Tech breakthroughs megatrend:
How to prepare for its impact

pwc

Contents

The technological breakthroughs megatrend is manifesting itself in a proliferation of technologies. To remain relevant and to succeed, emerging technology strategy needs to be a part of every company's corporate strategy. The most pertinent technologies— and the corresponding strategy— will of course vary from company to company; but our analysis of more than 150 emerging technologies pinpoints the eight that most C-suites should start with. Here's a look at what sets those technologies apart—and what business leaders now need to do about them, and emerging technologies in general.

Foreword

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Technology is changing the game in every industry.

Advances in technology have changed the way we do business. Corporate India is going through a transformation, with disruptive innovations constantly at its doorstep in today's digital ecosystem. Technological innovations are the means to derive a competitive advantage as they open up new revenue streams and transform business models. Companies are therefore actively entering into strategic tie-ups to gain synergies. With billions of connected devices and the resultant exponential data growth across all sectors, companies are being forced to adopt technology transformation with a view to harvesting data to gain and monetise insights. With technology being the driving force and enabler for various industries, India's IT & ITeS sector is on the cusp of unprecedented growth.

India continued to grow its share in the global IT & ITeS segment and became one of the fastest growing information technology markets globally. As per NASSCOM's Strategic Review 2016,[1] India's IT & ITeS industry is projected to grow at 8.5% to 143 billion USD in FY 2016—from 132 billion USD in FY 2015. Technology adoption in India is increasing rapidly, driven by a large mobile-only population, improvements in connectivity and increasing data consumption. This has led to unprecedented growth of the eCommerce industry in India, which has posed significant challenges to incumbents in multiple sectors.

Technology is also playing a critical role in the Government of India's key initiatives such as GST, Digital India, smart cities, and cyber security programmes, enabling transformation and supporting India's GDP growth. These initiatives are leading the government to increase its spending on software and IT services. Meanwhile, IT budgets in sectors such as banking and financial services, retail, telecom and logistics continue to remain robust.

Major disruptions across all industries

The Essential Eight technologies described in this report have the potential to transform business models across all industries and drive significant organisational change. In the healthcare industry, for instance, the proliferation of networked medical devices as part of the Internet of things (IoT) is helping in cost reduction, rural reach and patient efficacy; and artificial intelligence (AI) is being used in areas like diagnostics, medical literature and clinical trials. The financial services industry too is working to accommodate new payment systems as well as adopt the blockchain. In the manufacturing space, technologies like 3D printing, industrial IoT and robots have the potential to shrink supply chains, produce better quality, save product development times and increase customised offerings to customers. Furthermore, the development of intelligent devices—from aircraft engines to home appliances—demonstrates the focus of manufacturers on their customers, as well as their business models. Against this backdrop, the ability to work in an agile manner with petabytes of data is set to assume greater significance, making cloud transformation a major disrupter in the way these companies use and leverage computer power in India. The next big wave will be driven by advanced analytics platforms and data science specialists who can make sense of this huge volume of data.

Technology can reshape an industry, which is what we saw happen with the gaming industry this year. The launch of Pokémon Go, a mobile augmented reality (AR) game, in July 2016 took the industry by storm. It has been downloaded more than 500 million times worldwide and was one of the most used and profitable mobile apps in 2016. Pokémon Go has had a profound impact on the gaming industry, especially on smartphone games, and has bought AR into mainstream commercial use.

Disruptions create new leaders; this in turn creates a greater sense of urgency for incumbents to be agile and nimble, change existing products, services and business models, and thus create newer opportunities. Players in the industry will have to engage all stakeholders, including their boards of directors, in strategic discussions and analysis of disruptions and their impacts on all aspects of their business models. If the technology breakthroughs are not pursued as a 'significant opportunity' today, they will have to be tackled as a 'major challenge' in the not too distant future. Success will be dependent on industry players' ability to alter and scale up their business models in line with the rapidly changing technology environment, and also on their proactive contribution to this change by pushing the boundaries of innovation within the organisation.

How can C-suites even begin to make sense of the swirl of technological breakthroughs affecting business today?

'Sanveer, how do all these AI breakthroughs impact our IoT strategy?'

That's the kind of question that CEOs are much more likely to get these days from some board members. It's rarely a comfortable question—whether it's actually about artificial intelligence (AI) or any of dozens of fast-developing technologies, and whether it is asked conversationally or out of serious strategic concern.

Given the sheer pace and acceleration of technological advances in recent years, business leaders can be forgiven for feeling dazed and perhaps a little frustrated. When we talked to CEOs as part of our annual Global CEO Survey, 79% of them told us they were concerned about the speed of technological change in their industries.[2] Sure, more and more C-suite executives are genuinely tech-savvy—increasingly effective champions for their companies' IT vision—and more and more of them know that digital disruption can be friend as well as enemy. But it's fair to say that most struggle to find the time and energy necessary to keep up with the technologies driving transformation across every industry and in every part of the world.
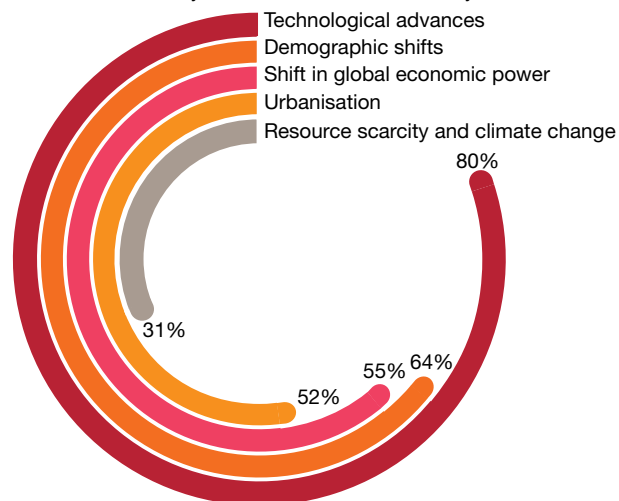
To help CEOs on their technology journeys, we've been evaluating more than 150 technologies globally and developing a methodology to help identify the ones most pertinent to a given company or industry. Additionally, we've been filtering for those that will have the greatest impact on the widest range of industries over the coming years. This article shines the spotlight on those eight technologies that we contend will be the most influential on businesses worldwide in the very near future—the ones we call the 'Essential Eight'. The article also sketches out a three-part guideline to help business leaders respond productively to emerging technologies by incorporating them into their overall strategy with the Essential Eight as a good starting point.

