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Belgian Edition

Tech Trends 2019

Beyond the digital frontier

EXPERIENCE & DIGITAL REALITY
ANALYTICS & COGNITIVE
CLOUD
BLOCKCHAIN
Asset intelligence
User engagement
Wireless and mobility
Information management
Information automation
Cloud revolution
Social computing
User engagement
Applied mobility
Visualization
Real analytics
Capability clouds
Gamification
Social business
User empowerment
Enterprise mobility unleashed
Geospatial visualization
Big data goes to work
Hyper-hybrid cloud
Gamification goes to work
Social reengineering by design
Mobile only (and beyond)
Finding the face of your data
Industrialized crowdsourcing
Social activation
Digital engagement
Wearables
Cognitive analytics
Cloud orchestration
Dimensional marketing
Ambient computing
Amplified intelligence
API economy
AR and VR go to work
Internet of Things
Industrialized analytics
Blockchain: Democratized trust
Mixed reality
Machine intelligence
Dark analytics
Everything-as-a-service
Blockchain: Trust economy
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BUSINESS OF TECHNOLOGY
CORE
RISK

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Introduction

LOOKING back a decade to headlines of the day, we are reminded how at that now-distant moment much of the world was still grappling with a cataclysmic recession. In the technology sector, Oracle announced it was acquiring Sun Microsystems.[1] Apple was gearing up to launch the iPad® mobile digital device,[2] and a mean-spirited worm called Stuxnet was changing the rules of cybersecurity.[3]

At this same time, a small number of dedicated tech enthusiasts at Deloitte Consulting were preparing to launch our firm's first annual *Tech Trends* report. Though this freshman effort was only one-third the length of subsequent *Tech Trends* publications, it effectively captured the awe that we and our clients felt about the incredible pace of technology-driven change underway—and the profound impact that change was having on business. This report featured chapters on cloud, cybersecurity, the Internet of Things, mobile's looming impact on the enterprise, and user-centered design—all topics that at the time felt overwhelming and fantastical. Interestingly, many of the things that seemed so incredible 10 years ago are now foundational.

Looking back, we can see the value these emerging innovations offered; in the moment, their promise seemed less clear. It is, therefore, remarkable how quickly organizations across industries and regions navigated the *so what?* and *now what?* for these trends and went on to successfully traverse the new digital landscape.

This journey from uncertainty to digital transformation informs our latest offering, *Tech Trends 2019: Beyond the digital frontier*. A persistent theme of every *Tech Trends* report has been the increasing, often mind-bending, velocity of change. A decade ago, many companies could achieve competitive advantage by embracing innovations and trends that were already underway. Today, this kind of reactive approach is no longer enough. To stay ahead of the game, companies must work methodically to sense new innovations and possibilities, define their ambitions for tomorrow, and journey beyond the digital frontier.

But the question remains: How can we sense and act upon a future that remains unclear? The good news is that much of the tech-driven disruption each of us experiences today—and will likely experience going forward—is understandable and knowable. Today, the most promising technology trends are grounded in nine powerful macro forces that form the backbone of technology innovation, past and present. In chapter 1, we examine how once-disruptive trends such as cloud, analytics, and digital experiences have been embraced to become foundational components of business and IT strategy. We also discuss how the work of reengineering technology's full life cycle, reimagining core systems, and elevating cyber to a strategic function are now critical elements of digital transformation. And finally, we take a look at three more recent trends—blockchain, cognitive, and digital reality—that are poised to become macro forces in their own right.

In the following six chapters, we spotlight emerging technology trends that, over the next 18 to 24 months, will likely offer new avenues for pursuing strategic ambitions. Three of them spotlight "top of the iceberg" technologies such as AI, intelligent interfaces, and experiential marketing. Three other chapters focusing on serverless computing, advanced connectivity, and DevSecOps, are more foundational and enabling, though no less critical to innovation and growth. Those feeling overwhelmed by change may take some comfort in the

fact that all of these trends are grounded in the nine macro forces. As in chaos theory, patterns and structures eventually emerge from perceived disorder.

In our final chapter, we try to demystify the future of digital transformation by examining approaches for turning something seemingly nebulous and uncertain into a process that is measurable and knowable.

So here's to the next decade of opportunity, whatever it may be. Along the way, embrace that queasy feeling of uncertainty. Be excited about it. Because what you are actually feeling is tremendous, unimaginable opportunity. Today, when every company is a technology company and everyone is a technologist, there could not be a more exciting or opportune time to leave your mark on your company, your industry, and on an entire world of possibility that awaits just beyond the digital frontier.

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1. Andrew Clark, "Oracle's takeover of Sun Microsystems comes as surprise to software industry," *Guardian*, April 20, 2009.
2. *Tech Trends 2019* is an independent publication and has not been authorized, sponsored, or otherwise approved by Apple Inc. iPad is a registered trademark of Apple Inc.
3. Kim Zetter, "How digital detectives deciphered Stuxnet, the most menacing malware in history," *Wired*, June 7, 2011.

Belgium: Looking back and beyond

LOOKING at the technology macro forces, Belgium has experienced a similar journey in the past 10 years; although it is probably fair to say we have not been the earliest adopters of some of these trends. Having said that, the more recent years we have seen an accelerated adoption of tech trends in Belgium resulting in a sustained digital transformation.

In the current digital revolution, technological advances have begun finding their way into real, practical applications. We do not need to look too far to find examples of these nine macro forces at play in Belgian's private and governmental sectors. Alongside large institutions, the proliferation of domestic start-ups have quickened the pace companies are delivering delightful experiences to digital savvy customers.

Take the insightful use of design thinking which has been experienced by all of us in our business and private lives. From increasingly intuitive online and mobile banking apps to the simplicity of the retail user experience, digital is moving fast to meet customer expectations.

However, in a time when most of our interactions are done online and have become a little too impersonal, phygital technologies reconnect with customers in a very human way in the physical space. For example, a Belgian public institution recently equipped its reception area with physical robots and interactive touch screens to raise awareness on its digital initiatives and provide answers to common FAQs.

Not as visible as these frontline high street changes but as equally disruptive is the adoption of cloud solutions in Belgium. According to the 2018 Belgium Cloud Barometer, just over five years ago there was only a 20% adoption; today, it's more than 70% in Flanders and above 60% in Brussels. Increasingly, cloud-based services have been revolutionising large and mid-sized organisations and governments. Case in point is the collaboration of multiple federal administration and social security entities to launch a community service G-Cloud.

Beyond that, the Belgian government has been raising the bar in the realm of cybersecurity influenced by rising concerns among many citizens. Across industries, cybersecurity has evolved from a regulatory compliance necessity to an enabler for transactions and into a non-negotiable from customers. Recognising the need to provide customer trust, DevSecOps ensures security measures are embedded throughout the software development life cycle without jeopardising the speed of go-to-market in highly competitive markets.

A decade ago some may have believed core ERP systems had achieved their nexus and would not feature significantly in the future of digital transformations. However, this has proven to be premature and core systems have experienced renewal and enhanced digital experience. Belgium being a large and mature SAP market we have seen an increased adoption to the latest S/4HANA release as companies strengthen their digital core as enabler for digital transformation.

The logistic ecosystem and subsequent supply chain operations is fraught with ineffeciencies, often still caught in legacy processes and paperwork. However, the Port of Antwerp has been very successful in utilising blockchain technology to drive efficiencies and increase security in its cargo handling processes. It is also one

of the organisations effectively applying algorithms to its big data, to enhance the monitoring and maintenance of their core infrastructure (bridges, locks and berths as to increase the efficiency of docking and invoicing.

There is good reason to believe that the change we have seen over the last decade will be dwarfed by what's on the horizon. Some of the more exciting future trends in AI, predictive analytics and cognitive and machine learning, are occurring on a mainstream and grassroots level. In the recent past we have seen some striking examples of Belgian start-up success in the fields of cognitive data sciences and data governance. Notably, Belgium has taken the lead in predictive maintenance with companies using sensors and big data to plan repairs in the utility sector.

As you will see in the final chapter, the pace of change is unlikely to slow down in the coming decade. It's incumbent on CIOs and Innovation teams to anticipate emerging technologies and new digital experience trends. Look to innovators, start-ups and digital leaders and take a more agile approach that emphasises experimentation. Become not just early adopters of these technologies, but incubators and leaders of change as you shape your transformation journey for 2019 and beyond.

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Macro technology forces at work

Technology trends past, present, and future

OVER THE LAST 10 YEARS, CLOUD, ANALYTICS, AND TECHNOLOGIES empowering digital experiences have steadily disrupted IT operations, business models, and markets. Though these now-familiar forces may no longer qualify as "trends," their impacts cannot be overstated, and their storylines continue to evolve. Recently three new technologies—blockchain, cognitive, and digital reality (AR, VR, IoT, and others)—have taken up the "disruptor" mantle. Today, each is poised to become a distinct macro force in its own right. Meanwhile, three foundational forces make it possible for organizations to harness innovation while maintaining operational integrity: modernizing legacy core systems, transforming the business of technology, and evolving cyber risk strategies beyond security and privacy. These nine formative forces are the backbone of technology innovation past and present. Their individual futures are advancing at a rapid pace, while the controlled collision between them compounds their overall impact to drive purposeful, transformational change.

Digital experiences. Analytics. Cloud. In the previous nine issues of *Tech Trends*, we examined these powerful forces as they evolved from promising innovations and novel approaches into full-fledged trends. We recognized their disruptive potential and looked to the horizon to find innumerable strategic opportunities they could—and eventually would—present. Indeed, each proved to be far more than a trend; over time they evolved and expanded across industries and today are considered foundational components not only of enterprise IT but of corporate strategy.

In the context of emerging technology trends, then, is there anything left to say about digital, analytics, and cloud? Yes: Despite their ubiquity and proven value, these technologies' full potential remains largely untapped. Investments in them are often departmental and limited in scope. Likewise, in some companies, initiatives driving analytics, cloud, and digital are disjointed, even competing efforts. And even this old guard of emerging technologies continues to evolve at an astounding pace—in capabilities, in business models, and across broader marketplace dynamics.

Meanwhile, three newer trends—digital reality, cognitive technologies, and blockchain—are growing rapidly in importance. In the last several issues of *Tech Trends*, we discussed how virtual reality and augmented reality are redefining the fundamental ways humans interact with their surroundings, with data, and with each other. We tracked blockchain's meteoric rise from bitcoin enabler to purveyor of trust. And as cognitive technologies such as machine learning (ML), robotic process automation, natural language processing, neural nets, and AI moved from fledgling siloed capabilities to tenets of strategy, we have explored their profound potential for business and society. These three trends, though still emerging, are poised to become as familiar and impactful as cloud, analytics, and digital experience are today.

Of course, any pursuit of tomorrow's promise should start from the technical realities of today. Three formative macro forces have proven essential in the pursuit of digital transformation past, present, and future: modernizing core systems, guiding how (and if) existing assets can serve as a foundation for innovation and growth; elevating cyber and the broader risk domain from a compliance-based activity to an embedded, strategic function; and, in a world where the only constant is constant change, reengineering an organization's technology function to quickly and impactfully deliver against the promise of technologies emerging and existing. Previous editions of *Tech Trends* have discussed how the business of technology, core modernization, and cyber became trends in their own rights. CIOs and business leaders recognize that in a marketplace being disrupted by rapid-fire innovation, IT must also fundamentally disrupt itself and make strategic decisions about its underlying assets or risk failing at its mission.

With macro forces, it's the controlled collision that leads beyond the digital frontier.

Taken together, these nine trends are the macro technology forces that matter. When we talk about technology trends, it is tempting to dismiss broader, more lasting truths and pursue the latest shiny objects. True, today there is nothing about these nine areas that screams "stop the presses!" But just because they are no longer particularly novel doesn't mean they are not vitally important. In fact, one of the most pressing challenges that technology and business leaders face is how to excavate and harness the value these macro forces can deliver *collectively*.

For example, the factory of the future needs to bring together next-gen ERP, machine learning, embedded sensors across the production floor, augmented reality training, mobile visualization and predictive flow scheduling, secure networks, and cloud-based tools for managing workflow across the supply chain. Not to mention the need to retool workers and cross-pollinate between traditional information and operational technology (IT and OT) roles and skills.

Through their collision and the innovation unleashed, these forces will likely dominate enterprise IT, business, and markets to an even greater extent than they have as individual technologies.

With macro forces, it's the controlled collision that leads beyond the digital frontier.

Exploring the forces at work

IN THE BEGINNING . . .

First, there was digital experience, analytics, and cloud. Of the nine macro forces, these three have consistently captured the most mindshare (and investment dollars) over the last decade, and with good reason. Today they are the pillars upon which many ambitions for the future are built. And we're far from done.

Digital experience

When the term *digital* entered the business-technology lexicon roughly seven years ago, it was used as shorthand for customer-facing sales and marketing with an emphasis on a specific channel, be it social, mobile, or web. Today, *digital* is increasingly used in tandem with *experience*, to describe all the ways organizations, customers, employees, and constituents engage and carry out transactions within digital environments. It's not only for the front office but for the entire enterprise. Think, for example, of how health plans are deploying new tools to simplify the preauthorization of claims. Behind the scenes, cognitive algorithms, robotic process automation, and predictive analytics tools are approving more of the simple and rote use cases that used to dominate many employees' workdays. Instead, workers can spend more of their time on nuanced, complex cases with an opportunity to more directly affect the health and wellness of their member population. Or how leading fast food and convenience restaurants are adopting mobile apps for remote ordering, not only transforming the customer experience but redesigning retail, preparation, and delivery operations. Human-centered design and user engagement have become centerpieces of business strategy—emphasizing how work gets done, how business gets conducted, and how meaningful memories and experiences are made.

Analytics

Data and its underlying complexities have been an enterprise narrative since the earliest days of technology investment. The promise of analytics has been its close and even more tantalizing spiritual successor—taking advantage of that data to generate insights about customers, citizens, markets, operations, and virtually every facet of how an enterprise runs. Most analytics efforts have struggled to deliver on the simplest version of that potential: the rearview mirror describing what has already happened—or, for the advanced few, presenting real-time views into what is currently happening. In the science of analytics, this is valuable but insufficient. Today companies need the ability to *predict* (I have a good idea what will happen next) and *prescribe* (I can recommend a response). But this is no simple undertaking. Though analytics engines, algorithms, and supporting infrastructure have grown more powerful, the amount of data available for analysis has grown exponentially. Organizations should consider information beyond the well-formed data that lives within traditional IT systems. How can a company leverage machine logs and sensor data, still images, video, audio, biometric information, government research, and sentiment from social feeds? And how does it tap into data across its own boundaries, as well as data sources that live outside of its four walls? For many companies, remaining competitive in the marketplace depends on their ability to answer those questions. And to move core data management and data architecture capabilities from flights of fancy to foundational forces.

We are already shifting our focus from what has already happened to what will happen in the future. Through a collision with cognitive, analytics may soon tell us how to act on our insights—and better yet, automate those actions.

Cloud

One could argue that during the last decade, no single technology trend has so dominated the arena of enterprise IT as *cloud*. During this time, it emerged from modest discussions of, "What is cloud and why does it matter?" to the next phase, which emphasized, "Where and when do we use cloud to lower costs?" to cloud's status today: "Why *not* cloud?" Cloud moved from low-level technology cost arbitrage lever to a means for delivery model optimization to a driver of business transformation. Simply put, cloud is increasingly the foundation upon which innovation is built.

As macro forces go, cloud is unparalleled in importance and likely will remain so for some time. And despite its ubiquity, cloud too has yet to reveal its full potential. Too many companies still think of cloud as a means for lifting and shifting workloads, or as simply the extension of data center

or infrastructure strategy. But this is changing as some begin to ask more complex, future-focused questions: Can we use cloud native services to build our products faster? How do we use the massive compute capacity to process more data and create new products? Could a new cloud back office create an engine for M&A agility? Are there advantageous tax implications of using cloud up, down, and across the stack?

In the coming years, expect to see major cloud service providers emphasize their offerings' potential value as platforms and patterns for achieving long-term growth and developing new innovation. Whereas their customers may have embraced cloud for, say, IaaS or SaaS features and functions, they may now turn to cloud for access to AI, blockchain, digital reality, quantum computing, and more. Cloud will likely continue to be a competitive differentiator.

Trends that only recently grabbed headlines as emerging topics have now assumed the mantle of macro force.

RAPIDLY APPROACHING

Over the next five years, digital reality, blockchain, and cognitive will likely become as important as digital experiences, analytics, and cloud are today. Yet even though their stories are still being written, their novelty is already beginning to wear off. Each is garnering more investment and seeing adoption across industries. Trends that only recently grabbed headlines as emerging topics have now assumed the mantle of macro force. Organizations that delay embracing the cloud may find themselves missing opportunities for innovation.

Digital reality

Digital reality—an umbrella term for augmented reality (AR), virtual reality (VR), mixed reality (MR), the Internet of Things (IoT), and immersive/spatial technologies—is currently redefining how humans interact with data, technology, and each other. Though breakthroughs in wearables, "smart" objects, and sensors sometimes dominate mindshare, the point is not the device itself—the hero of the story should be the interactions and experiences unlocked that would otherwise be impossible.

In the digital age, we have had to force engagement through glass screens in unnatural ways. Digital reality transcends keyboard and touchscreens, offering something that is more lifelike, intimate, and natural, unlocking new and compelling engagement patterns. The underlying capabilities required to deliver these experiences are progressing, with advances in conversational interfaces, computer vision, and auditory technologies turning the dream of entirely new ways for humans to interact with the digital world into a reality. Enterprise investment is outpacing consumer adoption, even as products and offerings in media, gaming, and entertainment continue to advance.[1] That's good news for the ecosystem at large, as existing capabilities mature, new ones emerge, and tools, patterns, and skill sets evolve to support digital reality's full potential.

Blockchain

Blockchain technology continues down the path toward broad adoption as organizations gain deeper understanding of its transformational value, within and across their industries. IDC projects that annual global spending on blockchain solutions will reach US$9.7 billion by 2021.[2] This technology's success in capturing both mindshare and investment is remarkable considering that a few years ago the word *blockchain* was known only through its relationship to cryptocurrencies. Today, blockchain is to trust what the web was to communication: a profoundly disruptive technology that transforms not only business but the way humans transact and engage. And large enterprises and consortia

are deploying enterprise-grade blockchain solutions, avoiding complexities in traversing multiple disparate databases. With technical hurdles and policy limitations being resolved, we will likely see breakthroughs in gateways, integration layers, and common standards in the next few years. Concerns around scalability and cost-performance of transaction processing are being addressed as proof of stake becomes a viable alternative to proof of work consensus, and enterprise tools have emerged to manage and maintain high-performance blockchain stacks. When further breakthroughs occur, expect blockchain to become even more ubiquitous. The door will be open for cross-organizational business process reengineering, an arena that encompasses massive transformation and possibilities across industries, functions, and geographies.

Cognitive technologies

Cognitive is shorthand for technologies such as machine learning (ML), neural networks, robotic process automation (RPA), bots, natural language processing (NLP), and the broader domain of artificial intelligence (AI). Cognitive technologies can help make sense of ever-growing data, handling both the volume and complexity that human minds and traditional analysis techniques cannot fathom. Algorithms replace queries, increasingly unsupervised and self-learning (through reinforcement learning, generative adversarial networks, and other techniques), which makes it possible for machines to explore potential connections and discover patterns and relationships that conventional wisdom would have never considered. And far from just visualizing findings, cognitive toolsets both augment human response and potentially automate the appropriate action. Where conventional analytics focused on finding and answering known crunchy questions, cognitive looks to both spark new questions and short-circuit the handling of the finding.

But similar to the story in analytics, foundational data is a crucial dependency for cognitive. Algorithms and advanced models are dependent on trusted, accurate input. New approaches to data management and data architecture provide more dynamic approaches to ingesting, classifying, and correlating data, using the very machine learning, natural language, and RPA capabilities upon which cognitive is built. But most organizations remain in the early days of the journey. Just as important is the broader culture and organizational dynamic. Becoming data-driven and analytically curious is hard enough; there is an extra leap of faith to allow machines to decision and actuate core business capabilities.

GETTING TO TOMORROW FROM THE REALITIES OF TODAY

Among the nine macro forces, the business of technology, core modernization, and cyber have long been overshadowed by digital, analytics, and cloud. And maybe they don't offer the same kind of headline-grabbing appeal as digital reality, cognitive, and blockchain. But they continue to be essential to the emergence of all the other macro trends, both established and emerging. Simply put, the business of technology, cyber, and core modernization enable technology transformation. When we say we need to imagine tomorrow and get there from today, these three macro forces put in place the foundation needed to make it happen.

The business of technology

For the last decade, CIO, CTOs, and other technology leaders have grappled with a persistent challenge: In a climate of rapid-fire innovation and technology-driven disruption, how can we reorganize and retool the IT organization to deliver fundamental capabilities the enterprise needs? Well-intended initiatives designed to address this challenge often capture inordinate amounts of IT budget. Yet in many cases, they miss the mark because the challenge, as some technology leaders are realizing, is formidable.

A major theme of our annual *Tech Trends* reports is that every company is now a tech company and every employee is a technologist. This theme is particularly relevant as the line between the busi-

ness and the technology organization continues to blur. There is an increasingly critical need to reorient technology teams around product and business outcomes, shifting effort and resources away from rote, repetitive, low-value activities that dominate energies in many IT organizations. In this new model, business and technology teams can work together to deliver outcomes faster without sacrificing those essential enterprise *-ilities* (scalability, reliability, security, maintainability, etc.), shape ambitions beyond conventional approaches and technologies, and look beyond IT boundaries. In the end, the business of technology is the broader story of how companies integrate technology into their strategy and reengineer their IT organization to cost effectively thrive in this new world of technology. It requires much more than a CIO or CTO making changes to her own team. Indeed, this is a CEO and board-level discussion that helps the company understand, prioritize, and execute against everything that disruptive technology represents.

Business and technology teams can work together to deliver outcomes faster without sacrificing those essential enterprise *-ilities* (scalability, reliability, security, maintainability, etc.).

Core modernization

Core modernization seeks to solve the riddle of how companies with significant investments in legacy systems can extract more value from these systems by making them a foundation for new disruptive innovations. That, in itself, is a tall order, given the complexity of many legacy environments and the magnitude of technical debt that these landscapes have incurred. Organizations start to show increased capability to reinvigorate their legacy core by exposing micro services to their technologists and the business. Beyond just replatforming legacy systems, core modernization involves creating a road map for building a next-generation ERP core that incorporates—rather than merely enabling—digital, cloud, and other macro forces.

Those who lead in this transformation see the opportunity to convert technical debt into technical equity. Core modernization can also provide an opportunity to chart an entirely new course for IT. CIOs can choose from several modernization strategies: replatform, revitalize, remediate, replace, and retrench.[3] Some may choose to upgrade and reuse legacy assets; others may replace them altogether with cloud-based technologies. Determining which combination of the five Rs can help you achieve your goals means knowing which core components meet your company's business objectives and which do not, and what the market and your customers are demanding. Identify the useful life of each legacy asset in your IT portfolio. Consider which assets address things about which the business cares deeply, such as the ability to respond to market conditions and address evolving customer needs. Then layer in technology concerns—reliability, security, and scalability. The answers you uncover can serve as a lever that helps you prioritize where and how to invest to modernize.

Cyber risk

For the past few years, as cyber risk threat vectors evolve and attacks become increasingly sophisticated, deliberate, and unrelenting in nature, we've discussed the implications on emerging technology trends for the CIO and CTO. But it's much bigger: The convergence of multiple macro technology trends and continually evolving digital transformation agendas that affect multiple stakeholders within an organization outside of the IT

function—marketing, sales and customer relations, regulatory and legal, finance and human resources—underscores the need for cybersecurity to be the purview of the entire enterprise.

It is critical that cyber risk strategy be built and managed from the ground up, embedded in the business mindset, strategy, and policies, not only within the IT architecture and systems design. IT and business leaders must collaborate to determine a comprehensive cyber risk strategy, encompassing security, privacy, integrity, and confidentiality. This requires considering the organization's risk tolerance, identifying the most vulnerable gaps as well as the most valuable data and systems, then devising plans for mitigation and recovery. A defined and comprehensive strategy could potentially drive an organization's market position, even positioning it with a competitive advantage.

This represents a fundamentally broader understanding of cyber risk—it is not simply a compliance-centric process that one undertakes at the end of a project. Rather, companies are pushing the boundaries of the security function and shaping their risk appetite before development begins. Going forward, cyber will undergird every component of the macro platform, and will be integrated into all aspects of an organization's digital transformation agenda.

WALMART: THE STARTUP DOWN THE STREET

Walmart, the world's largest retailer,[4] is no stranger to the macro technology forces that are driving innovation past and present. Nearly four years ago, Walmart's modernizations of its core systems created greater efficiency, speed, and adaptability within its supply chain, merchandising, store systems, point-of-sale, e-commerce, finance, and human resources functions.[5] In 2017, it made news for its use of virtual reality[6] to train store associates, doubling down on that effort in 2018.[7] The company has implemented mobile technologies that feed data and analytics to store associates to help them better serve customers; it even deployed its own cloud network to improve inventory, purchasing, sales, pricing, and security functions in brick-and-mortar stores.[8]

By now, Walmart understands how to apply leading technologies such as cloud, analytics, cognitive computing, and digital reality in concert to drive transformation and give rise to new opportunities. For the latest chapter of Walmart's innovation journey, it's thinking like a startup. The company is taking new steps to reach a new kind of shopper, one who prefers an online buying experience from unique brands and who demands a strong, personalized relationship with those brands. To do so, Walmart is acquiring multiple digitally native consumer brands and building a new team to innovate and incubate those brands, all under the Walmart umbrella.

"As everyone increasingly sells everything, companies need great proprietary brands to bring people to their platforms and make them sticky," says Andy Dunn, SVP of digital consumer brands at Walmart e-Commerce and co-founder of Bonobos, acquired by Walmart in 2017.[9] "We're creating a collection of the very best next-generation brands, with digital DNA at their core, to ensure customers keep coming back to our ecosystem."

Walmart has now acquired three digital consumer brands: Bonobos, ModCloth, and ELOQUII, which specializes in size 14-plus women's fashion. The company is also incubating digital brands such as Allswell, a mattress brand competing in the growing bed-in-a-box sector.[10]

"These emerging brands have a deep level of connectivity with the consumer. It's all about great products, great customer service, a story told through social media, lots of data and iterative feedback loops. Walmart's leadership is excited about the power of direct-to-consumer brands," Dunn says. "Though it can be done, it's not easy for these brands to operate independently. For example, when it comes to the role of technology, it's difficult for them to make the needed investments at the same time as they're buying inventory, hiring a team, and spending a ton of money on marketing. At Walmart, we can help these brands leverage our capabilities and cross-pollinate learnings and talent."

In addition to the digital brand strategy, Walmart is also acquiring multibrand e-tailers to deepen its assortment and capabilities. The company has made five acquisitions with that strategy: Art.com, Bare Necessities, Hayneedle, MooseJaw, and Shoebuy (now Shoes.com). Within the Walmart organization, new brands can access established and emerging technologies at scale to further innovate unique shopping experiences. For Walmart, these acquisitions, along with the birth of its Store No. 8 technology incubator, have brought some of the retail industry's most entrepreneurial digital talent and expertise to its organization.

Formed in 2017, Store No. 8 is charged with creating new assets to support Walmart's brands and bringing them to market faster, in order to drive value for all customers.[11] Walmart leadership set up the shop after identifying the need for a dedicated team, separate from day-to-day operations, to develop new ways to disrupt the future of retail. The company is exploring the expanded use of VR—among other technologies—to improve merchandising, particularly for higher-priced items that require more deliberate, thoughtful consideration before purchase. Additionally, Walmart acquired Spatialand to help drive content for VR applications. Store No. 8 is also developing "conversational commerce" through its first portfolio company, JetBlack, an all-text shopping service that allows customers to place and transact orders by texting on their phones, without the need for a lengthy online checkout. Over time, the company hopes to migrate to a voice application, leveraging augmented reality, machine learning, and natural language processing to automate

the conversation, as customers become more comfortable building an intimate relationship with service representatives.[12] It could significantly change how shoppers buy a product, while creating stronger ties between stores and customers.

Walmart's deep well of resources—including data, technology, staff, and infrastructure—is accelerating its business transformation, in both the long and short terms. And its business transformation efforts have already yielded positive results: Walmart's online sales for the second quarter of 2018 jumped 40 percent, and the company moved up one spot to be the third-largest online retailer.[13]

"From a technology perspective, I think splashy things can inspire, but we're more interested in things that fundamentally change people's lives, where everything is just *different* after," Dunn says. "Walmart's motto is, 'Save money, live better,' and I think our business transformation strategy will help many customers live better as we disrupt the industry."

The forces in action

It is important to remember that the nine macro forces are just ingredients in a much larger enterprise technology recipe. As with many good recipes, the measurements don't have to be exact and can be tailored to suit specific needs. But the point of this particular recipe is that the macro forces should come together in a manufacturing line, or an accounts-payable process, or in a new mode of engaging loyal customers. Their collision can trigger vast possibilities. Deploying them individually, at this point in the digital revolution, is no longer a recipe for success. Across industries, we are seeing how macro forces, working in concert, are driving digital transformation and giving rise to new strategic and operational opportunities.

For example, German insurance services provider **Talanx AG** is harnessing the core modernization and digital experiences macro forces in a broad, future-focused effort to collaborate with B2B partners more effectively and, perhaps more importantly, to meet customers' rapidly growing digital expectations. "Selling insurance was always a people business," says Michael Krebbers, a board member at Talanx Systeme AG (a division of Talanx AG). "Now it is becoming a digital business. A few years ago, we recognized that we needed to reposition ourselves as an insurance info-tech company, so we began redesigning our business for the future." The firm's digital transformation journey focuses on two areas: 1) reengineering legacy back-end systems to reduce technological complexity, in some areas also leveraging a fully automated, tools-based application modernization approach and 2) deploying cloud-based front-end systems to enhance digital B2B and B2C channels. Though the firm's digital effort is still in early stages, it has already opened up opportunities to leverage other macro forces, such as advanced analytics and data management and—notably—the way the IT organization operates. Recently, Talanx launched a best-practice lab to provide transparency into new insurance technology solutions, and to help the firm's far-flung offices align with ongoing digital transformation projects.[14]

In a different sector, **KONE**, a global provider of elevators, escalators, automatic doors, and turnstiles, is using cloud, analytics, digital experiences, cognitive, digital reality, and other technologies to reinvent the way its products are serviced.[15] For KONE, like many companies that manufacture physical products, operating in the digital world requires a profound shift in perspective, says CIO Antti Koskelin. "When you are working in a traditional industry, employees are accustomed to designing and experimenting with new products in a certain way. The dimensions and attributes of elevators are measurable and knowable. With digital experiments, everything is abstract and to a large extent unknowable, so employees have had to adjust to working with a high level of uncertainty. They want to move forward, but they don't know what the end state will be."

