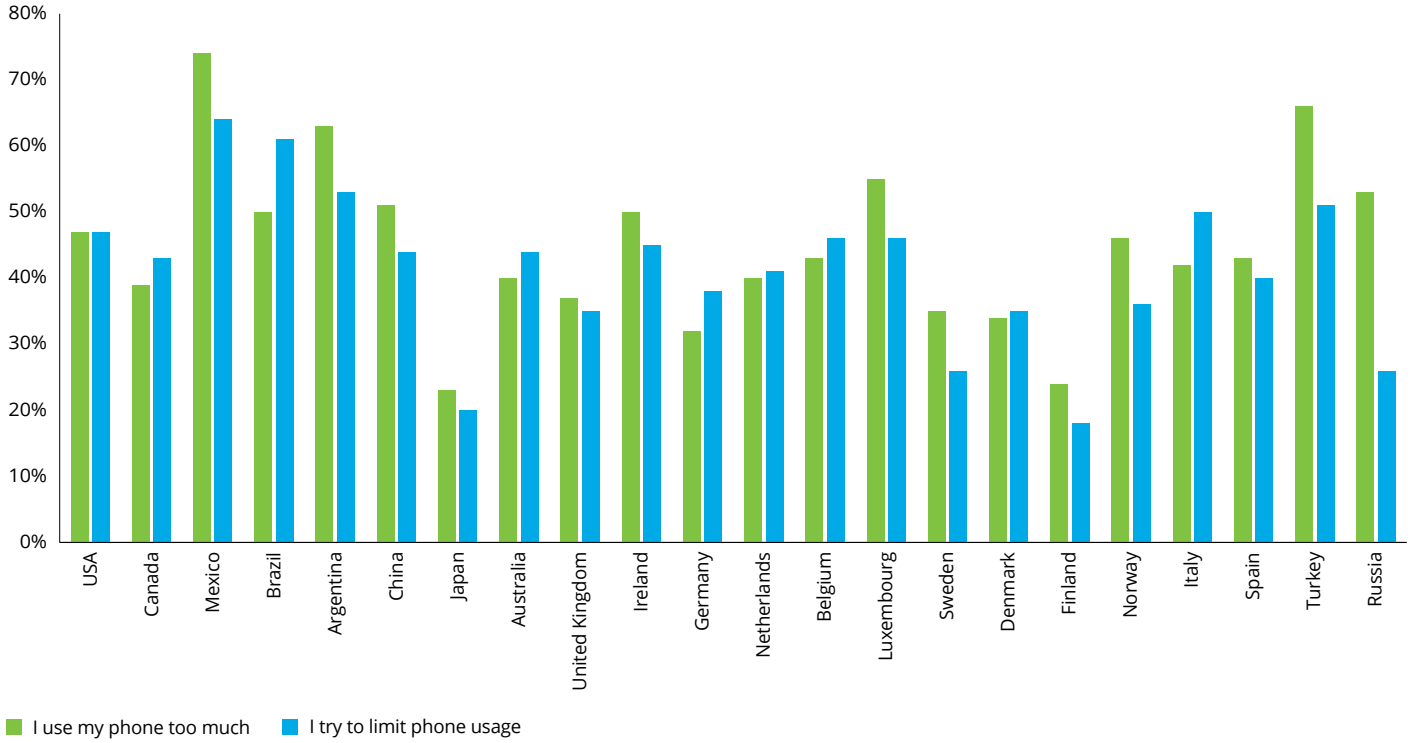
Deloitte Global predicts that 45 percent of global adult smartphone users in 2018 will worry they are using their phones too much for certain activities, and 45 percent of all adult smartphone users will try to limit their phone usage in various ways – from employing high-tech apps that measure or limit usage to sticking their device in a drawer.[265] 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 23, 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,[266] 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.[267] 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.

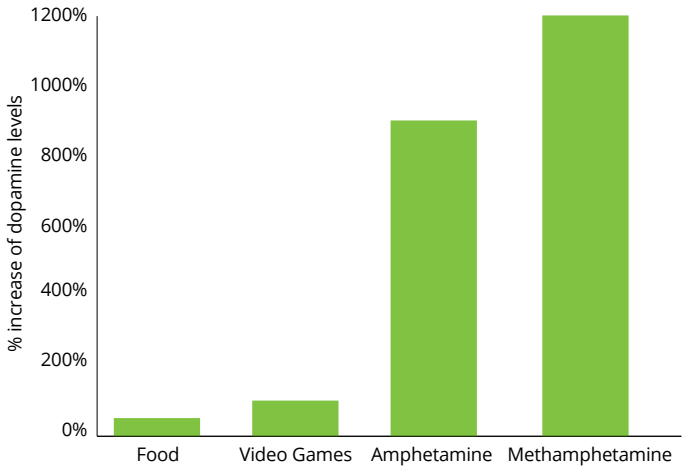
Figure 23. Concern about phone use and attempts to limit use; adults with smartphones in 2017



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.[268] Addiction and dependence are defined medical terms,[269] and very few adults suffer from genuine addiction to their smartphone.[270] Recent articles have called tablets, phones and gaming consoles "digital heroin" because they all raise dopamine levels,[271] but while it may be true, this happens on a completely different scale for electronic devices and food compared with addictive drugs,[272] as Figure 24 shows.