What makes technological breakthroughs a megatrend?

Q: Please rank the top three global trends which you believe will be most likely to transform wider stakeholder expectations of business within your sector over the next five years.

- Technological advances
- Demographic shifts
- Shift in global economic power
- Urbanisation
- Resource scarcity and climate change

80%
64%
55%
52%
31%

Source: PwC, 19th Annual Global CEO Survey – India summary, March 2016

History is littered with companies that have waited out the Next New Thing in the belief that it's a technology trend that won't amount to much, or that won't affect their industries for decades. Yet disruption happens. It's safe to say that the history of humankind is a history of disruption—a stream of innovations that have tipped the balance in favour of the innovators. In that sense, technological breakthroughs are the original megatrend. What's unique in the 21st century, though, is the ubiquity of technology, together with its accessibility, reach, depth, and impact.

The technological breakthroughs megatrend directly impacts every other megatrend. Every industry feels its influence now, and so does every company, of every size—everywhere. There is still a significant digital divide, but for the first time, the developed and developing worlds are using similar platforms, including the Internet, social media, and mobile technologies. Farmers in India track crop prices on their mobile phones; Kenyan and South African entrepreneurs crowdfund their new ventures.[3,4] There's new competition: Google and Uber are delving into driverless automobiles; Silicon Valley start-ups are competing with long-established defence contractors; and the health insurance industry is being overrun by companies that started out as SaaS (software-as-a-service) providers.[5]
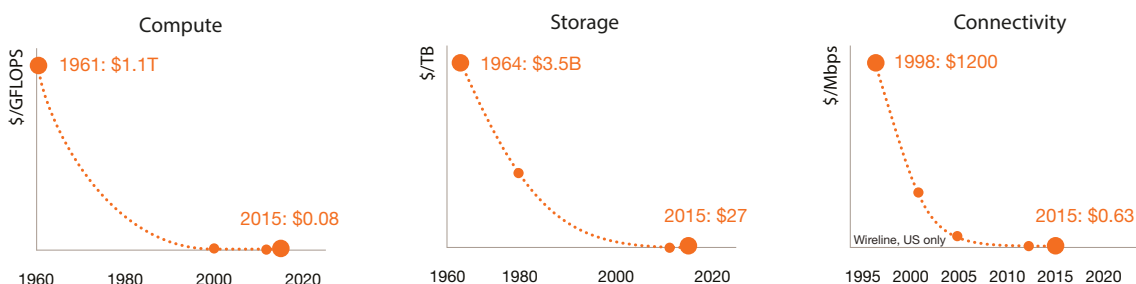
Business leaders in India acknowledge these changes, and have a clear sense of their significance. We asked CEOs what they believe will most shape stakeholders' expectations about businesses in their industries over the next five years. Our respondents were unequivocal in pointing to technological advances as the most influential by far (see Figure 1).

CEOs don't single out any particular catalyst that leads them to that conclusion. But we maintain that technological advancements are appearing, rapidly and simultaneously, in fields as disparate as healthcare and industrial manufacturing, because of the following concurrent factors:

- **Cheaper access to technology.**
  The three fundamental technologies of computation, storage, and connectivity are exponentially cheaper and more capable today than just a few decades ago (see Figure 2). The rapid growth of the Internet, mobility, and cloud computing, combined with the open-source movement and increased access to capital, has lowered the barriers to entry for start-ups and non-traditional competitors, enabling them to scale swiftly and to upend the playing field in industry after industry.

- **Globalisation of technology.**
  For the first time, the developed and developing worlds are creating, collaborating, communicating, and consuming on similar technology platforms, spurring global innovation. Of the 170 'tech unicorns' tracked by CB Insights, 28% are from the Asia-Pacific region, including 7 from India.[6] These highly valued, fast-growth newcomers have global ambitions and are developing innovative platforms for use in sectors as diverse as finance, online-to-offline services, and the sharing economy.

- **Increased comfort with technology.**
  The more we all use the Internet, laptops, mobile devices, collaboration tools, and other technologies in our personal and professional lives, the more society is comfortable with all things technology. Business users now expect the same ease of use in their workplace technologies that they experience with their personal devices, revealing consumer technology's huge influence.[7]

- **The competitive advantage of technology.**
  Our Digital IQ survey found that companies that are technology leaders in their industries are twice as likely to achieve rapid revenue and profit growth as the laggards.[8] Originally seen largely as a tool for improving efficiency—doing the same things better and more cheaply—technological innovations are now the fastest means of opening up new revenue streams and transforming traditional industries.

- **Multiplier effect of technology.**
  Individual technologies build on each other and amplify each other's effects, setting the stage for what some are calling a 'fourth industrial revolution'.[9] As participants noted at a recent technology panel hosted by PwC, AI—an emerging technology—is the motive force behind robots (another evolving technology) transitioning beyond the factory floor and into hotels and office suites.

Figure 2. Technology costs are plummeting (and the reach is increasing)

Compute
$/GFLOPS
1961: $1.1T
2015: $0.08
1960 1980 2000 2020

Storage
$/TB
1964: $3.5B
2015: $27
1960 1980 2000 2020

Connectivity
$/Mbps
1998: $1200
2015: $0.63
Wireline, US only
1995 2000 2005 2010 2015 2020

Source: PwC/Strategy& analysis; Michael Driscoll/Metamarkets

The eight emerging technologies you should absolutely consider

The eight technologies you should absolutely consider...