According to Koskelin, KONE employees have moved forward digitally with the rollout of KONE 24/7 Connected Services. The development involved embedding sensors throughout KONE elevators to transmit performance data to a machine learning-based IoT platform, which monitors, analyzes, and displays performance data in real time. The service is available to KONE's elevator and escalator customers and is fundamentally changing how maintenance services are provided, as potential faults can be predicted before they happen and equipment can be monitored in real time. In one example, through constant performance monitoring that suggests preventative measures for 100 customer elevators over a 12-month period, the company saw customers report 60 percent fewer maintenance issues. Earlier this year, KONE expanded the offering to escalators. Another significant element is the ability to connect KONE 24/7 Connected Services to earlier generations of equipment, as well as customers' equipment irrespective of the manufacturer. This means bringing the benefits of IoT, artificial intelligence, and analytics to a broad portfolio of assets. The company's marketing

campaigns gave elevators a voice with Machine Conversations,[16] while an escalator connected to Twitter allowed followers to see performance information on escalators operating in a select location in London. In addition to tweets, KONE made a VR and 360-degree video of an escalator ride to complement Machine Conversations, showcasing the business value of their new services to its users and also to its B2B customers."[17]

BOTTOM LINE

The nine macro forces are the enduring technology trends that will continue to shape strategies and dominate investment priorities. But importantly, the forces are not independent, isolated entities. And they're only partially compelling as stand-alone concerns. The calling of our time is to unlock what combination matters for any given line of business, function, agency, or country; to confidently chart a path beyond convention and organizational inertia; and to elevate the narrative from the *what* of the enabling technology into the *so what* of their combined effects—moving beyond trends, and beyond the digital frontier.

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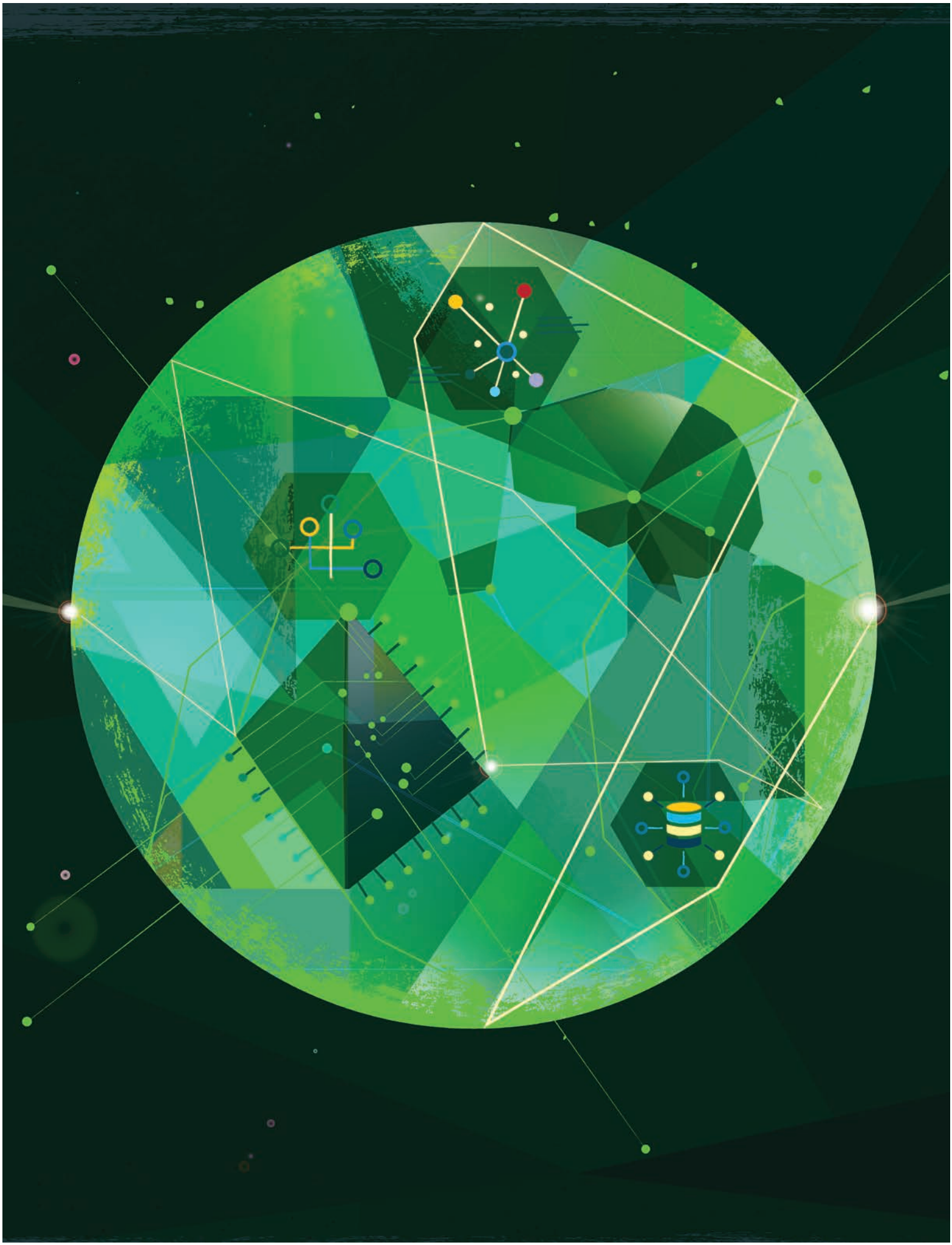


AI-fueled organizations

Reaching AI's full potential in the enterprise

FOR SOME ORGANIZATIONS, HARNESSING ARTIFICIAL INTELLIGENCE'S full potential begins tentatively with explorations of select enterprise opportunities and a few potential use cases. While testing the waters this way may deliver valuable insights, it likely won't be enough to make your company a market maker (rather than a fast follower). To become a true AI-fueled organization, a company may need to fundamentally rethink the way humans and machines interact within working environments. Executives should also consider deploying machine learning and other cognitive tools systematically across every core business process and enterprise operation to support data-driven decision-making. Likewise, AI could drive new offerings and business models. These are not minor steps, but as AI technologies standardize rapidly across industries, becoming an AI-fueled organization will likely be more than a strategy for success—it could be table stakes for survival.

In his new book *The AI Advantage*, Deloitte Analytics senior adviser Thomas H. Davenport describes three stages in the journey that companies can take toward achieving full utilization of artificial intelligence.[1]

In the first stage, which Davenport calls *assisted intelligence*, companies harness large-scale data programs, the power of the cloud, and science-based approaches to make data-driven business decisions.

Today, companies at the vanguard of the AI revolution are already working toward the next stage—*augmented intelligence*—in which machine learning (ML) capabilities layered on top of existing information management systems work to augment human analytical competencies.

According to Davenport, in the coming years, more companies will progress toward *autonomous intelligence*, the third AI utilization stage, in which processes are digitized and automated to a degree whereby machines, bots, and systems can directly act upon intelligence derived from them.

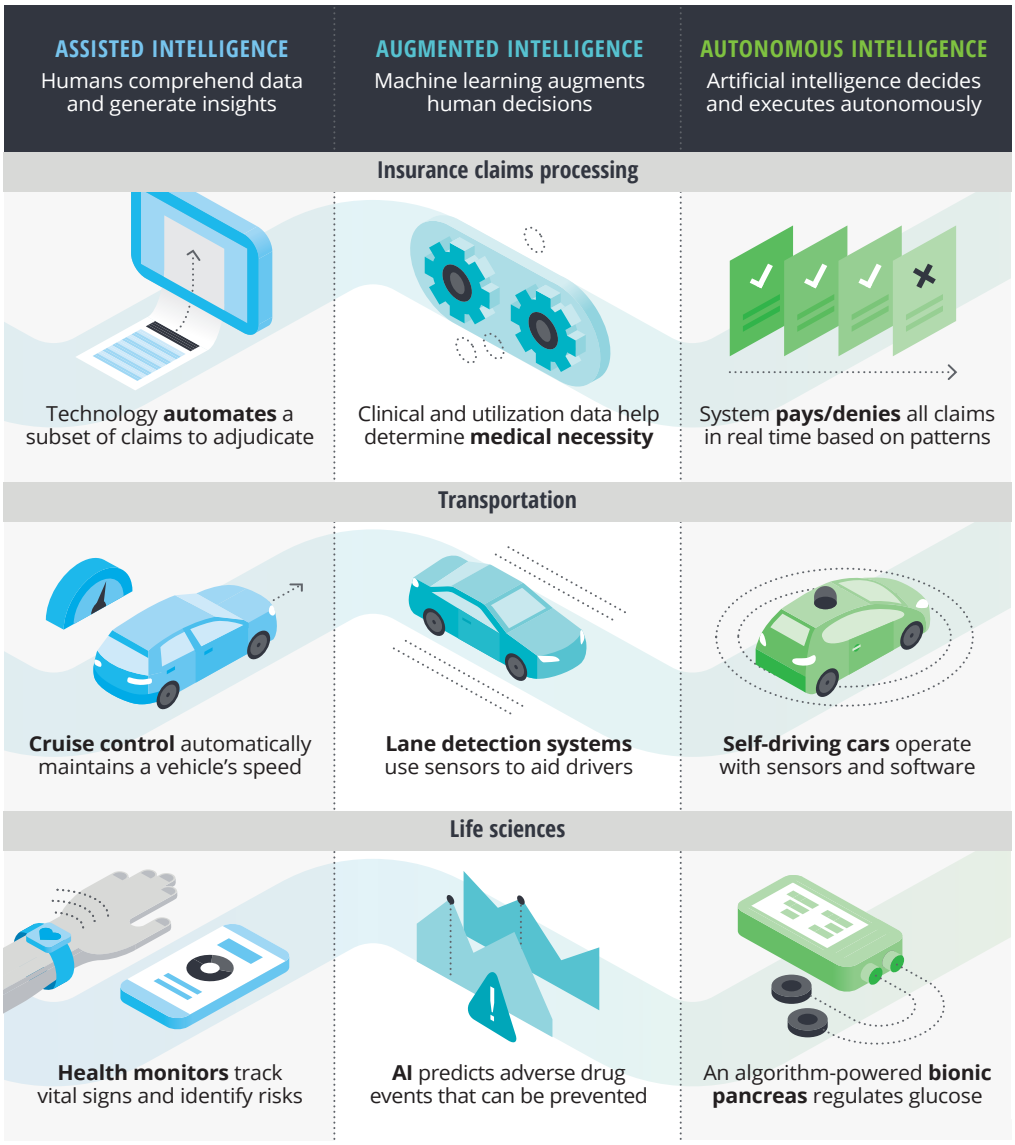
The journey from the assisted to augmented intelligence stages, and then on to fully autonomous intelligence, is part of a growing trend in

which companies transform themselves into "AI-fueled organizations." This trend is also about a sustained commitment to redesigning core systems, processes, and business strategies around AI and its possibilities. Its end goal: an AI-fueled organization in which humans and machines work together within designed digital systems to harness data-driven insights.

Over the last decade, *Tech Trends* has chronicled the emergence of AI and other cognitive technologies, and their growing disruptive potential. The *AI-fueled organization* trend, as we recognize it today, found its footing during the last several

FIGURE 1

Bringing the evolution of artificial intelligence to life



Source: Thomas H. Davenport, *The AI Advantage*. Deloitte analysis.

years when a few pioneering companies began experimenting with bots and other cognitive technologies to better understand their potential impact on productivity.[2] We now see companies representing all industries and regions embarking on their own AI-fueled journeys. For example, the German retailer Otto is currently using AI and ML to make operational decisions autonomously at a scale that humans cannot match.[3] In the financial services industry, Zurich Insurance Group is using intelligent bots to process personal injury claims.[4]

Meanwhile, companies even further along in their AI journeys are looking beyond discrete initiatives and beginning to approach AI as an integral component of corporate strategy. A recent survey by the *MIT Sloan Management Review* and Boston Consulting Group of more than 3,000 business executives found that pioneering companies such as Chevron, Allianz, and Daimler are deepening their commitments by prioritizing revenue-generating AI applications over cost-saving ones. They are scaling AI throughout their enterprise operations and are involving high-level management in AI initiatives. Notably, of the surveyed executives from pioneering companies, 90 percent report already having AI strategies in place.[5]

The number of companies following in the footsteps of AI pioneers will likely increase in the next 18 to 24 months as companies identify ways to use cognitive technologies to achieve strategic goals. This process is already underway. In two consecutive global surveys (2016–17 and 2018), Deloitte has asked CIOs to identify the emerging technology in which they plan to invest. Cognitive technologies/AI has consistently topped the list.[6]

Though these CIOs—much like society at large—may be fascinated by cognitive technologies' sci-fi-like possibilities, their AI ambitions are likely grounded in more practical (and achievable) benefits: Pursued strategically across cognitive's three stages, AI can increase productivity, strengthen regulatory compliance through automation, and help organizations derive meaning from ever-larger data sets.[7]

Enterprise tech leaders, start your engines. The time to launch your company's AI-fueled journey is now.

AI, AI—oh!

The AI-fueled organization trend is the latest in a series of technology-driven transformations that have delivered quantum leaps in productivity. In the early 20th century, new tabulating machines helped workers organize data and perform calculations. The 1950s saw the emergence of programmable systems—early antecedents of today's computing and internet technologies. And at the dawn of the new millennium, cognitive technologies such as AI, ML, and robotics began augmenting and amplifying human intelligence, a transformation that continues to disrupt operational models and illuminate new opportunities.[8]

FIGURE 2

The top five benefits of AI

Percentage of survey respondents who rated each benefit in the top three for their company

Source: Deloitte Consulting LLP, *State of AI in the Enterprise*, 2nd Edition, October 22, 2018.

Today, the possibility of achieving the next quantum leap in productivity propels our march toward autonomous intelligence.[9] The human brain can decipher and derive meaning from large volumes of data, but this unique ability is limited by the amount of data our brains can absorb at any moment. Unlike the human brain, AI has no such limitation, which has the net effect of turning a trickle of business insights into a raging river of strategic possibilities. More and better insights delivered autonomously can lead to increased productivity, greater efficiency, and lower operational costs. Yet in the context of AI, these three may prove to be low-hanging fruit. Consider how autonomous AI could fuel other opportunities, including:

- **Enhanced regulatory compliance.** Despite companies' best efforts, regulatory compliance remains a moving target, due largely to the pervasive nature of human bias. While subjective opinions and differing worldviews make for interesting conversation, they also make it challenging for any two (or more) people to interpret laws and regulations the same way. This is why we have judges. Algorithms, by contrast, do not have fluid thought processes: They always interpret and execute according to the literal letter of the laws with which they're set up. By intelligently automating compliance functions in IT systems, companies can leave human cognitive maneuverability to machine-based robotic execution, which is, ideally, free of subjectivity, bias, and mood.[10]
- **"Mass personalization" of products and services.** Today content, products, and services are largely designed for mass consumption. In the near future, they will likely be customized based on individual users' personas, needs, wishes, and traits—an approach known as *mass personalization*. What's more, this degree of personalization will take place both statically and dynamically. Some companies are already working toward this goal. In the media sector, for example, Netflix is developing an AI platform that creates personalized movie trailers based on the streaming histories of individual viewers. This is one element in the company's larger content strategy for using data to inform creative decision-making around genre, casting, and plot development.[11] (Learn more about mass personalization and the technologies that make it possible in the *Beyond marketing: Experience reimagined* chapter of *Tech Trends*.)
- **Asset intelligence.** Today, companies rely heavily upon human intelligence to interpret, anticipate, and intuit information in ways that machines cannot. That's about to change. In the future, the intelligence generated by data intelligence generated from company assets—infrastructure, IT systems, and inventory, for example—may surpass human insights as organizations' most mission-critical business intelligence. Sensors embedded in vast IoT networks, computer vision, and machine learning will feed data into analytics systems in real time. AI tools, acting autonomously on the resulting insights, can reconfigure dynamic pricing on store shelves, recalculate warehouse staffing projections, calibrate manufacturing machines, and optimize supply chains.

AI's next top model

Indeed, organizations are using AI in innovative ways, but as the *AI-fueled* trend progresses, more companies will evolve, moving from using the technology in isolated pilots to deploying larger AI systems. But which systems? Three system models are currently in play:

- **Cloud-native model.** Given AI's ascendance in the enterprise technology arena, it is conceivable that an AI-as-a-service platform could be the next big operating system. This may or may not happen, but even the possibility has set off a gold rush of sorts among major (and minor) tech players to build AI-based platforms. AWS, Microsoft, and Google Cloud Platform

are investing heavily in big data, ML, and AI capabilities, while Chinese vendors Alibaba and Baidu are developing a host of cloud-based AI solutions. None of these deep-pocketed tech giants has yet seized a first-mover advantage, but competition—and potential rewards—are steadily increasing.[12] Deloitte Global predicts that in 2019, companies will accelerate their usage of cloud-based AI software and services. Among companies that adopt AI technology, 70 percent will obtain AI capabilities through cloud-based enterprise software, and 65 percent will create AI applications using cloud-based development services.[13] Stay tuned.

- **Package-adjunct model.** In an alternative approach to the cloud-native model, several vendors are putting existing general-purpose AI platforms in the cloud. For example, IBM is now making Watson's AI and ML capabilities available to cloud customers.[14] Salesforce is taking a slightly different tack with its Einstein platform: The company is acquiring AI capabilities to add to its cloud services portfolio.[15] Similarly, SAP and Oracle continue to embed AI capabilities into their existing product suites.[16]
- **Open-algorithm model.** Established vendors with deep pockets are not the only companies to recognize a big opportunity in AI, and it is not a given that a single cloud-based or vendor model will come to dominate the market. For this reason, numerous startups and boutique software shops are developing AI solutions to meet specific business needs, use cases, and vertical-ized issues. Until market consolidation gains momentum and standards begin to emerge, expect more highly innovative startups to enter the AI fray—and for some of their early efforts to result in scalable deployments.[17]

Intelligence: Artificial and human

An AI-fueled organization places AI, ML, and other cognitive technologies at the very center of business and IT operations. While this may sound like a straightforward proposition, its disruptive ramifications will likely ripple across the enterprise, with particular impacts in the following areas:

- **Data management.** To realize the benefits of becoming an AI-fueled organization, you'll need to put in place more dynamic data governance, storage, and architecture. Advanced data management fuels an enterprise AI engine and is a core building block for deriving autonomous insights from your vast data stores. Data needs to be tagged properly before being fed to AI, and your team should be prepared to provide the business context for that information. To become an AI-fueled organization, you will need access to the right data sets, the ability to train algorithms on that data, and professionals who can interpret the information.

  While AI offers an opportunity to process, analyze, and act on data at phenomenal speeds,

Deloitte Global predicts that in 2019, among companies that adopt AI technology, 70 percent will obtain AI capabilities through cloud-based enterprise software, and 65 percent will create AI applications using cloud-based development services.

quality data is necessary to stand up AI in the first place. Unfortunately, preparing data for AI deployments—and then creating the dynamic capabilities you will need to manage it—can prove challenging. Of the roughly 1,100 IT and business executives interviewed for Deloitte's second annual *State of AI in the Enterprise* survey, 39 percent identified "data issues" as being among the top three greatest challenges they face with AI initiatives.[18]

- **Training machine learning**. To function, AI technologies rely on ML algorithms operating within neural networks that must be "trained" on massive volumes of data. In the context of the global AI gold rush, China—which takes a different approach to data privacy from those of many other nations—currently has an advantage. As they train their neural networks, Chinese developers enjoy ready access to enormous data sets owned by firms such as Alibaba and Baidu, all of which are ultimately controlled to a greater degree.[19] In Western economies, companies lack comparable access to vast, controlled data stores, which puts them—at least for now—at a competitive disadvantage.

39%

of Deloitte's second annual *State of AI in the Enterprise* survey respondents identified data issues as among the top three greatest challenges they face with AI initiatives.

Yet there is an alternative technology-based means for training AI that may help companies overcome this data access challenge. DeepMind, a UK-based company owned by Google, has developed a system for training neural networks on simulations rather than on real data. In other words, DeepMind's AI solution trains itself. It's too early to tell whether simulation-based AI training can fully match the benefits of training with traditional data, but it does offer an alternative approach that could put AI training and full deployment within the reach of millions of companies around the world—including startups without years of data sets already in hand.[20]

- **Ethical AI**. The current debate surrounding the ethical ramifications of using AI and its potential impact on society isn't ending anytime soon.[21] In the absence of ethical consensus on so many aspects of cognitive technologies, individual companies on AI journeys should factor ethical considerations—as well as their organization's values—into the development of their own AI solutions. Though a few organizations operating at the vanguard of cognitive exploration are using machines to write code, by and large humans continue to write it. As such, all their biases, assumptions, and perceptions may find their way into the algorithms being developed.[22] As you build your AI-fueled organization, ask yourself: What does ethical AI mean? How do governance and ethics overlap? Do the algorithms we are creating align with our values and those of society in general? How can you build transparency into AI decision-making? How can you calibrate algorithm models more consistently to remove the unconscious bias that may exist in underlying data or in the surrounding environment?
- **Talent**. Only the biggest companies with the deepest pockets likely have the resources to keep industry-leading AI talent on the payroll on a permanent basis. Moreover, as more organizations become AI-fueled, competition for expertise will only increase. How will you secure the talent and skills you need to compete in

As we move into the AI-fueled model, workers will have to adapt to a more advanced end state in which humans and machines interact and collaborate in ways that, until recently, existed only in the realm of science fiction.

this climate? The first step is to jettison the old-school idea that employees are, and must always be, full-time workers. As discussed in Deloitte's *2018 Global Human Capital Trends* report, "the traditional employer-employee relationship is being replaced by the emergence of a diverse workforce ecosystem—a varied portfolio of workers, talent networks, gig workers, and service providers that offers employers flexibility, capabilities, and the potential for exploring different economic models in sourcing talent."[23] This does not mean that full-time workers will no longer have a role to play in IT. It does mean, however, that as cognitive technologies and automation transform IT roles and skill sets, the definition of talent will evolve to include:

- full-time employees you can attract and hire
- contracted freelancers working in the gig economy
- crowdsourced activities, such as the creation of algorithms
- bots that automate some business processes and act as digital full-time employees

This last talent category—bots—is important. In the future, humans and machines will likely complement each other's efforts effectively, with intelligent bots assuming many of the tasks that full-time employees perform today. This will free humans from low-value, repetitive drudgery to focus on tasks and initiatives that create value. This hybrid talent model lies at the heart of what we foresee as the "future of work."[24] It is also a foundational component in the AI-fueled organization.

- **Organizational and culture changes**. Among the most prized IT skills today are those in the areas of data analysis, data modeling, and applications development. As AI adoption grows, companies will increasingly value expertise in data science, algorithm development, and AI system design—with special emphasis on the human-centered design skills required to develop personalized user experiences. For CIOs, this presents a challenge: What do you do with existing talent whose expertise lies in legacy systems? You can retrain, reskill, and retool your workers, or change your workforce altogether. Some CIOs may find that the best way to meet their needs is by pursuing both options, to the extent possible.

  Yet retraining and acclimating legacy talent to the world of AI may present its own challenges. It's not about just learning a new skill—it requires adapting to a new culture. AI-fueled organizations work in unorthodox ways. Anecdotally, we have seen companies struggle to get their people to accept using analytics to perform traditional tasks. As we move into the AI-fueled model, workers will have to adapt to a more advanced end state in which humans and machines interact and collaborate in ways that, until recently, existed only in the realm of science fiction. What will an organizational culture shift of this magnitude mean for AI adoption, buy-in, support, and sponsorship?
- **Insights, not information**. Traditionally, CIOs have spent much of their workdays (and careers) maintaining legacy systems and

"keeping the lights on." As AI, ML, and other cognitive tools drive automation across the IT ecosystem, CIOs and their teams may spend less time on maintenance and more time helping the enterprise with informed decision-making about how they use and what they expect from technology. CIOs have unique insights, directly affecting business strategy and tactics, to address key questions:

- What are the data assets within an organization?
- How could one monetize those assets?
- What insights could be generated from those assets?
- How do you interpret those insights?
- How do you use these insights to generate meaningful outcomes?
- Consequently, how do you make informed decisions on new products and services for your customers while at the same time increasing the engagement with those customers?

Ultimately, the AI-fueled journey presents CIOs with an opportunity to redefine their own role, from chief information officer to "chief insight officer"—the organizational leader who serves as custodian, facilitator, and catalyst for informed decision-making at the corporate level.[25]

LESSONS FROM THE FRONT LINES

PFIZER: AI-FUELED BUT PEOPLE FIRST

The speed with which pharmaceutical company Pfizer has deployed artificial intelligence to accelerate innovation across its organization demonstrates best practices that could serve as a model for the entire industry. "In terms of scaling up new technology, as an industry, we must work on moving that needle faster," says Mary Hall Gregg, vice president of business technology, research, and development. "Speed and efficiency are critical if we want to improve patients' health and quality of life; AI allows us to move forward, faster. Without it, it will take too long to have the kind of impact we need."[26]

Technology and business leaders within the organization quickly recognized AI's potential to deepen Pfizer's understanding of patients and their diseases, as well as accelerate the process of drug discovery and delivery to the market. But to realize that potential, the company needed to take a broad organizational, business-driven view, and be willing to "fail fast"—to quickly identify when an approach may not work and make appropriate changes. Pfizer saw AI as an untapped opportunity to enable innovation and a means to gain competitive advantage, but with so many potential applications, it needed to gain precision on where to apply the technology.

Pfizer offered AI training across the enterprise, to help business executives understand the broad range of possibilities for the technology as well as to separate the facts from the science-fiction hype. The company held five AI boot camps in 2018, with more than 1,000 employees taking part. Understanding what's possible with AI—and conversely, what the technology can't solve—has played a vital role in helping Pfizer's business units formulate their end goals, focused on driving speed, quality, and efficiency in areas as diverse as research and development, patient safety, medical, finance, and the global supply chain.

Pfizer's IT team—which placed a premium on agility and open-source technology—believed that the company would be served best by building an in-house AI workforce that could employ a wide range of tools, from natural language processing to neural networks to statistical models and more. Pfizer chose to invest in people—establishing an AI Center of Excellence and hiring AI developers who understood the pharmaceutical business and could rapidly apply AI techniques within a business context. With a software-driven approach and a significant data management framework already in place, implementing AI required only a modest capital investment.

Ryan Steinberger, vice president of business technology at Pfizer's Global Business Intelligence and AI Center of Excellence, explains, "AI adoption is accelerating at different rates across the enterprise. As one business unit innovates and begins to accelerate—such as the medical group did with natural language processing—other teams piggyback on that success, taking the lessons learned and applying that knowledge to their own business unit."[27]

To date, Pfizer's AI-fueled approach has enabled 30,000 colleague hours, a number that is continuously growing as more AI-fueled automation is deployed each month. Other significant achievements include the deployment of the company's scientific data cloud, which aggregates real-time data from a wide variety of instruments to create algorithms that improve compound prediction. The organization is also speeding pharmaceutical development teams' design-and-build process using AI. And it's engaging with the US Food and Drug Administration to explore AI for use in adverse-event reporting—a dramatic shift

in the regulatory space. Finally, AI has allowed Pfizer to more effectively engage with physicians to inform them about the appropriate use of products and customize engagement with patients who are participating in research, both of which have the potential to significantly improve patient outcomes.

CANADA'S GO-TO-MARKET IMPERATIVE DRIVES GLOBAL ETHICS DISCUSSION

Alex Benay, CIO of Canada, sees a convincing go-to-market imperative for governments to leverage artificial intelligence.[28] The need to keep up with industries such as banking and telecommunications—those with which the government does business and regulates—and the vast opportunities that AI affords its agencies are helping to drive Canada's push to operationalize the technology.

Public sector stakeholders face unique challenges in effectively fostering, procuring, and leveraging leading-edge innovation: lengthy contracting cycles, restricted budget dollars, and more, while balancing the need for transparency. As such, the government is investing in public-private partnerships, pursuing procurement reform, and issuing ethics standards, with the goal of accelerating the use of AI across government and furthering Canada's comprehensive digital innovation strategy.

Most notable is the government's advocacy for and need to develop transparent policies to support the responsible and ethical use of AI. "A different paradigm surrounding AI exists in the public sector and for our citizenry," Benay contends. "For example, we don't believe governments should be handing over life-and-death policy decisions to black boxes and software when they don't have the means to validate outcomes or intervene in the decision-making process if necessary. Nevertheless, we collectively have to close the digital gap between government and the industries we're charged with overseeing by using the same technology they are."

Setting standards and guiding principles for the government's AI deployment—and those organizations doing business with the government—is at the heart of Canada's digital strategy. And those standards are firmly rooted in the nation's values and ethics. The government is developing a directive on automated decision-making with input from the public; Canada's commitment to transparency allows citizens to monitor the process. This commitment to transparency will continue once the directive is approved, as it will direct federal departments to show Canadians how automation is being used to deliver services.

In addition to the directive, the Canadian government is developing a set of tools: an up-to-date list of approved AI vendors, from which departments can procure AI products and services; an algorithmic impact assessment tool to help project leaders determine how to select and apply AI within their particular functions; and an "ethical switch." That switch, developed with AI company Cognitive Scale, is an algorithm that identifies ethical biases in AI engines and aims to help mitigate them. The Canadian government is piloting the ethical switch so it can better evaluate countermeasures to deploy if biases within the AI program are encountered. Intended to be a failsafe, the switch is envisioned to monitor algorithmic decisions and pause the system so that human reviewers can take action.

And the government hasn't pursued its AI directive and policies in a bubble. Not only have officials consulted with citizens—they have consulted with corporations, academia, and other countries on the concept of openness, transparency, and traceability of decision-making. Canada's leaders, notably Scott Brison, the first-ever minister of digital government, hope to set an example and are working one-on-one with other countries and as part of the Digital 9

group of nations.[29] Benay shared the government's draft directive at the November 2018 D9 meeting to elicit both feedback and support from the member nations. "These are heated conversations that cut to the core of public-sector ethics across the world," he says. "It's triggered a lot of discussion about the future role of public service in light of artificial intelligence and automation." These conversations culminated in D9 members endorsing Canada's AI principles, a signal of international cooperation on the responsible use of AI.

Benay (also co-founder of the nonprofit CIO Strategy Council, a Canadian collaborative that discusses digital transformation issues and looks to help set industry standards[30]) stresses that the country's AI directive is only the first iteration: It will be reviewed quarterly or semiannually and adjusted as the technology and ethical environment evolves. "This isn't going to happen overnight," he concludes. "But that's a good thing on the ethical front: It's important that the government takes the time to do AI properly and—more importantly—to respect Canada's values."

