THE WHITE BOOK OF...

Digital Workplace Evolution

The definitive guide to enabling future ways of working

shaping tomorrow with you

FUJITSU

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Contents

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Preface

The White Book of Digital Workplace Evolution is the sixth installment of Fujitsu's **white book** series, which delivers practical, forward-looking guidance to enterprises as they develop their workplace IT infrastructure to support and grow their business. It builds on the research undertaken for **The White Book for Mobilizing the Enterprise** and helps businesses to deliver innovation in their working environment.

All of the technologies we talk about in this white book are already here – albeit still in uncommon usage. The key to innovation is enabling people to use them in fresh ways to create new business value and ways of working.

People, information, processes, things, infrastructure and computing systems meshing together will dramatically change the way that ICT services support industries. Given the enormous changes in store over the next five years, organizations must determine how they can meet and exceed business demands and user expectations if they are to compete in their respective markets. What strategies should be adopted to prepare for the workplace of 2020?

- Never before have workers enjoyed such freedom and flexibility. The days of being tied to a desk manning a landline are gone. Distributed teams can collaborate easily via virtual workplaces. The workplace can be in the office, at home, in public places or with customers. Premises will still be required but they will change.
- Applications are released from the device and are provided as a service from an app store held in the cloud.
- The Internet of Things converges IT with the physical world. Robots carry out services in various industries. Wearables connect people and systems. Temporary connections change to constant ones.
- Virtual reality technologies create the illusion of workers from multiple locations being in the same room or at the same site.
- Augmented reality provides information to people in the form of animations and projections from various perspectives.
- 3D printing transforms design, manufacturing and assembly processes.

The implementation of emerging technologies will impact the three pillars of people, process, and technology. Organizations need to transform their IT infrastructure to create seamlessly integrated networks of connected devices, and manage storage capacities for huge volumes of data. Business processes need to be reconfigured to optimize the benefits new tools can deliver. And of course, organizations must put their people at the heart of this change, delivering the technology they need in a way that enhances their work capabilities.

We hope this book will be useful in helping businesses and IT leaders on their journey towards implementing a workplace environment that is fit for 2020. As ever, your feedback is very welcome.

Karyn Jeffery
Head of End User Services

Executive summary

- **Emerging technologies such as wearables and augmented reality will expand the ability of the individual.** The Internet of Things (IoT) and augmented reality tools will enable information to be delivered to workers that enables them to perform high-level tasks proficiently without the pre-requisite knowledge they would need today. For example, Japanese water infrastructure repair firm Metawater already enables its engineers to use augmented reality technology to view components with relevant information overlaid on the screen of smart tablets[1]. This kind of functionality is expected to expand rapidly in the coming five years, as supporting technologies mature.

- **Workers will become increasingly immersed in 'connected' environments, as opposed to today's reliance on computers or smartphones.** A vast array of connected devices will ensure that employees are plugged into their organizations' wider IT ecosystems from the moment they arrive for work, with the ability to be fed relevant organizational data in real-time as they need it to perform their roles. For example, data stored on an office worker's wearable or smart devices will automatically link them into the organizational network as they enter a building, with all of the information required for them to perform their role automatically uploaded onto their desktop and smart devices.

- **Despite rapidly changing jobs in both field-based and office-based environments, a common set of IT requirements will still underpin them.** While emerging technologies will be applied in very different ways depending upon job type and industry sector, the challenges facing IT leaders will have a lot of common elements, such as integration, security, and data governance.

- **In an ever-expanding connected environment, data will become the lifeblood of every organization.** With workers increasingly reliant upon connected devices to perform their roles, the delivery of relevant, accurate data in real time becomes critical to the functioning of every organization. In preparation, CIOs must ensure the necessary universal data management plans are in place.

1. Metawater: Overhauling Water Facility Maintenance Using Augmented Reality Technology, Fujitsu, 2014
   http://www.fujitsu.com/global/vision/2014/casestudy/metawater/

- **Specialist personnel and internal frameworks must be in place to evaluate and quickly embrace the most promising emerging workplace technologies.** IT leaders need technology experts with a strong understanding of business process who can identify the latest workplace technologies that can boost their organization. It's also important that a framework is in place to enable the rapid evaluation and deployment of emerging technologies. Organizations will need a modular approach to select the technologies that work best for them and to easily integrate them with existing infrastructure.

- **The IT function must find smarter ways to adapt to a rapidly changing technology environment.** Organizations will move towards a software-defined workplace that is flexible, scalable, and secure, safeguarding assets and enabling smarter utilization of resources. Business leaders will need to trial and deploy new technologies more rapidly than ever, and build agility into everything they do, as business processes must be readily changeable in order to keep pace with the evolution of workplace technologies. The IT department will need to intensify their shift from cost center to business enabler.

- **IT consumption will be through aggregated services marketplaces.** Organizations will increasingly consume new services and capabilities through aggregated providers. Organizations are finding that they are using a greater number of cloud-based services to meet their business objectives; smarter and more streamlined capabilities are needed to deliver a higher level of quality services that evolve and flex at the speed of the market.

- **Workforce 'fusion' will become a key responsibility for CIOs as multiple generations get to grips with emerging technologies.** CIOs will need to play an important role in helping employees of different generations adopt new technologies. At a time when the pace of technology change is faster than ever, organizations are faced with an ageing workforce: it is predicted that by 2020, workers over 55 years of age will account for 25% of the US labor force, up from just 13% in 2000[2]. Putting effective training programs and knowledge-sharing frameworks in place will be a prerequisite for successful deployment of new workforce tools.

2. The Ageing US Workforce: A Chartbook of Demographic Shifts, Stanford Center on Longevity, July 2013
   http://longevity3.stanford.edu/wp-content/uploads/2014/01/The_Aging_U.S.-Workforce.pdf

Introduction: The new face of work

The speed at which workplace technology has evolved over recent decades has been startling, but we are now entering a period – and pace – of change that will put wholly new pressures onto CIOs and organizations.

It's surprising to think about how recently the smartphone reached the mass market. If we go back just five years to 2010, only one-fifth of the US population used smartphones[3]; by 2017, it is predicted that nearly two-thirds of the country's population will be using them.

This technology has already changed the face of work across industry sectors by enabling relevant information to be shared with employees in real time, whatever their location. For instance, building maintenance officers employed by local councils can now be allocated jobs in their locality, submitting relevant information via smartphone apps before proceeding directly to their next job, a vastly more efficient work process[4]. Meanwhile, healthcare professionals are using mobile apps for many purposes, from accessing diagnosis and treatment information, to providing drug references at the point of care[5].

3. Smartphone penetration in the United States from 2010 to 2017, Statista, 2015
   http://www.statista.com/statistics/201183/forecast-of-smartphone-penetration-in-the-us/
4. Fife Council saves £20m through flexible mobile working solution, ComputerWeekly, November 2013
   http://www.computerweekly.com/news/2240209032/Fife-Council-simplified-and-saves-through-flexible-mobile-working-solution
5. A Systematic Review of Healthcare Applications for Smartphones, University of Missouri School of Medicine, July 2012
   http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3534499/

Enabling this innovation is already throwing up challenges around security, integration and data governance, among other things. But in the workplace of 2020, people will rely more than ever on a suite of advanced technologies and applications to perform their jobs at the level required. IT leaders have a huge task ahead to keep pace with this change.

