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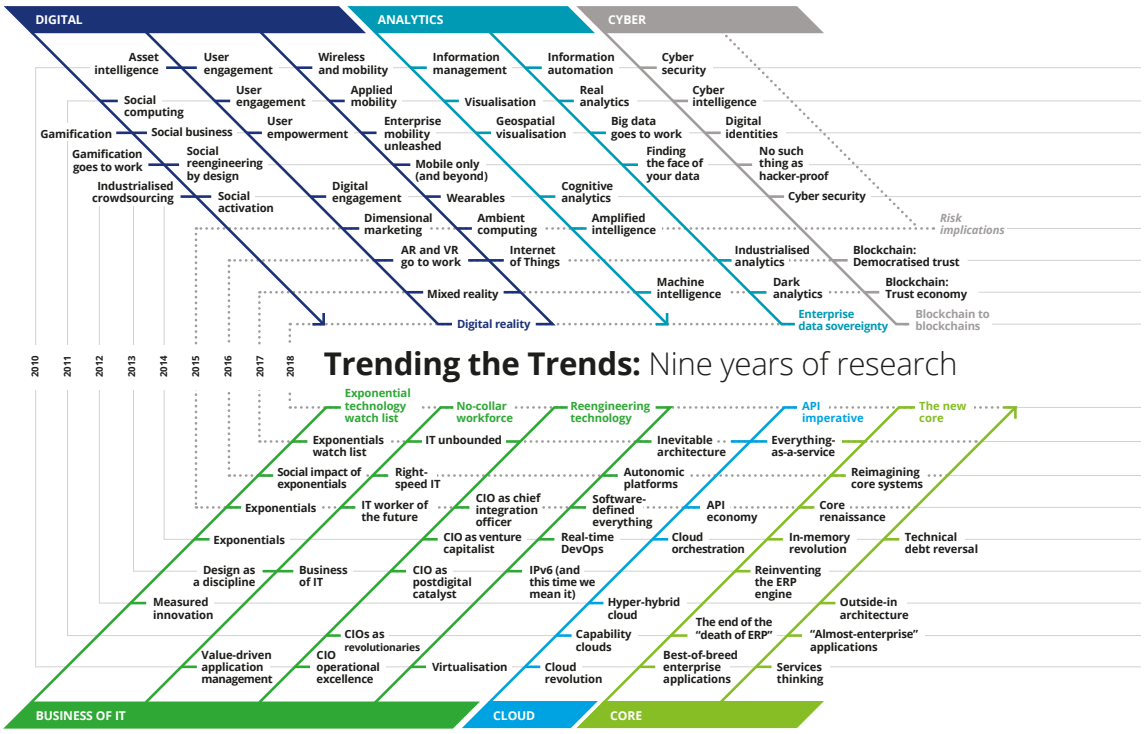
Tech Trends 2018

The symphonic enterprise



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Introduction

THE renowned German conductor Kurt Masur once noted that an orchestra full of stars can be a disaster. Though we have no reason to believe the maestro was speaking metaphorically, his observation does suggest something more universal: Without unity and harmony, discord prevails.

Many companies competing in markets that are being turned upside down by technology innovation are no strangers to discord. Today, digital reality, cognitive, and blockchain—stars of the enterprise technology realm—are redefining IT, business, and society in general. In the past, organisations typically responded to such disruptive opportunities by launching transformation initiatives within technology domains. For example, domain-specific cloud, analytics, and big data projects represented bold, if singleminded, embraces of the future. Likewise, C-suite positions such as "chief digital officer" or "chief analytics officer" reinforced the primacy of domain thinking.

But it didn't take long for companies to realise that treating some systems as independent domains is suboptimal at best. Complex predictive analytics capabilities delivered little value without big data. In turn, big data was costly and inefficient without cloud. Everything required mobile capabilities. After a decade of domain-specific transformation, one question remains unanswered: How can disruptive technologies work *together* to achieve larger strategic and operational goals?

We are now seeing some forward-thinking organisations approach change more broadly. They are not returning to "sins of the past" by launching separate, domain-specific initiatives. Instead, they are thinking about exploration, use cases, and deployment more holistically, focusing on how disruptive technologies can complement each other to drive greater value. For example, blockchain can serve as a new foundational protocol for trust throughout the enterprise and beyond. Cognitive technologies make automated response possible across all enterprise domains. Digital reality breaks down geographic barriers between people, and systemic barriers between humans and data. Together, these technologies can fundamentally reshape how work gets done, or set the stage for new products and business models.

The theme of this year's *Tech Trends* report is the *symphonic enterprise*, an idea that describes strategy, technology, and operations working together, in harmony, across domains and boundaries. This is the ninth edition of *Tech Trends*, and in a way, it represents the culmination of our dogged efforts to examine the powerful technology forces that are remaking our world. The trends we discussed early on in the series, such as digital, cloud, and analytics, are now embraced across industries. Meanwhile, more recent trends, such as autonomic platforms, machine intelligence, and digital reality, continue to gain momentum.

This year, we invite you to look at emerging technology trends from a different angle. When technologies act in unison, we no longer see the enterprise vertically (focused on line of business or isolated industries) or horizontally (focused on business processes or enabling technologies). In the symphonic enterprise, the old lines become blurred, thus creating a diagonal view that illuminates new business opportunities and creative ways of solving problems. For example, in the *new core* chapter, we discuss how in the near future, digitised

finance and supply chain organisations could blur the lines between the two functions. Sound unlikely? Consider this scenario:

IoT sensors on the factory floor generate data that supply chain managers use to optimise shipping and inventory processes. When supply chain operations become more efficient and predictable, finance can perform more accurate forecasting and planning. This, in turn, allows dynamic pricing or adjustments to cash positions based on real-time visibility of operations. Indeed, the two functions begin sharing investments in next-generation ERP, the Internet of Things, machine learning, and RPA. Together, finance and supply chain functions shift from projects to platforms, which expands the potential frame of impact. Meanwhile, business leaders and the C-suite are increasingly interested only in strategy and outcomes, not the individual technologies that drive them. Does the convergence of finance and supply chain really seem so unlikely?

Of course, some domain-specific approaches remain valuable. Core assets still underpin the IT ecosystem. Cyber and risk protocols are as critical as ever. CIO strategies for running "the business of IT" are valuable and timeless. Yet we also recognise a larger trend at work, one that emphasises the unified "orchestra" over individual advances in technology.

We hope this latest edition of *Tech Trends* helps you develop a more in-depth understanding of technology forces at work today. We also hope it can help you begin building a symphonic enterprise of your own. Beautiful music awaits.

Stephen Mercer
Technology Practice Leader, UK
Deloitte Consulting LLP
stmercer@deloitte.co.uk

Mark Lillie
Partner, CIO Programme lead
Deloitte Consulting LLP
mlillie@deloitte.co.uk

Reengineering technology

Building new IT delivery models from the top down and bottom up

With business strategies linked inseparably to technology, leading organisations are fundamentally rethinking how they envision, deliver, and evolve technology solutions. They are transforming IT departments into engines for driving business growth, with responsibilities that span back-office systems, operations, and even product and platform offerings. From the bottom up, they are modernising infrastructure and the architecture stack. From the top down, they are organising, operating, and delivering technology capabilities in new ways. In tandem, these approaches can deliver more than efficiency—they offer the tools, velocity, and empowerment that will define the technology organisation of the future.

FOR nine years, Deloitte Consulting LLP's annual *Tech Trends* report has chronicled the steps that CIOs and their IT organisations have taken to harness disruptive technology forces such as cloud, mobile, and analytics. Throughout, IT has adapted to new processes, expectations, and opportunities. Likewise, it has worked more closely with the business to develop increasingly tech-centric strategies.

Yet as growing numbers of CIOs and enterprise leaders are realising, adapting incrementally to market shifts and disruptive innovation is no longer enough. At a time when blockchain, cognitive, and digital reality technologies are poised to redefine business models and processes, IT's traditional reactive, siloed ways of working cannot support the rapid-fire change that drives business today. With technology's remit expanding beyond the back office and into the product-management and customer-facing realms, the problem is becoming more pressing.

This evolving dynamic carries some risk for CIOs. While they enjoy unprecedented opportunities to impact the business and the greater enterprise, these opportunities go hand-in-hand with growing expectations—and the inevitable challenges that

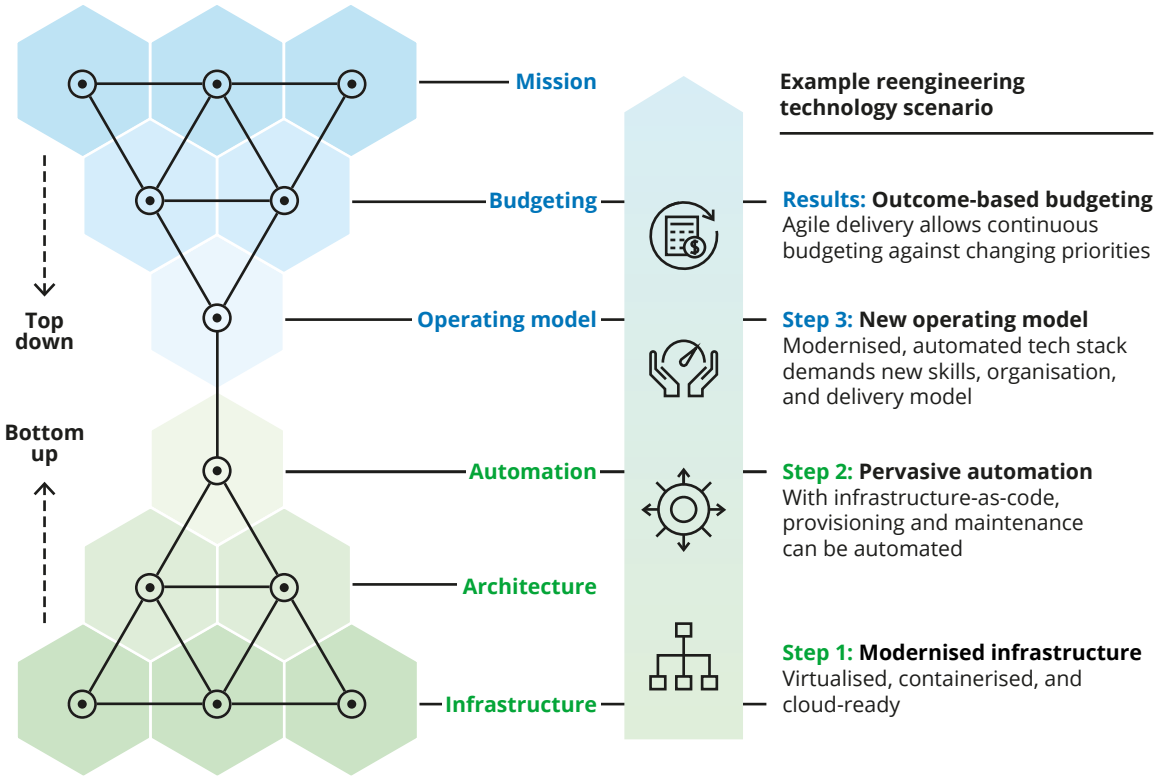
CIOs encounter in meeting these expectations. In a 2016–17 Deloitte survey of executives on the topic of IT leadership transitions, 74 percent of respondents said that CIO transitions happen when there is general dissatisfaction among business stakeholders with the support CIOs provide. Not surprisingly, 72 percent of those surveyed suggested that a CIO's failure to adapt to a significant change in corporate strategy may also lead to his transition out of the company.[1]

For years, IT has faithfully helped reengineer the business, yet few shops have reengineered themselves with the same vision, discipline, and rigor. That's about to change: Over the next 18 to 24 months, we will likely see CIOs begin reengineering not only their IT shops but, more broadly, their approaches to technology. The goal of these efforts will be to transform their technology ecosystems from collections of working parts into high-performance engines that deliver speed, impact, and value.

Reengineering approaches may vary, but expect to see many CIOs deploy a two-pronged strategy. From the bottom up, they can focus on creating an IT environment in which infrastructure is scalable and dynamic and architecture is open and extendable. Importantly, automation (driven by machine learning) will likely be pervasive, which can accelerate the processes of standing up, building on top of, and running the IT stack. These principles are baked into infrastructure and applications, thus becoming elemental to all aspects of the operation. From the top down, CIOs and their teams have an opportunity to transform how the shop budgets, organises, staffs, and delivers services.

Figure 1. Two-pronged reengineering technology approach

Top-down capabilities are amplified by a revamped bottom-up architecture, and bottom-up efficiency gains become more strategic and impactful when coupled with top-down transformation.



Source: Deloitte analysis.

The *reengineering technology* trend is not an exercise in retooling. Rather, it is about challenging every assumption, designing for better outcomes, and, ultimately, creating an alternate IT delivery model for the future.

Enough with the tasks, already

In their best-selling book *Reengineering the Corporation*, Michael Hammer and James Champy defined business processes as an entire group of activities that when effectively brought together, create a result customers value. They went on to argue that by focusing on processes rather than on individual tasks—which, by themselves, accomplish nothing for the customer—companies can achieve desired outcomes more efficiently. "The difference between process and task is the difference between whole and part, between ends and means," Hammer and Champy wrote.[2]

Today, many IT organisations take the opposite approach. As IT scaled continuously over the last three decades, it became excruciatingly task-focused, not just in applications and infrastructure but in networks, storage, and administration. Today, IT talent with highly specialised skillsets may work almost exclusively within a single functional area. Because they share few common tools with their highly specialised counterparts in other functional areas, low-bandwidth/high-latency human interfaces proliferate among network engineers, system administrators, and security analysts.

Until recently, efforts to transform IT typically focused on adopting new technologies, outsourcing, or offshoring. Few emphasised the kind of systematic, process-focused reengineering that Hammer and Champy advocated. Meanwhile, consumerisation of technology, the public's enduring fascination with young technology companies, and the participation of some IT functions in greenfield projects have put pressure on CIOs to reengineer. Yet, approaches that work well for start-ups and new company spinoffs might be unrealistic for larger companies or agencies. These organisations can tackle reengineering challenges by broadening the frame to include open source, niche platforms, libraries, languages and tools, and by creating the flexibility needed to scale.

Reengineering from the bottom up

One dimension of reengineering focuses on modernising underlying infrastructure and architecture. To jump-start bottom-up initiatives, forward-thinking companies can focus their planning on three major areas of opportunity:

- **Automation:** Automation is often *the* primary goal of companies' reengineering efforts. There are automation opportunities throughout the IT life cycle. These include, among others, automated provisioning, testing, building, deployment, and operation of applications as well as large-scale autonomic platforms that are self-monitoring, self-learning, and self-healing. Almost all traditional IT operations can be candidates for automation, including anything that is workflow-driven, repetitive, or policy-based and requires reconciliation between systems. Approaches have different names: robotic process automation, cognitive automation, intelligent automation, and even cognitive agents. However, their underlying stories are similar: applying new technologies to automate tasks and help workers handle increasingly complex workloads.[3]

  As part of their automation efforts, some companies are deploying *autonomic platforms* that layer in the ability to dynamically manage resources while integrating and orchestrating more of the end-to-end activities required to build and run IT solutions. When discussing the concept of autonomics, we are really talking about automation + robotics, or taking automation to the next level by basing it in machine learning. Autonomic platforms build upon two important trends in IT: software-defined everything's climb up the tech stack, and the overhaul of IT operating and delivery models under the DevOps movement. With more of IT becoming

expressible as code—from underlying infrastructure to IT department tasks—organisations now have a chance to apply new architecture patterns and disciplines. In doing so, they can remove dependencies between business outcomes and underlying solutions, and redeploy IT talent from rote low-value work to the higher-order capabilities. Organisations also have an opportunity to improve productivity. As one oft-repeated adage reminds us, "The efficiency of an IT process is inversely correlated to the number of unique humans it takes to accomplish it."

Another opportunity lies in self-service automation, an important concept popularised by some cloud vendors. Through a web-based portal, users can access IT resources from a catalog of standardised service options. The automated system controls the provisioning process and enforces role-based access, approvals, and policy-based controls. This can help mitigate risk and accelerate the marshaling of resources.

- **Technical debt:** Technical debt doesn't happen just because of poor code quality or shoddy design. Often it's the result of decisions made over time—actions individually justified by their immediate ROI or the needs of a project. Organisations that regularly repay technical debt by consolidating and revising software as needed will likely be better positioned to support investments in innovation. Companies can also accrue technical debt in physical infrastructure and applications, and maintaining legacy systems carries certain costs over an extended period of time. Re-platforming apps (via bare metal or cloud) can help offset these costs and accelerate speed-to-market and speed-to-service.

  As with financial debt, organisations that don't "pay it back" may end up allocating the bulk of their budgets to interest (that is, system maintenance), leaving little for new opportunities. Consider taking the following two-step approach to addressing technical debt:

  - **Quantify it:** Reversal starts with visibility—a baseline of lurking quality and architectural issues. Develop simple, compelling ways that describe the potential impact of the issues in order to foster understanding by those who determine IT spending. Your IT organisation should apply a technical debt metric not only to planning and portfolio management but to project delivery as well.
  - **Manage it:** Determine what tools and systems you will need over the next year or two to achieve your strategic goals. This can help you to identify the parts of your portfolio to address. Also, when it comes to each of your platforms, don't be afraid to jettison certain parts. Your goal should be to reduce technical debt, not just monitor it.
- **Modernised infrastructure:** There is a flexible architecture model whose demonstrated efficiency and effectiveness in start-up IT environments suggest that its broader adoption in the marketplace may be *inevitable*. In this cloud-first model—and in the leading practices emerging around it—platforms are virtualised, containerised, and treated like malleable, reusable resources, with workloads remaining independent from the operating environment. Systems are loosely coupled and embedded with policies, controls, and automation. Likewise, on-premises, private cloud, or public cloud capabilities can be employed dynamically to deliver any given workload at an effective price and performance point. Taken together, these elements can make it possible to move broadly from managing instances to managing outcomes.

  It's not difficult to recognise a causal relationship between architectural agility and any number of potential strategic and operational benefits. For example, inevitable architecture provides the foundation needed to support rapid development and deployment of flexible solutions that, in turn, enable innovation and growth. In a competitive landscape being redrawn continuously by technology disruption, time-to-market can be a competitive differentiator.[4]

Reengineering from the top down

Though CIOs' influence and prestige have grown markedly over the last decade, the primary source of their credibility continues to lie in maintaining efficient, reliable IT operations. This is, by any measure, a full-time job. Yet along with that responsibility, they are expected to harness emerging technology forces. They stay ahead of the technology curve by absorbing the changes that leading-edge tools introduce to operational, organisational, and talent models. Finally, an ever-growing cadre of enterprise leaders with "C" in their titles—think chief digital officer, chief data officer, or chief algorithm officer—demand that CIOs and their teams provide: 1) new products and services to drive revenue growth, 2) new ways to acquire and develop talent, and 3) a means to vet and prototype what the company wants to be in the future.

As growing numbers of overextended CIOs are realising, the traditional operating model that IT has used to execute its mission is no longer up to the job. Technological advances are creating entirely new ways of getting work done that are, in some cases, upending how we think about people and machines complementing one another. Moreover, the idea that within an organisation there are special types of people who understand technology and others who understand business is no longer valid. Technology now lies at the core of the business, which is driving enterprise talent from all operational areas to develop tech fluency.[5]

The time has come to build a new operating model. As you explore opportunities to reengineer your IT shop from the top down, consider the following areas of opportunity:

- **Reorganising teams and breaking down silos:** In many IT organisations, workers are organised in siloes by function or skillset. For example, network engineering is distinct from QA, which is different from system administration. In this all-too-familiar construct, each skill group contributes its own expertise to different project phases. This can result in projects becoming rigidly sequential and trapped in one speed (slow). It also encourages "over the wall" engineering, a situation in which team members work locally on immediate tasks without knowing about downstream tasks, teams, or the ultimate objectives of the initiative.

  Transforming this model begins by breaking down skillset silos and reorganising IT workers into multi-skill, results-oriented teams. These teams focus not on a specific development step—say, early-stage design or requirements—but more holistically on delivering desired outcomes. A next step might focus on erasing the boundaries between macro IT domains such as applications and infrastructure. Ask yourself: Are there opportunities to share resources and talent? For new capabilities, can you create greenfield teams that allow talent to rotate in or out as needed? Can some teams have budgets that are committed rather than flexible? The same goes for the siloes within infrastructure: storage, networks, system administration, and security. What skillsets and processes can be shared across these teams?[6]

  A final note on delivery models: Much of the hype surrounding Agile and DevOps is merited. Reorganising teams will likely be wasted effort if they aren't allowed to develop and deliver products in a more effective way. If you are currently testing the Agile-DevOps waters, it's time to wade in. Be like the explorer who burned his boat so that he couldn't return to his familiar life.
- **Budgeting for the big picture:** As functional silos disappear, the demarcation line between applications and infrastructure fades, and processes replace tasks, IT shops may have a prime opportunity to liberate their budgets. Many older IT shops have a time-honored budget planning process that goes something like this: Business leaders make a list of "wants" and categorise them by priority and cost. These projects typically absorb most of IT's discretionary budget, with care and maintenance claiming the rest. This basic budget blueprint will be good for a year, until the planning process begins again.

We are beginning to see a new budgeting model emerge in which project goals reorient toward achieving a desired outcome. For example, if "customer experience" becomes an area of focus, IT could allocate funds to e-commerce or mobile products or capabilities. Specific features remain undetermined, which gives strategists and developers more leeway to focus effort and budgetary resources on potentially valuable opportunities that support major strategic goals. Standing funding for rolling priorities offers greater flexibility and responsiveness. It also aligns technology spend with measurable, attributable outcomes.

When revising your budgeting priorities, keep in mind that some capital expenses will become operating expenses as you move to the cloud. Also, keep an eye out for opportunities to replace longstanding procurement policies with outcome-based partner and vendor arrangements or vehicles for co-investment.

- **Managing your portfolio while embracing ambiguity:** As IT budgets focus less on specifics and more on broad goals, it may become harder to calculate the internal rate of return (IRR) and return on investment (ROI) of initiatives. Consider a cloud migration. During planning, CIOs can calculate project costs and net savings; moreover, they can be held accountable for these calculations. But if an initiative involves deploying sensors throughout a factory to provide greater operational visibility, things may get tricky: There may be good outcomes, but it's difficult to project with any accuracy what they might be. Increasingly, CIOs are becoming more deliberate about the way they structure and manage their project portfolios by deploying a 70/20/10 allocation: Seventy percent of projects focus on core systems, 20 percent focus on adjacencies (such as the "live factory" example above), and 10 percent focus on emerging or unproven technologies that may or may not deliver value in the short term. Projects at the core typically offer greater surety of desired outcomes. But the further projects get away from the core, the less concrete their returns become. As CIOs move into more fluid budgeting cycles, they should recognise this ambiguity and embrace it. Effectively balancing surety with ambiguity can help them earn the right over time to explore uncertain opportunities and take more risks.
- **Guiding and inspiring:** IT has a unique opportunity—and responsibility—to provide the "bigger picture" as business leaders and strategists prioritise their technology wish lists. For example, are proposed initiatives trying to solve the right problem? Are technology-driven goals attainable, given the realities of the organisation's IT ecosystem? Importantly, can proposals address larger operational and strategic goals? IT can play two roles in the planning process. One is that of shaman who inspires others with the possibilities ahead. The other role is that of the sherpa, who guides explorers to their desired destination using only the tools currently available.

Skeptic's corner

The term "reengineer" may give some CIOs pause. The idea of challenging assumptions and transforming systems may seem like an open invitation to dysfunction, especially as the operational realities of the existing enterprise remain. In the paragraphs that follow, we will try to correct several misconceptions that skeptical CIOs may harbor about the growing reengineering technology trend.

Misconception: Technology will always be complex and require architects and engineers to decipher it for the business.

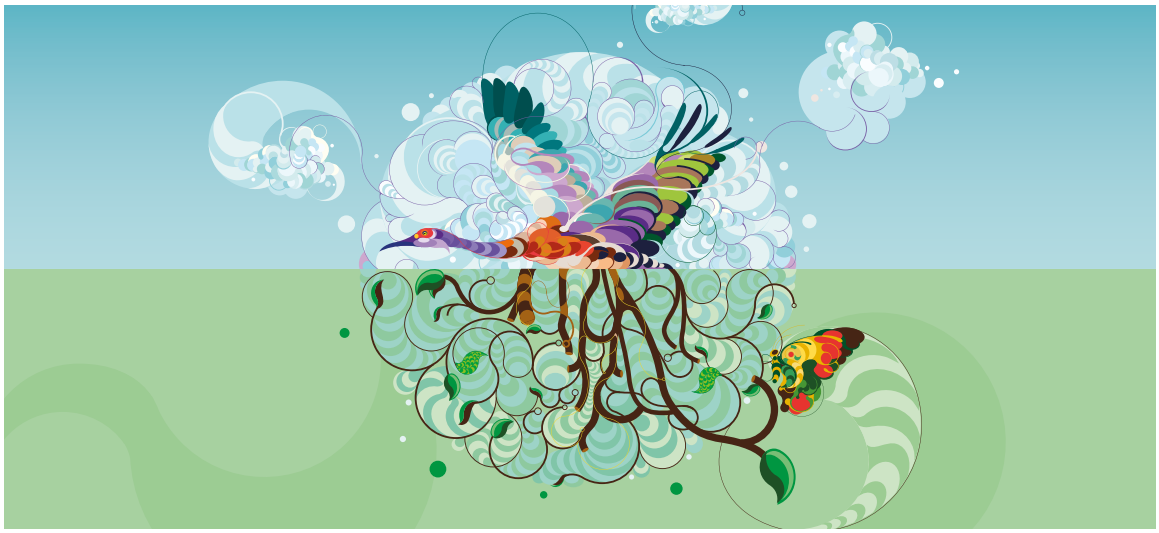
Reality: When they are new, technologies often seem opaque, as do the possibilities they offer the enterprise. But as we have seen time and again, yesterday's disruptive enigma quickly evolves into another entry in the tech fluency canon. Consider artificial intelligence, for example. In the beginning, it was the near-exclusive domain of the computer-savvy. Today, kids, their grandparents, and your board members use AI daily in the computer vision that dynamically focuses their smartphone cameras, and in the natural language processing engine powering their virtual personal assistants. Consistently, early adopters have a way of bringing the less technologically dexterous with them on the path to broad adoption.

Misconception: By distributing tech across the business, you lose efficiency that goes with having a centralised enterprise architecture.

Reality: We understand your point, but in fact, the process of reengineering technology can make federated architecture a viable alternative, in terms of efficiency, to traditional centralised models. For example, architectural standards and best practices for security, monitoring, and maintenance can be embedded in the policies and templates of software-defined infrastructure. When a new environment is provisioned, the architecture is built into the stack, becoming automatic and invisible. Instead of enterprise architecture being a religious argument requiring the goodwill of developers, it becomes codified in the fabric of your technology solutions. Rather than playing the thankless role of ivory-tower academic or evangelist (hoping-wishing-praying for converts), architects can focus on evolving platforms and tooling.

Misconception: Breaking down organisational silos sounds like a recipe for organisational chaos. IT functions and teams are delineated for a reason.

Reality: The issue of organisational siloes boils down to one question: Should IT remain a collection of function-specific fiefdoms, or should you organise it around processes and outcomes? By focusing on and organising around outcomes, you are not introducing disorder—you are simply reordering the IT organisation so that it can partner more effectively with the business, and maximise the value it brings to the enterprise. This is particularly true with bottom-up investments focusing on standardising platforms, automation, and delivery.



Sysco's secret sauce

Sysco, a leading food marketing and distribution company, took a bold stance to reevaluate a technology transformation initiative that was well under way. Twelve of Sysco's 72 domestic operating companies had gone live with a new ERP solution meant to standardise processes, improve operations, and protect against outdated legacy systems with looming talent shortages. The problem: Those businesses that were up and running on the new ERP solution were seeing no significant operating advantages. Worse: Even as Sysco was outspending its industry peers in technology, competitors were focusing their investments on new digital capabilities that facilitated and simplified the customer experience. Sysco's sizable back-office implementation, on the other hand, was perceived as an obstacle by customers doing business with the company.

Sysco's IT leadership considered an alternate approach. They reevaluated those same legacy systems with an eye on modernising and amplifying the intellectual property and "secret sauce" embedded in decades of customised order management, inventory management, and warehouse management solutions. At the same time, they recognised the need to fundamentally transform the IT department, shifting from an org that had evolved to support large-scale packaged software configuration to one that could move with more agility to engineer new capabilities and offerings—especially customer-facing solutions.

IT leadership needed the corporate management team's buy-in to pivot strategies and alter its current trajectory, into which they had sunk significant time, resources, and dollars. From an architecture perspective, many of the technologies central to the new approach—cloud, application modernisation platforms, microservices, and autonomics—didn't exist or were not mature when the original ERP strategy was formed. Explaining how technology, tools, and methodologies had advanced over the past several years, the IT team made the case to the executive leadership team to modernise the core with these tested technologies, which would position Sysco for the future more effectively and with greater flexibility, while costing far less than it would if they continued to roll out the ERP solution to the other operating companies.

"Our legacy systems are customised specifically for what we do," says Wayne Shurts, executive vice president and chief technology officer at Sysco. "The systems are old, but they work great. Operating companies were so happy to be back on familiar ground, even while we were modernising the underlying technology—the hardware they run on,

the language they are built on, the way we manage them."[7]

To achieve these results, Shurts also convinced company leadership to completely reorganise IT operations: He wanted software product, platform, and service teams working in an Agile framework embracing DevOps rather than the traditional waterfall processes that were characteristic of Sysco's IT organisation.

"First came the why, then came the how. We are changing everything about the way we work," Shurts says. "We are changing the technology and methodologies that we use, which requires new tools and processes. Ultimately, it means we change how we are organised." With more than half of the IT organisation having made the shift, teams are embracing new tools, techniques, and methods. Each individual team can stand up a fully functioning new application organised around the team's product and customer experiences, owning a mandate to not just continually innovate but own both feature/function development and ongoing operational support. Plans are in place to transform the rest of IT in the year ahead.

In addition to reorganising the internal IT team, Shurts brought in experienced third-party architects, engineers, and developers to build Sysco's microservices' capabilities and help codify the new Agile behavior. His team worked side by side with surgically placed experts, with the goal of "creating our own disciples so we could be self-sufficient." So began a systemic effort to retool and rewire Sysco IT in order to broaden the organisation's skillset, balanced with teams of veteran employees familiar with the company's legacy systems.

Shurts continues to evolve the IT processes to meet his team's goal of delivering new releases daily—to bring new ideas, innovation, and help to customers every day. "Our competition and our customers expect to see things they've never seen before in heavy doses. If you believe that the pace of change in the world today will only accelerate, then you need to move to not only a new method but a new mind-set. My advice to other CIOs? Every shop needs to go down this path—from the top down, and the bottom up."

Vodafone Germany develops great customer experiences

Vodafone Germany is one of the country's leading telecom operators, offering mobile, broadband, TV, and enterprise services. In order to support its business needs and better integrate its markets, the company launched a multi-year program to modernise its infrastructure and ready its IT stack for digital. The initiative also required implementing new work processes and retraining workers to better support end-to-end customer experiences—reengineering IT to respond to the future of technology.

The first step was virtualising the infrastructure enabling local market legacy systems. Vodafone Germany migrated from its own data centers to a cloud-dominant model, modernising IT operations according to the evolved architecture, tools, and potential for automation. The reengineered stack drove down costs while improving resiliency; it made disaster recovery easier, facilitated scaling up to capacity, and gave Vodafone Germany the agility to position IT activities for transformation—not just net-new digital initiatives but areas requiring deep integration to the legacy core.

The organisation did face challenges in the migration, which included some legacy systems that didn't fit in a virtualised infrastructure. Those systems would have required significant development costs to prepare them for migration. So, Vodafone Germany coupled the infrastructure effort with a broader modernisation mission—changing legacy core applications so that they could serve as the foundation for new products, experiences, and customer engagement, or decommissioning end-of-life legacy systems. As they did so, Vodafone Germany built a new definition of their core and pushed their IT operating model to undergo a similar transformation.

"Most IT organisations are cautious about replacing legacy systems due to the risks and business disruption, but we saw it as a way to accelerate the migration," says Vodafone Germany chief technology officer Eric Kuisch. "Aging systems presented roadblocks that made it difficult or impossible to meet even four-to-six-month timeframes for new features. Our goal was to deliver initiatives in weeks or a couple of months. We believed that modernisation of technology capabilities could improve time to market while lowering cost of ownership for IT."[8]

The next step in Vodafone Germany's modernisation is an IT transformation for which it will invest in network virtualisation, advanced levels of automation, and making the entire IT stack digital-ready.

To accomplish so much so fast, Kuisch's team chose a multi-modal IT model, incorporating both Agile and waterfall methodologies. They used an Agile framework for the front-end customer touchpoints and online experience, while implementing the back-end systems' legacy migration with the more traditional waterfall methodology. The company undertook a massive insourcing initiative, putting resources into training its own IT team to create business architects to manage end-to-end service-level agreements for a service rather than for individual systems.

Vodafone Germany's transformation will enable the company to provide end-to-end customer experiences that were not possible with its legacy systems. The results so far have been increased efficiency and significant cost savings. The infrastructure virtualisation alone realised a 30–40 percent efficiency. The potential around improvements to digital experience, new feature time to market, and even new revenue streams are tougher to quantify but likely even more profound.

Beachbody's digital reengineering workout

Since 1998, Beachbody, a provider of fitness, nutrition, and weight-loss programmes, has offered customers a wide variety of instructional videos, first in VHS and then in DVD format. The company's business model—the way it priced, packaged, and transacted—was to a large extent built around DVD sales.

Roughly three years ago, Beachbody's leadership team recognised that people were rapidly changing the way they consumed video programming. Digital distribution technology can serve up a much bigger catalog of choices than DVDs and makes it possible for users to stream their selections directly to mobile devices, TVs, and PCs. As a result of the new technology and changes in consumer behaviour, Beachbody subsequently decided to create an on-demand model supported by a digital platform.

From an architectural standpoint, Beachbody built the on-demand platform in the public cloud. And once the cloud-specific tool sets and team skills were in place, other teams began developing business products that also leverage the public cloud.

Beachbody has developed its automation capabilities during the last few years, thanks in part to tools and services available through the public cloud. For example, teams in Beachbody's data centre automated several workload and provisioning tasks that, when performed manually, required the involvement of five or more people. As Beachbody's data centre teams transitioned to the cloud, their roles became more like software engineers than system administrators.

To create the on-demand model, Beachbody established a separate development team that focused exclusively on the digital platform. When the time came to integrate this team back into the IT organisation, they reorganised IT's operations to support the new business model. IT reoriented teams around three focal areas to provide customers a consistent view across all channels: the front end, delivering user experiences; the middle, focusing on API and governance; and the back end, focusing on enterprise systems.[9]

My take

Michael Dell, chairman and CEO

DELL TECHNOLOGIES

Digital transformation is not about IT—even though technology often is both the driver and the enabler for dramatic change. It is a boardroom conversation, an event driven by a CEO and a line-of-business executive: How do you fundamentally reimagine your business? How do you embed sensors, connectivity, and intelligence in products? How do you reshape customer engagement and outcomes? The wealth of data mined from the increasing number of sensors and connector nodes, advanced computing power, and improvements in connectivity, along with rapid advances in machine intelligence and neural networks, are motivating companies to truly transform. It's an overarching priority for a company to quickly evolve into a forward-thinking enterprise.

Digital is a massive opportunity, to be sure, and most likely to be top of the executive team's agenda. But there are three other areas in which we're seeing significant investment, either as stand-alone initiatives or as components of a broader digital transformation journey. We took a look at each of these to determine how we could best assist our customers in meeting their goals.

Close to our heritage is helping IT itself transform to dramatically improve how organisations harness technology and deliver value. Companies want to use software-defined everything, to automate platforms, and to extrapolate infrastructure to code. It is not atypical these days for a company to have thousands of developers and thousands of applications but only a handful of infrastructure or operations resources. Of course, they still need physical infrastructure, but they are automating the management, optimisation, and updating of that infrastructure with software. Our customers want to put their money into changing things rather than simply running them; they want to reengineer their IT stacks and organisations to be optimised for speed and results. In doing so, IT is being seen as BT—"business technology," with priorities directly aligned to customer impact and go-to-market outcomes. In doing so, IT moves from *chore to core*—at the heart of delivering the business strategy.

The changing nature of work is driving the next facet of transformation. Work is no longer a place but, rather, a thing you do. Companies are recognising they must provide the right tools to their employees to make them more productive. There has been a renaissance in people understanding that the PC and other client devices are important for productivity. For example, we are seeing a rise in popularity of thinner, lighter notebooks with bigger screens, providing people with tools to do great work wherever they are located. Companies are rethinking how work could and should get done, with more intuitive and engaging experiences, as business processes are rebuilt to harness the potential of machine learning, blockchain, the Internet of Things, digital reality, and cloud-native development.

Last but definitely not least, we are seeing an increased interest in securing networks against cyber-attacks and other threats. The nature of the threats is constantly changing, while attack surfaces are growing exponentially due to embedded intelligence and the increased number of sensors and expansions in nodes. Security must be woven into infrastructure and operations. Companies are bolstering their own security-operation services with augmented threat intelligence, and they are segmenting, virtualising, and automating their networks to protect their assets.

We realise we need to be willing to change as well, and our own transformation began with a relentless focus on fulfilling these customer needs. At a time when other companies were downsizing and streamlining, Dell went big. We acquired EMC, which included VMware, and along with other technology assets—Boomi, Pivotal, RSA, SecureWorks, and Virtustream—we became Dell Technologies. We created

a family of businesses to provide our customers with what they need to build a digital future for their own enterprise: approaches for hybrid cloud, software-defined data centres, converged infrastructure, platform-as-a-service, data analytics, mobility, and cybersecurity.

Like our customers, we are using these new capabilities internally to create better products, services and opportunities. Our own IT organisation is a test bed and proof-of-concept centre for the people, process, and technology evolution we need to digitally transform Dell and our customers for the future. In our application rationalisation and modernisation journey, we are architecting global common services such as flexible billing, global trade management, accounts receivable, and indirect taxation, to deliver more functionality faster without starting from scratch each time. By breaking some components out of our monolithic ERPs, we significantly improved our time to market. We implemented Agile and DevOps across all projects, which is helping tear down silos between IT and the business. And, our new application development follows a cloud native methodology with scale out microservices. From a people standpoint, we are also transforming the culture and how our teams work to foster creative thinking and drive faster product deployment.

If we don't figure it out, our competitors will. The good news: We now have a culture that encourages people to experiment and take risks. I've always believed that the IT strategy must emanate from the company's core strategy. This is especially important as IT is breaking out of IT, meaning that a company can't do anything—design a product, make a product, have a service, sell something, or manufacture something—without IT. Technology affects everything, not just for giant companies but for all companies today. The time is now to reengineer the critical *technology* discipline, and to create a foundation to compete in the brave new digital world.

As we modernise technology infrastructure and operations, it is critical to build in modernised risk management strategies from the start. Given that nearly every company is now a technology company at its core, managing cyber risk is not an "IT problem" but an enterprise-wide responsibility:

- Executives, often with the help of the CIO, should understand how entering a new market, opening a new sales channel, acquiring a new company, or partnering with a new vendor may increase attack surfaces and expose the organisation to new threats.
- CIOs should work with their cyber risk leaders to transform defensive capabilities and become more resilient.
- Risk professionals should get comfortable with new paradigms and be willing to trade methodical, waterfall-type approaches for context, speed, and agility.

Increasingly, government and regulators expect executives, particularly those in regulated industries, to understand the risks associated with their decisions—and to put in place the proper governance to mitigate those risks during execution and ongoing operations.

Historically, cyber risk has fallen under the purview of the information or network security team. They shored up firewalls and network routers, seeking to protect internal data and systems from external threats. Today, this approach to cybersecurity may be ineffective or inadequate. In many cases, organisations have assets located outside their walls—in the cloud or behind third-party APIs—and endpoints accessing their networks and systems from around the globe. Additionally, as companies adopt IoT-based models, they may be expanding their ecosystems to literally millions of connected devices. Where we once thought about security at the perimeter, we now expand that thinking to consider managing cyber risk in a far more ubiquitous way.

From an architecture (bottom up) perspective, cloud adoption, software-defined networks, intensive analytics, tighter integration with customers, and digital transformation are driving IT decisions that expand the risk profile of the modern technology stack. However, those same advancements can be leveraged to transform and modernise cyber defense. For example, virtualisation, micro-segmentation, and "infrastructure as code" (automation) can enable deployment and teardown of environments in a far faster, more secure, more consistent, and agile fashion than ever before.

Additionally, as part of a top-down reengineering of technology operating and delivery models, risk and cybersecurity evaluation and planning should be the entire organisation's responsibility. Development, operations, information security, and the business should be in lockstep from the beginning of the project life cycle so that everyone collectively understands the exposures, trade-offs, and impact of their decisions.