WORK THAT AI: THE ADECCO GROUP AUGMENTS ITS WORKPLACE—AND YOURS

Many have speculated about the potential for artificial intelligence to replace much of the human workforce,[31] but the Adecco Group foresees a future in which *augmented intelligence* will enhance rather than replace human skills such as critical thinking, emotional intelligence, and value judgments. And the company is accelerating the use of the emerging technology across both its internal and market-facing functions. Leaders see two paths of opportunity for artificial intelligence: to amplify the Adecco Group employees' recruiting efforts and performance through automation of core legacy tasks, and to offer innovations to clients to improve their talent recruitment and career management.

"We don't see ourselves as a tech company," says the Adecco Group CEO, Alain Dehaze.[32] "But we see an opportunity to leverage technology to complement, advance, and even disrupt our existing business to stay attuned to today's workforce."

Currently, its general staffing brand, Adecco, uses Mya System's chatbot to streamline its initial screening of candidates. The chatbot prescreens potential job candidates by matching their skill sets, experience, geographic location, availability, and salary requirements with open positions; it reaches out to suitable candidates to set up appointments with an Adecco recruiter. Because automation provides better-qualified leads and follow-up happens quickly, both recruiters and candidates have responded positively.

The Adecco Group's initial foray into AI prompted the company to explore other opportunities to scale the technology for greater efficiencies within other core processes across the enterprise, such as using robotic process automation to manage the time registration and payroll administration of 700,000 temporary workers daily, as well as applying analytics to prioritize work for company recruiters.

The market interest in AI-driven efficiencies in recruitment and hiring drove the Adecco Group's acquisition of Vettery in 2018, for its fully automated, zero-touch recruitment AI platform. The acquisition gained the company the algorithm it needed to expand its capabilities, while providing Vettery's AI engine with data on which it could train and learn over time. Vettery began with listing IT-related jobs—such as programmers and DevOps professionals—because they were the easiest to codify and, in just a few months, had realized automated recruiting processes for the vast majority of the permanent positions for which it was seeking talent.

The firm also plans to capitalize on the market shift toward a gig economy, driven in most part by millennials seeking freelance work; it created YOSS (your own boss), an end-to-end digital marketplace that leverages AI to match supply with demand.[33] The platform helps build trust between freelancers and hiring companies and can match freelancers with benefits and training as well as handle payment arrangements.

"We see an opportunity to disrupt a traditional market, which is still heavily based in high-touch, personal relationships and contacts," Dehaze says. "AI has given us the opportunity to grow our digital strategy and broaden our offering into a fast-growing digital recruitment market while also complementing our professional recruitment business. We want to grow these capabilities geographically as well as expand into additional vertical markets."

GOOGLE CLOUD'S SMART SEARCH FOR UBIQUITOUS AI

While many companies are just beginning to explore the potential benefits of artificial intelligence, Google recognized the value the technology can bring to its business model from the beginning.[34] Over the course of the last five years, the organization has gone from deploying AI in narrow strategic areas to becoming "AI-first" and mandating its use across the Google enterprise. And it's taking best practices gained from operational use and building those AI capabilities into nearly all its products. Now, Google Cloud is working to bring Google's innovation in AI to all businesses.

"We've found that in most cases where we had a particular business challenge, artificial intelligence could be applied to help us solve it," says Rajen Sheth, senior director of product management at Google Cloud Artificial Intelligence. "We believe every company is going to be transforming itself with AI over the course of the next 10 years, so we felt it was imperative that we deploy it broadly as part of our own business strategy."

One of the keys to successfully applying artificial intelligence, Sheth says, is identifying an internal business challenge and then exploring how AI might solve it. For example, Google Cloud leveraged Google Assistant technology to personalize experiences with the service department in its customer contact center. Using natural language recognition and simulation combined with machine learning automates the handling of tier 1-level calls. Rather than asking a generic set of questions from a script, the technology is able to understand the specific issues about which the customer called and access the knowledge repository to provide relevant questions and comments in a conversational manner. Another use case for AI allowed Google Cloud to improve the energy efficiency in its data centers: Using machine learning to set cooling system algorithms and reinforcement learning—where the system tries different things to test an outcome and then retrains itself based on findings—the system learned, on its own, what the optimal settings were. The cooling energy needed was reduced by 40 percent, resulting in a 15 percent reduction in overall data-center energy usage and producing significant cost savings for the organization.

Google Cloud continues to explore internal deployment opportunities that could inform future commercial product development—from demand forecasting to systems control optimization and quality control. Its AI team is exploring use cases for artificial intelligence across the medical, scientific, and automotive industries, and it's made its AI training program open source so that all technologists can benefit from the learning. It is also devoting resources to investigating how to monitor and analyze AI behavior, to detect and rectify bias in AI engines, and to facilitate the transformation of a traditional workforce in the age of machine learning.

MY TAKE

RAJEEV RONANKI, CHIEF DIGITAL OFFICER, ANTHEM

Digital technology is fundamentally transforming the way we interact with the world. People, machines, data, and processes are becoming increasingly connected, and the result is an explosion of information that can be used to understand customer needs. Yet the sheer volume of data and data sources required to get us where we need to go has exceeded the pace and scale of our human capacity to process it. Enter artificial intelligence. Poised to lead the next wave of exponential change disrupting health care, AI can mobilize analytics and automation to deliver moments that matter. The winners in the health care industry will be those organizations that not only empower patients to own their health data but use AI to generate actionable insights from data in real time to drive engagement and outcomes.

Our multidimensional digital transformation strategy and AI-first mindset help us treat every individual as a population of one. Our first step was to stand up a platform-based AI engine rather than point-to-point data solutions. We invested heavily over the years in our underlying data management capabilities as a foundation for this transformation. For example, our data infrastructure was already able to process both structured and unstructured data, feeding and curating our data pipeline and continually governing and certifying the data. Next was implementing data governance, security, and a trusted layer around the data stores. We added machine learning engines, algorithm layers, and software development kits, which facilitated building out APIs for portal, mobile, and internal channels. And we built feedback mechanisms allowing our AI to evolve from gathering data to providing insights to prompting actions—automating and speeding up processes and continuously learning from the feedback to improve future interactions.

Also critical to realizing the full potential of AI across Anthem was gaining enterprisewide support for the initiative, which meant conceptualizing with our stakeholders the positive business outcomes we could achieve. We asked our business partners for input on how we could use AI to rethink, reimagine, and re-implement across core business processes. Initially, we focused on automating data processing and analysis where AI could have the most impact on our business: serving customers more efficiently. The team identified operational functions, including claims adjudication, prior authorization of procedures, provider payments, and consumer/customer billing functions as the top choices for the initial pilot programs. We built a proof of concept for each, and if the application provided value, we doubled down to scale it, applying agile techniques, and pushing the process into production.

Finally, we knew that, to execute on our vision for AI throughout Anthem, we needed to be proactive in broadening our talent base. So we created Anthem AI, to attract skilled technologists and cultivate existing internal talent by offering a structured AI training program. The unit works to retain that talent by building a culture that promotes innovation and ideation of AI solutions for the business.

Currently, AI is just one technology fueling our digital transformation across the enterprise. One of our recent projects is a yearlong data trial to test whether blockchain and precision medicine, along with AI, can predict when people will experience allergies. The hope is that our predictive model can add accuracy, speed, and cost-effectiveness to health-related insights.

One thing we've learned from this journey is to do away with the notion of starting with a greenfield. Instead, we see how AI can impact business outcomes, then connect related, fit-for-purpose use cases to achieve small wins. By approaching AI and machine learning with a process-level view, we've been able to deploy next-generation technology in a way that significantly improves our customers' experiences.

RISK IMPLICATIONS

Cybersecurity professionals are becoming exceedingly aware of the threat of hackers using artificial intelligence to gain access to customer and organizational data.[35] However, as we navigate the risk, security, and privacy implications of AI technology, it is important to understand that AI also can be an effective tool to fight cybercrime, fraud, and threats. As AI gets more intelligent over time, learning from events and feedback loops to increase its ability to recognize threats and vulnerabilities, its accuracy in determining the likelihood of an event will become even more precise. Here's how.

- **Automation to detect and fight cyber threats.** Over the last decade, many organizations have employed on-premises security information and event management solutions to monitor threats to their networks and data, which required a significant investment of time, personnel, hardware, and money. IT teams have battled a rising number of increasingly sophisticated threats, often via labor-intensive, manual processes that take too much time to be entirely effective. Analysts watched for events and indicators of compromise, passing occurrences up the line from triage to threat-hunters to Level-4 incident-response specialists, all while sorting through frequent false positives. Today's threat vectors are continuously evolving and changing, requiring faster, more proactive detection and response, often through security orchestration automation and response tools, which automatically execute remediation actions such as shutting down routers and ports or locking down endpoints in near-real time.
- **AI versus AI.** Many of the cyberattacks that organizations confront today are orchestrated by AI engines on behalf of bad actors exploiting gaps in their targets' security. The good news is that companies can deploy AI technology as a proactive measure against these attacks, speeding detection and response. Cognitive computing has enabled the ability to process data in real time—particularly unstructured data such as documents, images, files, and audio—so that artificial intelligence can learn from that data and automatically adapt its threat detection and response as new threats evolve.
- **Machine learning to identify new threats.** Traditional rules- and experience-based threat-detection systems were handicapped because they typically could search only for known threats, which account for just a small number of cyberattacks. Organizations can infuse artificial intelligence and machine learning into a rules-based environment to augment the expertise gained from previous, known cyber threats with detection of new, evolving threats. Today's enterprise has massive amounts of internal and external data at its disposal, all of which can offer insight into a system's vulnerabilities and potential external threats. Processing that significant amount of data in a timely fashion through the human workforce has been impossible. But with the supervised and unsupervised techniques and supporting technologies now available, such as graph databases and natural language processing, organizations can augment and layer threat models to increase visibility of both

Organizations can infuse artificial intelligence and machine learning into a rules-based environment to augment the expertise gained from previous, known cyber threats with detection of new, evolving threats.

known and unknown threats. This may be accomplished by bringing together data scientists and cyber professionals to create higher fidelity and more accurate alerts for security events, which may facilitate a more effective response.

- **But first, governance.** Finally, thwarting threats from outside the organization is not the only factor organizations need to consider as they start to deploy AI both in singular use cases and across the enterprise. The speed with which AI engines act and make decisions, the sensitivity of the data they consume, and the ethical implications of decisions made, when not properly monitored or governed, can create an exponential risk within the organization as harrowing as an external bad actor.

When deploying AI within your organization, there must be a governance plan in place to monitor these AI engines, much as the HR department would oversee the management and behavior of human employees. This governance encompasses a wide swath of considerations, including employee and customer privacy, data security and integrity, and safety in interactions between humans and machines. Data handling, management, and governance—both of direct data inputted into the AI engine as part of its training, as well as derived data, which results from AI's feedback loop—becomes even more critical when rules-based artificial intelligence is able to act on its own.

ARE YOU READY?

No two companies will adopt a technology trend in the same way. Every organization has its own goals, strengths, and weaknesses to ponder before it embarks on its own transformation journey. If you are unclear on what the AI-fueled trend offers—or requires of—your organization, ask yourself the following questions:

What business objective(s) can our organization achieve by deploying artificial intelligence?

Artificial intelligence may offer a wealth of benefits to your organization, but only when viewed through a strategic business lens rather than as an IT project, and only when brand rhetoric gives way to measurable results. Collaborate across functions to identify the enterprise's main objectives, then align the AI strategy alongside to achieve those outcomes. You may choose to pursue solutions that reduce costs, facilitate a leap in productivity, monitor compliance, reduce risk scenarios, or derive greater meaning from more data. The first step of the AI journey should be setting end goals, which will enable you to draw a much more detailed, actionable road map with clearly marked milestones.

How can I use AI to achieve a competitive advantage?

AI is a broad category that includes natural language processing, computer vision, machine learning, and more, all of which can augment back-office, intra-office, and customer-facing systems. If you're not sure where to start, look to your organization's vertical industry for guidance and inspiration. Proceeding with an eye on your industry's trends can ensure that you'll both meet customers' needs and remain competitive. For example, in the financial services industry, developers are creating highly personalized products and services; a financial firm may want to initiate its AI pilots by creating a robo-adviser or chatbot that can offer customers one-on-one investment advice. Deriving your initial AI pilots and use cases from your industry's trajectory—which you can understand better by talking to customers, vendors, and industry analysts—helps ensure that your resources are utilized to meet business goals.

- **Is my technology adequate for an AI-fueled organization? If not, how do I find the right partners to build my AI ecosystem?**

  To move forward, your organization's existing technology and talent pool may be inadequate to meet the needs of standing up an AI system. You might look to bring in next-gen IP, products, and solutions to broaden your ecosystem. Once you've determined where AI fits into your business processes, you can evaluate your existing technology, talent, and expertise to determine where there are gaps. You may decide to augment your existing resources by investing in startups that are further along in their AI journeys, or you may identify vendors and other industry partners with whom to collaborate and potentially co-invest in building market-ready applications with shared resources.

- **I'm sensing "cognitive fatigue" in my IT organization. What should I do?**

  There are companies that dove headfirst into cognitive only to realize that they had taken on too much, too soon. Underwhelming results from early cognitive initiatives can dampen enthusiasm for further exploration. If you find yourself in this situation, consider starting a "lessons learned" dialogue with stakeholders and IT talent to review what went wrong and what can be done differently in future initiatives. And discuss AI approaches that other companies in your industry have taken that delivered desired outcomes.

- **Do I think big and start small—or go all-in?**

  More important than going big or starting small is moving purposefully. CIOs and business leaders appear to recognize the value of creating a long-term AI strategy to guide their efforts. Stay focused on the desired outcome and employ design thinking, and the right plan will fall into place. Begin by identifying opportunities for AI within your organization, such as transactional, time-consuming tasks or data-heavy processes that require a bit of "tribal" knowledge. Carry out a cost-benefit analysis to determine whether an AI solution is feasible for that process, taking into consideration both existing resources and those you will need to acquire. Next, structure a pilot program around one of those transactions to run four to eight weeks. If those results are positive, you're ready to determine how you can move forward to scale to production and, eventually, expand to other products and service lines.

BOTTOM LINE

AI's role in the enterprise is growing as cognitive tools and tactics are standardized across IT environments. While it is true that in coming years, AI will likely be deployed not only to augment human performance but to automate some operational and business processes altogether, proactively printing pink slips is an ineffective means of planning for the next cognitive stage. Now is the time to fundamentally rethink the way humans and machines interact within working environments, and what they can achieve together in the AI-fueled organization of the future.

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NoOps in a serverless world

Shift IT's focus from operations to outcomes

WE HAVE REACHED THE NEXT STAGE IN THE EVOLUTION OF cloud computing in which technical resources can now be completely abstracted from the underlying system infrastructure and enabling tooling. Cloud providers are continuing to climb the stack; rather than simply providing everything from the "hypervisor on down," they are now—through their own focus on hyper-automation—taking on many core systems administration tasks including patching, backup, and database management, among others. Together, these capabilities create a NoOps environment where software and software-defined hardware are provisioned dynamically. Going further, with serverless computing, traditional infrastructure and security management tasks can be fully automated, either by cloud providers or solution development teams. Freed from server management responsibilities, operations talent can transition into new roles as computing farm engineers who help drive business outcomes.

Traditionally, the CIO's responsibility of keeping business-critical technology systems running has absorbed up to 70 percent of IT's budget as well as considerable amounts of labor bandwidth. Cheaper storage, cloud, and outsourcing have lowered this budgetary outlay by 20 percent or more. Yet in an era of perpetually tight IT budgets, finding ways to redirect financial and human assets from operations to innovation remains a top CIO goal.[1]

In previous issues of *Tech Trends*, we have examined how CIOs are pursuing this goal by transforming their technology ecosystems from collections of working parts into high-performance engines that deliver speed, impact, and value. From the bottom of the IT stack up, they are building infrastructure that is scalable and dynamic, and architecture that is open and extendable. From the top down, CIOs are rethinking the way their IT shops organize, staff, budget, and deliver services.[2]

In many reengineering initiatives, automation is the keystone that makes meaningful efficiency and cost reduction achievable. With more of IT becoming expressible as code—from underlying infrastructure to IT department tasks—organizations

are applying new architecture patterns and disciplines in ways that remove dependencies between business outcomes and underlying solutions. They are applying those patterns as well as engineering techniques to redeploy IT talent from rote, low-value work to the higher-order capabilities.

Now, as part of a growing trend, CIOs are taking their automation efforts to the next level with serverless computing. In this model, cloud vendors dynamically and automatically allocate the compute, storage, and memory based on the request for a higher-order service (such as a database or a function of code). In traditional cloud service models, organizations had to design and provision such allocations manually. The end goal: to create a NoOps IT environment that is automated and abstracted from underlying infrastructure to an extent that only very small teams are needed to manage it. CIOs can then invest the surplus human capacity in developing new, value-add capabilities that can enhance operational speed and efficiency.

Serverless' value proposition is driving considerable interest in the serverless market.[3] A recent Cloud Foundry global survey of 600 IT decision-makers found that 19 percent of respondents were already using serverless computing, with another 42 percent planning to evaluate it within the next 24 months.[4] Moreover, MarketsandMarkets, a B2B competitive research firm, projects that the value of the serverless architecture market will reach US$14.93 billion by 2023, up from US$4.25 billion in 2018.[5]

Thus far, a number of large companies including Netflix,[6] Coca-Cola,[7] and the New York Times Co.[8] have been at the vanguard of the serverless trend. In the next 24 months, expect more organizations to begin following their lead, exploring ways to use serverless to scale their DevOps practices and to build greenfield applications. The goal of achieving pure NoOps environments may take several years to achieve, but across industries, the transition, however preliminary, is underway.

Enough already with the "care and feeding"

For the purposes of discussing this trend, the terms *NoOps* and *serverless* are not interchangeable. "Ops" comprises any number of operational areas—think networking, security, management, and monitoring. In the marketplace and in the context of this technology trend, the term serverless basically describes server administration. To further muddy the definitional waters, both terms are misnomers: With the serverless model, there are still servers, but their functions are automated; likewise, in NoOps environments, traditional operations such as the code deployment and patching schedules remain internal responsibilities—they are simply automated to the extreme.

Both terms can trace their roots to the first as-a-service offerings and the dream that one day IT organizations would be able to hand onerous care-and-feeding responsibilities of enterprise systems to someone else. Today, *serverless computing* is an umbrella term for a spectrum of cloud-based options available to organizations wishing to get out of the business of managing servers. At one end of this spectrum is the platform-as-a-service model in which customers buy always-on access to a database. At the other end is the function-as-a-service model, which offers a fine-grain pricing model, substantiating and running code only when a customer needs

***Serverless computing* is an umbrella term for a spectrum of cloud-based options available to organizations wishing to get out of the business of managing servers.**

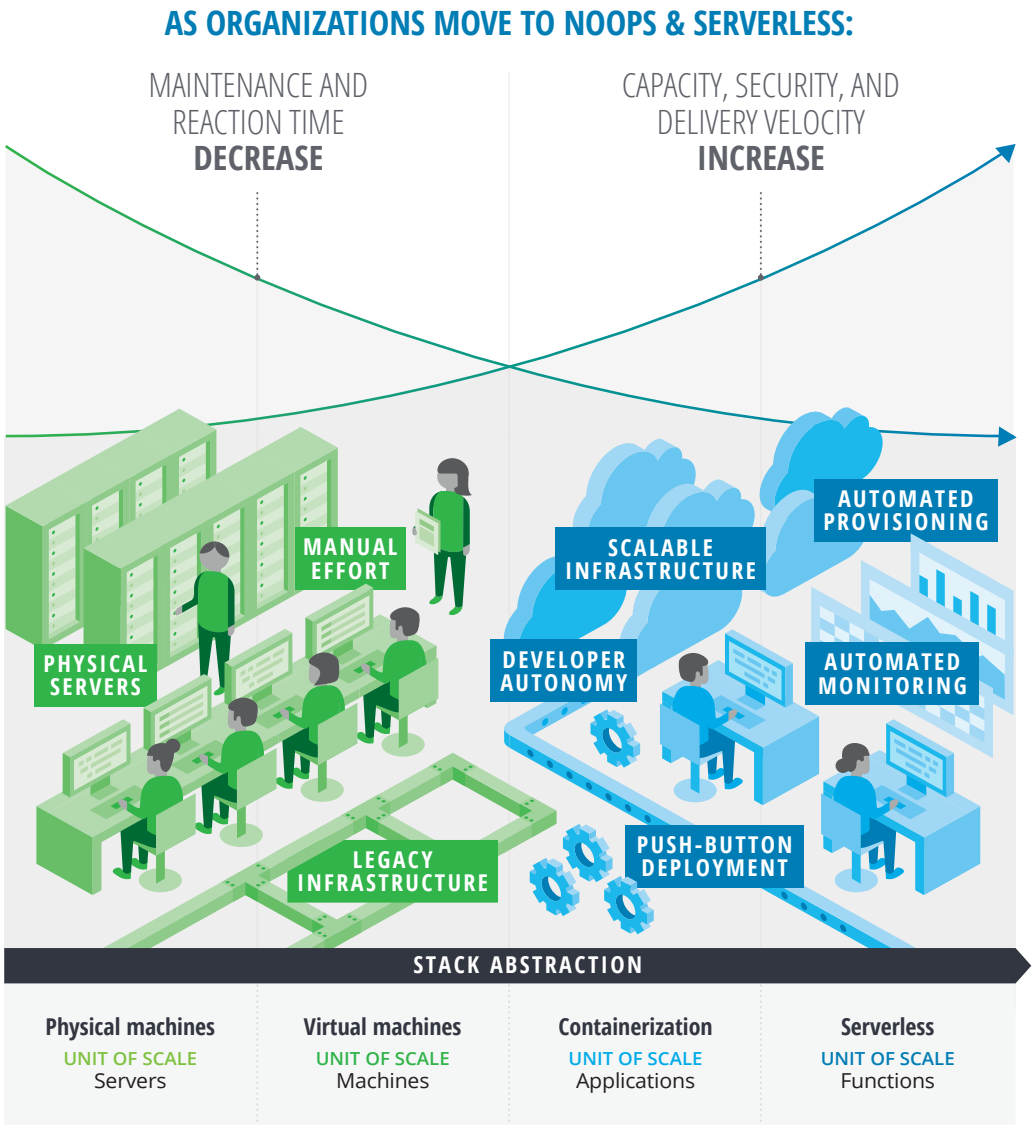
it. As such, customers pay for only the requests they make.

Serverless computing offers CIOs a toolkit for transforming their IT operations. Its potential benefits include:

- **Infinite scalability and high availability.** Functions scale horizontally and elastically depending on user traffic.
- **NoOps (or at least less ops).** Though operational tasks such as debugging typically remain in-house, infrastructure management is fully outsourced.

FIGURE 1

The digitalization of IT



Source: Deloitte analysis.

- **No idle time costs.** In a serverless computing model, consumers pay for only the duration of execution of a function and the number of functions executed. When a function is not executed, no charge is levied—thus eliminating any idle time. In terms of cost, this represents an improvement over legacy cloud computing models in which users are charged on an hourly basis for running virtual machines.

In many companies today, cloud strategies remain works in progress, as do efforts around virtualization and containers. Likewise, serverless computing, with its promise of a NoOps future, does not suddenly render these efforts redundant, but it does offer a vision of a highly automated end state to which CIOs can aspire.

And aspire they do. In Deloitte's *2018 global CIO survey*, 69 percent of respondents identified "process automation and transformation" as the primary focus of their digital agendas.[9] In the coming years, serverless will likely be a key technology that many CIOs use to automate the deployment, scale, maintenance, and monitoring of applications. Today, cloud vendors are steadily adding new capabilities such as databases and natural language processing interfaces to their portfolios of serverless offerings. It is now possible to build greenfield applications without deploying a physical or virtual machine. By understanding the investments that companies are making today in serverless computing and by embracing the broader *NoOps in a serverless world* trend, they can make this transition foundational to their short- and long-term digital transformation agendas.

Chasing the elusive NoOps dream

The NoOps trend is gaining traction in part because it offers a new way of looking at an age-old problem: How can we make resources go further? For budget-strapped CIOs whose enterprise fiefdoms generate no revenue directly, this question remains largely unanswered. But one thing is clear—there is not a lot of business value to be found in maintaining servers and data centers. Keeping on the payroll people whose expertise lies solely in patching servers has traditionally been just another cost of doing business.

69%

of Deloitte's *2018 global CIO survey* respondents identified process automation and transformation as the primary focus of their digital agendas.

The NoOps trend offers CIOs an opportunity to shift these employees' focus from patching, monitoring, and measuring to higher-value engineering and development tasks. More broadly, this trend makes it possible to manage IT operations more efficiently using automation and orchestration capabilities that others pioneered and have proven.[10] Much of what we think of when we talk about *NoOps* and *serverless* are infrastructure components that Amazon, Google, and Microsoft developed to support their as-a-service offerings. These vendors realized that these same components could benefit their as-a-service customers too, particularly in the area of software development.[11] In a *NoOps* model, developers no longer have to coordinate with other teams to execute minor tasks involving underlying infrastructure, operating systems, middleware, or language runtime.

Transitions from traditional to serverless environments do not happen overnight, a fact that helps to mitigate the fears that some in IT may have about

job security. During these transitions, operations talent may still have to do some routine database tasks and make sure that core systems are tuned and maintained. But they will now have the bandwidth to upskill and redefine their roles; perhaps more importantly, they can begin approaching operations tasks less from a plumber's perspective than from an engineer's. Many may find this a much better place to be professionally: Writing software that monitors and heals certainly seems preferable to getting an urgent 2 a.m. text that a critical system is down. More broadly, think of this as transitioning operations talent from being reactive to proactive, and finding new opportunities to leverage automation. In the NoOps world, IT talent engineers variability out of operations, thus making things routine, repeatable, efficient, and effective.

Working with serverless platform vendors

At present, several major cloud providers are offering serverless platforms that can help users move ever closer to a NoOps state. Amazon, Google, and Microsoft dominate today's serverless market. Alibaba, IBM, Oracle, and a number of smaller vendors are bringing their own serverless platforms and enabling technologies to market.[12] Meanwhile, open-source projects such as OpenFaas and Kubeless are attempting to bring serverless technologies from the cloud to on-premises.[13]

The serverless model offers several advantages, particularly over the IaaS and SaaS models for which customers often pay a fixed monthly or yearly price whether or not they use the entire capacity provided. By contrast, serverless models charge customers for only the resources consumed for the life of the function that is called. It's a fine-grain, pay-as-you-go model, with significant projected cost savings over other cloud models for many workloads. For example, as competition in the serverless space heats up, it is not unreasonable for users to get up to a million free compute requests per month, which provides a large amount of computing power without huge upfront costs.[14]

As you explore serverless offerings, be aware that the serverless computing model is still evolving—it should not be construed as a cure-all for development and operations problems. For example, the production tooling that provides visibility in serverless development environments is currently limited. Recently, cloud infrastructure provider DigitalOcean surveyed 5,000 development professionals about the challenges they have encountered when using serverless. Their responses varied, but respondents identified the following major areas:[15]

- **Monitoring and debugging.** Unsurprisingly, 27 percent of survey respondents cited monitoring and debugging in a serverless environment challenging, which is perhaps unsurprising given the ephemeral nature of serverless computing. Capturing the information needed to monitor and debug is more challenging with a serverless model because there is no machine to log onto. In some situations, developers working to debug tricky problems may be forced to log manually into a data store. The good news is that a new generation of debugging tools and applications that make it possible to run serverless functions locally are emerging.
- **Vendor lock-in.** Concern over vendor lock-in emerges often in the early stages of disruptive technology waves. Until industry standards are set and a single model becomes a market leader, early-stage customers are often concerned that they will pick the wrong horse. What if you are locked in an agreement with a vendor whose products eventually become nonstandard? If you want to switch vendors, you could face significant costs to retool and redesign your architecture. DigitalOcean found that 25 percent of respondents were concerned about getting locked into an agreement with their serverless vendor. In many cases, a suitable architecture can minimize your ties to a particular vendor. With function-as-a-service, for example, it is

possible to abstract your business logic from the serverless "handler" to make porting easier. With other serverless features, consider weighing their benefits against the potential costs of getting locked into an agreement you may neither want nor need.

- **Migration.** Roughly 16 percent of survey respondents cited migration as challenging. Indeed, for large companies, migrating at scale is no small task. For example, it can involve re-architecting one or more of your applications (as in the case of function-as-a-service) or at least swapping major system components such as databases. For this reason, some companies may view full-scale migration of their application portfolios to serverless as overly costly and disruptive. They may opt instead for migrating select existing applications or those that are a part of greenfield development initiatives.

LESSONS FROM THE FRONT LINES

CARGILL'S FUTURE-READY FOUNDATION

By the year 2050, the planet will be home to some 9.5 billion people. That's a big number—one that requires companies to think and act differently. For Cargill, a leader in the food and agriculture industry, its sole purpose is to nourish the world in a safe, responsible, and sustainable way. Cargill recently placed an increased focus on innovation and technologies that will help the 153-year-old company transform and effectively address some of the world's greatest food challenges today and into the future.

One way Cargill is making improvements to its software engineering capability is by automating the development life cycle. This shift via technology not only drives the business, but also empowers Cargill's developers to write code without the worry of deployment or packaging. "A strong digital foundation helps us work better while serving our customers and businesses more efficiently," says Keith Narr, vice president, Cargill Digital Labs.[16]

The renewed investment in engineering has been an important part of Cargill's core modernization and cloud journey and supports the ambitions of technology-minded but business-focused leaders within the organization. Development and operations standards are being embedded in the technology platforms and automatically enforced behind the scenes. Additionally, Cargill developers have embraced automated security scans leading toward DevSecOps, as well as providing the backbone for API-based development, and paving a path toward open standards and open platform adoption.

Narr and his team worked to ensure that the resulting cloud journey wasn't relegated to a lift-and-shift exercise: the same old capabilities running on a new technology stack. He instead used the opportunity for Cargill to transform the IT landscape within the organization by exploring new ways to work. A refactored core and a modern architecture, rooted in autonomy and DevOps with an eye toward NoOps, enables the development of modern applications that run and operate on a scalable platform and can self-monitor and self-heal. "The technology is the easy part; it's the mental shift that's difficult," Narr says. "As part of this journey, we are retraining ourselves to think differently about our expectations of technology and how we consume it."

A big part of the NoOps journey is rooted in breaking down the walls between traditional IT and the business. While building the new platform, Narr and his team started by seeking out business units that already possessed a startup mentality, understood the value of the platform, were already using DevOps processes, and were eager to embrace a NoOps philosophy. The IT team continued to build out the platform capabilities based on what those business-unit teams needed.