We screened 150+ technologies for global, cross-industry business impact

Scan
Data from companies, start-ups, academia and research

Assess
For cross-industry relevance, technical viability, global scalability (including size and growth) and investment requirements

Select
Those deemed to have most impact over the next three to seven years
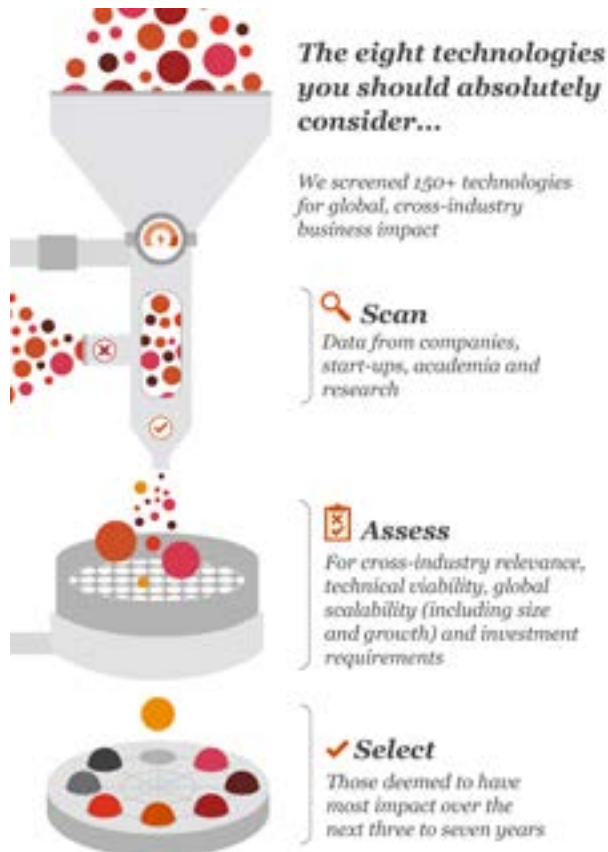
Collectively, those driving factors are forcing big questions to the surface—questions that C-suite executives themselves are asking. Some of the key questions are—'Where should we start exploring emerging technologies? What technologies should we invest in? How do we stay current? How do we reduce the associated risks of failure?' These are the types of questions we're getting from CEOs.

To help provide answers, we track more than 150 discrete technologies, and have developed a methodology to identify the most pertinent of those technologies; the aperture being flexible enough to scale from a business unit to a company, an industry, or even the global enterprise landscape as a whole.

The multifactor criteria screens for business impact and commercial viability of these technological breakthroughs over the next five to seven years (and as little as three to five years in developed economies). Examples of these criteria include: the technologies' relevance to the company, the industry, or across multiple industries, ranging from banking and insurance to hospitality services and industrial process manufacturing; their global reach; their technical viability, including the potential to become mainstream; their market size and growth potential; and the pace of public and private investment in them (see Figure 3).
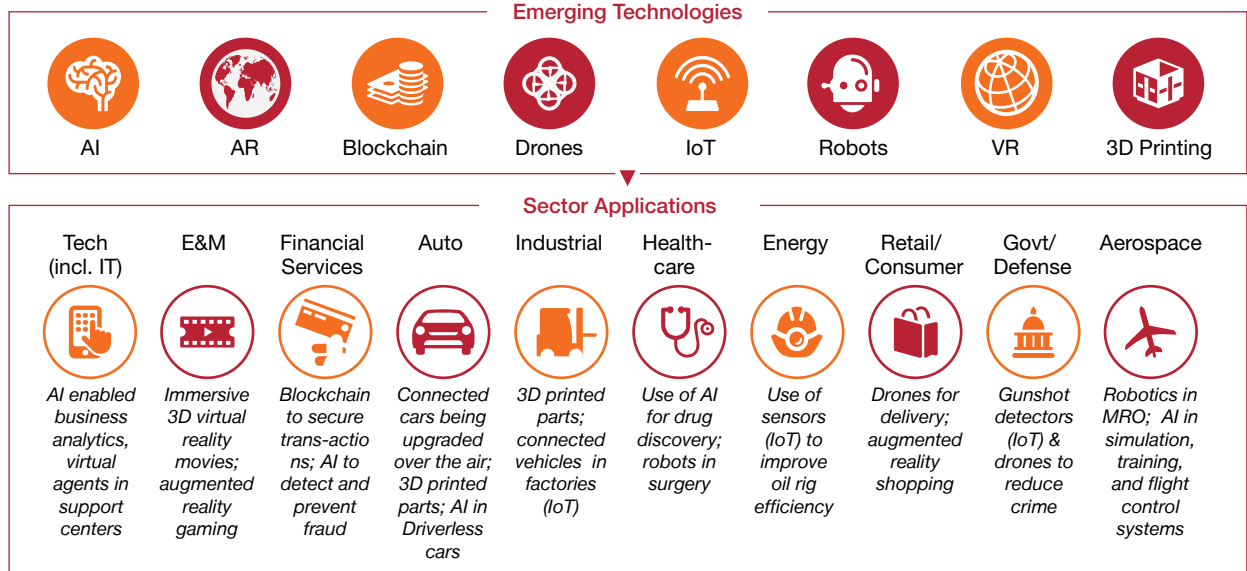
The Essential Eight technologies that matter now

1. **Artificial intelligence (AI).** Software algorithms that are capable of performing tasks that normally require human intelligence, such as visual perception, speech recognition, decision-making, and language translation. AI is an 'umbrella' concept that is made up of numerous subfields such as machine learning, which focuses on the development of programs that can teach themselves to learn, understand, reason, plan, and act (i.e. become more 'intelligent') when exposed to new data in the right quantities.