To manage risk proactively in a modernised infrastructure environment, build in security from the start:

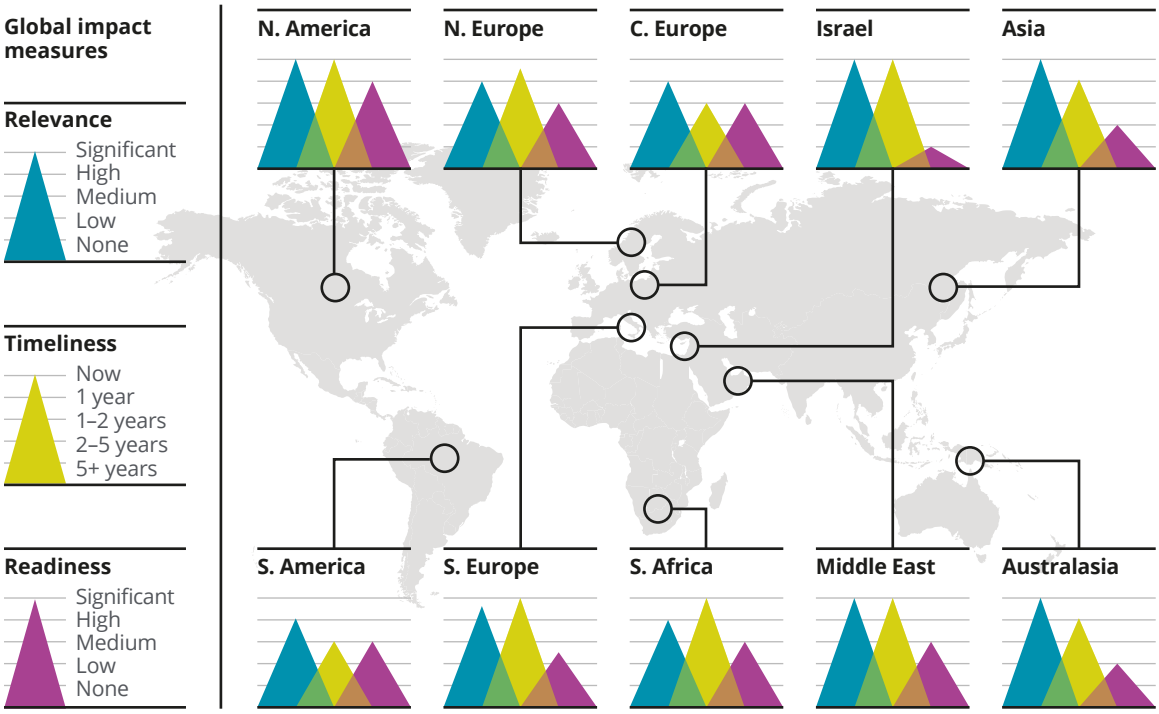
- **Be realistic.** From a risk perspective, acknowledge that some things are outside of your control and that your traditional risk management strategy may need to evolve. Understand the broader landscape of risks, your priority use cases, and revisit your risk tolerance while considering automation, speed, and agility.
- **Adapt your capabilities to address increased risk.** This could mean investing in new tools, revising or implementing technology management processes, and standing up new services, as well as hiring additional talent.
- **Take advantage of enhanced security capabilities enabled by a modern infrastructure.** The same changes that can help IT become faster, agile, and more efficient—automation and real-time testing, for example—can help make your systems and infrastructure more secure.
- **Build secure vendor and partner relationships.** Promote resilience across your supply chain, and develop an operating model to determine how they (and you) would address a breach in the ecosystem.

The *reengineering technology* trend is a global phenomenon. In a survey of Deloitte leaders across 10 global regions, respondents consistently find companies in their market looking for opportunities to enhance the speed and impact of technology investments. Several factors make the trend highly relevant across regions: increasing CIO influence, IT's desire to drive innovation agendas, and the scale and complexity of many existing IT portfolios and technology assets.

Expected timeframes for adoption vary around the globe. Survey respondents in all regions are seeing many companies express an active interest in adopting Agile or implementing DevOps, regardless of whether their investments in ITIL and IT service management are mature. In Asia Pacific and Latin America, this tension between desire and readiness may actually be impeding reengineering progress. In southern Europe, we are seeing some companies building digital teams that operate independently of existing processes and systems. North America is the only region where organisations across many industry sectors are taking on the kind of overarching top-down and bottom-up transformation this chapter describes, though there are some emerging discrete examples elsewhere—for example, in UK financial services and Asia high tech.

Finally, survey results indicate that company readiness to embrace the *reengineering technology* trend differ region to region. Regional economic downturns of the last few years and weakened currencies have compressed IT budgets in southern Europe and Latin America. Cultural dynamics and skillsets are also impacting trend readiness. For example, in northern Europe, factors range from potential delays due to hierarchical biases and a lack of executive mandates, to optimism and clear desire for change in companies where building and teaming leadership styles are the norm. Broadly, however, lack of expertise and landmark proof points are common obstacles to executing ambitious change.

Figure 2. Global impact



Source: Deloitte analysis.

Where do you start?

Reengineering IT shops from the top down and bottom up is no small order. Though a major goal of the reengineering trend is moving beyond incremental deployments and reacting to innovation and market demands, few companies likely have the resources to full-stop reengineer themselves in a single, comprehensive project. Before embarking on your journey, consider taking the following preliminary steps. Each can help you prepare for the transformation effort ahead, whether it be incremental or comprehensive.

- **Know thy organisation:** People react to change in different ways. Some embrace it enthusiastically; others resist it. The same can be said for organisations. Before committing to any specific reengineering strategy, take a clear-eyed look at the organisation you are looking to impact. Failure to understand its culture and workers can undermine your authority and make it difficult to lead the transformation effort ahead.

  Typically, IT organisations fall into one of three categories:

  - *"There is a will, but no way."* The organisation may operate within strict guidelines or may not react well to change; any shifts should be incremental.
  - *"If there is a will, there is a way."* People in these IT shops may be open to change, but actually getting them to learn new tools or approaches may take effort.
  - *"Change is the only constant."* These IT organisations embrace transformational change and respond well to fundamental shifts in the way that IT and the business operate.

  By understanding an organisation's culture, working style, and morale drivers, you can tailor your reengineering strategy to accommodate both technological and human considerations. This may mean offering training opportunities to help IT talent become more comfortable with new systems. Or, piloting greenfield development teams that feature rotational staffing to expose workers from across IT to new team models and technologies.
- **Know thyself:** Just as CIOs should understand their IT organisations, so should they understand their own strengths and weaknesses as leaders before attempting to reengineer a company's entire approach to technology. There are three leadership patterns that can add value in distinct ways:
  - *Trusted operator*. Delivers operational discipline within their organisations by focusing on cost, operational efficiency, and performance reliability. Also provides enabling technologies, supports business transformation efforts, and aligns to business strategy.
  - *Change instigator*. Takes the lead on technology-enabled business transformation and change initiatives. Allocates significant time to supporting business strategy and delivering emerging technologies.
  - *Co-creator*. Spends considerable time collaborating with the business, working as a partner in strategy and product development, and executing change across the organisation.

  Examining your own strengths and weakness as a technology leader is not an academic exercise. With explicit understanding of different leadership patterns and of your own capabilities, you can better set priorities, manage relationships, and juggle responsibilities. Moreover, this leadership framework may even inspire some constructive soul-searching into how you are spending your time, how you would like to spend your time, and how you can shift your focus to deliver more value to your organisations.
- **Change your *people* or *change* your people?** Most successful tech workers are successful in IT because they like change. Even so, many have gotten stuck in highly specialised niches, siloed functions, and groupthink. As part of any

reengineering initiative, these workers should change—or consider being changed out. Given reengineering's emphasis on automation, there should be plenty of opportunities for IT talent to upskill and thrive. Of course, it's possible there will be fewer IT jobs in the future, but more of the jobs that remain will likely be more satisfying ones—challenging, analytical, creative—that allow people to work with technologies that can deliver more impact than ever before.

Bottom line

In many companies, IT's traditional delivery models can no long keep up with the rapid-fire pace of technology innovation and the disruptive change it fuels. The *reengineering technology* trend offers CIOs and their teams a roadmap for fundamentally overhauling IT from the bottom up and the top down. Pursued in concert, these two approaches can help IT address the challenges of today and prepare for the realities of tomorrow.

CONTACTS

JOHN STARLING
Partner, Technology Consulting
Deloitte LLP
+44 20 7007 2389
jstarling@deloitte.co.uk

RICHARD FORREST
Director, Technology Consulting
Deloitte LLP
+44 20 7303 8547

AUTHORS

KEN CORLESS

Principal, Deloitte Consulting LLP

JACQUES DE VILLIERS

Managing Director, Deloitte Consulting LLP

CHRIS GARIBALDI

Principal, Deloitte Consulting LLP

Risk implications

KIERAN NORTON

Principal, Cyber Risk Services, Deloitte LLP

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No-collar workforce

Humans and machines in one loop—collaborating in roles and new talent models

As automation, cognitive technologies, and artificial intelligence gain traction, companies may need to reinvent worker roles, assigning some to humans, others to machines, and still others to a hybrid model in which technology augments human performance. Managing both humans and machines will present new challenges to the human resources organisation, including how to simultaneously retrain augmented workers and to pioneer new HR processes for managing virtual workers, cognitive agents, bots, and the other AI-driven capabilities comprising the "no-collar" workforce. By redesigning legacy practices, systems, and talent models around the tenets of autonomics, HR groups can begin transforming themselves into nimble, fast-moving, dynamic organisations better positioned to support the talent—both mechanised and human—of tomorrow.

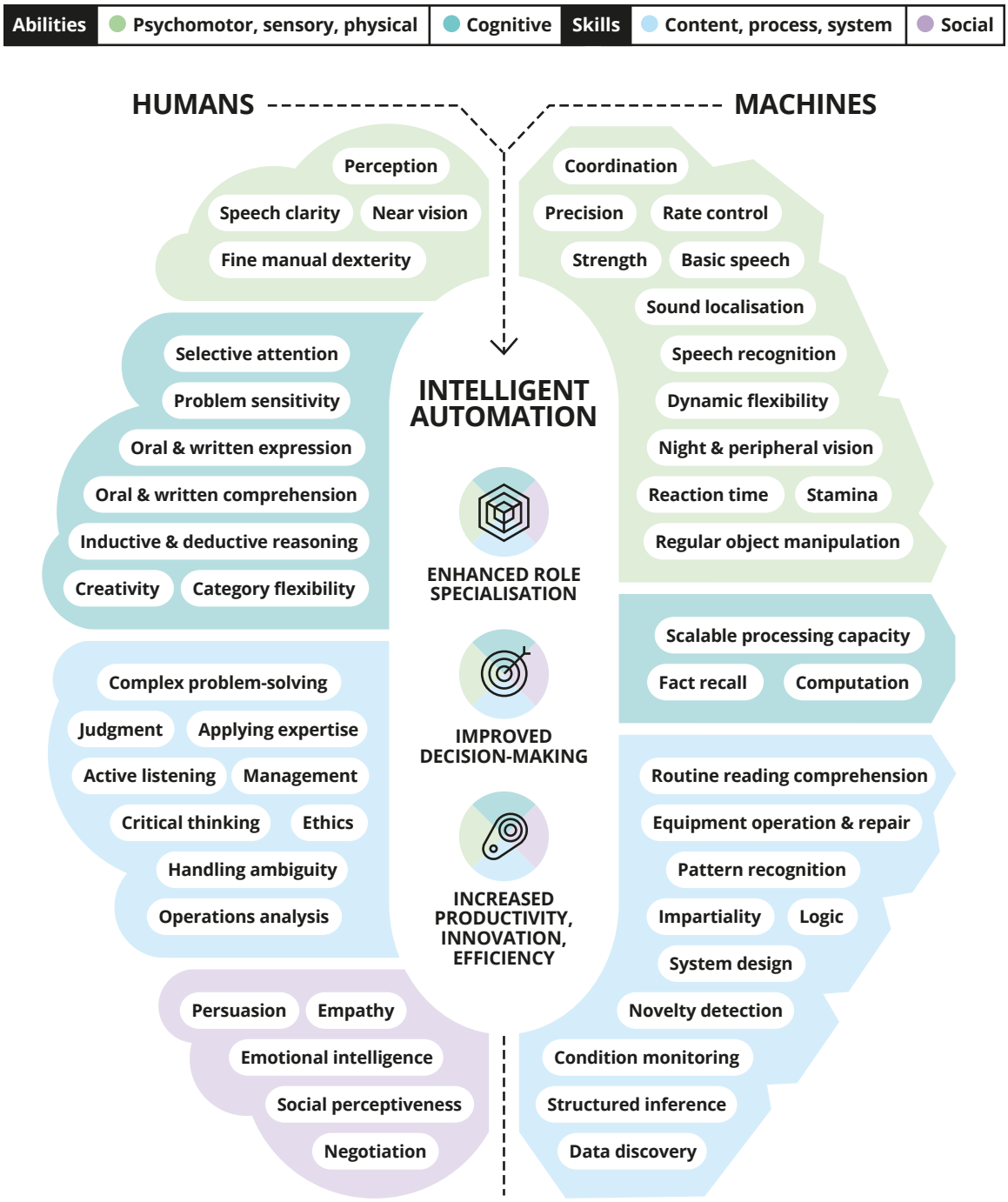
WITH intelligent automation marching steadily toward broader adoption, media coverage of this historic technology disruption is turning increasingly alarmist. "New study: Artificial intelligence is coming for your jobs, millennials,"[1] announced one business news outlet recently. "US workers face higher risk of being replaced by robots,"[2] declared another.

These dire headlines may deliver impressive click stats, but they don't consider a much more hopeful—and likely—scenario: In the near future, human workers and machines will work together seamlessly, each complementing the other's efforts in a single loop of productivity. And, in turn, HR organisations will begin developing new strategies and tools for recruiting, managing, and training a hybrid human-machine workforce.

Notwithstanding sky-is-falling predictions, robotics, cognitive, and artificial intelligence (AI) will probably not displace most human workers. Yes, these tools offer opportunities to automate some repetitive low-level tasks. Perhaps more importantly,

Figure 1. A new mind-set for the no-collar workforce

Humans and machines can develop a symbiotic relationship, each with specialised skills and abilities, in a unified workforce that delivers multifaceted benefits to the business.



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intelligent automation solutions may be able to a*ugment* human performance by automating certain parts of a task, thus freeing individuals to focus on more "human" aspects that require empathic problem-solving abilities, social skills, and emotional intelligence. For example, if retail banking transactions were automated, bank tellers would be able to spend more time interacting with and advising customers—and selling products.

Consider this: In a survey conducted for Deloitte's 2017 *Global Human Capital Trends* report, more than 10,000 HR and business leaders across 140 countries were asked about the potential impact of automation on the future of work. Only 20 percent said they would reduce the number of jobs at their companies. Most respondents (77 percent) said they will either retrain people to use new technology or will redesign jobs to better take advantage of human skills.[3] Recent Deloitte UK research suggests that despite inroads by digital and smart technologies in the workplace, essential "human" skills will remain important for the foreseeable future.[4]

The future that this research foresees has arrived. During the next 18 to 24 months, expect more companies to embrace the emerging *no-collar workforce* trend by redesigning jobs and reimagining how work gets done in a hybrid human-and-machine environment.

For HR organisations in particular, this trend raises a number of fundamental questions. For example, how can companies approach performance management when the workforce includes bots and virtual workers? What about onboarding or retiring non-human workers? These are not theoretical questions. One critical dimension of the no-collar workforce trend involves creating an HR equivalent to support mechanical members of the worker cohort.

Given how entrenched traditional work, career, and HR models are, reorganising and reskilling workers around automation will likely be challenging. It will require new ways of thinking about jobs, enterprise culture, technology, and, most importantly, people. Even with these challenges, the no-collar trend introduces opportunities that may be too promising to ignore. What if by augmenting a human's performance, you could raise his productivity on the same scale that we have driven productivity in technology?

As they explore intelligent automation's possibilities, many of those already embracing the no-collar trend no longer ask "what if." For these pioneering companies, the only question is, "How soon?"

Workers (and bots) of the world, unite!

According to the *2017 Global Human Capital Trends* report, 41 percent of executives surveyed said they have fully implemented or have made significant progress in adopting cognitive and AI technologies within their workforce. Another 34 percent of respondents have launched pilot programmes.

Yet in the midst of such progress, only 17 percent of respondents said they are ready to manage a workforce in which people, robots, and AI work side by side.[5]

At this early stage of the no-collar workforce trend, there is no shame in being counted among the 83 percent who don't have all the answers. Given the speed with which AI, cognitive, and robotics are evolving, today's clear-cut answers will likely have limited shelf lives. Indeed, this trend, unlike some others examined in *Tech Trends 2018*, is more like a promising journey of discovery than a clearly delineated sprint toward a finish line. Every company has unique needs and goals and thus will approach questions of reorganisation, talent, technology, and training differently. There are, however, several broad dimensions that will likely define any workforce transformation journey:

Culture. Chances are, your company culture is grounded in humans working in defined roles, performing specific tasks within established processes. These workers likely have fixed ideas about the nature of employment, their careers, and about technology's supporting role in the bigger operational

picture. But what will happen to this culture if you begin shifting some traditionally human roles and tasks to bots? Likewise, will workplace morale suffer as jobs get redesigned so that technology augments human performance? Finally, is it realistic to think that humans and technology can complement each other as equal partners in a unified seamless workforce? In the absence of hard answers to these and similar questions, workers and management alike often assume the worst, hence the raft of "AI Will Take Your Job" headlines.

The no-collar trend is not simply about deploying AI and bots. Rather, it is about creating new ways of working within a culture of human/machine collaboration. As you begin building this new culture, think of your hybrid talent base as the fulcrum that makes it possible for you to pivot toward the digital organisation of the future. Workers accustomed to providing standard responses within the constraints of rigid processes become liberated by mechanical "co-workers" that not only automate entire processes but augment human workers as they perform higher-level tasks. Work culture becomes one of augmentation, not automation. As they acclimate to this new work environment, humans may begin reflexively looking for opportunities to leverage automation for tasks they perform. Moreover, these human workers can be held accountable for improving the productivity of their mechanical co-workers. Finally, in this culture, management can begin recognising human workers for their creativity and social contributions rather than their throughput (since most throughput tasks will be automated).

Tech fluency. As companies transition from a traditional to an augmented workforce model, some may struggle to categorise and describe work in a way that connects it to AI, robotic process automation (RPA), and cognitive. Right now, we speak of these tools as technologies. But to understand how an augmented workforce can and should operate, we will need to speak of these technologies as *components of the work*. For example, we could map machine learning to problem solving; RPA might map to operations management.

But to categorise technologies as components of work, we must first understand what these technologies are, how they work, and how they can potentially add value as part of an augmented workforce. This is where tech fluency comes in. Being "fluent" in your company's technologies means understanding critical systems—their capabilities and adjacencies, their strategic and operational value, and the particular possibilities they enable.[6] In the context of workforce transformation, workers who possess an in-depth understanding of automation and the specific technologies that enable it will likely be able to view tech-driven transformation in its proper strategic context. They may also be able to adjust more readily to redesigned jobs and augmented processes.

Today, many professionals—and not just those working in IT—are dedicated to remaining tech fluent and staying on top of the latest innovations. However, companies planning to build an augmented workforce cannot assume that workers will be sufficiently fluent to adapt quickly to new technologies and roles. Developing innovative ways of learning and institutionalising training opportunities can help workers contribute substantively, creatively, and consistently to transformational efforts, no matter their roles. This may be particularly important for HR employees who will be designing jobs for augmented environments.

HR for humans and machines. Once you begin viewing machines as workforce talent,[7] you will likely need to answer the following questions about sourcing and integrating intelligent machines into your work environments:

- What work do we need to do that is hard to staff and hard to get done? What skills do we need to accomplish the work? How do we evaluate if a prospective hire's skills match the skills we are looking for?
- How do we onboard new members of the workforce and get them started on the right foot?
- How do we introduce the new "talent" to their colleagues?

- How do we provide new hires with the security access and software they need to do their jobs? How do we handle changes to access and audit requirements?
- How do we evaluate their performance? Likewise, how do we fire them if they are not right for the job?

These questions probably sound familiar. HR organisations around the world already use them to guide their recruiting and talent management processes for human workers.

As workforces evolve to include mechanical talent, HR and IT may have to develop entirely new approaches for managing these workers—and the real risk of automating bad or inaccurate processes. For example, machine learning tools might begin delivering inaccurate outcomes, or AI algorithms could start performing tasks that add no value. In these scenarios, HR will "manage" automated workers by designing governance and control capabilities into them.

Meanwhile, HR will continue its traditional role of recruiting, training, and managing human workers, though its approach may need to be tailored to address potential issues that could arise from augmentation. For example, augmented workers will likely need technology- and role-specific training in order to upskill, cross-train, and meet the evolving demands of augmented roles. Likewise, to accurately gauge their performance, HR—working with IT and various team leaders—may have to create new metrics that factor in the degree to which augmentation reorients an individual's role and affects her productivity.

Keep in mind that metrics and roles may need to evolve over time. The beauty and challenge of cognitive workers is they are constantly working and developing an ever more nuanced approach to tasks. In terms of productivity, this is tremendous. But in the context of augmentation, what happens to the human role when the augmenting technology evolves and grows? How will metrics accurately gauge human or machine performance when tasks and capabilities are no longer static? Likewise, how will they measure augmented performance (humans and machines working in concert to achieve individual tasks)?

Leading by example

Just as the no-collar trend may disrupt IT, finance, and customer service, so too could it disrupt HR organisations, their talent models, and the way they work. Some HR organisations are already playing leading roles in enterprise digital transformation. Likewise, many are developing new approaches for recruiting digital talent, and are deploying apps and a variety of digital tools to engage, train, and support employees. But in terms of process and tools, the opportunities that AI, cognitive, and robotics offer make HR's digitisation efforts to date seem quaint. In the near future, HR will likely begin redesigning its own processes around virtual agents, bots, and other tools that can answer questions, execute transactions, and provide training, among many other tasks traditionally performed by human workers.

What about using cognitive tools to manage mechanical workers? Another intriguing possibility in the no-collar workforce of the future.

Skeptic's corner

The word "automation" is a loaded term these days. To some, it inspires hopeful thoughts of turbocharged efficiency and bottom-line savings. To others, it conjures images of pink slips. With your indulgence, we would like to correct a few common misconceptions about this evocative word and the no-collar workforce trend with which it is associated.

Misconception: There's a long history of workers being replaced by automation. Isn't reducing labour costs the entire point of automating?

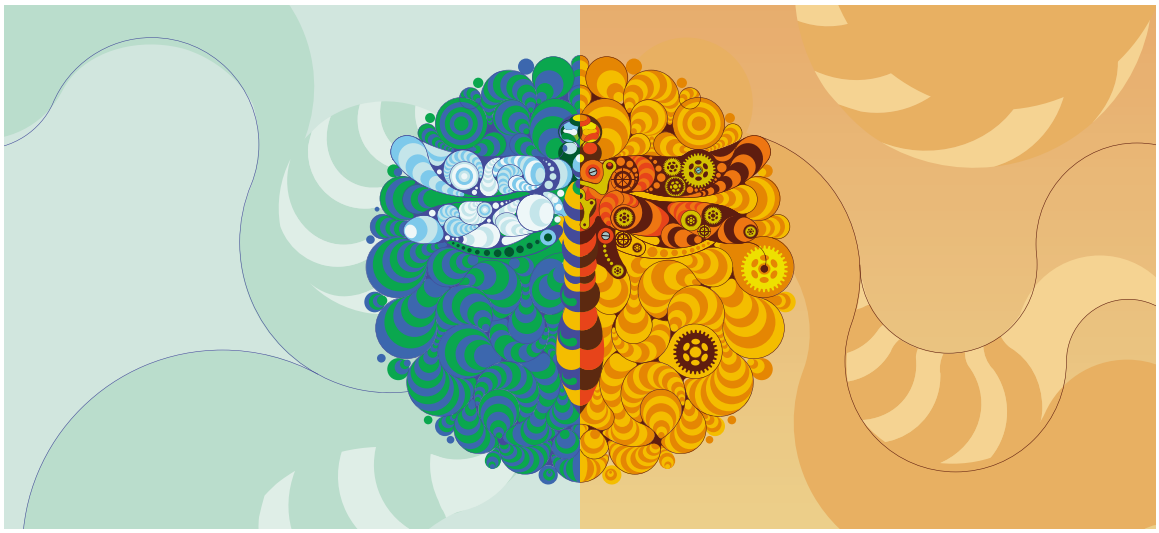
Reality: You are assuming that AI, cognitive technologies, and robots can do everything human workers can do, only more cheaply and quickly. Not true, by a long shot. At present, technology cannot duplicate many uniquely human workplace strengths such as empathy, persuasion, and verbal comprehension. As the no-collar trend picks up steam, companies will likely begin redesigning jobs around unique human capabilities, while looking for opportunities to augment these capabilities with technology.

Misconception: Robotics and cognitive technologies fall under IT's domain. What's HR got to do with this?

Reality: Yes, IT will play a lead role in the deployment and maintenance of these technologies. But in an augmented workforce, the traditional boundary between humans and machine disappears. The two types of workers work symbiotically to achieve desired goals. Integrating people and technology becomes an interdisciplinary task, with HR taking the lead in redesigning jobs and training the augmented workforce.

Misconception: I can understand why some workers should develop their tech fluency. But all workers? That seems like a waste of time and resources.

Reality: The strongest argument for all workers becoming more tech fluent—and for their employers to create learning environments to help them on this journey—is this: In the absence of a shared understanding of enterprise technologies and their possibilities, companies cannot nurture the collective imagination necessary to move toward a new strategic and operational future. Becoming conversant in technology can help workers of all backgrounds understand not only the realities of today but the possibilities of tomorrow.



NASA's space-age workforce

One of NASA's newest employees works at the Stennis Space Center. Fully credentialed, he operates out of Building 1111, has an email account, and handles mainly transactional administrative tasks. His name is George Washington, and he's a bot.

"Rather than viewing bots as a replacement for people, I see them as a way to simplify work," says Mark Glorioso, executive director of NASA Shared Services Center (NSSC). "We are building bots that will make our people more effective, so as we grow, we are able to do more without adding staff."

George is one of a small team of bots that NASA has developed to take on rote, repetitive bookkeeping and organisational tasks so human workers may focus on higher-level, strategic activities. Conceived two years ago as part of NSSC's drive to optimise budgetary resources, the "bots-as-a-service" programme started to take shape in May 2017 when George went to work. Soon, Thomas Jefferson and other bots joined him.

Glorioso's team chose to start small so they could measure the return on investment, as well as help ensure the bots would not inadvertently add to IT's workload. They identified opportunities to integrate bots by creating journey maps and breaking up processes into analytical pieces—looking for tasks that could be automated. George's responsibilities include cutting and pasting job candidates' suitability reports from emails and incorporating the information into applications for the HR team. The other bots' tasks include distributing funds for the CFO's office and automating purchase requests for the CIO's team. Tasks that took hours for a human to complete now take just minutes.

NASA has started to deploy bots throughout the agency. A decentralised approach allows the NSSC's 10 centres to decide how they want to reposition their staff members, then lets them build their own bots according to the tasks they choose to automate. Each centre runs its bots off a single bot community, so the initial investment is shared. Because each task may require robots with different skills, centres can choose software vendors that specialise in specific areas, such as finance. Glorioso's team ensures that all bots across the 10 centers meet NASA standards, then pushes them into production and manages them. This allows NSSC to scale the bots programme as needed. Rather than investing in infrastructure, the centre invests in one bot at a time.

The buy-in of the human workforce has been a priority for NSSC from the start. Glorioso's team demonstrated the bots for the business leads of the centre's major units, then let the leads present the technology to their own teams. They also instituted "Lunch and Learn" sessions to educate employees on

the benefits of bots and demonstrate how they work. Staff quickly embraced the bot programme as a way to automate repetitive, time-consuming tasks and actively suggested transactions that could be augmented with worker bots.

Although credentialed like human workers, the bots have performance reviews skewed to different metrics. For example, Glorioso's team is considering turning over password resets to the bots. A bot should be able to handle many more password resets than a human employee, so a higher level of turnaround will be expected of them. However, the quality of the user experience will be the ultimate test. If users find it difficult to communicate with the bots, the experiment won't be considered a success.

Glorioso says there will always be a need for humans on his team—their expertise is needed to approve budgetary requests, bring in new business, and assist the bots when there are unusual rules exceptions. As the programme grows, Glorioso sees potential job creation in the areas of bot-building and bot-performance management: "I'd like to think ultimately we will hire people who can 'bot-ify' their own transactions. For now, we build the bots and show everyone how they can help. We are giving them a reason to build their own bot."[8]

Exelon Utilities powers up the bots

Exelon provides power generation, energy sales, transmission, and delivery in 48 states, Washington, DC, and Canada. The company champions competition as a way to meet economic and environmental policy objectives, so driving efficiencies is key to achieving its overall mission. These efficiencies include optimising its workforce to fuel innovative thinking. After seeing success with its Strategic Supplier Programme—in which Exelon outsourced transactional work to free up IT employees for creative and analytical tasks—company leadership has begun exploring opportunities to augment its human workforce with bots.

"Innovation isn't a group in an ivory tower—innovation is everyone's job," says Mark Browning, Exelon Utilities VP of IT and chief information officer. "It's an expectation that we all innovate across the organisation to reinvent ourselves as a utility. The only way to get there is to let go of transactional work and migrate resources to value-added work that helps the business achieve even greater performance and higher levels of service for our customers."[9]

Exelon's CEO has charged leadership throughout the enterprise with exploring the potential of robotic process automation to drive efficiencies and cost savings. The organisation recently completed a multi-month assessment to identify areas of opportunity for deploying bots, and the IT organisation is facilitating an initiative to build out pilots. A number of departments—IT, finance, supply chain, human resources, legal, risk, and communications—are evaluating their processes to recommend possible use cases that could prove out the capabilities and benefits. With work time-sliced across several different individuals, a key part of the roadmap is not just identifying what tasks are ripe for automation but determining how to adjust job definitions, how employees are organised, and how to navigate through the cultural implications.

"We were able to outsource transactional IT work, reduce costs, and redeploy employees to higher-value work, and we believe we can do that again as we shift to a robotic model," Browning says. "We want

to use RPA to offer employees the opportunity to do more challenging, satisfying work that directly contributes to the organisation's success."

As Exelon builds a business case showing concrete return on investment, leaders are grappling with how the bots fit into its organisational structure. "It's not just a technology issue—this affects our people and our mission."

Browning sees a future in which RPA has matured within the organisation, enabling his team to build out capabilities that leverage Exelon's investments in big data, machine learning, next-generation ERP, the Internet of Things, and other technologies—intersecting to create a closed-loop cycle that could have an impact on business outcomes, he says. "We believe it's a core competency we want to own and mature. We need to do this right, because RPA is as much about technology challenges and as it is about change management and cultural shifts."

The Center for Cyber Safety and Education has predicted that there will be 1.8 million unfilled cybersecurity positions by 2022.[10] An augmented workforce—one in which automation can carry out rote tasks to free up human workers for higher-level activities—could help fill that demand. However, corporations should consider how this no-collar workforce could change the dynamic of their existing operations.

CULTURAL

This new way of working already is affecting how the workforce interacts and engages. It's not uncommon for employees to communicate with their teammates solely via email, social collaboration applications, or instant message, with unclear impacts on creative collaboration. This can be further complicated when teammates are bots, a development that could stymie knowledge sharing. For example, a cyber professional's job includes collaborating with peers to build knowledge of attack mechanisms and to develop creative solutions. When automation replaces those functions, there may be less opportunity for interactive collaboration, which could affect the team's effectiveness. However, with effective training of people and ongoing training and calibration of the machines, the two working together can help effectively execute a broader cyber strategy.

Additionally, teams augmented with robotic process automation could experience friction derived from the dynamic of mission-based humans versus rules-based bots. When humans perform a cybersecurity-related task, they can apply a sense of mission as well as judgment in executing their task, make exceptions when necessary, and change course quickly to react to immediate threats. But bots often possess limited situational awareness and may be unable to make decisions regarding exceptions. It is critical to automate tasks only after evaluating which functions may require a human's judgment and capacity for decision-making.

CYBER

Bots can help mitigate cyber risk by automating control activities to facilitate reliability, consistency, and effectiveness. RPA capabilities can enable cyber automation, such as processing vast threat intelligence sources.

But bots themselves could be targets in an attack, exposing sensitive employee and customer data that could damage a company's reputation. Protecting bot workers, IoT devices, applications, and networks—whether on-premises or in far-flung virtual offices—becomes paramount. Controls should be built in from the start, and then continuously monitored, tested, and adapted to new challenges as they emerge. Because this entails more than equipment decisions, comprising policy and personnel strategies as well, business and IT should work together closely to define cyber workplace guidelines to mitigate risk.

LEGAL AND REGULATORY

As we automate tasks and augment workers, new regulatory and compliance issues may emerge. Privacy issues, for example, could be a concern, particularly for global organisations subject to the European Union's General Data Protection Regulation. Workplace bots collecting and processing data through sensors, devices, cameras, and even microphones could inadvertently collect workers' personal data, which may violate privacy laws in some countries. Additionally, bots performing tasks in highly regulated industries, such as finance, could prove liabilities if a network outage or equipment failure results in a breakdown of automated oversight functions. Finally, labour laws could evolve around as-yet-unanticipated issues as human workers increasingly collaborate with their robot counterparts.

Despite this uncharted territory, the no-collar workforce can help enhance cybersecurity planning and response and could improve overall risk management. Automation of functions such as threat intelligence, security application monitoring, and privilege management may result in greater consistency, reliability, and coverage.

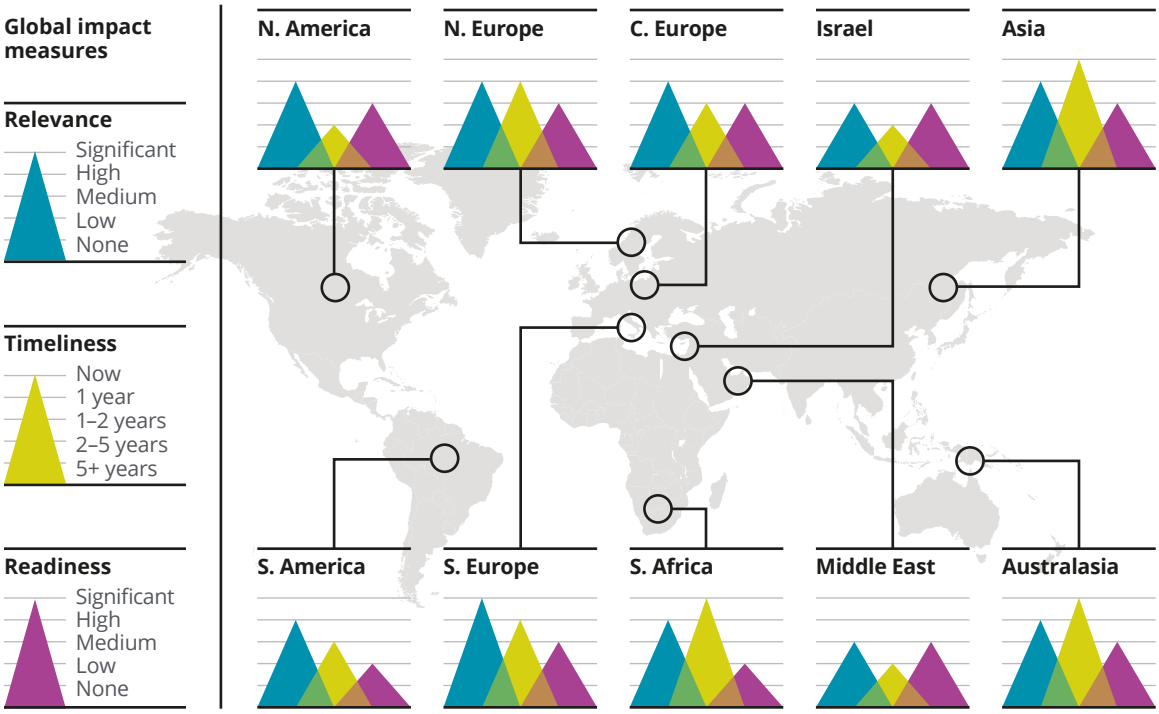
Robotic process automation is changing the way we work around the world. Findings from a survey of Deloitte leaders across 10 regions show that automation is affecting most regions, to some degree, across a variety of industries. Cognitive computing and artificial intelligence are not as widespread, but the no-collar workforce is a trend that global organisations likely will need to address if they want to stay competitive.

In Latin America, robotic process automation is of interest to mining and resource companies that require big data for critical decision-making. In Central Europe, robotics and cognitive automation will likely affect the large number of shared service centres and business process outsourcing providers located in the region. Likewise, the talent pool likely will shift from supporting simple processes to delivering solutions that require skills such as critical thinking. This is true for Northern Europe, as well, which expects new roles to emerge as global, around-the-clock, man-and-machine workforces develop; part of this change could involve a more prominent role for IT organisations. Australia's increasing prioritisation of customer and employee experiences, coupled with lower barriers to entry for cloud technologies, is fuelling the adoption of augmenting and enabling technologies.

In Africa, the no-collar workforce presents complex challenges within developing markets with high unemployment rates. Highly regulated labour environments could present obstacles, although the region's technology readiness and availability of cloud platforms could make it possible for organisations to gear up for this much-needed transformation.

Most respondents see RPA being widespread within a year or two, with artificial intelligence and cognitive computing taking a bit longer—from two to five years. All regions expect that some degree of upskilling will be necessary to make the shift.

Figure 2. Global impact



Source: Deloitte analysis.

Where do you start?

Building a no-collar workforce requires deliberate planning. Machines and humans can work well together if you anticipate the challenges and put in place the resources and governance to make all elements of the hybrid workforce successful. The following initial steps can provide a framework for deconstructing existing roles into underlying jobs, determining which are uniquely human and which can be redesigned for augmentation.

- **Assess your needs:** Is the no-collar trend a viable option for your company? To answer this question, identify all the areas in your organisation where mission-critical activities that do not contain uniquely human work elements occur. Are there opportunities to augment human performance in these areas? If so, are the opportunities compelling? In some companies, augmentation opportunities are potentially transformative; in others, not so much. Remember: Let needs, not technology, drive your strategy.
- **Understand how work currently gets done:** For each task within a given process, identify who is performing the task, the skills required to complete the task, and the technologies enabling not only this specific task but adjacent or dependent tasks within the larger process. This informational baseline will help you challenge your own assumptions about existing processes, and then explore different talent options and technologies that can be used in concert to improve overall process efficiency. It may also spark fresh ideas about the impact that automation will have on your organisational structure.
- **Categorise skills and tasks:** Define the difference between skills that only humans have, such as ethical or creative thinking, and nonessential tasks that machines can perform. Understanding that difference can eventually help you redesign jobs, identify opportunities for augmentation, and develop automation strategies.
- **Investigate tools and tactics:** What cognitive technologies and advanced robotics solutions are currently used in your industry? What new advances appear on the horizon? The speed of technological innovation is bringing disruptive tools online faster than ever. In this environment, IT, HR, and business leaders should stay up to speed on advances in intelligent automation, and try to identify how emerging capabilities and concepts could impact productivity and job design at their companies.
- **Easy does it or full steam ahead?** Different smart technologies require different approaches. Are you sufficiently ambitious to explore opportunities for "brute force" automation initiatives involving bots? Or does your ambition (and perhaps your budget) align more closely with less disruptive deployments of cognitive technologies or AI? Which approach better supports your organisation's overall mission and strategic priorities?

Bottom line

Advances in artificial intelligence, cognitive technologies, and robotics are upending time-honored assumptions about jobs, careers, the role of technology in the workplace, and the way work gets done. The no-collar trend offers companies the opportunity to reimagine an entirely new organisational model in which humans and machines become co-workers, complementing and enhancing the other's efforts in a unified digital workforce.

CONTACTS

SURESH KANWAR
Partner, Technology Consulting
Deloitte LLP
+44 20 7007 1775
skanwar@deloitte.co.uk

OLEG TYSCHENKO
Manager, Technology Consulting
Deloitte LLP
+44 20 7303 6891
otyschenko@deloitte.co.uk

AUTHORS

ANTHONY ABBATIELLO

Principal, Deloitte Consulting LLP

TIM BOEHM

Principal, Deloitte Consulting LLP

JEFF SCHWARTZ

Human Capital Principal, Deloitte Consulting LLP

Risk implications

SHARON CHAND

Principal, Cyber Risk Services, Deloitte LLP

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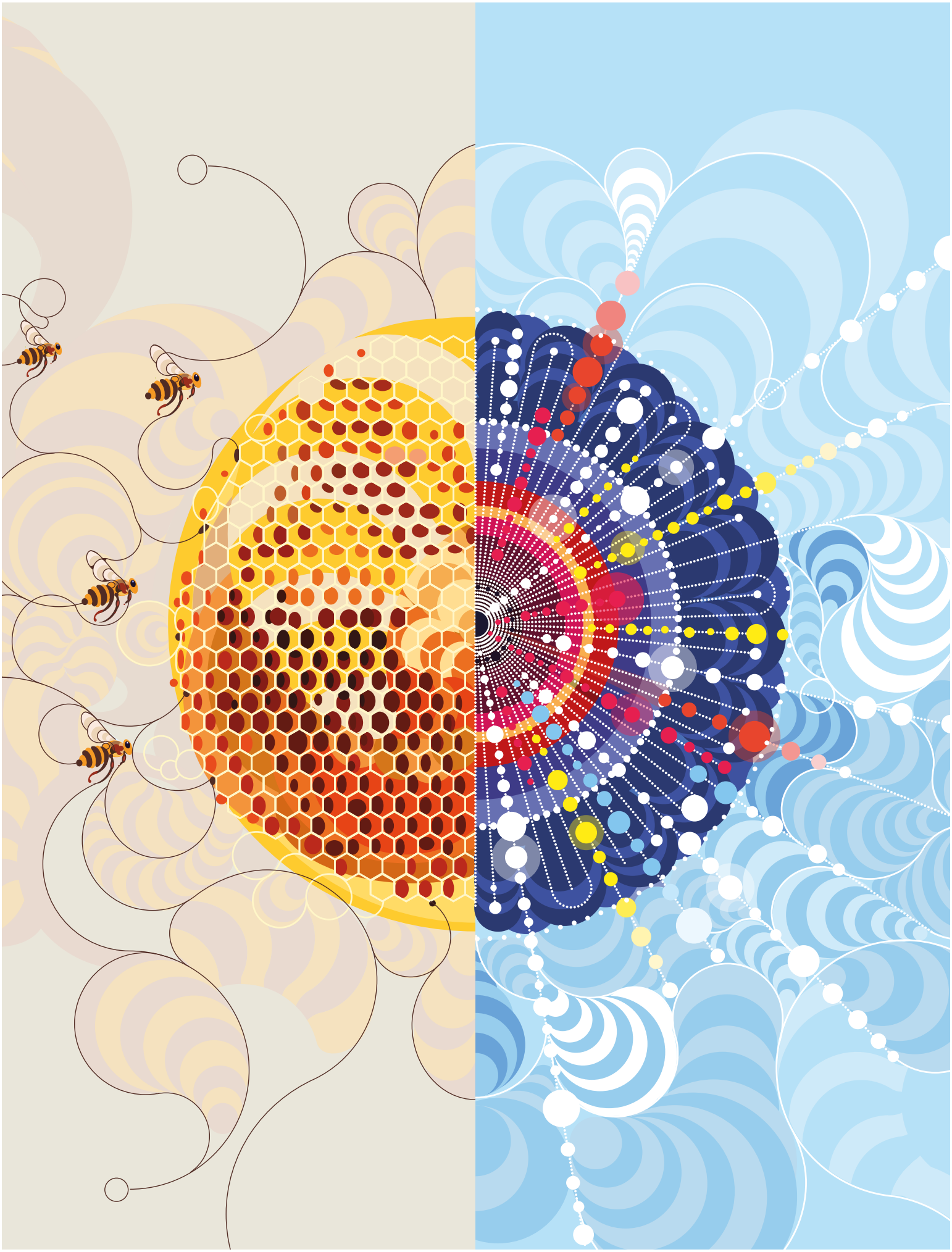


Enterprise data sovereignty

If you love your data, set it free

As every organisation recognises data as a key asset, there is an increasing demand to "free" it—to make information accessible, understandable, and actionable across business units, departments, and geographies. This requires modern approaches to data architecture and data governance that take advantage of machine learning, natural language processing, and automation to dynamically understand relationships, guide storage, and manage rights. Those same capabilities are needed to navigate changing global regulatory and legal requirements around data privacy and protection.