Leading organizations are experimenting with a host of exciting new technologies that could make a dramatic impact in the workplace, such as wearables, the Internet of Things (IoT), augmented reality, telepresence, robotics and cognitive computing, to name but a few.

The value of the global cognitive computing market, for example, is forecast to grow from $2.5 billion in 2014 to $12.5 billion by 2019[6]. Meanwhile, US consultancy Digi-Capital's research suggests that the augmented reality market could reach around $120 billion in revenue by 2020[7].

If this projected rate of adoption of emerging technologies comes to fruition over the next few years, we will see work in all industries transformed. And while some of these new technologies will become almost universally applied across industries, in the same way that smart mobile technology has become ubiquitous today, others may remain specific to particular sectors.

For CIOs and IT leaders, however, a common set of challenges will present themselves. They must ensure their organizations are agile enough to implement the most effective emerging technologies for their business ahead of their competitors, while designing human-centric systems that bring together the dimensions of people, information and infrastructure to optimize the capabilities and performance of each employee.

6. Cognitive Computing Market by Technology (Natural Language Processing, Machine Learning, Automated Reasoning), by Deployment Model (On-Premises, Cloud) & by Regions - Global Forecast to 2019, MarketsandMarkets, April 2015
http://www.marketsandmarkets.com/Market-Reports/cognitive-computing-market-136144837.html

7. Augmented And Virtual Reality To Hit $150 Billion, Disrupting Mobile By 2020, Tech Crunch, April 2015
http://techcrunch.com/2015/04/06/augmented-and-virtual-reality-to-hit-150-billion-by-2020/#.6yrqnx:BZRv

1

Optimizing
ways of working

In many respects, the digital revolution – the transition from analogue, mechanical and electronic technology to digital technology – is only just getting underway. We have barely scratched the surface in terms of the potential for digital to revolutionize the workplace.

A new world of hyperconnectivity is now emerging in which people and the things around them are capable of becoming linked, and sharing information. The IoT is increasingly becoming a reality, with everyday devices and smart wearables becoming networked, and collecting data about their environment.

In 2013 there were around 3 billion internet-connected 'things' in use. This number will likely reach 25 billion or more by 2020[8]. "Instead of the temporary connectivity of workers we have today, there will be an immersive connection in future, facilitated by wearables of all kinds, that ensures individuals are continuously plugged into an organizational network that can feed them the information they need at the right times," explains Joseph Reger, Chief Technology Officer at Fujitsu.
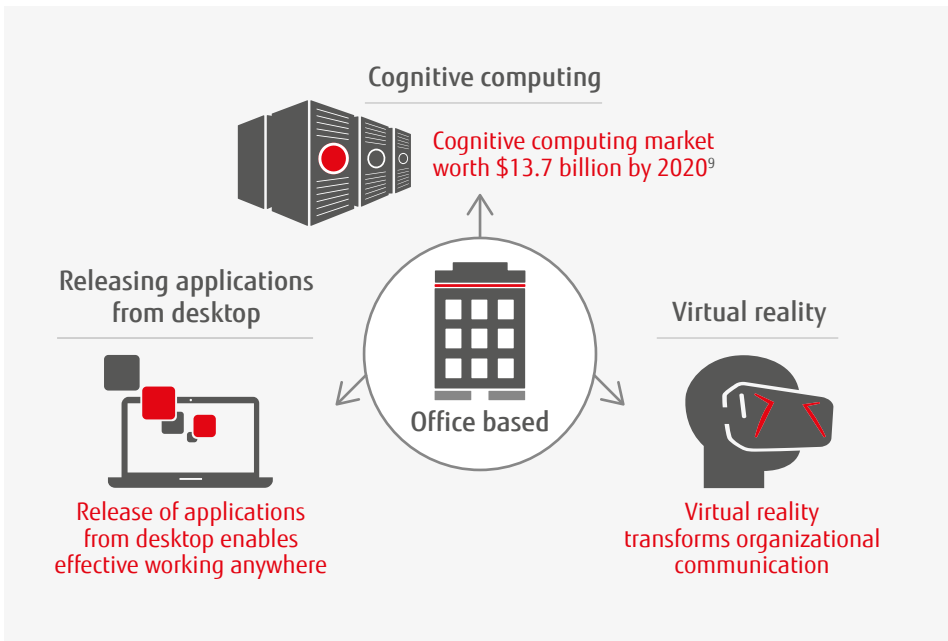
Massive amounts of information are being generated as a result of these vast connected ecosystems, and this is providing organizations with opportunities to make significant gains in terms of how their workforce operates – enhancing productivity, efficiency and capability.

In this new environment, leading organizations will find ways to empower employees by ensuring that all of the information and tools they need to excel in their role are right at their fingertips.

"Instead of the temporary connectivity of workers we have today, there will be an immersive connection facilitated by wearables"

Joseph Reger, Chief Technology Officer, Fujitsu

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8. Gartner Says 4.9 Billion Connected "Things" Will Be in Use in 2015, Gartner, November 2014
http://www.gartner.com/newsroom/id/2905717

Office-based work

Cognitive computing

Cognitive computing market worth $13.7 billion by 2020[9]

Releasing applications from desktop

Release of applications from desktop enables effective working anywhere

Office based

Virtual reality

Virtual reality transforms organizational communication

At the heart of how digital technology enhances ways of working is its ability to rapidly connect people with the information they need irrespective of time or location.

"Wearable technology is going to become embedded within our bodies, tracking our internal systems and movements"

Paul Miller, Founder, Digital Workplace Group

In an office environment, organizations are focusing on emerging technologies that can enable greater collaboration with information between employees in different locations. For instance, virtual reality rooms are being developed that give users the ability to visualize colleagues in different locations and share information as though they were sitting beside one another. "Virtual reality technology is taking telepresence communication to new levels," says Paul Miller, CEO of the Digital Workplace Group. "This vastly reduces the need for travel within organizations to get work done."

9. Global Cognitive Computing Market Size, Industry Analysis, Trends, Opportunities, Growth and Forecast, 2014 – 2020, Allied Market Research, June 2015

In the financial services sector, some banks are already expanding the reach of their consultants to serve higher numbers of customers at their convenience. For example, UK-headquartered Nationwide Bank launched its 'Nationwide Now' service last year, which enables its experts to deliver mortgage advice on demand via HD video link technology[10]. As augmented reality applications and holographic technologies evolve, banks will have the opportunity to become an even more integrated part of customers' lives.
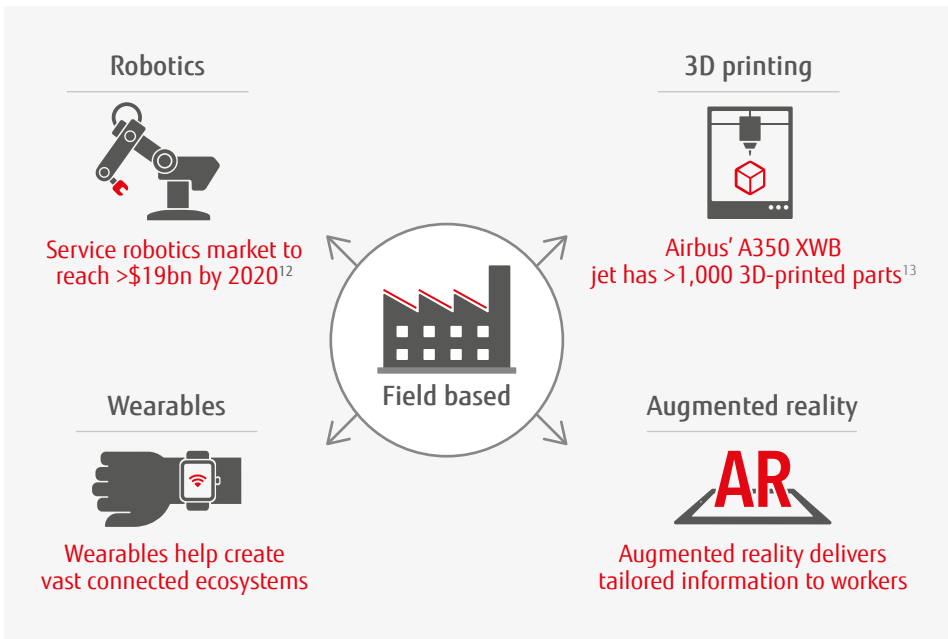
With wearables becoming more commonplace, there will be new opportunities for improving employees' efficiency by delivering easier and quicker access to the applications relevant to each individual. "It's going to be more persona-based – as soon as an end-user walks into a building they'll be recognized via a wearable or smart device and by the time they reach their desk it will be populated with all of the applications they need, regardless of where in the organization they are working that day," says Robin Lipscomb, Head of Offerings – Managed Infrastructure Services, Fujitsu.