2. **Augmented reality (AR).** Addition of information or visuals to the physical world, via a graphics and/or audio overlay, to improve the user experience for a task or a product. This 'augmentation' of the real world is achieved via supplemental devices that render and display said information. AR is distinct from virtual reality (VR); the latter being designed and used to re-create reality within a confined experience.

3. **Blockchain.** Distributed electronic ledger that uses software algorithms to record and confirm transactions with reliability and anonymity. The record of events is shared between many parties and information once entered cannot be altered, as the downstream chain reinforces upstream transactions.

4. **Drones.** Air- or water-based devices and vehicles—for example, unmanned aerial vehicles (UAVs) that fly or move without an on-board human pilot. Drones can operate autonomously (via on-board computers) on a predefined flight plan or be controlled remotely. (Note: This category is distinct from autonomous land-based vehicles.)

5. **Internet of things (IoT).** Network of objects—devices, vehicles, etc.—embedded with sensors, software, network connectivity, and compute capability that can collect and exchange data over the Internet. IoT enables devices to be connected and remotely monitored or controlled. The term IoT has come to represent any device that is now 'connected' and accessible via a network connection. Industrial IoT (IIoT) is a subset of IoT and refers to its use in manufacturing and industrial sectors.

6. **Robots.** Electro-mechanical machines or virtual agents that automate, augment or assist human activities, autonomously or according to set instructions—often a computer program. (Note: Drones are also robots, but we list them as a separate technology.)

7. **Virtual reality (VR).** Computer-generated simulation of a three-dimensional image or a complete environment, within a defined and contained space (unlike AR), that viewers can interact with in realistic ways. VR is intended to be an immersive experience and typically requires equipment, most commonly a helmet/headset.

8. **3D printing.** Additive manufacturing techniques used to create three-dimensional objects based on digital models by layering or 'printing' successive layers of materials. 3D printing relies on innovative 'inks' including plastic, metal, and more recently, glass and wood.

The Essential Eight impact is being felt across multiple sectors

Emerging Technologies

AI	AR	Blockchain	Drones	IoT	Robots	VR	3D Printing

Sector Applications

Tech (incl. IT)	E&M	Financial Services	Auto	Industrial	Health-care	Energy	Retail/ Consumer	Govt/ Defense	Aerospace
AI enabled business analytics, virtual agents in support centers	*Immersive 3D virtual reality movies; augmented reality gaming*	*Blockchain to secure trans-actions; AI to detect and prevent fraud*	*Connected cars being upgraded over the air; 3D printed parts; AI in Driverless cars*	*3D printed parts; connected vehicles in factories (IoT)*	*Use of AI for drug discovery; robots in surgery*	*Use of sensors (IoT) to improve oil rig efficiency*	*Drones for delivery; augmented reality shopping*	*Gunshot detectors (IoT) & drones to reduce crime*	*Robotics in MRO; AI in simulation, training, and flight control systems*

How India is embracing the Essential Eight technologies

Artificial intelligence (AI)

AI has had a significant impact on sectors such as retail, eCommerce, auto manufacturing, healthcare and banking in India. AI is also helping drive developments in emerging areas such as robotic manufacturing, self-driving cars and advanced medicine. Global technology companies have increased their focus on AI—Apple's acquisition of Turi, Emotient, and Hyderabad-based start-up Tuplejump; Intel's acquisition of Nervana Systems; Google's acquisition of DeepMind Technologies, API.ai and Moodstocks; and several acquisitions by Microsoft, Twitter, Facebook confirm the trend.[10] In the coming months, Indian companies are also expected to invest in assets that add AI and machine learning capabilities to their operations.

In terms of the business landscape, Mumbai-based AI start-up **Arya.ai** was selected as one of 21 global standout innovators by Paris&Co, a French innovation agency. Arya.ai provides advanced AI tools that developers use to build robots who can assist in the efficient completion of tasks.[12] Major AI companies in India include **Niki.ai**, **Mad Street Den**, **Artifacia** and **SigTuple**.

> Bengaluru-headquartered **Manipal Hospital** deployed IBM Watson in their oncology department. Watson, an AI (cognitive computing) platform helps doctors provide individualised healthcare to cancer patients by analysing data to identify evidence-based treatment options and suggesting the best alternative. The deployment was a major step in transforming the healthcare space in India.[11]

Augmented reality (AR)

AR has found use in several verticals in India, including retail, gaming and entertainment, defence, education services, publishing and industrial products. In terms of adoption, retailers are using AR in various ways— online shopping; virtual retail stores through AR apps; AR advertisements with web content, product videos and coupons; and 3D product previews at stores. For the publishing industry, Print-to-Mobile AR Activation is one of the best examples of increasing reader engagement. AR has had the biggest impact on the functioning of the gaming sector, with technology being one of the most prominent features for game developers and designers today. In a first, the Hyderabad-based start-up gaming firm **Empower Labs** launched India's first AR mobile game driven by the global success of **Pokémon Go**.[13]

Major Indian providers of AR services include **Imaginate**, **FlippAR**, **Gamooz**, **Trimensions**, **TELIbrahma** and **Whodat**.

> Several Indian companies have been using AR in their business operations. **CommonFloor**, a real estate portal, offers retina headgear to view properties virtually in 3D, and eCommerce companies like **Voonik**, **CaratLane** and **LensKart** have developed virtual trial rooms using AR to offer a better customer experience.[14]

Blockchain

With cryptocurrency usage expanding rapidly, India remains one of the global hubs for blockchain technology. The financial services industry as a whole is a first mover when it comes to the blockchain, and several banks and financial institutions in India are actively evaluating the technology and are in the process of deploying certain workloads on the blockchain. The **Reserve Bank of India** has recommended that banks work on developing applications for digital currencies and distributed ledgers.[15] However, the impact of the blockchain may not be limited to financial services. It can also come in handy in the public sector (managing public records and elections), healthcare (keeping records anonymous but easily available) and retail (handling large-ticket purchases such as auto leasing and real estate).