WE have entered a new age of digital enlightenment—one driven by ever-growing volumes of data and the valuable customer, strategic, and operational insights that information contains. In this new age, not only is there more data than ever before—it is being generated by a wider variety of sources, making it more revealing. As Deloitte's *2017 Tech Trends* report explored, insight-rich data from transactional systems, industrial machinery, social media, IoT sensors—and from nontraditional sources such as images, audio, video, and the deep web—increasingly informs decision-making and helps chart new paths to the future.[1]

To those already on the path to digital enlightenment, it is becoming increasingly clear that to realise its full potential, data should be free—*free* not in a monetary sense but, rather, in terms of accessibility and ubiquity. At a time when traditional boundaries separating organisational domains are coming down, it becomes more important than ever to expose data widely so that analysts can use it to create value.

Yet even when data is free, we have to make sense of it. Traditionally, "making sense of data" meant imposing upon it top-down, canonical definitions and hierarchies of access rights and creating layer upon layer of governance protocols. This

Dewey Decimal System-esque approach has been, in essence, just a formalised way to try to control chaos using brute force.

We expect that, in the next 18 to 24 months, more companies will begin modernising their approaches to data management, working to strike the right balance between control and accessibility. As part of the growing trend toward *enterprise data sovereignty*, these companies will develop deliberate techniques for managing, monetising, and unlocking the value of an increasingly vital enterprise asset.

Their efforts will focus on solving data challenges in three domains: management and architecture, global regulatory compliance, and data ownership. The challenges that many organisations encounter in each of these areas are varied and persistent. For example:

- How can we expose data across organisational boundaries and functional domains while still managing it deliberately and effectively?
- How can we automate laborious and often manual data classification and stewardship tasks?
- How can we, as a global company, comply with regulatory and privacy requirements that differ dramatically by nation?
- Who in the enterprise is ultimately responsible for all this data? Does the CIO own it? The COO? Anybody at all?

The enterprise data sovereignty trend offers a roadmap that can help companies answer these and other questions as they evolve into insight-driven organisations. Without a doubt, this transition will require long-term investments in data integration, cataloging, security, lineage, augmented stewardship, and other areas. But through these investments, companies can create a dynamic data management construct that is constantly evolving, learning, and growing.

Data, then and now

IT departments developed traditional data management techniques when data volumes were still relatively small. In this simpler time, structured business data typically lived in tables or basic systems.

Even then, strategists, CIOs, and other decision-makers struggled to get their arms—and heads—around it. Many companies took one of two basic approaches for dealing with data:

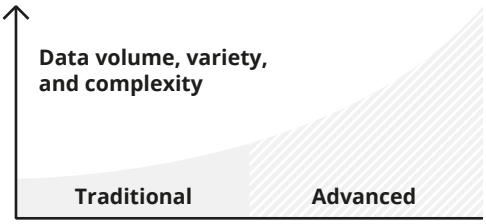
Laissez-faire. Decision-makers accepted that data management was messy and difficult, so rather than face its challenges deliberately, they built one-off systems to address specific needs. Data warehouses, operational data stores, reports, and ad-hoc visualisation ruled the day, requiring behind-the-scenes heroics to rationalise master data, cleanse dirty data, and reconcile discrepancies.

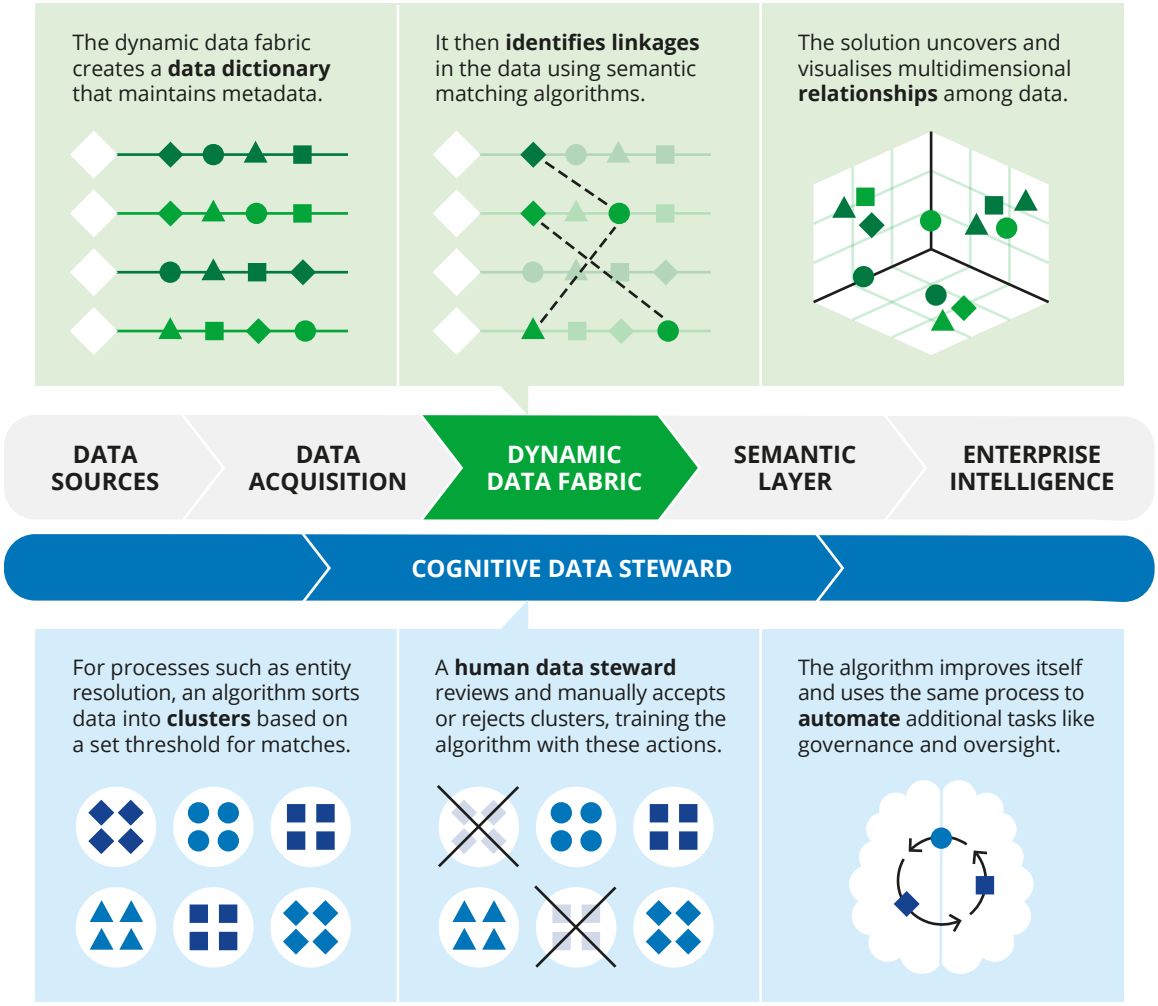
Brute force. Recognising data's greater potential, some companies tried—with mixed success—to get their arms around the data they possessed by creating a citadel in which data was treated as scripture. All processes were strict and regimented, which worked when all data was structured and uniform but became difficult to sustain when different types of data entered the system. To maintain data consistency and quality, companies relied heavily on mandates, complex technologies, and manual procedures.

Fast-forward two decades. Both of these approaches have proven inadequate in the age of big data, real-time reporting, and automation, especially as data continues to grow in both volume and strategic importance. Moreover, this phenomenon is encompassing all industries and geographies. Consider the automobile, which has in recent years become less a machine than a sensor-laden, data-spewing computer on wheels. Recently, Toyota, Ericsson, and several other companies announced that they will jointly develop new data management

Figure 1. The new data management architecture

Traditional data management provides basic but critical information, built on manual intervention and regimented storage and processes. As part of an advanced data management architecture, a cognitive data steward and dynamic data fabric can help an enterprise gain insights on a deeper level and transform decision-making.





Source: Deloitte analysis.

architectures to accommodate an expected explosion of automotive-generated data. "It is estimated that the data volume between vehicles and the cloud will reach 10 exabytes per month around 2025, approximately 10,000 times larger than the present volume," the consortium reported.[2]

To be clear: 10XB is *10 billion* gigabytes—from cars alone, every month.

IDC offers a macro view, predicting that by 2025, the world will create and replicate 163 zettabytes of data annually (a ZB is 1 trillion gigabytes), representing a 10-fold increase over the annual amount of data generated just nine years earlier.[3]

With this data tsunami approaching—or already here, depending on whom you ask—forward-thinking companies can launch their enterprise data

sovereignty journeys by answering the following foundational questions about advanced data management and architecture, global regulatory compliance, and ownership:

What will advanced data management and architecture look like in my company? When we speak of data management in the context of enterprise data sovereignty, we are talking about much more than how and where data is stored. We are also describing:

- Sourcing and provisioning of authoritative data (for example, batch, real-time, structured, unstructured, and IoT-generated), plus reconciliation and synchronisation of these sources
- Metadata management and lineage
- Master data management and unique identifiers
- Information access and delivery (for example, analytics and upstream/downstream consuming applications)
- Security, privacy, and encryption
- Archiving and retention

Using traditional data management tools and techniques, these complex tasks often require manual intervention. Moving to the cloud or adopting a federated system can add additional layers of complexity.

As companies explore ways to deploy new tools and redesign their data management architectures, they should think less about organising data into specific structures, instead focusing on deploying tools within new architectures to automate the decision-making processes in sourcing, storing, and governance. Though architectures vary by need and capability, most advanced data management architectures include the following components:

- **Ingestion and signal processing hub:** Sourcing and ingestion solutions for structured and unstructured public, social, private, and device data sources; can include natural language processing and text analytics capabilities.
- **Dynamic data fabric:** Solutions that dynamically build a data dictionary across the enterprise while maintaining metadata and linkages. Using data discovery solutions, ontologies, and visualisation tools, a dynamic data fabric explores and uncovers multidimensional relationships among data. It also depicts these relationships using interactive technologies and spatial, temporal, and social network displays.
- **Data integrity and compliance engine:** Capabilities to enhance data quality and fill data gaps to ensure quality and integrity while maintaining regulatory compliance.
- **Cognitive data steward:** Cognitive technologies that help users understand new compliance requirements, and augment human data stewardship by defining data quality and compliance rules. Cognitive data stewards—deployed in tandem with machine intelligence, bots, and other technologies—can automate many traditionally manual governance, oversight, and accountability tasks.
- **Enterprise intelligence layer:** Machine learning and advanced analytics solutions that illuminate deeper data insights, which can lead to more confident decision-making and real-time action. Among other tasks, the enterprise intelligence layer dynamically builds master data, catalogs, lineage, and security profiles, identifying changes in usage, consumption, and compliance.

Who should "own" data in my organisation? Currently, many organisations employ a data steward who focuses primarily on data quality and uniformity. While this individual may not "own" data in the enterprise, she is the closest thing the company has to a data authority figure. With data increasingly a vital business asset, some organisations are moving beyond simple data management and hiring chief data officers (CDOs) to focus on illuminating and curating the insights the data can yield. Increasingly, CDOs develop data game plans for optimising collection and aggregation on a global scale; this includes leveraging both structured and unstructured data from external sources. Finally, a CDO's data game plan addresses geographic and legal considerations about storage.

How do global companies meet regulatory requirements that vary widely by nation? Data hosted on cloud services and other Internet-based platforms is subject to the jurisdiction of the countries where the data is hosted or stored. As straightforward as this may sound, global regulation of data remains a persistently thorny issue for business. Several key questions must be addressed: Who has ownership rights to data? Who is permitted to access data stored in another country? Can a host country lay claim to access the data of a third country that might not be on the same continent as the host nation? There are surprisingly few easy answers.

On May 25, 2018, the European Union will, depending on whom you talk to, either bring welcome clarity to such issues or add yet another layer of regulatory complexity to data management regimes worldwide. On this day, a body of data privacy and usage laws known as the General Data Protection Regulation (GDPR) goes into effect,[4] aiming to prevent companies from collecting, processing, or using consumer data without first obtaining consent from the individual to whom the data pertains. And it doesn't matter whether the data is stored on servers located outside of the EU—if the data pertains to an EU citizen, GDPR rules apply. Failure to abide by GDPR rules can lead to staggering fines: up to 4 percent of company revenues or a maximum of $22 million.[5]

Meanwhile, Australia, China, and many other countries also enforce their respective regulations, and aggressively pursue noncompliant organisations. A recent report by Ovum, an independent analyst and consultancy firm in London, has observed that while the cost of regulatory compliance might be substantial, noncompliance will likely be even more expensive.[6]

Currently, global companies have several technology-based options to aid in meeting the letter of jurisdictional laws. For example, a sophisticated rules engine deployed directly into cloud servers can dynamically apply myriad rules to data to determine which stakeholders in specific jurisdictions are allowed access to what data. Or companies can segregate data into logical cloud instances by legal jurisdiction and limit cloud access to those data stores to users in each locale.

Finally, as any good CDO understands, draconian regulation of a particular jurisdiction may freeze data—with any luck, only temporarily. However, insights gleaned from those data assets are not subject to jurisdictional regulations and can be transferred freely throughout global organisations. With this in mind, shifting the focus from data to insights can help global organisations capitalise on data while remaining in compliance with local law.

Skeptic's corner

As a discipline, data management is not new—nor are half-baked claims to have "reinvented" it. Because we understand that some may greet news of an emerging data trend with a degree of hard-earned skepticism, we will try in the following paragraphs to address concerns, correct common misunderstandings, and set the record straight on enterprise data sovereignty and its possibilities.

Misconception: We've already tried using master data solutions to turn lead into gold. What you are describing sounds like another fool's errand.

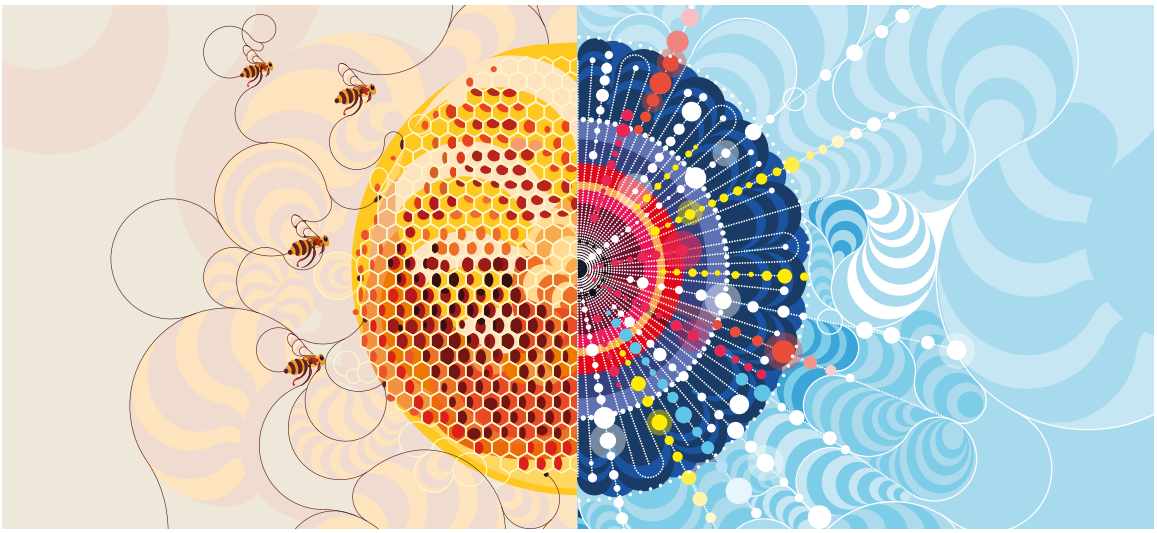
Reality: It's different this time . . . seriously. Here's why: Many of the master data solutions available during the last 20 years were federated systems with a master data set and separate "working" sets for storing various data types—for example, customer, product, or financial data. The process of reconciling the master and working sets was manual and never-ending. Moreover, all data management rules had to be written prior to deployment, which had the net effect of straitjacketing the entire system from day one. The enterprise data sovereignty trend offers something different. Federated models and manual processes give way to automation and an advanced data management toolkit that includes natural language processing and dynamic data discovery and ontologies, plus advanced machine learning and cognitive capabilities. The system requires less up-front rule-making and can teach itself to manage complexity and maintain regulatory compliance consistently across internal and external ecosystems.

Misconception: Even with automation, you still have frontline people inputting dirty data.

Reality: True, workers inputting and manipulating system data have historically introduced more complexity (and dirty data) than the systems ever did. Moreover, rewarding and penalising these workers did little to address the issue. In an advanced management system, automation, machine learning, and relational capabilities can help improve data quality by organising data uniformly and consistently, providing a context for it, and making specific data sets accessible broadly—but only to those who need it. Moreover, when designing their data architectures, companies should consider moving data quality, metadata management, and lineage capabilities away from system centres and relocate them to the edges, where they can correct a human error before it enters enterprise data flows.

Misconception: "Freeing" data will only lead to problems.

Reality: Suggesting that data should be freely accessible does not mean all data should be accessible to everyone across the enterprise at all times. Doing so would overwhelm most people. Perhaps worse, sharing R&D or other sensitive data broadly could tempt some to engage in nefarious acts. But by using metadata, dynamic ontologies and taxonomies, and other relational capabilities, the system can have sufficient context to map data content to enterprise functions and processes. Using this map, the system—not users—determines who gets access to which data sets, and why.



Data drives competitiveness in Asian markets

In response to increased competition across the Asian market, in 2012 one global manufacturer began looking for ways to amplify its business model and operations. How could it grow the top line, reduce costs, and develop entirely new ways to drive revenue? Leaders found an answer in ever-growing volumes of data and the valuable customer, strategic, and operational insights contained therein. By developing new approaches for managing and leveraging data, the company would be able to develop the insights it needed to achieve its strategic and operational goals.

Step one involved building a new digital foundation that, once complete, would drive repeatable, reliable data collection and usage, while remaining compliant with data regulations across borders.

The project also involved integrating new data sources, constructing a more robust customer master data system with a single view of the customer, and enhancing the protection of data both in storage and in transit across Europe and Asia. In addition to its far-reaching technical components, the project plan called for transforming the company's "my data" culture into one that encourages data sharing across the organisation.

Since its completion, the digital foundation has enabled greater visibility into trends across functions and geographies, which has subsequently made it easier to identify improvement areas both internally and externally. For example, in 2016 the company launched a series of pilots to increase efficiencies and improve customer service. The first focused on aggregating data from a variety of internal operations and transactions across geographies—such as call centres, customer service departments, and dealer visits—and identifying early-warning indicators of potential quality issues.

Shortly thereafter, the company launched a second pilot in which it placed hundreds of sensors in the field to obtain real-time performance data. It has used these insights to optimise operations, alert customers proactively of potential quality issues, empower customer-facing employees with more in-depth product knowledge, and identify inefficiencies in the supply chain.

Though leaders intend to continue exploring new data management approaches and applying new tactics, their ultimate goal remains consistent: harness data to become more competitive not only within the existing landscape but against newcomers as well.

Making dollars and sense of data

Data is rapidly becoming the hard currency of the digital economy. To manage this currency more efficiently—and to mine it more extensively for valuable insights—leading financial services organisations are modernising their approaches to data architecture and governance.

Today, many financial services firms have large stores of potentially valuable historical data residing in disparate legacy systems. Much of this data is organised in siloes for use by specific groups. For example, sales might "own" customer data while finance would own transactional data. In an effort to make more data accessible to everyone across the enterprise, companies are breaking down traditional information silos. One payment services provider established a big data platform with cognitive and machine learning to improve its data discovery and real-time research capabilities. Likewise, a global insurance firm created a "360-degree view" of the customer by connecting customer data across business units and then deploying predictive models to help drive process improvements. This approach also supported the creation of new capabilities in marketing, sales, risk management, fraud detection, underwriting, claims, and other lines of business. Meanwhile, a financial services firm implemented a metadata management repository, critical data lineage capabilities, and an enterprise data identification and tracking system that, together, make it possible to identify and track data across the global enterprise using cognitive capabilities versus traditional methods. As data moves from one system to another, accountability for that data shifts to whomever will be using it, automatically reorienting accountability to the data itself.

Some firms are also working to advance their data governance strategies. Increasingly strict regulatory oversight has made data quality management a priority at the executive and board levels. More than ever, financial services firms require complete, timely, accurate, and granular data to support regulatory reporting disclosures. To this end, they are exploring ways to automate traditionally manual governance, oversight, and accountability tasks. For example, one investment management company established a governance system in which responsibilities for the global enterprise are held by a community of data stewards who operate within a defined set of policies and procedures. These stewards handle day-to-day data management and governance issues. In parallel, the company implemented an enterprise data identification and tracking system that extends governance workflow across all systems, which helps the data stewards maintain compliance with jurisdictional data privacy and security regulations.

My take

Bill Ruh, chief digital officer of GE and CEO of GE Digital

GENERAL ELECTRIC

Data was the impetus for GE's digital journey. We're more than just the equipment we sell—we also help our customers run and operate their businesses more efficiently. Almost a decade ago, we started adding more sensors to our machines to better understand their performance, then realised our customers were analysing that same data in new and different ways. We know the machines inside and out, and we are in the best position to help our customers get every bit of value out of that data and, ultimately, our machines. We knew we needed to do things differently—to evolve our business. So we launched GE Digital, with the goal of mapping the new digital industrial world by integrating our machinery, software, IT, security, fulfillment, and product management capabilities.

We viewed this move through a business lens rather than a technology one, focusing on how to help our customers improve productivity, achieve better outcomes, even create new revenue opportunities. There was no roadmap to follow, but as we started, we quickly realised it would require deep domain knowledge of our equipment to understand both the physics and the analytics of the mined data. It also meant acquiring new capabilities—such as cloud, mobile, and data science—to put in place an infrastructure and to scale it.

Many big companies lack speed but do have scale, so moving into new areas requires leveraging existing assets and then building speed. Big companies tend to operate well in the vertical, with each business unit able to operate semi-independently. But the value of digital is in the horizontal, in the ability to integrate and leverage data across the enterprise: Being digital is the only way to move forward, and that has to be driven from the top of the organisation. At the same time, you want to—and need to—enable those verticals to move fast. In the beginning, we didn't pretend that we knew what belonged in the vertical and what belonged in the horizontal; instead, we recognised the inherent conflict while committing to iterate and evolve our thinking. But we did get comfortable with the idea of reusing, interchanging, and reinforcing a culture of collaboration in order to optimise our existing assets.

We focused first on bringing new capabilities to GE's services business, which allowed us to collect data, expand our knowledge, and determine what talent and skillsets we needed. We started in 2011 and focused internally the first two years, so we could develop a speed muscle. In 2013, we pivoted to adapt the offerings for our customers. Packaging together the data, analytics, and domain knowledge has immense value, not only in the ability to pull out cost but in the customers' realisation of the benefit to their operations.

For example, GE's IT group built FieldVision on the Predix platform. Initially aimed at our Power services group, FieldVision became a blueprint for an automation layer for any services team. Now we provide the service to power plants to automate controlled outages, which saved one customer $200 million in one year. Most organisations utilise spreadsheet- or paper-based operations, so FieldVision is truly an outcome-focused solution for data. It allows organisations to put data in the hands of the operator to yield greater efficiencies.

There's no inherent value in the data itself. The value is in the belief system of what the data represents, and the potential impact if it can be unlocked. Everyone has been talking about the importance of data for decades, but the complexity and cost around ERP has created a skepticism around it. Companies don't want to get three years into their data sovereignty journey and realise the business isn't seeing any value from it. You need to think about the transformation you will make, the outcome you will deliver, and the change you will bring. The value of data is sitting out there for everybody to take, but to optimise it, organisations need to be willing to change their operating procedures, and their people need to be willing to change how they work.

RISK IMPLICATIONS

As the enterprise's most valuable asset, data is increasingly at risk for misuse, misplacement, and mishandling. This is due in part to increased bandwidth and computing power, as well as the sheer volume of data available, growing rapidly due to advanced mining capabilities, increased storage, cloud computing, the Internet of Things, and cognitive tools. Additionally, these technologies have extended data's reach beyond the enterprise to third parties whose practices and protocols are beyond its direct control. These circumstances call for a new approach to data security and governance.

Data governance—the process of ensuring the quality of data throughout its life cycle—isn't intended to lock away information. In fact, data can play a key role in developing a more robust risk strategy. For example, applying analytics to nontraditional data sources can help build predictive risk models to better target potential threats (by location, population, period of time, and other factors). Similar data could assist in assessing the security protocols of new vendors and partners with whom you share a network.

With such deep data troves, an organisation can lose track of its data life cycle. The value of business intelligence has led to a school of thought that if some data is good, more is better, and all the data is best. Accessible, fast-growing data stores can introduce a litany of cyber risk scenarios if the enterprise fails to adopt and adhere to leading practices around its creation/collection, storage, use, sharing, and disposal. Such scenarios have given rise to consumer-centric regulations such as the European General Data Protection Regulation (GDPR) and China's Cybersecurity Law, both of which are causing some global enterprises to rethink their data management strategies. After years of collecting as much data as possible, organisations are beginning to realise that in some instances data may be more of a liability than an asset.

For decades, many organisations spent their time, money, and resources on defences—such as network, application, and infrastructure security—designed to keep cyber adversaries out of their networks. But because no organisation can be immune to a breach, a more effective approach may be focusing on the data itself. While organisations should continue to implement and maintain traditional security measures, which act as a deterrent to cyber threats, they should also consider the following steps:

Inventory, classify, and maintain sensitive data assets. The first step to protecting data is knowing what you have and where it is. Maintaining a current inventory of data can enable an organisation to proceed with data protection in a methodical manner. Additionally, when you identify your most valuable assets—the data with the highest threat vectors—you can shore up your defences around them. Finally, an accurate inventory facilitates compliance with regulatory requirements such as the GDPR's provisions for data portability and an individual's "right to be forgotten"; once data has proliferated throughout an organisation, locating all of it quickly for transfer or deletion could be a daunting task without an inventory. To expedite such tasks, organisations should develop and enforce rigorous governance processes that include oversight for data exchanged with third parties.

Implement data-layer preventative and detective capabilities. It is important to implement capabilities such as data classification, data loss prevention, rights management, encryption, tokenisation, database activity monitoring, and data access governance. These types of capabilities enable preventative and detective capabilities at the last line of defence: the data layer itself.

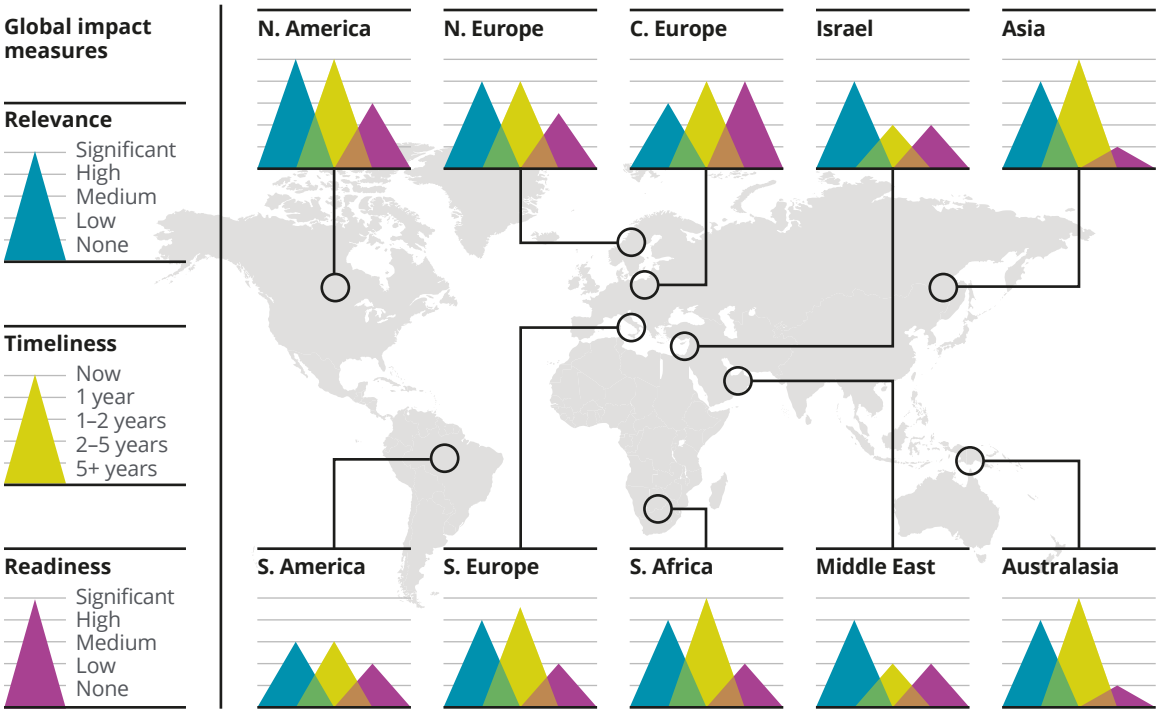
Reduce the value of sensitive data. One way to reduce the value of sensitive data is to encrypt, tokenise, or obfuscate the data to render it difficult to use when compromised. A second way is to destroy it when it is no longer necessary. Decades-old data rarely generates revenue, but it can be costly to a company's reputation when compromised.

Focusing risk strategy on the data layer itself may be one of the most effective ways to secure growing data troves and protect its value to your organisation.

The diverse, nascent-stage, and dynamic nature of global data privacy, residency, and usage regulations are a major driver of the *enterprise data sovereignty* trend. Across regions, there is acknowledgment of its profound impact, even while investments tend to focus on tactical responses to existing or looming government policies. From the 2018 deadlines for the European Union's GDPR to recent Australian privacy laws, some believe that these country-specific responses are necessary to navigate the void created by industry regulations that often lag behind technology advances. In light of these complex laws, however, many organisations are realising they don't know—much less have control over—what data exists within the enterprise, where it sits, and how it is being used across business units and geographies, or by third parties.

The range of adoption timelines may reflect the global lack of technical skills and reference use cases within specific country and industry intersections. Region- and country-specific challenges play a role in these varying timelines. In Northern Europe, for example, historical context related to civil liberties, privacy, and nation-state data collection may make the topic of data sovereignty particularly sensitive and highly politicised. Across the Americas, Europe, and Asia Pacific, active discussions are under way between the government and private sectors to shape regulation. In all corners of the world—including South Africa, Italy, Brazil, and China—public providers are racing to build "national" clouds in advance of evolving privacy laws. Region-specific timeframes and barriers reflect these considerations, indicating either the expected window for investments and policies to mature or a cautious buffer due to the complexities involved.

Figure 2. Global impact



Source: Deloitte analysis.

Where do you start?

For companies looking to boost data management capabilities, the holy grail is creating the architecture and processes required to handle growing volumes of data in an agile, efficient fashion. Yet for many organisations, the distance between current capabilities and that goal may seem daunting. The following steps can help you lay the groundwork for the journey ahead:

- **Pay data debt.** CIOs think a lot about technical debt—the quick fixes, workarounds, and delayed upgrades that bedevil legacy systems and undermine efficiency. Many companies face comparable challenges with data debt. Consider the amount of money you are spending on one-off data repositories—or the cost, in terms of both time and efficiency, of creating reports manually. A first step in transforming your data management systems is assessing (broadly) just how much data sprawl you have. How many interfaces and feeds connect disparate repositories and systems? With an inventory of systems and data, you can try to quantify how much manual effort is expended daily/monthly/yearly to keep the sprawl intact and functioning. This information will help you better understand your current data capacity, efficiency (or lack thereof), and costs, and provide a baseline for further analysis.
- **Start upstream.** Data scientists use technologies such as text and predictive analytics and machine learning to analyse largely unstructured data. This process typically begins at the end of the information supply chain—the point at which users tap into data that has been aggregated. By deploying these and other technologies at the *beginning* of the information supply chain—where an organisation initially ingests raw data—companies can start the process of linking, merging and routing data, and cleansing bad data before data scientists and users begin working with it. This approach helps impose some structure by creating linkages within raw data early on, laying the groundwork for greater storage and management efficiencies. Also, when you can improve data quality at the point of entry by correlating it and performing relationship analysis to provide more context, data scientists will likely end up spending less time organising data and more time performing advanced analysis.
- **Use metadata, and lots of it.** Adding metadata to raw data at the point of ingestion can help enhance data context, particularly in unstructured data such as random documents, newsfeeds, and social media. Greater context, in turn, can help organisations group and process thematically similar information more efficiently, as well as enable increased process automation.
- **Create a cognitive data steward.** Raw data is anything but uniform. Any raw data set is likely rife with misspellings, duplicate records, and inaccuracies. Typically, data stewards manually examine problematic data to resolve issues and answer questions that may arise during analysis. Increasingly, we see data stewards use advanced cognitive computing technologies to "assist" in this kind of review—there's only so much a human can do to resolve these issues. The ability to automate this process can free up data stewards to focus on more valuable tasks.
- **Help users explore data more effectively.** Navigating and exploring data can be challenging, even for experienced users. Providing a natural language interface and cognitive computing tools to help guide users as they undertake predictive modeling and advanced searches can turn laymen into data scientists—and help companies extract more value from their data management investments.

Bottom line

As data grows exponentially in both volume and strategic importance, enterprise data sovereignty offers companies a blueprint for transforming themselves into data-driven organisations. Achieving this goal may require long-term investments in data integration, cataloging, security, lineage, and other areas. But with focus and careful planning, such investments can generate ongoing ROI in the form of a dynamic data management construct that is constantly evolving, learning, and growing.

CONTACTS

NADUN MUTHUKUMARANA
Partner, Technology Consulting
Deloitte
+44 20 7303 2744
nmuthukumarana@deloitte.co.uk

AUTHORS

NITIN MITTAL

Principal, Deloitte Consulting LLP

SANDEEP KUMAR SHARMA, PH.D

Deputy Chief Technology Officer and Managing Director, Deloitte Consulting LLP

ASHISH VERMA

Managing Director, Deloitte Consulting LLP

Risk implications

DAN FRANK

Principal, Privacy and Data Protection, Deloitte LLP

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The new core

Unleashing the digital potential in "heart of the business" operations

Much of the attention paid to cloud, cognitive, and other digital disruptors today centres on the way they manifest in the marketplace: Individually and collectively, these technologies support new customer experiences, product innovation, and rewired industry ecosystems. Often overlooked, however, is their disruptive potential in core back- and mid-office systems and in operations, where digital technologies are poised to fundamentally change the way work gets done. This transformation is beginning with finance and supply chain, two corporate and agency pillars ready to embrace all things digital. From there, next-generation transaction and financial systems, blockchain, machine intelligence, automation, and the Internet of Things (IoT) are redefining what is possible in these mission-critical functions.

FOR many in the business and tech worlds, the word *digital* conjures up thoughts of marketing, e-commerce, and omnichannel experiences that increasingly capture business mindshare (and investment). This is hardly surprising given that improving digital engagement with customers, patients, citizens, and business partners is now a defining mandate across industries and sectors.

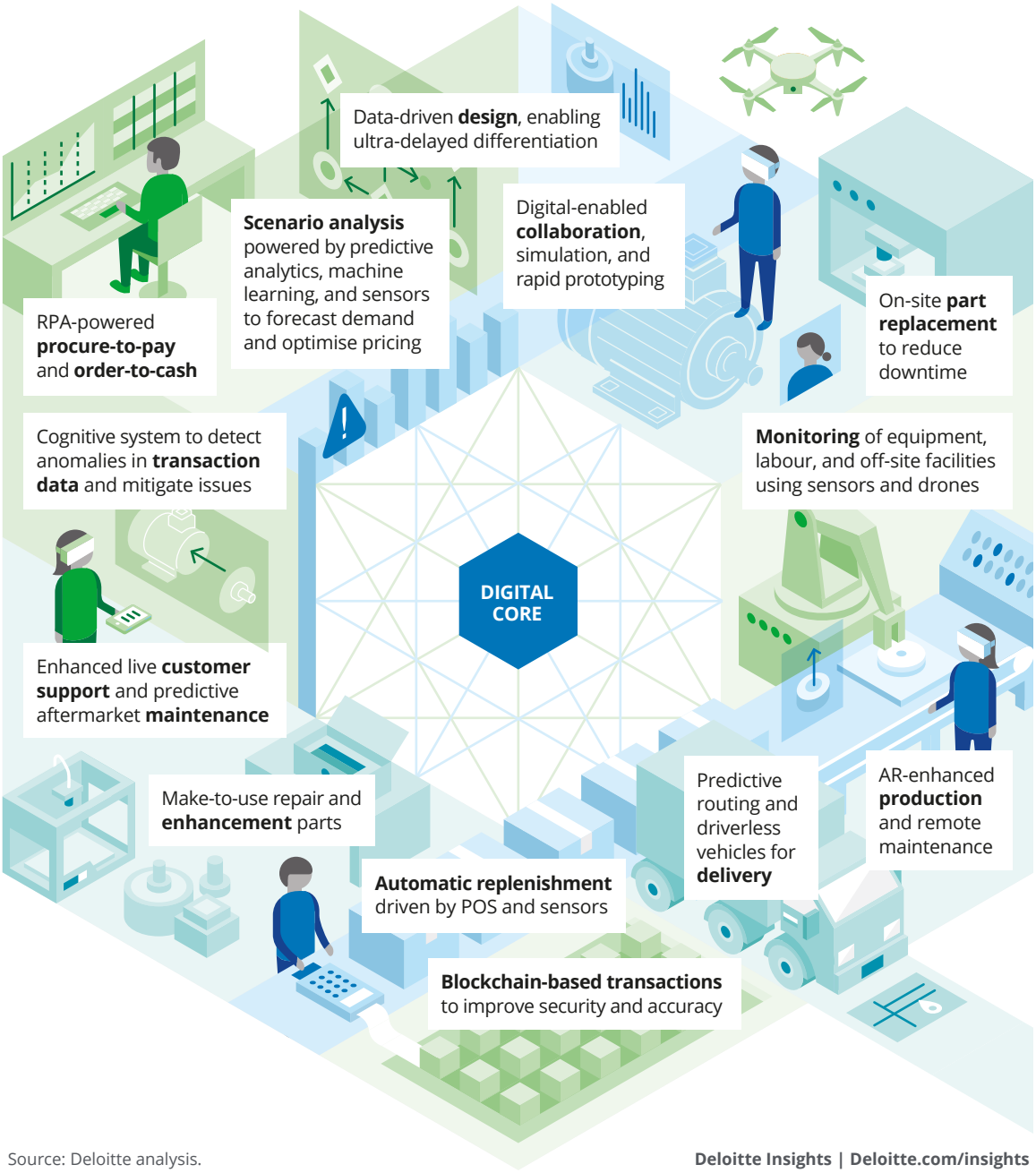
Though savvy organisations are approaching the digital mandate from a number of angles, one issue remains consistently important: the interconnectedness of front- and back-office systems. CIOs recognise that any effort to transform the front office won't get far unless new digital systems have deep hooks into the core. These critical hooks make pricing, product availability, logistics, quality, financials, and other "heart of the business" information residing in the core available to sales and customer service operations.

Creating connective tissue between enterprise functions and the core represents progress, but in terms of opportunity, it only scratches the surface.

Here in the midst of the digital revolution, the core's full potential remains largely untapped. Why? Because thus far, few organisations have extended the digital mandate beyond customer-facing functions to the middle and back offices.

Expect this to change over the course of the next 18 to 24 months as CIOs, CFOs, and supply chain leaders begin developing new digital capabilities in their core systems. We're not talking about deploying point solutions or shiny digital add-ons. Rather,

Figure 1. The new digital core: Finance and supply chain in action



Source: Deloitte analysis.

this is about constructing a *new core* in which automation, analytics, real-time analysis and reporting, and interconnections are baked into systems and processes, fundamentally changing how work gets done. In many ways, the new core trend mirrors digitisation efforts already under way in other enterprise functions, such as HR, sales, and marketing. Though their tactics and milestones certainly differ, all of these groups share a vision of enterprise functions as symbiotic building blocks in a larger ecosystem, working in concert to reshape business.

Digital *déjà vu*

Efforts to digitise core business processes are hardly new. Over the last two decades, companies have invested in ERP implementations, large-scale custom systems, business process outsourcing, and other ghosts of innovations past. Some of these investments delivered tangible benefits—for example, standardised workflows and automated tasks. However, others created unintended side effects: unintuitive employee user experiences, rigid and overly prescriptive operating procedures, limited data visibility, and in some cases, stagnation because needed changes were too costly or difficult to implement.[1]

After completing a few of these initiatives and the occasional one-off deployment of the latest digital tool, some companies began to feel core system fatigue, a situation exacerbated by the compounding complexity that eventually appears in aging mission-critical solutions.

Meanwhile, CXOs and line-of-business leaders struggled to reconcile two seemingly contradictory realities: They recognised the shadow that technology's rapid advancement was casting over their operations. At the same time, they were becoming ever more skeptical about one-off technology deployments.

The new core flips these dimensions on their heads. As this trend gains momentum in the coming months, expect to see CXOs target core business areas such as finance and supply networks for meaningful change. Rather than focusing on discrete tasks or individual tools, they will be broadly exploring how digital technologies can support global ecosystems, platform economies, complex operational networks, and new ways of working in the future.