Figure 24. Relative increases in dopamine: food, video games and drugs

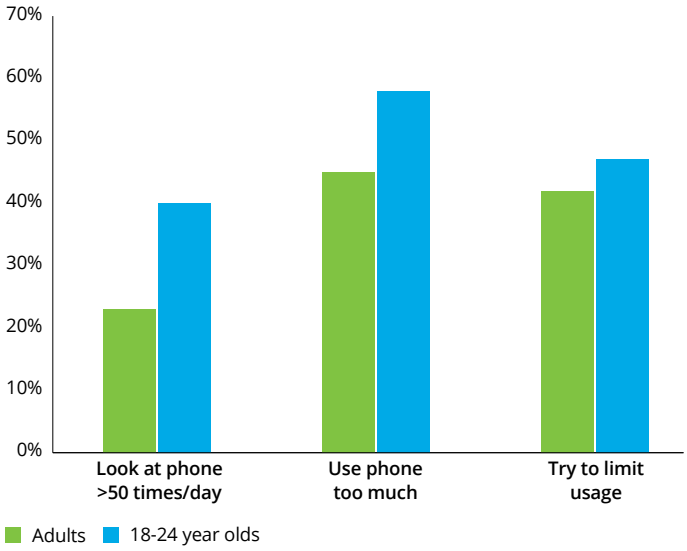


Source: Smartphones aren't addictive – but their increasing usage points to bigger problems, Medium, 21 April 2017

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 25, 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 25. Phone use and possible over-use in 2017, by age

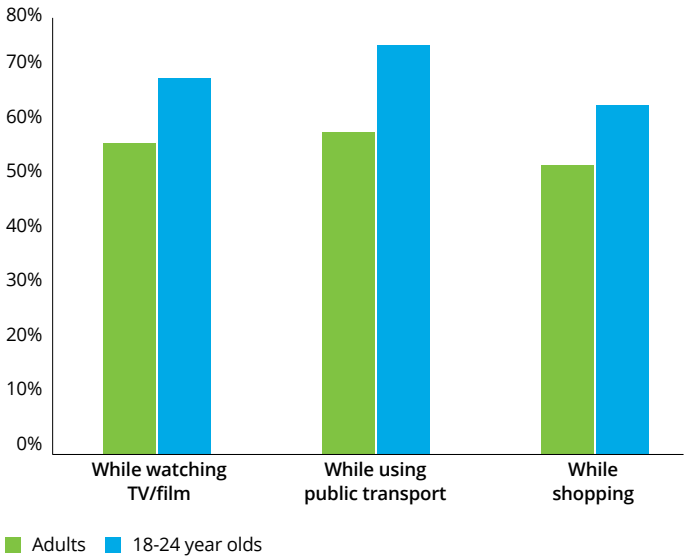


Weighted base: All adult smartphone owners (34,588), 18-24 (5,351)
Source: Global edition, Deloitte's Global Mobile Consumer Survey, May-June 2017

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 26 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 26. Phone use that is not distracting; percentage of smartphone owners in 2017 who almost always/very often/sometimes use their phone during different activities

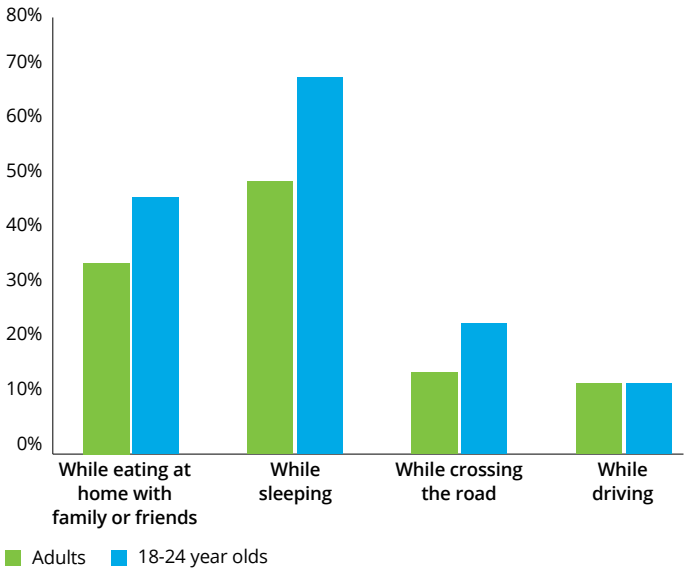


Weighted base: All adult smartphone owners (34,588), 18-24 (5,351)
Source: Global edition, Deloitte's Global Mobile Consumer Survey, May-June 2017

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 27 for the Deloitte Global data on these activities in 2017.[273] 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 27. Phone use that is distracting; percentage of smartphone owners who almost always/very often/sometimes use their phone during different activities



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.