What is more, the virtualization of technology gives organizations the power to provide employees with whatever application they need on the device of their choosing, taking worker flexibility to new levels[11]. "The release of applications from the desktop is going to have a dramatic impact on the way that work changes," says Karyn Jeffery, Head of End-User Services at Fujitsu. "The future of work is all about people rather than devices – the device is going to become ubiquitous. What's important is what applications you can use on it and how it makes a difference to your job."

10. Nationwide to become first in Europe to launch innovative video link service offering customers greater access to mortgages, Nationwide, April 2014
   http://www.nationwide.co.uk/about/media-centre-and-specialist-areas/media-centre/press-releases/archive/2014/4/16-april-nationwide-launch-video-link-service
11. White Paper – Virtual Client Services, Fujitsu, 2014
   http://www.fujitsu.com/global/Images/35565_Virtual_Client_Services.pdf

Field-based work

Robotics

Service robotics market to reach >$19bn by 2020[12]

Wearables

Wearables help create vast connected ecosystems

Field based

3D printing

Airbus' A350 XWB jet has >1,000 3D-printed parts[13]

Augmented reality

AR

Augmented reality delivers tailored information to workers

In the same way that smartphones have been transformative as a result of their ability to combine technologies, enabling call and video as well as supporting online applications, the organizations that achieve greatest success in future may be those finding applications that harness multiple emerging technologies.

12. Service Robotics Market (Professional and Personal), by Application (Defense, Agriculture, Medical, Domestic & Entertainment), & by Geography - Analysis Forecast (2014-2020), MarketsandMarkets, September 2014

13. Airbus had 1,000 parts 3D printed to meet deadline, BBC News, May 2015

Adolfo Suarez Roos, Group Robotics Expert at Airbus, says that instilling robots with increasingly advanced cognitive computing capabilities is enabling them to interact far more closely with humans in areas such as manufacturing. "Robots used to work in a closed environment where everything was in an exact position, but now you can throw a part on a table or have it moved by a human and the robot can re-compute its path – they are more capable in terms of perception," explains Mr Suarez Roos.

Airbus Helicopters 'Factory of the Future' research team is already studying the application of collaborative robots to perform waterproofing tests on fuselages, doors and windows. Robots track the entire perimeter of the part, centimeter by centimeter, recording and listening for noise that would indicate a leak or hole in the airframe[14].

Robotics manufacturer Kuka is also developing a lightweight, multi-jointed arm known as the Intelligent Industrial Work Assistant, that harnesses IoT, cloud networking and 3D sensing technologies to jointly perform delicate tasks with humans, without needing a human controller. It streams movement data back to a central cloud-based platform, and is able to notify nearby technicians via wearable technology if it encounters a problem.

Amazon too has begun to utilize more automated solutions to increase the productivity of its workforce. Over the last three years, it has increasingly used robots to bring stored items to pickers in selected warehouses, instead of using pickers to get the items themselves. It is estimated that the adoption of this technique across Amazon could increase productivity by a factor of four[15].

According to a recent MarketsandMarkets report, the service robotics market – comprising robots used for various applications such as medical and healthcare, aerospace and defense, and security and surveillance – will reach $19.4 billion by 2020, compared to just over $3.5 billion in 2013[16].

14. Factory of the future – New ways of manufacturing, Airbus
http://www.airbusgroup.com/int/en/story-overview/factory-of-the-future.html
15. Robotics and the ever increasing automation of logistics, The Ti Blog, February 2014
http://transportintellblog.com/2014/02/11/robotics-and-the-ever-increasing-automation-of-logistics/
16. Service Robotics Market (Professional and Personal), by Application (Defense, Agriculture, Medical, Domestic & Entertainment), & by Geography - Analysis Forecast (2014 - 2020), Marketsand Markets, September 2014
http://www.marketsandmarkets.com/Market-Reports/service-robotics-market-681.html

The UK Met Office: Augmented reality transforming weather forecasts

While both augmented reality (AR) and virtual reality (VR) are finding new applications within a work environment, it is expected that the AR market will grow fastest in future. AR also brings far greater potential value in a field-based environment given that it puts virtual things into users' real worlds, augmenting them, as opposed to the VR approach of fully immersing users in a closed virtual environment.

Charles Ewen, Chief Information Officer at the UK Met Office, envisages augmented reality technology transforming the ability of Met Office staff to deliver forecasts. "We've done a couple of case studies that show how augmented reality could overlay the environment to show levels of air pollution, or what the wind speeds will be in several hours' time, for instance," says Mr Ewen.

Such a system is made possible by the Internet of Things (IoT), with devices ranging from smart sensors on buildings and transport vehicles, to wearables, feeding back weather-related information via the cloud, enabling the collation and analysis of data from thousands of sources.

The data supply chain

Mr Ewen argues however, that it may be some time before we see augmented reality capable of forecasting the full range of environmental behavior because the data supply chain is not yet sufficient to support this. "The limitations are all about the information, not about the technology," says Mr Ewen. "The information supply chain needs to quickly mature – there's no metadata or emerging standards for calibrating data from IoT. Without this, it's impossible to build an accurate model as you don't know how much you can rely on a piece of information."

If this can be rectified, the possibilities for enhancing human performance through augmented reality weather forecasting are huge. The Met Office already works with the aviation industry, for example, providing tools to advise pilots on where and how to fly safely based on what is happening in the atmosphere. "Right now, those tools are not good enough on their own, so we often use face-to-face forecasters to provide a narrative overlay to the information," explains Mr Ewen. "But that doesn't have to be a human being – that might be the future of cognitive IT. It could be that there's IT out there that is capable of understanding a context, and providing an explanatory narrative on top of a visualization."

Wearable technology has already achieved significant consumer uptake as compared to other experimental emerging technologies such as robotics, AR and VR, and it is perceived by many to be a natural successor to smart mobile devices in terms of dominating the consumer market. But for application in a work environment, particularly those that involve field-based work, more customized wearables are being designed.

For instance, some work settings are not amenable to the use of smart mobile devices to access information, such as those where manual work is performed by hand, or where tasks require gloves to be worn. In roles such as mechanics and engineering, the development of smart gloves can help workers by delivering instructions and other information via near-field communication technology. Users can access real-time information about the properties of the device, what tasks other engineers have recently performed with it, and instructions on how to use it.