That's not to say the individual technologies are unimportant. They can be essential enablers for achieving an end vision. For example, blockchain's distributed ledger offers a means for exchanging assets in an open, secure protocol, which has interesting implications for trade finance, supply chain validation processes, and other areas. Yet blockchain alone is only one component in a dynamic, interconnected new core stack. As companies begin their new core journeys, it will be critical to understand how digital innovations can work in concert with existing capabilities to drive business value.

Making it real

New core principles can be applied to all heart-of-the-business functions and processes. But to make the trend real, we are focusing on two areas with long histories of technology-enabled transformation: finance and supply chain.

The "heart of the business" meets the future

For finance organisations, the digital revolution presents both significant opportunities and nagging challenges. For example, exploding volumes of structured and unstructured data contain insights that could potentially transform business and operating models. By harnessing digital technologies and enhancing existing analytics capabilities, finance—a traditional purveyor of analysis—could become the go-to source across the enterprise for strategic advice. This opportunity becomes even more promising as boundaries between enterprise domains disappear, function-specific data sets consolidate, and individual systems give way to unified digital networks. At present, however, many finance organisations struggle with data and have neither the technologies nor skillsets needed to turn this opportunity into reality.[2]

Or consider "smart" technologies—a collection of cognitive tools that could drive greater efficiencies throughout the finance organisation by automating an array of manual tasks. In a recent Deloitte survey of CFOs, only 42 percent of respondents indicated that they and their teams were aware of such technologies.[3]

Recently, this logjam of opportunities and challenges has shown signs of breaking up. Increasingly, forward-thinking CFOs and CIOs are charting finance's course toward a digital future built around interconnected and automated systems, unified data sets, and real-time analysis and reporting. Though new core finance organisations differ by company and industry, many will likely share the following characteristics that together can help finance work more efficiently and better serve the business:[4]

- **Agile and efficient.** In the digital finance model, new product integrations and upgrades can be fast and effective. Public, private, or hybrid clouds offer a full stack of flexible, scalable "as-a-service" functionality without the large startup costs or technical debt associated with IT architecture and code maintenance.
- **"Faster, cheaper, better."** Automation offers finance organisations opportunities to increase efficiencies and lower overall operating costs. Robotic process automation (RPA), for example, uses software programs to perform repetitive tasks and automate processes, such as procure-to-pay and order-to-cash. These processes often involve numerous manual activities, including data entry and reports.
- **Information accessibility.** Planners and analysts can "see" developing trends and circumstances that directly impact decision-making. Predictive algorithms feeding visualisation technologies translate the kinds of information and insights that have traditionally been the domain of data scientists into understandable visual metrics that workers across the enterprise can leverage. Over time, CFO and COO data and insights may converge, enabling more seamless oversight, planning, and decision-making.
- **Automated insights in real time.** The term *cognitive computing* describes an array of technologies including machine learning, natural language processing, speech recognition, computer vision, and artificial intelligence. Taken together, these tools simulate human cognitive skills, grinding through mountains of data to automate insights and reporting in real time.
- **Detailed insights and forecasts.** Analytics has long been part of the finance arsenal, but new techniques are helping businesspeople tackle the crunchy questions with more insightful answers. It can also help them illuminate connections and trends buried within data—findings that can make forecasting more detailed, more accurate, and more efficient as well. Such opportunities are fuelling ongoing investments in analytics tools. In a recent Deloitte survey of CFOs, roughly 45 percent of respondents said they had invested in finance and accounting analytics, with 52 percent indicating they plan to invest more in the future.[5]
- **Super-sized data management capacity.** To manage digital information effectively, fi-

nance organisations will likely need a technical architecture that can handle massive data sets, without sacrificing availability, timeliness, or the quality of "books and records." This is what in-memory technology provides. Its key applications include transaction processing, event processing, distributed caching, and scenario modeling.

- **Digital trust.** As discussed in previous editions of *Tech Trends*,[6] in the digital economy, financial and legal transactions that involve third-party intermediaries such as a bank or credit agency may be replaced by person-to-person transactions that do not require traditional trust mechanisms. Instead, parties to a transaction will create digital identities that verify their trustworthiness and store these identities in a blockchain where others can access but not alter them. Similarly, digital identities will be essential trust elements in blockchain-based digital contracts. Though currently not binding in a legal sense, "smart contracts" represent a next step in the progression of blockchain from a financial transaction protocol to an all-purpose utility.

Even with digital technologies maturing and use cases emerging in other enterprise domains, new core digital finance initiatives are still relatively rare. Data discipline remains a challenge in many companies. Likewise, historically, decision-makers have not viewed finance organisations as particularly rich targets for achievable savings. Yet there are a few pioneering companies that are developing digital finance capabilities in a concerted way. Others are experimenting with specific tools, such as RPA. Though these experiments may take place within the context of a larger roadmap, they may not represent a holistic embrace of the new core trend. But in the end, these early efforts can give pioneers a competitive advantage as the trend picks up steam.

Digital finance in action

At Pfizer, a healthy dose of digital helps finance stay ahead

Pfizer Inc. is one of the largest global pharma organisations in the world, with operations in more than 180 countries. With an operation of that size and scale, the finance function is not a back-office consideration but, rather, a vital part of the overall operation.

Given its importance, Pfizer's finance organisation has always sought to be at the forefront of embracing technology as an enabler to help drive the business. The journey began several years ago, when the overall enterprise began migrating to a centralised ERP platform. The move to a common global ERP helped to standardise processes and enabled a significant move to global shared services and centres of excellence; it also allowed finance business partners to focus on driving analytics and business insights with the broader enterprise. Now that 95 percent of Pfizer's revenue is running on its ERP platform, taking advantage of emerging digital technologies was the natural next step in its journey.

"We don't view digital in and of itself as unique or different for us," says Paul DeBartolo, Pfizer's VP of finance portfolio management and optimisation. "We have always been mindful of maintaining our finance expense-to-revenue ratio, while at the same time evolving our compliance posture and improving service levels. Centralisation, standardisation, and optimisation of the function play a central role in achieving that. Now, we're harnessing the next generation of digital technologies and tools to continue down that path."[7]

While the view of digital was not different, the approach for evaluating and deploying it was. According to DeBartolo, it was important for Pfizer's finance leadership to understand which digital technologies were ready now and which tools were still emerging and might have an impact in the future. As a result, finance leaders decided to take a "rapid rolling" model, which allowed the function to quickly pilot digital tools and understand their functionality and relevance before rolling them out. In this model, the company's combined finance and business technology team began exploring and implementing tools differently and more rapidly than ever before. The team started with pilots in several of the more mature solutions, RPA, predictive analytics and data visualisation. They piloted the technology in four processes that could quickly demonstrate measurable ROI—wholesaler chargebacks (order-to-cash), accounts payable, management reporting, and intercompany reconciliations—and could help leadership understand the value of the tools and how best to deploy them. In certain pilots, the RPA automated between 30 and 80 percent of the in-scope tasks, including running reports, populating spreadsheets, uploading data to the server, and sending emails. As a result of the pilots, leaders have signed on, putting active programmes in place to significantly deploy RPA and predictive analytics more broadly, with an attractive, accelerated payback. Moreover, some of the savings generated by the RPA pilot will be used to fund future digital finance pilots.

"Taking this 'rapid rolling' approach was important for us. The key to moving fast was to initially look at automating existing processes rather than redesigning and automating them concurrently," DeBartolo says. "We operate in a heavily regulated industry, so we were very deliberate about maintaining compliance as we made changes and added capabilities. Feedback from the early pilots and implementations will help us to streamline and simplify processes over time in light of the new technology landscape."

From the lessons learned in the first two pilot areas, Pfizer has created a roadmap to pilot other tools, including blockchain, natural language generation, and cognitive computing. Collectively, the capabilities represent the opportunity to further improve how finance supports the business. For example, by

developing predictive models for commercial forecasting, finance can provide additional insights on revenue, patient populations, and proactive risk detection, rather than focusing on manual efforts to calculate and assemble the information for assessment.

Finance leaders do recognise that the move to digital solutions will necessitate a shift in colleagues' mind-set, since new efficiencies could change how Pfizer executes finance processes. "In certain areas, we are looking to move to as touchless a process as we can, but just because there's more digital automation involved in a process doesn't mean we don't need a culture of accountability," DeBartolo says. "The shift to digital is as much about our people as it is about the technology. We want our people to own it, understand it, manage it, embrace it, and think about what's possible."

Finally, DeBartolo is optimistic about the future because of how leaders and colleagues at all levels continue to embrace change. "Our digital initiative was embraced at the most senior level in our organisation," he says. "Our business leadership understands the potential of this, and the finance and business technology leaders are willing to own it and sponsor it. That's been the key differentiator. Given the speed of advancement, we may have to change ourselves again. Having leadership who are willing to take that journey makes all the difference to our organisation."

Moving from linear to dynamic

The digital revolution is driving profound change in every core function, but perhaps none more so than in the supply chain.

Traditionally, organisations have structured their supply chains to support a linear progression of planning, sourcing, manufacturing, and delivering goods. For each of these functions and their dependencies, supply chains enabled large numbers of transactions involving the exchange of time, money, data, or physical materials for some other unit of value.

With the rapid digitisation of the enterprise, this time-honored model is now giving way to an interconnected, open system of supply operations in which data flows through and around the nodes of the supply chain, dynamically and in real time. This interconnectedness is transforming staid, sequential supply chains into efficient and predictive *digital supply networks* (DSNs) with the following characteristics:[8]

- **Always-on agility and transparency.** Securely and in real time, DSNs integrate traditional datasets with data from sensors and location technologies. This provides visibility into all aspects of the supply network, making it possible to dynamically track material flows, synchronise schedules, balance supply with demand, and drive efficiencies. It also enables rapid, no-latency responses to changing network conditions and unforeseen disruptions.
- **Connected community.** DSNs allow multiple stakeholders—suppliers, partners, customers, products, and assets, among others—to communicate and share data and information directly, rather than through a gatekeeper. Being connected in this way allows for greater data synchronicity, ensuring that stakeholders are all working with the same data when making decisions. It also makes it possible for machines to make some operating decisions.
- **Intelligent optimisation.** By connecting humans, machines, and analytics (both data-driven and predictive), DSNs create a closed loop of learning, which supports on-the-spot human-machine decision-making. What's more, through analytics, DSNs put data to work solving challenges in targeted areas such as commodity volatility, demand forecasting, and supplier-specific issues.
- **Holistic decision-making.** When all supply chain processes become more transparent, the net result can be greater visibility, performance optimisation, goal setting, and fact-based decision-making. This enables complex decisions to be made more quickly and with an understanding of the trade-offs involved, thus avoiding sub-optimisation.

A centralised data hub operating within the DSN stack makes big-picture transparency possible. In traditional, linear supply chains, datasets are often siloed by function: customer engagement, sales and service customer operations, core operations and manufacturing, and supply chain and partnership. In this model, each dataset remains separate from the others, which can lead to missed opportunities, as organisations cannot see where these functional areas intersect or align. An integrated DSN hub serves as a digital foundation that enables the free flow of information across information clusters. This hub, or digital stack, provides a single location to access near-real-time DSN data from multiple sources—products, customers, suppliers, and aftermarket support—thereby encapsulating multiple perspectives. It also includes multiple layers that synchronise and integrate the data.[9]

DSN's emergence is part of the broader digital revolution advancing across industries and markets. Increasingly, digital technologies are blurring the line between the physical and digital worlds. Companies can now gather vast datasets from physical assets and facilities in real time, perform advanced analytics on them to generate new insights, and use those insights to make better decisions, develop strategies, and create efficiencies.[10]

Likewise, companies are already using these insights to reimagine the way they design, manufacture, and deliver products to customers, with tremendous implications for the supply chain. In retail, for example, omnichannel customer experiences rely first and foremost on inventory visibility. When purchasing an item online, a customer wants to know if the item is available and, if not, when it will be. For some retailers, answering this question quickly and accurately is not always easy. In traditional supply chains, information travels linearly, with each function dependent on the one before it. Inefficiencies in one step can result in a cascade of similar inefficiencies in subsequent stages. In some companies, supply chain stakeholders have little if any visibility into other processes, which limits their ability to react or adjust their activities. With the DSN model, all steps are interconnected, creating a unified digital network that gives supply chain managers a real-time view of all process steps, from design to manufacture to delivery.

Skeptic's corner

Back-office and operational functions are no strangers to the digital revolution. In fact, countless finance and supply organisations deploy some digital tools and are likely exploring other digital opportunities. But because the new core trend involves transformation on a much larger and fundamental scale, it might be useful to correct a few misconceptions that digital dabblers may have about the journey ahead.

Misconception: I'm better off waiting for my ERP vendor to offer cognitive tools specifically designed for the finance and supply chain modules I'm running.

Reality: The cognitive market is already showing signs of consolidating. Big enterprise software and cloud vendors are selecting cognitive tools and incorporating them into their products. In the future, small companies currently driving much of the innovation in the cognitive space likely will either be swallowed up or find a niche trajectory to follow independently. You can't afford to wait for the market to sort itself out. Your competition is already kicking the tires on existing products and laying the groundwork for a digital future.

Misconception: I have a robust finance system that allows me to see all numbers and processes in gory detail. What's more, there's very little latency. Why would I want to automate?

Reality: We would venture a guess that many of the dedicated finance team members who think they are performing analysis are, in reality, trying to protect the predictability of earnings forecasts. CFOs can unburden these underused workers by using machine learning tools to automate the planning and forecasting processes. This can free finance talent to focus on generating real business insights. There is a bigger automation picture to consider. Chances are other enterprise groups are already exploring automation opportunities. Though domain-specific automation initiatives can drive discrete efficiencies, in the near future, companies may be able to maximise automation's impact by applying it consistently across HR, supply chain, finance, and other enterprise domains. Automation—with RPA, cognitive, and other dedicated tools—represents the future.

Misconception: Staff members in my finance organisation are top-notch. They should have no problem with new digital systems and processes.

Reality: No doubt your workers are top-notch. But remember: The skills needed to operate finance and supply chains in a digital world are very different from traditional accounting and logistics skills. Some staff members will make the transition to more digital roles; others may not. As you think about your talent model, how will you help current employees upskill? Likewise, how will you recruit in-demand digital veterans who can pick and choose from any number of job offers? As you embrace the new core trend, don't underestimate the importance of recruiting the right talent—every hire you make is an opportunity to prepare for a digital future.

As we automate, digitise, and integrate functions in areas such as supply chain and finance, attack surfaces expand and new risk considerations arise. However, digitising the core can enable greater transparency, real-time communication, and faster response times, facilitating increasingly sophisticated risk management tactics that can protect an organisation's operations and assets.

SUPPLY CHAIN RISKS

While digitising legacy supply chains can streamline processes and improve transparency, it also can create huge data stores with multiple points of vulnerability.

- The risks around data encryption and confidentiality are still a concern: It is critical to protect data, both at rest and in transit, as well as in memory.
- The use of open APIs can increase your network's vulnerabilities; management of API-specific identities, access, data encryption, confidentiality, and security logging and monitoring controls are essential.
- The risks of a traditional supply chain—counterfeiting, malicious modifications, threats to intellectual property—still apply in a digital supply network, while the digital footprint also requires securing the flow of intellectual property.

In terms of data stewardship, organisations should thoroughly inventory the data moving through their supply chains. Determine who will monitor and manage data at each point, as well as who owns detection and response if there is a breach. Identify the core privacy and security requirements that need to be fulfilled, and who will own the tracking and auditing for these at each node. Finally, put in place validation, review, and update mechanisms once the digital supply chain is operational.

FINANCE RISKS

In recent years, technology advances and enterprise cost pressures have rapidly incentivised finance functions to streamline and automate with cognitive solutions. However, these opportunities also introduce new dimensions of data risk. Organisations can manage this risk by establishing end-to-end governance, comprehensive review procedures, and ongoing monitoring and surveillance techniques from the very beginning. Some critical steps include the following:

- Monitor and surveil bots and cognitive systems. An organisation needs to verify a bot is acting as designed and intended. For instance, if a system with only read access were able to gain write access, it could change data in the general ledger.
- Carefully vet third-party capabilities and continuously monitor black box solutions. Third-party solutions can impose risks—from an initial vendor proof of concept to adhering to ongoing requirements. Further, "black box" solutions can pose significant infrastructure risk once given access to systems, processes, or data.
- Customise approaches to validation and testing. Traditional periodic, point-in-time compliance testing and oversight may no longer be sufficient for cognitive technologies.
- Escalate the importance of preventive and automated controls. Before cognitive solutions go live, they should undergo rigorous review boards, pre-authorisation clearances, and impact analyses.

Business process automation in both the digitised supply chain and finance functions—including robotics, cognitive engines, natural language processing, and blockchain-related technologies—offers opportunities for a more robust risk management strategy. It can reduce the propensity for human error and make tracking, monitoring, detecting, and responding faster, more consistent, and smarter. While risks are inherent in the implementation of any new technology, the modern core is helping enable more efficient, thorough, and intelligent risk strategies to protect two of the most critical areas in any organisation—supply chain and finance.

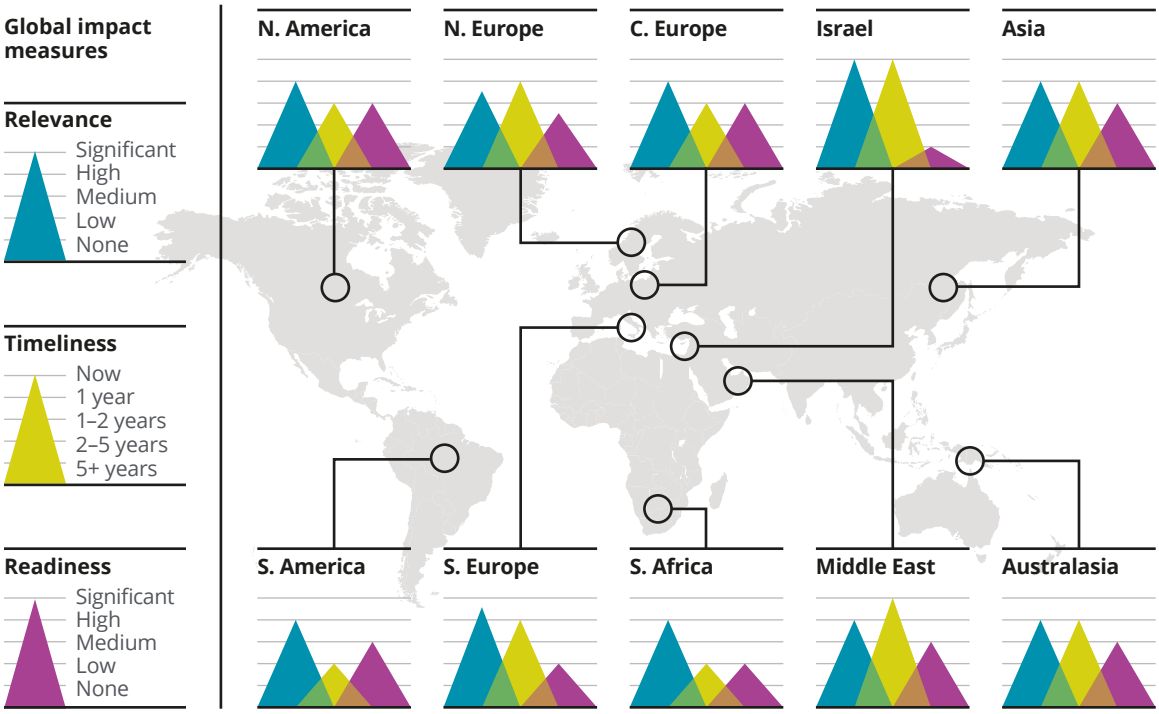
Around the globe, organisations increasingly recognise the value that the new core trend can offer. According to findings from a recent survey of Deloitte leaders across 10 regions, the new core is gaining traction as an effective means for framing broader digital transformation agendas. These agendas often include, among others, core ERP upgrades, and deployments of disruptive technologies, such as cognitive, robotics, and IoT.

Survey responses suggest that new core timelines vary greatly among regions. For example, countries with industries that adopted large-scale ERP or custom system deployments early on—the United Kingdom, the United States, Canada, and Germany, for example—are becoming the new core pioneers. Countries with industries that embraced large-scale ERP later are at a different stage transitioning from "acknowledge need" to formal efforts to develop actionable plans—for example, financial services in Brazil, Mexico, Asia Pacific, and the Middle East.

Other factors also account for regional variations in adoption timelines. In Latin America and South Africa, for example, companies are more likely to focus on customer-facing transformation activities. Survey respondents report that companies in these regions are linking digital capabilities to ERP and other back- and mid-office systems. However, few have launched large-scale transformation projects.

Across the globe, there are consistent readiness challenges. Survey respondents report significant concerns over the potential impact that new core initiatives could have on company culture, talent, and organisational structures. The cost and complexity of maintaining existing systems also contribute to lack of readiness. Finally, many technology leaders worldwide struggle to develop an architectural vision to guide various facets of core modernisation.

Figure 2. Global impact



Source: Deloitte analysis.

Deloitte Insights | Deloitte.com/insights

Where do you start?

Just as looking beyond individual domains' boundaries unlocks the underlying technologies' full potential, the new core gets even more interesting when the lines between core functions start to blur.

The same digital backbone needed for an automated financial close could allow dynamic scheduling of outbound delivery to prioritise order flow. IoT-empowered quality control metrics from the supply chain or embedded in products could allow dynamic, real-time visibility into actual selling, general, and administrative expenses—and trigger pricing and promotions based on fluctuating product availability or performance issues of a customer's previous purchases.

Creating a new core is neither a marathon nor a sprint—rather, it's a series of sprints toward an overall destination. As you begin exploring digital possibilities, the following initial steps can help you get off to a good start.

- **Learn from others.** If you haven't already, create a small cross-functional team to help you understand the trend's possibilities. Also, chances are, some of your peers in other parts of the company are already leading digital initiatives. Don't reinvent the wheel—there is a lot you can learn from their experiences. Talk to your colleagues. Find out how transformation has reshaped their talent and operating models, and learn from successes they've had—and from their failures.
- **Make a plan.** Map out a transformation plan for your function, focusing first on applications that have proven to be clear winners in other finance or supply chain organisations. This can serve as a master blueprint, but remember to execute it one step at a time. Things are changing fast in the digital world. Try to avoid making big bets until you know you are ready and you fully understand the potential risks.
- **Don't just imagine tomorrow—get there from today.** Before committing to bold visions of digital grandeur, consider the hardest part of the equation: Where do your people, organisational structure, processes, and technology fit in this brave new world? Many established assets can serve as building blocks for the new core. But make sure any modernisation needs are well understood before provisioning budget and locking down milestones. Don't limit the reality check to your "legacy," either. For emerging and new technologies, you will likely have to move beyond the rhetoric of what's real today, the path to enterprise scale and controls, and the pace of advancement. Build confidence in the when to invest, not just the *where* and the *what*.
- **Start cleaning up your use case data.** Data is the lifeblood of the digital core—and a potential source of trouble in any new core initiative. In many companies, the data needed for use cases is siloed and rife with misspellings, duplicate records, and inaccuracies. Consider creating a cognitive data steward to automate the tedious process of examining problematic data and resolving issues. Also, be more proactive in the way you manage use case data. Adding metadata can enhance data context. Greater context, in turn, can help organisations group and process thematically similar information more efficiently, as well as enable increased process automation.

Bottom line

Most boardrooms lack the appetite to fund (or the patience to weather) expansive transformation agendas. This is especially true when the agendas in question focus on back-office institutional processes. Be that as it may, digital's disruptive march across the enterprise continues apace. Fuelled by digital innovation, the new core trend presents a host of potentially valuable opportunities to redefine heart-of-the-business work and establish a better foundation for customer-facing innovation and growth initiatives.

CONTACTS

LUCINDA CLEMENTS
Director, Technology Consulting
Deloitte LLP
+44 20 7007 9948
lclements@deloitte.co.uk

REZA HAZEMI
Partner, Technology Consulting
Deloitte LLP
+44 20 7007 7827
rhazemi@deloitte.co.uk

AUTHORS

BILL BRIGGS

Principal, Deloitte Consulting LLP

STEVEN EHRENHALT

Principal, Deloitte Consulting LLP

DOUG GISH

Principal, Deloitte Consulting LLP

NIDAL HADDAD

Principal, Deloitte Consulting LLP

ADAM MUSSOMELI

Principal, Deloitte Consulting LLP

ANTON SHER

Managing Director, Deloitte Consulting LLP

Risk implications

VIVEK KATYAL

Global and US Risk Analytics leader, Deloitte LLP

ARUN PERINKOLAM

Principal, Cyber Risk Services, Deloitte LLP

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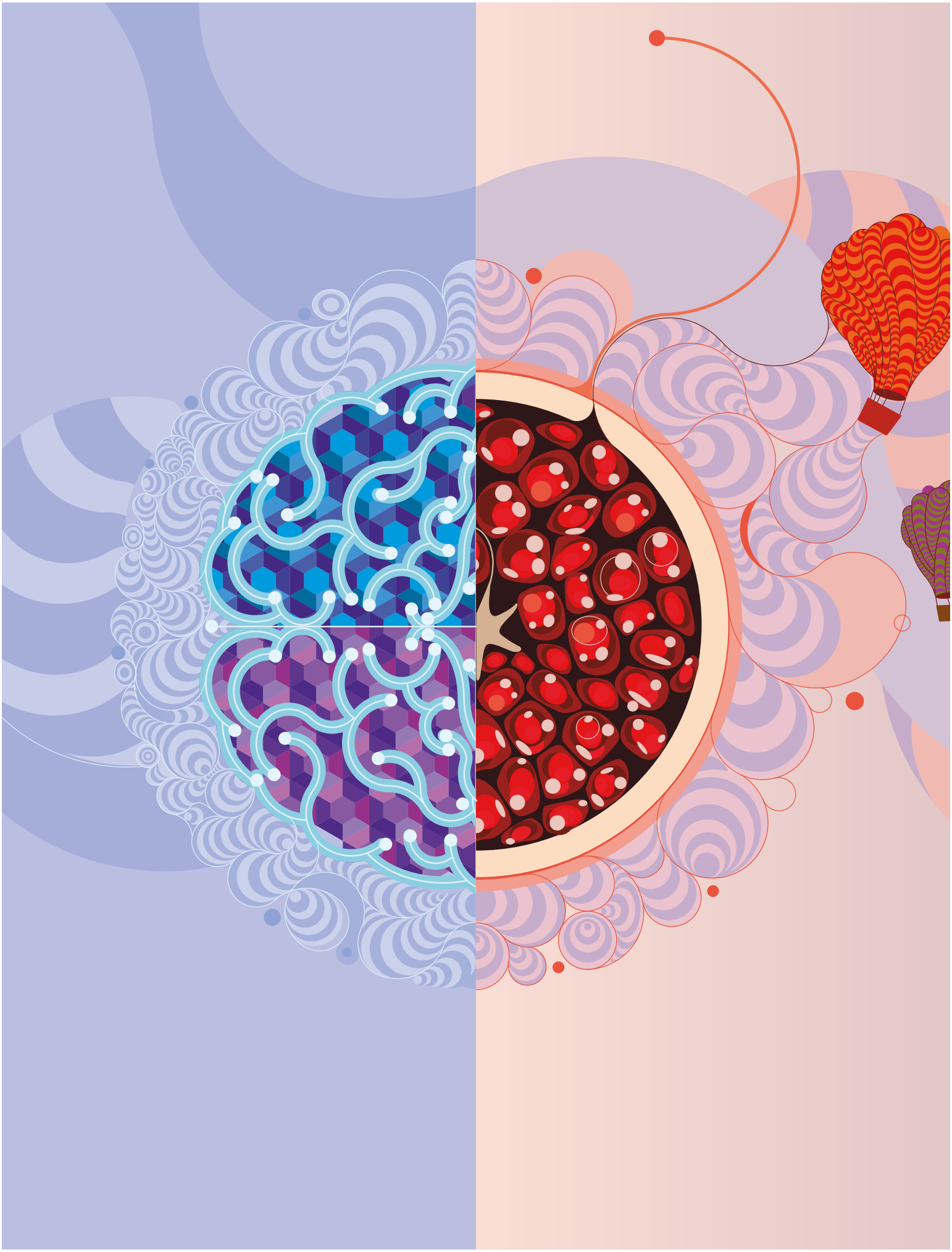


Digital reality

The focus shifts from technology to opportunity

The augmented reality and virtual reality revolution has reached a tipping point. Driven by a historic transformation in the way we interact with technology and data, market leaders are shifting their focus from proofs of concept and niche offerings to strategies anchored in innovative use cases and prototypes designed for industrialisation. They are laying the groundwork for broader deployment by tackling issues such as integration experiences with the core, cloud deployment, connectivity, cognitive, analytics, and access. Some have even begun developing new design patterns and nurturing non-traditional skillsets, heralding a new era of engagement. These early adopters recognise a shift in the AR/VR winds: The time to embrace digital reality is now.

OVER the next decade, advances in digital reality—an amalgamation of augmented reality (AR), virtual reality (VR), mixed reality, 360°, and immersive technologies—will lead to more natural and intuitive ways for technology to better our lives. Indeed, our means of interfacing with digital information will likely no longer be screens and hardware but gestures, emotions, and gazes.

This represents a leap forward comparable to historic transitions from client-server to the web, and web to mobile. And it may already be under way. International Data Corp. (IDC) projects that total spending on AR/VR products and services will soar from $9.1 billion in 2017 to nearly $160 billion in 2021, representing a compound annual growth rate of 113.2 percent.[1]

What accounts for such explosive growth? Increasingly, companies are shifting their focus from experimenting with “shiny object” AR and VR devices to building mission-critical applications in the enterprise. Consumer-oriented investments in

gaming and entertainment continue, but increasingly the real action is happening in the workplace. IDC estimates that industry AR/VR use cases that will attract the largest investments in 2017 are onsite assembly and safety ($339 million), retail showcasing ($250 million), and process manufacturing training ($248 million).[2]

During the next 18 to 24 months, the *digital reality* trend will likely gain momentum as more companies pilot use cases and accelerate into production. Some early adopters are now in their second or third iteration of product or service design. Others have taken use cases all the way to industrialisation. For example, BMW has incorporated virtual reality into its automobile design process,[3] while Air France has deployed "immersive entertainment systems" on some flights that allow passengers wearing VR headsets to watch movies in 3D.[4]

This trend may accelerate as three promising design breakthroughs are integrated into digital reality systems:

- **Transparent interfaces:** A blend of voice, body, and object positioning capabilities will make it possible for users to interact with data, software applications, and their surrounding environments. Though such functionality will develop further in the coming years, it can already make interfaces seem much more natural.
- **Ubiquitous access:** Much like we enjoy with mobile devices today, in the near future AR/VR will likely provide an "always on" connection to the Internet or to enterprise networks. But unlike having to reach into our pockets for our phones, we may soon wear AR/VR gear for hours at a stretch. Advances in design and the underlying technology are giving rise to a new generation of comfortable, self-contained digital devices free of tethering wires or bulky battery packs.
- **Adaptive levels of engagement:** You are attending a virtual meeting with colleagues and a loud 3D advertisement launches in your field of vision, disrupting your concentration and interrupting the meeting. For the same practical reasons that we must be able to mute the ringers on our smartphones and block pop-ups when surfing the Internet, with AR/VR having the ability to control data feeds appearing in our virtual environments will be crucial. In the near future,

A guide to digital reality terms and acronyms

Augmented reality (AR): Overlays digitally created content into the user's real-world environment. Features include transparent optics and a viewable environment in which users are aware of their surroundings and themselves.

Virtual reality (VR): Creates a fully rendered digital environment that replaces the user's real-world environment. Features body- and motion-tracking capabilities.

Mixed reality (MR): Seamlessly blends the user's real-world environment and digitally created content in a way that allows both environments to coexist and interact. Utilises advanced sensors for spatial awareness and gesture recognition.

Immersive: A deeply engaging, multisensory, digital experience, which can be delivered using VR, AR, 360° video, mixed reality, and other technologies. Formats vary.

Digital reality (DR): An umbrella term for augmented reality, virtual reality, mixed reality, 360°, and immersive technologies.

contextual "traffic cop" capabilities may be able to tailor data feeds to user preferences, location, or activities.

Development of these game-changing capabilities may not happen overnight. Designing user experiences for immersive environments is a fundamentally different process than creating experiences for flat screens. Indeed, it utilises entirely new languages and patterns. Some design techniques will have to be invented by a new generation of programmers whose skills fit more naturally in Hollywood than in a traditional IT department. Already, we are seeing CIOs enlist film and videogame design veterans with computer-generated image (CGI) expertise to help design VR experiences.[5] Meanwhile, the major Hollywood studios are ramping up their own VR content development programmes.[6]

As with any development initiative, there are real IT ecosystem issues to consider, including core integration, cloud deployment, connectivity, and access. What's more, digital reality's component parts are still evolving, as are standards and governance strategies. Yet even with these headwinds, digital reality initiatives march steadily forward.

Welcome to the Metaverse.[7] It's time to get to work.

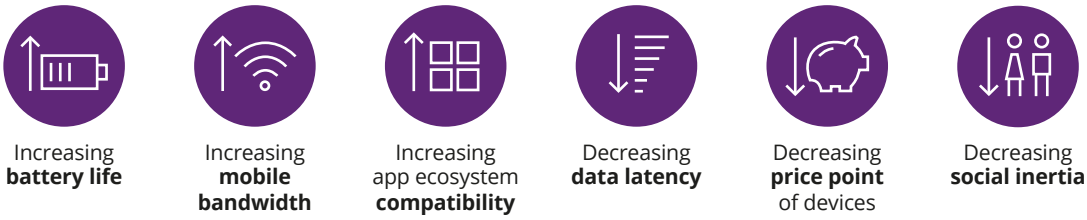
Five big digital reality opportunities

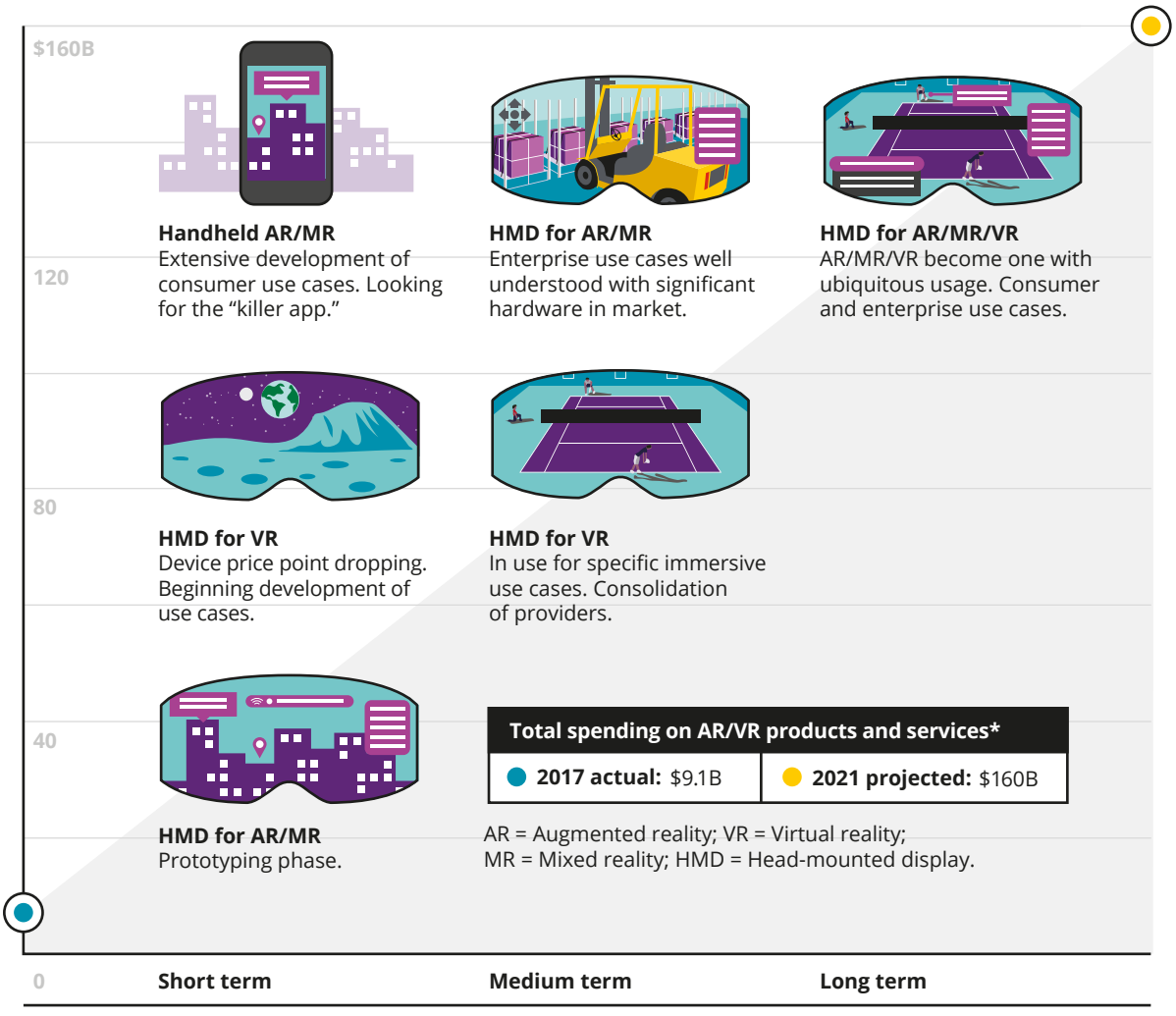
In previous editions of *Tech Trends*, we examined AR/VR technologies and early use cases through a future-perfect lens, recognising that broader adoption and commercialisation would not happen overnight.[8] Well, the future has arrived. The *digital reality* trend shifts the focus away from technology and firmly toward their development and deployment. As you explore digital reality's potential for your organisation, consider the following opportunity areas:

- **Connect:** "Cooperation without co-location." Digital reality already makes it possible for workers to engage, share information with, and support colleagues in other locations. Some may think of this as glorified video telephony, but it is much more than that. For example, engineers sitting in a regional office will be able to see what field workers see as they repair and maintain remote equipment, helping to guide their actions. Scientists separated by oceans will convene in a "virtual sandbox" where they can perform collaborative research. Videoconferencing and live chats—often frustrating experiences hobbled by broken connections and unflattering camera angles—become immersive interactions that serve up replicated facial expressions, gesticulations, and holograms in real time. Teams will be able to work together on shared digital assets such as virtual whiteboards or digital models that can be manipulated in real time.
- **Know:** Digital reality can offer knowledge workers—a broad term that basically applies to anyone using a computer—access to the specific information at the exact moment they need it to do their jobs. This is more than a souped-up document-sharing tool—it can actually present information in a visual context. For example, wearing DR glasses, construction engineers can see a detailed description of a project's electrical and plumbing parts, and also how the individual parts will fit into a wall. Imagine leveraging this same flexibility in any initial conceptualisation phase, such as architecture and interior design, consumer product R&D, or supply chain and logistics mapping. Immersive analytics can further enhance virtual collaboration by helping users explore data in multiple axes and dimensions. For example, by applying immersive analytics to historical data on urban cellphone tower placement, engineers immersed in a virtual environment might be able to move cellphone towers around a map to gauge the potential impact that

Figure 1. Digital reality in the marketplace

As technology develops, we move even closer to our data with the disintermediation of hardware and interfaces. Six specific developments are paving the way for the mass adoption of digital reality.





Sources: Deloitte analysis; *International Data Corp., *Worldwide Semiannual Augmented and Virtual Reality Spending Guide*, October 28, 2017; spending line is representative.

each placement could have on nearby residents' quality of life.

- **Learn:** Some pioneering companies are using digital reality to immerse trainees in lifelike situations that would be too expensive or logistically impossible to recreate on the ground. For example, UPS now provides VR driving tests that allow new drivers to prove themselves in a virtual environment before taking the wheel of a five-ton delivery van.[9] In its training simulation, KFC places employees in a virtual "escape room" where they must successfully complete a five-step chicken preparation process before they are released.[10]
- **Explore:** Consumer-focused use cases are proliferating across the retail, travel-hospitality-leisure, and real estate sectors as vendors use digital reality to bring potential customers closer to the products, services, and experiences on offer. For example, Estée Lauder has launched an AR virtual makeup mirror on its web and mobile sites that adjusts for light, skin texture, and shine so that users can virtually try on product shades using their photo or live video.[11] Meanwhile, guided virtual visits are poised to transform the real estate industry and the way agents work on a daily basis; they may never have to show up for an open house again.[12]
- **Play:** Use cases and full deployments of DR technologies in gaming, storytelling, and live events are varied and numerous—and will likely become more so in the coming years. IDC projects that the investment in AR/VR gaming use cases alone will reach $9.5 billion by 2021.[13]

What does this mean for IT?

Many questions about the impact that digital reality technologies could have on IT ecosystems remain unanswered. However, we are far enough along in the immersive journey to know that CIOs should start thinking now about their company's DR strategies and the computing power required to support them fully.

Storage. The amount of data required to render DR experiences is staggeringly large—and will grow even larger as technologies evolve and new functionality emerges. Consider this: Providing 360° views in VR requires storing each video viewpoint so that users can turn their heads while the video continues to run behind them. Translated, this means that designers need 10 to 20 times the storage capacity that they would need to play a standard HD video file.[14] Cloud can likely meet increased storage requirements in a cost-efficient way, but it is not the only option. Perhaps digital reality could also be a forcing function to modernise your approach to data management, governance, and architecture (see *Tech Trends 2018: Enterprise data sovereignty* for more details).

Core integration. Headgear manufacturers are designing APIs that tie core technologies and business processes into DR experiences. Imagine, for instance, being able to present customer, facility, or product content in a virtual environment. Likewise, imagine being able to use this content in transactions initiated in digital reality. In the near future, deep hooks into ERP/CRM/CMS systems will be a critical component of DR system design.

Analytics. What is the intent behind a gaze? It is currently possible to track the gaze of an individual wearing an augmented reality headset and then, to discern user intent, analyse the data this tracking generates. Eventually it may be possible to use tracking analysis to drive advertising. For example, when an individual gazes at the refrigerator, a pop-up discount to a neighborhood restaurant could appear in that person's field of vision. But what if it were possible to track an individual's gaze for 12 hours at a time? The amount of storage needed to support tracking on this scale would be immense. What's more, analysing this volume of data in real time would require immersive analytics capabilities far more powerful than those many companies currently deploy.