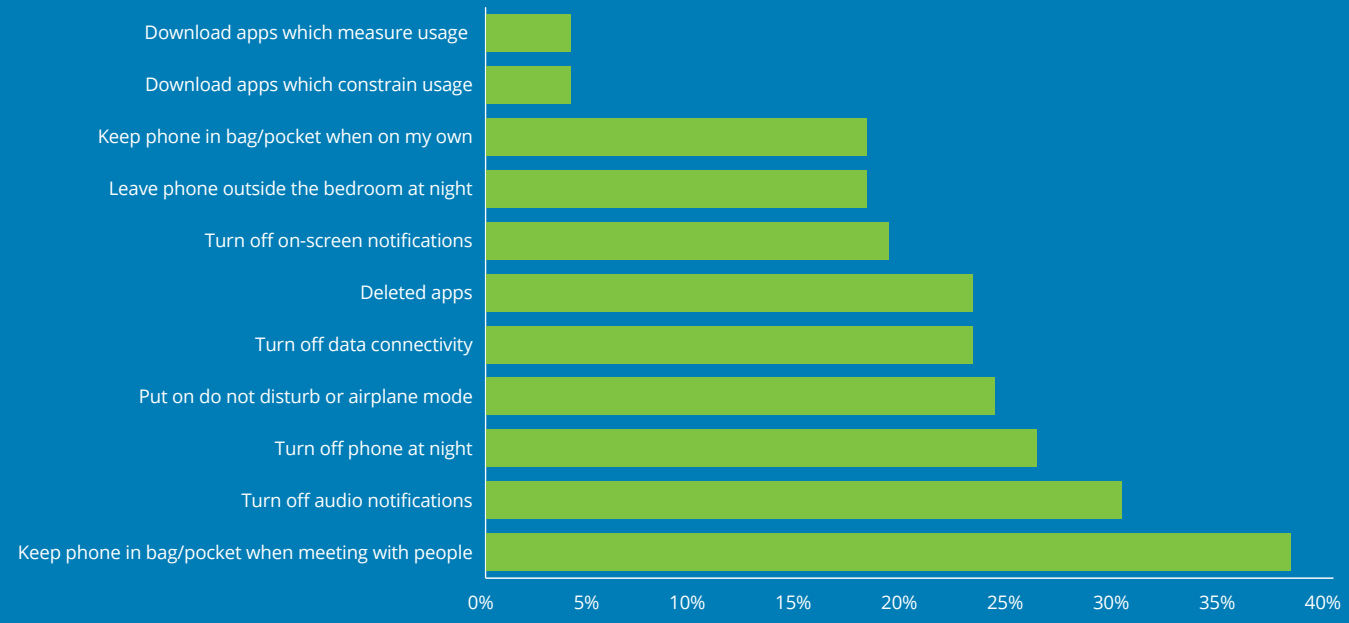
The bottom line

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.[274]

But as Figure 28 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.

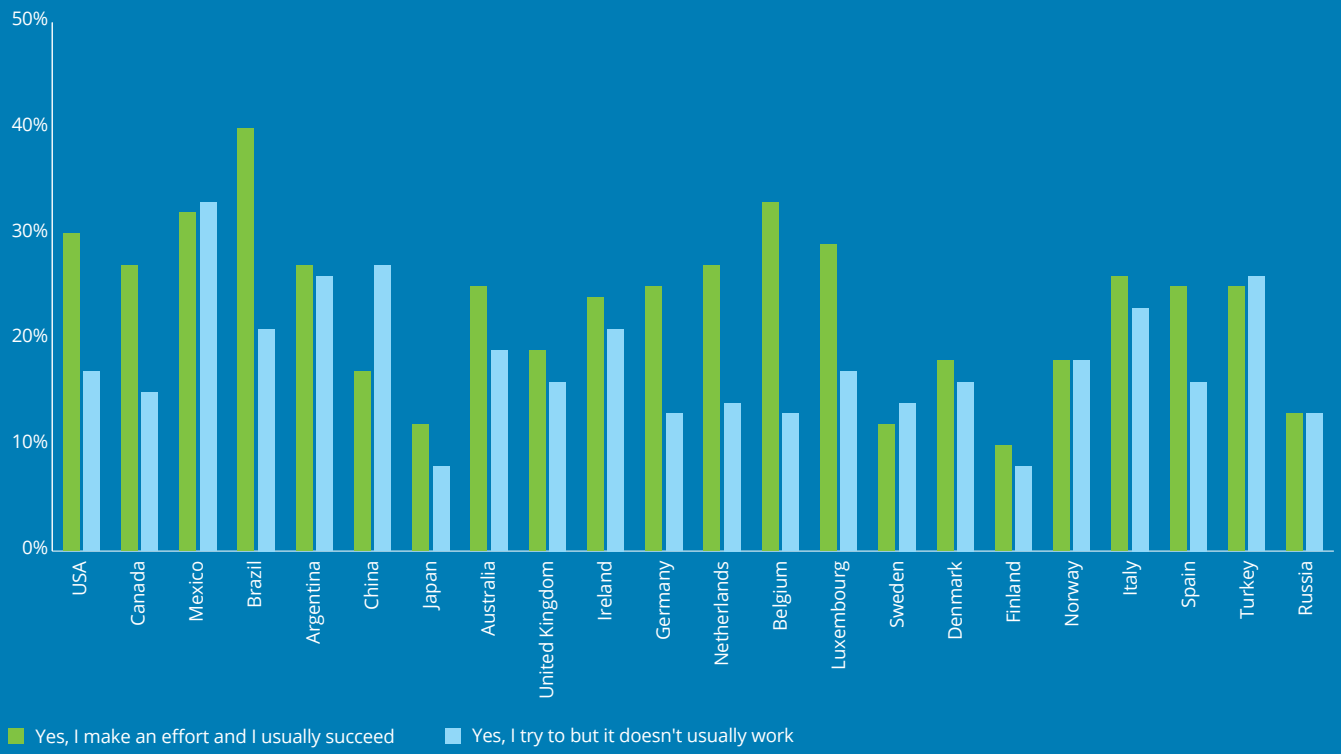
Figure 28. Steps taken by smartphone owners who are trying to limit their usage



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 29, 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 Turkey (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 29. Limiting mobile usage: success versus failure for smartphone owners



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).[275] In September 2017, *The Atlantic* magazine published a lengthy article that summarized the zeitgeist on this issue: "Have Smartphones Destroyed a Generation?"[276]

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.*[277]

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[278] and computers themselves were all labeled as harmful. The US Senate Judiciary Committee investigated the effects of comic books on young people[279] in 1954 and of rock-and-roll music in 1956.[280] 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.[281]

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.

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.

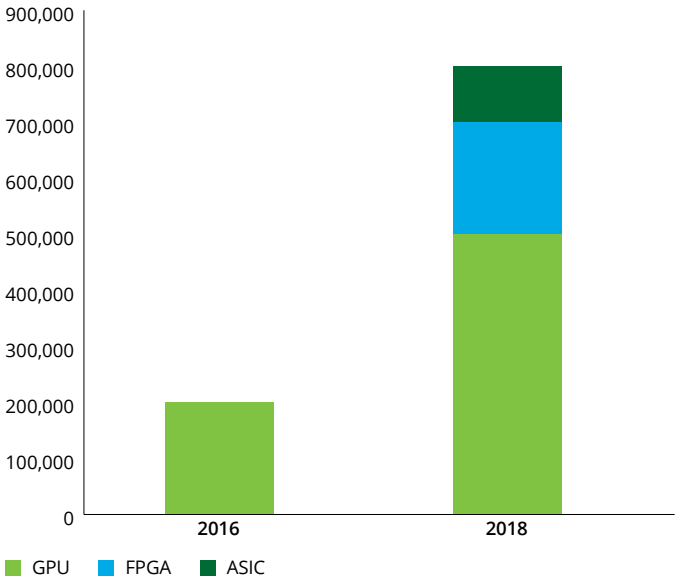
This is a dramatic shift; in 2016, almost all ML involving the artificial neural network (ANN) approach used a combination of standard GPU chips (graphics processing units) and CPU chips (central processing units) in large data centers.