There are several blockchain companies in India—the major ones being bitcoin wallets/exchanges. (Blockchain is the technology that underlies bitcoin, the most popular digital currency, which is created and held electronically). In an important development, one of India's most popular bitcoin wallets, **Unocoin**, partnered with the bitcoin shopping platform **Purse.io** to allow customers to shop on Amazon India at a discount when using bitcoin as the trading currency.[17] Other blockchain companies in India include **Coinsecure**, **Zebpay** and **BTCXIndia**.

> Banks such as **ICICI Bank**, **Axis Bank** and **Kotak Mahindra Bank** have been aggressively looking at blockchain technology, and leading IT players have started to build applications to help banks use the blockchain.[16]

Drones

In India, drones have long been used for military and security purposes; applications of drones are increasing phenomenally among India's security forces as well as public sector undertakings (PSUs). Karnataka State Police was the first police department in India to acquire and use a fleet of UAVs, and deployed drones to detect illegal sand mining.[18] Although their use is still at a nascent stage, drones are now increasingly being used in commercial areas such as media, photography, cinema, agriculture, energy and delivery services.
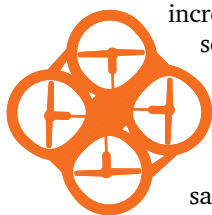
Even though there are major restrictions on the commercial use of drones—and arguably so because of the possibility of misuse—the Indian market for drones is now a promising one, with immense opportunities for Indian companies. One of the major players in this space, **AirPix**, gives recommendations to industries and businesses by carrying out data analytics on aerial data collected by drones for its customers in areas such as real estate, aviation, oil and energy. Other names include **Garuda Robotics**, **Edall Systems**, **IdeaForge** and **Aurora Integrated Systems**.

> The logistics company **DHL Group** announced plans of using drones for deliveries and managing logistics in India in the future. The use of drones in logistics will result in substantial benefits, especially in saving time and reaching remote and disaster-hit areas of the country.[19]

Internet of things (IoT)

IoT has acquired significant market traction in India over the last few years, driven by the increasing need for connectivity among devices and systems, business processes automation, and real-time monitoring and tracking of services and systems. The **Government of India** is also upbeat about the growth prospects of this technology and launched an IoT-focused Centre of Excellence in Bengaluru along with NASSCOM.[20] Planned government projects such as smart cities, smart grids and smart transportation are also expected to be major revenue-generating sources for IoT solution providers in the future.

IoT is being rapidly brought into use across diverse industry verticals to reduce costs and increase operational efficiency. Manufacturing, healthcare, transport and automobiles, retail, supply chain and logistics, housing, financial services, and consumer electronics are the key emerging areas where IoT technology is being adopted. Healthcare is another sector which is witnessing the booming application of IoT. Wearables for fitness and preventive healthcare have taken centre stage, and remote patient monitoring and clinical trial applications are some of the ways IoT is transforming the healthcare industry.

Over the last few years, several Indian IoT start-ups have sprung up, and IoT technology is receiving widespread attention from established technology players. Pune-based **Altizon Systems**, an IoT platform, received an investment from Wipro Technologies, which picked up a 20% stake in Altizon in line with their focus on investing in disruptive technologies. Wipro plans to resell Altizon's flagship product, Datonis Platform, to global customers under the Wipro brand[22]. Other popular IoT companies in India include **EcoAxis**, **Entrib**, **SenseGiz**, **Maven Systems**, **Nexiot** and **Altiux Innovations**.

> A prime example of a company that has embedded IoT in its business model is GOQii, a wearable tech company that provides comprehensive health management solutions and offers a wearable fitness tracker and app, guidance from global experts and coaching counsel. The company recently added NFC Payments, health reports and diagnostics to its offerings.[21]

Robots

In India, robots have significant use in industries like manufacturing, pharmaceutical, FMCG and logistics (packaging and inspection). Robots can be used to manage the end-to-end manufacturing process—from handling operations, welding, assembly and dispensing to processing. Other industries too have adopted robots in a variety of operational functions—healthcare uses robots in medical assistance and skill development technologies, while defence has a variety of use-cases, from bomb defusal to surveillance.

Until recently, the business landscape of robots in India was dominated by foreign players. However, Indian companies have now started investing in this space. **TAL Manufacturing Solutions**, a Tata Group company, announced the launch of an India-made robot, 'Tata Brabo', developed for micro, small and medium enterprises which require cost-effective robotic solutions for their manufacturing purposes.[24] There are several robotics start-ups in India across several segments—consumer, industrial and academic research, warehouse automation, telepresence, space exploration, marketing/advertising, etc. A prominent start-up in this space, **GreyOrange**, provides warehouse automation solutions to India's eCommerce and logistics companies and has built the robot 'Butler', a mobile intelligent ground vehicle used for material handling.[25] Other robotics start-ups include **Team Indus**, **Sastra Robotics** and **Inventrom**.

> Robots are being increasingly used at automotive plants in India. **Volkswagen India** and **Hyundai Motor India** have robots performing functions ranging from welding to casting and foundry operations to laser applications. Hyundai India has automated several functions, such as sealer and oil applications, cleaning operations and loading of body panels, which are performed by programmed robots. Usage of robots and automation at these companies has helped reduce avoidable wastage, resulting in cost savings of 10–20%.[23]
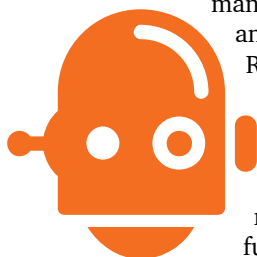
Virtual reality (VR)

The VR market in India is expected to grow substantially over the next five years, driven by the rising demand for VR technology among smartphone users and the introduction of affordable VR headsets in the market. Bundled offerings from smartphone manufacturers have boosted prospects. Further, the adoption of VR-based products is increasing among various end users across defence, automotive, real estate and consumer electronics, especially in applications such as gaming and entertainment. VR also has uses in other application segments such as healthcare, industry, education, and retail and marketing.