Recognizing the need to overcome the mental shift, Narr's team also looked to raise awareness beyond early adopters. To demonstrate the potential of the NoOps model, Narr took the entire IT leadership team through a six-hour DevOps 101 boot camp so they could see the impact the capabilities could have on their individual businesses. The team was fully engaged—writing code snippets, checking in source code, deploying, and witnessing firsthand the power of a fully-automated continuous integration and continuous deployment platform. The effect was eye-opening for the business.

"The first 12 months of the journey were intentionally grassroots and focused within IT, building out a core set of capabilities before people started asking for it," Narr says. "As adoption grows and success is mounting, the emphasis shifted from the platform to the outcome: the prototype, the business proof of concept, or the new product rapidly brought to market." As Cargill's strategy evolves, the platform is becoming an embodiment of the "future-ready foundation" that is a cornerstone of the company's technology road map for its business strategy.

MUTUAL DECISION: BUSINESS AND IT PARTNER IN COMMONWELL'S SYSTEM MODERNIZATION

When the Commonwell Mutual Insurance Group set a goal to significantly increase its premium growth rate, the company aimed to simultaneously maintain high standards of member value, member service, and employee engagement. Leadership recognized that this would require a fundamental shift in how supporting technology was deployed. To drive innovation, Commonwell's small IT department built a partnership with the business, and their common goals led to a core systems modernization project. This project was executed within a DevOps framework and is changing the way IT delivers services to the business. The success of that journey has given rise to the organization's next major transformation: moving toward a NoOps model and serverless environment that will further enable business transformation and change how the IT team operates and manages its infrastructure.

"Some people think of DevOps as eliminating steps of the development life cycle, but we see it as expediting some of the more repetitive, time-consuming parts of workflow," says Commonwell solution delivery manager Paul Stamou[17] "We want to deliver on the promise of the business rather than just focus on keeping the lights on."

Because Commonwell's IT department is streamlined, it has chosen to implement a cloud platform that provides an automated and secure foundation. The solution is based on an "infrastructure as code" approach, enabling better agility. The IT management processes—backup and security features, in particular—will be written into the configuration and deployed on containers. The serverless platform will allow the IT organization to build and deploy applications as cost-effective services that provide built-in availability and scalability. This will enable Commonwell IT to focus on its business outcomes instead of managing servers, with automation provisioning capacity on demand.

"Our previous solution required a significant amount of infrastructure and human intervention to maintain and service operations," says IT vice president Jennifer Baziuk.[18] "The platform and a NoOps model is a fundamental shift from that traditional approach; we're looking to leverage cloud computing, software as a service, and an ecosystem of partnerships to help us manage operations rather than internalizing those costs with our own hardware and human capital."

According to Commonwell solution architect Justin Davidson,[19] it is less about accelerating infrastructure than about enabling IT to be as agile as the business in driving speed to market and delivering continuous value. While the transition to NoOps is still in progress, Commonwell's IT team has already seen a significant impact from the move to DevOps and a serverless environment. Additionally, that success has built a groundswell of support and enthusiasm from employees and leadership for the shift to NoOps.

"From a qualitative perspective," Baziuk says, "one of IT's aspirations is to be a trusted adviser to the business. As a result of the success of our DevOps and NoOps strategies, we've earned a seat at the business strategy and development discussions, driving forward the conversation of how IT can be a strategic differentiator. We're freeing up our capacity so we can be the partner we aspire to be, and help make digital part of Commonwell's business path forward."

VERIZON: FORGING NEW GROUND THROUGH CLOUD

To better serve millions of customers each day, Verizon continuously seeks to advance its networks' performance and efficiency. When leadership saw an opportunity to increase stability and reliability leveraging modern cloud computing technologies, the company launched its cloud migration journey, aiming to both deliver and exceed the performance levels its clients expect, while increasing the level of automation of its systems operations.

Verizon's architecture review board conducted legal and regulatory assessments to determine which of its network systems were eligible to move to the public cloud. Due to the variety and specificities of the applications and workloads, Verizon Network System's strategy combines public cloud, private cloud, and on-premises hardware with a phased migration approach.

In the initial exploratory phase, the teams started migrating nonproduction applications to the cloud while leaving production on-premises, with a goal to learn about cloud services technologies and the advanced automation they provide while developing new skill sets. Traditional cloud computing services in which Verizon's engineers instantiate and manage the equivalent of virtual machines were, in many cases, the initial technologies considered, as they were close to the on-premises environment that some teams were used to. But this bifurcated approach limited the potential benefits.

In the second phase, once the teams successfully deployed the first production applications into the cloud, everything accelerated. Verizon's engineers became proficient in leveraging the emerging serverless cloud services just released by the major public cloud providers. The advanced automation quickly generated benefits, enabled by letting the cloud service provider handle the lower-level cloud infrastructure operations such as database patching or server instantiation and management. The engineers could focus on developing their application faster and delivering value to the business at an increased pace. As a result, the serverless environment became part of Verizon's directional tech stack and the footprint of such technologies expanded, as did the benefits of the cloud migration.

Some of the early, big wins include migrating a complex provisioning system that handles all of Verizon's service activation and provisioning for fiber-based services. Another was building a cloud-native, microservices-based provisioning gateway that provides a common interface for its many legacy businesses. The provisioning gateway serves as the team's model for building new applications.

"We're completing our first significant year of migration, and part of our portfolio has been moved to the public cloud," says Lynn Cox, senior VP and network CIO.[20] "While we still have work ahead of us, we've successfully transitioned several large, monolithic applications, so there are no excuses to say something is too complex. Additionally, I've seen a real culture shift within my team. We are now building new applications directly in the public cloud when possible—a big shift in mindset from where the team was even just one year ago." Verizon is already seeing financial and operational benefits, including greater stability and reliability of applications, increased automation, and auto-scaling of compute resources, which was of paramount importance to Verizon's engineers and technicians in the field.

Within the first year, Cox's team has realized benefits transitioning operational resources to more strategic activities. For example, several teams have been refocused on enabling the deployment of Verizon's next-generation converged core network and on meeting business timelines, as cloud has provided a higher level of automation and shorter lead time than deploying on-premises hardware.

Capabilities enabling 5G rollout and automation have also been delivered faster and with higher levels of reliability."

The NoOps approach enabled by the serverless environment has been incredibly motivational for team members," Cox says. "Rather than being limited to a production support role managing operations, they can focus on growing their skills. Now we can lay out a path to the future for them—developing strategic solutions with technologies like machine learning and robotic process automation—and they see career potential for the long term."

Prior to the move to serverless and cloud computing, Cox's team sometimes struggled to keep pace with the needs of their internal customers. As applications have moved to the cloud, that went away. "Now, the question is: How fast can the client work?" she says. "It's not about the system managing the pace of the client—it's the client now managing the pace of the system, which has been a big win for us."

MY TAKE
GENE KIM, AUTHOR, RESEARCHER, AND DEVOPS ENTHUSIAST

For almost 20 years, I've had the privilege of studying high-performing technology organizations, and all our research shows decisively that high performers are massively outperforming their peers, often by orders of magnitude. They ship software to their customers more quickly and safely, which enables them to rapidly innovate and experiment, so that they can win in the marketplace by outlearning the competition.

In the past, this topic was important mostly to technology executives. These days, almost every CEO is being asked about how they are responding to digital disruption, defending their market from the dominant technology platform players, and how they are investing in their software capabilities. In the age of software, almost every act of investment has something to do with software.

It's difficult to overstate the technology miracles that are now possible that would have been impossible a decade ago. Instagram had only 13 employees—six of whom were generalist developers—when Facebook acquired it for US$1 billion.[21] Pokémon Go broke the record for fastest time to gross US$100 million among other records,[22] and that was achieved with fewer than 40 employees.[23]

I think these examples frame the most important goal of DevOps: to create the conditions in which small teams of developers in a modern business context can achieve the same type of amazing outcomes. Because it's not just for social media and games—it's to solve the business problems that will determine the next generation of winners and losers in the marketplace.

According to one study, developers will be able to raise global GDP by US$3 trillion in the next decade.[24] In my opinion, the majority of this value will be created not by today's tech giants or by startups but, rather, by the largest brands in every industry. These are the organizations that have better access to capital, already have large customer bases, and can access the same amazing technology talent the tech giants can.

This is not a story about "small beats big." Instead, it's "fast beats slow." And the best of all worlds is being both fast and big—which is what DevOps enables.

I don't think that DevOps is just about developers, but it *is* about enabling developer productivity, which requires world-class infrastructure and operations skills. This goal is what led to NoOps—an unfortunate term, since it implies that Ops engineers will disappear, something I believe will never happen.

However, I do believe that the days when Ops can operate as a silo are going away. The same can be said about information security, compliance, and infrastructure in general. In this new era, the goal is not to interact with developers as adversaries or fellow sovereign states—instead, they act as fellow engineers, working together to achieve common business goals. Often it means creating platforms that developers use to do their work quickly, safely, and securely, without ever having to open up tickets and having work performed on their behalf.

Here's why I am certain Ops is so important: For two decades, I've self-identified primarily as an Ops person. This is despite being formally trained as a developer, having received my master's degree in computer science in 1995. I always gravitated to Ops because it's where I thought the real action was. But something changed about two years ago: I started self-identifying primarily as a developer. Without a doubt, this is because I learned the Clojure programming language.

It was one of the most difficult things I've ever learned: It's a functional programming language, which disallows mutation of state and encourages writing only pure functions. But I believe it's a safer and more productive way to build applications, and it's brought the joy of programming back into my life.

Here's the strange and unexpected thing that happened on this journey—I now hate dealing with infrastructure. It's so messy and unpredictable. I've become one of those developers, who just wants to live in a perfect little application bubble, despising having to deal with messy infrastructure.

And this is why I'm so convinced that the best days of infrastructure engineering are ahead of us. We need skilled engineers who can help ensure that developers can be truly productive, armed with the platforms that can help us build, test, secure, and deploy our code into production, without having to write custom scripts, manage security credentials, deal with logging, monitoring, connecting to databases, and so forth. These are the necessary things we need to do to create value in a messy and imperfect world, but they slow developers down.

That's why infrastructure is so important. And developer productivity isn't free. The reality is that most organizations are probably massively underinvesting in this area. Leading technology players invest heavily in their own technology.[25] In contrast, many traditional organizations do not. In an age where fast beats slow, these organizations are orders of magnitude slower than their peers.

But this is changing. The DevOps story in large, complex organizations is often one of rebellion, in which brave and courageous technologists seek to overthrow an ancient, powerful order—the conservative functional silos. My advice to top leadership is twofold: Identify engineering leaders who understand the value of the DevOps way, and partner them with passionate business leaders who want to reimagine how they create value. Get them together and empower them with a budget, autonomy, and authority. Magical things will happen.

RISK IMPLICATIONS

Many organizations may find daunting the cyber risks of working in a serverless and cloud computing environment. But there is a tremendous enterprise opportunity in leveraging automation to better protect itself against potential threats. Organizations should understand that, done properly, security protocols in a serverless environment supported by a NoOps operating model might significantly reduce cyber risk. Done poorly, it can accelerate cyber risk across the entire enterprise and at scale.

The key to overcoming the potential cyber risks associated with serverless environments is to shift your point of view—to see risk mitigation as an opportunity to develop and implement security and risk processes (or guardrails) within the code itself. Analyze the potential vulnerabilities in the code and the serverless environment to determine which threat vectors are most significant and most tolerable, then focus resources on protecting your most valuable assets and susceptible entry points. Embed security controls to detect and auto-respond to adverse events throughout your network and systems, as well as to automatically update configurations when new cyber risks are detected.

Where should an organization start? First, it is crucial to understand how your network and infrastructure are designed, and identify the vulnerable points. This is no small task and should be given proper attention at the start of your serverless journey. Applying the same approach that you've used during more traditional technology transformations is no longer sufficient: Logic, tools, and processes do not necessarily translate directly from your on-premises networks to serverless. Take the example of reusing internal code and turning it into an external-facing API—without adding additional protections, you could accidentally expose your network to malicious attacks by using code that was never meant to be deployed in the hostile environment of the internet.

The good news is that cloud providers have built-in mechanisms that can be leveraged to enable strong authentication, proactive surveillance of the network, configuration monitoring, and more. To further shore up your defenses, seek to build security into various layers of your environment, throughout development, delivery, and operations—from the cloud platform management layer to the process and application layers. With your new automated ops capabilities, systems should be able to test for, detect, stop, and fix threats before they can affect your network, data, or reputation. It is worth noting that many organizations will continue to operate concurrently in the cloud and in traditional environments. They will face the additional challenge of maintaining the old controls and strategies, while designing and implementing new, very different controls within their modernized infrastructure.

There is no way to eliminate cyber risk altogether, so it is imperative that you reevaluate and redefine your risk tolerance in the light of serverless technology adoption. By leveraging the power of serverless technologies, security teams can deploy solutions that will help contain and respond to threats, new and old, in a way previously not possible. Revisiting cyber risk events and proactively writing, tuning, and updating code to shield against newly discovered threats should be a regular process, not a quarterly or annual event. Gone are the days of setting policy on paper and monitoring for, then managing, breaches after the fact. In a serverless world, managing cyber risk requires daily revisions, tweaks, and tune-ups, but NoOps automation can make it easier—and take active defense to a new level.

In a serverless world, managing cyber risk requires daily revisions, tweaks, and tune-ups, but NoOps automation can make it easier.

ARE YOU READY?

Like the macro cloud journey that many companies are currently on, any pursuit of NoOps or serverless can unfold in manageable stages. But where—and how—to begin? As you explore the NoOps in a serverless world trend's potential for your organization, consider the following questions:

- **Is the trend right for me?**

  At their core, the NoOps and serverless trends are grounded in two fundamental use cases: Infrastructure engineers can drive automation to new levels, and application developers can lessen their dependency on infrastructure engineers. It's also important to remember that while serverless won't be a good fit for every app in your stack, there's little downside to embracing automation and self-service to run and manage some of your solutions. Additionally, when done right, serverless architecture may yield faster time-to-market, more flexibility, a reduction in human error, and lower infrastructure and maintenance costs, all of which make good sense for the right workloads.

- **How do I go from doing this in small pockets to driving it across my organization? How do I make movement at a tactical level?**

  From a technical perspective, a serverless environment allows for faster and continuous scaling through automation, so the technology enables faster deployment across the enterprise. As the application load increases and more functions are executed, the cloud provider is responsible for scaling the underlying infrastructure. This may allow established organizations with monolithic legacy systems to stand up new capabilities as quickly as small startups. From an operational perspective, however, a NoOps environment requires a cultural shift in your organization. You must be willing to break down silos, assign new roles, and reorganize your roster to gain the necessary traction to deploy at scale. Much like efforts to migrate to the cloud, a steering committee that establishes and enforces standards and lays out the road map—which at first glance may seem to counter the spirit of DevOps as well as NoOps—can keep the transformation on course.

- **What if I need to start from scratch? I'm not very far along with automation or DevOps.**

  Serverless architectures may be your fastest way to embrace NoOps. With a serverless environment, software applications can be broken down into individual functions (that is, a microservices-based architecture) that are portable, cost-efficient, and, most importantly, not bound to a legacy infrastructure footprint. The separation of application functionality from supporting infrastructure provides the greatest opportunity for application modernization.

- **What sort of workloads will be appropriate for serverless environments?**

  A serverless approach is not one-size-fits-all but is often a good fit for applications that rely on microservices or APIs, such as Web applications, mobile backend, IoT backend, and real-time analytics and data processing. Applications well suited for serverless environments are ephemeral and stateless and don't require access to file-level systems. On the other hand, functions with high read-and-write volumes and those that require sustained computing power may be poor candidates. Longer-running, more complex computational tasks—such as data migration to NoSQL, applications requiring significant disk space or RAM, or those that require server-level operational access—may be better suited to a hybrid solution that employs servers and serverless capabilities.

- **Where do I start? Every company has several core, heart-and-lungs systems—do I begin there? Do I tackle it on the periphery first?**

  Some companies are focusing their serverless efforts in areas where they have already made some progress on the digital front, such as customer-facing e-commerce applications and microservices. These areas are often ripe for the move to serverless because digital teams have probably begun the cultural shift (as well as some of the retraining and upskilling that may be necessary) that is an essential part of a NoOps transformation. As companies anchor their efforts in their digital foundations, they can simultaneously begin the NoOps and serverless transformation from both a top-down and bottom-up progression.

- **From an infrastructure perspective, what do I need to adopt? Do I have to go full cloud, or can I remain on-premises?**

  You certainly can reap some benefits of DevOps practices on-premises, but unless you have a truly robust private cloud, your automation capabilities will likely be limited. And while you could deploy a hybrid solution of serverless and server-based components, you may realize only select serverless benefits. Even with just one on-premises server to manage, you will still perform anti-virus and vulnerability scanning and patching. To reach NoOps nirvana, you will likely need to go all in.

BOTTOM LINE

For years, basic care-and-feeding of critical systems claimed large portions of IT's budget and labor capacity. Today, the *NoOps in a serverless world* trend offers CIOs a way to redirect these precious resources away from operations and toward outcomes. It also offers development teams opportunities to learn new skills and work more independently. The journey from legacy internal servers to cloud-based compute, storage, and memory will not happen overnight. Nor will it be without unique challenges. But as more and more CIOs are realizing, an opportunity to fundamentally transform IT from being reactive to proactive is just too good to ignore.

Authors

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RISK IMPLICATIONS

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Connectivity of tomorrow

The spectrum and potential of advanced networking

ADVANCED NETWORKING IS THE UNSUNG HERO OF OUR DIGITAL future, offering a continuum of connectivity that can drive the development of new products and services or transform inefficient operating models. Increasingly, digital transformation through data- and networking-dependent technologies such as cognitive, IoT, blockchain, and advanced analytics are fueling adoption of connectivity advances. Next-generation technologies and techniques such as 5G, low Earth orbit satellites, mesh networks, edge computing, and ultra-broadband solutions promise order-of-magnitude improvements that will support reliable, high-performance communication capabilities; software-defined networking and network function virtualization help companies manage evolving connectivity options. In the coming months, expect to see companies across sectors and geographies take advantage of advanced connectivity to configure and operate tomorrow's enterprise networks.

Traditionally, networking has lived in the shadow of high-profile disruptive enterprise technologies such as digital experiences, cognitive, and cloud that capture imaginations and headlines. Networking, though mission critical, is not particularly sexy.

This is about to change. Increasingly, technology forces dependent on networking are transforming enterprise architecture. For example, proliferating mobile devices, sensors, serverless computing, exploding volumes of shared data, and automation all require advanced connectivity and differentiated networking. Indeed, advanced connectivity is fast becoming a linchpin of digital business. In *TechTarget's* most recent IT Priorities Survey, 44 percent of respondents cited upgrading their networking foundations as a top priority for the coming year.[1] Similarly, a 2018 survey of IT leaders by Interop ITX and *InformationWeek* found that companies are increasingly focused on adding bandwidth, exploring ways to modernize their networks with software, and expanding their networking capabilities.[2]

Going forward, one of the CIO's primary responsibilities will be getting data from where it is collected, to where it is analyzed, to where it is needed to drive real-time decisions and automated

operations—at scale and at speed, in a data center, in the cloud, or, increasingly, on the edge at the point where business occurs and missions are realized. As such, building and maintaining the networking capabilities required to meet this responsibility is a growing CIO priority. As part of the growing *connectivity of tomorrow* trend, CIOs have begun developing connectivity strategies that support their broader digital agendas. They are exploring opportunities to use software-defined networking (SDN), network function virtualization (NFV), and network slicing to build controllable, secure, distributed networks that feature different kinds of devices and have the ability to utilize distributed computing power. Likewise, they are defining the roles that evolving access mechanisms such as 5G and low Earth orbit (LEO) satellites will play in their connectivity strategies. And importantly, CIOs are learning ways to maintain control over these networking components without increasing the cost of ownership.

Networking models featuring some or all of these components can transform an organization's agility, efficiency, and competitiveness—but only to the extent that they can reliably deliver connectivity, security, and performance seamlessly to end users and applications. Often, the expectation behind every digital experience is the infinite availability and omnipresence of seamless network connectivity. And when that expectation cannot be met, the experience—and the strategy behind it—fail.

The orders-of-magnitude performance boost that 5G promises doesn't happen very often.

The orders-of-magnitude performance boost that 5G promises doesn't happen very often. Very soon, LEO satellite-based connectivity and mesh networks will deliver 5G capabilities to locations that currently have only limited coverage. During the next 18 to 24 months, expect to see more companies embrace the *connectivity of tomorrow* trend by exploring how a host of advanced networking capabilities can be used to enhance products, services, and enterprise architectures.

From a strategy perspective if you are in an industry that can benefit from greater bandwidth and more digital technology capabilities in your stores, warehouses, field operations, or across your global networks, what does this trend mean for your company's future? How will you build your connectivity of tomorrow?

Connectivity building blocks

Advanced connectivity raises the bar on network flexibility, making it possible to configure networks to fit different types of performance and availability requirements. Network management frameworks are increasingly allowing companies to dynamically configure and control network resources through software. As they develop advanced networking strategies, CIOs should start by examining how the following core capabilities may be able to advance their digital transformation agendas.

The latest advanced connectivity building blocks include:

- **5G.** The fifth generation of cellular wireless technology represents a sweeping change, far beyond being just another new wireless interface for smartphones. It offers greater speed, lower latency, and—importantly—the ability to connect massive numbers of sensors and smart devices within a network.[3] How? By breaking technology constraints. With 5G, many networking protocols can coexist to meet device and application specific requirements, and can be managed seamlessly. In *connectivity of tomorrow*, billions of connected devices will be communicating directly as machine-to-machine, and addition or subtraction of connected devices will be possible at unprecedented scale. In this environment, the ability to manage

large volumes of connected devices and the information being exchanged between them will be critical. 5G acts as a unifying technology, bringing together all the networking capabilities needed to manage the information flow and density at scale. The protocol also lowers power requirements for base communication, extending sensor battery life and viability of many IoT potential use cases.

The 5G revolution is well underway with telecom operators. Deloitte predicts that 2019 will be the year in which 5G networks arrive in scale. There were 72 operators testing 5G in 2018,[4] and by the end of 2019 we expect 25 operators will have launched 5G service in at least part of their territory (usually cities). An additional 26 operators could launch in 2020, more than doubling the total.[5]

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operators will have launched 5G services in at least part of their territory by the end of 2020, according to predictions by Deloitte Global.

In addition, with regulatory approval for spectrum use, enterprises can deploy private local area networks with 5G technology. In some industrial settings such as factory floors, 5G can replace local area networking over Wi-Fi, significantly increasing the network's reliability, performance, and predictability. This 5G capability could be used to untether robots from fixed locations or to enable remote control of robots, thereby providing higher levels of flexibility in operations.

- **Low Earth orbit satellites.** Companies have long used large, high-altitude, geostationary satellites to connect remote areas to the outside world. These satellites have served a purpose, but they lag fiber and cable-based internet in terms of reliability and responsiveness and have potentially high cost profiles. In what some have characterized as a "new space race," SpaceX, OneWeb, and other organizations are developing small, low Earth orbit satellites that, deployed in clusters, may be able to deliver high-performance broadband anywhere on Earth. In addition to providing access to rural or isolated communities, low-orbit satellites could become essential networking infrastructure tools for industries operating in remote areas such as energy, mining, transportation, and even finance.[6]

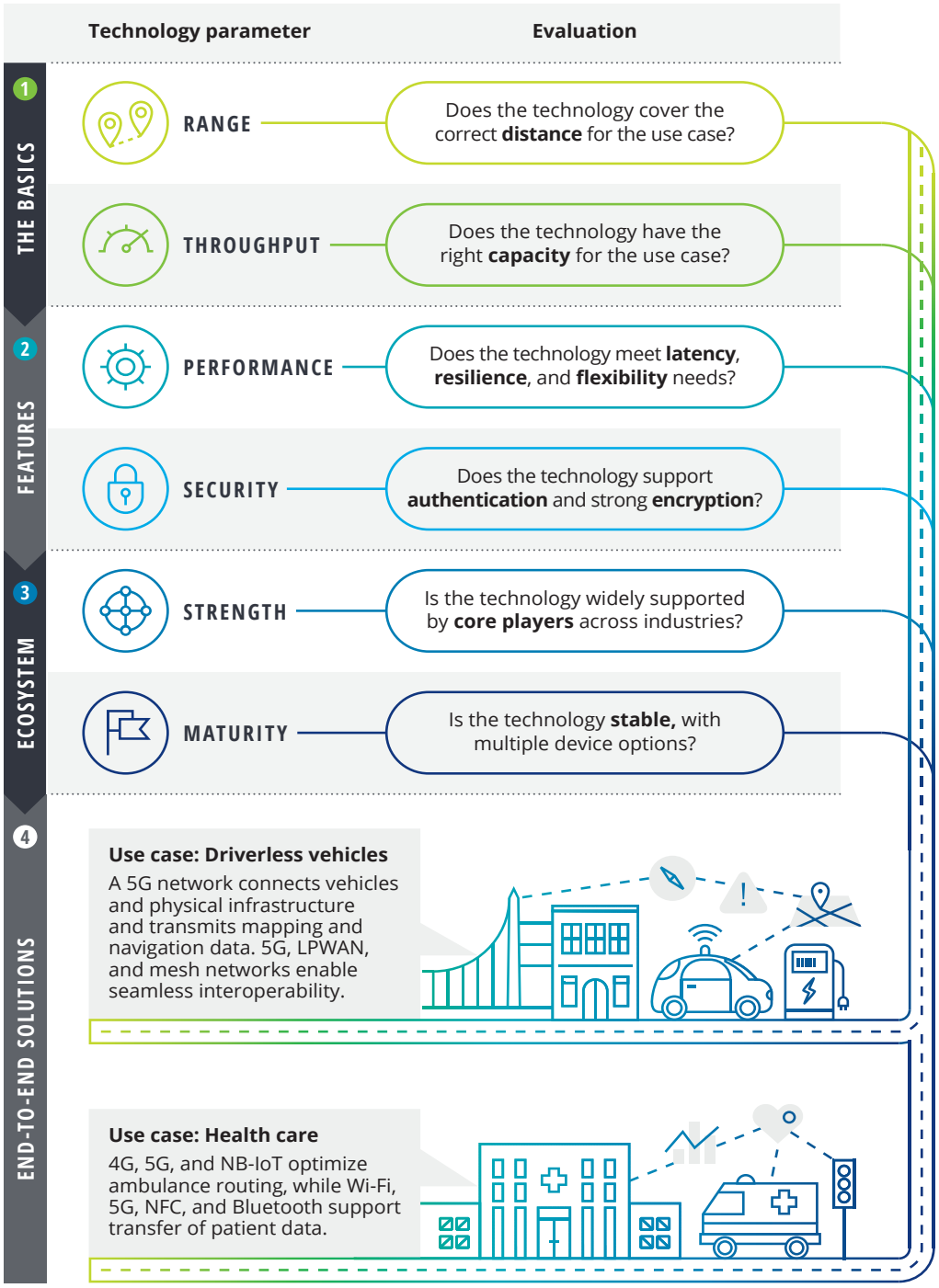
To monitor and manage evolving connectivity options that are increasingly varied, CIOs are virtualizing parts of the connectivity stack using the following network management techniques:

- **Software-defined networking.** SDN is a software layer that sits atop a physical network composed of networking appliances such as switches and routers. Long restricted primarily to use within the data center, the technology is now being extended for wide area networking (SD-WAN) to connect data centers, branch banks, stores, or other multilocation applications. These physical appliances still forward data packets, but SDN software controls where these packets get forwarded. In the SDN model, software can centrally program and manage a network, potentially boosting flexibility.[7]
- **Network function virtualization.** NFV replaces network functions such as routing, switching, encryption, firewalling, WAN acceleration, and load balancing provided by dedicated physical network appliances with virtualized software. These virtual network functions appear and behave like their physical

FIGURE 1

Considerations for connectivity technology selection

When designing end-to-end solutions, start by thinking about connectivity building blocks



Source: Deloitte analysis.

counterparts without the need for dedicated, specialized hardware. NFV deployments typically use commodity servers. Through virtualization, these network services can scale horizontally or vertically on demand.[8] With NFV, services such as multimedia voice, evolved packet core routing, and radio access networking can now be operated completely in a cloud environment using low-cost, general-purpose computing platforms as network infrastructure.

SDN and NFV are complementary. SDN controls network functions centrally; it doesn't matter whether the network functions are provided by dedicated hardware appliances or virtualized network functions.

What does this mean for IT?

CIOs can use these advanced connectivity building blocks together with existing local area networking technologies like Ethernet, and Wi-Fi, and wide-area capabilities such as Gigabit broadband and 4G LTE to create configurable networks that can be tailored to fit a variety of enterprise needs (see Figure 1). Similar to how enterprises utilize elastic cloud computing infrastructure, with SDN and NFV they will be able to spin up, tear down, and optimize network capabilities on demand to fit specific application or end-user requirements.

As you begin developing your *connectivity of tomorrow* strategy, consider the following demand and supply factors:

- **Growing demand for real-time computation and low latency at the end device.** Applications such as industrial automation, virtual reality, and autonomous decision-making will require high computation capabilities with very low latency (round-trip time from the device to the cloud and back). In these situations, data processing can be partitioned with a portion executed in a "mini cloud" as close as possible to the device. The remaining data-processing functions can be distributed among cloud service providers or corporate data centers. This mini cloud is also known as *edge computing*—a useful model in situations where low latency connectivity to the end device is an essential component. For IoT networks that generate and move massive amounts of data, edge computing is a game-changer. It makes it possible for these IoT devices—many with minimal computing power and low-speed connectivity—to process data at the edge. This model increases efficiencies for both the telecom operator and the enterprise by reducing network backhaul traffic to central repositories.[9]
- **Proliferation of connected devices to monitor and manage.** Enabled by 5G, both the volume and variety of connected device types are expected to dramatically increase within an enterprise. These devices are likely to have a range of operating systems, computing, storage, and networking capabilities. For CIOs and their IT teams, new end-point security requirements and challenges are likely to emerge, including prevention of unauthorized devices on the corporate network, security policy management at the device level, and avoiding potential for network storms by rogue devices.
- **IT talent models evolve.** As examined in the *Reengineering technology* chapter of *Tech Trends 2018*, talent models will need to evolve as IT talent upskills and retrains to address the new normal. In the context of advanced connectivity, SDN and NFV expertise is not widely available in all regional and industry talent pools. Likewise, enterprise architects will need to address partitioning of applications between the edge and the cloud/enterprise data centers, while ensuring that data is transported efficiently and securely.