We estimate that about 100,000 to 200,000 GPU chips were sold for ML in 2016.[282] 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.[283]

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 30, 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,[284] which would be many millions of chips of various kinds per year, though probably not tens of millions.

Figure 30. 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.[285]

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.[286] 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[287] 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.[288] A paper published at the beginning of 2017[289] 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.[290] Amazon Web Services (AWS) and Baidu are also said to be using FPGAs in their data centers for machine learning purposes,[291] 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.[292] Fujitsu also plans to launch a chip called Deep Learning Unit (DLU) that will be available in 2018.[293] Unit volumes are difficult to predict; they could be in the tens of thousands or hundreds of thousands.

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.

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).[294] The first-generation TPU was announced in 2016, and the second-generation chip was introduced in May 2017.[295] 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.[296]

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.[297] One example outside the smartphone world would be the Movidius chip from Intel, which is specifically used for ML acceleration for vision processing.[298]

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.[299]

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.[300] 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.[301] 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.[302] In the 1880s, new processes for refining aluminum from bauxite ore were invented, and the price dropped by orders of magnitude.[303] 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.

Is there an #adlergic epidemic? Ad blocking across media

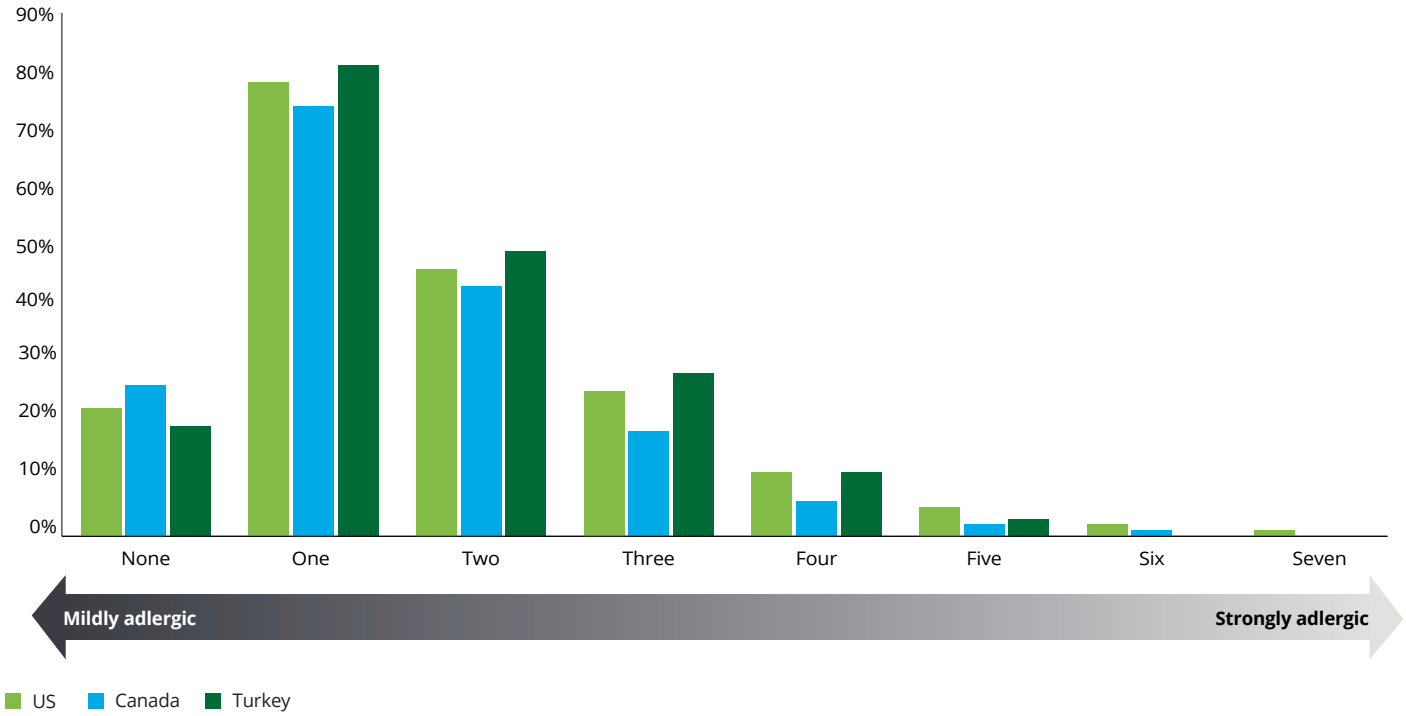
Deloitte Global predicts that 10 percent of North Americans over age 18 will be engaged in four or more multiple, simultaneous advertisement-blocking behaviors in 2018; we call these people adlergic. In a Deloitte Global survey conducted in mid-2017 of 1,096 Americans and 1,090 Canadians aged 18 to 75, 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 31) 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 34).

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.