The Noida-based VR company **SmartVizX** is one of the well-funded start-ups in this space and offers a range of interactive VR solutions, with a specialisation in three core areas—virtually immersive visualisation, collaborative design work and architectural visualisation. The company also introduced a dedicated R&D facility in Bengaluru to develop more VR applications.[27] A few other start-ups like **GreyKernel**, **Meraki**, **AuraVR**, **SpectraVR**, **Tesseract** and **Xenium**, which specialise in VR solutions, have also come up in the last few years.

> Bengaluru-based online furniture and home decor company, **Urban Ladder**, has developed VR solutions wherein using their mobile app, customers can visualise how a particular piece of furniture would fit in their house. The company's in-house VR team has developed an app for kitchen and wardrobe solutions to start with, and plans to extend it to other categories.[26]

3D printing

India is relatively new to 3D printers and the adoption of 3D printing in India is still at an early stage as compared to that in other developed/emerging countries. However, companies across verticals are seeing the benefits of 3D printing, especially for advanced applications. With the advancements in technologies, the development of new printing material, and improvements in design software and 3D scanners, the market for 3D printing is further likely to develop. With the increasing focus on Make in India, a lot of Indian manufacturers are expected to place emphasis on producing goods locally and will need technology which is both cost and time effective. The manufacturing segment is the largest user of 3D printers, specifically around industrial products, consumer electronics, automotive, medical equipment and aerospace. 3D printers also offer great potential in segments such as healthcare, education and architecture.

In the past, global companies have partnered with Indian technology companies for increasing their customer base, and several Indian companies have set up 3D printing companies both in the manufacturing as well as distribution space. Bengaluru-based **Fracktal Works** has developed a 3D printer named 'Julia+' and provides a full-solution 3D ecosystem—hardware, software, accessories, support, solutions and services, etc. The company now aims to focus on more niche verticals under 3D printing such as jewellery, dental and biomedical devices.[29] Some other interesting start-ups and companies in this sector in India are **Global 3D Labs**, **Brahma3**, **Altem Technologies**, **Imaginarium**, **J Group Robotics**, **REALiz3D** and **df3d**.

> 3D printing is making inroads into the Indian healthcare industry. **think3D**, a provider of 3D printing solutions, is working with hospitals like **MaxCure**, **Sunshine Hospitals**, **SRM Hospital**, **LV Prasad Eye Institute** and **Dr Reddy's**. 3D printed models are being used in treating complex fractures and face reconstruction surgeries, and have led to higher success rates in such treatments.[28]

Assessing the impact of the Essential Eight technologies

The specific technologies most impactful to a company can—and likely will—vary, of course, but when we analysed for technologies with the most cross-industry and global impact over the coming years, eight technologies emerged (see 'The Essential Eight technologies that matter now'). They are at varying degrees of maturity; some have been around for years but are finally hitting their stride, while others are maturing rapidly. None will be surprising to CEOs; they are regular subjects of often breathless coverage in popular newspaper coverage.

So what exactly do we mean by 'impact'? We believe that these technologies will shake things up across all five aspects of your business model—some in very beneficial ways, and some in quite challenging ways, as seen in the following snapshots:[30]

- **Strategy:** If strategy is about defining 'what business to pursue', then these technologies are opening up a slew of new opportunities and corresponding considerations. IoT (and IIoT), for example, are giving manufacturers the ability to 'sensorify' their existing products, creating 'intelligent' new offerings with value-added analytics and software services to go with them.[31] In some cases, these new offerings require a comprehensive rethink of innovation and portfolio strategies. In other cases, they may necessitate fresh go-to-market and even merger and acquisition strategies. But the technologies can accelerate and amplify bigger shifts: manufacturers' moves into service sectors, for instance, or fluid joint ventures with other corporate entities to leverage broad technology platforms for mutual advantage. For instance, Future Group, an Indian retail, fashion and grocery conglomerate acquired the online furniture retailer FabFurnish in April 2016. Future Group plans to leverage the technology platforms and integrate its tech-enabled delivery model in their operations. Future Group also entered into a strategic tie-up with Paytm, a mobile payment and eCommerce platform, in order to build an integrated mobile-first, omnichannel retail and payment solution for their consumer base.[32]

- **Customer engagement:** The Essential Eight technologies are already reshaping almost every dimension of companies' interactions with their customers, from sales and marketing to billing and after-sales support. Just one example: AI, applied as machine learning, for instance, can help process volumes of customer-behaviour data to identify patterns that enterprises can use to improve customer engagement (see sidebar on 'digibank', India's first mobile-only bank[33]).

Customer engagement and AI

In April 2016, DBS Bank launched digibank, India's first mobile-only bank. Asia's only bank harvesting experimental conversational technology, digibank aims to help customers operate completely digitally with in-built features like biometrics and AI. digibank looks to make banking more interactive and intuitive for users and provides 24x7 customer service by an AI-driven virtual assistant.

- **Operations:** AI, robots, drones, and 3D printing can all improve operational efficiency and provide significant competitive advantage. Consider the following data point: We've determined that in the hospitality industry, service robots can drive down the cost of deliveries by one or two orders of magnitude.[34] Is it any wonder therefore that we see continued adoption of robots across an array of business sectors?[35]

At the same time, early adopters of VR and AR are already reaping benefits (see Figure 4).[36] And, 3D printing is set to shrink supply chains, cut product development times, and broaden offerings for customers that expect products tailored to their preferences and needs.[37] The accompanying box showcases how Hero Motocorp and Hindustan Aeronautics are using 3D printing to be both faster and more efficient.[38]

Operations and 3D printing

At Hero Motocorp, 3D printing is used for product designing for all parts of two-wheelers for fitment and aesthetic evaluation. The technology leads to quick evaluation of designs and reduces lead time of the development process, and also helps in maintaining confidentiality of design prototypes. Meanwhile, Hindustan Aeronautics Limited (HAL) has also started using 3D printing technology to manufacture components for its aircraft engines.