LESSONS FROM THE FRONT LINES

MINING THE POSSIBILITIES: BHP ENABLES SAFETY AND PRODUCTIVITY THROUGH CONNECTIVITY

LESSON ONE

Technology such as automated drills, self-driving haulage trucks, and real-time supply chain analytics has transformed the once-traditional mining industry to make it more efficient, more profitable, and safer. Melbourne, Australia-based BHP—which extracts and processes minerals, oil, and gas around the world—has set a path to fully integrate its use of these technologies and automate its value chain to increase productivity, gain process efficiencies, and reduce costs. This ambitious strategy relies on a robust, next-generation connectivity infrastructure.[10]

BHP is leveraging technologies such as the Industrial IoT, digital mesh, Wi-Fi, and 4G LTE to stand up its integrated remote operations centers (IROCs)—the first launched in 2013—which operate 24/7 and give the business real-time visibility into its mining processes from pit to port.[11] The IROCs enable teams that manage planning, scheduling, controlling, and analysis to perform their jobs more effectively by providing a real-time, end-to-end view of a mine's supply chain network from one central location. For the IROC to be successful, BHP had to expand its network over a 2,000-kilometer distance, launch interconnected telecommunications infrastructure, implement closed-circuit television monitoring systems, engineer downtime management systems, and enforce security measures across the entire network.

BHP's next step is to leverage its investment in enhanced connectivity to scale automation and efficiencies across its entire value chain. The organization has installed 4G LTE, leveraged edge computing to schedule train routes, and implemented automated track signaling to control and monitor its rail systems. These measures have reduced the minimum gap between trains, allowing BHP to potentially double the capacity of its rail network. The company is also exploring ways to integrate these new capabilities with its existing, fully functional legacy systems and, at the same time, manage increased cybersecurity risks within the connectivity infrastructure.

BHP is seeing bottom-line results and process efficiencies across projects. These successes have created leadership support for the connectivity strategy, which is now integrated into BHP's overall business strategy. Moving forward, BHP plans to scale and maintain a robust connectivity infrastructure to support future innovation and functionality centrally and at the edge.

Ultimately, BHP continues to lead the transformation in the industry. Advances in connectivity will enable the acceleration of the development and deployment of remote safety systems, sensors, conveyors of the future, virtual mining with autonomous drilling and haulage fleets,[12] and predictive analytics for maintenance of its fleets and devices.[13]

SMOOTH SAILING: MSC CRUISES MAKES THE GUEST CONNECTION

More people are cruising now than ever before,[14] and as destinations grow more far-flung, staying connected at sea has never been more challenging. Today's passengers want a constant connection to their lives on shore and to their families and friends on board, as well as a way to optimize their cruising experience with instant access to facilities, entertainment, and events. To that end, MSC Cruises has been working to make its ships' connectivity fast and reliable across the seven seas as well as investing in a range of new digitally enabled services and experiences.

"It's vital that technology be at the service of the guest experience, and we're committed to investing in our fleet to develop technology and infrastructure that is capable of meeting the needs of guests for years to come," says chief business innovation officer Luca Pronzati.[15]

MSC's fleetwide digital innovation program, called MSC for Me, launched in early 2017 and debuted on board the MSC *Meraviglia* a few months later. Designed in collaboration with digital and behavioral design experts, the plan is part of a 10-year, US$10 billion investment to create a cruise experience designed around guests' preferences and behaviors.[16] To deliver a world-class customer experience at this scale, first and foremost the cruise line needed a robust and connected infrastructure.

Pronzati envisions its ships to be like smart, connected cities, but with the added complexity of being at sea and having advanced technology solutions on board that demonstrate MSC Cruises' commitment to true innovation to amplify the customer experience. MSC chose a multidimensional approach, addressing in turn connectivity for passengers and crew on board, connectivity from ship to shore, and connectivity between ships within the fleet. The company applied advanced networking techniques to make this possible, including satellites, Bluetooth beacons, edge computing, on-premises location-based services, and sensors. *Maritime Executive* reported that the entire MSC fleet connects to a dedicated cloud of bandwidth on the Marlink VSATs network, comprising 25 satellites and 32 overlapping beams.[17]

Delivering advanced connectivity to crew and passengers will require an overhaul of MSC's existing fleet, but the company is building the capability into new ships scheduled to launch by 2026. MSC Cruises announced that, on a single ship, the MSC for Me initiative is enabled by 3,000 sensors placed throughout the vessel, with 16,000 points of connectivity such as Wi-Fi and NFC beacons, 700 digital access points, 358 informative and interactive screens, and 2,244 cabins with RFID/NFC access technology. This helps guests with boarding, dynamic wayfinding, scheduling services, booking excursions, making purchases, and identifying the location of children anywhere on board the ship, while the crew is better enabled to tailor onboard operations and serve the passengers' ever-changing needs.

This advanced connectivity has paved the way for new, cutting-edge technologies and digital experiences, with new functionality coming in 2019, including facial recognition to help staff identify passengers and virtual reality capabilities for enhanced previews of excursions. Additionally, leveraging its mesh networks onboard ships, MSC is working to implement the first AI platform on a cruise ship, with a voice assistant in all staterooms. The company's proprietary digital concierge is specifically tailored to its business, supporting seven languages at launch (including Chinese) and deployed onboard to ensure seamless operations across the voyage.

"It's all about the experience for the customer," Pronzati says. "They expect speed and consistency in connection, and we want to offer that. We still have challenges in getting the right bandwidth, which is the nature of being at sea, but as the technology evolves, we will be prepared with infrastructure and services already in place to further elevate the guest experience."

MY TAKE

PROFESSOR THEODORE RAPPAPORT, NEW YORK UNIVERSITY, TANDON SCHOOL OF ENGINEERING

The amount of data consumed globally increases by 50 percent each year,[18] and I predict that four years from now our current 50 percent annual ramp will reach 70 to 80 percent. Why the jump? Because the rollout of 5G will accelerate data consumption exponentially. Organizations continually need wider pipes to accommodate ever-growing data volumes. Base stations and other 5G infrastructure will be rolling out in 2019 and 2020, and as they come online, 5G's impact will be felt around the world: in urban and rural areas, in burgeoning IoT ecosystems, on factory floors, and in corporate boardrooms.

Think about 5G's potential. For the first time, cell phones will perform as if they were connected to wireless fiber optic cables. In the arena of networking, this is a historic event, one that many doubted could ever come to pass. This bears out my longstanding argument that millimeter waves—unused bands at the top of the radio spectrum—could work better than any generation of cellular thus far.

My colleagues and I demonstrated the usage of millimeter waves in Texas and New York in 2011 and 2012.[19] Our demonstrations showed that if you use directional antennas that point the beam in specific directions, you get better coverage for the same bandwidth and the same radiated power. Moreover, you get better coverage and a better signal-to-noise ratio as you go higher in frequency. This is completely counterintuitive, but it proved to be true (neglecting the impact of heavy rain or snow, which can be compensated for with more antennas or power).

In terms of performance, 5G—which uses those high-frequency bands and the existing lower bands—exceeds 4G by several orders of magnitude. With 5G, applications traditionally dependent on cable connectivity will be able to seamlessly function on mobile devices. Think about everything right now that depends on a fiber optic or copper cable connection. Whether it be data-center functions or entire office buildings, 5G allows pretty much everything to be done wirelessly, untethering applications and networks themselves in new ways. 4G launched a wireless renaissance in which everyone (at least in urban markets) uses a cell phone for everyday activities such as banking, communication, and transportation. 5G looks to magnify this renaissance globally, with wireless pervading every part of our lives and new applications we cannot even yet envision.

There is another aspect of the global wireless renaissance that is historic. I believe that 5G can benefit rural and suburban areas that have not enjoyed the same access to wireless as cities. Throughout rural America and the world, there is a lot of aging copper wire that was installed decades ago to support voice transmission. While carriers could replace it with fiber optic cable, from a technical perspective, there is nothing preventing them from replacing it with *in-band backhaul*. Fixed point-to-point links can be easily accommodated by 5G spectrum allocations to daisy-chain base stations and small cells, and to carry traffic back to the internet and public switch networks for rural areas.

For carriers, 5G presents a ripe opportunity to become more valuable to their Fortune 500 clients by getting deeper into enterprise operations. Consider *network slicing*, a relatively new concept in which carriers spin up virtual networks using portions of 5G spectrum for particular users or use cases.[20] Let's say that a factory within a certain geographic area needs a low-latency, high-bandwidth capability to control its mobile robots. A carrier could provide this customer with a dedicated virtual network over the 5G spectrum, but with huge bandwidth pipes and the specific millimeter waves that the government is auctioning off, carriers will also be able to parse out spectrum to enterprises on demand. Moreover, large enterprises—particularly those with campus networks—may soon find millimeter wave products in the marketplace that will enable them to provision connectivity between buildings. Expect these products to quickly become so reliable and easy to install that IT personnel will have control and flexibility as they manage on-site networks. Unlicensed band products will also allow enterprises to install "instant fiber" using on-campus wireless infrastructure.

Opportunity awaits. The time to start thinking about your organization's networking strategy is now.

RISK IMPLICATIONS

It is a herculean task for future-thinking organizations to comprehend all of the various connected networks, internal boundaries, and interactions with externally connected networks that will be possible moving forward. Already, most enterprise networks are accessed from multiple locations by employees, vendors, customers, partners, and the general public, by a variety of devices connected through different wireless technologies, mesh networks, and IoT sensors, significantly increasing threat vectors and the enterprise attack surface. But though technology has evolved dramatically in the last decade, some organizations protect their networks using the same approach they've always employed. Companies should employ new tactics to ensure ubiquitous security throughout the network, its users, and their connected devices.

Build security controls so that they are embedded, inspected, and enforced at the data, device, and user identity levels.

- **Build it in.** Homogeneous, firewall-protected networks should be a relic in today's market; as connectivity evolves, networks will likely be a mix of 5G, Long Term Evolution (LTE), software-defined networks, multiprotocol label switching, Wi-Fi, satellite, and more. Additionally, the number and nature of devices ("things") will expand exponentially, resulting in a scope and complexity well beyond what we see today. Building security capabilities to meet the requirements of a single network model or protocol will not suffice, leaving organizations vulnerable through other channels. A solution is to build security controls so that they are embedded, inspected, and enforced at the data, device, and user identity levels.
- **Segmentation.** A large, flat network can allow malicious actors (internal or external) to move freely throughout connected systems if an actor manages to breach the external perimeter or otherwise has access to the network (for example, a "trusted" third party). Segmenting the network at both a broad level—such as separating security and administrative traffic from general user traffic from critical business application traffic—and on the device and workload-level via micro-segmentation is a key tactic in building a secure, resilient environment.
- **Zero-trust networks.** Organizations can benefit tremendously from implementing a zero-trust architecture, one in which every actor and device must be identified and authenticated, whether they appear to be within your walls or outside your network. A zero-trust approach deploys strategies such as identity and access management, multifactor authentication, encryption, risk scoring, and role-based access controls to enforce strict governance policies that allow users to access the bare minimum of applications and resources necessary to complete their tasks.[21]
- **Automation.** Automation of security processes enables an organization to tolerate some amount of cyber risk due to the speed and agility with which it can respond to potential threats. For example, when a traditional network experiences a breach, engineers must identify that a breach has occurred, determine which segment it affects, disconnect it, and figure out how to fix the problem. If the breach occurs in the cloud or in a software-defined network environment, the fix can be accomplished in just minutes through automation before more damage can be done. Additionally, going forward, AI systems increasingly will be designed to identify breaches in the environment and contain the

attack, identify the right fix, and apply it without human intervention.[22]

The upside to future connectivity is in its speed, agility, and increasingly software-driven nature. As networks become faster and grow more dynamic, their speed, flexibility, and resiliency allow their built-in security mechanisms to identify and address potential threats more quickly than ever before. Your organization will also benefit from relationships with your ecosystem of trusted partners and vendors, who are multiplying your efforts with their own security capabilities and threat identification tools, from the cloud provider with built-in security methods to third-party API providers that are guarding their connection points diligently. Even as they embrace newer technologies and security protocols, organizations will also need to maintain their legacy infrastructure through existing cyber risk processes. As networks become more varied and complex, deliberate automation and orchestration of security and risk processes become considerably more critical.

ARE YOU READY?

As the *connectivity of tomorrow* trend gains momentum, new capabilities to support differentiated, fit-for-purpose networking for devices and applications will become available around the world. What steps can you take to lay the groundwork for new networking models in your enterprise? Step one could involve scenario planning, in which you create models that consider your business and advanced connectivity together. You can then use these models to develop strategic options within a connectivity road map aligned with your company's business strategy.

As part of this planning effort, consider the following questions:

- **In the context of our business strategy, where and how can advanced connectivity create a material impact?**

  These capabilities could be a catalyst within an enterprise to accelerate both information technology and operational technology. Knowledge of these capabilities and potential timing should serve as a key input to shape customer- and internal-facing digital transformation initiatives. Viewed through an alternate lens, digital transformation, enterprise agility, mobility, and cloud technology features such as serverless computing are all dependent on advanced connectivity. However, with advanced capabilities comes higher network complexity in the form of multiple networking protocols, proliferation of devices and device types, and edge computing. Moreover, these capabilities will likely become available and evolve at different speeds across geographies. Taking into consideration your enterprise's business and technology strategy, consider building capabilities that could be transformative to your enterprise, assess potential availability and timing, and develop strategic options and a three-year *connectivity of tomorrow* adoption road map.

- **What impact could advanced networking systems have on my enterprise architecture?**

  As capabilities such as 5G, LEO satellites, SDN, and NFV are advancing, so are compute and storage, significantly affecting enterprise compute infrastructure and data architecture. For example, sensors in the field and telemetry in applications and on mobile devices will generate increasing volumes of data to be stored, analyzed, and acted upon. Enterprise architecture must consider the impact of distributed computing—between devices, edge, cloud, and data centers and where, how, and when advanced connectivity will be deployed.

As you develop strategies for connectivity and cloud, both should align with the strategic goals set forth in your digital transformation agenda. How will cloud and connectivity help your enterprise operate more efficiently? How can the ability to deliver and process enormous volumes of data where and when they are needed help your enterprise to more effectively engage customers, business partners, or your global operations? Which specific networking and cloud capabilities, deployed in tandem and managed similarly, might support new product and service offerings?

How will this trend affect my budget?

As the trend gains momentum, user expectations of networking capabilities and performance will rise. Vendors will want to recoup their significant capital investments in new products and services. Competition will likely put downward pressure on prices as technologies become more widely available. As a result, enterprise customers may have to make decisions about the capability/value requirements for advanced connectivity. Prices may be dynamic for some time, requiring enterprises to continually balance user and system demand for advanced connectivity with cost and business value. The likelihood is that CIOs will need to factor ongoing change into their networking strategy for the next several years.

How could the trend affect my IT/networking function?

Advanced connectivity can significantly raise the bar on automation. As automation levels increase, IT's primary responsibility will shift more heavily to engineering and driving the convergence of IT and operational technology. Depending on how far along you are on this path, you may need to make organizational changes to support new operational realities. Likewise, as you adopt configurable networks deployed with SDN and NFV, your connectivity service provider landscape may take on a different profile. Of course, this will depend on which capabilities you source, from where you source them, and how you integrate them into your infrastructure.

BOTTOM LINE

The *connectivity of tomorrow* trend represents a necessary and much-anticipated transformation in the way organizations move business-critical data from where it is generated to where it is needed. Across industries, this transformation will only accelerate as the total number of networked devices grows exponentially. Increasingly, technology and business leaders are recognizing that when deployed as part of a well-planned connectivity strategy, building blocks such as 5G, satellites, SDN, and NFV can deliver an order-of-magnitude boost in network flexibility, efficiency, and velocity. What will your strategy be for harnessing the connectivity of tomorrow?

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Intelligent interfaces

Reimagining the way humans, machines, and data interact

TODAY, PEOPLE INTERACT WITH TECHNOLOGY THROUGH EVER MORE intelligent interfaces, moving from traditional keyboards to touchscreens, voice commands, and beyond. And even these engagement patterns are giving way to new and more seamless and natural methods of interaction. For example, images and video feeds can be used to track assets, authenticate individual identities, and understand context from surrounding environments. Advanced voice capabilities allow interaction with complex systems in natural, nuanced conversations. Moreover, by intuiting human gestures, head movements, and gazes, AI-based systems can respond to nonverbal user commands. Intelligent interfaces combine the latest in human-centered design techniques with leading-edge technologies such as computer vision, conversational voice, auditory analytics, and advanced augmented reality and virtual reality. Working in concert, these techniques and capabilities are transforming the way we engage with machines, data, and each other.

At a dinner party, your spouse, across the table, raises an eyebrow ever so slightly. The gesture is so subtle that no one else notices, but you received the message loud and clear: "I'm bored. Can we leave yet?"

Most people recognize this kind of intuitive communication as a shared language that develops over time among people in intimate relationships. We accept it as perfectly natural—but only between humans. It seems a bit farfetched—or, at least, premature—that machines might also be able to recognize the intent behind a subtly raised eyebrow and respond in contextually appropriate ways.

Yet in an emerging technology trend that could redraw—or even erase—boundaries between humans and computers, a new breed of intelligent interfaces is turning the farfetched into reality. These interfaces are actually a sophisticated array of data-gathering, processing, and deploying capabilities that, individually or in concert, provide a powerful alternative to traditional modes of human-computer interaction. For example, using cameras, sensors, and computer vision, a retailer can track and analyze shoppers' store movements, gaze, and behavior to identify regular customers and gauge their mood. By cross-analyzing the information with these customers' purchase histories, the retailer can push promotions in real time to shoppers' mobile devices—or, in the not-too-distant future, be able to predict a need based on a customer's subconscious behavior and preemptively place an order on her behalf.

In this example, the deployed technologies become an intelligent interface between users and systems. And this is only the beginning. Thermal imaging technologies can detect changes in shoppers' heart rates. A variety of wearables ranging from today's smartwatches to tomorrow's augmented-reality goggles capture a wearer's biofeedback. Smartphone data captured in real time can alert retailers that customers are checking online to compare prices for a specific product, suggesting dissatisfaction with store pricing, product selection, or layout.[1]

Such potential is fueling a growing demand for a broad range of human-machine interface devices. The global market for speech and voice recognition technologies alone could reach US$22.3 billion by 2024.[2] The market for affective computing—another name for emotion-sensing software—is projected to reach US$41 billion in value by 2022.[3]

During the next two years, more B2C and B2B companies will likely embrace aspects of the growing *intelligent interfaces* trend. As a first step, they can explore how different approaches can support their customer engagement and operational transformation goals. Companies already on such journeys can further develop use cases and prototypes. Though investments of time, labor, and budget may be required before companies can begin reaping benefits, the steps they take during the next 18 to 24 months will be critical to maintaining future competitiveness.

The voice of authority

Intelligent interfaces represent the latest in a series of major technology transformations that began with the transition from mainframes to PCs and continued with the emergence of the web and mobile. At each stage, the ways in which we interface with technology have become more natural, contextual, and ubiquitous—think of the progression from keyboards to mice to touchscreens, to voice and the consequent changes in the way we manipulate onscreen data.

Today, voice-user interfaces such as those found in popular mass-market products such as Amazon's Alexa, Google Assistant, Apple's Siri® voice recognition software, and Microsoft's Cortana are the most widely deployed type of intelligent interface. The ongoing competition among these tech giants to dominate the voice systems space is standardizing natural language processing and AI technologies across the interface market—and fueling innovation.[4] Amazon offered a US$1 million prize through its annual Alexa competition to any team of computer-science graduate students building a bot capable of conversing "coherently and engagingly with humans on popular topics for 20 minutes."[5]

At each stage, the ways in which we interface with technology have become more natural, contextual, and ubiquitous.

Voice use cases are proliferating in warehouse, customer service, and, notably, in field operation deployments where technicians armed with a variety of voice-enabled wearables can interact with company systems and staff without having to hold a phone or printed instructions. Likewise, we are seeing more organizations explore opportunities to incorporate voice dialog systems into their employee training programs. Their goal is to develop new training methodologies that increase the effectiveness of training, while shortening the amount of time employees spend learning new skills.

Though conversational technologies may currently dominate the intelligent interfaces arena, many see a different breed of solutions gaining ground, harnessing the power of advanced sensors, IoT networks, computer vision, analytics, and AI. These solutions feature, among other capabilities, computer vision, gesture control devices, embedded eye-tracking platforms, bioacoustic sensing,

emotion detection/recognition technology, and muscle-computer interfaces. And soon this list also may include emerging capabilities such as brain-controlled interfaces, exoskeleton and gait analysis, volumetric displays, spatial computing, and electro-vibration sensing.

To understand how these capabilities could work in concert in an enterprise setting, picture a widely distributed array of IoT sensors collecting data throughout a manufacturing facility, and streaming it rapidly back to a central neural system. In many cases, these sensors function like a human's senses by visually, haptically, and acoustically monitoring operational environments. For example, microphones embedded in assembly-line motors can detect frequency changes. Or computer vision monitoring those same motors can "see" a malconfigured part. Enter AI algorithms—acting as a logic-based brain—that derive inferences from the data generated by these and other sensors. The brain may infer that a specific assembly-line function is underperforming, and based on that identification, the brain/AI component of an intelligent suite of interfaces can respond. Moreover, by collecting, for example, manufacturing variances in real time versus in batches, the system can accelerate response times and, ultimately, increase operational throughput.

To be clear, skilled human observation, combined with machine data, still delivers the most robust and impactful understanding of manufacturing processes or retail operations. And with intelligent interfaces, the flow of information between humans and machines runs both ways (see figure 1). As we have examined in previous editions of *Tech Trends*, augmented reality (AR), virtual reality (VR), and mixed reality devices—which act as delivery vehicles for intelligent interfaces—are drawing upon a wide variety of data to provide users information-rich, contextually detailed virtual environments.[6] This represents a fundamental reordering of the way that people have traditionally used technology. Rather than being the beginning state of the human-machine interface, we are now the end state.

Knowing me, knowing you

Intelligent interfaces offer B2C and B2B opportunities in several areas:

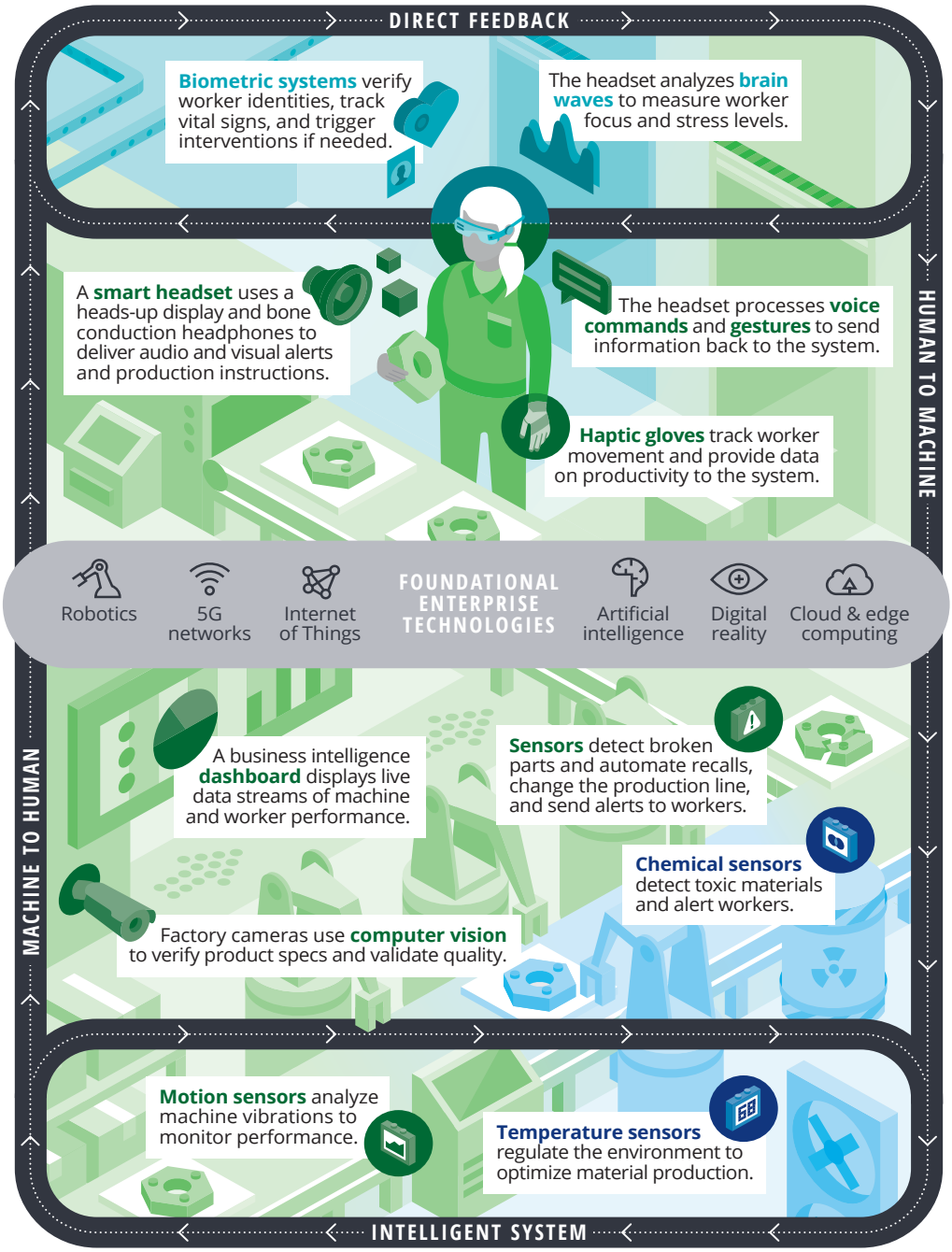
- **Tracking customers' offline habits.** Just as search engines and social media companies can track their customers' digital habits, some intelligent interface capabilities already make it possible to track physical behavior. Mobile phones are the most ubiquitous intelligent interface today: You may not have your phone turned on, but thanks to tracking functionality, service providers can tell whether, for instance, you are repeatedly visiting a certain restaurant or spending a lot of time at the beach. They can then push offers to you for discounted beverages or sunscreen. As smartglasses and digital reality become more widely accepted, those same offers could appear in your field of vision at the very moment you enter that establishment or arrive at the beach. As the *intelligent interfaces* trend progresses, expect companies to learn more about us—our habits, routines, tastes, experiences—than we could have ever thought possible.
- **New products and solution sets.** Understanding customers at a personal, detailed level will make it possible to "micro-personalize" products and services. For example, emotion sensors can detect when humans are experiencing stress. Perhaps they are being confronted, are stuck in traffic, or are engaged in an online political debate; their blood pressure rises, and their breathing becomes shallow. An enterprising health services provider could take this information and build an application that helps users manage their emotions during stressful episodes. If the user is online, perhaps the app creates a distraction to help delay an immediate—and ill-considered—email response. In another setting, it might create another kind of digital distraction to help the user remove herself from the immediate situation. With intelligent interfaces, opportunities for micro-personalization

FIGURE 1

Intelligent interfaces create real-time, context-aware, automated feedback loops

Intelligent interfaces have applications across industries—from life sciences and health care to energy, automotive, public sector, and more. Here's one scenario from the factory floor.

Information Sensory Physical Biological



Source: Deloitte analysis.

become infinite—and we have yet to scratch the surface in this area.

- **Efficiency.** Today, companies are exploring opportunities to use VR, AR, mixed reality, 360-degree, AI, and sensor technologies to enhance operational efficiency and individual productivity. For example, Amazon is experimenting with ways to use AR to track to the microsecond the behaviors of its warehouse workers in order to help them work more effectively.[7] As organizations begin integrating intelligent interfaces into their operations, they will likely face an increasingly common challenge: how to increase efficiency without micromanaging workers through sensors and real-time feedback. No doubt many workers are troubled by the prospect of wearing employer-mandated AR goggles or other forms of mechanical augmentation to perform their jobs. Yet their discomfort may be short-lived. Today, earbuds and some wearable technologies are as ubiquitous as watches and jewelry. Resistance to smartglasses and monitored work environments will likely wane as employees acclimate to new modes of human-machine interaction and see how mechanical augmentation can help them work more efficiently.

What does this mean for IT?

Any intelligent interface initiative involves underlying technology capabilities to bring it to life. As the fidelity and complexity of these experiences evolve, those foundational elements become even more critical. If you are collaborating with a colleague in a virtual environment via a head-mounted display, a 50-millisecond delay in a spoken conversation is annoying; if you find yourself waiting a full 10 seconds for a shared visual to load, you will probably lose confidence in the system altogether. Developing the supporting infrastructure necessary to harvest, analyze, and disseminate infinitely more data from more input sources will make or break experiences. There are also data syndication, capture, storage, compression, and delivery considerations, and this is where having an IT strategy for managing the backbone elements of intelligent interfaces will be crucial.

An effective strategy for prioritizing data, breaking it apart, processing it, and then disseminating to systems and network devices should include the following considerations:

- **Bandwidth.** In the *Connectivity of tomorrow* chapter in this year's *Tech Trends* report, we examine how in this data-hungry world advanced networking may hold the key to our digital futures. A primary networking component is 5G, the next generation of mobile connectivity technology that is poised to dramatically increase the speed and capacity of wireless networks. For their intelligent interface networks to traffic data within and between systems without a lag, companies will need the kind of bandwidth that 5G offers.
- **Cloud and edge computing.** If they hope to get their AI-driven interfaces to function in real time, companies can no longer channel all data through centralized servers in San Jose. During the 15 milliseconds of lag time, intelligent interface users will have grown impatient waiting for an AI response, and will have moved on. *Real time* means real time, with no discernible delay. For this reason, moving data and AI-driven decision-making to the edge of the organization and dynamically prioritizing what is processed will be a necessary step.
- **IoT.** Contextual computing capabilities require data inputs from vast networks of sensors in a user's surrounding environment that feed contextual information into the AI systems. This includes everything from temperature to humidity to air quality that could help the system understand the context in which a human gesture is made, or in an enterprise setting, when a machine vibrates unnaturally. If data is the lifeblood pulsing through an intelligent interface environment, IoT is the vascular system. As the *intelligent interfaces* trend progresses, building, maintaining and expanding IoT capabilities should be near the top of every CIO's priority list.

LESSONS FROM THE FRONT LINES

MAKING AR EXPERIENCES A SNAP

Despite the potential of AR to entertain and educate the masses, a barrier to widespread adoption has been developing an interface that is accessible, nondisruptive, and intuitive to use. Snap has found a way to attract hundreds of millions of daily users to its app using AR technology as a hook.

"Ultimately, we're a camera company, but we focus on creating new ways of communicating through an intelligent and connected camera," says technology VP Steve Horowitz.[8] "Snap has leveraged AR to build a close and loyal relationship with our users; in turn, we're constantly learning about how people interact with their devices, so we can evolve the Snap experience based on their natural interactions."