Embedding wearables into systems that enable users to combine their benefits with other technologies such as AR is where the greatest gains stand to be made, according to Dr Reger. "For field personnel, augmented reality will mean that information and instructive manuals are superimposed onto machinery, cars, buildings and complicated installations. Your system can overlay additional information onto the physical environment, for example, describing the required manual steps to remove a specific part from a car," says Dr Reger.

The beauty of this approach for organizations is that it can expand the abilities of individual employees, stripping out the need for additional skilled workers for carrying out multi-stage processes. "In retail for instance, we'll see the consolidation of tasks through augmented reality technology. The person transporting the merchandise will be able to install it for the customer because it will be connected to the seller's system – so it's instantly recognized once it's online, and can guide the employee on what steps to take," explains Dr Reger.

Wearable technology is being trialed in many field-based work settings already. For instance, oilfield services company Schlumberger is testing smart glasses as part of a workflow management tool for oilfield workers. The glasses can deliver ambient data and information to individuals in the field in real time, as well as using dictated messages, photos, and videos to collect data on the length of time taken to complete tasks, helping operations managers to assess where performance can be improved[17].

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17. The surprising reason oil companies love Google glass, Fast Company, May 2014
http://www.fastcompany.com/3031171/the-surprising-reason-oil-companies-love-google-glass

Meanwhile, it is in the healthcare industry that many foresee wearables having the greatest impact. For instance, engineers at the University of Illinois at Urbana-Champaign and Northwestern University have demonstrated thin, soft stick-on patches for sophisticated wireless health monitoring. These patches can send updates to an individual's smartphone or computer, and could revolutionize clinical monitoring such as electrocardiogram testing[18].

Again, the impact of wearables in a healthcare environment can be enhanced by connecting them with a wider ecosystem of sensors, mobile devices and cloud services, for example, to transform end-to-end emergency services responses by delivering information to paramedics about a patient's location and state of health[19]. And as biometric technology becomes more advanced, this could even circumvent wearables as a means of patient identification. Longmont United Hospital, for example, now uses a vein pattern recognition system to do this[20]. "If you can read somebody's palm and identify them even when they're unconscious, you can administer the correct drug at the right dosage, and that's going to make a significant difference to the quality of outcomes in the healthcare sector," says Ms Jeffery.

Looking further ahead, Paul Miller, CEO of the Digital Workplace Group, argues that internal wearables will be the next step. "Wearable technology is going to become embedded within our bodies, tracking our internal systems and movements," says Mr Miller. "At that point, healthcare professionals will be able to tap into that data for diagnosis and prescribing treatments."

While CIOs will be aware of many of the emerging technologies described above, and some of their potential applications, others may be less well known to them. For each of these technologies however, their adoption and implementation will likely present a raft of similar challenges, with common solutions required.

18. Off the shelf, on the skin: Stick-on electronic patches for health monitoring, University of Illinois at Urbana-Champaign, April 2014
     http://www.sciencedaily.com/releases/2014/04/140403212615.htm

19. Fujitsu showcases its Human Centric Innovation approach using its award winning "life and death" demonstration at the Fujitsu Forum 2014, Fujitsu, December 2014
     https://www.runmyprocess.com/press/2014/12/23/fujitsu-showcases-its-human-centric-innovation-approach/

20. Longmont United adopts new vein pattern recognition system, Times-Call Local News, August 2014
     http://www.timescall.com/longmont-local-news/ci_26434763/longmont-united-adopts-new-vein-pattern-recognition-system

2
Implications for organizations

As organizations move into this new era in which digital technology is interwoven into everything their people do, they may need to make dramatic structural changes. For many, it will not be a case of simply understanding how technology can enhance their existing models of work, but actually designing fresh models based on the new technologies.

The implementation of many of the emerging technologies discussed in this paper will have profound implications for the three core organizational pillars of people, process and technology infrastructure, as well as for the structural models of organizations.

Process

When considering the ways in which new technologies may drive process change, one of the clearest examples to assess is 3D printing – a technology with the potential to transform design, manufacturing and assembly processes in industries such as aviation. Airbus, for instance, is beginning to use 3D printing to shape the future of aircraft component manufacturing. The company's recently manufactured Airbus A350 XWB jet contained more than 1,000 3D-printed parts, more than any other aircraft before it[21].

The Airbus Group has started using 3D printing for tooling, prototyping, making parts for test flights and also for parts that will fly on commercial aircrafts. It has a team developing the capability to manufacture customized parts in less than 24 hours, to prevent delays in assembly due to missing parts. It is also developing new design processes, exploring titanium powder, aluminum alloys, nickel and plastic as the raw materials for 3D printing new parts quickly and at low cost, to speed innovation. "You can reduce costs and improve production flow because the workers themselves can think about ways to improve their workplace – they send requests for customized tools and receive them within hours," says Airbus' Mr Suarez Roos. Organizations considering the implementation of such technology will first need to engage the business in detailed discussion to understand how business processes can be reconfigured to optimize its benefits.

"The workers themselves can think about ways to improve their workplace – they send requests for customized tools and receive them within hours"

Adolfo Suarez Roos, Group Robotics Expert, Airbus

21. Airbus had 1,000 parts 3D printed to meet deadline, BBC News, May 2015
http://www.bbc.co.uk/news/technology-32597809

Organizational structure

The process change driven by emerging technologies will also be accompanied by shifts in organizational structure, as digital tools empower frontline employees to make better decisions alone, aided by accurate and tailored information that will flow 'as easily as electricity'[22] across organizations in 2020. One significant upshot is that fewer interactions with senior managers will be necessary to ensure high levels of performance. "People in frontline roles are being given more powerful technology and this disintermediates an awful lot of managers," says Mr Miller. "If you're a logistics driver for instance, you don't have a boss aggregating information from multiple sources and working out where you should go – an online platform is calculating your journey routes, and you're updating what's happening in real time so it can plot the most efficient path for you."

In healthcare meanwhile, cognitive computing technology is already being used to assist doctors at Memorial Sloan Kettering Cancer Center in New York to choose treatment options for cancer patients. By mining massive quantities of data and incorporating new research as it is published, the cognitive tools can effectively 'learn' by acquiring more knowledge, and so improve the accuracy of their guidance[23]. Armed with this technology, oncologists anywhere will be able to make more specific and nuanced treatment decisions more quickly, based on the latest data.

Organizations will experience significant disruption to existing work structures if the trend towards digital engagement of external workers continues to strengthen too. The rise of online freelance exchange platforms such as Elance, coupled with the growing use of crowdsourcing to generate solutions in areas beyond software programming, suggests there will be more open information flow between organizations and external partners in the future. For instance, recent research from CGMA, the global membership body for management accountants, found that 33% of organizations plan to increase their use of talent sourced via online exchanges over the next five years, while 37% will rely more on freelancers and contractors[24].