Figure 5. More robots, new roles, fewer jobs?

Bots replace humans

58%

CEOs who intend to reduce headcounts over the next five years as a result of robotics

More humans hired

16%

CEOs who intend to increase headcounts over the next five years as a result of robotics

Jobs lost to bots

47%

Jobs in the US that could be replaced by robotics and other computerisation by 2034

New roles created

67%

CEOs who agree that robotics will create new and exciting opportunities for their employees by automating repetitive tasks

Source: PwC, CEO Agenda: Pulse on Robotics, 2016

Compliance and blockchain

We anticipate that new blockchain technology will do much to transform the compliance practices of enterprises large and small. As we noted in our recent article, blockchain enables a 'central, immutable ledger of transactions' that 'would allow auditors and regulators to rapidly monitor the flow of financial data, avoiding after-the-fact verification'. However, there is still significant debate about how this technology gets monitored and regulated.[41]

- **People and talent:** The Essential Eight technologies are creating brand-new job categories, but a worrying consequence may be slower job growth. Our global CEO Pulse survey showed that 56% of global CEOs expect the widening use of robots to reduce head count over the next five years (see Figure 5).[39] A recent Citibank report contended that the banking industry could lose up to 30% of its workforce over the next 10 years owing to technologies such as AI and blockchain.[40] Concurrently, new technologies beget new companies (Flipkart, just nine years old, has more than 34,000 employees) and new job categories (the jobs of a data scientist or an app developer were all but unknown a decade ago). So employers will have to determine how to integrate machines into their talent pools and, at the same time, determine how to hire, retain, and develop the talent they need—talent that may need to embrace their machine-colleagues rather than fear them.

- **Compliance:** This is an often overlooked aspect of the business model. We believe the shortlisted technologies will see many companies scrambling to adapt to—and trying to influence—the resulting regulatory landscapes. The regulators themselves are likely to be in a catch-up mode for a while. How do we protect the data collected by billions of IoT devices? How is blockchain regulated (see sidebar)? How do we plan for liability and insurance considerations as drones and service robots proliferate? Questions like these are no longer hypothetical. There have already been quite a few high-profile incidents where drones have entered airspace reserved for commercial aircraft, and have injured humans.

Your job now

So what should CEOs and their leadership teams do with such brief glimpses of the business impact of these influential technologies? For starters, it is best not to treat the technologies as a kind of checklist to delegate for routine checks and balances in the form of 'impact analysis'. Instead, CEOs must take very seriously their own obligations to turn these technologies to strategic advantage—and to protect their organisations against others using the technologies for advantage. If that sounds something like an arms race, that's because it is: Technology must be viewed as a competitive weapon, one that merits regular discussion and decision-making in the C-suite.

Technological breakthroughs megatrend is manifesting itself as a proliferation of technologies - the Essential Eight, and hundreds more. The tracking, evaluation, and action plan development for these emerging technologies, while a complex and involved undertaking, should now be an integral component of the overall corporate strategy. To do so, there are three questions that the C-suite must find effective answers to:

1) Do we have a sustainable innovation strategy and process?

2) Have we quantified the impact of new technologies? If not, how can we do that—and how soon?

3) Do we have an emerging-technologies road map? If so, are we keeping it up to date?

Answers to these fundamental questions will give you the meta-actions—moves that enable the executive team as a whole to properly and effectively harness the best new technologies.

Tracking, evaluating and developing the action plan for emerging technologies should be an integral component of the overall corporate strategy.

Do we have a sustainable innovation strategy and process?

Our research shows[42] that the most successful companies shape their future by creating the change they want to see. They do not respond to external changes as rapidly as possible—which is another way of saying that they do not chase the next exciting emerging technology as soon as it emerges. It is therefore vital to build an innovation strategy, capability, and culture that allows you and your leadership team to engage in profitable pursuit of emerging technologies aligned to your 'Way to Play' (i.e. how you create value for your customers in the market).[43]

For a sustainable and repeatable innovation strategy and process, here are some things you will need to solve for:

- **Funding:** How will we fund the emerging-technology-driven innovation? Will there be a separate investment pool or will each organisation be given flexibility to pursue investments within guidelines? If the former, will existing profit centres be taxed or will it be part of the corporate overhead?
- **Portfolio fit:** How will the emerging-technology pursuit fit within the overall product and services portfolio? Will it be under a separate unit or an overlay organisation, or will there be incubation factories within existing organisations? Running

innovation through the standard operating procedure is often a recipe for failure, so new development and go-to-market processes might be needed. What are the best ones for us? How do we mitigate risk? How do we convert successful experiments to mainstream products and services?

- **Accountability:** Emerging-technology strategy will require myriad business and technology trade-offs. Who is the senior executive on whose desk the buck finally stops? Should the CEO helm the process, or should the chief strategy officer? What about a business-line leader? Regardless of the choice, we suggest two things: The person should be experienced and seasoned in running a business, and the CEO's involvement should be hands-on.
- **Metrics and monitoring:** What does success look like? How do you make it 'safe to fail'[44]? What are the milestones—public and private—you are shooting for? What is the time frame for those milestones? How will you monitor progress against those milestones? How will you ensure that the monitoring is not stifling?

Our experience has shown that these answers have fundamental implications on both the capability systems and the culture of the company—so think hard, think well, and be bold but also pragmatic.

2.

Have we quantified the impact of new technologies? If not, how can we do that—and how soon?

Championed by the CEO, the corporate strategy team should quantify the effect of these emerging technologies on all aspects of the company's business model. The team has to look both externally (in terms of new products and services, new competitors, and new substitutes made possible by the technologies) and internally (using the technologies to improve operational efficiencies and to accelerate time to market).