Most of Snapchat's users probably don't think much about interacting with AR when they layer mouse ears onto their head, dub a higher voice tone, or add dancing llamas to a video's background. This is because Snap's choice of a smartphone's camera as the interface is a familiar, comfortable tool that is almost always within reach. Snap adapted an interface that complemented users' natural movements—leveraging sophisticated facial mapping and computer vision technology that creates 3D animations that rotate and expand. Yet the "lenses," or filters, are easily accessible to users as they intuitively move the phone, point, and click. There is virtually no learning curve in creating, sending, and viewing a snap, and the result is immediate.

And Snap has been working with market leaders to change the boundaries of digital engagement—helping to make interactions seemingly effortless for consumers. These experiences combine digital reality technology with a cloud-based e-commerce platform and on-demand fulfillment. For example, customers can view products before they are released at geofenced events or virtually "try on" limited-edition merchandise with geofilters, make purchases without leaving the app, and have them delivered the same day.

What's next for Snap? Technically, the company believes that cameras won't stop evolving with the smartphone but will be incorporated into less disruptive tools such as camera glasses and other yet-to-be-invented devices. For engagement, Snap plans to continue to shape the future by delivering intuitive and creative AR experiences to their users.

THE FACE THAT LAUNCHED A THOUSAND DELTA FLIGHTS

LESSON TWO

Delta Air Lines made headlines in late 2018 by opening the United States' first-ever terminal where passengers can get from the curb to the gate using only their face as proof of identity.[9] Travelers flying out of Atlanta's Maynard H. Jackson International Terminal F, direct to an international destination, can check in at kiosks, drop baggage at lobby counters, pass through security checkpoints, and board their flight using facial recognition technology.

The airline's initial findings suggest that facial recognition decreases passenger wait times and can shave nine minutes off the time it takes to board a wide-body aircraft.[10] The launch builds on Delta's biometric boarding tests at ATL, Detroit Metropolitan Airport, and John F. Kennedy International Airport over the past several years, and the airline's second curb-to-gate biometrics experience will expand to DTW in 2019. The airline hopes that implementing biometrics—including fingerprint, along with facial recognition—will improve and expedite the travel experience. In addition, Delta aims to improve customers' interactions by streamlining operations and empowering employees with technology so they have more time to engage with customers more meaningfully.

"We want to leverage high-tech to drive high-touch," says Matt Muta, Delta's Operations Technology & Innovation vice president.[11] "Our employees are our greatest competitive advantage, so a big part of our approach is to empower them with tech tools that boost their ability to deliver an empathetic, seamless travel experience—that's the Delta difference our people are known for around the globe."

Muta works with operational teams throughout Delta's divisions, and at the airline's midtown Atlanta global innovation center called The Hangar—a startup-like setting that tests and scales proven technologies.[12] The team uses a design-thinking process, which helps them dig in and understand the problem, quickly model, and deploy. To understand travelers' and employees' challenges, team members engage heavily with Delta's employees, business, and technology partners across the organization.

Since its inception in 2017, the Hangar team has explored ideas, including how to use technology to help Delta One customers select meals before their flights; interactive voice solutions that offer travelers flight information; real-time flight communication devices for pilots, flight attendants, and gate agents; a gate interface allowing agents to perform tasks without a PC so they could be more mobile; a suite of technologies to study traffic in Delta's Sky Clubs; and drone-enabled lightning inspections.

Within three years, Muta says, Delta will explore more technologies to intelligently interact with customers and employees, to help Delta better engage through the travel experience by further mobilizing the workforce, and promoting consistent messaging. Delta's people and their renowned service will remain at the core of the airline's success as it explores how to leverage more applications of artificial intelligence—including computer vision, machine learning, predictive analytics, and optimization. Muta is confident that the way Delta is approaching innovation and leveraging biometrics and facial recognition will set a standard not just for Delta but for the industry as a whole. As for the Terminal F biometrics, Delta is drawing the industry's blueprint for the biometric customer experience of the future while capturing customer and employee feedback, refining and retooling processes as it scales out its intelligent interfaces in new locations.

MY TAKE

PATTIE MAES, DIRECTOR, MIT MEDIA LAB'S FLUID INTERFACES RESEARCH GROUP

We've seen a lot of media coverage on artificial intelligence in the last few years, often focusing on how the technology might cost people their jobs. But I think a much more exciting possibility is a future in which people are *augmented* with intelligent interfaces—thereby elevating and combining human decision-making with machine intelligence. At the lab, we like to talk about *intelligence augmentation* rather than artificial intelligence, and we view the future of interaction with our devices as one that is more natural and intimate.

There are three ways in which we would like to see our devices change. First, we live in two worlds now—the physical and the digital—and they're not well integrated. We are constantly forced to multitask and shift our attention from one to the other. Second, while today's personal devices provide access to the world's information, they don't do much to assist with other issues that are important for being successful, such as attention, motivation, memory, creativity, and ability to regulate our emotions. And third, our devices today pick up on only the very deliberate inputs that we give them through type, swipe, and voice. If they had access to more implicit inputs such as our context, behavior, and mental state, they could offer assistance without requiring so much instruction.

Today's devices are aggregating more and more information about users. But in the future, they will also gather data on the surrounding environment and current situation, perhaps by analyzing what we are looking at or sensing what our hands are doing. This context will enable our devices to provide us with data based on explicit intent and well-defined actions, as well as our state of mind, unspoken preferences, and even desires. These systems will gain an increased awareness about the user and their context and will form predictions about the user's behavior and intentions.

Devices will be able to learn from their interactions with us, which over time will yield much more efficient decision-making and communication between human and device. I often joke that the device of tomorrow will know each of us better than our spouse, parents, or best friends because it will always be with us, continually monitor us, and be able to detect even subtle cues from our behavior and environment. Are we focused or absent-minded? What is our stress level? Are we in physical discomfort from a medical condition or injury? All these factors very much affect engagement but are almost impossible to quantify without improvements in sensing and understanding of the contextual signals around us. Current interfaces such as a computer keyboard or mouse do not adjust automatically to those kinds of cues.

To optimize the delivery of data, interfaces, as we know them, must evolve. Today, receiving information from devices is disruptive: The user needs to stop what they're doing in order to receive the message, decide what to do with the information, and then indicate to the phone, tablet, or laptop what they would like to do next with a keystroke, swipe, or voice command. Using olfactory, visual, and auditory display technologies, as well as electrical and vibration stimuli, devices will be able to communicate with us in ways that do not require our full attention. We can perceive and process stimuli—such as smells or sounds—while we focus on the document we're typing or the TV show we're watching—without deliberate rational thinking.

Our goal at the lab is not only to enable seamless input of all manner of user data into devices but to enable users to act on the data and insights the devices provide in a way that is intuitive, nondisruptive, and comfortable. We need to create methods that will enable the user to accomplish certain tasks with minimal effort, time, and difficulty. We're searching for more subtle ways to provide information without distracting users from what they're doing, and that requires exploring the potential of all five senses.

Our Essence project, for example, explores the use of olfactory cues. The small clip-on device senses, perhaps, the declining alertness of the wearer during a meeting, and emits a burst of lemon or peppermint, scents demonstrated to increase attentiveness in humans. The intensity and frequency of the scent are based on biometric or contextual data. In another of our projects, AlterEgo, a wearable, peripheral neural interface, allows humans to "converse" with machines without using their voice and without "unplugging" from their environment. The device senses subtle signals when the user internally articulates words, without voicing them, and then sends audio feedback via bone conduction without disrupting the user's ability to hear their surroundings. One of my students is even studying the validity of the so-called "gut feeling" by monitoring changes in stomach activity as an indicator of unconscious feelings or mental status.

Our devices are so much a part of our lives, but there is still a long way to go to fully and seamlessly integrate them in our lives. The opportunities for cognitive augmentation are tremendous, and the first step to exploring those possibilities is creating more intelligent, intuitive interfaces.

MY TAKE

GLENN GAINOR, PRESIDENT, INNOVATION STUDIOS, SONY ENTERTAINMENT & TECHNOLOGY, AND HEAD OF PHYSICAL PRODUCTION, SCREEN GEMS

As I see it, the future of entertainment is a world where storytellers—big and small—are empowered to tell stories that couldn't be told before. It's a future in which we get to share the best practices Hollywood has to offer and allow storytellers from around the world to make their own dreams a reality. It's a future with not just one centralized voice but many important disparate voices that haven't been heard before. It's a future where Innovation Studios empowers and disrupts the known industry to enable what was once impossible.

Innovation Studios, Sony Entertainment & Technology, was born out of Sony Pictures Entertainment and opened in June 2018. We have taken up residence in a 7,000-square-foot soundstage on the Sony Pictures studio lot and are using Sony's latest research and development to help storytellers around the world create content for today and the future.

This is incredibly important because somewhere around the world is a voice that yearns to be heard. Somewhere in Amman, Jordan, is a young woman with a story ready to share. Somewhere in the mountains of Morocco is a location yet to be seen. From Hollywood to Moscow are millions of magnificent places that speak to so many people.

What if we could collapse these great distances and reproduce the reality of each place in the most realistic of 3D experiences? What if we could film in—and feel like we are living in—these worlds … while never having to leave our Culver City, California, stage? Well, we can. Volumetric video technology with quadrillions and quintillions of data points—much like the atoms that make up you and me—allows us to create more than 30,000-pixel resolution and moving environments captured on 6K Sony Venice cameras. We can film live performers in virtual worlds with traditional motion-picture and television cameras.

Now you're starting to see the potential of Innovation Studios to create virtual worlds with people in a multitude of locations while never leaving our volumetric stage. Volumetric storytelling offers filmmakers a realistic immersive experience of any object in each space, from any viewpoint employing a parallax that reacts like the physical world. The technology we're using allows for real-time visual effects so the real fuses with the unreal.

When we can capture the analog world synthetically in a resolution that is beyond anything possible with today's cameras, it gives us the opportunity to do more than entertain—we can preserve and protect monuments and locales, to celebrate humanity and the Earth. This technology also offers inherent cost savings to the industry: Rather than spending millions to send a cast and crew of hundreds to a location to film for weeks or months, or to rebuild sets for a blockbuster sequel, we can send a small crew to a location or set to shoot the images and preserve them forever for reuse.

I'm a firm believer that we should celebrate the US$200 million film and all the technical prowess that goes into making it, but I'd like to be able to say that I helped create a world where that kind of innovation wasn't limited to big-budget films. I'd like anyone who is making any form of content to have access to these capabilities. Technology shouldn't be for the best-financed content creators—it should be for *all* content creators, because in the end, we all benefit from the stories others tell.

We see the potential value in this technology not just for the next generation of filmmakers but for equipment manufacturers, governments, health care providers, educators, the aerospace industry, art dealers, and museums. We're working now with engineers throughout Sony to pursue opportunities to eventually partner with other industries that could benefit from leveraging the technology.

We're working on technology that saves money, increases opportunity, expands horizons, and enables dreamers. The words "What if?" used to be the two most expensive words in the film industry, but now they're the most cost-effective words. If you have the asset, you can say, "Sure, let's do it!"

RISK IMPLICATIONS

Today, data is the currency that runs through a digital ecosystem, and interfaces are the tools that help us interact with that data. Enterprises are recognizing the many use cases for intelligent interfaces in mitigating cyber risks in their systems and networks. Yet as the deployment of intelligent devices grows—in airports, health care, schools, manufacturing, and retail—organizations need to consider the potential cyber risks they pose to users and the organizations that host them. Companies should implement appropriate security measures with respect to accessing the interface and, subsequently, the data collected from and sent to the interface.

Intelligent interfaces help mitigate cyber risk in a variety of applications and across multiple industries. Take the use case of biometrics: The benefits of facial recognition, retinal scans, and fingerprints as identification in airport security checkpoints and border protection, for example, are obvious. Using biometrics unique to one person provide a more reliable, accurate, and expedited validation of identification and citizenry, thereby increasing the safety of the general public. These same characteristics make biometrics the de facto method of securely accessing smartphone devices. Because biometrics are irrevocable—you can't easily alter the patterns of an iris or characteristics of a fingerprint—they don't require upkeep like a password and are far more difficult to steal.

However, because of this unique permanence, the repercussions of biometric data being compromised could be devastating: The same identity markers used to make access more secure and efficient, in the event of a breach, creates multiple layers of risk. These can include:

- **Ethical risks.** It is now possible for organizations, and even nation-states, to target, manipulate, and discriminate against populations based on biometric data collected.
- **Privacy.** Data and interfaces used to monitor the health status of individuals, such as blood glucose levels for diabetics, can be sold to health insurers to assess long-term risk and set premiums.
- **Security.** The large volume of data collected through intelligent interfaces, as well as the interface itself, presents a significant security risk if not maintained by organizations. Theft of an irrevocable identity marker, such as a fingerprint, can have lifetime implications on an individual's ability to secure her personal data.
- **Regulatory.** The adoption of intelligent interfaces is expanding at a rate with which it is difficult for regulators to keep pace. The General Data Protection Regulation (GDPR), which affects businesses operating in the European Union, includes protection of biometric data, but the United States lacks similar widespread privacy and security enactments.

The repercussions of biometric data being compromised could be devastating: The same identity markers used to make access more secure and efficient, in the event of a breach, creates multiple layers of risk.

To address these cyber risks, organizations should establish data governance models from the beginning that define the value of their data, its ownership, where it resides, and how it will be used—and that help

ensure they are making ethical decisions in the use and destruction of that data.

Additionally, organizations should put in place a data risk management program that identifies the value that data has to bad actors, as well as sensitivities and vulnerabilities of the data they are consuming and processing through these interfaces. It is critical to put controls in place so that high-value data is secured no matter where it is located: on premises, at a remote data center, or in the cloud. Companies should anonymize information if it's irrelevant to the use of the data, establish additional boundaries for handling data that is transferred externally to third parties, and, finally, put thoughtful consideration into data deletion and archival.

ARE YOU READY?

The *intelligent interfaces* trend represents an opportunity to use converging exponential technologies to understand customers more deeply, enhance operational efficiency, and create highly personalized products and services. But as every CIO knows, the devil is in the details. Some industries, such as retail and manufacturing, are currently at the vanguard of intelligence interfaces adoption. Other industries? Time will tell. As you explore the opportunities and potential pitfalls of intelligent interfaces, consider the following questions:

- **My budget is limited. How can I show a return on this kind of investment sooner rather than later?**

  Intelligent interface initiatives will almost certainly require investing in hardware such as sensors, head-mounted displays, and microphones. These are not as-a-service plays—they are hard costs. And while an individual sensor is inexpensive, adding up the number of sensors needed to monitor a manufacturing facility may suggest a very different level of investment. While this may give you pause, you should avoid falling into the common trap of viewing IT solely as a cost center. CIOs often view initiative costs linearly: *Investments in emerging technologies will deliver specific outcomes within certain time periods.* Perhaps a more effective—and accurate—approach might be to look more broadly at how investment costs could amortize across operations and returns. In today's interfaces marketplace, there is a gap between what these nascent technologies truly do and how their costs are justified. As you explore opportunities in your company, think critically about what you want to achieve, how this trend may help you achieve it, and about the level of commitment you are willing to make.

- **What skill sets will I need?**

  With intelligent interfaces, human bodies become the instruments for creating commands, with users wearing devices on their bodies that constantly track movements, voices, and gazes. For this reason, human-centered design skills will likely be more important than ever to IT organizations. For example, people with medical backgrounds understand the way bodies function and process stimuli. Linguists might offer insight into what constitutes an effective voice conversation for humans, and what humans would respond to in terms of a computer-generated response. Physical therapists could bring specialized expertise to the development and use of haptic technologies.

  In addition to those with human-centered skills, technology generalists or "connectors" will also play an important role going forward. These are people who deeply understand all intelligent interface technologies and, more broadly, how they interact and interface with each other. They will be able to understand how to deploy these technologies in combinations to fuel the levels of growth that the trend promises.

- **At a fundamental level, the intelligent interfaces trend involves understanding the behaviors of customers and employees in much greater detail than ever before. Should I be concerned about privacy issues?**

  Yes. In terms of privacy, tracking users' online behaviors is one thing. Tracking both online *and offline* is a fundamentally different proposition—one that many users may find invasive and unacceptable. How this will play out in terms of regulation remains to be seen. But for now, companies can take steps to make sure all interfaces—particularly those, such as AR or VR gear, that are designed primarily for the consumer market—are deployed consistently with enterprise standards of privacy and security. For example, when using headsets in the workplace, you don't want to capture coworkers' faces for extended

periods of time, so users need the ability to activate the headsets only when necessary. This same consideration applies to voice interfaces: How do you determine what conversations should or should not be recorded? Microphones in popular virtual assistants in the consumer market are always on, which may be acceptable in some enterprise deployments but surely less so in retail or home settings. As part of any intelligent interfaces deployment, it will be necessary to put checks in place before data is gathered or processed to help ensure that individual privacy is respected consistently.

There are so many hardware and software players in this space right now. Should I wait until standards and a few dominant platforms emerge?

No. The solution space is fragmented, but growing numbers of companies—some of them likely your competitors—are developing use cases and exploring ways that the intelligent interfaces trend might add value. You can follow their lead or develop your own in-house use cases. Either way, your efforts can and should be contained in an innovation portfolio where the costs are understood as research. Your programs can be quick-cycling, seek immediate user feedback, and can be catalogued as impactful or not (and ideally tied to KPIs that can be identified and projected). You can then measure and evaluate these efforts with a go/no-go. Of course, developing use cases and exploring opportunities is only one piece of a larger digital transformation puzzle. Bigger picture, your company needs a coherent innovation strategy that incorporates rapidly evolving, fragmented ecosystems and unproven use cases today and in the future. In the end, nimble innovation makes it possible for companies to try, fail, and learn.

BOTTOM LINE

Unlike many technology trends that present new ways to streamline processes or engage customers, the *intelligent interfaces* trend offers something much more personal: an opportunity to fundamentally reimagine the way we, as humans, interact with technology, information, and our surroundings. To say this trend is potentially disruptive would be an understatement—simply put, it represents the next great technology transformation. And this transformation is already underway. If you are not exploring the role that voice, computer vision, and a growing array of other interfaces will play in your company's future, you are already late to the game.

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RISK IMPLICATIONS

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Beyond marketing: Experience reimagined

CMOs and CIOs partnering to elevate the human experience

THE NEW WORLD OF MARKETING IS PERSONALIZED, CONTEXTUALIZED, and dynamic. Increasingly, this world is orchestrated not by outside parties but by chief marketing officers partnering with their technology organizations to bring control of the human experience back in-house. Together, CMOs and CIOs are building an arsenal of experience-focused marketing tools that are powered by emerging technology. Their goal is to transform marketing from a customer acquisition-focused activity to one that enables a superb human experience, grounded in data. In experiential marketing, companies treat each customer as an individual by understanding their preferences and behaviors. Analytics and cognitive capabilities illuminate the context of customers' needs and desires, and determine the optimal way to engage with them. Experience-management tools tailor content and identify the best method of delivery across physical and digital touchpoints, bringing us closer to truly unique engagement with each and every human.

Imagine a world in which a brand knows who you are and what you want, and can deliver the product, service, or experience that best suits your needs seamlessly and in real time, across physical or digital channels. This world has arrived.

Marketing technology is undergoing a renaissance. Channel-focused solutions such as websites, social and mobile platforms, content management tools, and search engine optimization are fast becoming yesterday's news. As part of the growing *beyond marketing* trend, organizations are adopting a new generation of martech systems that deliver unprecedented levels of customer intimacy, targeted engagement, and precision impact. By deploying new approaches to data gathering, decisioning, and delivery, companies can now create personalized, contextualized, dynamic end-to-end experiences for individual customers. These experiences, in turn, can help customers create deep emotional connections to products and brands, which drive loyalty and business growth.

With its emphasis on the human experience, the *beyond marketing* trend represents a turning point in marketing strategy and practices. Traditionally,

marketing's broad goal was to bend consumer will in ways that advance a seller's strategy. Going forward, its goal will be to adapt the seller's objectives and methods of engagement to meet specific customer expectations—expectations formed on a deep, sensory level. How deep? Consider this: The human eye is capable of seeing more than seven million colors, our ears can sense when two notes are ever-so-slightly out of tune, and 20 million nerve endings allow us to feel everything. Humans are sensory creatures, our lives lived through experiences. When it comes to companies communicating and connecting with people, logic and system limitations have sometimes trumped emotional intelligence. Reclaiming the human experience and reconnecting with emotion are on the rise. Brands are expected to understand wants, needs, and previous interactions. An optimal brand experience demonstrates emotional sensitivity and sets the bar for all brand expectations moving forward, regardless of category or sector.

To meet these expectations, some companies are looking beyond longstanding relationships with marketing services providers (MSPs) and ad agencies, and are bringing data management and customer engagement processes back in-house. Likewise, CIOs and CMOs have begun collaborating more closely than ever and are aligning their companies' marketing, business, and broader digital strategies. They are trading in "black box" customer marketing solutions for cloud-based, flexible, automated marketing systems that offer greater control of data. Organizations farther along in their *beyond marketing* journeys are exploring opportunities to integrate first-, second-, and third-party data, cognitive analytics, machine learning, and real-time/right-time touchpoint delivery into their data management stacks.

During the next 18 to 24 months, expect more companies to launch their own *beyond marketing* journeys. Established organizations may start by launching pilots in individual brands or by consolidating vast volumes of consumer data that are currently spread across enterprise systems and operational silos. Startups might launch greenfield efforts by defining what the optimal consumer experience can be, and then working to make it real.

Organizations, large and small, will likely shift their marketing technology exploration and use case development into high gear. Going forward, consumers—not marketers—will be behind the wheel.

My way or the highway

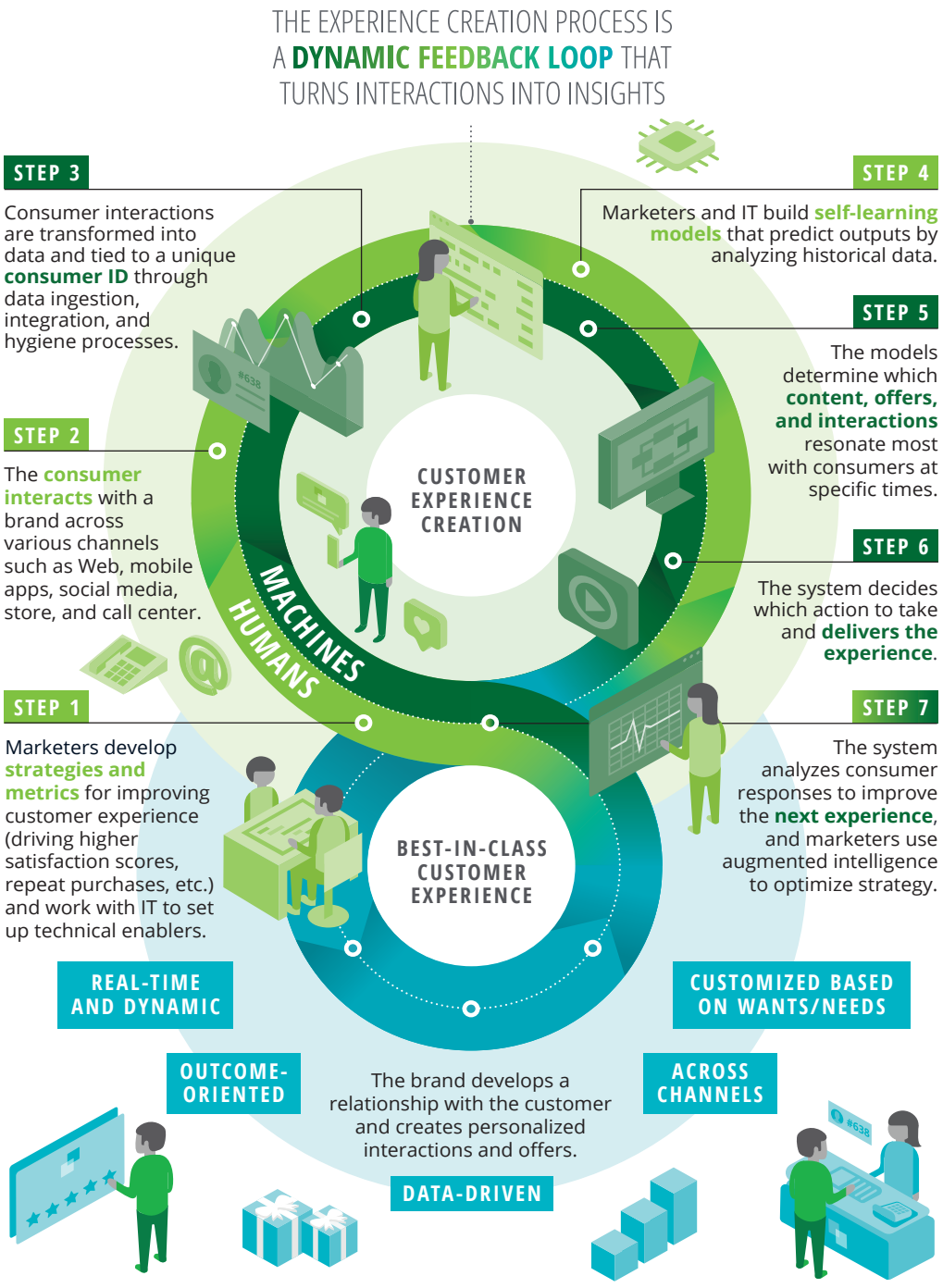
Constant online access is dramatically changing customer expectations. Customers want personalized experiences and communication, delivered when and how they want it. In a CMO Council/SAP survey, 47 percent of respondents said they would abandon a brand that delivers poor, impersonal, or frustrating experiences.[1] In response, CMOs are allocating nearly a third of their budgets to marketing technology.

Across industries, we are seeing companies use a variety of technologies to enhance their customer experiences. For example, clothing retailer Nordstrom recently debuted a digital shopping experience platform that uses smartphone shopping application features to enhance in-store experiences. Customers might see an article of clothing they like on social media; using the Nordstrom app, they can contact their personal Nordstrom stylist, who will direct them to the closest store that has the item. When the customer arrives at that location, they will find a dressing room with their name on the door, and the item inside, ready to be tried on.[2]

In sports, the Kansas City Chiefs are using a decision cloud rooted in machine learning and artificial intelligence to improve the fan experience. "The platform allowed us to connect multiple levels of fan data to many different offers, promotions, and solicitations," says Tyler Kirby, Chiefs VP of ticket sales. "Ensuring we were delivering our content to only those fans who would be most likely to purchase, and equally as important, not cannibalizing our retail sales. The audiences identified were valuable for all email, paid social, and lead distribution efforts to our sales team."[3]

FIGURE 1

CIOs and CMOs partner to reimagine human experience



Source: Deloitte analysis.

Tech-enabled CX initiatives like these are becoming common as a couple of factors push the *beyond marketing* trend forward. First, traditional ad agencies and other MSPs are struggling to deliver integrated experiences across sales, marketing, and data. In some cases, legacy data management systems cannot support real-time access and decisioning; in others, siloed organizational functions prove inefficient in the digital age. The problem of silos is exacerbated in larger organizations, as MSPs can't easily look across product lines, business units, functions, and geographies. As a result, more companies are exploring opportunities to bring data-management and customer-engagement initiatives back in-house.

At the same time, technology has created a multitude of ways to engage customers on their paths to purchase. But the tech stack required to engage and deliver an end-to-end customer experience can be incredibly complex and challenging if not developed within the parameters of a digital strategy. CMOs are increasingly owning the delivery of the entire customer experience—including CX systems—and are finding themselves taking on facets of the traditional CIO role. At the same time, CIOs are being called on to transform legacy systems and build new infrastructure to support next-generation data management and front-office customer engagement systems. How does this impact IT's mission and broader digital transformation strategy? How can IT and marketing ensure security, data integrity, and adequate tech support in this environment? As organizations travel farther down the *beyond marketing* path, CIOs and CMOs are finding they will have to collaborate more closely than ever in order to deliver not only on their company's new marketing strategies but on established digital strategies.

The tech stack required to engage and deliver an end-to-end customer experience can be incredibly complex and challenging if not developed within the parameters of a digital strategy.

The three Ds

From a technology perspective, this trend involves the infrastructure around data, decisioning, and delivery that your company will need to meet consumer expectations.

- **Data.** In *beyond marketing*, data is the starting point for all efforts. Greater volumes of diverse data—in an environment that a company controls—make it possible to develop a deeper understanding of customers and individual preferences and behaviors. Think about the customer information your company may have in its systems: names, email addresses, responses to marketing campaigns, past purchases, post-sale contacts, and the outcomes of those transactions. (Were the products returned? Did the customer engage the company for any reason after the sale?) These are basic elements of a customer profile that can be enhanced with public or third-party data, all while complying with today's stringent privacy standards.

  Knowing each customer's age range, gender, and location can help you compare their purchase history and preferences to others in the same demographic group. This analysis helps build a more complete picture of customers engaging with your brand. The process for gathering, integrating, and enriching audience and customer data will vary according to each organization's capabilities and needs. But in general, after

ingesting and transforming data from a myriad of sources, you can link each data transaction to a unique customer identifier. This data can then be stored in a customer data platform for use in decisioning and delivery.

- **Decisioning.** Through advanced analytics, audience management, and real-time personalization and decisioning engines, the system can determine how and when to provide an experience to a potential or known customer that optimizes value to the customer and the company. This goes beyond simple creative copy, image, and messages. It can also include pricing, promotion, and unique services and offerings being presented to a customer. Integrating machine learning capabilities into the decisioning process can help the system further refine the company's understanding of the customer—and of the effectiveness of experiences already delivered. Finally, decisioning should include necessary hooks into inventory and logistics systems to ensure that products and services being offered are actually available and can be delivered quickly.
- **Delivery.** Following data transformation and decisioning, content management and campaign experience management tools orchestrate delivery of dynamic CX content consistently across channels such as email, text, and customer portal. It also integrates with interaction channels like call centers and mobile apps. In some environments, this process can be largely, if not completely, automated. These delivery interactions ultimately create customized, personalized human engagement.

What does this mean for IT?

Reengineering your company's current approaches to data, decisioning, and delivery does not require ripping out your legacy technology stack and replacing it with a host of shiny new tools. Rather, your goal should be to integrate the technologies and processes that can make your existing systems smarter and provide real-time, seamless interactions with customers. There are some black-box data solutions that you can bring back in-house, and those can and should live in the cloud. But for many companies today, these changes are already taking place as part of broader digital transformation strategies. Whether it be analytics, cognitive, or cloud, the technologies that are driving the *beyond marketing* trend are likely driving other transformation initiatives in your organization and have been for some time. Look for opportunities to leverage in-flight digital investments and evolving IT talent.