Bandwidth and networking. At present, few network operators can deliver the bandwidth speeds that AR/VR streaming and 360° experiences require. For example, the kind of low-resolution experience available with many VR displays requires at least 25Mbit/s for streaming; for HD resolutions, the requirement jumps to roughly 80Mbit/s.[15] Recent research finds that only 7.1 percent of global connect speeds are above 25Mbit/s.[16] Though nascent efforts to develop the intelligent traffic management solutions, compression algorithms, and low-latency/high-throughput capabilities needed for AR/VR are under way, in the short term, bandwidth and networking could slow progress in digital reality initiatives.

Skeptic's corner

Okay, so the VR goggles you got for your birthday make you feel seasick. Don't let green gills color your opinion of digital reality technologies and the possibilities they offer your company. Please allow us to set the record straight on the future that lies ahead.

Misconception: Digital reality in manufacturing? Field operations? Give me a break. Right now, VR headsets must be tethered to a computer during operation.

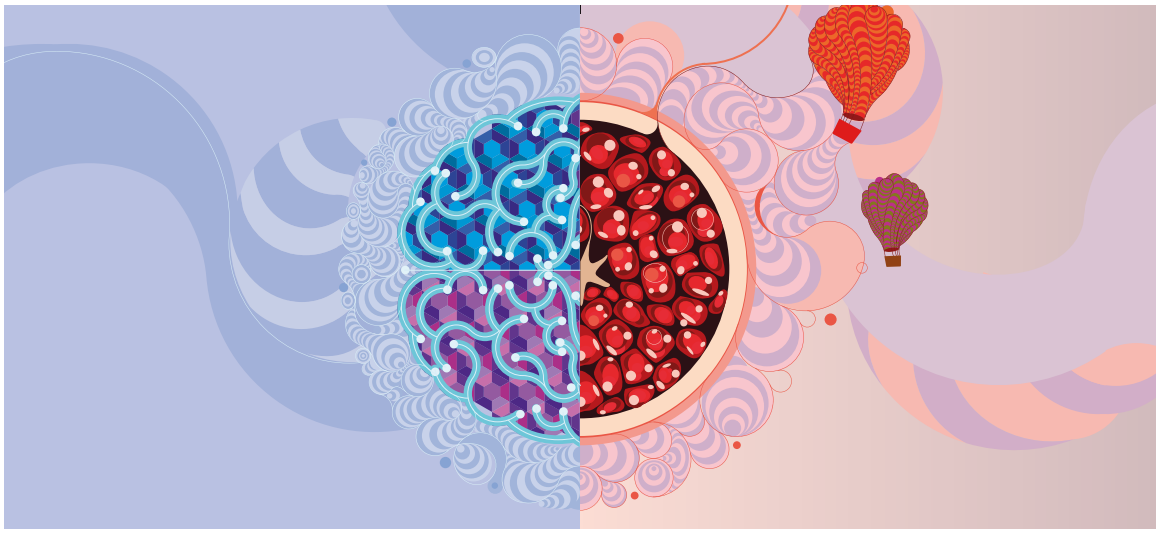
Reality: Fair enough. Currently, VR mobility is largely limited by cord length. The good news is that tetherless products are emerging, with battery technology evolving at a fast clip. Moreover, "inside-out" tracking technology is poised to increase VR mobility. Some higher-end headsets use external cameras and sensors to track a VR user's position within a room. Since mobile VR systems don't typically offer positional tracking capabilities inside-out tracking places sensors that read depth and perception cues on the headset itself, which allows users to escape the confines of sensor- and camera-filled rooms.[17]

Misconception: You've got to be kidding: $850 for VR glasses?

Reality: In late summer 2017, prices for major-label VR gear took a welcome nosedive.[18] VR kits are running anywhere between $200 and $600, last time we checked. At these prices, the threshold for achieving positive ROI with existing VR capabilities becomes considerably lower. As expanded capabilities emerge, new experiences and designs could boost ROI further.

Misconception: We haven't even figured out how to get the most from smartphones and tablets. Before we get lost in science fiction, let's finish the job with today's technology.

Reality: It's not an either/or scenario. Just as mobile has not replaced desktop and web applications, digital reality isn't likely to replace mobile. However, it can help us to tackle some problems in ways that traditional technologies do not. If the use cases discussed in this chapter resonate with you, it might be worth launching a few digital reality bets in parallel with your ongoing smartphone and tablet deployments. This might give you an early-adopter advantage when the DR trend heats up in the months to come.



At Google, the revolution will be virtualised

Google is no stranger to digital reality: Over the last few years, it has launched Cardboard, Tango, Daydream, and most recently, ARCore. Like many companies operating in the space, it is studying possible use cases, testing ideas, and designing roadmaps. But while some firms aim to make a quick impact with a one-shot device, Google is preparing to launch a series of developmental "chess moves" over the next three to five years that it believes will deliver a powerful virtual experience. These deliberate initiatives are driven by the company's belief in AR/VR's long-term potential.

"AR/VR works as a platform not because of portability or personalisation but because of its increased *intuitiveness*," says Steven Kan, Google's head of AR/VR global strategy. "The primitives of computer science are input and output. On the output front, display technology has been improving for years, but the claims of 'immersion' from bigger screens and higher resolution haven't fundamentally changed what's possible. On the input side, we have gone from punch cards to keyboards to touching and swiping. Now we're able to reach out and touch something. Put those together, and you have the next computing platform. What could be more intuitive than manipulating real or virtual objects that aren't being viewed on a device but appear right in front of you?"

Google's AR/VR strategy team is looking to build a full-stack platform—hardware, operating system, and end-user applications. Each layer of the stack has its own trajectory: Hardware, software, and components will have 18-month to three-year development cycles; displays can take five years to develop; and applications can be built in just weeks, months, or quarters. Kan's team maps out each journey to extrapolate where they will converge, a process he likens to playing a game of chess.

To date, most of Google's forays into digital reality have targeted the consumer market, but Kan sees the enterprise market playing a key part in the technology's future. There are use cases delivering hard ROI with today's technologies to spur business and government investment, even though the timing and trajectory of broader mass adoption remain uncertain. Google has identified four enterprise scenarios that show promise:

- **"Help me learn."** Google validated the technology's power to educate with Google Expeditions, putting Cardboard headsets in schools to facilitate virtual field trips.[19] Now the company is looking at potential uses in corporate training and even as a replacement for how-to manuals on job sites.

- **"Help me create."** In architecture and industrial design, the technology could enable real-time, collaborative discussion among professionals involved with a project. They could walk through a real-sise model of the proposed product or building from their disparate remote locations, which could improve the quality and cycle time of the design process and drive down project costs.
- **"Help me operate."** In the field, engineers could access the service history of specific equipment or written guidance for performing triage and repairs. They would review this information in a hands-free, heads-up manner that maintains their autonomy and supports worker safety. If needed, they could also connect via their headsets to remote specialists who could virtually demonstrate repair techniques.
- **"Help me sell."** One of the leading use cases for AR/VR is sales—most notably for demonstrating products, allowing interaction with digital product catalogs, and allowing buyers to get familiar with equipment prior to closing a deal.

Developers are still working on some of the elements needed to expand beyond these use cases, Kan notes. For example, it is still difficult to access 3D models and digital assets: CAD programmes were not built with AR and VR in mind, which can lead to rendering problems. Likewise, existing policy management, device management, and enterprise controls for access and entitlements also present challenges. "The initial round of devices were not designed with manageability in mind, though we are able to address this retroactively, much like enterprises did in the early days of smartphones and tablets," Kan says. That said, competition for already-scarce design and development talent has become fierce as the entertainment and gaming industries ramp up digital reality initiatives.

Even at this early stage, Kan is optimistic about digital reality's enterprise potential. "We see evidence of positive ROI for these use cases—for example, R&D design times are being shortened by up to 20 percent. The potential for positive ROI is the bedrock of my faith in AR/VR's enterprise possibilities," he says, adding, "As long as that potential exists, we'll figure out how to bring the other pussle piece together."

The investments Google has made over the last three years in ARCore, Tango, and Cardboard, among others, have already enhanced the enterprise ecosystem. "When adoption of this technology eventually accelerates, we are confident Google will be able to continue adding value to the ecosystem," Kan says. "People underestimate how big of an impact this shift will have once it happens."[20]

Facebook's virtual thumbs-up to the enterprise

Facebook has set a goal of reaching 1 billion users through virtual reality with Oculus, the VR headset and platform maker it acquired in 2014. Although Facebook is primarily a consumer-focused platform, in the past couple of years it has seen large-scale enterprises adopt its Oculus technology, including the Oculus Rift headset, to assist in training, sales, marketing, and collaboration.

"Our virtual reality products originally were targeted at consumers, but by addressing the social aspect and presence, VR can remove barriers that transcend distance and time in ways that can benefit the enterprise," says Ash Jhaveri, VP of business development at Facebook and Oculus. "We found people using Oculus headsets to create experiences we wouldn't have imagined ourselves. They were doing things within their organisations such as finding efficiencies, reducing costs, and improving sales and operations, all with virtual reality. Our new Oculus for Business programme is a direct response to this growing interest from business-to-business customers. We'll be able to better serve demand with a dedicated focus and interest in evolving VR in the workplace."[21]

Companies across industries have found rich and varied applications for VR technology:

- A multinational consumer goods corporation uses the technology as a merchandising aid, mocking up shelves with complementary products to assist multiple product-line owners in collaborative marketing efforts, as well as to present suggested display ideas to retailers.
- Automaker Audi has outfitted showrooms with virtual models to educate customers on its vehicles' inner workings as well as help them choose, and preview, thousands of model configurations and interior and exterior colours and fittings.
- Cisco is experimenting with new collaboration tools by integrating its existing Cisco Spark product with VR technology. Remote teams can be "present" in the same room collaborating by writing on and pinning to either a virtual whiteboard or a connected whiteboard device that is on-premises. The resulting diagrams and content can be printed for reference.
- Across industries, several organisations have begun to experiment with data visualisation programmes that allow users to immerse themselves in data with a 360-degree view, as well as with 3D versions of autoCAD that would allow designers to collaborate over a 3D rendering of a building, car, or engine.
- Children's Hospital Los Angeles is training residents in emergency care by simulating a realistic ER scenario in which they need to resuscitate an infant. Students try to diagnose and save the child by navigating emergency-room equipment and medications in a small space with a hysterical parent watching their every move.

Oculus is also adding core features to its products to support the enterprise. One upcoming new feature is virtual desktop, which unlocks the PC to turn a user's desktop screen into a 720-degree command centre that provides better access to information to do her job. There are still challenges to address before it becomes ubiquitous, such as the costly price point for screens and panels, rendering clarity, tweaking optics for prolonged use, and developing interfaces that don't require constant movement of limbs to be effective, but Jhaveri is convinced there will be demand for a virtually immersive workspace.

"As great as we think phones and tablets are, there's just something magical about unbounded screen space," he says. "Truly immersive VR experiences trigger emotional responses, which is important for consumer and enterprise adoption. Ultimately, those responses will help you tell stories better, translate relationships, and help grow your business."

Driving the enterprise's digital reality

Unity Technologies is a leading game development platform, known for its Unity creation engine, which reaches more than 2 billion devices worldwide.[22] With many of the initial forays into virtual and augmented realities being videogames, it's probably unsurprising that Unity created a development platform for 2D, 3D, VR, and AR experiences. However, Unity's leadership team is also turning its attention to the enterprise, where the automotive, architecture, aerospace, and creative fields, among others, are looking to digital reality to create rich user experiences for customers and employees.

"Immersive technology is the next computing platform, after mobile," says Tony Parisi, Unity's global head of AR/VR strategy. "It will just be a part of daily life, like the mobile phone is today, although form factors and costs will have to evolve before we'll see mass consumer adoption. We believe most of the interesting activity will be in the enterprise over the next few years."[23]

Unity is working with industries far beyond gaming looking to derive value from digital reality tools. For example, the auto industry has taken an interest in using digital reality for tasks as varied as designing vehicles, training operators and service technicians, performing simulations for autonomous vehicle training, and creating compelling marketing and sales experiences. Unity is ex-

tending its platform by adding tools that can assist in automobile design. While automakers have used CAD software for years, most continue to use physical prototypes made of clay—which can be a costly and time-consuming proposition. But with 3D environments and digital reality, auto designers can take simple physical mockups and augment them with design geometry, paint and material finishes, and even interactive capabilities in digital prototype equivalents. This can reduce the time to iterate, provide a more realistic experience, enable new ways to collaborate, be cost-effective, and ultimately improve product quality.

Of course, there are challenges ahead in creating digital reality solutions for the enterprise—data integration, enterprise licensing, the logistics of software deployment, and producing product lifecycle management tools to move 3D data around an organisation. However, companies are forging ahead, and Unity's teams continue to evolve its digital reality platform to support their clients' use cases, including home furniture shopping, equipment-failure diagnosis applications for both industrial and office equipment, and training, merchandising, and store planning for retail.

"The next two to three years will be all about understanding and mastering the medium, with new classes of content creators who can master real-time 3D," Parisi says. "We can provide platforms, and we will see independents and production studios creating digital reality content to deploy over them. There are tremendous opportunities across many industries."

My take

Judith McKenna, executive vice president and chief operating officer

WALMART US

How people live, work, and shop is changing rapidly—and so is Walmart. By combining technology and innovation with a commitment to training, skill development, and lifelong learning, we are reinventing our store experience and empowering our people to deliver for customers, grow in their jobs, and have the opportunity for advancement and success.

Our journey began by reviewing how work was getting done in our stores with an eye toward simplification. The result was a complete rewrite of nearly every process used to manage our day-to-day business. We also saw an opportunity to equip our people with mobile technology and a suite of custom-built apps that provide real-time data on everything from sales to availability to customer satisfaction, helping our associates know where they can make the biggest difference. Today, thanks to data and technology, our people are able to manage their stores directly from a tablet on the sales floor.

At the same time, we set out to reinvent our training programmes to support the new way of working and skill development our people would need for their future. Our existing online and job-shadowing training programmes were replaced with a hands-on classroom experience called Walmart Academy, which will have trained approximately 220,000 associates in 200 sites across the country by the end of the year.

When you do something at that scale, you need to think about how you will teach as well as what you will teach. From the start, we wanted to enhance the training experience with technology. In the academies, the coursework doesn't require printed or written materials—just tablets, screens, and facilitators. We designed the curriculum to be 25 percent in the classroom and 75 percent on the sales floor, so our people could gain hands-on experience using technology in real-life scenarios.

But not every situation can be easily created on the sales floor—like a spill or the holiday rush. So we began looking for new ways to bring those experiences to life. Around that time, one of our associates saw football players at the University of Arkansas training with virtual reality. While we were exploring ways we might use VR, we hadn't yet considered it as a way to teach.

We started with one VR headset in one Walmart Academy, with a single-use case: We placed an associate in a virtual store environment and asked her to look for potential problems such as litter on the floor, a spill, or a sign hanging incorrectly. The other trainees observed, in real time, the associate's interaction with the environment on screens in the classroom. The trainees were fully engaged in the experience, able to clearly visualise the surroundings and the corresponding behaviours. It worked so well that we're now expanding VR-based training and a wide variety of use cases to all 200 academy locations.

Looking at engagement and recall of the material, the power of virtual reality as a training tool became clear. I'm not sure VR will ever be a 100 percent replacement for real-life sales floor situations, though there is value in being able to experience situations that are difficult to recreate, and using cutting-edge technology makes the experience fun and engaging for our associates.

There is undoubtedly a lasting impact on our associates' overall experience when they learn from this technology. More than a how-to manual that spells out routine actions and responses, the immersive experience helps build confidence and prepare our people to run great stores.

Technology is reshaping the future of retail, and in order to compete, we must always lean into innovation and try new things. Some will work; some will not. We test, learn, and move on. At one time, in-store Wi-Fi was a novelty—now it's a table stake. In the same way, we weren't sure whether VR training would work or if it was just an intriguing idea. Now we know VR is a powerful and effective way to empower our associates and teach them new skills. Combined with our academy training programme and handheld technology, it will help drive the transformation of what it means to work (and shop) at Walmart.

With digital reality changing how people interact with data, the environment, and each other, the cyber risk implications of technology systems become even more complex. While no organisation is immune to a cyber breach, organisations are expected to secure virtual as well as physical worlds, at a time when the technology is being deployed in critical situations, such as surgical procedures or military training. Rather than viewing these issues as obstacles, meeting them head-on early in the development process can help mitigate cyber risks, enable faster deployment and innovation, and minimise brand and reputational risks.

The risks associated with digital reality are varied, becoming more nuanced and serious as applications are ported onto DR platforms. They can include physical harm, property damage, public safety, and operational disruption. Organisations should view risk management as an expected standard of care, taking into account customer well-being, contractual obligations, and stakeholder expectations. Start with the fundamentals: Issues such as identity and authentication in the virtual world will differ from logging into a laptop with a user name and password. Embedding risk management into the organisational construct—throughout the conceptual, delivery, and run phases of development—is a crucial step in digital transformation.

One aspect to consider is protecting user identity and data. Users upload and generate their own content, then interact with other users. The challenge is protecting that data without sacrificing a rich user experience. This requires a thorough inventory of the data you are extracting and how you are accessing, using, and storing it. The same data privacy and security controls that you implement throughout the rest of your organisation should be in place for DR applications. Additionally, determine your internal and customer-facing privacy and data protection policies (including jurisdictions) for DR activities, and communicate those within the organisation and to customers.

Another dimension is third-party access to your platform and network. If you use third parties or open-source software to build your platform, you should mitigate the risk of exposing code or sensitive data due to poor or malicious design. Build in security from the start of development, and extend it throughout your technology ecosystem. With today's pressure around speed to market and first-mover advantage, developers may not consider risk implications until after the fact. Understand the components that enable your DR experience; review the policies and processes of your developers, third-party vendors, and partners; and promote resilience and have them follow your organisation's security protocols.

VR equipment can also pose risks. With users relying on VR headsets and the content served to guide their actions and responses, it is critical to maintain the integrity of the data, device, and infrastructure to minimise physical harm, disorientation, and action triggered by erroneous information. Your technology stack should be monitored and managed on a real-time basis, and assess devices and interfaces to identify points of vulnerability. Enterprise security protocols—including third-party oversight protocols—should be extended or adapted to the DR platform. Thus far, there are few standards regulating VR experiences, and regulations likely will continue to lag behind technological development. However, it is essential to integrate robust controls into the product or platform. Customers expect it, as do regulators and shareholders.

Virtual reality can play an important role in planning for and responding to both physical and cyber threats. It can simulate disasters for response training without putting employees or the organisation's infrastructure in harm's way. Also, it makes an effective threat-modeling tool for physical and logical threats. In the very near future, VR could allow security professionals to visualise the paths that an adversary might take through a network, building, city block, or industrial facility. It could also provide penetration testers with three-dimensional virtual threat models of applications, software, and solution blueprints.

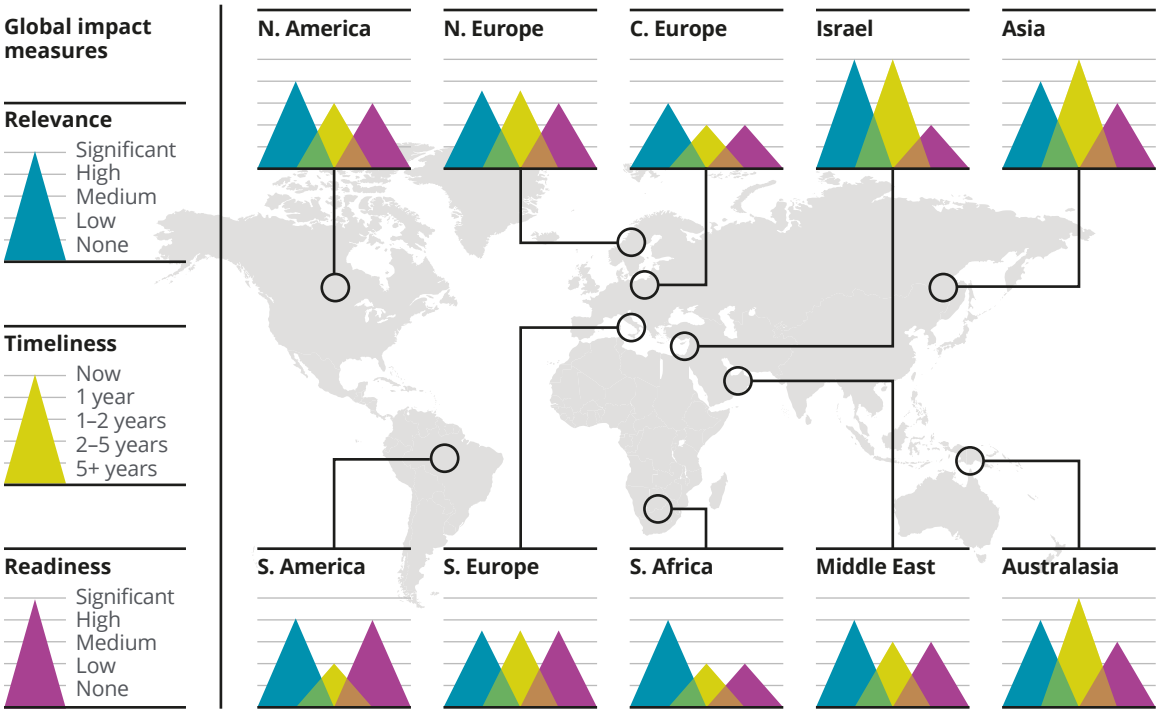
There's a global excitement around digital reality's potential to transform many industries. However, the expected timeframe for adoption is a bit further out than most of the other trends, based on findings from a survey of Deloitte leaders across 10 regions. The opportunities to drive organisational efficiency, make dangerous occupations safer, and augment worker skillsets through virtual and augmented realities are being explored in Africa, Australia, and Latin America, in particular.

In Africa and Latin America, mining companies and other high-risk industries are beginning to experiment with the technology to help mitigate safety risks.[24] However, the high costs of initial investment will likely stave off widespread adoption of the technology in those regions for another two to five years.

Australia is already deploying digital reality in the entertainment and retail sectors,[25] while real estate, financial services, and education are exploring opportunities as well.[26] Leading organisations in the region are integrating multidimensional layers of experience architecture across strategic, digital, and spatial initiatives and are measuring these against key performance indicators. On the European front, organisations are piloting the technology in a variety of contexts, including infrastructure maintenance and retail, but the main barrier to widespread adoption is the low adoption rate of ultra-broadband networks.

Australia is already seeing widespread impact from digital reality while other regions are moving toward large-scale adoption in approximately one to five years. In addition to cost concerns, Deloitte leaders cite the dramatic cultural shift required to work in virtual worlds—specifically in Africa and the Middle East—and a need to reskill the workforce, particularly in Southern Europe and Latin America, as barriers to widespread deployment.

Figure 2. Global impact



Source: Deloitte analysis.

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Where do you start?

Few companies have fully commercialised their digital reality deployments. Many are just beginning their journeys by learning more about these solutions and surveying the growing AR/VR market. Because DR components are still being tested in enterprise environments, diving headfirst into an ambitious AR/VR initiative could be risky. Consider, instead, taking the following preliminary steps to lay the foundation for larger projects to come:

- **Learn more about the technology:** Traditional IT skillsets offer little practical value to those working with AR, VR, 360°, and immersive technologies. Take this opportunity to upskill. Formal training or even a few hours spent with one of many development kits on the market can help you develop the skills and vocabulary you'll need to kick devices' tires and understand their value potential.
- **Speak a new language:** Designing for digital reality requires embracing new patterns and perspectives along with a wholly different design vocabulary. It also requires new enabling tools and services to bring the experiences to life and make them work in the real world. High-definition 3D image capture and mapping equipment are emerging, thus accelerating developers' abilities to recreate real-world physical environments with new AR/VR tools. Gaming engines are finding new purchase in the enterprise, with Unreal, Unity, and others being used to create simulations and virtual environments for AR and VR interaction.
- **Take a look around you:** Across industries, companies and government agencies are developing use cases, piloting DR technologies, and in some cases moving toward production deployments. As you explore your organisation's possibilities, look first within your own sector. What are your competitors doing in this space? Likewise, what business goals are companies in adjacent sectors pursuing with their DR initiatives? Finally, your supplier, vendors, and business partners may be willing not only to discuss their own efforts but to provide their perspectives on potential use cases and opportunities that you can pursue jointly.
- **Don't hold out for perfection:** The pace of innovation in the DR space is accelerating and will continue to do so for the foreseeable future. The consumer market is driving much of this innovation, but increasingly insights emerging from enterprise use cases, PoCs, and production deployments are influencing designs and driving the development of new capabilities. The "perfect" digital reality system does not exist—yet. But that should not keep you from exploring DR opportunities and developing use cases of your own. Remember: The shelf life of any given device needs to be only long enough to support its original purpose. The technology will evolve, as will your deployment strategies. It's time to get started.

Bottom line

As more DR use cases accelerate into full production, the idea that immersive technologies could become the "next big platform" seems less like science fiction and more like a reasonable vision of the future. To be sure, challenges remain on digital reality's path to full commercialisation. But these challenges do little to diminish its long-term disruptive potential. Digital reality is poised to transform the way we interact with data and experience the world around us. Are you ready?

CONTACTS

PAUL LEE
Partner, Technology Consulting
Deloitte
+44 20 7303 0197
paullee@deloitte.co.uk

ED GREIG
Chief Disrupter
Deloitte Digital
+44 20 7303 2663
egreig@deloitte.co.uk

AUTHORS

ALLAN COOK

Managing Director, Deloitte Consulting LLP

RYAN JONES

Principal, Deloitte Consulting LLP

Risk implications

ASH RAGHAVAN

Principal, Deloitte LLP

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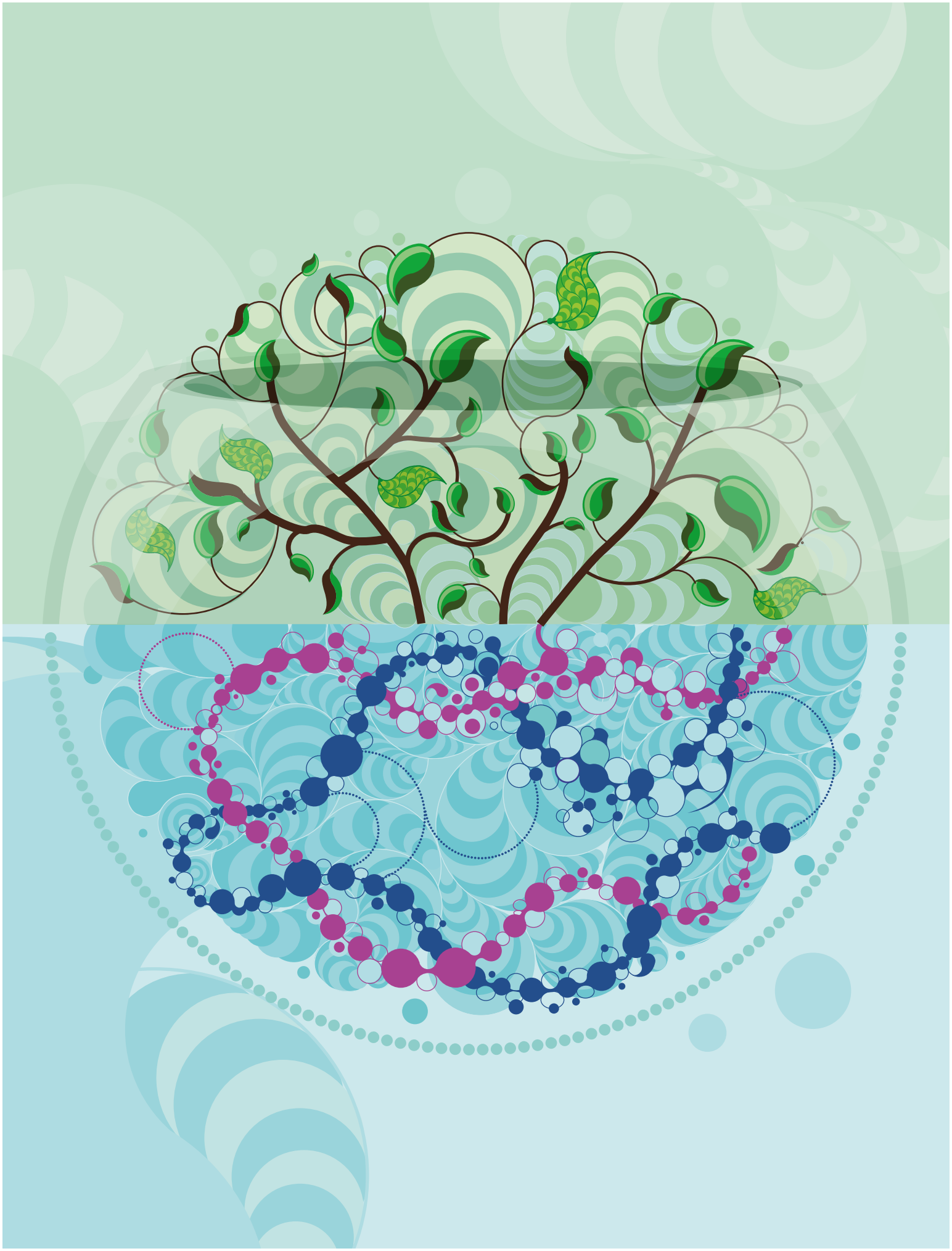


Blockchain to blockchains

Broad adoption and integration enter the realm of the possible

Blockchain technologies are on a clear path toward broad adoption, with proofs of concept shifting toward production and leading organisations exploring multiple concurrent use cases of increasing scope, scale, and complexity. Moreover, initial coin offerings and smart contracts are finding more applications and creating more diversity throughout the blockchain ecosystem. Now is the time for organisations to begin standardising on the technology, talent, and platforms that will drive future blockchain initiatives. Likewise, they can begin identifying business consortia to join. Beyond these immediate steps, they should also look to the horizon for the next big blockchain opportunity: coordinating, integrating, and orchestrating multiple blockchains working together across a value chain.

AMID the media frenzy surrounding bitcoin a few years back, prescient technologists and business leaders recognised that the real story was not the scandals swirling around Silk Road or Mt. Gox but, rather, bitcoin's technology endoskeleton, blockchain. They saw tremendous disruptive potential in this open, shared ledger platform. For example, public and private sector organisations might use it to share information selectively and securely with others, exchange assets, and proffer digital contracts.[1] Individuals could use blockchain to manage their financial, medical, and legal records—a scenario in which blockchain might eventually replace banks, credit agencies, and other traditional intermediaries as the gatekeeper of trust and reputation.[2]

Though at the time few use cases for such opportunities were ready for prime time, the notion that blockchain had significant potential not just for business but in society as a whole began to gain traction. Today, blockchain is garnering headlines once again, this time for the vast ecosystem of cross-

industry use cases emerging around it. Blockchain is now finding applications in every region and sector. For example:

- Europe's largest shipping port, Rotterdam, has launched a research lab to explore the technology's applications in logistics.[3]
- Utilities in North America and Europe are using blockchain to trade energy futures and manage billing at electric vehicle charging stations.[4]
- Blockchain is disrupting social media by giving users an opportunity to own and control their images and content.[5]
- Blockchain consortiums—including the Enterprise Ethereum Alliance, Hyperledger Project, R3, and B3i—are developing an array of enterprise blockchain solutions.

This list is growing steadily as adopters take use cases and PoCs closer to production and industry segments experiment with different approaches for increasing blockchain's scalability and scope. Indeed, the path to broad blockchain adoption looks strikingly well paved. Gartner Inc. projects that blockchain's business value-add will grow to $176 billion by 2025.[6]

Yet there are several issues that warrant attention. With the proliferation of platforms and protocols in the marketplace today, no single solution has emerged as the clear winner; consequently, no technical or process standards are yet in place. Likewise, operational siloes keep some companies from either developing clear business plans around blockchain or collaborating with ecosystem partners for mass adoption.

In the latest blockchain trend that will unfold over the next 18 to 24 months, expect to see more organisations push beyond these obstacles and turn initial use cases and PoCs into fully deployed production solutions. Though the tactics they use to achieve this goal may differ by sector and unique need, many will likely embrace three approaches that, together, comprise the latest blockchain trend:

- Focus blockchain development resources on use cases with a clear path to commercialisation
- Push for standardisation in technology, business processes, and talent skillsets
- Work to integrate and coordinate multiple blockchains within a value chain

Because we are only now coming to the end of a hot blockchain hype cycle, many people assume that enterprise blockchain adoption is further along than it actually is. In reality, it will take time and dedication to get to large-scale adoption. But when it does arrive, it will be anchored in the strategies, unique skillsets, and pioneering use cases currently emerging in areas such as trade, finance, cross-border payments, and reinsurance.

As these sectors lead in the coming months, blockchain's future will follow.

Treading the path to commercialisation

Regardless of industry bias, blockchain use cases that feature a clear path to commercialisation often stand a better chance of reaching production. Why? Because in the minds of stakeholders and decision-makers, the words "potential ROI" can magically transform a nebulous tech concept into a scalable business opportunity.

By focusing available resources exclusively on those use cases and PoCs offering a path to commercialisation, CIOs are offering clear incentives for stakeholders and partners, driving ROI in individual blockchain solutions, and potentially creating additional revenue or cost savings opportunities. In a way, they are also formalising and legitimising blockchain development strategies, both prerequisites for further refining project goals, setting timelines, and recruiting specialised talent.

By answering the following questions, CIOs can assess the commercial potential of their blockchain use cases:

- How does this use case enable our organisation's strategic objectives over the next five years?
- What does my implementation roadmap look like? Moreover, how can I design that roadmap to take use cases into full production and maximise their ROI?
- What specialised skillsets will I need to drive this commercialisation strategy? Where can I find talent who can bring technical insight *and* commercialisation experience to initiatives?
- Is IT prepared to work across the enterprise (and externally with consortium partners) to build PoCs that deliver business value?

One final point to keep in mind: Blockchain use cases do not necessarily need to be industry-specific or broadly scoped to have commercial potential. In the coming months, as the trend toward mass adoption progresses, expect to see more use cases emerge that focus on enterprise-specific applications that meet unique value chain issues across organisations. If these use cases offer potential revenue opportunities down the road—think licensing, for example—all the better.

Next stop, standardisation

As blockchain use cases grow in scope, scale, and complexity, the need for standardised technologies, platforms, and skillsets becomes more pressing each day. Consider standardisation's potential benefits—none of which companies developing blockchain capabilities currently enjoy:

- Enterprises would be able to share blockchain solutions more easily, and collaborate on their ongoing development.
- Standardised technologies can evolve over time. The inefficiency of rip-and-replace with every iteration could become a thing of the past.
- Enterprises would be able to use accepted standards to validate their PoCs. Likewise, they could extend those standards across the organisation as production blockchains scale.
- IT talent could develop deep knowledge in one or two prominent blockchain protocols rather than developing basic knowhow in multiple protocols or platforms.

Unfortunately, there are currently no overarching technical standards for blockchain, and it is unrealistic to think we will get them soon, if ever, across all use cases. For CIOs, this presents a pressing question: Do you want to wait for standards to be defined by your competitors, or should you and your team work to define the standards yourselves?

For financial services giant JP Morgan Chase, sitting on the sidelines while others in the financial sector developed blockchain standards was not an option. In 2017, the firm launched Quorum, an open-source, enterprise-ready distributed ledger and smart contracts platform created specifically to meet the needs of the financial services industry. Quorum's unique design remains a work in progress: JP Morgan Chase invited technologists from around the world to collaborate to "advance the state of the art for distributed ledger technology."[7]

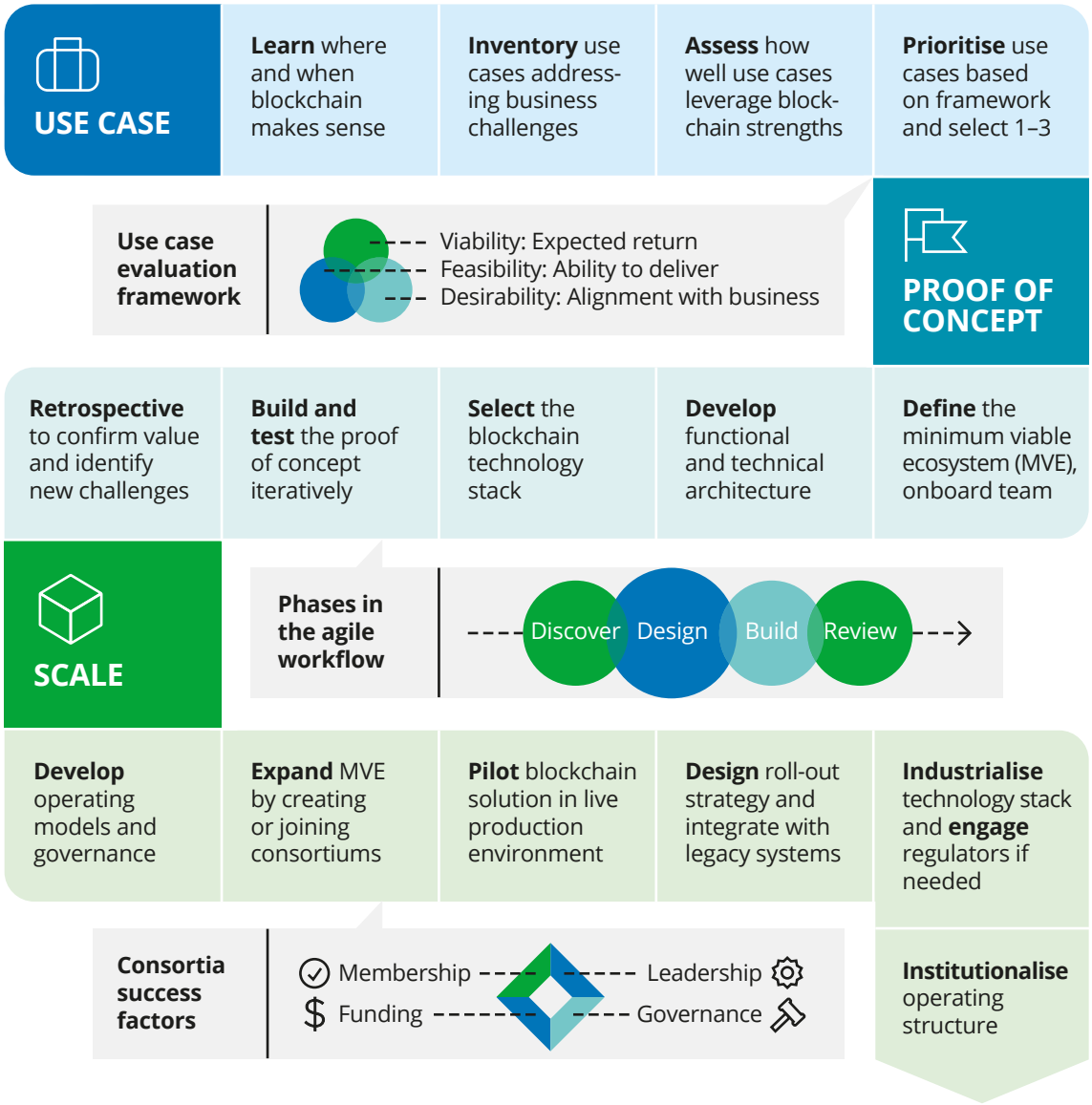
Not all IT shops are in a position to emulate this strategy for influencing the development of blockchain standards. But there are steps that CIOs can take to promote standardisation within their companies and industries rather than waiting passively for universal standards to emerge. For example, by plugging into external developer ecosystems, IT shops can begin influencing standardisation discussions and exchanging best practices with like-minded organisations. Internally, CIOs can empower their teams to make decisions that drive standards within company ecosystems. Finally, in many organisations, data management and process standards already exist. Don't look to reinvent the wheel. Apply these same standards to your blockchain solution.

Integrating multiple blockchains in a value chain

In the future, blockchain solutions from different companies or even industries will be able to communicate and share digital assets with each other seamlessly. For organisations whose use cases turn on blockchain ecosystem diversity and scalability, the potential benefits of integration are clear: Having more partnerships within a blockchain ecosystem can drive greater value and boost blockchain ROI. Likewise, interoperability can make it possible to customise and enhance blockchain solutions without rendering them obsolete.

Unfortunately, many of the technical challenges preventing blockchain integration persist. Different

Figure 1. The blockchain implementation roadmap



Source: Deloitte analysis.

protocols—for example, Hyperledger Fabric and Ethereum—cannot integrate easily. Think of them as completely different enterprise systems. To share information between these two systems, you would need to create an integration layer (laborious and painful) or standardise on a single protocol.

Even if the technical challenges were solved, connecting two blockchains is much harder than connecting two networks. Why? Because with blockchain integration, you are connecting two *value* networks that may not necessarily talk to each other. This means that when transferring digital assets from one blockchain to another, you must be able to transfer the first blockchain's *value set* of all its past transactions as well. You must also be able to guarantee that the data packets point to the same places in both blockchains, which helps maintain data integrity and auditability.

Right now, the Hyperledger Foundation and others are working to establish technical standards that define what constitutes a blockchain, and to develop the protocols required to exchange assets. These efforts will continue, and as they do, convergence of protocols will likely accelerate and standards emerge. Likewise, interoperable technologies will eventually mature, with new protocols that support communication between different technologies becoming broadly available. Until then, organisations can enjoy some integration benefits by working within a consortium model in which all participants deploy the same solutions and protocols. (When integration challenges are solved, those already sharing common processes and standards within a consortium may enjoy the competitive advantage of momentum.) There are also bridge technologies available that make it possible to move digital assets between blockchains. Think of the process like this: You move digital assets from point A to point B in a car. At point B, you transfer the assets from the car to a train, which takes it to its final destination at point C. It's inelegant, but it can deliver the desired business outcome.

Skeptic's corner

Few technologies today are as misunderstood as blockchain. That a simple Internet search produces a cornucopia of articles with titles such as "WTF Is Blockchain?" or "A Blockchain Explanation Even Your Parents Can Understand" suggests that for many, the world of shared ledgers, protocols, and consortiums remains opaque. With this in mind, join us as we correct a few common misconceptions about blockchain and its enterprise potential:

Misconception: Standards must be in place before my organisation can adopt a production solution.