The overarching task is to identify the technologies that provide the greatest opportunities for growth, including expansion into adjacent markets and increasing efficiencies, with the proviso that there is a net increase in value for the enterprise. We acknowledge that this is a complex task. We have highlighted the Essential Eight emerging technologies (see Figure 6) that should definitely be on your radar, but there are hundreds more out there. The timeline and number of technologies to emphasise will vary depending on multiple factors, such as the company's size and its capabilities, its culture, its shareholders, and the industry it is part of. This is

exactly the kind of problem our emerging-technologies methodology is designed to help enterprises with.

The lead technologists in the company (e.g. the CTO and the CIO) should be an integral part of this identification process from the get-go. Finally, keep in mind: It is critical, early in the technology identification process, to involve influential leaders from select lines of business because they are often closer to customers than the top team is. One thing to watch out for, though: Inclusiveness must not overshadow agility.

Once the technologies with highest impact have been shortlisted (as admitted, not an overnight exercise and one deserving sustained C-suite focus), it's time to involve the relevant line(s)-of-business executives who can help prototype them. This has to be an iterative process, changing as fresh opportunities come

along. Prototypes that show promise should be expanded; those that don't work, halted. All along, CEOs should keep their hands on the steering wheel, so the effort doesn't turn into a functional crusade instead of a strategic endeavour.

Figure 6. The Essential Eight emerging technologies
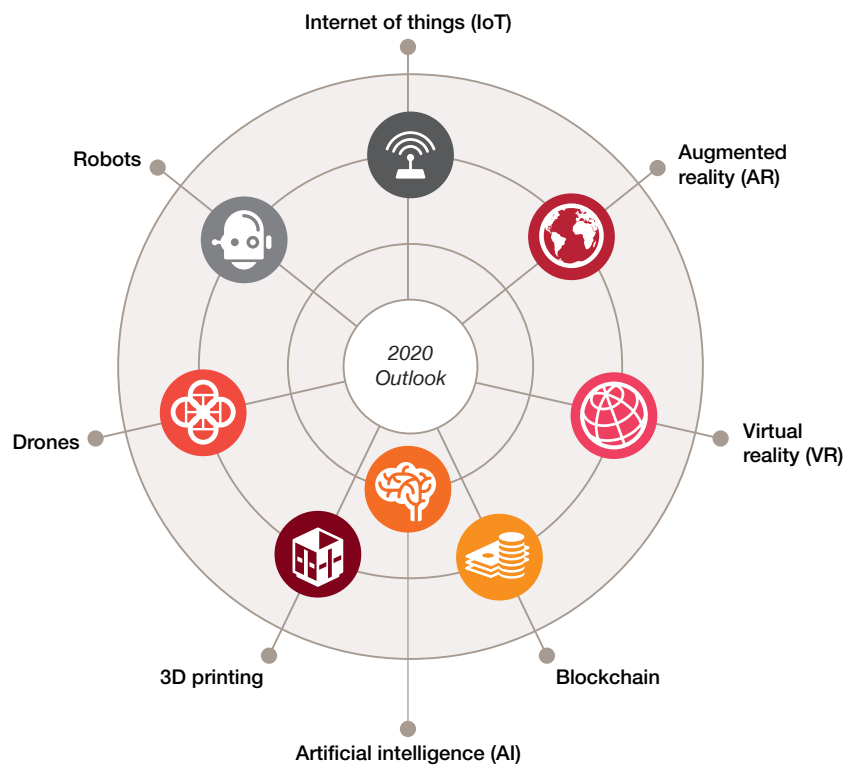
Do we have an emerging-technologies roadmap? If so, are we keeping it up to date?

With confidence about the company's strategic vision, a sustainable innovation process in place, and a clear view of the technologies that will matter most to the company over the next half-dozen years, it's time to draw up the road maps that will guide the application and implementation of those technologies across the enterprise and the customer base. The company's product and technology organisations should collaborate on creating these product and service road maps. The process of creating the maps should be led by the business side of the house in order to create alignment to the enterprise goals and to cement broad buy-in across the organisation.

The emerging-technology road maps cannot, of course, stand on their own; they've got to be aligned to your innovation strategy and integrated into your overall product and services portfolio. A road map that is not appropriately funded struggles to be much more than a great thought experiment. We are not saying that the road map execution necessarily needs to go through your regular development process, but we do contend that the cost and time allocation must be deliberate, clearly thought through, and continuously monitored (this is where broad business buy-in is very helpful).

A defining characteristic of the digital age is the rapid pace of change and disruption. The upshot?

No technology plan is 'one and done'; it must be continuously revisited, refreshed, and reworked.

As pointed out, successful companies do not chase change. However, the days of static five-year road maps are over. You need a robust review mechanism of your product and services road maps and innovation strategy across your portfolio. It demands pragmatism in pruning parts of the product and services portfolio that are not delivering (and reallocating their funding)—and doubling down on the ones that show the most promise (with an eventual plan for mainstreaming should they demonstrate success). It means keeping the lines of business involved and the cross-organisation lines of communication open.

This is a delicate balancing act; there's a real risk of creating more churn and uncertainty than the organisation can handle. This is why choosing the right executive leader and the hands-on involvement of the CEO are critical.

No argument: It is not easy to stay ahead of emerging technologies

No argument: It is not easy to stay ahead of emerging technologies. But you really don't have a choice; your organisation must adapt. By winnowing down the welter of possible technologies to a starting list of the Essential Eight, we hope we have helped provide some focus and clarity. More than that, we hope that we can begin to re-energise the C-suite's discussion of how best to leverage the right technologies in the right ways at the right time—for the right business reasons.

So, develop an innovation strategy and start making the exploration and quantification of emerging technologies (and planning for them) a core part of your corporate strategy. But before you do that, familiarise (or reacquaint) yourself with these technologies and what they can do.

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