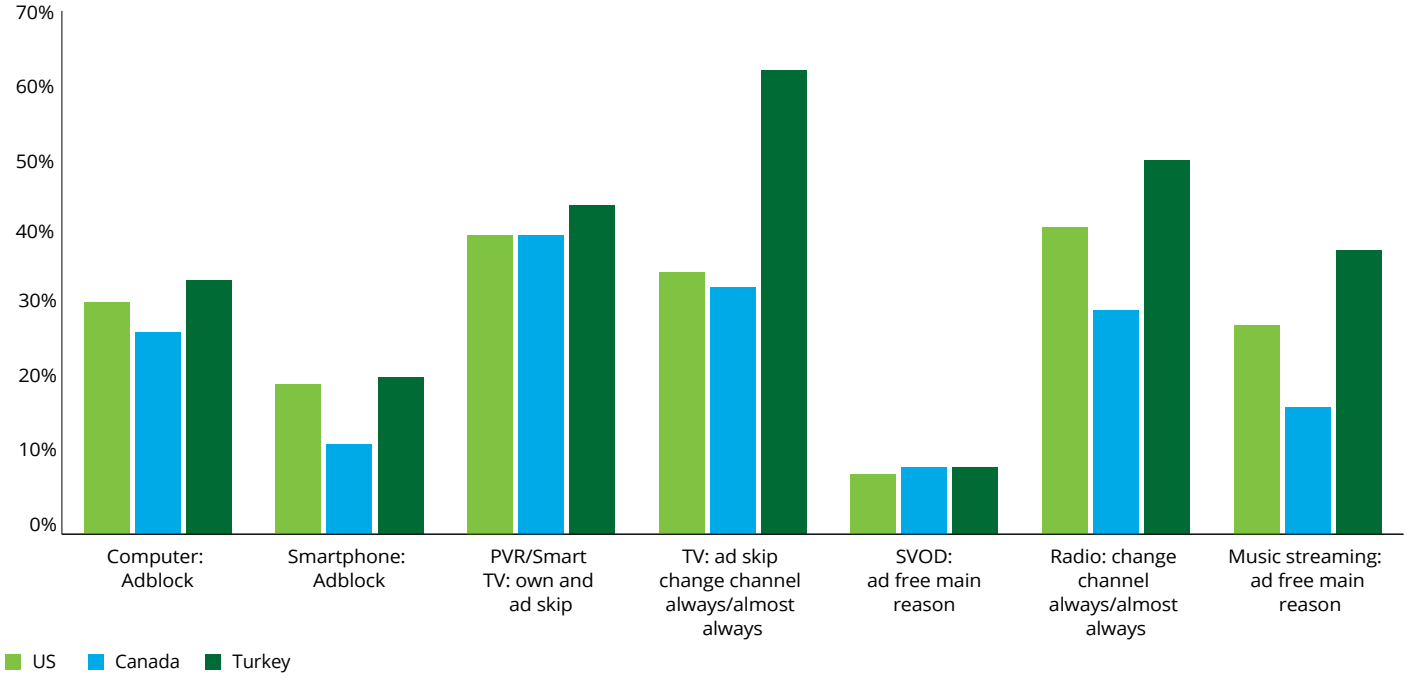
Figure 31. #Adlergic population measured by number of ad-blocking behaviors



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 32 for an overview of how the various behaviors occur across the countries studied.

Figure 32. 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.[304] 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.[305] 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[306] or even zero.[307] 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.

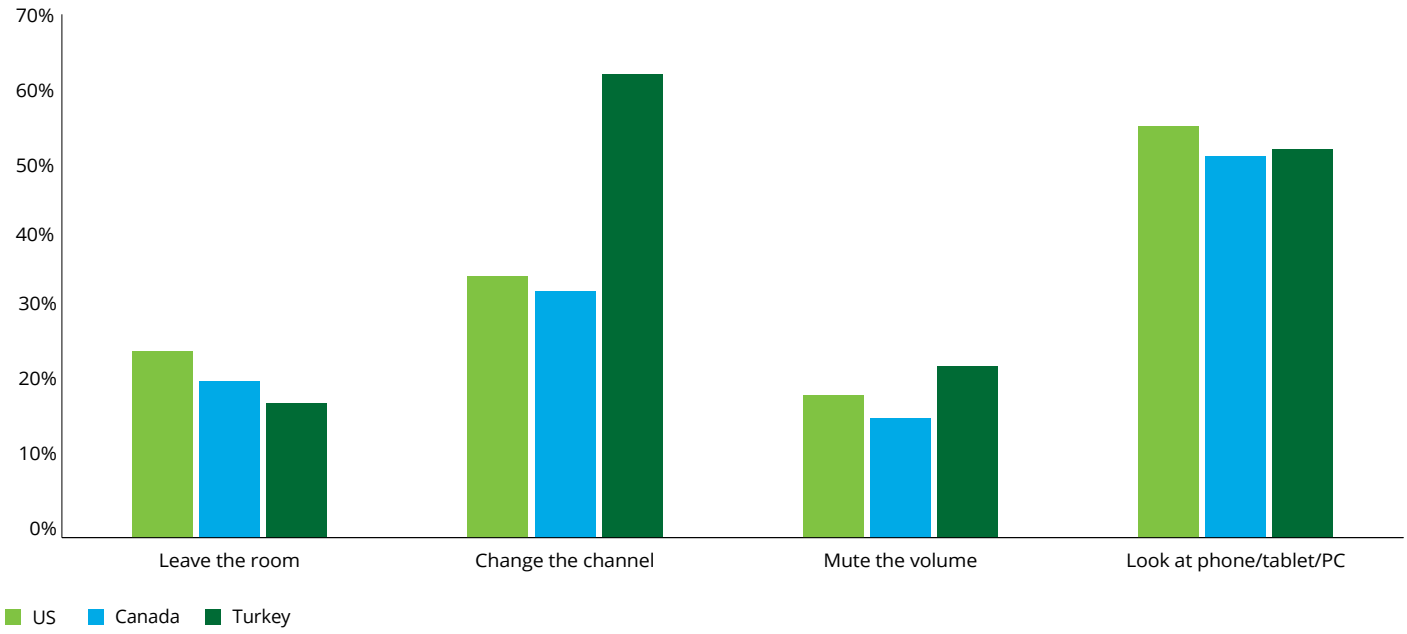
According to the official TV measurement data, only 11 percent of all traditional TV viewing is time-shifted (watched after original broadcast) in the US,[308] and under 9 percent is time-shifted in Canada.[309] These numbers are broadly consistent across ages, with American 35-to-49-year-olds watching 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.[310] Canadian 18-34 year olds are more likely than average to time shift, at almost 12 percent.[311]

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 33 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.