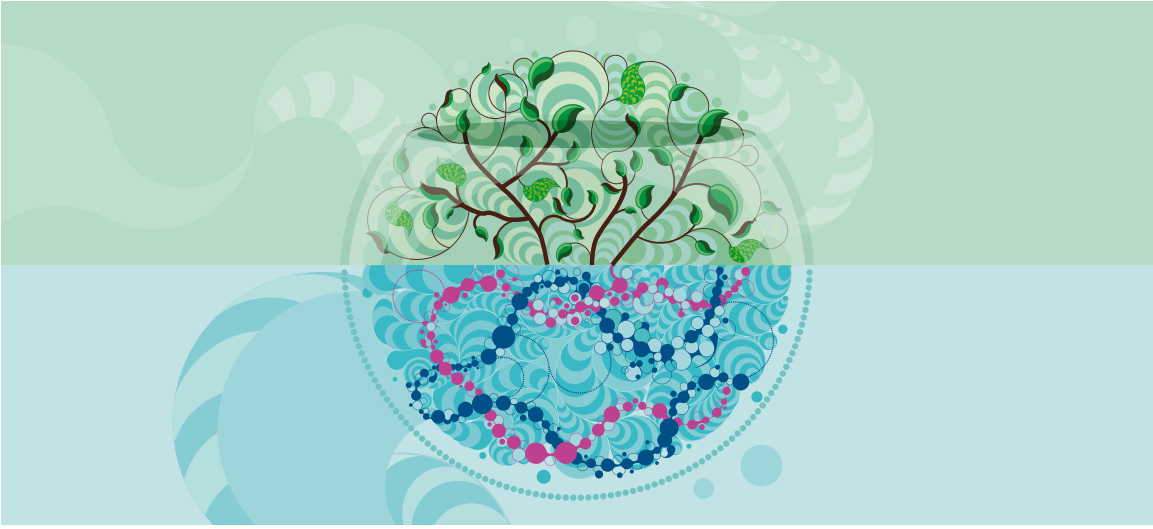
Reality: Currently, there are no overarching technical standards for blockchain, and it is unrealistic to think we will get them soon, if ever, across all use cases. There are, however, some technical and business standards for specific uses, such as cross-border transactions and smart contracts. These use case-based standards are established, if not commonly accepted, which means you may not have to wait for universal standards to emerge before adopting a blockchain production solution.

Misconception: I read about how quantum computing may completely invalidate blockchain as we know it. If that's true, why should I bother with blockchain?

Reality: That is a possibility, but it may never happen. Quantum computing provides enormous computing power that could be used to crack current encryption schemes. On the flip side, quantum computing may be able to help cryptologists generate stronger encryption algorithms. Either way, blockchain technologies will continue to evolve in ways that accommodate quantum's eventual impact—for better or worse—on encryption.

Misconception: Blockchain is free, isn't it?

Reality: Not quite. While most blockchain codes are open-source and run on low-cost hardware and public clouds, the full integration of blockchains into existing environments will require both resources and expertise, which don't come cheap. What's more, supporting new blockchain-based business platforms will not be free. Blockchain technologies, like the systems and tools that users need to interact with them, require IT maintenance and support. Finally, because they are still new, for some time blockchain platforms will likely run in parallel with current platforms, which may add short-term costs. So, no, blockchain is not free. That said, understanding its true cost requires identifying the *net value* you may be able to harvest from blockchain cost savings and revenue generation.



Linking the chains

In October 2016, global insurance and asset management firm Allianz teamed up with several other insurance and reinsurance organisations to explore opportunities for using blockchain to provide client services more efficiently, streamline reconciliations, and increase the auditability of transactions.[8]

"Blockchain is a new technology that is a bit mind-bending," says Michael Eitelwein, head of group enterprise architecture at Allianz. "It only makes sense if it is a shared concept, which is the motivating factor for peers in our industry to try and understand this together."

Over the course of the following year, the joint effort—the Blockchain Insurance Industry Initiative (B3i)—welcomed 23 new members from across the insurance sector and began market-testing a new blockchain reinsurance prototype.[9] Test participants were granted access to a "sandbox" environment in which they could simulate creating and settling contracts. "We took a straightforward, iterative, R&D approach," Eitelwein says. "Our goal was to gauge how useful this prototype is in transacting contracts, and to understand its strengths and limitations before taking it to the next level of development."[10]

In addition to participating in B3i, Allianz is working internally to determine if the same basic mechanism can be deployed across its global operations to facilitate interaction among multiple entities—a possibility that, while promising, presents several technical challenges. For example, can a blockchain platform be embedded in the architecture of systems that already communicate with each other? How would policy administration system designs for blockchain differ from traditional designs? And is it even possible to scale existing prototypes sufficiently to meet global enterprise needs?

A broader opportunity looms large above Allianz's blockchain initiatives as well as those underway in other industries: integrating and orchestrating multiple blockchains across a single value chain. Currently, multiple parties can transact digitally only when everyone adopts a single shared ledger technology and one set of standards within a consortium—a limitation that diminishes blockchain's potential value across B2B and peer-to-peer transactions.

"Our view is that blockchain makes sense only if you have common standards for interacting digitally, like those developed for the Internet," Eitelwein says. "This would be especially powerful in retail; you can't have 50 different blockchains for 50 different customers—it would never pay off." Eitelwein says that multi-chain integration is certainly a goal

of blockchain exploration, but the concept remains "unknown territory."

For now, the B3i use case is laying the groundwork for future collaboration and even standardisation across the insurance sector. "If by working together we can eventually create common standards for blockchain processes, we will be able to remove a lot of inefficiency from digital business," Eitelwein says. "This could provide tremendous benefits to our customers, and for the digital economy as a whole. This is what we are aiming for."[11]

Blockchain beyond borders: Hong Kong Monetary Authority

The Hong Kong Monetary Authority (HKMA) is the central banking authority responsible for maintaining the monetary and banking stability and international financial centre status of Hong Kong. Given its scope of responsibilities in developing and operating the territory's financial market infrastructure, it comes as no surprise that its leadership took an interest in exploring blockchain's or distributed ledger technology's (DLT) potential for a variety of financial applications and transactions. After researching the value proposition of the technology alongside the Hong Kong Applied Science and Technology Research Institute, the HKMA published a white paper in November 2016[12] that raised more than 20 governance, legal, regulatory, and operational concerns that the financial industry should address when implementing blockchain or DLT. Leaders then decided to develop a proof of concept (PoC) to test the value proposition as well as to address those concerns.

The proof of concept focused on trade finance for banks, buyers and sellers, and logistics companies. It leveraged DLT to create a platform for automating labour-intensive processes via smart contracts, reducing the risk of fraudulent trade and duplicate financing, and improving the transparency and productivity of the industry as a whole. DLT provided immutable data integrity, enhanced reliability with built-in disaster recovery mechanisms, enabled near-real-time updates of data across the nodes, and acted as a repository for transactional data.

The trade finance PoC ran on a private blockchain network for a 12-week period from December 2016 through March 2017, with five Hong Kong banks participating. In addition to trade finance, HKMA developed two other successful PoCs for mortgage applications and digital identification.

"When banks saw the prototypes, they were excited and keen to commercialise the PoC as quickly as possible," says Shu-pui Li, HKMA executive director of financial infrastructure. "At the beginning of the PoC project, we all thought distributed ledger technology had potential, but we had a lot of questions about whether it would work in a commercial environment. The prototype's success opens up many possibilities."

With seven banks now participating in the trade finance blockchain, HKMA intends to launch a production pilot in the second half of 2018. It plans to have a full commercialised solution in production by 2019. Also, there are a number of other banks waiting in the queue to participate in this platform.

Building on the success of its proofs of concept, HKMA is exploring interconnectivity between blockchains with Singapore's government and Monetary Authority of Singapore (MAS), which could be the foundation of an international blockchain ecosystem. HKMA announced its joint venture with Singapore in October 2017 and a formal cooperative agreement was signed in November between the HKMA and MAS. Both authorities plan to implement the cross-border infrastructure (i.e. Global Trade Connectivity Network) at around the same time that it launches its domestic platform. Then, if other countries want to participate in the network, they would plug their local platform into the integrated distributed ledger technology infrastructure.

Since HKMA doesn't know how many countries might connect to the infrastructure or what technology they might use, Li says the authority is exploring how to address interoperability. "We don't have a perfect solution to interoperability, but we have identified some considerations and have some suggestions. We intend to work through those issues over the next year. But so far, so good. It's encouraging to see so many banks working together to reach a consensus. In addition, a common standard for digitisation of the documentations and trades is a critical success factor for this infrastructure."[13]

My take

Peter Miller, president and CEO

THE INSTITUTES

Over the last 108 years, The Institutes has supported the evolving professional development needs of the risk management and insurance community with educational, research, networking, and career resource solutions. Now, as the industry faces increasingly fast-moving, innovative, and data-driven challenges, insurers have varying levels of knowledge about the benefits of blockchain. The next step is for The Institutes to help educate them about and prepare them for this technology.

People are starting to understand blockchain's broader applications and how it can link various parties; it's a distributed ledger and therefore, by definition, requires cooperation by participants. Like any century-old organisation, we've adapted to our industry's changing needs and problems, and we see blockchain's potential applications. For our industry, blockchain has the capacity to streamline payments, premiums, and claims; reduce fraud through a centralised record of claims; and improve acquisition of new policyholders by validating the accuracy of customer data.

We've formed The Institutes RiskBlock Alliance, the first nonprofit, enterprise-level blockchain consortium. It will bring together risk management and insurance industry experts and blockchain developers to research, develop, and test blockchain applications for industry-specific use cases. It is by design a platform that's agnostic of specific underlying technologies, developed in concert with other groups involved in the insurance industry—from life to property and casualty, including our membership, issuers, reinsurers, brokers, and others. Rather than focusing on single blockchain use cases, we believe in the need to communicate to multiple blockchains and enable federated inter-blockchain communication to facilitate reuse of capabilities among 30 organisations from various industry segments.

To start, we are tackling four use cases that technology has struggled to tame: proof of insurance, first notice of loss, subrogation, and parametric insurance. These cases all include multiple parties working together, using shared data and predefined contracts. They are ideal use cases because we can solve a business problem while demonstrating the capabilities of blockchain technology, which in turn will educate the industry on its potential. And while we're excited about these initial focus areas, there are literally hundreds of equally compelling examples waiting to be explored.

A big challenge to interoperability is getting organisations to work together. We want to enable secure blockchain interconnectivity across the industry, and we are developing a framework that would support this. Since all organisations are under constraints to optimise cost structure, we are looking at an API layer to enable shared data and operations. We envision the consortium controlling the end products, with the integration into back-end legacy systems depending on each vendor.

To facilitate adoption, organisations need to advance along the learning curve and focus on the business problems that blockchain could solve. Finding great partners is essential, as is understanding why confidence in the technology is justified: Blockchain is building on a package of proven technologies—including distributed computing, cryptographic encryption, and hashing—and concerns about its capabilities shouldn't hold back potential agreements for its use, whether in insurance or other industries.

Risk practitioners across industries are excited about blockchain's potential to help organisations manage risks posed by current systems. However, organisations should understand that while blockchain may drive efficiency in business processes and mitigate certain existing risks, it poses new risks broadly classified under three categories: common risks, value transfer risks, and smart contract risks.[14]

COMMON RISKS

Blockchain technology exposes institutions to similar risks associated with current business processes—such as strategic, regulatory, and supplier risks—but introduces nuances for which entities need to account. Organisations that adopt blockchain should evaluate both the participating entities and the underlying platform; the choice of the latter could pose limitations on the services or products delivered, both now and in the future. From an infrastructure perspective, blockchain technology is part of the enterprise's core, so it should integrate seamlessly with back-end legacy systems. Additionally, firms may be exposed to third-party risks, as some of the technology might be sourced from external vendors. For example, the typical risks of cloud implementation apply here for cases in which cloud-based infrastructure is part of the underlying technology for blockchain.

VALUE TRANSFER RISKS

Because blockchain enables peer-to-peer transfer of value, the interacting parties should protect themselves against risks previously managed by central intermediaries. In the case of a blockchain framework, evaluate the choice of the protocol used to achieve consensus among participant nodes in the context of the framework, the use case, and network participant requirements. While the consensus protocol immutably seals a blockchain ledger, and no corruption of past transactions is possible, it remains susceptible to private key theft and the takeover of assets associated with public addresses. For example, if there is fraud on the value-transfer network, and a malicious actor takes over a non-compliant entity, then that actor can transfer and siphon value off of the network.

SMART CONTRACT RISKS

Smart contracts can encode complex business, financial, and legal arrangements on the blockchain, so there is risk associated with the one-to-one mapping of these arrangements from the physical to the digital framework. Additionally, cyber risks increase as smart contracts rely on "oracles" (data from outside entities) to trigger contract execution. Smart contracts apply consistently to all participant nodes across the network; they should be capable of exception handling that adheres to business and legal arrangements and complies with regulations. Like other software code, smart contracts require robust testing and adequate controls to mitigate potential risks to blockchain-based business processes. For example, smart contracts allow for straight-through processing (contractual clauses may be made partially or fully self-executing, self-enforcing, or both) as they directly interact with other smart contracts. One corrupted smart contract could cause a chain reaction that paralyzes the network.

The successful adoption of any new technology is dependent on the appropriate management of the associated risks. This is especially true when that technology is part of the organisation's core infrastructure, as is the case with blockchain. Additionally, it's important to understand the evolution of regulatory guidance and its implications. For example, the Financial Industry Regulatory Authority has shared operational and regulatory considerations for developing use cases within capital markets.[15] Organisations should work to address these regulatory requirements in their blockchain-based business models and establish a robust risk-management strategy, governance, and controls framework.

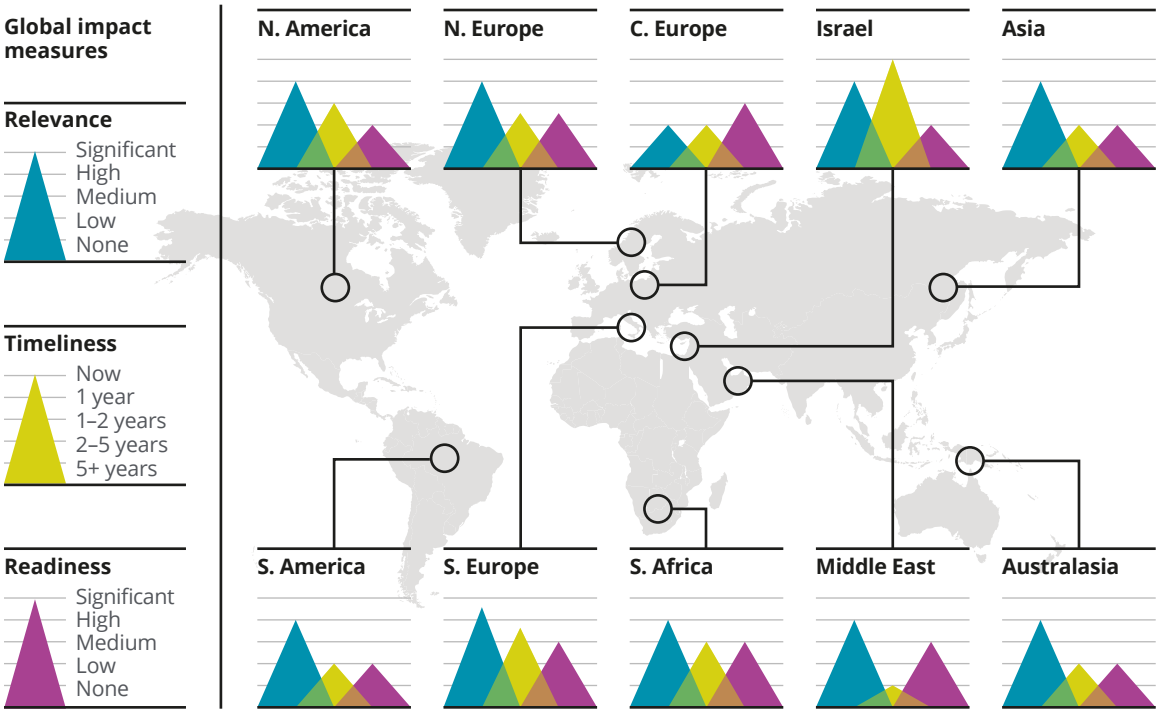
Blockchain technology and its derivatives are continuing to mature, but a number of enabling conditions need to be addressed for its mainstream potential to be realised around the world. Deloitte leaders across 10 global regions see varying levels of certainty around the anticipated impact that the technology could have on financial services, manufacturing, supply chain, government, and other applications. While there are pockets of innovation in places such as Asia Pacific, Northern Europe, and Africa, many countries in Europe and Latin America are taking it slow, awaiting more standardisation and regulation.

The general expected time frame for adoption is two to five years, with some notable exceptions. Most regions have seen an uptick in proof-of-concept and pilot activity, mostly by financial institutions working with blockchain start-ups. A few countries in Africa and Northern Europe are exploring national digital currencies and blockchain-based online payment platforms. In Asia Pacific, several countries are setting up blockchains to facilitate cross-border payments.

The Middle East, while bullish on blockchain's potential—Dubai has announced its intention to be the first blockchain-powered government by 2020, for example[16]—finds itself in the very early phases of adoption; widespread adoption is expected to take up to five years in the region.

In most regions, the main barrier to adoption is public skepticism as well as concerns about regulation. However, as consortiums, governments, and organisations continue to develop use cases for smart contracts, and the public becomes more educated on potential benefits, viable blockchain applications should continue to evolve around the world.

Figure 2. Global impact



Source: Deloitte analysis.

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Where do you start?

Though some pioneering organisations may be preparing to take their blockchain use cases and PoCs into production, no doubt many are less far down the adoption path. To begin exploring blockchain's commercialisation potential in your organisation, consider taking the following foundational steps:

- **Determine if your company actually needs what blockchain offers.** There is a common misconception in the marketplace that blockchain can solve any number of organisational challenges. In reality, it can be a powerful tool for only *certain use cases*. As you chart a path toward commercialisation, it's important to understand the extent to which blockchain can support your strategic goals and drive real value.
- **Put your money on a winning horse.** Examine the blockchain uses cases you currently have in development. Chances are there are one or two designed to satisfy your curiosity and sense of adventure. Deep-six those. On the path to blockchain commercialisation, focusing on use cases that have disruptive potential or those aligned tightly with strategic objectives can help build support among stakeholders and partners and demonstrate real commercialisation potential.
- **Identify your minimum viable ecosystem.** Who are the market players and business partners you need to make your commercialisation strategy work? Some will be essential to the product development life cycle; others will play critical roles in the transition from experimentation to commercialisation. Together, these individuals comprise your minimum viable ecosystem.
- **Become a stickler for consortium rules.** Blockchain ecosystems typically involve multiple parties in an industry working together in a consortium to support and leverage a blockchain platform. To work effectively, consortia need all participants to have clearly defined roles and responsibilities. Without detailed operating and governance models that address liability, participant responsibilities, and the process for joining and leaving the consortium, it can become more difficult—if not impossible—to make subsequent group decisions about technology, strategy, and ongoing operations.
- **Start thinking about talent—*now*.** To maximise returns on blockchain investments, organisations will likely need qualified, experienced IT talent who can manage blockchain functionality, implement updates, and support participants. Yet as interest in blockchain grows, organisations looking to implement blockchain solutions may find it increasingly challenging to recruit qualified IT professionals. In this tight labour market, some CIOs are relying on technology partners and third-party vendors that have a working knowledge of their clients' internal ecosystems to manage blockchain platforms. While external support may help meet immediate talent needs and contribute to long-term blockchain success, internal blockchain talent—individuals who accrue valuable system knowledge over time and remain with an organisation after external talent has moved on to the next project—can be critical for maintaining continuity and sustainability. CIOs should consider training and developing internal talent while, at the same time, leveraging external talent on an as-needed basis.

Bottom line

With the initial hype surrounding blockchain beginning to wane, more companies are developing solid use cases and exploring opportunities for blockchain commercialisation. Indeed, a few early adopters are even pushing PoCs into full production. Though a lack of standardisation in technology and skills may present short-term challenges, expect broader adoption of blockchain to advance steadily in the coming years as companies push beyond these obstacles and work toward integrating and coordinating multiple blockchains within a single value chain.

CONTACTS

MICHAEL ROBINSON
Partner, Technology Consulting
Deloitte LLP
+44 20 7007 8524
microbinson@deloitte.co.uk

TYLER WELMANS
Senior Manager, Technology Consulting
Deloitte LLP
+44 20 7303 5653
twelmans@deloitte.co.uk

RUCHIR DALMIA
Consultant, Technology Consulting
Deloitte LLP
+44 20 7007 8595
rudalmia@deloitte.co.uk

AUTHORS

ERIC PISCINI

Principal, Deloitte Consulting LLP

DARSHINI DALAL

Technology Strategist, Deloitte Consulting LLP

Risk implications

DAVID MAPGAONKAR

Principal, Cyber Risk Services, Deloitte LLP

PRAKASH SANTHANA

Managing Director, Deloitte Transactions and Business Analytics LLP

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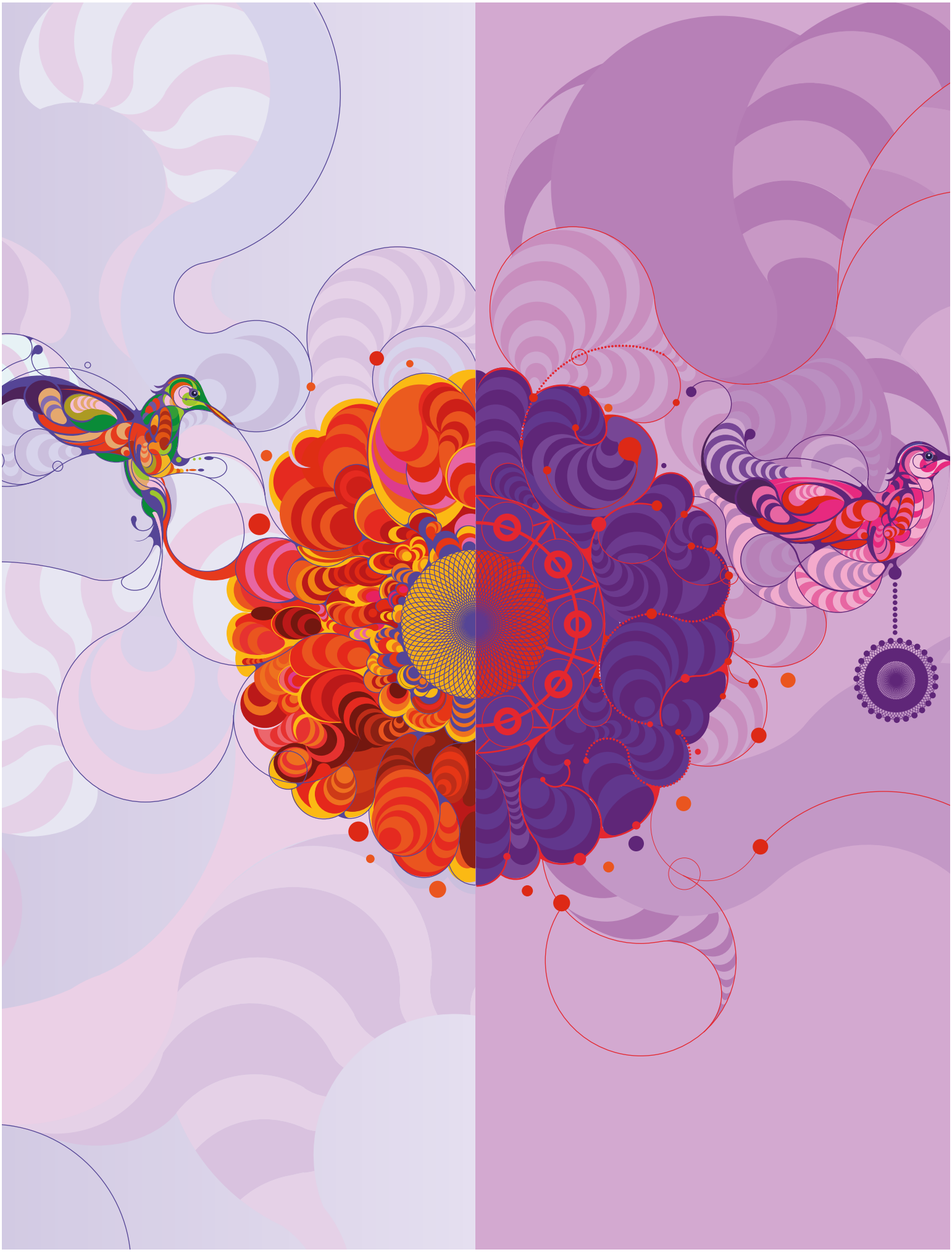


API imperative

From IT concern to business mandate

For many years, application programming interfaces (APIs) have made it possible for solutions and systems to talk to each other. But increasingly, companies value these often-overlooked technologies for another capability: They expose technology assets for reuse across and beyond the enterprise. Not only can reuse drive greater ROI in IT investments—it can offer API consumers a set of building blocks for using existing data, transactions, and products in creative ways. As part of the growing API imperative trend, organisations have begun exploring new ways to expose, manage, and control APIs. As this trend gathers momentum in the coming months, expect further innovative approaches to emerge for contracting, pricing, servicing, and even marketing a venerable technology that has become a critical pillar of many digital ambitions.

LOOKING back across successive industrial revolutions, interoperability and modularity have consistently delivered competitive advantage. Eli Whitney's interchangeable rifle parts gave way to Henry Ford's assembly lines, which ushered in the era of mass production. Sabre transformed the airline industry by standardising booking and ticketing processes—which in turn drove unprecedented collaboration. Payment networks simplified global banking, with SWIFT and FIX becoming the backbone of financial exchanges, which in turn made dramatic growth in trade and commerce possible.

The same concept manifests in the digital era as "platforms"—solutions whose value lies not only in their ability to solve immediate business problems but in their effectiveness as launching pads for future growth. Look no further than the core offerings of global digital giants, including Alibaba, Alphabet, Apple Inc., Amazon, Facebook, Microsoft, Tencent, and Baidu. These companies have become dominant in part by offering platforms that their customers can use to extend services to entire ecosystems of end users, third parties, and others—platforms

designed around the principles of interoperability and modularity.

In the world of information technology, application programming interfaces (APIs) are one of the key building blocks supporting interoperability and design modularity. APIs, an architectural technique as old as computer science, can help improve the way systems and solutions exchange information, invoke business logic, and execute transactions. In previous editions of *Tech Trends*, we have tracked the growth of API deployment and the increasingly critical role that APIs are playing in systems architecture, innovation, modernisation, and in the burgeoning "API economy."[1] This growth continues apace: As of early 2017, the number of public APIs available surpassed 18,000, representing an increase of roughly 2,000 new APIs over the previous year.[2] Across large enterprises globally, private APIs likely number in the millions.

What accounts for such growth? Increasingly, APIs are becoming a strategic mandate. If every company is a technology company, then the idea that technology assets should be built for reuse seems intuitive. Reuse compounds return on technology investments in ways that couldn't be imagined when IT departments were developing many legacy solutions.

That said, reuse requires new capabilities to manage the exchange of what is essentially an encapsulation of intellectual property. These new capabilities also make it possible to support the flow of information and operations across organisational boundaries, and to manage the discovery, usage, and servicing of API assets. Collectively, the strategic intent of APIs and this underlying enabling response represent the API imperative trend.

A fresh look

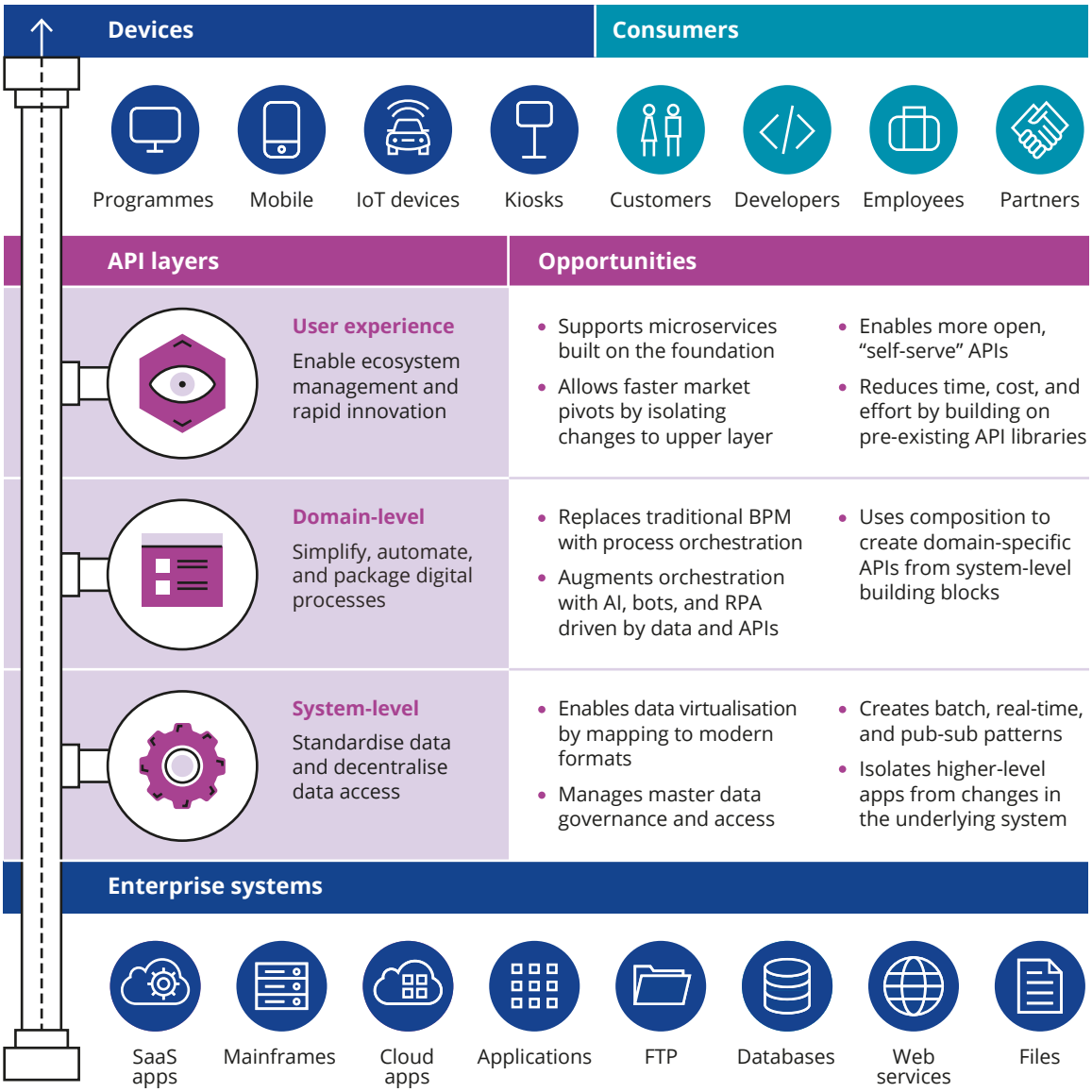
Given that APIs have been around for many years, moving forward suggests that we separate the tenets of the API imperative trend from previous incarnations and potential biases. Large, complex projects have always featured interfaces that exchange information between systems. A vast majority of these interfaces were, and continue to be, completely bespoke, engineered to meet specific project needs. As point-to-point interfaces proliferated, complex interdependencies between systems begat the spaghetti diagrams that represent too many IT landscapes today. In brittle, custom-built interfaces, customer, order, product, and sales information is often duplicated; making changes has required trying—often unsuccessfully—to unwind a tangled mess. Meanwhile, each successive project introduces new interfaces and more complexity.

APIs were an attempt to control the chaos by encapsulating logical business concepts like core data entities (think customer or product) or transactions (for example, "place an order" or "get price") as services. APIs could be consumed in broad and expanding ways. What's more, good API design also introduced controls to help manage their own life cycle, including:

- **Versioning.** The ability to change without rendering older versions of the same API inoperable.
- **Standardisation.** A uniform way for APIs to be expressed and consumed, from COM and CORBA object brokers to web services to today's RESTful patterns.
- **API information control.** A built-in means for enriching and handling the information embodied by the API. This information includes metadata, approaches to handling batches of records, and hooks for middleware platforms, message brokers, and service buses. It also defines how APIs communicate, route, and manipulate the information being exchanged.

Today, many organisations have yet to fully embrace API opportunities. We know anecdotally that while developing shared APIs inside IT is growing in popularity, traditional project-based, siloed integration approaches remain the rule, not the exception. Much of IT's budget and effort go into paying back technical debt and maintaining legacy assets that were not designed to gracefully expose data

Figure 1. API logical architecture



Source: Deloitte analysis.

and business logic. Remediating that existing legacy to be API-friendly is akin to open-heart surgery.

At the same time, rebuilding a foundation with greenfield solutions can be challenging, adding new expectations of cost, time, and complexity to project plans. It also requires a different set of skills to architect and realise the vision. For many companies, the prospect of disrupting established controls, budgeting models, processes, and talent models seems daunting—especially if the "so what" is left as a tactical IT architecture decision.

And this apprehension is hardly unfounded: The need for agility, scalability, and speed grows more pressing each month as innovation presents new opportunities, remakes markets, and fuels competition. Over the next 18 to 24 months, expect many heretofore cautious companies to embrace the API imperative—the strategic deployment of application

programming interfaces to facilitate self-service publishing and consumption of services within and beyond the enterprise.

The why to the what

In embracing the API imperative, companies are making a strategic choice. They are committing to evolve their expectations of technology investments to include the creation of reusable assets—and committing to build a lasting culture of reuse to inform future project planning. Preparing, both strategically and culturally, to create and consume APIs is key to achieving business agility, unlocking new value in existing assets, and accelerating the process of delivering new ideas to the market.

APIs can deliver a variety of operational and strategic benefits. For example, revitalising a legacy system with modern APIs encapsulates intellectual property and data contained within that system, making this information reusable by new or younger developers who might not know how to use it directly (and probably would not want to). Likewise, building APIs onto monument systems makes it possible to extract more value from IT assets, while at the same time using valuable existing data to drive new innovations. Finally, incorporating APIs into new applications allows for easier consumption and reuse across new web, mobile, and IoT experiences, not to mention the option for exposing those APIs externally to enable new business models and partner ecosystems.

APIs' potential varies by industry and the deploying company's underlying strategy. In a recent in-depth study of API use in the financial services sector, Deloitte, in collaboration with the Association of Banks and the Monetary Authority in Singapore, identified 5,636 system and business processes common to financial services firms, mapping them to a manageable collection of 411 APIs.[3] Once created, these building blocks could allow for vastly accelerated development of new solutions and offerings—from blockchain-driven trade finance to a virtual-reality retail branch experience.

Support from the top

As companies evolve their thinking away from project- to API-focused development, they will likely need to design management programmes to address new ways of:

- **Aligning budgeting and sponsorship.** Embed expectations for project and programme prioritisation to address API concerns, while building out shared API-management capabilities.
- **Scoping to identify common reusable services**. Understand which APIs are important and at what level of granularity they should be defined; determine appropriate functionality trade-offs of programmatic ambitions versus immediate project needs.
- **Balancing comprehensive enterprise planning with market need**. In the spirit of rapid progress, avoid the urge to exhaustively map potential APIs or existing interface and service landscapes. Directionally identifying high-value data and business processes, and then mapping that list broadly to business's top initiative priorities, can help prevent "planning paralysis" and keep your API projects moving.
- **Incenting reuse before "building new."** Measure and reward business and technology resources for taking advantage of existing APIs with internal and external assets. To this end, consider creating internal/external developer forums to encourage broader discovery and collaboration.
- **Staffing new development initiatives to enable the API vision.** While IT should lead the effort to create effective API management programmes, it shouldn't be that function's sole responsibility. Nor should IT be expected to build and deliver every API integration. Consider, instead, transforming an existing shared-services centre of excellence (COE) that involves the

lines of business. Shifting from a COE mentality that emphasises centralised control of all shared services to a federated center for enablement (C4E) approach—tying in stakeholders and development resources enterprise-wide—can help organisations improve API program scalability and management effectiveness.

Enterprise API management

Deploying and scaling APIs requires capabilities that are different from those typically used in established integration and messaging layers. Whether APIs are being consumed internally to orchestrate a new business process or externally as parts of new products, managing APIs deliberately throughout their life cycle can help make them more discoverable, serviceable, and more easily monitored.

As your ambitions evolve, explore how one or more of the following technology layers can help you manage APIs more strategically throughout their life cycle:

- **API portal:** a means for developers to discover, collaborate, consume, and publish APIs. To support the overall goal of self-service, these portals describe APIs in a way that represents their functionality, context (the business semantics of what they do, and how they do it), nonfunctional requirements (scalability, security, response times, volume limits, and resiliency dimensions of the service), versioning, and metrics tracking usage, feedback, and performance. For organisations without mature master data or architectural standards, the API portal can still offer visibility into existing APIs and provide contact information for individuals who can describe features, functions, and technical details of services.
- **API gateway:** a mechanism that allows consumers to become authenticated and to "contract" with API specifications and policies that are built into the API itself. Gateways make it possible to decouple the "API proxy"—the node by which consumers logically interact with the service—from the underlying application for which the actual service is being implemented. The gateway layer may offer the means to load balance and throttle API usage.
- **API brokers:** enrichment, transformation, and validation services to manipulate information coming to/from APIs, as well as tools to embody business rule engines, workflow, and business process orchestration on top of underlying APIs.
- **API management and monitoring:** a centralised and managed control level that provides monitoring, service level management, SDLC process integration, and role-based access management across all three layers above. It includes the ability to instrument and measure API usage, and even capabilities to price and bill chargeback based on API consumption—to internal, or potentially external, parties.

Tomorrow and beyond

The *API imperative* trend is a strategic pillar of the reengineering technology trend discussed earlier in *Tech Trends 2018*. As with *reengineering technology*, the API imperative embodies a broader commitment not only to developing modern architecture but to enhancing technology's potential ROI. It offers a way to make broad digital ambitions actionable, introducing management systems and technical architecture to embody a commitment toward business agility, reuse of technology assets, and potentially new avenues for exposing and monetising intellectual property.

Skeptic's corner

Even with digital platform use cases proliferating and excitement about reusability gaining traction, who can really blame veteran CIOs for harboring a few reservations about the API imperative trend? After all, in a media climate in which every new innovation is described as earth-shattering, it is sometimes difficult to separate fact from fiction.

Let's set the record straight on a few common misconceptions about APIs and their potential:

Misconception: APIs have been around for a long time. There's nothing new here.

Reality: Yes, IT organisations have deployed APIs in different ways for years. Even though a lack of standards and immature underlying technology limited their potential, the vision behind them was, and remains today, remarkably grounded. In the last generation of APIs, many mistakenly thought that service-oriented architecture initiatives powered via SOAP-based web services would deliver on APIs' promise. The issue? The underlying protocols and supporting stacks were complex and offered limited reach. Repositories such as UDDP never reached maturity, and the lack of cloud platforms and services constrained broader scale. Today, however, developers are following Silicon Valley's lead by reimagining core systems as microservices, building APIs using modern RESTful architectures, and taking advantage of robust, off-the-shelf API management platforms.

Increasingly, organisations are deploying a microservices approach for breaking down systems and rebuilding them as self-contained embodiments of business rules. Traditional approaches to wrap specific chunks of functionality within a more complex code base succeeded in exposing a transaction or data element as an interface or API. However, they didn't allow individual APIs to scale or evolve independent of the whole. Microservices look to break larger applications into small, modular, independently deployable services. This approach turns the rhetoric of SOA into a modernised application architecture and can magnify APIs' impacts.

REST stands for "representational state transfer." APIs built according to REST architectural standards are stateless and offer a simpler alternative to some SOAP standards. For example, REST enables plain-text exchanges of data assets instead of using complex WSDL protocols. It also makes it possible to inherit security policies from an underlying transport mechanism. At a high level, these and other simplified approaches can deliver better performance and faster paths to develop, deploy, and triage.

Finally, API management platforms have evolved to complement the core messaging, middleware, and service bus offerings from yesteryear. Vendors include new entrants and established players, including IBM, SAP, Oracle, Tibco, MuleSoft, Dell, Software AG, CA, Dell, and Apigee.

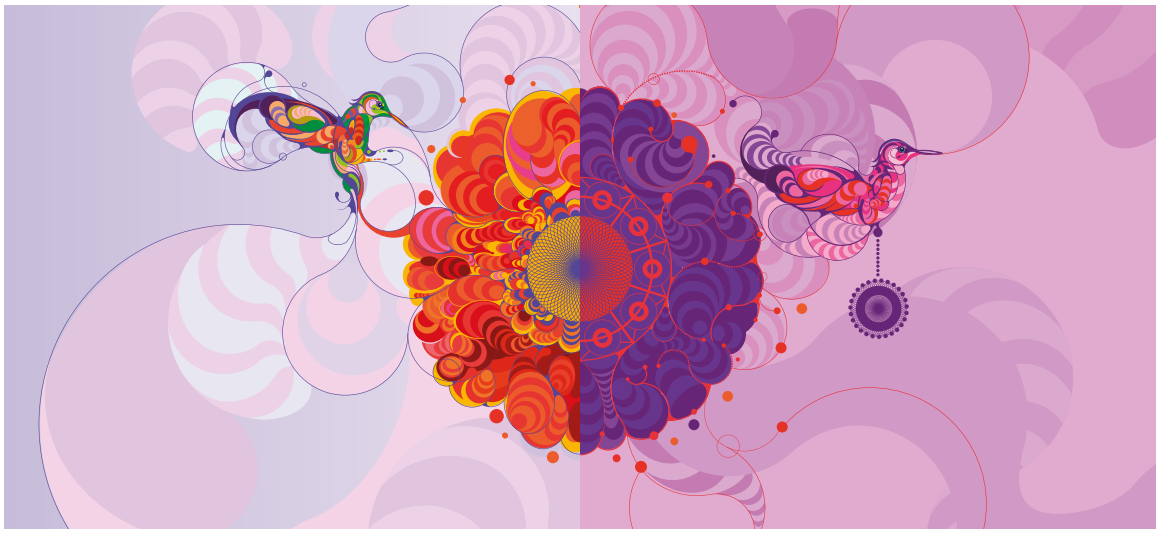
Misconception: Project-based execution is cheaper and faster. I don't have time to design products.