Over time, the *beyond marketing* trend may require rethinking, redesigning, or reimplementing your current channel systems to support more tailored and personalized touchpoints. Supporting the journey to create more emotionally intelligent interactions often requires different approaches for delivering messages and content. Promotions will become more dynamic, potentially requiring changes to core systems that were configured for a less personalized world. Analyzing your portfolio of systems for potential "pinch points" today will be important to supporting better velocity in the future.

Supporting the analytics, machine learning, and artificial intelligence capabilities that underlie many of the decisioning systems will also likely require evolving your current approach to IT talent. The technologies and techniques that are driving your organization's AI-fueled transformation will also support marketing decisioning. Getting ahead of the curve by training internal resources and identifying external support will be key. Moreover, marketing and IT will also need more CX talent, which warrants a discussion to identify where and how those individuals can be most successful.

LESSONS FROM THE FRONT LINES

USTA'S MATCH POINT: A GRASSROOTS DIGITAL MARKETING STRATEGY TO GROW THE SPORT OF TENNIS

LESSON ONE

Since 1881, the United States Tennis Association (USTA) has fulfilled its mission of growing the sport primarily by building its membership base of active players—administering amateur tournaments and developing adult and youth programming that requires participants to join the organization. To continue to grow the game, the organization has more recently broadened its lens to create relationships with coaches, teachers, tennis fans, and players' parents, along with players of all ages and abilities.

"If we can get people—no matter where they are in their tennis life—into the right activity with the right training, people will play the sport throughout their life," says Kevin Mahoney, managing director of digital at the USTA.[4] In order to do that, he says, the organization has to build a personal relationship with anyone who might pick up a tennis racket, get them on the court, and keep them coming back.

To match each individual with the perfect experience, the USTA has implemented a personalized marketing strategy that required a transformation of the USTA digital network. To support its efforts, the USTA has built out a data lake to collect information from a variety of touchpoints on and off the website—event registration and results, purchases and search history—and created a single view of each customer. This single view enables the USTA to understand player participation patterns and to facilitate a specific tennis experience for each person. Next, the organization initiated a campaign encouraging players and others involved in the sport—including nonmembers—to register at USTA.com.

"The better we understand how an individual has interacted with the site, the better positioned we are to offer the right opportunity—whether the individual is a fan, a college varsity player, or a senior picking up a racket for the first time—based on that history," Mahoney says. "For example, we're able to target the parent of a junior team tennis player who likely won't want to receive messages about improving their own backhand, but instead is interested in a new junior team being organized or a coach offering junior clinics in their city or town."

This approach has been deployed within Net Generation, the USTA's official youth tennis brand, centered around giving kids the skills to be great, on and off the court. To date, Net Generation has more than 300,000 registered USTA accounts, accomplishing this in a little over a year. And as the USTA collects more relevant information, it becomes easier to create customized experiences, matching players with coaches, teams, tournaments, facilities, and other resources to expand their playing opportunities.

The USTA is also using its newly developed marketing tools to broaden its digital offerings beyond its core member universe. As a part of the Tennis 2020 initiative, the USTA will give providers—such as coaches, equipment manufacturers, and facility managers—tools, such as web page development and scheduling software, to better target offerings and grow their businesses.

"Over the next couple of years, we'll connect the dots, building a data-driven culture as we push digital products into the market to support the USTA's programs and the growth of the sport," Mahoney says. It has been a journey to change the direction of an organization that's nearly 140 years old, but the USTA is embracing the digital age to create products that enhance its sport and get more people on the court.

APPETITE FOR DATA: TYSON FOODS' CUSTOMER-DRIVEN DIGITALIZATION

After 85 years, Tyson Foods is growing an appetite for digital transformation that is dramatically evolving how the company serves its customers and reaches its end consumers. Generational preferences for meat protein and variable patterns of demand are creating a market shift. At the same time, availability of social media and other big data, along with advances in analytic tools, cloud, and cognitive technologies such as machine learning, are all changing how the company predicts, influences, and responds to market behavior.

For Tyson Foods, digital transformation is consumer-driven, and according to CTO and executive VP Scott Spradley,[5] this means evolving the whole technology stack. Having better insight into customer behavior while digitizing the supply chain enables the company to more quickly respond to demand fluctuations; as part of that, the legacy analog company is reimagining how it markets to customers. "Intelligent marketing is driven by analytics; digitizing the entire process is needed for us to gain insights into the market," Spradley says. "We are pursuing efforts to digitize structured and unstructured data sets—including information about the weather, sporting events, and life events—that will allow us to be much more predictive of the specific demands of our consumers and more accurately plan what, how, when, and why we market."

Tyson Foods recognizes that many demographic factors drive preferences and consumption patterns, making personalized marketing even more critical. Consumers have unique touchpoint preferences and triggers that motivate them to buy. To predict diet preferences and consumption patterns, the company is delving into how age groups use media, even segmenting within those age groups, such as distinguishing between millennials who use Twitter from those who use Instagram.

Spradley and his team recently concluded a pilot in which they analyzed a variety of social media feeds to determine trends that lead to "food acquisition events," or consumer purchases, across multiple demographic groups and compared the results with third-party market research. The information will be used to hone marketing efforts to better forecast and influence buying patterns—from more traditional food acquisition events such as holiday, football tailgate, and summer grilling seasons—to more specific, local activities that prompt consumers to purchase food: concerts, amateur sporting events, political rallies, and birthdays. Better forecasts support improved supply chain management—from fine-tuning meat production to distribution, including preventing stockouts and minimizing wastage at grocery stores.

Understanding the market itself has also required Tyson Foods to transition its IT talent model. New skill sets, including both statistical application and a broad comprehension of macroeconomics to help identify economic impacts within data sources, are now essential. The company is meeting these needs by expanding current workers' knowledge base, as well as acquiring a new data sciences team.

"The complexity of the food chain—from farm to fork—can truly be understood with digital capabilities," Spradley says. "Rich data stacks, strong talent, and emerging technologies are allowing us to establish a new normal around thinking and planning. As we move down our transformation road map, our hope is that Tyson Foods can move faster and cheaper, resulting in lower end prices for the consumer."

MY TAKE
JIM FOWLER, CIO, NATIONWIDE INSURANCE

Insurance is, by definition, a very personal business. Since selling its first policy to an Ohio farmer in 1926, Nationwide Insurance's mission has been to help its members protect the things in their lives that matter most: their homes, cars, businesses, and retirement savings. Today, with 30,000 associates and more than US$230 billion in total assets, Nationwide's mission remains the same, though the list of insurable things that matter to our members has grown to include pets, motorcycles, boats, digital assets, and much more.

Just as our members' lives and personal circumstances have evolved, so too have their expectations of Nationwide. Like many other sectors, the insurance industry is being disrupted by changing consumer attitudes and buying behaviors. Consumers increasingly expect companies to tailor products, services, and buying experiences to meet their personal needs and tastes. It is no longer enough to buy high-quality leads from list providers. You need to meet members wherever they want to make the purchase with a product that is customized for the individual.

Going forward, the only way we can succeed is by using data to create a unified view of each customer and connect our services to all the stages of their lives. Take, for example, my daughter. After graduating from college in a couple of years, she will have her first experience with an insurance company. She will probably buy renter's insurance and auto insurance. A few years later, she may get married, have children, and buy a house, so she might purchase life and homeowner's policies. Like many in her generation, she will probably change jobs five or six times over the course of her career, so she may need to roll over her 401(k). Later in life, she may want to look at annuities. It is critical that Nationwide meet her at each of these important life stages, and data is at the heart of how we can make that possible.

To harness data's full potential, Nationwide has had to rewrite every underlying transactional system. Whether these systems supported retirement plans or insurance policies, they were grounded in 1980s-era mainframe technology. Upgrading these transactional systems has been a critical investment. We have also made IT organizational changes, specifically with a move to agile development. Within our IT organization, 100 percent of our lines are now agile. We have expanded these agile lines to include our internal business partners, who provide invaluable process and product expertise as we develop new capabilities. And because we know that customers are going to research, purchase, and manage their policies through different channels such as independent agents and advisers, we established a technology strategy that enables us to meet members in new channels digitally. Now our members can access our products where they choose.

For those who are considering a transformation journey of their own, I can offer a few bits of hard-earned wisdom. First, the CMO and CIO are not adversaries—they are partners. It is in the best interest of any company, its employees, and its customers for this relationship to work well. Break down divisions that exist between IT and marketing, because when the two teams collaborate as partners, they will be able to reach shared goals much more quickly. In our customer-facing teams, it's difficult to tell who is from IT and who is from marketing. That is driving huge success for our customers.

Secondly, recognize that data is at the very heart of this journey. If you do not have a strong team focused on connecting the data elements around your customers, you are going to have a hard time competing in your industry. Moreover, you should develop guidelines for using data ethically. We constantly review and discuss ethical boundaries to determine how we will and will not use customer data. This is a conversation that you should have before you get too far down the road of products and services—otherwise you may find yourself at odds with customers, regulators, and public opinion.

Finally, the C-suite—just like IT and marketing—must be willing to disrupt its own status quo. At Nationwide, every executive is actively engaged in our transformation efforts. This includes our board of directors, who meet six times a year to discuss ongoing technology initiatives. They, like the entire leadership team, recognize that our industry is in the midst of a profound shift—one being driven by consumers.

RISK IMPLICATIONS

It is becoming increasingly apparent that marketing and customer experience professionals understand that identity management not only is foundational to their organization's survival—it can be a key contributor to market growth by differentiating the company's brand, products, and services. Great customer experiences rely on identity management, and done right, it can provide a secure and seamless experience with access to what customers need, when and where they need it, and from any device. However, those in the enterprise charged with protecting privacy and security need to appreciate the significant risks around the collection, storage, and management of data and consumers' digital identities. As stricter privacy and consent regulations go into effect around the globe, and the incidence of fraud and cyberattacks proliferates, organizations must balance customer experience and usability with security and risk management. There are three common drivers that have transformed cyber risk into a strategic business consideration:

- **Fraud and cyber threats born from stolen credentials**. Stolen passwords are the most vulnerable touchpoints when it comes to customer engagement and experience, primarily because the entities responsible for creating secure passwords and keeping them secure … are human. Even after years of warnings, people share, reuse, forget, and fail to secure their passwords.
- **Limiting friction while securing data at multiple touchpoints.** Organizations struggle with being able to offer a user experience that is simple and seamless yet still secure. For example, when users are asked to opt in to more rigorous security measures to protect their identities, there is a risk that the process will add friction and the consumer will give up and log off—or, worse, move onto a competitor. Adding front-end security, such as site registration or multifactor authentication, as a knee-jerk reaction to breaches reported in the news, may clutter the customer experience while failing to fix identity security issues.
- **Regulation as a market force.** The need to keep pace with regulatory and compliance demands for protecting consumer data and preferences, such as the sweeping General Data Protection Regulation (GDPR) and California Consumer Privacy Act of 2018, requires organizations with consumers and users all over the world to develop a comprehensive strategy ensuring security and privacy. This could mean hiring experienced compliance professionals and investing resources to meet and exceed regulations—beyond traditional consumer protections—that have not existed before.

Perhaps the biggest lesson to learn from organizations that have responded well to these drivers is this: Personalization and brand experience are important, but the responsibility of protecting customers' privacy is not just the responsibility of the chief security officer. To survive and thrive in the marketplace, the entire C-suite—from the CEO and CFO who drive growth and value; to the CISO, CTO, and CIO who innovate to keep data and systems secure; to the CMO who owns the implementation of consumer engagement strategies—should be invested in creating a unified enterprisewide approach to customer identity management.

Simply put, customers who trust you will give you more data. More data means more insight, and more insight begets better engagement—which, ultimately, generates more revenue.

ARE YOU READY?

For even the most knowledgeable CIOs and CMOs, developing and implementing new approaches to data, decisioning, and delivery is rarely a light lift. Luckily, you don't have to take the entire effort on at once. As you explore the possibilities that the ***beyond marketing*** trend offers your company, ask yourself the following questions:

- **This trend represents a big change in the way my company engages customers. What initial steps can I take to lay the groundwork?**

  First, define what an optimal experience would be for a customer engaging your brand, and use this to create a vision and guiding principles for the journey ahead. How do your current operations align with this vision and set of principles? To what extent can your current CX tech portfolio—martech, CRM, social platforms, e-commerce—support your vision, and where are there gaps? The same goes for your existing strategies for customer engagement. Once you have identified gaps, you decide which ones to prioritize—maybe start small by going for quick wins that can demonstrate value to leadership and detractors. From there, you can broaden the scope of your initiative with more ambitious milestones and timelines. Whatever your approach, remember: Deploying the tools and tactics you will need to deliver tailored experiences to customers is not easy. Beyond deploying new technologies and processes, it may require shifting mindsets and aspects of your company's culture. This is a journey, one that begins with a few steps.

- **What are some quick wins I can achieve?**

  There are opportunities for quick wins across the board—for example, lowering the cost of customer acquisition, enhancing customer engagement, or driving greater customer retention and loyalty. You don't have to launch a huge transformation initiative tomorrow. Instead, consider starting with a single channel like the call center, emails, or mobile apps, and focus on a specific desired outcome. Maybe you can complete more upsells or get higher click-through rates. With these small successes under your belt, you can further develop use cases or launch pilots. Another quick win—though one that can be a bit more involved—is consolidating your data. In many companies, human data lives in operational silos, discrete systems, and with third-party vendors. Consolidating this disparate data in a cloud-based data lake and identifying one owner is an essential step you will eventually have to take in any *beyond marketing* journey. Why not start now?

- **As I reengineer my company's marketing operations to deliver individual experiences, how will I know if I am succeeding?**

  The *beyond marketing* trend is about truly knowing individual customers on a one-to-one personalized level and using that knowledge to deliver personalized experiences every time they engage with your brand. Success in this arena means developing the ability to collect data from all interactions that a customer has with your organization—think of responses to marketing campaigns, sales interactions, customer service calls, and online brand engagement, among others. With advanced analytics, you will be able to develop a highly nuanced understanding of customer behaviors and preferences, which you can then use to tailor the interaction experiences you offer each customer. As an example of a successful experience, consider a life sciences company that segments its customers into broad archetypes, such as *collaborative* and *competitive*. Someone in the *competitive* archetype may respond better to a gamification technique that encourages healthy choices and adherence to a health regimen. Others in the *collaborative* archetype group may respond to messages that offer anecdotes and human-interest content. With archetype designations identified, the company can tailor content, messaging, and interactions to individual people based on their needs.

- **Who in my company should ultimately "own" the human experience?**

  A brand may decide to share ownership of the human experience across functions, including marketing, sales, and service and establishing a cross-functional leadership council, while other companies may expand the role of the CMO to own the human experience; some are adding a chief experience officer to the C-suite. In any case, the ownership must be clear, with metrics in place for accountability and to measure value.

- **What will humans continue to do versus machines in my company to enable this trend?**

  Marketers and experience owners will likely continue to guide the overall strategy and use insights produced from machines to make more systemic and macro level changes to the strategy and design of the human experience. For their part, machines can bring in vast quantities of data, make sense of it, and be able to act upon it in real time, guiding the optimal message to consumers in the right channel at the right time.

- **My company has a longstanding relationship with an MSP. What does the *beyond marketing* trend mean for this relationship in the future?**

  As you explore the trend's potential for your company, think about where you might need MSPs and agencies to play, as well as what you need to bring in-house in order to create a differentiated experience. A decade ago, companies went through a similar exercise as they tried to determine which, if any, functions could be outsourced to others. Today, you can follow a similar decision-making process: What can MSPs do better than you? What can you do better—and given today's real-time, always-on demands—more cost-effectively, under your own roof? Do you want to bring all your data in-house or, perhaps, keep data management outsourced, focusing instead on analytics and decisioning? Should you bring only a few channels or adopt only select capabilities? Finally, be realistic about what your organization can support. Can you provide sufficient governance? Do you have the capabilities and support relationships in place to bring new capabilities in-house? These are not decisions to be taken lightly.

BOTTOM LINE

In today's world, the customer is in charge. And in a marketplace of endless options and channels, companies realize that to remain competitive, they will have to create a differentiated human experience and deliver consistently on ever-evolving customer expectations of brand engagement. The *beyond marketing* trend ushers in a new set of tools and tactics that, deployed strategically, can help companies elevate their marketing operations from art to a blend of art and science, while keeping the customer firmly in the center of all decisions.

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RISK IMPLICATIONS

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DevSecOps and the cyber imperative

Elevating, embedding, and evolving your risk response

TO ENHANCE THEIR APPROACHES TO CYBER AND OTHER RISKS, forward-thinking organizations are embedding security, privacy, policy, and controls into their DevOps culture, processes, and tools. As the DevSecOps trend gains momentum, more companies will likely make threat modeling, risk assessment, and security-task automation foundational components of product development initiatives, from ideation to iteration to launch to operations. DevSecOps fundamentally transforms cyber and risk management from being compliance-based activities—typically undertaken late in the development life cycle—into essential framing mindsets across the product journey. Moreover, DevSecOps codifies policies and best practices into tools and underlying platforms, enabling security to become a shared responsibility of the entire IT organization.

DevOps tactics and tools are dramatically changing the way IT organizations innovate. And in the midst of this transformation, IT leaders are finding that longstanding approaches for integrating security into new products are not keeping pace with high-velocity, continuous delivery software development. Indeed, in the DevOps arena, traditional "bolt-on" security techniques and manual controls that are reliant on legacy practices are often perceived as impediments to speed, transparency, and overall security effectiveness.

In a growing trend, some companies have begun embedding security culture, practices, and tools into each phase of their DevOps pipelines, an approach known as *DevSecOps*. Deployed strategically, DevSecOps can help improve the security and compliance maturity levels of a company's DevOps pipeline, while boosting quality and productivity and shrinking time-to-market. How? Automation tools execute tasks uniformly and consistently, whereas humans using manual controls can and do make mistakes. At the same time, with DevSecOps, application changes flow freely through DevOps pipelines, giving developers more autonomy and authority without compromising security or elevating risk.

To be clear, DevSecOps is an evolution of DevOps culture and thinking. Rather than dis-

rupting your current cyber agenda, it actually embeds many of the security processes, capabilities, and intelligence learned over the years into your underlying platforms and toolchains. Building on your experience of developing and operating applications, DevSecOps enables you to automate good cybersecurity practices into the toolchain so they are utilized consistently.

The *DevSecOps* trend is only beginning to gather steam. For its 2018 *DevOps Pulse Report*, Logz.io surveyed more than 1,000 IT professionals worldwide about the state of DevOps in their industries. Roughly 24 percent of respondents indicated their IT organizations were practicing some DevSecOps elements. The other 76 percent said their IT organizations either do not practice DevSecOps or are still in the process of implementation.[1]

Notably, 71 percent of respondents feel that their teams currently lack adequate working knowledge of DevSecOps practices.[2] During the next 18 to 24 months, expect that working knowledge to grow markedly as more CIOs and development leaders explore DevSecOps opportunities. Likewise, those with more advanced DevOps programs in place may begin implementing governance, maximizing automation, and cross-training both DevOps and cybersecurity specialists with new processes and tools.

Building on your experience of developing and operating applications, DevSecOps enables you to automate good cybersecurity practices into the toolchain so they are utilized consistently.

DevOps' fundamental value is speed to market.[3] Organizations that do not incorporate security into every phase of their development and operations pipelines risk leaving much of its value on the table. Every product you stand up should be a known entity—tested, secure, and reliable. Internal and external users should not have to waste time grappling with cyber surprises, nor should you.

It's time to stop playing the patch management game with security.

In a DevSecOps state of mind

Even as IT organizations began embracing agile development practices over the last decade, many continued to approach security issues in the same incremental, siloed way they had with waterfall.[4] Building on agile's nimble, team-based approach to development, DevOps is now driving dramatic increases in end-to-end velocity. Yet with its heavy reliance on legacy processes and manual controls, security remains a challenge. In many DevOps pipelines, security is still treated as a bolt-on rather than a design feature. This can create pipeline bottlenecks, in part because few developers and system operators have cyber expertise and even fewer cyber specialists possess a deep understanding of development and operations. As a result, DevOps teams and cyber specialists continue to work separately within the pipeline, often slowing progress.

Increasingly, CIOs and DevOps leaders understand that unless these groups work as a unified team to bake security into products throughout the development and operations cycles, their companies may never realize DevOps' full promise.[5]

DevSecOps is not a security trend in and of itself but, rather, an aspect of the ongoing DevOps revolution that *Tech Trends* has chronicled in past issues.[6] It is also more of a mindset than a formal set of rules and tools. DevSecOps offers companies practicing DevOps a *different way of thinking*

about security. Consider the following characteristics of DevSecOps, and how they differ from the way you are approaching security in your development pipeline today:

- **Open collaboration on shared objectives.** DevSecOps creates shared expectations and metrics for measuring success. It aligns security architects and focuses activities based on business priorities.
- **Security at the source.** DevSecOps features consumable, self-service security capabilities, establishes security guardrails, and makes it possible for teams to monitor results and provide targeted feedback. It can find cyber vulnerabilities early in the application development cycle, reducing the need for rework just before or after deployment.
- **Reinforce and elevate through automation.** By automating recurring tasks, DevSecOps makes it possible to orchestrate an integrated process flow, embed preventative operational controls, and create ongoing audit trails.
- **Risk-oriented operations and actionable insights.** Organizations incorporating DevSecOps into their development pipelines can utilize operational insights and threat intelligence to drive process flow, prioritization, and remediation recommendations. They no longer have to rely solely upon code scans and can take a more risk-based approach to testing.
- **Holistic approach to security objectives.** Integrated frameworks help secure both the pipeline and application. This helps create a more comprehensive, end-to-end defense throughout the production environment.
- **Proactive monitoring and recursive feedback.** Automated, continuous testing helps identify problems before they become issues. Developers can also leverage logging and telemetry to drive learning and innovation.
- **Automated operations security.** Because visibility into some aspects of operations security can be limited, CIOs overseeing security audits have often found themselves in a position of having to *assume* (hope) that various security administrators have performed their jobs correctly. Security-as-code may offer a more effective approach. New techniques in containerization and public cloud infrastructure automation now make it possible to audit security and compliance in operations reliably and consistently, with less effort.
- **Operations engineering.** When humans are part of the loop, the process of detecting an intrusion and taking action can eat up precious hours or even days. However, in secure infrastructure-as-code environments in containers or public cloud/containerized environments, engineered response capabilities can automatically and instantly redirect traffic, freeze nodes for later inspection, notify operators, and spin up fresh instances—all automatically.

Taken together, these DevSecOps elements can help improve the overall quality of security, boost productivity, and reduce compliance issues. Importantly, they can break the bottleneck that traditional security creates in high-velocity development environments, thus unleashing DevOps' full potential.

DevSecOps in four parts

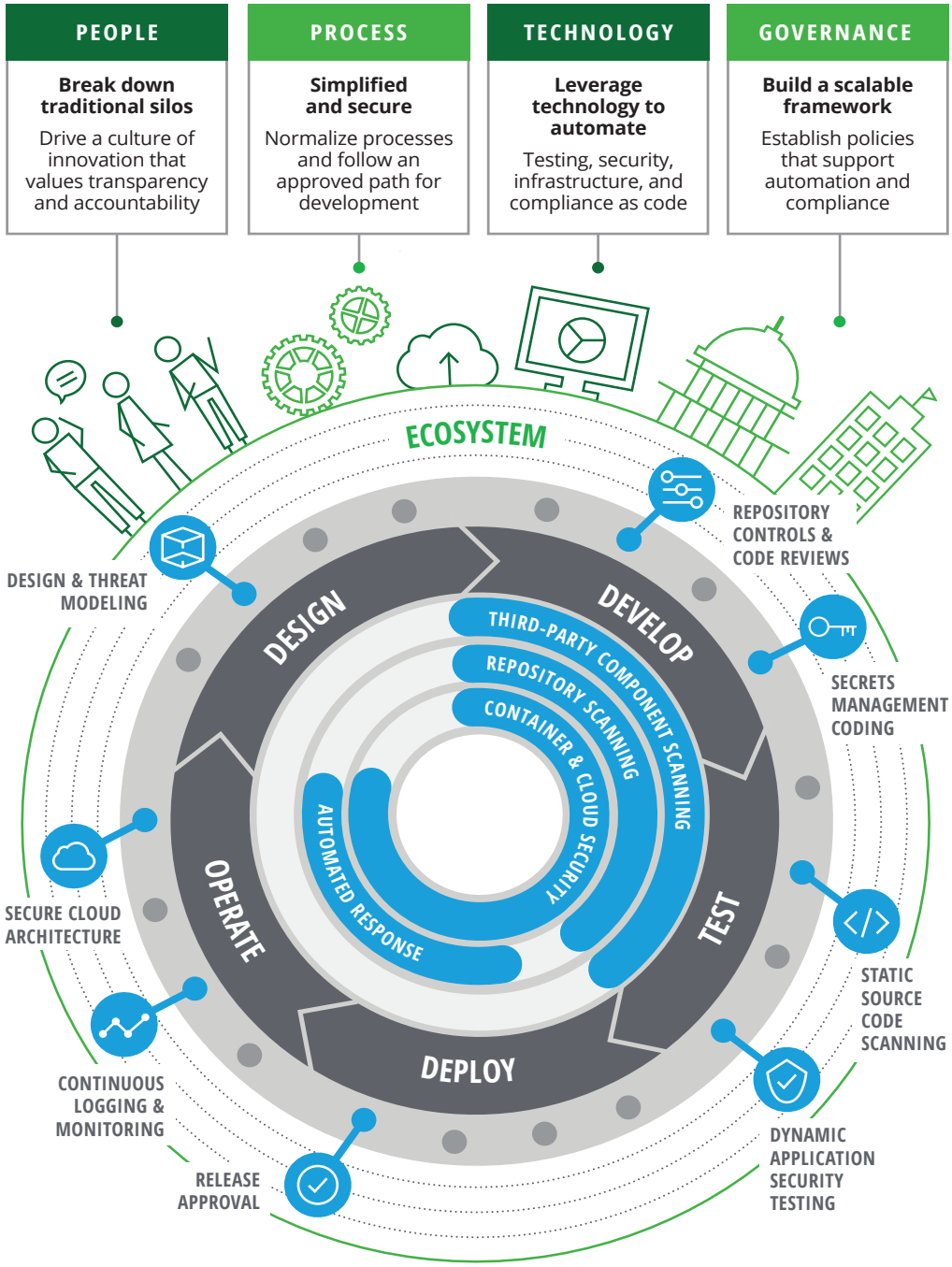
DevSecOps incorporates secure culture, practices, and tools to drive visibility, collaboration, and agility into each phase of the DevOps pipeline. Though companies can tailor their security approaches to support their own cyber agendas and product needs, DevSecOps initiatives typically rest on four foundational pillars:

- **People.** As you integrate security into your DevOps pipeline, remember that people are still your greatest efficiency (or inefficiency) asset. In the traditional waterfall model, the development, security, and operations teams are siloed. As you

FIGURE 1

What is DevSecOps?

It is a transformational shift that incorporates **secure** culture, practices, and tools into each phase of the DevOps process.



Source: Deloitte analysis.

move into the DevOps world, teams may still operate that way for a while; breaking down those traditional barriers can be the first and most important catalyst to your DevSecOps journey. Try to identify and remedy those silos quickly, create shared goals within DevSecOps teams, and drive a culture of innovation that consists of openness, transparency, ownership, and accountability. While the human resource hierarchy may remain separated, the development culture should be product-based and therefore lead by *product teams*. Each responsible party (dev, sec, ops) owns a portion of the product success.

A positive by-product of DevSecOps is that cybersecurity specialists often develop a greater understanding of development pressures and therefore drive more backend automation of security functions.

It is also important to start small. Small teams gradually come together cohesively; if successful, more and more product teams may start self-adopting DevSecOps practices across the enterprise. As you scale DevSecOps, the product teams will likely become ever more self-sufficient, identify their own security challenges, and automatically course-correct for the benefit of secure product delivery. A positive by-product of DevSecOps is that cybersecurity specialists often develop a greater understanding of development pressures and therefore drive more backend automation of security functions. Likewise, development teams with a deeper understanding of cybersecurity approaches can proactively adopt secure coding practices. The net result in both instances is increased efficiency.

- **Process.** Keeping in mind that speed and quality are key to DevSecOps, try to simplify manual processes as much as possible without sacrificing cybersecurity needs. Since development and deployment are now accelerated much faster than before, security software development processes should become more factory-like. Otherwise, efforts to exponentially accelerate secure software deployments may be unsustainable.

  Consider creating normalized development processes that follow consistent approaches. This is where the security process concept of "shifting-left" becomes important.[7] For example, try incorporating design thinking to understand customers' security needs. Implement threat-modeling storyboards into software changes to build cyber resilience into the application even before the first line of code is written. And incorporate incremental static code scanning into the integrated development environment before the application is packaged. Yes, the shift-left mentality takes a bit of extra effort upfront, but it can help prevent many more breaches waiting to happen—and a lot of product rework. In a nutshell, consider your cybersecurity requirements right away and try to move them as early into the design stage as possible, aiming to eliminate manual security "gatekeeper" delays later on.
- **Technology.** The introduction of DevOps has created a plethora of cloud-based solutions that development teams are using to speed delivery. Fortunately, cybersecurity software is now beginning to keep pace. For example, assorted pipeline tools—testing-as-code, security-as-code, infrastructure-as-code, compliance-as-code, and others—can eliminate the need for some manual security activities, thus boosting velocity. When tools such as these are implemented with the right processes, development and security teams can become more unified, defect costs can plummet, and quality can become consistent

throughout the pipeline. Consider taking an incremental approach to technology deployment, testing these new security tools with specific product teams before releasing to the enterprise.

- **Governance.** The term *governance* is broad by design, but there are two ways to think about governance for cybersecurity in the world of DevSecOps:

  - **At the micro level (the world that revolves around the product teams).** Embedding cybersecurity into DevOps can boost efficiency in governance. How? DevSecOps, by design, requires a highly consistent process that uses a uniform set of tools and automated controls. This helps simplify the monitoring and testing of required controls. In fact, by designing DevSecOps processes to accommodate the needs of compliance and control teams, you may be able to gradually automate testing processes and free up developer resources. The process of pulling a list of tickets, selecting samples, and identifying all relevant audit trails from multiple systems might have taken *days* of a developer's time. Using compliance-as-code, it can be accomplished in minutes.

  - **At the macro level.** DevOps has transformed how IT organizations work. In some companies, IT operations—traditionally comprising a mix of senior management, management, and engineers—is moving to a flatter hierarchy made up of fewer management positions supported by architects and engineers. At the same time, penalties for running insufficiently governed IT environments have grown. This means that the overall governance of the *projected* IT landscape is more important than ever before. The success of your company brand increasingly depends on products developed using DevOps.