22. Digital life in 2025, Pew Research Center, March 2014
   http://www.elon.edu/docs/e-web/imagining/surveys/2014_survey/PEW-Elon%20DIgital%20Life%20in%202025_Report%20I%203-11-14.pdf

23. Memorial Sloan Kettering Trains IBM Watson to Help Doctors Make Better Cancer Treatment Choices, Memorial Sloan Kettering Cancer Center, April 2014
   https://www.mskcc.org/blog/msk-trains-ibm-watson-help-doctors-make-better-treatment-choices

24. New ways of working: Managing the open workforce, CGMA, 2014
   http://www.cgma.org/Resources/Reports/DownloadableDocuments/CGMA-new-ways-of-working.pdf

As remote collaborative working becomes more commonplace
with both in-house and external workers, it will create a host of
challenges for CIOs in terms of enabling the free flow of organizational
data in a secure environment, and managing system access for
an ever-expanding network of users. In this more open workforce,
the nature of the security challenge will change. Companies
cannot simply secure all possible points of risk, so have to instead
plan for how they proactively respond to potential breaches.

People

In the past, the ability to use cutting-edge technologies itself
was a source of competitiveness for leading organizations,
improving efficiency and building operational excellence.
However, in a world where digital technologies are so accessible,
this advantage is unsustainable. In tomorrow's environment,
the key to success will be ensuring that an organization's people
are placed at the heart of its technology transformation.

By grounding any technology change firmly on their people,
organizations will ensure employees can deliver maximum gains through
the use of new tools, and their empowerment is the most effective
way to drive innovation that delivers greater value for customers.

Employees are already increasingly connected to their workplace
as it becomes more commonplace for individuals to synchronize
their smartphones and tablets to work email accounts, typically
connecting via a central server that enables remote access. Towards
2020, the potential for employees to carry out work away from
the office will not only be linked to smartphones and tablets;
developments in virtual reality technology suggest that more deeply
immersive virtual communication experiences will be possible
from remote locations. "If you're looking at holographic versions
of people communicating with one another, that will be a huge
transformation in the whole nature of what you can do virtually that
previously you could only do in a face-to-face setting. The physical
value of meeting will become quite incidental," says Mr Miller.

One obvious benefit of such enhanced connectivity for employees will be the possibility to carry out work wherever they happen to be, removing ties to a particular office space, for instance. However, organizations must recognize that most employees are ill equipped to deal with this new 'hyperconnected' environment. In a survey by Good Technology, 68% of workers in the US said they already check their work emails before 8am, while 69% will not go to sleep without checking their work email[25].

"Emerging digital technologies are taking us to a point where work and life become interchangeable, and I think that as organizations provide more mobile ways of accessing work, there has to be a parallel activity to understand how people work," argues Fujitsu's Ms Jeffery. "There is the potential for people to become overwhelmed by such a high degree of connectivity, so organizations will need to establish some different ways of working and clearly define what the expectations are in terms of using that connectivity for the benefit rather than the detriment of workers." Another significant people issue that CIOs will need to tackle as they implement emerging technologies in the workplace is the task of retraining the workforce. "It's about people learning not just how to use new devices, but how to comprehend and use the outputs that they're receiving, for example, from connected sensors and big data processing," says Nicholas Lee, Head of Global Offerings – End-User Services, at Fujitsu.

And the growing generational divide in the workforce only serves to exacerbate this problem. The UK's Office for National Statistics for example, has estimated that the number of people aged 50 and over in the UK's labor force will rise to 24.5 million by 2020, up from 19.8 million in 2005, equivalent to an increase of 23.5%[26]. The implication for organizations is that the workforce will be constituted of a broader range of generations, each of which will embrace technology in slightly different ways. Looking to 2020, Mr Lee says companies will need to look at what knowledge and training programs are in place to help employees of different generations adopt new technologies. "We'll need to see generational fusion over the next few years, which means integrating different users by presenting them with the right context or environment to meet their requirements," adds Mr Lipscomb.

25. Good Technology Survey Reveals Americans are Working More, but on their Own Schedule, Good Technology, July 2012
https://www1.good.com/about/press-releases/161009045.html

26. Projections of the UK labour force, 2006 to 2020, Office for National Statistics, January 2006
www.bls.gov/opub/mlr/2012/01/art3full.pdf

Technology infrastructure

Much of the benefit realized from the emerging technologies discussed in this white book are derived from the ability for individuals to be fed information in real time that can assist them in performing their role.

The data necessary to enable this will be gathered from not just workers, but also physical assets – vehicles, products, customers, and more. Furthermore, the interactions and movements of customers or staff or suppliers will add yet more data.

For this to happen, however, organizations will need to transform their technology infrastructure by building networks of smart sensors, IoTs and wearables, breaking down data siloes, and ensuring there is sufficient capacity to process huge volumes of data through harnessing cloud storage and even building private data centers. "Enterprises will be forced – by the sheer volume they're processing – to think about tiering of data and what they can offload into the cloud – it will likely mean a change in the definition of what needs to remain on-premises," says Calvin Hsu, Vice President for Desktop and Applications at Citrix.

Workers of the future may even arrive at organizations with their own personal network and software that will need to connect into whatever systems a particular provider of work gives them. Such an approach will throw up significant challenges around integration and interoperability for CIOs, as well as giving rise to added security risks.

For the vast majority of organizations, the reality is that they will need to maintain part of their existing IT infrastructure, rather than wholly replace it with new cloud-based systems. CIOs will therefore need to assess how best to tie-in new technologies with existing legacy IT infrastructure. This will involve complex decisions, such as what data should be migrated into the cloud from existing servers, and how to adapt existing operational management and governance. See our previous report, The White Book of Managing Hybrid IT[28], for a comprehensive guide to dealing with a hybrid IT environment.

> "Enterprises will be forced – by the sheer volume they're processing – to think about tiering of data and what they can offload into the cloud"
>
> Calvin Hsu, Vice President for Desktop and Applications, Citrix

27. What 5-Year-Olds Today Will Expect From the Workplace of 2029, CMS Wire, November 2014
http://www.cmswire.com/cms/social-business/what-5yearolds-today-will-expect-from-the-workplace-of-2029-027212.php#null

28. The White Book of Managing Hybrid IT, Fujitsu, September 2014
http://www.fujitsu.com/mk/Images/Fujitsu_Whitebook_Managing_Hybrid_IT.pdf

3

How can IT leaders prepare their organizations?

Emerging technologies present huge opportunities for
organizations to enhance workforce capability and effectiveness.
Yet the new technology landscape will create multiple challenges
that must be overcome to realize the gains on offer.

CIOs need to embed an organizational agility that ensures a readiness
to adopt promising new technologies at speed; to put the facilities
and governance in place to enable data to flow freely; and to ensure
the workforce has the requisite knowledge to excel in using these new
tools. "Today's CIO role is all about how we pull together organizational
information and data, how we manage multiple clouds, and keeping on
top of the technology innovation that's coming in leaps and bounds,"
says Lance Fisher, CIO, at UK-based recruitment firm SThree.

Evaluating new technologies

The swift evolution of technology in the digital era means
that organizations must embed a readiness for continuous
change into their structures and processes to succeed.

It is no accident that leading organizations constantly manage to steal
a march on competitors by getting the best new tools in place for their
workforce. There are several key lessons to be learnt in order to achieve this:

● **Understand the latest tools, and what value they can deliver to your
business.** Keeping abreast of the latest emerging technologies is time
consuming and confusing in today's market. CIOs need to understand
what technologies are under development, but also which of them could
best serve their particular business. This requires an outward-looking
mindset. Mr Fisher has built a management structure that allows him
to commit more time to speak with vendors about new technologies
and what tools their competitors are exploring. It's also important to
have IT professionals with a deep understanding of business processes,
and to engage the wider business in decision-making around new
technologies as they can advise on potential applications for them.
"These days it's more and more important to demonstrate to business
users the kinds of technologies becoming available and what's possible
in their context, and then let them engage and come up with ideas of
how that could be used to change a process or an outcome," explains
Murray McPhee, Consulting Lead for Western Australia at Fujitsu.