Figure 33. "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.

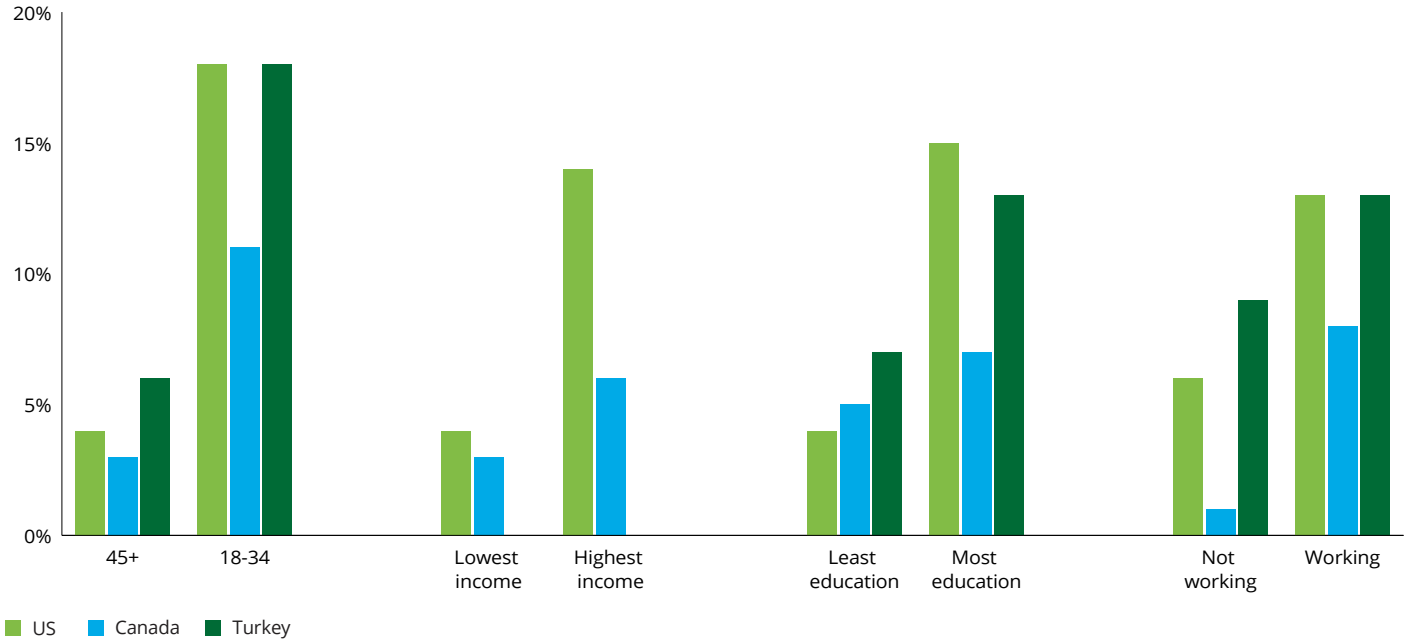
Radio and music: People can also subscribe to ad-free versions of streaming music. In our survey, 33 percent of Americans pay for at least one ad-free streaming music service, while in Canada the number is only 19 percent. In both countries, the familiar demographic trends follow, with those who are 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 34). 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 34. 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)[312], and social media ad spend by 14 percent.[313]

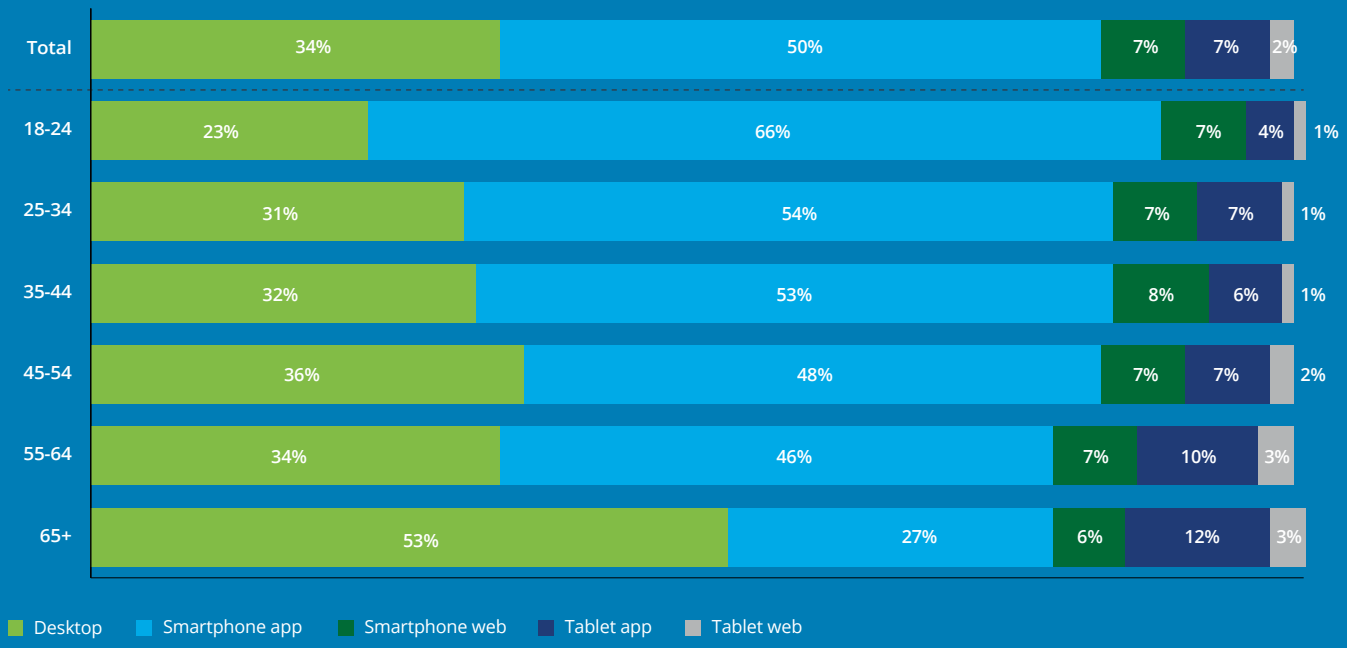
Even within social, there are growing subcategories that should be considered. The rise of the social media influencer was worth $1 billion in 2017, and this is expected to double by 2019, which is equivalent to over 40 percent compound annual growth.[314] When targeting the youth market, some advertisers are moving past influencers and sponsoring Slack channels (Slack is a digital workspace, and channels are how users communicate and share) and even festivals.[315]