Reality: With urgent projects, or those dependent upon tactical integrations, you may not be able to invest much design time up front. But understand that you will have to duplicate your efforts, A to Z, when you begin the next project. By spending some time on understanding cross-project requirements and designing for reuse, your costs—in both time and budget—become leveraged, and the value you create compounds over time. The goal is not to construct centralised, enterprise-wide controls and governors—rather, it is to create assets that can empower teams to drive accelerated time-to-value. Sure, there will be some stand-up cost. And the initial projects

will involve scoping, designing, and building different types of assets. Consider subsidising those investments so that business owners and project sponsors don't feel as though they are being taxed. Also, look for ways to reward teams for creating *and* consuming APIs.

Misconception: I don't have the executive sponsorship I need to take on an API transformation. If I don't sell it up high and secure a budget, it's not going to work.

Reality: You don't have to take on a full-blown API transformation project immediately. Begin building a business case by completing a few small, low-cost projects that demonstrate the ROI around reuse of a common set of APIs. CIOs may be able to develop a proof point with as few as three APIs delivered across two or more projects (three is a manageable number to prove reuse ROI). Subsequent success with a few tightly scoped projects can then help lay the groundwork for business support and, eventually, executive sponsorship.



AT&T's lean, mean API machine

In the last decade, AT&T embarked upon a series of mergers, uniting several large companies. They resulted in an IT organisation having to manage more than 6,000 applications, as well as distinct operating and software development life cycle processes, each of which worked well in its own right. With the ultimate goal of bringing all of these applications and processes under the AT&T umbrella, the organisation pursued a transformation effort to integrate the systems, remove duplicate costs, streamline global products and network care, and increase speed—all while delivering an effortless customer experience. To enable this transformation, the company defined a variety of big technology plays, with API platforms as the core, integral component.

The first step was application rationalisation, which leaders positioned as an enterprise-wide business initiative. In the last decade, the IT team reduced the number of applications from 6,000-plus to 2,500, with a goal of 1,500 by the year 2020. When the team started the rationalisation process in 2007, they quickly recognised the need for a modern, platform-based architecture designed for reuse rather than purpose-built applications with point-to-point interfaces. The team spent the next couple of years putting a platform architecture in place, and then introduced an API layer in 2009 with a common data model across the wired and wireless business.

"We saw an opportunity to reduce the total cost of ownership by billions of dollars, as well as achieve huge savings for care centres as they were consolidated," says Sorabh Saxena, president of business operations (formerly, CIO of network and shared services) for AT&T. "APIs also enable more agility and speed to market for product teams. The goal was to motivate both the corporate and technology teams to build a software-driven, platform-based company."[4]

AT&T made the API platform the focus of its solutions architecture team, which fields more than 3,000 business project requests each year and lays out a blueprint of how to architect each solution within the platform. Saxena's team implemented a federated development programme so each business unit's unique needs would be taken into consideration on the API platform. As a $160 billion-plus company, some voiced concerns that business knowledge couldn't be centralised on one team. AT&T now has close to 200 federated development teams, aligned to the applications themselves. Federated teams develop on the platform, combining the commonality of the platform with the teams'

business knowledge. However, the platform teams are responsible for the environment, development standards, design and test assurance, deployment, and production support.

In the beginning, they seeded the API platform by building APIs to serve specific business needs. Over time, the team shifted from building new APIs to reusing them. In 2017, they had approximately 4,000 instances of reuse, which Saxena values at hundreds of millions in savings over the years. Likewise, by September 2017, AT&T had 24 billion transactions per month on its API platforms—for internal, developer, and business-to-business applications—compared to 10 billion transactions per month in 2013. The number of APIs has grown more than threefold in that timeframe, and cycle time and quality have improved significantly. Though the API platform hasn't removed all instances of point-to-point application interfaces, the bias is to use APIs.

But in the beginning, the IT team needed to encourage buy-in across the organisation for the API strategy. Saxena says teams were reluctant at first, expecting latency to result from a shared services model, so his team cultivated relationships with local champions in each area of the organisation and tied their performance to the programme. They also zoned in on potential detractors and proactively provided white-glove service before any issues bubbled up, thereby increasing overall support.

Additionally, the team instituted an exception process that was "made *painful* on purpose." Saxena hosted a twice-weekly call in which departments presented a request to build an application outside the API platform, and he would personally approve or deny the exception. In the beginning, there was a 20 percent exception rate that eventually stabilised to 4 to 5 percent, as teams saw that the upfront investment would quickly pay back, with big dividends. They redirected business funding to build the APIs, which became the architecture standard. By sharing reuse benefits with the business, the API platform has succeeded in speeding up deployment while lowering costs.

The next step in AT&T's transformation is a microservices journey. The team is taking monolithic applications with the highest spend, pain points, and total cost of ownership, and turning them and all the layers—UI/UX, business logic, workflow, and data, for example—into microservices. At AT&T the microservices transformation has tangible business goals. Since "change" is the one constant, the goals are to increase the speed, reduce the cost, and reduce the risk of change to the enterprise suite of APIs. The "right sizing" of microservices versus previous monoliths helps componentise the distributed business functions, which facilitates change. To ease the microservices transition, the team is deploying a hybrid architecture, putting in place an intelligent routing function to direct services to either the monolith or microservices, and implementing data sharing.

The API and microservices platform will deliver a true DevOps experience (forming an automated continuous integration/continuous delivery pipeline) supporting velocity and scalability to enable speed, reduce cost, and improve quality. The platform will support several of AT&T's strategic initiatives: artificial intelligence, machine learning, cloud development, and automation, among others.

"We positioned the API journey as a business initiative, rather than a technology effort," Saxena says. "We worked with product partners to educate them on how technology changes would streamline nationwide product launches, with single processes, training programmes, and greater flexibility in arranging the workforce. We built the necessary upswell and secured the support across teams. Now, whenever we want to do something new with technology, we think business first."

The Coca-Cola Co.: APIs are the real thing

What's the secret to being an industry leader for 131 years? For the Coca-Cola Co., it's adapting to the needs and desires of its customers, which entails everything from crowdsourcing new sweeteners to delivering summer shipments via drones. More importantly, it means embracing digital, a goal set by the organisation's new CEO, James Quincy. The enterprise architecture team found itself well positioned for the resulting IT modernisation push, having already laid the foundation with an aggressive API strategy.

"All APIs are not created equal," says Michelle Routh, Coca-Cola chief enterprise architect. "It's one thing to have an API, and another thing to have an API that operates well."

Coca-Cola's API journey began several years ago, when Routh was CIO for North America and she and her team put in place a modern marketing technology platform. They moved all of their applications onto the public cloud and based their marketing technology platforms on software-as-a-service solutions. Routh's team then built an API conceptual layer across the marketing and technology stack, facilitating a move from a monolithic to a modern platform. Next, they decomposed and decoupled the platform into a set of easily consumable microservices and made them available to the thousands of marketing agencies with which they work.

The team leveraged Splunk software to monitor the APIs' performance; this enabled them to shift from being reactive to proactive, as they could monitor performance levels and intervene before degradation or outages occurred. A friendly competition ensued between the teams and departments providing APIs to build the best performer, resulting in even greater efficiencies over time. The marketing agencies could access the services quickly and easily, and Coca-Cola scaled its investment with agility and speed-to-market, resulting in best-in-class digital marketing.

Now the enterprise architecture team is leveraging that experience as it works alongside the chief digital officer to transform Coca-Cola's business and modernise its core to meet the demands of a digital enterprise. The organisation is undergoing a systemwide assessment to gauge its readiness in five areas: data, digital talent, automation innovation, cloud, and cyber. The enterprise architecture team is developing reference architectures to align with each of those five capabilities—mapping all the way to an outcome that builds a solution for a particular business problem. Routh realised that to become more digital, the company needs to do things at scale to drive growth: "For us to provide a technology stack for a truly digital company, we need a set of easily consumable APIs to help the business go to market quickly."

The modernisation programme first targeted legacy systems for Foodservice, one of Coca-Cola's oldest businesses. The challenge was to convince long-established customers—some with contracts dating back a century—that moving away from paper-based data delivery would make it easier to do business with the company. The ability to develop and publish standard APIs facilitated the process and elevated the organisation's engagement with those customers.

"We want to be able to offer a series of services that people can call on, by domain, to start building their own experiences right away," says Bill Maynard, Coca-Cola global senior director of innovation and enterprise architecture. "We don't debate the need for APIs. We just do it."

Indeed, APIs have already become an integral part of the fabric of the new, digital Coca-Cola. "When we look at the business case, we don't decompose it into parts," Routh says. "Migrating to the public cloud, embracing Agile methodology and DevOps, and building an API layer were all components of the overall initiative to move to a modern best-in-class technology stack. The collective of all three is enabling our growth and allowing us to achieve a digital Coca-Cola."[5]

State of Michigan optimises resources through reuse

The State of Michigan's Department of Technology, Management and Budget (DTMB) provides administrative and technology services and information for departments and agencies in the state government's executive branch. When the Michigan Department of Health and Human Services (MDHHS) needed to exchange Medicaid-related information across agencies in support of legislative changes mandated by the Affordable Care Act, DTMB implemented an enterprise service bus and established a reusable integration foundation.

Later, the health and human services department embarked on a mission to reform how the agency engages with citizens, seeking to tailor service delivery to specific citizen needs via an Integrated Service Delivery programme. In expanding services to help more families achieve self-sufficiency, the department—offering new cloud-based, citizen-facing programmes—needed to scale technology to support the increased activity. DTMB decided to evolve its architecture to expand the enterprise service bus and add an API layer. An API layer would allow for reuse and scalability, as well as provide operational stability through service management, helping to prevent outages and performance degradation across the system by monitoring and limiting service consumers.

"Paired with our ongoing cloud initiatives, APIs were a sensible approach for a more effective architecture and reuse across all state agencies," says DTMB general manager Linda Pung. "They can share APIs with each other to help drive down cost, as well as facilitate a quicker time to market."[6]

DTMB has taken a multi-phased approach in leveraging APIs with existing IT assets such as back-end systems, data, enterprise shared services, and infrastructure. Data is the key driver to the entire strategy.

"We need to support sharing data in a standardised and simplified manner between cloud services and on-premises data sources, not only in the department but across multiple agencies to enable better customer service and data security," says Judy Odett, DTMB's business relationship manager. "Additionally, the solution must be scalable so it can continue to expand with additional datasets over time."

The first step was to expand the enterprise service bus to enable the cloud-based portal to leverage existing state assets. This was followed by the deployment of an API management platform, building upon existing architecture and enabling reuse. The team chose a platform that allowed rate limiting and load balancing, as well as the ability to ingrain the state's security policies. DTMB recently released its first pilot phase with bounded functionality, and the department plans to roll out the platform enterprise-wide, with full functionality, in the near future. A service management solution will provide a portal for DTMB architects to review and analyse consolidated web services, a responsibility that each individual system owner currently handles. This will reduce the number of duplicate web services and facilitate reuse.

Development time has decreased by leveraging existing enterprise shared services such as a master person index and address cleansing. It also has achieved centralised security by allowing citizens to verify their identities through third-party identity management services and enabling secure data exchange through centralised gateway services. Finally, MDHHS is anticipating a reduction in the number of customer inquiries by enabling citizens to access data through mobile applications supported by the APIs.

Reaction to the pilot has been positive, and the faster time to market, improved operational stability, and data quality are already yielding benefits to the consumers.

CIBC: Building the bank of the future

In the new digital economy, consumer expectations are rapidly evolving. They want "frictionless" transactions and rich digital experiences. Like many financial institutions, the Canadian Imperial Bank of Commerce (CIBC), a 150-year-old institution, is building new capabilities to help it meet customers' increasingly sophisticated needs. This means integrating new functionality into its existing infrastructure. However, technology integration—whether it be extending an existing capability or introducing a new one—is often time-consuming and expensive. While CIBC has been on a service-oriented architecture journey for over a decade, it wants to further modernise its architecture to reduce the cost and effort of integration, while continuing to meet customer demands for an end-to-end experience.

Building a platform for integration is not new to CIBC, which has thousands of highly reusable web services running across its platform. But the team recognised that the current SOA-based model is being replaced by a next-gen architecture—one based on REST-ful APIs combined with a micro-services architecture.

CIBC evaluated different approaches for modernising its integration architecture, and decided to focus on cloud-native, open-source frameworks. The bank moved to a self-service publishing model, where API consumers can access microservices without a traditional API gateway intermediary. This simplified, democratised model has alleviated the bottlenecks common to more traditional approaches.

"From a technology standpoint, the combination of APIs, the cloud, and open source frameworks such as Light4J are creating tremendous benefit," says Brad Fedosoff, CIBC vice president and head of enterprise architecture. "We currently have APIs implemented across some of our production systems, and implementation has been faster and cheaper, with greater flexibility, than initially thought."

For example, internally CIBC identified a new technology for its data services. Working with the API platform team, CIBC had a working version a week later. Traditionally, this request would have taken months to come to fruition. From a business perspective, CIBC has been able to innovate and offer new capabilities in rapid fashion. One example is its Global Money Transfer service that allows clients in Canada to send money to more than 50 countries for no fee. The IT team quickly integrated internal and external capabilities from third parties to simplify the money transfer and to provide a smooth experience for its customers.

As it continues to evolve its customer experience, CIBC is turning its attention to payments and identity as the next areas of opportunity to expand its API footprint.

"We envision an API/microservices-based approach as the heart of the Global Open Banking movement," Fedosoff says. "Financial services firms will look to open up capabilities, and as a result, will need to develop innovative features and effortless journeys for clients. APIs may be a smart way to do it."[7]

My take

Werner Vogels, vice president and chief technology officer

AMAZON.COM

When Jeff Bezos started building Amazon, there was nothing else like it from a technology perspective. We were doing iterative development on a monolithic codebase that included everything from content to customer service apps to the logistics of shipping packages. Amazon's mantra has always been "delight customers," and that has been the driving force behind our evolutionary journey.

With each stage of growth, we refine our approach. Around 2000, our engineers were building stateless applications maintained in back-end databases. These databases were shared resources, so employees could easily access the data they needed and not worry about where the data lived. As Amazon rapidly scaled—adding product categories and expanding internationally—these shared resources became shared obstacles, compromising speed.

So the engineers started thinking about a different kind of architecture, one in which each piece of code would own its own database and encapsulated business logic. We called them "services," well before the popularity of service-oriented architecture. Dependencies were embodied in APIs, giving teams the freedom to make rapid changes to the underlying data model and logic as the business demanded. This allowed an evolutionary approach to engineering and let us carve out the monolith, piece by piece. Performance metrics began ramping up again.

Then, around 2004, we realised that a few of the services had become as big as the monolith had been. Services were organised by data—order, customer, products—which had exploded as the business grew. For example, a single service maintained all of the code that operated on Amazon's global customer base, even as that base expanded exponentially. Different capabilities needed different levels of service, but because they were grouped together, everything had to resort to the highest common need—for scalability, security, reliability, and more. We realised we needed to shift to a functional decomposition, creating what we now call microservices. We ended up with around 600 to 800 services.

After enjoying several years of increased velocity, we observed productivity declining again. Engineers were spending more and more time on infrastructure: managing databases, data centres, network resources, and load balancing. We concluded that a number of capabilities were much better suited to be shared services, in which all of our engineers could reuse technology without having to carry the burden of solving for the underlying platform. This led to the build-out of the technical components that would become Amazon Web Services (AWS).

Amazon is a unique company. It looks like a retailer on the outside, but we truly are a technology company. Senior management is not only supportive of technology initiatives—they are technologists themselves who take part in the architectural review. Technology is not a service group to the business—the two are intertwined. We hire the best engineers and don't stand in their way: If they decide a solution is best, they are free to move forward with it. To move fast, we removed decision-making from a top-down perspective—engineers are responsible for their teams, their roadmaps, and their own architecture and engineering; that includes oversight for reuse of APIs. Teams are encouraged to do some lightweight discovery to see whether anybody else has solved parts of the problems in front of them, but we allow some duplication to happen in exchange for the ability to move fast.

Our experience with services and APIs has been crucial to building AWS, which turns everything—whether it's a data centre, outbound service, network, or database—into a software component. If we hadn't experienced the process ourselves, we would have been unable to understand either the value it would have for our customers or the needs our customers would have to build, run, and evolve in such an environment. We realised this technology could help Internet-scale companies be successful, and it completely transformed the technology industry. Now, many of our AWS customers are transforming their worlds as well.

Speed of execution and speed of innovation are crucial to Amazon's business. The shift to APIs enabled agility, while giving us much better control over scaling, performance, and reliability—as well as the cost profile—for each component. What we learned became, and remains, essential to scaling the business as we continue to innovate and grow.

Historically, organisations secured their siloed and controlled environments by locking down devices, systems, and platforms in order to protect data that lived inside their own four walls. In today's computing environment, with the proliferation of loosely coupled systems, multi-vendor platforms, integrations across traditional enterprise boundaries, and open APIs, this strategy is likely no longer adequate.

Today's API imperative is part of a broader move by the enterprise to open architectures—exposing data, services, and transactions in order to build new products and offerings and also to enable more efficient, newer business models. But this expansion of channels inherently increases the permeability of an organisation's network, which can create new seams and a broader attack surface that can be exploited as a result of new vulnerabilities.

Cyber risk should be at the heart of an organisation's technology integration and API strategy. Organisations should consider how to secure data travelling across and beyond enterprise boundaries—managing API-specific identities, access, data encryption, confidentiality, and security logging and monitoring controls as data travels from one API to another.

An API built with security in mind from the start can be a more solid cornerstone of every application it enables; done poorly, it can multiply application risks. In other words, build it in, don't bolt it on:

- Verify that your API developers, both internal and third-party, employ strong identity authentication, authorisation, and security-event logging and monitoring practices.
- Build in second-level factors of authentication and in-memory, in-transit, and at-rest data encryption methods when high-risk data sets or environments are involved.
- Evaluate and rigorously test the security of third-party APIs you leverage.
- Clearly understand the exposure and technical security requirements of public versus private APIs, and apply enhanced security due diligence and monitoring considerations on your public API set.
- Allocate enough time to conduct API unit and integration security testing exercises to detect and fix potential security vulnerabilities. Lack of credential validation, data type checking, data validation, improper error handling, insufficient memory overflow handling, and privilege escalation are just a few examples of issues on which hackers can capitalise.

While APIs can introduce new risks to an ecosystem, they can also help organisations facilitate standardised, dynamic protection against evolving threats.

An open and API-forward architecture can be well suited to address and help standardise on the implementation of core security, monitoring, and resiliency requirements in computing environments. Cyber risk capabilities made available to applications, developers, partners, and third parties alike through a standardised API set can help address security policy mandates, minimum security and privacy guidelines, and compliance obligations. When common cyber risk APIs are implemented effectively, organisations can update, upgrade or re-engineer services such as identity and access management, data encryption, certificate management, and security logging and monitoring, and have this enhanced functionality be automatically pushed out across their enterprise, extraprise, or customer base. APIs can also improve an organisation's resiliency posture and enable rapid updates when new threats are identified—within a matter of hours, not days—thereby helping to reduce costs, operational overhead, and overall time to detect and respond. Many security technology vendors are also moving to open API-based models, which could mean an increasingly integrated security ecosystem in which multi-vendor platforms integrate with one another to present a united front rather than layers of disjointed security solutions that could present exposures which hackers can exploit.

As APIs become more common in organisations, the flexibility and scalability they provide can help improve an enterprise's approach to being more secure, vigilant, and resilient against cyber-attacks.

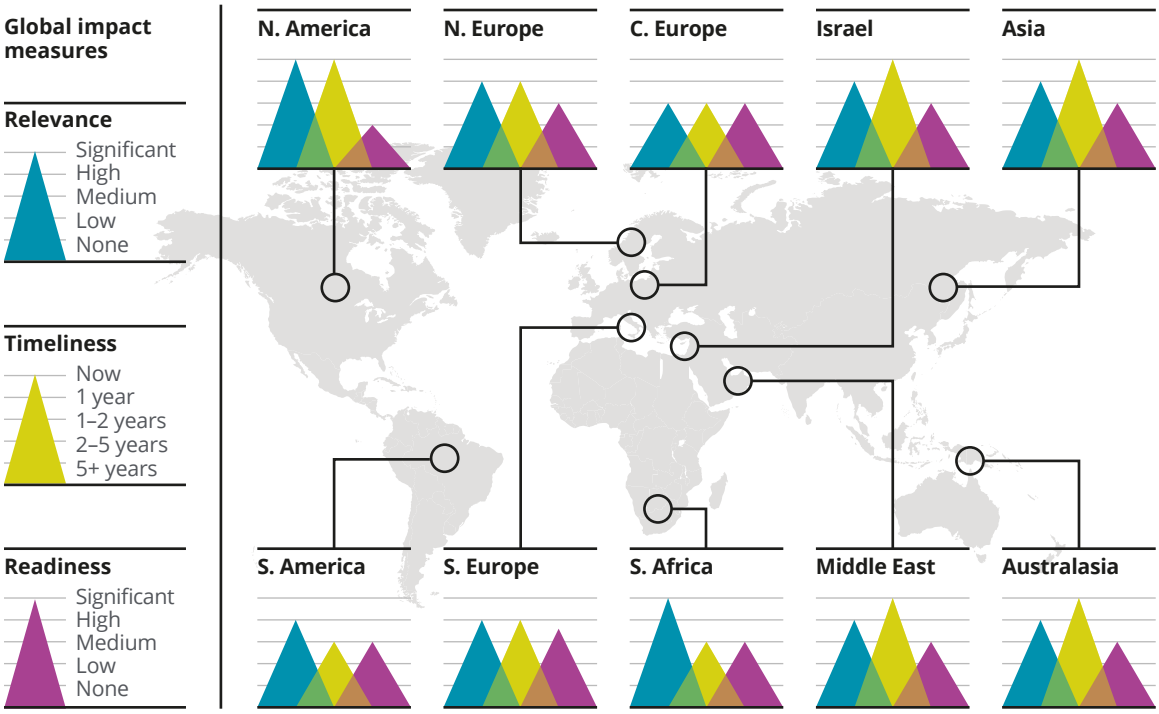
Findings from a recent survey of Deloitte leaders across 10 regions suggest that several factors are driving the *API imperative* trend globally. First, with more organisations modernising IT and re-engineering technology delivery models, APIs are becoming centerpieces of digital transformation agendas and complex business models. Likewise, as major software vendors upgrade their solutions to support APIs and microservices, they are providing building blocks for API adoption. Finally, start-ups embracing API-driven architectures and capability models are providing proof points—and some competitive pressure—in regional ecosystems.

Survey respondents see API adoption progressing in several countries, with particular momentum in two industry sectors: financial services in the UK, US, Brazil, Canada, and across Asia Pacific; and media and telecommunications in Germany, Ireland, Italy, and Latin America. Across global markets, public-sector API adoption lags somewhat, perhaps due to ongoing "open government" guidelines that mandate longer time frames for organising and executing larger-scale API transformation initiatives. And even though APIs are relatively new to the Middle East, a large number of businesses have already demonstrated how APIs can help organisations become leaner. Survey respondents see API adoption accelerating throughout the region, especially in Israel.

Globally, companies are recognising that API ambitions go hand-in-hand with broader core modernisation and data management efforts. Survey respondents in Denmark specifically called out an issue that appears to be universal: New systems are being built with APIs incorporated within, while legacy systems continue to impede information sharing.

On the regulation front, a recent EU ruling makes providing transparency into all IT services that will be used in technology projects a condition for receiving government funding. The net result? Funding and procurement become forcing functions for the API imperative.

Figure 2. Global impact



Source: Deloitte analysis.

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Where do you start?

Viewed from the starting block, an API transformation effort may seem daunting, especially for CIOs whose IT environments include legacy systems and extensive technical debt. While the following steps do not constitute a detailed strategy, they can help lay the groundwork for the journey ahead:

- **Embrace an open API arbitrage model.** Don't waste your time (and everyone else's) trying to plot every aspect of your API imperative journey. Instead, let demand drive project scope, and let project teams and developers determine the value of APIs being created based on what they are actively consuming. That doesn't mean accepting a full-blown laissez-faire approach, especially as the culture of the API imperative takes root. Teams should have to justify decisions *not* to reuse. Moreover, you might have to make an example of teams that ignore reuse guidelines. That said, make every effort to keep the spirit of autonomy alive within teams, and let the best APIs win.
- **Base API information architecture design on enterprise domains.** The basic API information architecture you develop will provide a blueprint for executing an API strategy, designing and deploying APIs to deliver the greatest value, and developing governance and enforcement protocols. But where to begin? To avoid the common trap of over-engineering API architecture, consider basing your design on existing enterprise domains—for example, sales and marketing, finance, or HR—and then mapping APIs to the services that each domain can potentially expose. Approaching architecture design this way can help avoid redundancies, and provide greater visibility into APIs' effectiveness in driving value and supporting domain-specific strategies.
- **Build it and they won't come.** Driving API consumption is arguably more important than creating APIs, a point often lost on organisations as they embrace the API imperative trend. To build an organisational culture that emphasises API consumption, start by explaining the strategic importance of consumption to line-of-business leaders and their reports, and asking for their support. Likewise, create mechanisms for gauging API consumption and for rewarding teams that embrace reuse principles. Finally, share success stories that describe how teams were able to orchestrate outcomes from existing services, or rapidly create new services by building from existing APIs.
- **Determine where microservices can drive value**. If you are beginning your API transformation journey, you probably have multiple services that could be managed or delivered more effectively if they were broken down into microservices. Likewise, if you already have API architecture in place, you may be able to gain efficiencies and scalability by atomising certain platforms into microservices. To determine whether this approach is right for your company, ask yourself a few questions: Do you have a large, complex code base that is currently not reusable? Are large teams required to develop or support an application? Are regular production releases required to maintain or enhance application functionality? If you answered yes to any or all of the above, it may be time to begin transitioning to microservices.
- **Define key performance indicators (KPIs) for all exposed services.** Deploying an API makes a service reusable. But is that service being reused enough to justify the maintenance required to continue exposing it? By developing KPIs for each service, you can determine how effectively API platforms are supporting the goals

set forth in your API strategy. If the answer is "not very effective," then KPIs may also be able to help you identify changes to make that can improve API impact.

- **Don't forget external partners.** APIs should be built for consumers, partners, and internal lines of business. For external partners, including the developer community, it is important to develop and provide necessary support in terms of documentation, code samples, testing, and certification tools. Without it, collaboration and the innovation it drives rarely take off.

Bottom line

As pioneering organisations leading the API imperative trend have discovered, companies can make more money by sharing technology assets than by controlling them. Embracing this trend fully will require rethinking long-held approaches to development, integration, and governance. But clinging to the old ways is no longer an option. The transition from independent systems to API platforms is already well under way. Don't be the last to learn the virtues of sharing.

CONTACTS

MATTHEW LACEY
Partner, Technology Consulting
Deloitte
+44 20 7007 8036
matthewlacey@deloitte.co.uk

AARTI BALAKRISHNAN
Senior Manager, Technology Consulting
Deloitte
+44 20 7303 7005
abalakrishnan@deloitte.co.uk

AUTHORS

LARRY CALABRO

Principal, Deloitte Consulting LLP

CHRIS PURPURA

Managing Director, Deloitte Consulting LLP

VISHVESHWARA VASA

Managing Director, Deloitte Digital LLP

Risk implications

ARUN PERINKOLAM

Principal, Cyber Risk Services, Deloitte LLP

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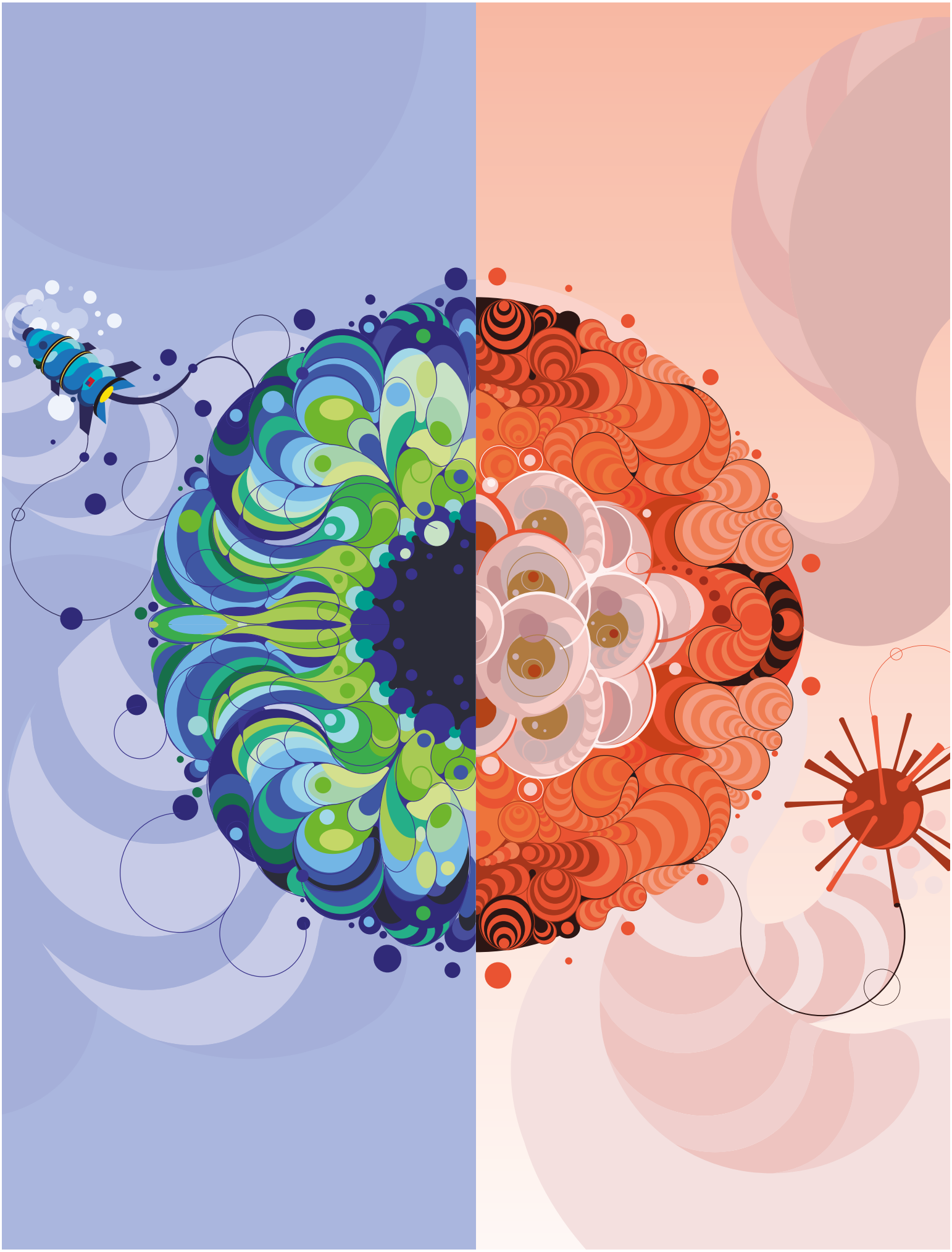


Exponential technology watch list

Innovation opportunities on the horizon

Is quantum computing becoming powerful enough to render your data encryption technology at risk? If so, will it be possible to "quantum proof" your information and communications? When does that need to be done? Will artificial general intelligence actually emerge and tilt the man/machine equation further toward machines? Will it put your own job at risk? What about your business—or even your industry? Does AI represent an equal amount of opportunity to innovate and thrive? In the face of these and other exponential forces, leading organisations—working within ecosystems that include business partners, start-ups, and academics—are developing the disciplined innovation responses and capabilities they will need to sense, experiment with, incubate, and scale exponential opportunities.

SCIENCE author Steven Johnson once observed that "innovation doesn't come just from giving people incentives; it comes from creating environments where their ideas can connect."[1]

In a business and technology climate where the ability to innovate has become critical to survival, many companies still struggle to create the disciplined, innovation-nurturing environments that Johnson describes. The process of innovating is, by definition, a hopeful journey into new landscapes. Without a clear destination, some executives can become unsure and frustrated. Where should we focus our innovation efforts? How can we develop breakthrough innovations that will set our business up for success in the future while delivering for the quarter? How can we turn our haphazard, episodic innovation efforts into methodical, productive processes?

With exponential technologies, the challenge becomes more daunting. Unlike many of the emerging tools and systems examined in this report—which demonstrate clear potential for impacting business-

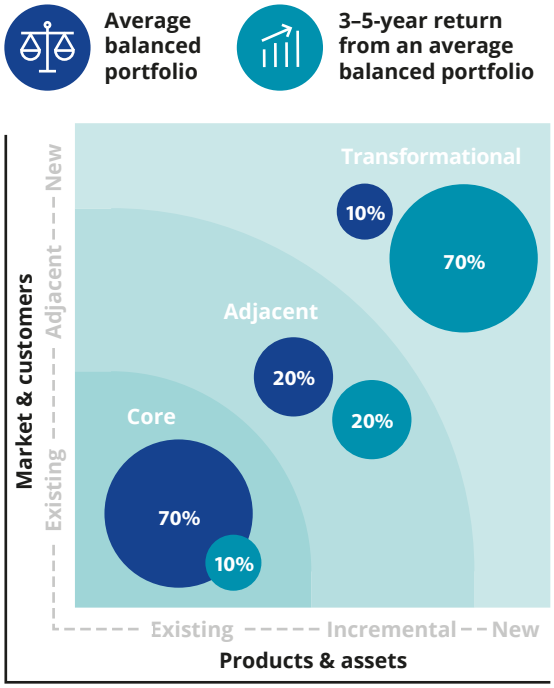
es in the next 18 to 24 months—exponentials can appear a bit smaller on the horizon. These are emerging technology forces that we think could manifest in a "horizon 3 to 5" timeframe—between 36 and 60 months. With some exponentials, the time horizon may extend far beyond five years before manifesting broadly in business and government. For example, artificial general intelligence (AGI) and quantum encryption, which we examine later in this chapter, fall into the 5+ category. Others could manifest more quickly; even AGI and quantum encryption are showing breadcrumbs of progress that may lead to breakthroughs in the nearer time horizon. As you begin exploring exponential forces, keep in mind that even though they may appear small on the horizon, you should not assume you have three to five years to put a plan together and get started. Now is the time to begin constructing an exponentials innovation environment in which, as Johnson says, "ideas can connect."

At present, many enterprises lack the structures, capabilities, and processes required to innovate effectively in the face of exponential change—a reality that carries some risk. Though exponential initiatives may require leaps of faith and longer-term commitments, they can potentially deliver transformative outcomes. For example, in our *Tech Trends 2014* report, we collaborated with faculty at Singularity University, a leading research institution, to explore robotics and additive manufacturing. At that time, these emerging technologies were outpacing Moore's Law: Their performance relative to cost (and size) was more than doubling every 12 to 18 months. Just a few years later, we see these same technologies are disrupting industries, business models, and strategies.

Researchers at Doblin, the innovation practice of Deloitte Digital, have studied how effective innovators approach these challenges and risks. They found that companies with the strongest innovation track records clearly articulate their innovation ambitions and maintain a strategically relevant portfolio of initiatives across ambition levels. Some efforts will focus on *core innovation* that optimises existing products for existing customers. Others are around *adjacent innovation* that can help expand existing markets or develop new products working from their existing asset base. Others still target *transformational innovation*—that is, deploying capital to develop solutions for markets that do not yet exist or for needs that customers may not even recognise that they have.

Doblin researchers examined companies in the industrial, technology, and consumer goods sectors, and correlated the pattern of companies' innovation investments with their share price performance. (See figure 1.) A striking pattern emerged: Outperforming firms typically allocate about 70 percent of their innovation resources to core offerings, 20 percent to adjacent efforts, and 10 percent to transformational initiatives. In contrast, cumulative returns on innovation investments tend to follow an inverse ratio, with 70 percent coming from

Figure 1. Manage a portfolio of innovation investments across ambitions



Source: Deloitte analysis.

the transformational initiatives, 20 percent from adjacent, and 10 percent from core.[2] These findings suggest that most successful innovators have struck the ideal balance of core, adjacent, and transformational initiatives across the enterprise, and have put in place the tools and capabilities to manage those various initiatives as parts of an integrated whole. To be clear, a 70-20-10 allocation of innovation investments is not a magic formula that works for all companies—it is an average allocation based on cross-industry and cross-geography analysis. The optimum balance will vary from company to company.[3]

One might assume that innovations derived from exponential technologies will emerge only in the transformational zone. In fact, exponential innovation can occur in all three ambition zones. Author and professor Clayton Christensen observed that truly disruptive technologies are often deployed first to improve existing products and processes—that is, those in the core and nearby adjacent zones. Only later do these technologies find net new whitespace applications.[4]

Pursuing the "unknowable"

Innovation investments allocated to exploring exponentials might be broadly characterised as "unknowable." Whether targeted at core, adjacent, or transformational returns, exponential investments focus largely on possibilities and vision that work beyond today's habits of success. Even though an exponential technology's full potential may not become apparent for several years, relevant capabilities and applications are probably emerging today. If you wait three years before thinking seriously about them, your first non-accidental yield could be three to five years beyond that. Because exponential forces develop at an atypical, nonlinear pace, the longer you wait to begin exploring them, the further your company may fall behind.

As you begin planning the *exponentials innovation* journey ahead, consider taking a lifecycle approach that includes the following steps:

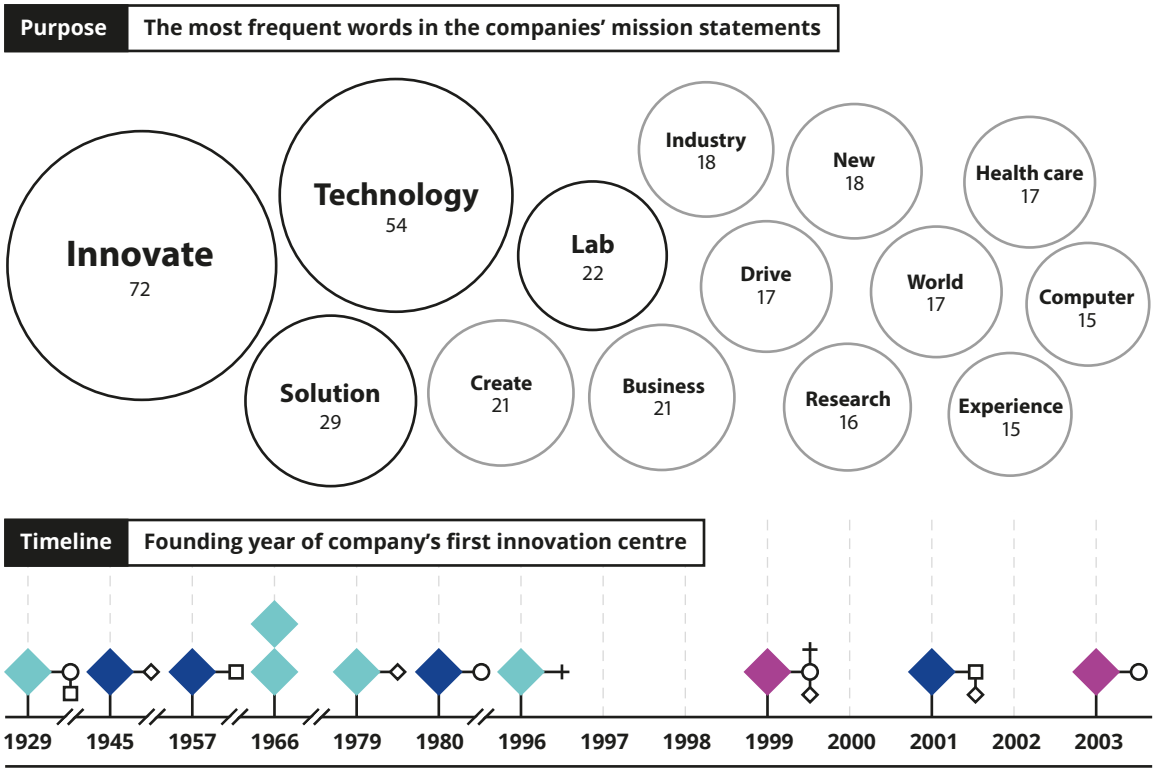
- **Sensing and research.** As a first step, begin building hypotheses based on sensing and research. Identify an exponential force and hypothesise its impact on your products, your production methods, and your competitive environment in early and mid-stage emergence. Then perform research around that hypothesis, using thresholds or trigger levels to increase or decrease activity and investment over time. It is important to note that sensing and research are not R&D—they are preliminary steps in what will be a longer effort to determine an exponential force's potential for your business.
- **Exploration and experimentation.** At some point, your research reaches a threshold at which you can begin exploring the "state of the possible." Look at how others in your industry are approaching or even exploiting these forces. At this point, *show* is better than *tell*. Try to collect 10 or more exemplars of what others are doing with exponentials. These can help you and your colleagues better understand exponential forces and their potential.

  Also examine how *developing an ecosystem* around each exponential force could help you engage external business partners, vendors, and suppliers as well as stakeholders in your own organisation. How could such an ecosystem enable exchanges of value among members? What kind of governance and processes would be needed to manage such an ecosystem? How could your enterprise benefit from ecosystem success?

  As you and stakeholders across the enterprise gradually deepen your understanding of exponential forces, you can begin exploring "state of the practical." Specifically, which elements of a given exponential force can potentially benefit the business? To develop a more in-depth understanding of the state of the practical, examine an exponential's viability through the lens of a balanced breakthrough model: What about this opportunity is desirable from a customer perspective? Is this opportunity viable from a business perspective? And importantly, do you have

Figure 2. Innovation centres in *Fortune* 100 companies

Deloitte research reveals that 67 of the *Fortune* 100 companies have at least one innovation centre—a formal initiative that harnesses disruptive technologies and partnerships to improve operations, products, and customer experiences. Early on, a handful of forward-thinking organisations pioneered the innovation centre model. In the decades since, more companies have created their own innovation centres, which evidences a steadily growing need to tackle innovation more methodically.