"Today's CIO role is
about pulling together
organizational data,
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Lance Fisher, CIO, SThree

"It's about saying 'we can
do things in a wholly
different way that will
radically transform the
business process or drive
indirect savings' – that's
where the business case
will come from"

Murray McPhee, Consulting
Lead – Western Australia,
Fujitsu

- **Develop an agile methodology for trialing new tools.** For organizations to keep pace with the speed of technology innovation, they must ensure their processes for evaluating and deploying new technologies are geared for speed. There are huge advantages to trialing new applications in the cloud – it can be done at low cost in comparison to building a solution on-premise, and it provides flexibility. "Lines of business can trial applications, see if they meet their business requirements, and either admit them into the organization's app store if they do, or easily drop them if not," says Ms Jeffery. It's important not to become tied into long-term contracts too, and cloud providers offer more flexibility in this respect. "The IT department can monitor how often applications are being accessed in the cloud and retire those that aren't being used with minimal disruption," adds Ms Jeffery.

Integration

One of the hardest problems for IT leaders to solve when on-boarding new technologies is how to seamlessly integrate them with existing legacy IT infrastructure; with other new applications; and with business processes.

There is a need for interoperability between a wide range of applications, yet in reality, when business leaders are requesting different tools from a whole range of providers, this is hard to achieve. "Each vendor has its own reason to try and create its own ecosystem, and not a huge incentive to create integration between their systems and those of other vendors," says Mr Miller. There are several key considerations here:

- **Create a centralized application store.** CIOs will need to assume responsibility for an organizational library of approved applications that are accessible to other business functions via the cloud, and can be assessed for interoperability prior to implementation. "The IT function will be able to add value by curating a range of hosted applications which have been validated with service providers to ensure seamless integration, and making the wider business aware of that," says Ms Jeffery.
- **Integrate in the cloud.** As organizations explore the applications of new digital solutions, cloud platforms can provide cheaper, more flexible ways to build and integrate them than can be achieved with on-premise solutions. This enables CIOs to rapidly build and deploy customized business applications. "It enables you to identify what functionality you need, and design that in the cloud so it knits together the various applications to make a seamless end-to-end process," says Ms Jeffery. It simplifies the process of integrating new on-premises solutions too. "With an appliance-based approach, you still deploy it on-premises, in the data center, but you can do all of the configuration, setup and integration from a cloud service – that makes it much easier," explains Mr Hsu.

BP takes smart deployment approach with new collaboration technologies

At BP, Director of Strategy and Change for IT&S Global Operations and Infrastructure, David Chapman, has recently completed the implementation of an emerging technology initiative labeled #workyourway across the entire group.

The #workyourway suite of tools includes internal social media and desktop conferencing that enable employees around the world to collaborate more closely than ever before, overcoming geographical barriers. Such tools deliver vital knowledge transfer capabilities to the workforce. For instance, employees are able to pose questions to others in the organization who they may not be in direct contact with, and quickly receive answers or guidance from people who have experienced similar issues. As a global business, this ability to share knowledge fluidly across its workforce brings many benefits for both employees and BP.

The #workyourway tools are also generating significant cost savings for the business. For instance, the use of desktop conferencing has reduced teleconferencing costs, and, because of the high quality communication it enables, BP now uses this platform for the majority of its conferencing requirements.

One key focus in the design and delivery of the project was to ensure that employees using the tools would benefit from an integrated experience. "We knew that to get buy-in and drive adoption across the business we needed to ensure the tools were simple, easy-to-use, and could work seamlessly with existing tools," says Mr Chapman.

When selecting new technologies to make up the #workyourway suite, Mr Chapman deliberately selected those that would integrate easily with existing platforms. Not only did this approach encourage employees to use the new collaborative tools interchangeably, as information could be easily shared across different platforms, but it also meant the tools were more familiar and intuitive, thus enabling faster adoption by the workforce.

Another important advantage of this joined-up approach to selecting the new tools was that it reduced the investment required and meant that BP could roll out the tools more quickly. With the rapid rate of technology evolution in today's market, speeding deployment time is a key consideration. "We've established a governance board of senior stakeholders where the function will put forward a detailed business case for any new tools and, among other things, will demonstrate the return on investment. That process allows us to move quickly in terms of deploying new services across the wider organization," says Mr Chapman.

In addition, a digital innovation team has been established within the IT&S function to help identify emerging technologies that could be adopted at scale elsewhere across the group.

- **Let new tools drive fresh process innovation.** While it can be a struggle trying to shoehorn new technologies into existing business processes, in some instances, the introduction of a new tool can create the opportunity for designing brand new, improved processes. Mr McPhee says the focus in workplace design should be on developing the capability to enable different device types, regardless of who owns them or where they are procured, and being able to distribute information to those devices in a useful fashion. "It's increasingly about an applications delivery conversation," says Mr McPhee. "It's effective to do that from a business change perspective, focusing on the business process, and having the conversation about whether the new technologies enable change in the business process, versus trying to take the existing business process and simply apply it to new technologies."

- **Use virtualization technology to save valuable legacy applications.** As traditional IT infrastructure struggles to cope with increased workloads generated by emerging technology trends, virtualization can allow easy scalability as well as running valuable legacy applications independently from local operating systems. According to CIO Insight, virtualization has already surpassed 50% of all server workloads and will reach 86% by 2016[29].

Data and security

As the quality and accessibility of organizational data becomes a key determinant of performance in future, CIOs must begin to think about the data supply chain in its entirety. High volumes of accurate data need to flow freely into the organization and be delivered to end users via multiple devices. Increasingly, this data flow must be extended to the organization's ecosystem of partners too.

At the same time, new security vulnerabilities are opening up as the increased use of mobile devices and closer interactions with third parties creates new access points. Towards 2020, CIOs face a complex and multi-faceted challenge – they must take organizational data processing and transfer to new levels of efficiency, while tightening security controls to protect against both external and internal threats. To put this threat into context, the Ponemon Institute's 2014 Global Report on the Cost of Cyber Crime found that it takes a large organization an average of 31 days at a cost of $20,000 per day just to clean up and remediate after a cyberattack[30]. While SpectorSoft's 2014 Inside Threat Survey of IT professionals found that 35% of respondents had suffered an insider attack, but many go unnoticed. A full 59% of respondents admitted that they could not even detect an insider attack.

29. Useful Virtualisation Stats, Trends and Practices, CIO Insight, August 2014
http://www.cioinsight.com/it-strategy/cloud-virtualization/slideshows/useful-virtualization-stats-trends-and-practices.html
30. 2014 Global Report on the Cost of Cyber Crime, Ponemon Institute, 2014
http://www.ponemon.org/library/2014-global-report-on-the-cost-of-cyber-crime

Q&A: Deakin University's Chief Digital Officer on facilitating emerging technologies in the education sector

Australia's Deakin University is at the forefront of the education sector in its adoption of emerging technologies such as cognitive computing and augmented reality tools. Chief Digital Officer William Confalonieri explains how the organization's IT architecture is evolving to facilitate their ambitions in this area.