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.[316] 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 35 below).[317]

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.[318]

Figure 35. Share of platform time spent, by age, 2017



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,[319] 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,[320] 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.[321] 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 32), and the gaps between those working/not working and most educated/least educated are narrower than in North America (Figure 34). 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.

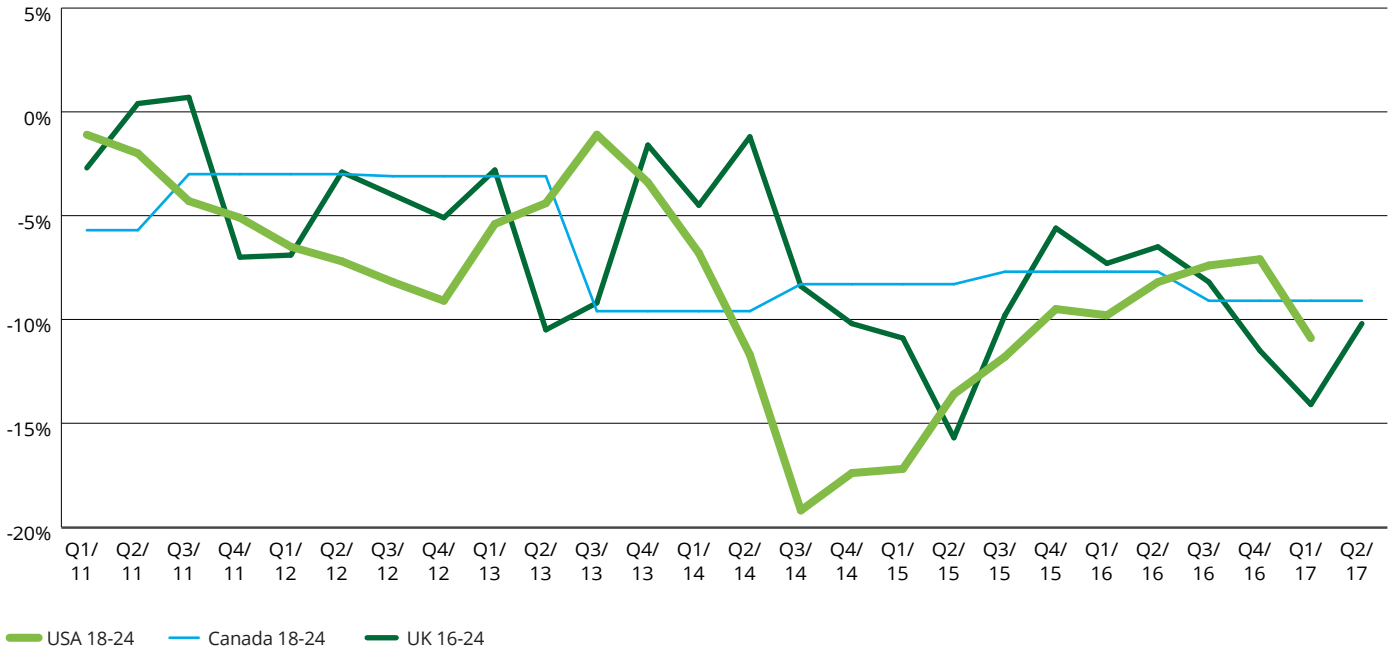
Millennials, also known as Gen Y in some countries, are those born between 1981 and 2000, who will be 18 to 37 years old in 2018. Demographers often split them into two groups, leading millennials being older and those 18-24 in 2018 belong to the category of trailing millennials. However, our prediction 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 36 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 36. 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.[322] Even in the UK, the US election TV ratings in 2016 were double those in 2012.[323] 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.)[324]

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.[325] 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.[326]