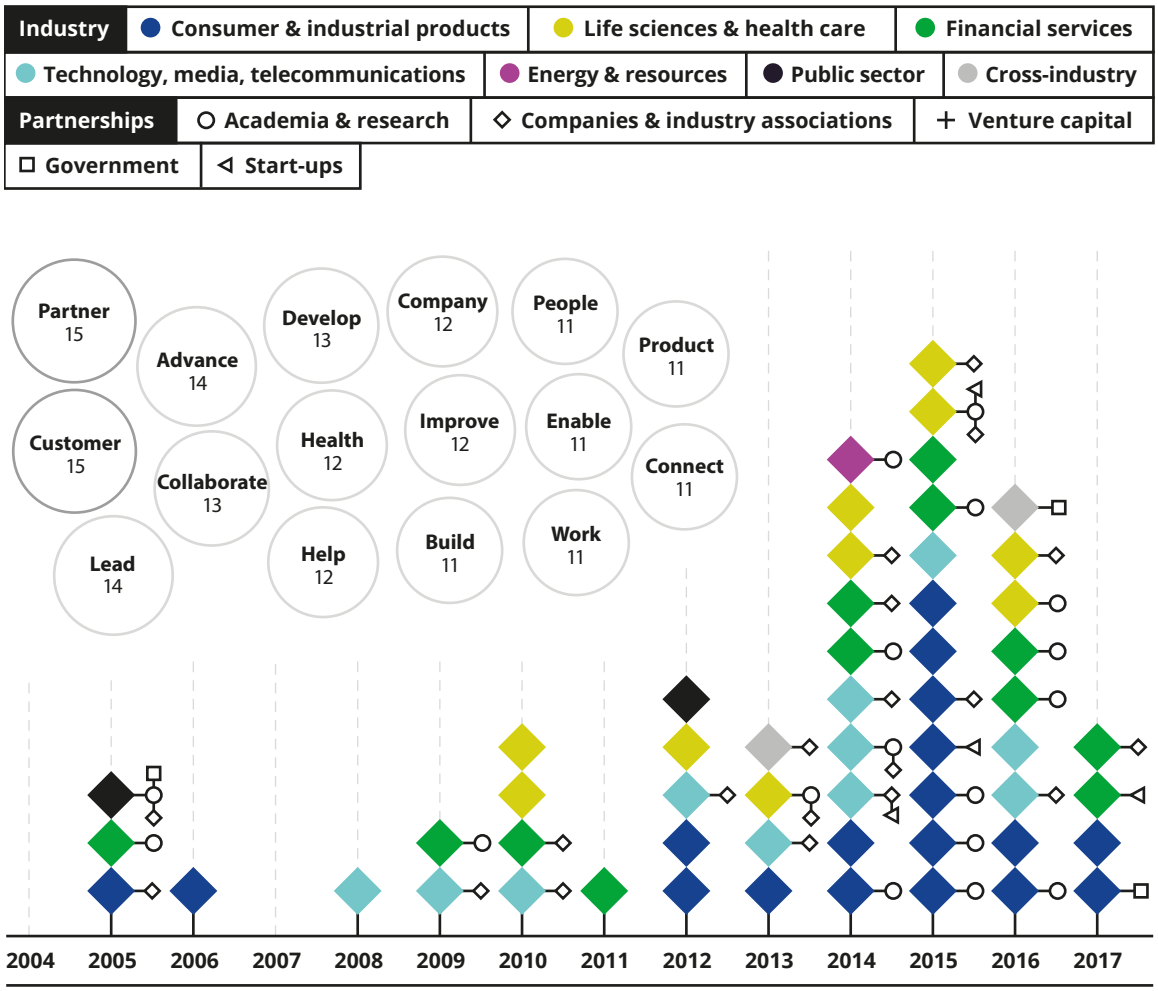


Source: Publicly available information on all *Fortune* 100 companies; representative sample of partnerships.

the critical capabilities and technology assets you will need to capitalise on this opportunity?

To move beyond exploration and into experimentation, try to prioritise use cases, develop basic business cases, and then build initial prototypes. If the business case yields—perhaps with some use case pivots—then you may have found a winning innovation.

- **Incubation and scaling.** When the value proposition of the experiment meets the expectations set forth in your business case, you may be tempted to put the innovation into full enterprise-wide production. Be cautious about moving too quickly. Even with a solid business case and encouraging experiments, at this stage your innovation is not proven out at scale. Some companies have established innovation centres that are separate from the core business and staffed with dedicated talent. These formal initiatives typically have incubation and scaling expertise. They may also have the capacity to carry out the level of enhancement, testing, and hardening needed before putting your innovation into production.
- **Be programmatic.** Taking any innovation—but particularly one grounded in exponential forces—from sensing to production is not a two-step process, nor is it an accidental process.



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Some think of innovation as nothing more than *eureka!* moments. While there is an element of that, innovation is more about programmatic disciplined effort, carried out over time in a well-considered portfolio approach, than it is about serendipity. Inspiration is an ingredient, but so is perspiration.

Don't forget the humans

As you dive into exponentials and begin thinking more deliberately about the way you approach innovation, it is easy to become distracted or discouraged. You may think, "This is scary and can't be true" or, "This is only about technology." It's important not to lose sight of the fact that for most companies, *human beings* are the fundamental unit of economic value. For example, people remain at the centre of investment processes, and they still make operational decisions about what innovations to test and deploy. Exploring exponential possibilities is first and foremost about driving certain human behaviours—in your operation, and in the marketplace. Moreover, as Steven Johnson suggests, when human ideas connect, innovation surely follows. With humans as the focus of your efforts, you will be able to keep exponentials—in all their mind-blowing grandeur—in a proper perspective.

Our take

Jonathan Knowles, head of faculty and distinguished fellow
Pascal Finette, vice president of startup solutions

SINGULARITY UNIVERSITY

Humans are not wired to think in an exponential way. We think linearly because our lives are linear journeys: We move from sunup to sundown, from Mondays to Fridays. The idea that something could be evolving so dramatically that its rate of change must be expressed in exponents seems, on a very basic level, nonsensical.

Yet exponential progress is happening, especially in technologies. Consider this very basic example: In 1997, the $46 million ASCI Red supercomputer had 1.3 teraflops of processing power, which at the time made it the world's fastest computer.[5] Today, Microsoft's $499 Xbox One X gaming console has 6 teraflops of power.[6] Mira, a supercomputer at Argonne National Laboratory, is a 10 petaflop machine.[7] That's *ten thousand trillion* floating point operations per second!

Exponential innovation is not new, and there is no indication it will slow or stop. More importantly, exponential advances in computers enable exponential advances—and disruptions—in other areas. And therein lies the challenge for CIOs and other executives. How can companies ultimately harness exponential innovation rather than be disrupted by it? Consider the often-cited cautionary tale of Kodak. In the 1970s, Kodak created a .01 megapixel camera but decided to sit on the technology rather than market it.[8] If you try to do what Kodak did, will somebody eventually come along and disrupt you?

Should you assume that every technology can have exponential potential? In 2011, a group of researchers demonstrated a neural network AI that could recognise a cat in a video—a breakthrough that some people found funny. If they had been able to see five years into the future, they might not have laughed. Today, retailers are projecting store performance and positively impacting revenue by analysing in-store video feeds to determine how many bags each shopper is carrying.[9]

Reorienting linear-thinking, quarterly revenue-focused stakeholders and decision-makers toward exponential possibilities can be challenging. Institutional resistance to change only hardens when the change under consideration has a five-year time horizon. But exponential change is already under way, and its velocity only continues to increase. The question that business and agency leaders face is not whether exponential breakthroughs will upset the status quo, but how—and how much, and how soon...

In the 2013 Spike Jonze film *Her*, a sensitive man on the rebound from a broken marriage falls in love with "Samantha," a new operating system that is intuitive, self-aware, and empathetic.[10] Studio marketers advertised the film's storyline as science fiction. But was it? Ongoing advances in artificial intelligence suggest that at some point in the future, technology may broadly match human intellectual (and social or emotional) capabilities and, in doing so, erase the boundary between humans and machines.[11]

Known as artificial general intelligence (AGI), this advanced version of today's AI would have many capabilities that broadly match what humans call our gut instinct—the intuitive understanding we bring to unfamiliar situations that allows us to perceive, interpret, and deduce on the spot.

Consider the disruptive potential of a fully realised AGI solution: Virtual marketers could analyse massive stores of customer data to design, market, and sell products and services—data from internal systems fully informed by social media, news, and market feeds. Algorithms working around the clock could replace writers altogether by generating factual, complex, situation-appropriate content free of biases and in multiple languages. This list goes on.

As an exponential force, AGI may someday prove profoundly transformational. However, before that day arrives, AI will have to advance far beyond its current capabilities. Existing variations of AI can do only the things that programmers tell them to do, either explicitly or through machine learning. AI's current strength lies primarily in "narrow" intelligence—so-called artificial narrow intelligence (ANI), such as natural language processing, image recognition, and deep learning to build expert systems. A fully realised AGI system will feature these narrow component capabilities, plus several others that currently do not yet exist: the ability to reason under uncertainty, to make decisions and act deliberately in the world, to sense, and to communicate naturally.

These "general" capabilities that may someday make AGI much more human-like remain stubbornly elusive. While there have been breakthroughs in neural networks, computer vision, and data mining, significant research challenges beyond computational power must be overcome for AGI to achieve its potential.[12] Indeed, the most formidable challenge may lie in finding a means for technology to reason under uncertainty. This is not about harnessing a spectrum of existing learning, language, and sensing capabilities. It's about creating something entirely new that enables mechanisms to explore an unfamiliar environment, draw actionable conclusions about it, and use those conclusions to complete an unfamiliar task. Three-year-old humans can do this well. At present, AI cannot.

Talkin' 'bout an evolution

In all likelihood, AGI's general capabilities will not appear during some *eureka!* moment in a lab. Rather, they will emerge over time as part of AI's ongoing evolution. During the next three to five years, expect to see improvements in AI's current component capabilities. Likewise, there will likely be progress made toward integrating and orchestrating these capabilities in pairs and multiples. What you probably won't see in this time horizon is the successful development, integration, and deployment of *all* AGI component capabilities. We believe that milestone is at least 10+ years away. (See "My take" below for more on this topic.) As AI use cases progress into full deployment and the pace of enterprise adoption accelerates, standards will likely emerge for machine learning and other AI component capabilities, and eventually for AI product suites.

From an enterprise perspective, many companies have already begun narrow intelligence journeys, often by exploring potential applications for ANI components, such as pattern recognition to diagnose skin cancer, or machine learning to improve decision-making in HR, legal, and other corporate functions.

In many cases, these initial steps yield information that becomes part of an internal ANI knowl-

edge base—one that can be refined in the coming years as technologies advance and best practices emerge. For example, in a pioneering ANI initiative, Goldman Sachs is investing in machine learning in what will be an ongoing effort to leverage data as a strategic asset.[13] Across the financial and other sectors, expect to see smaller applications as well—for example, applying deep learning to emails to identify patterns and generate insights into best practices and insider threats. Some of these individual successes will likely be launched in greenfield initiatives. Others may be accretive, but they too could illuminate insights that help companies develop and refine their ANI knowledge bases.

The state-of-the-art reflects progress in each sub-problem and innovation in pair-wise integration. Vision + empathy = affective computing. Natural language processing + learning = translation between languages you've never seen before. Google Tensor Flow may be used to build sentiment analysis and machine translation, but it's not easy to get one solution to do both well. Generality is difficult. Advancing from one domain to two is a big deal; adding a third is exponentially harder.

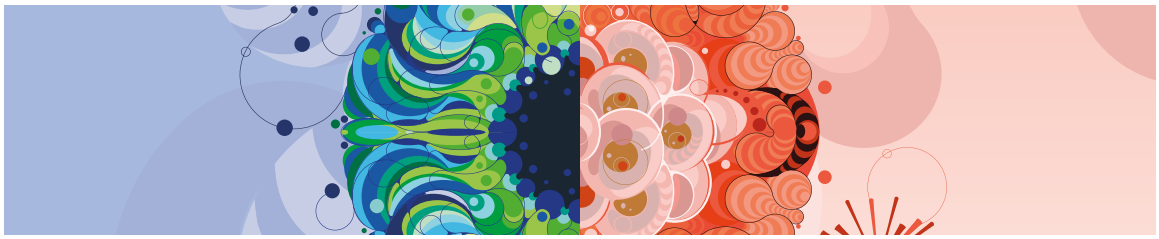
John Launchbury, former director of the Information Innovation Office at the Defense Advanced Research Projects Agency, describes a notional artificial intelligence scale with four categories: learning within an environment; reasoning to plan and to decide; perceiving rich, complex, and subtle information; and abstracting to create new meanings.[14] He describes the first wave of AI as handcrafted knowledge in which humans create sets of rules to represent the structure of knowledge in well-defined domains, and machines then explore the specifics. These expert systems and rules engines are strong in the reasoning category and should be important elements of your AI portfolio. Launchbury describes the second wave—which is currently under way—as statistical learning. In this wave, humans create statistical models for specific problem domains and train them on big data with lots of label data, using neural nets for deep learning. These second-wave AIs are good at perceiving and learning but less so at reasoning. He describes the next wave as contextual adaptation. In this wave, AI constructs contextual explanatory models for classes of real-world phenomena; these waves balance the intelligence scale across all four categories, including the elusive abstracting.

Though many believe that computers will never be able to accurately recognise or fully understand human emotions, advances in machine learning suggest otherwise. Machine learning, paired with emotion recognition software, has demonstrated that it is already at human-level performance in discerning a person's emotional state based on tone of voice or facial expressions.[15]

These are critical steps in AI's evolution into AGI. Other breadcrumbs suggest that the evolution may be gaining momentum. For example, a supercomputer became the first machine to pass the long-established "Turing test" by fooling interrogators into thinking it was a 13-year-old boy.[16] (Other experts proffer more demanding measures, including standardised academic tests.)

Though it made hardly a ripple in the press, the most significant AGI breadcrumb appeared on January 20, 2017, when researchers at Google's AI skunkworks, DeepMind, quietly submitted a paper on arXiv titled "PathNet: Evolution Channels Gradient Descent in Super Neural Networks." While not exactly beach reading, this paper will be remembered as one of the first published architectural designs for a fully realised AGI solution.[17]

As you work in the nearer time horizons with first- and second-wave ANIs, you may explore combining and composing multiple sub-problem solutions to achieve enterprise systems that balance the intelligence categories, including abstracting. Perhaps in the longer horizons, Samantha, Spike Jonze's empathetic operating system, is not so fictional after all.



My take

OREN ETZIONI, CEO
ALLEN INSTITUTE FOR ARTIFICIAL INTELLIGENCE

In March 2016, the American Association for Artificial Intelligence and I asked 193 AI researchers how long it would be until we achieve artificial "superintelligence," defined as an intellect that is smarter than the best human in practically every field. Of the 80 Fellows responding, roughly 67.5 percent of respondents said it could take a quarter century or more. 25 percent said it would likely never happen.[18]

Given the sheer number of "AI is coming to take your job" articles appearing across media, these survey findings may come as a surprise to some. Yet they are grounded in certain realities. While psychometrics measure human IQ fairly reliably, AI psychometrics are not nearly as mature. Ill-formed problems are vague and fuzzy, and wrestling them to the ground is a hard problem.

Few interactions in life have clearly defined rules, goals, and objectives, and the expectations of artificial general intelligence on such areas as language communications are squishy. How can you tell whether I've understood a sentence properly? Improving speech recognition doesn't necessarily improve language understanding, since even simple communication can quickly get complicated—consider that there are more than 2 million ways to order a coffee at a popular chain. Successfully creating AGI that matches human intellectual capabilities—or artificial superintelligence (ASI) that surpasses them—will require dramatic improvements beyond where we are today.

However, you don't have to wait for AGI to appear (if it ever does) to begin exploring AI's possibilities. Some companies are already achieving positive outcomes with so-called artificial narrow intelligence (ANI) applications by pairing and combining multiple ANI capabilities to solve more complex problems. For example, natural language processing integrated with machine learning can expand the scope of language translation; computer vision paired with artificial empathy technologies can create affective computing capabilities. Consider self-driving cars, which have taken the sets of behaviours needed for driving—such as reading signs and figuring out what pedestrians might do—and converted them into something that AI can understand and act upon.

You need specialised skillsets to achieve this level of progress in your company—and currently there aren't nearly enough deep learning experts to meet the demand. You also need enormous amounts of label data to bring deep learning systems to fruition, while people can learn from just a few labels. We don't even know how to represent many common concepts to the machine today.

Keep in mind that the journey from ANI to AGI is not just difference in scale. It requires radical improvements and perhaps radically different technologies. Be careful to distinguish what *seems* intelligent from what is intelligent, and don't mistake a clear view for a short distance. But regardless, get started. The opportunity may well justify the effort. Even current AI capabilities can offer useful solutions to difficult problems, not just in individual organisations but across entire industries.

Endangered or enabled

At some point in the future—perhaps within a decade—quantum computers that are exponentially more powerful than the most advanced supercomputers in use today could help address real-world business and governmental challenges. In the realm of personalised medicine, for example, they could model drug interactions for all 20,000-plus proteins encoded in the human genome. In climate science, quantum-enabled simulation might unlock new insights into human ecological impact.[19]

Another possibility: Quantum computers could render many current encryption techniques utterly useless.

How? Many of the most commonly deployed encryption algorithms today are based on integer factorisation of large prime numbers, which in number theory is the decomposition of a composite number into the product of smaller integers. The mathematical proofs show that it would take classical computers millions of years to decompose the more than 500-digit number sequences that comprise popular encryption protocols like RSA-2048 or Diffie-Hellman. Mature quantum computers will likely be able to decompose those sequences in seconds.[20]

Thought leaders in the quantum computing and cybersecurity fields offer varying theories on when or how such a mass decryption event might begin, but on one point they agree: Its impact on personal privacy, national security, and the global economy would likely be catastrophic.[21]

Yet all is not lost. As an exponential force, quantum computing could turn out to be both a curse and a blessing for cryptology. The same computing power that bad actors deploy to decrypt today's common security algorithms for nefarious purposes could just as easily be harnessed to create stronger quantum resistant encryption. In fact, work on developing *post-quantum encryption* around some principles of quantum mechanics is already under way.

In the meantime, private and public organisations should be aware of the quantum decryption threat on the horizon, and that in the long term, they will need new encryption techniques to "quantum-proof" information—including techniques that do not yet exist. There are, however, several interim steps organisations can take to enhance current encryption techniques and lay the groundwork for additional quantum-resistant measures as they emerge.

Understanding the quantum threat

In *Tech Trends 2017*, we examined quantum technology, which can be defined broadly as engineering that exploits properties of quantum mechanics into practical applications in computing, sensors, cryptography, and simulations. Efforts to harness quantum technology in a general-purpose quantum computer began years ago, though at present, engineering hurdles remain. Nonetheless, there is an active race under way to achieve a state of "quantum supremacy" in which a provable quantum computer surpasses the combined problem-solving capability of the world's current supercomputers.[22]

To understand the potential threat that quantum computers pose to encryption, one must also understand Shor's algorithm. In 1994, MIT mathematics professor Peter Shor developed a quantum algorithm that could factor large integers very efficiently. The only problem was that in 1994, there was no computer powerful enough to run it. Even so, Shor's algorithm basically put "asymmetric" cryptosystems based on integer factorisation—in particular, the widely used RSA—on notice that their days were numbered.[23]

To descramble encrypted information—for example, a document or an email—users need a key. Symmetric or shared encryption uses a single key that is shared by the creator of the encrypted information and anyone the creator wants to access the information. Asymmetric or public-key encryption uses two keys—one that is private, and another that is made public. Any person can encrypt a message

A view from the quantum trenches

Shihan Sajeed holds a Ph.D. in quantum information science. His research focuses on the emerging fields of quantum key distribution systems (QKD), security analyses on practical QKD, and quantum non-locality. As part of this research, Dr. Sajeed hacks into systems during security evaluations to try to find and exploit vulnerabilities in practical quantum encryption.

Dr. Sajeed sees a flaw in the way many people plan to respond to the quantum computing threat. Because it could be a decade or longer before a general-purpose quantum computer emerges, few feel any urgency to take action. "They think, 'Today my data is secure, in flight and at rest. I know there will eventually be a quantum computer, and when that day comes, I will change over to a quantum-resistant encryption scheme to protect new data. And *then*, I'll begin methodically converting legacy data to the new scheme,'" Dr. Sajeed says. "That is a fine plan if you think that you can switch to quantum encryption overnight—which I do not—and unless an adversary has been intercepting and copying your data over the last five years. In that case, the day the first quantum computer goes live, your legacy data becomes clear text."

A variety of quantum cryptography solutions available today can help address future legacy data challenges. "Be aware that the technology of quantum encryption, like any emerging technology, still has vulnerabilities and there is room for improvement," Dr. Sajeed says. "But if implemented properly, this technology can make it impossible for a hacker to steal information without alerting the communicating parties that they are being hacked."

Dr. Sajeed cautions that the journey to achieve a reliable implementation of quantum encryption takes longer than many people think. "There's math to prove and new technologies to roll out, which won't happen overnight," he says. "Bottom line: The time to begin responding to quantum's threat is now."[26]

using a public key. But only those who hold the associate private key can decrypt that message. With sufficient (read *quantum*) computing power, Shor's algorithm would be able to crack two-key asymmetric cryptosystems without breaking a sweat. It is worth noting that another quantum algorithm—Grover's algorithm, which also demands high levels of quantum computing power—can be used to attack ciphers.[24]

One common defensive strategy calls for larger key sizes. However, creating larger keys requires more time and computing power. Moreover, larger keys often result in larger encrypted files and signature sizes. Another, more straightforward post-quantum encryption approach uses large symmetric keys. Symmetric keys, though, require some way to securely exchange the shared keys without exposing them to potential hackers. How can you get the key to a recipient of the encrypted information? Existing symmetric key management systems such as Kerberos are already in use, and some leading researchers see them as an efficient way forward. The addition of "forward secrecy"—using multiple random public keys per session for the purposes of key agreement—adds strength to the scheme. With forward secrecy, hacking the key of one message doesn't expose other messages in the exchange.

Key vulnerability may not last indefinitely. Some of the same laws of quantum physics that are enabling massive computational power are also driving the growing field of *quantum cryptography*. In a wholly different approach to encryption, keys become encrypted within two entangled photons that are passed between two parties sharing information,

typically via a fiber-optic cable. The "no cloning theorem" derives from Heisenberg's Uncertainty Principle and dictates that a hacker cannot intercept or try to change one of the photons without altering them. The sharing parties will realise they've been hacked when the photon-encrypted keys no longer match.[25]

Another option looks to the cryptographic past while leveraging the quantum future. A "one-time pad" system widely deployed during World War II generates a randomly numbered private key that is used only to encrypt a message. The receiver of the message uses the only other copy of the matching one-time pad (the shared secret) to decrypt the message. Historically, it has been challenging to get the other copy of the pad to the receiver. Today, the photonic-perfect quantum communication channel described above can facilitate the key exchange. In fact, it can generate the pad *on the spot* during an exchange.

Now what?

We don't know if it will be five, 10, or 20 years before efficient and scalable quantum computers fall into the hands of a rogue government or a black hat hacker. In fact, it's more likely that instead of the general-purpose quantum computer, special-purpose quantum machines will emerge sooner for this purpose. We also don't know how long it will take the cryptography community to develop—and prove—an encryption scheme that will be impervious to Shor's algorithm.

In the meantime, consider shifting from asymmetric encryption to symmetric. Given the vulnerability of asymmetric encryption to quantum hacking, transitioning to a symmetric encryption scheme with shared keys and forward secrecy may help mitigate some "quantum risk." Also, seek opportunities to collaborate with others within your industry, with cybersecurity vendors, and with start-ups to create new encryption systems that meet your company's unique needs. Leading practices for such collaborations include developing a new algorithm, making it available for peer review, and sharing results with experts in the field to prove it is effective. No matter what strategy you choose, start now. It could take a decade or more to develop viable solutions, prototype and test them, and then deploy and standardise them across the enterprise. By then, quantum computing attacks could have permanently disabled your organisation.

Some think it is paradoxical to talk about risk and innovation in the same breath, but coupling those capabilities is crucial when applying new technologies to your business. In the same way that developers don't typically reinvent the user interface each time they develop an application, there are foundational rules of risk management that, when applied to technology innovation, can both facilitate and even accelerate development rather than hinder it. For example, having common code for core services such as access to applications, logging and monitoring, and data handling can provide a consistent way for developers to build applications without reinventing the wheel each time. To that end, organisations can accelerate the path to innovation by developing guiding principles for risk, as well as developing a common library of modularised capabilities for reuse.

Once you remove the burden of critical and common risks, you can turn your attention to those that are unique to your innovation. You should evaluate the new attack vectors the innovation could introduce, group and quantify them, then determine which risks are truly relevant to you and your customers. Finally, decide which you will address, which you can transfer, and which may be outside your scope. By consciously embracing and managing risks, you actually may move faster in scaling your project and going to market.

Artificial general intelligence. AGI is like a virtual human employee that can learn, make decisions, and understand things. You should think about how you can protect that worker from hackers, as well as put controls in place to help it understand the concepts of security and risk. You should programme your AGI to learn and comprehend how to secure data, hardware, and systems.

AGI's real-time analytics could offer tremendous value, however, when incorporated into a risk management strategy. Today, risk detection typically occurs through analytics that could take days or weeks to complete. leaving your system open to similar risks until the system is updated to prevent it from happening again.

With AGI, however, it may be possible to automate and accelerate threat detection and analysis. Then notification of the event and the response can escalate to the right level of analyst to verify the response and speed the action to deflect the threat—in real time.

Quantum computing and encryption. The current Advanced Encryption Standard (AES) has been in place for more than 40 years. In that time, some have estimated that even the most powerful devices and platforms would take decades to break AES with a 256-bit key. Now, as quantum computing allows higher-level computing in a shorter amount of time, it could be possible to break the codes currently protecting networks and data.

Possible solutions may include generating a larger key size or creating a more robust algorithm that is more computing-intensive to decrypt. However, such options could overburden your existing computing systems, which may not have the power to complete these complex encryption functions.

The good news is that quantum computing also could have the power to create new algorithms that are more difficult and computing-intensive to decrypt. For now, quantum computing is primarily still in the experimental stage, and there is time to consider designing quantum-specialised algorithms to protect the data that would be most vulnerable to a quantum-level attack.

Bottom line

Though the promise—and potential challenge—exponential innovations such as AGI and quantum encryption hold for business is not yet fully defined, there are steps companies can take in the near term to lay the groundwork for their eventual arrival. As with other emerging technologies, exponentials often offer competitive opportunities in adjacent innovation and early adoption. CIO, CTOs, and other executives can and should begin exploring exponentials' possibilities today.

CONTACTS

MARK LILLIE
Partner, CIO Programme Lead
Deloitte LLP
+44 20 7007 2395
mlillie@deloitte.co.uk

AUTHORS

JEFF MARGOLIES

Principal, Cyber Risk Servies, Deloitte LLP

RAJEEV RONANKI

Principal, Deloitte Consulting LLP

DAVID STEIER

Managing Director, Deloitte Consulting LLP

GEOFF TUFF

Principal, Deloitte Digital LLP

MARK WHITE

Principal, Deloitte Consulting LLP

AYAN BHATTACHARYA

Advanced Analytics Specialist Leader, Deloitte Consulting LLP

NIPUN GUPTA

Senior Consulting, Deloitte LLP

Risk implications

IRFAN SAIF

Principal, Deloitte

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EXECUTIVE EDITOR

BILL BRIGGS
Global and US chief technology officer
Deloitte Consulting LLP
wbriggs@deloitte.com | Twitter: @wdbthree

Bill Briggs' nineteen-plus years with Deloitte have been spent delivering complex transformation programmes for clients in a variety of industries, including financial services, health care, consumer products, telecommunications, energy, and public sector. He is a strategist with deep implementation experience, helping clients anticipate the impact that new and emerging technologies may have on their business in the future—and getting there from the realities of today.

In his role as CTO, Briggs is responsible for research, eminence, and innovation, helping to define and execute the vision for Deloitte Consulting LLP's Technology practice, identifying and communicating those technology trends affecting clients' businesses, and driving the strategy for Deloitte Consulting LLP's evolving technology services and offerings.

As the founding global leader of Deloitte Digital, Briggs was responsible for the launch and growth of a new global practice redefining the vision of a digital consulting agency. Deloitte Digital offers a mix of creative, strategy, user experience, engineering talent, and technology services to help clients harness disruptive digital technologies to imagine, deliver, and run the future—to engage differently with customers, reshape how work gets done, and rethink the very core of their markets.

GLOBAL IMPACT AUTHORS

SEAN DONNELLY
Technology Strategy and Innovation leader
Deloitte LLP

Sean Donnelly leads Deloitte's Technology Strategy and Innovation practice in Canada. He focuses on defining and integrating business and IT strategies and developing operational capabilities within IT. With more than 20 years of consulting experience in the financial services industry, Donnelly is a trusted adviser for numerous financial institutions on the adoption of new technologies and transformation of their IT functions. As the Canadian CIO Programme lead, he is responsible for communicating with the technology executive community across industries on the latest technology trends, challenges, and opportunities.

MARK LILLIE
EMEA Energy Resources leader
Deloitte MCS Limited

Mark Lillie leads the Power and Utilities practice for Deloitte North West Europe, as well as the EMEA Energy and Resources Consulting business. He is the global lead for the CIO Programme and technology strategy, which includes the annual CIO survey, tech trends, CIO transition labs, and the NextGen CIO Programme. Lillie specialises in organisation redesign, business change, IT strategy, and transformation programs including business strategy alignment, target operating model definition, cost reduction, and IT-enabled business process transformation. He also has experience across the energy value chain including energy trading, risk management, commercial optimisation and retail operations.

KEVIN RUSSO
Technology Strategy and Architecture leader
Deloitte Touche Tohmatsu

Kevin Russo is a lead partner for Deloitte Touche Tohmatsu's Technology, Strategy and Architecture practice in Australia and the Asia-Pacific region. He has more than 20 years of experience in the technology industry, focusing on strategy development and implementation of emerging technology programmes. Russo works with some of Australia's most innovative companies in the FSI, telecommunications, public sector, and energy and resources industries. Prior to Deloitte, he held global roles in both management consulting and software industries and led account management of several large multinational clients. Russo was also involved in two technology start-ups in the United States and is a member of Deloitte's innovation council.

GORDON SHIELDS

Global Technology Strategy and Architecture leader
Deloitte LLP

Gordon Shields is a partner with Deloitte LLP. He leads the Analytics practice in Canada and is the global leader for the Technology, Strategy, and Architecture practice. Shields has more than 30 years of industry experience. He specialises in information system strategies, outsourcing advisory, mergers and acquisitions, systems analysis, design, and implementation with a focus on data architectures, data governance and data quality. Shields has led international projects in the health, financial, public sector, pulp and paper, outsourcing, HR transformation, mining, pharmaceuticals, and energy and resources industries.

HANS VAN GRIEKEN

EMEA Technology Research & Insights leader
Deloitte Consulting B.V.

Hans van Grieken is the EMEA technology research and insights leader with Deloitte's global CIO Programme. He helps shape Deloitte's global research agenda in addition to identifying and driving EMEA research initiatives. Van Grieken frequently addresses conferences and corporate boardrooms on the topics of digital DNA, digital transformation, and innovation. He is a fellow of Deloitte's Center for the Edge where he helps senior executives understand the fundamental technology-driven changes that shape their business world, navigate short-term challenges, and identify long-term opportunities. Van Grieken is also a part-time executive lecturer at Nyenrode Business School.

KEVIN WALSH

Global Consulting Technology leader
Deloitte MCS Limited

Kevin Walsh is the Global Consulting Technology leader with Deloitte MCS Limited, and a member of the Deloitte Global Consulting Executive. In his current role, he is responsible for the development and execution of the global strategy for Deloitte's Technology Consulting business. Walsh started his career in systems implementation for businesses across Europe, and has accrued more than 25 years of experience leading the successful delivery of complex technology programmes for clients in both the public- and private-sectors. He is also chair of the Technology Leadership Group for the Princes Trust, a trustee of Ada, and a Fellow of the British Computer Society.

GLOBAL IMPACT CONTENT DEVELOPED IN COLLABORATION WITH:

Maria Arroyo, Aarti Balakrishna, Redouane Bellefqih, Magda Brzezicka, Lorenzo Cerulli, Christian Combes, David Conway, Javier Corona, Heidi Custers, Eric Delgove, Freddy du Toit, Salimah Esmail, Clifford Foster, Wojciech Fraczek, Ruben Fuentes, Juan Pedro Gravel, Steve Hallam, Kim Hallenheim, Andrew Hill, Rob Hillard, Jessica Jagadesan, Jesper Kamstrup-Holm, John Karageorgiou, Andreas Klein, James Konstanczak, Karoly Kramli, Rajeev Lalwani, Patrick Laurent, Fernando Laurito, Mariadora Lepore, Michael MacNicholas, Tony Manzano, Daniel Martyniuk, Os Mata, Brad Miliken, Richard Miller, Andre Filipe Pedro, Fabio Luis Alves Pereira, Kyara Ramraj, Steve Rayment, Kathy Robins, Galit Rotstein, Goncalo Jose Santos, Rizwan Saraf, Catrina Sharpe, Paul Sin, Christophe Vallet, Andries van Dijk, Andre Vermeulen, Markku Viitanen, Gilad Wilk, Ben Wylie, and Mohamed Yusuf

GLOBAL IMPACT METHODOLOGY

In Q3 2017, Deloitte Consulting LLP surveyed 60 leaders at Deloitte member firms in Europe, the Middle East, Africa, Asia Pacific, and the Americas on the impact (existing and potential) of the seven trends discussed in *Tech Trends 2018*. Specifically, for each trend we asked them to rank their respective regions in terms of 1) relevance of the trend; 2) timeliness of each trend; and 3) readiness for the trend. We also asked each leader to provide a written perspective to support their rankings.

Based on their responses, we identified 10 geographic regions in which the trends discussed in *Tech Trends 2018* were either poised to advance or are already advancing: North America, South America, Northern Europe, Central Europe, Southern Europe, the Middle East, Israel, South Africa, Australia and Asia. The countries that are represented in these regions include Argentina, Australia, Belgium, Brazil, Canada, Chile, China, Czech Republic, Denmark, Finland, France, Germany, Hong Kong, India, Ireland, Israel, Italy, Japan, Latvia, Luxembourg, Mexico, Middle East, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Serbia, South Africa, Spain, Sweden, Switzerland, the United Kingdom, and the United States.

We summarised respondent perspectives that applied to each of these regions. Those summary findings and regional ranking are discussed in this report and presented visually in trend-specific infographics.

CHAPTER AUTHORS

REENGINEERING TECHNOLOGY

Ken Corless
Cloud chief technology officer
Deloitte Consulting LLP
kcorless@deloitte.com

Jacques de Villiers
Cloud Services managing director
Deloitte Consulting LLP
jadevilliers@deloitte.com

Chris Garibaldi
Technology Strategy & Transformation principal
Deloitte Consulting LLP
cgaribaldi@deloitte.com

Risk implications

Kieran Norton
Cyber Risk Services principal
Deloitte & Touche LLP
kinorton@deloitte.com

NO-COLLAR WORKFORCE

Anthony Abbatiello
Human Capital Digital leader
Deloitte Consulting LLP
aabbatiello@deloitte.com

Tim Boehm
Application Management Services principal
Deloitte Consulting LLP
tboehm@deloitte.com

Jeff Schwartz
Human Capital principal
Deloitte Consulting LLP
jeffschwartz@deloitte.com

Risk implications

Sharon Chand
Cyber Risk Services principal
Deloitte & Touche LLP
shchand@deloitte.com

DIGITAL REALITY

Allan Cook
Operations Transformation leader
Deloitte Consulting LLP
allcook@deloitte.com

Ryan Jones
Virtual and Mixed Reality leader
Deloitte Consulting LLP
rcjones@deloitte.com

Risk implications

Ash Raghavan
Deloitte Advisory's Center for Intelligent Automation & Analytics leader
Deloitte & Touche LLP
araghavan@deloitte.com

Irfan Saif
US Advisory leader, Technology
Deloitte & Touche LLP
isaif@deloitte.com

BLOCKCHAIN TO BLOCKCHAINS

Eric Piscini
Global Financial Services Consulting Blockchain leader
Deloitte Consulting LLP
episcini@deloitte.com

Darshini Dalal
US Blockchain Lab leader
Deloitte Consulting LLP
ddalal@deloitte.com

Risk implications

David Mapgaonkar
Cyber Risk Services leader
Deloitte & Touche LLP
dmapgaonkar@deloitte.com

Prakash Santhana
US Advisory managing director
Deloitte Transactions and Business Analytics LLP
psanthana@deloitte.com

ENTERPRISE DATA SOVEREIGNTY

Nitin Mittal
US Analytics and Information Management leader
Deloitte Consulting LLP
nmittal@deloitte.com

Sandeep Kumar Sharma, Ph.D.
Deputy chief technology officer
Deloitte Consulting LLP
sandeepksharma@deloitte.com

Ashish Verma
Analytics and Information Management leader
Deloitte Consulting LLP
asverma@deloitte.com

Risk implications

Dan Frank
US Privacy and Data Protection leader
Deloitte & Touche LLP
danfrank@deloitte.com

API IMPERATIVE

Larry Calabro
Cloud Engineering leader
Deloitte Consulting LLP
lcalabro@deloitte.com

Chris Purpura
Cloud Services managing director
Deloitte Consulting LLP
cpurpura@deloitte.com

Vishveshwara Vasa
Deloitte Digital managing director
Deloitte Consulting LLP
vvasa@deloitte.com

Risk implications

Arun Perinkolam
Cyber Risk Services principal
Deloitte & Touche LLP
aperinkolam@deloitte.com

THE NEW CORE

Bill Briggs
Global and US chief technology officer
Deloitte Consulting LLP
wbriggs@deloitte.com

Steven Ehrenhalt
Global and US Finance Transformation principal
Deloitte Consulting LLP
hehrenhalt@deloitte.com

Nidal Haddad
Deloitte Digital chief of markets
Deloitte Consulting LLP
nhaddad@deloitte.com

Doug Gish
Supply Chain and Manufacturing Operations leader
Deloitte Consulting LLP
dgish@deloitte.com

Adam Mussomeli
Supply Chain Strategy principal
Deloitte Consulting LLP
amussomeli@deloitte.com

Anton Sher
Digital Finance Strategy and Transformation principal
Deloitte Consulting LLP
ansher@deloitte.com

Risk implications

Vivek Katyal
Global and US Risk Analytics leader
Deloitte & Touche LLP
vkatyal@deloitte.com

Arun Perinkolam
Cyber Risk Services principal
Deloitte & Touche LLP
aperinkolam@deloitte.com

EXPONENTIAL TECHNOLOGY WATCH LIST

Mark White
US Innovation Office chief technologist
Deloitte Consulting LLP
mawhite@deloitte.com

Jeff Margolies
Cyber Risk Services principal
Deloitte & Touche LLP
jmargolies@DELOITTE.com

Rajeev Ronanki
Cognitive Computing and Health Care Innovation leader
Deloitte Consulting LLP
rronanki@deloitte.com

David Steier
Deloitte Analytics managing director
Deloitte Consulting LLP
dsteier@deloitte.com

Geoff Tuff
Deloitte Digital Transformation leader
Deloitte Consulting LLP
gtuff@deloitte.com

Ayan Bhattacharya
Analytics and Information Management specialist leader
Deloitte Consulting LLP
aybhattacharya@deloitte.com

Nipun Gupta
Cyber Risk Advisory senior consultant
Deloitte & Touche LLP
nipgupta@deloitte.com

Risk implications

Irfan Saif
US Advisory leader, Technology
Deloitte & Touche LLP
isaif@deloitte.com

CONTRIBUTORS

Rahul Bajpai, Charles Balders, Ranjit Bawa, William Beech, Melissa Bingham, Naaman Curtis, Traci Daberko, Asha Dakshinamoorthy, Larry Danielson, Sukhdev Darira, Preetha Devan, Tim Dickey, Habeeb Dihu, Sean Donnelly, Tony Easterlin, Jon Eick, Nikita Garia, Ryan Gervais, Doug Gish, Lee Haverman, Erica Lee Holley, Chris Huff, Mary Hughes, Lisa Iliff, Sarah Jersild, Junko Kaji, Abrar Khan, Kim Killinger, Krishna Kumar, Sunny Mahil, Melissa Mailley, Karen Mazer, Bev McDonald, Laura McGoff, Peter Miller, Alexander Mogg, Ramani Moses, Pratyush Mulukutla, Devon Mychal, Mahima Nair, Chandra Narra, Alice Nhu, Renu Pandit, Alison Paul, Linda Pawczuk, Joanie Pearson, Alok Pepakayala, Rick Perez, Anoop R, Robert Rooks, Maximilian Schroeck, Ashley Scott, Faisal Shaikh, Alina Shapovalenko, Omer Sohail, Rithu Thomas, JT Thomson, Jonathan Trichel, and Paul Wellener

RESEARCH TEAM

LEADS

Jasjit Bal, Gokul Bhaghavantha Rao, Michael Davis, Rachel Halvordson, Solomon Kassa, Alyssa Long, Andrea Reiner, and Nicholas Tawse

TEAM MEMBERS

Jackie Barr, Trent Beilke, Nick Boncich, Matt Butler, Sean Cremins, Jiten Dajee, Ankush Dongre, Cristin Doyle, Kevin Errico, Alex Feiszli, Inez Foong, Rob Garrett, Amy Golem, Sam Greenlief, Grace Ha, Dylan Hooe, Syed Jehangir, Yili Jiang, Nandita Karambelkar, Ava Kong, Kaitlyn Kuczer, Varun Kumar, Kartikeya Kumar, Andrew Lee, Anthony Lim, Luke Liu, Andrea Lora, Betsy Lukins, Lea Ann Mawler, Joe McAsey, Robert Miller, Talia O'Brien, Deepak Padmanabhan, Sarita Patankar, Ellie Peck, Gilberto Rodriguez, Katrina Rudisel, Cabell Spicer, Jordan Stone, Jenna Swinney, Elizabeth Thompson, Casey Volanth, Greg Waldrip, Myette Ware, Michelle Young, and Chris Yun

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