Which emerging technologies will the university focus most heavily on over the next few years?
We've started to work with augmented reality (AR) – we've conducted pilots with AR navigation around the university, delivering overlaid information to students and staff depending on their campus location. We're implementing a big infrastructure, and a content management framework to develop AR applications on both the corporate and learning side of things. Teachers will soon be able to develop their own learning material using AR. We're also progressing our use of advanced cognitive computing systems. We can feed this with all of our organizational information and it can deliver answers to increasingly complex questions. Additionally, we are at the stage of testing pilot solutions in the virtual reality (VR) and Internet of Things spaces.

How will you need to adapt your architecture to support new AR/VR capabilities?
Deakin is the first Australian university to be accepted into the Open Source Virtual Reality consortium, so we're going to be working with partners within that to develop our own standards. In the case of AR we are also trying to create an architecture that is as open and flexible as possible. We'll also need a specific content management system to manage the augmented content and to link that with our normal content, and to distribute that across all of our selected channels. We then need to build buttons into our infrastructure at the various geographic trigger points for the AR to be delivered to users.

What challenges arise in the integration process between your cognitive computing systems and DeakinSync, the university's existing online student hub?
Our cognitive computing systems are held in the cloud by an external data centre, which means it is in a totally separate environment from DeakinSync that is held on internal servers. We manage our cognitive system as an add-on to our existing portal. For the first version, the integration is more straightforward, as it's a case of firing a question at a machine, and it tries to understand a lot of content and come up with a generic answer. The next phase will require deeper integration with existing systems as the cognitive systems will need to connect with the users' personal information in order to deliver customized responses.

What implications will the need for deeper integration have for your data management practices?
The data we feed into the cognitive system all needs to be in a standard format. It's about structured content. For example, if you point the system in the direction of a website, it won't know what to do with the pictures because it understands written text and not images at this point. So we need to apply a common set of rules to all of our data in order for the cognitive system to operate effectively.

- **Create a comprehensive universal data management plan.** As organizations seek to feed their employees with relevant information in real time via a gamut of devices from AR headsets to wearables, the need arises to store and transfer data on a greater scale than ever before. An in-depth dialogue with all stakeholders is needed to define the limitations around how data is managed, including in relation to private and public data centers. "There needs to be a universal data management plan that talks about the quality of the data, the type of data, where the data is shared, where the data is stored, how the data is accessed, when it's accessed and who has access to it." says Mr Lee. The plan must take into account any data storage requirements imposed by regulators too, as severe fines can be levied on those that breach such rules. A Voltage Security survey of nearly 300 IT professionals found that 60% had concerns over data residency preventing them from uploading data to the cloud, 48% didn't know which countries their data resided in once uploaded, and 30% were simply unaware of data residency requirements or laws[31].

- **Implement common data standards and governance processes.** From a usability and a security perspective, it is vital that common data standards are enforced. For instance, common data codes must be applied across the whole organization to enable meaningful analytics to be conducted, while stricter verification of input data sources must be put in place if such data is to be relied upon for decision-making. Charles Ewen, CIO at the UK's Met Office, says it is critical for any organization attempting to use data collated via IoT for modeling or predictive analytics purposes that common standards for attaching metadata to the information are developed. "The problem with the Internet of Things right now is there's no emerging standard or approach to delivering metadata, so you can't know how reliable a piece of information is," says Mr Ewen. The standardization of data is also crucial for enabling data to flow freely across different functions. Governance processes will extend to outlining criteria that must be met by vendors providing applications to the organization, with the IT department providing the container and consumption model for applications.

- **Employ virtualization and tokenization techniques to bolster security.** As we move towards an era of connected ecosystems, virtualization can be used to ensure that individual pieces of hardware do not actually store any data that could potentially be stolen, restricting the organization's perimeter of exposure back to a central data center, while tokenization helps to secure the transfer of

"The problem with the Internet of Things right now is there's no emerging standard or approach to delivering metadata, so you can't know how reliable a piece of information is"

Charles Ewen, CIO, UK Met Office

31. Overcoming Data Residency Issues, Voltage Security, October 2013
http://www.informationsecuritybuzz.com/overcoming-data-residency-issues/

information by substituting sensitive data elements for non-sensitive equivalents. "Microsegmentation within virtual networks can be used to ensure that an intruder is not able to penetrate any further than a single virtual desktop, and indeed that desktop can be auto healing," says Ms Jeffery. "All the data access can then be virtualized and centralized so that you provide that security at both ends."

- **Introduce biometrics to control user-access management.** The biometrics market has become more established over the last couple of years. Improving security that links directly to a human being provides the ability to identify and authenticate individuals at speed and with greater confidence than via password access. Tractica forecasts that the global biometrics market will increase from $2 billion in 2015 to $14.9 billion by 2024, with cumulative revenue for the 10-year period totaling $67.8 billion[32]. "As biometrics becomes cheaper and cheaper to implement, I think it will become the access control mechanism for a whole range of applications and devices, from wearables to the organization's central IT system," says Ms Jeffery. Mr Hsu adds that standardization of access management for enterprise applications is important in identifying when to switch a particular user's access on or off. "It helps to have a standardized software client providing a single point of control, while enabling the user to choose any device," explains Mr Hsu.

Cost

The introduction of transformative emerging technologies creates unique cost challenges for CIOs. It is no longer possible to keep pace with the rate of global technology innovation without adopting a new organizational IT investment model. At the same time, the financial benefits of implementing some emerging technologies can be harder to quantify than those for existing hardware such as PCs. Moving forward, there are several important considerations in this area:

- **Position IT as a service broker.** A new model for determining IT spend is required if organizations are to adopt the latest, most effective technologies for their workforce. Fortunately, advances in cloud technology are making such new models possible. CIOs can enable other business leaders to be innovative with new technology by acting as a service broker. By trialing new tools in the cloud, organizations can adopt flexible, pay-as-you-use pricing models for the business, buying and scaling up particular services in the cloud as the business needs them and quickly retiring those applications once they have served their purpose.

32. Biometrics Market Forecasts, Tractica, 2015
https://www.tractica.com/research/biometrics-market-forecasts/

- **Find new ways to build the business case.** Building the business case for emerging technologies such as AR will need a new approach. It will be a challenge to get high levels of detail initially about the savings likely to be made – but better to explain the transformative impact new technologies could have to business processes. "Rather than saying 'this will save us $X per month', it's about saying 'we can do things in a wholly different way that will radically transform the business process or drive indirect savings such as cut office space costs in half' – that's where the business case will come from," says Mr McPhee. As the workforce becomes more mobile by 2020 there will also be increased opportunity for property consolidation by many organizations, given the reduced physical desk space required. As emerging technologies are implemented, CIOs can help to evaluate where such savings can be made.

IT consumption

Organizations will seek to deliver competitive advantage to their workforce by speeding the rate at which they can pick up and drop new applications. Those that meet the business' requirements can be admitted into the organization's IT infrastructure on a longer-term basis. However, to make this possible, the existing model for IT service consumption will need to be adapted:

- **Demand an aggregated marketplace for IT services.** Through a combination of CIO lobbying, and forward-thinking platform providers seeking to gain competitive edge by delivering greater value for customers, 2020 could see external providers supporting cloud platforms from AWS, IBM, HP, Citrix, Fujitsu, Google, Microsoft and other habit-forming enterprise players. Taking the sting out of integration, but leaving workplace-anywhere options to pick and choose the combinations that best suit users. This benefits businesses because they can select the best solution features, and ask the platform provider to aggregate them. There will be no need to compromise. However, CIOs may need to campaign hard to make this a reality. "If there was a neat development environment, with a common set of APIs – a tool that means you could develop anything and it would work on any device – then that would be the ideal situation, but you'd need to overcome the platform wars that are prevalent in today's market," says Phil Colman, Chief Information Officer at British American Tobacco.