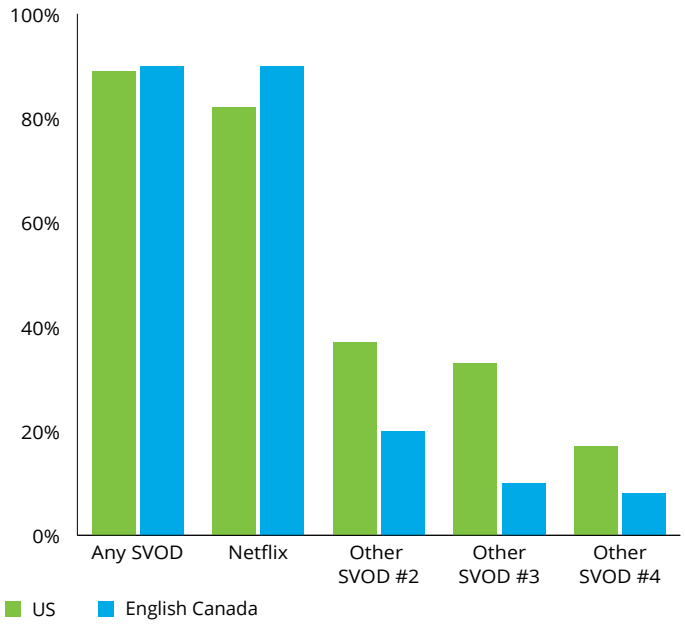
Growth in time spent with smartphones may be about to start slowing. In the US, time spent on apps and the web among 18-24 year olds surged from 90 minutes daily in 2015 to 156 minutes per day in 2017, a 73 percent increase.[327] But 18-24 year olds in the US are already spending more minutes per day 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.[328] 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.[329] 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.[330] 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 37), 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.[331] (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.[332] 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,[333] which suggests that in 2018, streaming will not be subtracting much more from TV viewing. There are other SVOD services, but as Figure 37 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 37. 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.[334] 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.[335] Snapchat was used by 38 percent of US 18-24 year olds in December 2013 and by 78 percent in December 2016.[336] 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).[337] 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.[338] 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.[339] 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.[340] 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.[341] 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.[342]

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.[343]

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,[344] 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.[345] 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,[346] about 7 million 16-24 year olds in the UK, and over 3 million 18-24 year olds in Canada.[347]

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.[348]

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.[349]

    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.[350]

    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:

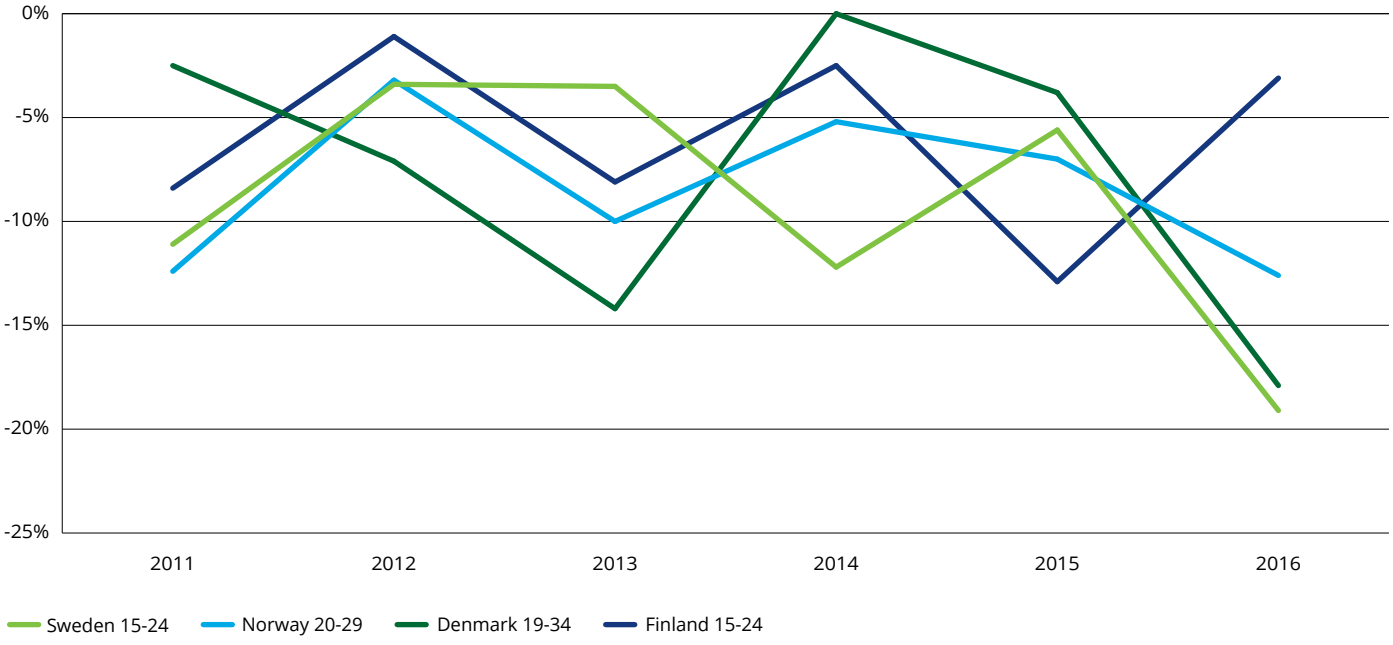
    A. Whether in regards to the football World Cup or the Champions League, strong or weak performance by any of the UK teams has a large positive or negative effect on viewing in the UK market. Although some in North America watch these matches, the effect on viewing numbers is much smaller.

    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 36 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 38 shows annual data over the same time span as Figure 36 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.[351]

Figure 38. Yearly change in traditional TV viewing by young people, Nordics 2011-16



Sources: Kantar Gallup Denmark, Finnpanel, Kantar TNS Norway, MMS.

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).[352, 353] 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.[354, 355]

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.[356]

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.[357] 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.[358] 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.[359]

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.[360] GoGo, the main ATG provider today, is expected to launch its next-generation ATG network in 2018.[361] The ATG market is likely to see new entrants, with their services expected to begin to be available at the end of 2017.[362]

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.[363] 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.[364]

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.[365]

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.[366]

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.[367] 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.[368]

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.[369] 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.[370] 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.[371]

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.[372]

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.[373] 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.[374]

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.[375]

The most popular charging model is for a certain period of connection time or for a flight (regardless of the route).[376] 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.[377]

Other airlines may choose to delay IFC deployment, given the capital cost of between $200,000 and $300,000 per plane[378], the revenue forgone from grounding the plane during the three-day installation[379], 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.[380]

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.[381]

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[382]. 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 digital 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[383]. 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[384].

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[385].

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.

Acknowledgements - Global

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