Training and culture

While adapting organizational structures and processes is a crucial part
of on-boarding emerging technologies, these efforts will ultimately
be rendered useless if an organization's people are left behind.

The complexity of retraining employees is heightened because
organizations face a growing generational divide in the workforce, as
people carry on working for longer. By 2020, the US labor market will
consist of five generations: traditionalists, baby boomers, generation X,
generation Y, and generation Z. Each of them interacts with technology
differently and has a distinct learning curve for new digital tools.

CIOs can play a key role in ensuring that workers are ready for the
change, not just in terms of learning to use new devices and systems,
but also more broadly in terms of their mindset – helping employees
to develop new habits and routines as they carry out their roles
with unfamiliar tools. There are two main aspects to address:

● **Implement training programs to educate employees spanning
multiple generations.** There will need to be a wider reach into the
business to relay information about the emerging technologies
identified as having greatest potential for their organization.
It's important to keep employees up to speed with how their
future tools of work are developing. A variety of methods can be
used, from small-scale hands-on workshops led by IT leaders,
to new online learning tools. At the same time, this message
needs to be tailored to different generations: millennials may
be comfortable with digital learning tools, but baby boomers
may require more human interaction, for example.

● **Shift organizational culture, transforming workers into
early adopters.** It can be easy to think the job of technology
transformation is complete once new tools have been integrated
into the existing IT infrastructure, trialed and rolled out to the
workforce. However, there is often a huge task still to be undertaken
in persuading the workforce to swap ingrained and proven ways
of working for new ones. "We have made sophisticated document
collaboration tools available, but you often find people revert to
using whatever tools they're used to," says Mr Ewen. Breaking
down these tendencies can only be achieved through positive
reinforcement of new behaviors throughout the organization.

Future workplace technology speak:
Key terms explained

Access control: A way to control who and/or what may access a given resource, either physical (e.g. a server) or logical (e.g. a record in a database).

Aggregated marketplace: Platform providers that support cloud solutions from habit-forming enterprise players across the market (Citrix, Fujitsu, Google, Microsoft), removing the challenge of integration.

Application integration: Interfaces/converters enabling applications from different sources to interact.

Application programming interface (API): An interface from which users can operate a cloud platform using their own programs and tools.

Augmented reality: Overlaying virtual reality onto real life environments. This involves delivering information through images and text that blends in with contents in the real world.

Biometrics: The analysis of human body characteristics such as fingerprints, eye retinas and irises, voice patterns, facial patterns, palm vein patterns and hand measurements, especially for authentication purposes.

Cloud application: An application that is never installed on a local computer and instead is only accessed in the cloud.

Cloud architecture: The architecture of the systems involved in the delivery of cloud computing. This typically involves multiple cloud components communicating with one another over a loosely coupled mechanism (i.e. one where each component has little or no knowledge of the others).

Cloud service broker: A third-party IT services partner who handles the day-to-day ongoing supplier management of an organization's array of cloud service providers.

Cloud service provider: A service provider that makes a cloud-computing environment – such as a public cloud – available to others.

Cognitive computing: Self-learning systems that use data mining, pattern recognition and natural language processing to mimic the way the human brain works.

Data integration: The technical and business processes used to combine data from disparate sources into meaningful information.

Data residency: The location of data in terms of both the legal location (the country in which the cloud-service contract is enforced) and the physical location (i.e. the data centers where they are stored).

Desktop-as-a-Service: The provision of hosted virtual client services on a pay-as-you-go basis.

Desktop virtualization: The provision of centralized desktop services that can be accessed via multiple devices from multiple locations over a network. These devices may include thin clients, desktops, tablet PCs and smartphones.

Enterprise architecture: The definition for the structure of an enterprise (including its supporting technology) that maps out different business entities and the relationships between them.

Fujitsu cloud services: Services that provide a fully flexible model for IT infrastructure, platforms and applications, allowing companies to match technology systems and costs directly to changing business needs.

Human-centric innovation: A new approach to realizing business and social value by creating solutions and services that bring together the dimensions of people, information and infrastructure.

Hybrid cloud: The delivery of an IT landscape or business service from multiple, integrated cloud service providers.

Hybrid IT: The result of combining internal and external services, usually from a combination of cloud services with on-premises systems, in support of a business outcome.

Hyperconnectivity: An emerging environment in which people and the objects around them are capable of becoming linked, and sharing information via the internet. (See entry on Internet of Things).

Identity and access management (IAM): Identifies and manages the data used in a system to authenticate users and grant or deny access rights to data and system resources.

Identity federation: The provision of security to allow for a clean separation between the service being accessed and the associated authentication and authorization procedures. This enables secure collaboration across multiple systems, networks and organizations employing different security systems.

Internet of Things: A development of the internet in which everyday objects have network connectivity, allowing them to send and receive data.

Interoperability: The ability of diverse systems and organizations to work together.

IT as a service (ITaaS): An operational model where the enterprise IT department acts and operates as a distinct business entity, creating services for the other lines of business within the organization.

Private cloud: A cloud service commissioned and owned by an organization and delivered either by internal or third-party teams, or hosted externally by a provider as an IT outsourcing service.

Public cloud: A cloud service hosted on a common infrastructure, shared by different users or enterprises, with the location of applications and data typically unspecified.

Process integration: Efforts to create direct links between on-premises business applications and services on public clouds. It also constructs a business process linked with tasks requiring human decisions.

Real time: Real-time programs must guarantee a response (from event to system response) within strict time constraints. A real-time system may be one where the application is considered (in context) to be mission-critical.

Service integration: Allows an organization to manage IT-service providers in a consistent and efficient way, ensuring that performance across a portfolio of services meets the needs of the end users.

Service integration and management (SIAM): A framework for managing multiple IT suppliers, providing a single view of IT services to the rest of the business.

Service level agreement (SLA): Part of a service contract where the level of service is formally defined to provide a common understanding of services, priorities, responsibilities, and guarantees.

Single sign-on: A mechanism whereby a single action of user authentication and authorization permits access to multiple systems without the need to enter multiple passwords.

Systems integration: The joining of different subsystems into one large system to deliver a whole functionality.

Telepresence: Technologies which allow a person to feel as if they were present, to give the appearance of being present, or to have an effect, via telerobotics, at a place other than their true location.

3D Printing: The use of additive processes, in which successive layers of material are laid down under computer control, to produce objects of almost any shape or geometry from a 3D model or other electronic data source.

Tokenization: A data security technique that involves substituting a sensitive data element with a non-sensitive equivalent, referred to as a token, that has no extrinsic or exploitable meaning or value.

Virtualization: A way to consolidate servers by allowing an organization to run multiple different workloads on one physical host server. The average server consolidation ratio is 10:1. In a security context, virtualization can be used to reduce sensitive data stored on mobile devices, by holding this on virtual servers in a central data center.

Virtual reality: The creation of a closed virtual world that users can interact with, commonly designed in such a way that it feels real to users.

Wearables: Clothing items and accessories incorporating computer and advanced electronic technologies.

Web services: Application programming interfaces or web APIs that are accessed via the Hypertext Transfer Protocol (HTTP) and executed on a remote system hosting the requested services.

Workforce fusion: The implementation of training programs and knowledge-sharing frameworks to assist a multi-generational workforce in the adoption of new technologies.