Like any other IT program, DevSecOps should directly tie to your broader IT strategy—which, in turn, should be driven by your business strategy. If a DevOps program supports your IT and business strategies, then embed the "Sec" at the same time. In short order, it may help you bolster your cyber maturity posture and save you from having to rework your DevOps program later when it's much harder to do.

LESSONS FROM THE FRONT LINES

NOTHING TO SNEEZE AT: NIAID PRIORITIZES CULTURE CHANGE IN ITS DEVSECOPS TRANSFORMATION

LESSON ONE

The National Institute of Allergy and Infectious Diseases (NIAID) works to keep us all safe by conducting and supporting research to prevent infectious, immunologic, and allergic diseases. Within NIAID, the IT organization is working to "future-proof" itself and provide timely and secure support to researchers and staff who conduct and manage key research projects. While the agency has used DevOps to ensure faster delivery of its software solutions, its need to protect sensitive health data has resulted in a vision for automated security everywhere and led to DevSecOps—the next logical step to DevOps.

"I think of DevSecOps as three legs of a stool: management practices, technological practices, and cultural practices," says Joe Croghan, chief of NIAID's software engineering branch.[8] "The cultural piece is the most challenging, though: You ask teams for transparency, to admit mistakes, and to change continuously; it can be a lot for people to put their arms around." Croghan believes the change is vital to ensure continued productivity in the face of rapid change, and that it has enabled his team to continue to quickly respond to requests with secure products.

Long software release cycles were causing bottlenecks in delivering technology solutions at NIAID, compounding the existing challenges of the rapidly changing security landscape. Implementing DevOps practices—continuous integration and continuous delivery, automated testing, and infrastructure-as-code—has helped shorten the lead time to deliver software and to patch critical defects. Infrastructure-as-code practices reduce vulnerabilities by making some aspects of security, such as application and server configurations, inspectable. And integrating security scanning tools like Fortify into the DevSecOps pipeline stops coding vulnerabilities from getting to production in the first place.

"The challenges we've always had with security are consistency, predictability, and putting security policies into a systematic framework," Croghan says. "By implementing a DevSecOps approach, we can run scans and put specific, consistent security protocols in place. When we're using these techniques, we can be very confident in what our servers look like, and if there's a problem, we can fix it consistently by changing the code."

In the coming year, Croghan hopes to address some of the cultural and management changes that are crucial to sustaining the team's DevSecOps momentum. Staff and customers now see the value of the new approach and have been pleased with the speed of new application deployment, with the software engineering team completing more than 250 automated deployments in a month. But Croghan aspires to change the culture and do much more. "I think a year from now we will continue to adopt new technologies," he says, "but we need to change the way we work. The culture of DevSecOps is to constantly measure, reevaluate, and change." These changes include aligning behaviors by educating his staff on delivering secure code within a DevSecOps framework and exceeding his customers' expectations of software delivery, security, and velocity.

THE FDA'S PIPELINE DREAMS

Security and safety lie at the heart of everything the US Food and Drug Administration does. Each day, the agency's 17,500 employees work diligently to ensure the safety and efficacy of the United States' food supply, pharmaceuticals, medical devices, cosmetics, and more. Amid recent calls for the agency to accelerate the process by which approvals occur, teams throughout the agency are working to strike the right balance between speed and safety.

Given the criticality of this mission, the FDA needs to support the security, privacy, and stability of its IT systems at speed. To this end, the Center for Biologics Evaluation and Research (CBER) has launched an ambitious DevSecOps initiative to reengineer its approach to security throughout the product development process. Although the project is still in the early stages, its goals are clear: 1) build in security upfront rather than treating it as an afterthought, 2) automate as much as possible, and 3) transform the agency's development culture into one that emphasizes agility and speed.

According to senior IT project manager Christopher Kiem, DevSecOps represents a significant opportunity to get everyone working on the same page from the start of every project. "On day one, we want our operations talent to provide security insights and guidance to our developers in what we hope will become a loop of continuous conversation in which everyone is learning from each other," he says.

This project loop will include inputs from security automation tools as well. A static code analysis tool will scan the source code for security issues. Application scanners will review open-source library files for security issues. Upon detecting problems, all of these tools will open issues for developers and DevSecOps engineers to assess and resolve.

These and other DevSecOps tools will streamline the overall development process and accelerate the pipeline. "When project managers come up with new system requirements, critical development tools, processes, and automation will already be in place," Kiem says. "This will make it possible for project managers to make decisions quickly. Our goal is to eliminate the meetings, emails, and back-and-forth that slow people down."

Currently, the CBER is performing a modernization analysis to identify the different pieces and parts—data standards, regulatory rules, submission types, stakeholders, among others—to include in a formal game plan. This plan will also identify the DevOps elements already in place that can be leveraged. In the coming months, CBER's IT leadership will present the plan to the Center's management to solicit their input and secure their sponsorship. "Once we have backing for the project, we will begin assessing our technology needs and developing plans for putting a pipeline in place," Kiem says. "We will also be working closely with our enterprise IT partners to design a DevSecOps architecture that fills any current infrastructure gaps and supports our priorities."

The priorities to which Kiem refers are not limited to software development and enhanced product security. Indeed, with DevSecOps he sees a tangential opportunity to reengineer core systems and, in doing so, keep the agency's costs in check. "I think that across the public and private sectors, there are opportunities to decrease expenditure on IT. As you reengineer development processes to enhance security and quality, you can use this opportunity to consolidate your technology footprint. When things are humming along in a well-developed pipeline and you are releasing the products your users want, you should no longer need your less secure legacy systems, the massive suites of tools, and the time required to support and enhance them. Imagine being able to get rid of all those things—and the costs related to them."[9]

MY TAKE

ADAM BANKS, CHIEF TECHNOLOGY AND INFORMATION OFFICER AND CHIEF DIGITAL OFFICER, MAERSK

Maersk, like many other industrial organizations, has become digitally dependent—for operational efficiency and as the driver into new products, offerings, and markets. Maersk has always been a forward-looking business, but we have a heightened focus today in part because of a global cyberattack in 2017 that infected our network across ports and offices across dozens of countries. As part of the recovery, we rebuilt our core IT capability, including reconstructing server and network infrastructure, moving more than 60,000 devices to a new common standard, deploying global operating system upgrades, restoring our entire application stack, and restarting the world's most automated terminal, all in a matter of weeks. We now have one of the most standardized environments of any company in the industry—a foundation that's letting us deliver change at the pace of digital business.

Given the ever-changing cyber landscape, we're building an even more secure and reliable infrastructure that can support the future growth of Maersk. We're focusing on automated toolchains, building relevant static and dynamic scanning processes into our continuous integration and deployment processes. We've adopted post-deployment monitoring through production, and we've been able to go from writing a line of code to deploying it in production with no human touch. That's posed some interesting challenges across the organization: When do you do a product release? With such rapid churning and changing, at what point do you declare it a new version? Currently, we're spending a good deal of time exploring these concepts, making DevSecOps a core area of interest.

We've asked our CISOs to identify the gaps we have in our infrastructure as well as the compensating controls available to address those gaps. One of the main things we've done in the last two years is move the governance of risk from a central corporate function to a CISO function, so the CISO makes policy as well as enforces it. I want them to kick down the door where there's an area of the business that "doesn't have any risk," because that's just not possible. CISOs work with business owners to make deliberate decisions, and business owners can decide how to address the existing risks when they are contained within their functional geography. It's a consultative approach, but it's consultation with teeth.

To that end, our CISO may not be a standing member, but there's not a quarterly audit committee meeting where he's not on the agenda. At our supervisory board, every other update has some cyber topic associated with it. We show the board a funnel diagram representing the number of attacks on the external surface, the penetrations, all incidents, and then the major incidents—not to show them what we are doing but, rather, to demonstrate that our processes are working. We want them to understand that if the external surface attacks go from 200 to 800 a week, they should be asking us questions; if they see an increase in those that are penetrating, we want a dialogue to ensue about how we can handle the uptick. We want non-technologists as well as IT leaders to understand there is a minimum level of control and recoverability that should be in place if and when we fail to stop a future attack. With their support, we can control the amount of damage done and speed our recovery.

In this environment, I don't think it's an either/or approach when it comes to traditional waterfall development, DevOps, integrated toolchains, and agile delivery. We still organize our people under traditional plan-build-run structures, with functional homes organized around technology or IT life cycle capabilities. But we deploy our people in a DevSecOps model aligned to products, platforms, and initiatives. This enables all areas of the business to gain from improvements in any area, across all activities. Without a functional home for people to return to, you're constantly churning people and process, which means you're failing to improve them each time. For example, I don't want every one of my global teams solving for automated regression testing.

So we implemented a center of excellence that provides team members the tools, thinking, and models they need to complete their tasks. This model has allowed us to increase in maturity and capability, while deploying applications in a more modern, diverse fashion.

This model only works, however, if everyone around the leadership table understands the inherent value in the technology organization. Maersk is a digital business, and we are incapable of operating if the technology does not work correctly, so our business leaders need to understand what's at stake. You need a degree of trust, openness, and desire in all the players around the table to play as a single team. I knew we'd achieved that at Maersk when I proposed a reduction to the technology budget and my peers argued against the notion, fearing we'd miss out on too much value. I think that's the target for which we're all aiming for: complete understanding of how security and DevSecOps can impact business outcomes.

My goal is to have anyone around the executive table capable of leading the technology function in a few years. This would reflect that operations and the underlying technology stack have stabilized, and that the business leaders are tech-savvy enough to step in and lead the charge. But the real test will be if they strive to take roles in which technology enablement responsibilities are as recognized and as important as leading sales or a line of business. We're well on our way.

MY TAKE

WES HUMMEL, VP OF SITE RELIABILITY ENGINEERING, PAYPAL

For PayPal, with more than 254 million active account holders and over 7.5 billion payment transactions in 2017, security and trust are central to everything we do and what our customers expect. As such, we treat security as a strategic business priority and a fundamental part of how we develop, release, and maintain our product code, integrating it by default into every layer, throughout the entire development life cycle.

For me, DevSecOps means not only empowering our developers with the tools necessary to develop high-quality, secure software, but also creating a culture that builds secure products by default. With our company, customer base, and transaction volume growing so fast, we need security at scale: As of 2017, PayPal had 4,500 developers, 50 million lines of code, 1 million builds per month, 2,600 apps, nine availability zones, 230 billion hits, and 42,000 batch executions per day! We give developers as much control as possible over their code and its outcomes to help them achieve this scale. When you offer developers flexibility and autonomy, it is important to build a talent base that lives and breathes your security mantra. We've worked to create a culture in which developers understand that successful products require an equal appreciation of development, security, and operations. That's been our journey: to meet security, availability, and quality needs while enabling high-velocity code releases.

We adopted an agile methodology at the start of our journey, and we're currently transitioning to DevSecOps. We try to find balance between development and operations by providing tools that make every step—from ideation to releasing code—frictionless for developers. We empower them with the freedom to use our recommended tool suite, the "opinionated path," which includes security penetration testing, auto-enabled security controls, threat modeling, automated scanning, and other features. But we also believe developers shouldn't be forced to use a specific tool suite, so we give them the autonomy to follow an un-opinionated path and bring their own stack. We provide the tools and processes they need to deploy code while meeting our security, availability, and quality standards. This way of working under a DevSecOps framework is resulting in better performance and productivity for our developers. We are also seeing a reduction in potential vulnerabilities and improvements in maintaining product security standards—a result of ingraining risk-based thinking and processes within the DevOps pipeline.

Our primary focus now is to stand up an autonomous fleet of development, operations, and security tools that we can maintain virtually hands-free. There's tremendous value in being able to run scans and end-to-end tests on a minute-by-minute basis, deploy patches through automation, identify potential vulnerabilities at regular intervals, and ensure that applications are meeting standards, including configuration changes or vendor interface updates in production. Automating these processes is key for scaling a 200,000-plus-node fleet with speed and consistency while holding all deployments and processes to the same security and quality standards.

Our security and compliance automation have been helpful in related areas, as well. Our focus on automation has made it easier to address the complexities of legal and compliance obligations and policies, given that we operate in more than 200 global markets. With the nature of our business, security and trust will remain a core capability and priority for PayPal. It doesn't matter what size company you are—if you build in security at your core, it will serve your business well.

ARE YOU READY?

Embedding security into DevOps pipelines may initially seem like a straightforward proposition. After all, if DevSecOps is just a way of thinking about security, then deploying it in your DevOps factory should be a light lift, right? For those few who have fully mastered DevOps, perhaps. For everyone else—and that is most organizations—developing DevSecOps practices will likely be another component in existing DevOps initiatives that are still in early stages. For example, in its *2018 Global Developer Report*, GitLab surveyed roughly 5,300 IT professionals about their DevOps experiences. Thirty-five percent of respondents said the DevOps culture at their companies was "somewhat established." Only 23 percent of those surveyed would go so far as to describe their development method as DevOps.[10]

As you explore DevSecOps opportunities, ask yourself the following questions not only about security but about how they may affect your current DevOps efforts.

- **Will I have to hire developers with security expertise?**

  Not necessarily. First, work to turn the combined knowledge of the security expert and the developer into code. Next, upskilling existing talent may be the only viable staffing option as the *DevSecOps* trend progresses, but it allows you to retain important business knowledge gained over the years from each respective area. Besides, developers with security expertise (and vice versa) are in high demand right now and increasingly hard to recruit (and keep).[11]

- **Won't DevSecOps slow down my pipeline?**

  Probably not. Granted, if you had no security controls prior to DevSecOps, there will be some efficiency trade-off, but DevSecOps provides two major efficiency benefits: 1) Incorporating security into a DevSecOps pipeline still results in a faster pipeline than the waterfall method, and 2) DevSecOps gets faster as time moves forward because vulnerabilities are mitigated over time and efficiency increases. Developers also gradually gain more freedom and autonomy to move product through the pipeline because of automated controls.

- **Can DevSecOps be compatible with my compliance requirement?**

  Yes—if anything, it helps ease the burden of maintaining compliance. In an ideal DevSecOps state, security auditing, monitoring, and notification are fully automated and continuously monitored, enhancing compliance.

My DevOps process is still immature. How can I make sure that my DevSecOps governance is scalable?

Plan, storyboard, and start small. Sustainable and scalable DevSecOps governance models typically feature the following components:

- Clearly defined roles and responsibilities in all *cross-functional* teams
- DevSecOps-specific policies and procedures that enable organizations to keep up with the pace of application development in a DevOps environment
- Automated security tools throughout the pipeline that reduce vulnerabilities and the lower the frequency of human error
- Security monitoring and notification systems in DevSecOps that create automated audit trails throughout the software development life cycle—which, in turn, facilitate compliance reporting
- Continuous monitoring of security metrics, which helps DevOps teams constantly improve their security decision-making

BOTTOM LINE

The ever-growing need to get quality products out the door faster has elevated DevOps practices to the position they hold today in the arena of software development. In a natural extension of DevOps evolution, the DevSecOps trend offers CIOs and their development teams a new mix of tools, practices, and automation that, deployed in concert, can help secure development and operations.

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Beyond the digital frontier: Mapping your future

Digital transformation demystified

DIGITAL TRANSFORMATION HAS BECOME A RALLYING CRY FOR business and technology strategists. To those charged with mapping the future, it promises a triumphant response to the pressures and potential of disruptive change. Yet all too often, companies anchor their approach on a specific technology advance. To fuel impactful digital transformation, leading organizations combine technology with other catalysts of new opportunities—from emerging ecosystems to human-centered design and the future of work. Why? Because the technology trends that inspire digital transformation efforts don't take place in a vacuum. They cross-pollinate with emerging trends in the physical and social sciences and in business to deliver unexpected outcomes. Developing a systematic approach for identifying and harnessing opportunities born of the intersections of technology, science, and business is an essential first step in demystifying digital transformation, and making it concrete, achievable, and measurable. It is time to move beyond the frontier of random acts of digital.

Digital technology is now so ubiquitous and affordable that many people are using it with little or no learning curve to create new business models and pursue opportunities that never existed before. Its influence spans industry, geography, cultural, and demographic boundaries. We use digital in our personal lives to entertain ourselves, schedule our days, and stay connected with friends and family. In business, it expands capabilities and disrupts sectors and business models. In broader society, digital is reengineering the way government works—and is redefining cultural norms.

But what exactly is digital? And how does one reconcile its formidable potential with the hyperbole and empty rhetoric often used to describe it? In corporate boardrooms, *digital* has become an umbrella term for any strategy that uses innovations to drive disruption and new opportunities. In IT organizations, CIOs and their teams define it in terms of specific technologies. In this final chapter

Only 1/3 of Deloitte's *2018 global CIO survey* respondents reported having an enterprise digital strategy.

of *Tech Trends 2019*, we will try to unpack this often-misunderstood term—and discuss how using more precise verbiage, adopting disciplined approaches, and making investments with a bounded scope and measurable outcomes can help transform your digital efforts from explorations of shiny emerging technology into long-term strategies that inspire confidence.

Let's start with the word *digital*. Seasoned technology veterans often bristle at the way this term was co-opted in the early 2010s and used as shorthand for emerging channels such as mobile, social, and the evolution of the web. Soon mobile app development, responsive web, social listening, and even cloud were flying the digital flag. Yet savvy organizations realized that this was an artificial construct that obscured digital's real value proposition: the use of emerging technologies to reimagine the entire business.

Today, we refer to the pursuit of that business-critical value proposition as *digital transformation*. Simply put, digital transformation is the process of future-proofing one's organization. It typically begins with leaders and strategists defining new ambitions—often in the broadest of terms. They frequently cite high-profile examples of how companies used digital innovation to disrupt established markets and business models: Netflix in video rentals; Amazon in bookselling and then mass retail; Airbnb in the hospitality industry. The list goes on. As callouts in keynote speeches, these examples are useful. But digital transformation can and should be just as concerned with modest and immediate ambitions as it is with broadly reimagining the future. For example, reengineering individual business units and processes, or creating opportunities for specific products and customers can have a more immediate impact on long-term competitiveness. By adopting a strategy of putting smaller, more tightly scoped offerings into the market quickly and successfully, organizations can incrementally achieve an end-state business ambition.

The mistaken belief that digital transformation requires a grand, enterprise-encompassing vision causes a fair amount of consternation among technology leaders, largely because so few organizations have one. In Deloitte's *2018 global CIO survey*, only one-third of the 1,400 executives surveyed reported having an enterprise digital strategy.[1]

What's more, many of those with digital strategies in place have made only minimal progress executing them. Recently, *MIT Sloan Management Review* and Deloitte surveyed 4,300 managers and executives globally to learn more about their digital journeys. Only 30 percent of respondents said their digital transformation journeys were "maturing." The rest described their efforts as being in the "early" or "developing" stages.[2]

But there is hope. By following a more prescriptive approach to shaping their ambitions, organizations can focus their digital efforts with precision while building an engine for bringing digital products and services to market rapidly and at scale. Over time, successfully realized digital ambitions—each with a positive income statement—will grow in number and ultimately make an enterprise-wide impact. This is the secret to the digital success stories we showcase throughout *Tech Trends 2019*, from the investments Walmart is making as it thinks more like a startup,[3] to Maersk's development of a new digital backbone,[4] to Anthem's move to a platform-based AI engine and beyond.[5] It can work just as effectively in organizations of different size and scale, and in different industries, operating across the globe.

Driving catalysts to market

Discussions of digital transformation frequently begin and end with technology. Although emerging technology does play a critical role in transformation strategies, it should not be the center of the universe upon which the entire conversation is anchored. There are other crucial drivers to consider. One common characteristic of the organizations we have spotlighted in this report is their ability to apply technology advances to their pursuits of new opportunities, whatever those opportunities may be. We've seen Pfizer take this approach with its finance organization,[6] Cargill with its IT function,[7] and Nationwide with its marketing mission.[8]

In the context of digital transformation, we describe technology advances that companies use to turbocharge their pursuits of new opportunities. Like their chemical counterparts, these technology catalysts can amplify and accelerate reactions without being consumed by them. The following seven digital transformation catalysts warrant exploration:

- **Connectivity.** Think of the ecosystems, competition, and new market dynamics that could develop among established and emerging players. Explore concepts of *borderless* and *boundaryless*—how new combinations of evolving actors across industry, sector, government agencies, functions, departments, and market segments could create value through sophisticated models of collaboration and competition.
- **Experience innovation**. This powerful catalyst involves taking a human-centered approach to designing and reimagining experiences across touchpoints with all key stakeholders, including customers, citizens, employees, business partners, prospects, recruits, and ecosystem players.
- **Cybersecurity.** How can modern approaches to security and privacy advance your pursuits of new opportunities? The cybersecurity catalyst becomes even more relevant as you develop new assets, repurpose legacy assets, and expand trust zones. New approaches to cyber include protecting potentially valuable intellectual property and customer and employee information, putting in place mechanisms for vigilance to detect threats and changes to risk profiles, and deploying resilient responses in case of incidents.
- **Risk.** This catalyst focuses on understanding, navigating, and potentially shaping external regulations and evolving statutes. It also involves exploring scenario planning and evolving strategic responses to operational and financial risk, geopolitical stability, and macroeconomic forces. Increasingly, risk approaches also take into account potential ethical and social ramifications of investment and innovation priorities.
- **Real-time data intelligence.** Strategy-focused organizations now consider data an elemental value driver in the new world order. Harnessed as a digital catalyst, it can provide a competitive edge to organizations that can analyze divergent data sources and streams in real time, and disseminate critical insights seamlessly within and across organizational boundaries.
- **Automation.** As the traditional workplace boundaries between human workers and machines blur, organizations should reevaluate which jobs and skills they will need in their digitally transformed operations. They should also determine whether there are alternative ways to achieve desired outcomes. Increasingly, automation is becoming one of the main alternative levers that organizations can use to achieve those outcomes while at the same time modernizing their operations and fundamentally transforming how work gets done.
- **Game-changing technology.** In a way, this last catalyst is the spiritual home for everything we discuss in *Tech Trends 2019*. As you create a road map for using game-changing digital technologies to transform your enterprise, use the opportunity to eliminate the divides that have long existed between information technology, operational technology, and product technology. Together, these three areas comprise the game-changing technologies that serve as your organization's digital backbone.

Technology horizons

As this is a report on technology trends, let's double-click on the *game-changing technologies* catalyst. Digital transformation strategies should extend across time horizons, taking into account today's possibilities, those coming soon, and those that may emerge farther down the road. *Tech Trends* has always focused on a sweet spot that we call "horizon 1.5": the technologies and opportunities that we expect to mature in the next 18 to 24 months. These innovations are undoubtedly important, but without the proper context they can look like a parade of shiny objects. In chapter 1, we provide some of that needed context with our discussion of fundamental technology forces past, present, and future.[9] The foundational role these macro forces play in digital transformation is important, but it is only part of the contextual story. Another part is the advancements taking place now in research, science, and applied technology. We don't know when these efforts will bear fruit, but it's safe to assume that when they do, the impact could be profound.

There's a clear need for a unified view of the landscape of potential technologies, organized by both the macro forces described in chapter 1 and by their relative horizons of influence. The construct in figure 1 is neither exhaustive nor gospel truth, especially since the timing can vary widely by use case and scenario. But it does convey our confidence that in a world of seemingly infinite unknowns, it is possible to focus attention on a meaningful collection of known technologies and catalysts that, taken together, can help you shape your ambitions, focus your investments, and chart a path to tomorrow. While the trends, technologies, and catalysts listed do not form a definitive recipe for success, it's key that they—like the macro forces and trends discussed in this report—are important and *knowable*. Looking beyond the digital frontier involves thinking more broadly, both in the present and in the future, to give yourself an advantage that you do not have today.

Playbook for reinvention

The stage has been set. The directive is clear. Now what? Leading organizations are adopting a repeatable, disciplined approach to make digital transformation real. Importantly, their goal is not about creating glorified proofs of concepts or spinning up random acts of incremental digital to substitute activity with progress. Indeed, they are working to inspire new opportunities and launch offerings into the market rapidly, successively, and at scale. Along the way, they will be laying the foundation they will need to *imagine, deliver,* and *run* the future.

- **Imagine.** The first step is getting the right focus, quickly setting ambitions, and charting a path to success with a deliverables road map. This process involves sensing, scanning, and scouting the market to uncover trends and establish the initial hypothesis of potentially untapped or trapped value. That value can exist anywhere along the scale of use, from improving the *way* you do business, to completely rethinking the businesses you are in. Linking value to offerings that are used in the market is a key next step. Iterations are measured in days, putting in place a new cadence for "enterprise agility," and helping set the pace for a new way of working. User journeys, customer stories, and moment maps bring to life new ideas, along with immersive labs to showcase the potential of new technologies and techniques. The road map should light up relevant in-flight initiatives, allowing disjointed, disparate pilots to be shown as part of one unified ambition that the entire enterprise will share. Importantly, as you imagine the digital transformation path ahead, you should also consider the impact new ambitions, technologies, and offerings may have on your current and future talent models (see sidebar, "Group loops and the future of work.")

- **Deliver.** The next step requires getting the concept right—and putting your ambition in motion by moving from early ideas to fully tested, refined, and validated offerings rolled out to live concerns in the market or the enterprise. Customer and employee ethnographic research can help shape the effort, as can a consistent approach to distilling ideas into the products and services, and the enabling capabilities required. There are two other components that are essential at this stage: a digital foundry for agile delivery of new technology and product teams focused on preparing existing core systems, data, interfaces, and operations for the reimagined offerings.
- **Run.** Some digital initiatives overlook one of the most important aspects of digital transformation: how to scale and then support fledgling ideas and innovative new offerings. As we examine in the *NoOps in a serverless world* chapter, designing autonomics and platform architectural principles into new solutions is a good first step.[10] But to consistently achieve scalability, it is important to establish common standards for product scalability and support across all dimensions of a digital transformation effort. This can help all teams align on a common terminology approach, whether they are focused on marketing, end-user support, release planning, or developing mechanisms to measure value and return. Keep in mind, however, that as your organization's road map expands and you stand up additional teams, you should continue to enforce common standards and approaches in order to maintain architectural and platform integrity across agile design and development efforts, and in all platform dependencies.

The key is to iterate rapidly through these facets to get offerings into the market as quickly as possible. As the road map expands, more of the technology portfolio can adopt the *imagine-deliver-run* construct, leading to a broader footprint across the organization and a corresponding shift in cultural dynamics. Remember, your goal should not be simply exploring or transactionally doing but, rather, embracing and embedding the digital mindset into business, operating, and customer models.

GROUP LOOPS AND THE FUTURE OF WORK

Any discussion of digital transformation's role in your company's future inevitably turns to its impact on human workers and legacy talent models. What role, if any, can humans play in a world of robotics, artificial intelligence, and machine learning? As it turns out, the roles that individuals *and groups* will play as their companies move beyond the digital frontier will likely be as important as ever.

As examined in a recent ***Deloitte Review article*** on human-cognitive collaboration, companies increasingly recognize that cognitive technologies are most effective when they *complement* humans, not replace them.[11] Manufacturers such as Airbus and Nissan are finding ways to use collaborative robots, or "co-bots," that work side by side with workers in factories.[12] Amazon now has 100,000 robots in operation,[13] which has shortened training for holiday workers to less than two days.[14]

Moreover, there is a growing recognition that some cognitive tools require human oversight. The need for human involvement complicates the widely held view that AI, for example, will automate everything. If anything, humans and their innate skills seem to be growing *more* important as the need to devise, implement, and validate AI solutions becomes widespread. Indeed, despite the recent surge of interest in AI, automation, and robotics, respondents to Deloitte's ***2018 Global Human Capital Trends survey*** predict tremendous future demand for human skills such as complex problem-solving (63 percent), cognitive abilities (55 percent), social skills (52 percent), and process skills (54 percent). While 65 percent also predict strong demand for technical skills, research shows that the technical skills to create, install, and maintain machines account for only a small fraction of the workforce.[15]

Understanding the unique capabilities that machines and humans bring to different types of work and tasks will be critical as the focus moves from automation to the redesign of work. Leading organizations are working hard to put humans in the loop: rethinking work architecture, retraining people, and rearranging the organization to leverage technology to transform business. The broader aim is not just to eliminate routine tasks and cut costs but to create value for customers and meaningful work for people.

And not just individuals. In a recent interview in *Deloitte Review*, Thomas W. Malone, founding director of the MIT Center for Collective Intelligence, says that the idea of putting "humans in the loop" typically assumes that computers will be doing most of the work, which is not the most useful way to approach the issue. Humans working together in groups—for example, companies, armies, or families—are responsible for the greatest achievements in history. "So rather than start with the 'human-in-the-loop' concept of one person, one computer," says Professor Malone, "let's start with the human groups we've used to accomplish almost everything and add computers into those groups. When we do that, computers can use their specialized intelligence to do the things they do better than people; and people can use their general intelligence to do everything else. In other words, we need to move from thinking about 'humans in the loop' to 'computers in the group.'"[16]

OPPORTUNITY ON THE HORIZON

LET'S EXPLORE HOW TWO BUSINESS TRENDS CAN BE REALIZED THROUGH A COMBINATION OF TECHNOLOGIES AND MACRO FORCES.

ADVISER APPS AND THE FUTURE OF MOBILITY

Today, ride-hailing companies act as network orchestrators, connecting people requiring a service with those offering that service. Yet in the near future, applications that aggregate and analyze transportation information from a broad array of service providers will likely advise individuals about their options for moving from point A to point B. For example, a mobility-advisor app might coordinate ridesharing among friends, neighbors, or those connected through social media. Or it could provide integrated location, pricing, and scheduling functionality for car-, bicycle-, and scooter-sharing services, or public transport.

These and a host of other possibilities offer a preview of what the future holds for mobility—and the role digital transformation will play in that future. As more organizations begin to set up digital mobility infrastructure, develop and test autonomous technologies, and reengineer the in-vehicle experience, it appears likely that an integrator will emerge to connect autonomous vehicles and other modes of transit to the end consumer.[17] In the near future, fully realized *mobility adviser applications* may be able to deliver a seamless intermodal transportation experience, providing easy access, exemplary in-transit experience, a smooth payment process, and overall customer satisfaction. These adviser apps could take into consideration customer preference, traffic data, and other circumstances to arrive at the most convenient and cost-effective mobility plan—whether that entails a shared car, a train, a bike, or a combination of them.

There will likely be both customer-facing and asset-owning dimensions to mobility management. And while the two roles are distinct, in practice a company could fill both of them simultaneously. The mobility adviser directly interfaces with the customer, who will expect a customized experience that relies on the adviser app's ability to execute trip planning, adjust routes to allow for traffic and disruptions, and handle payments. A variety of technology companies that collect consumer business data (for example, venue information and activity information) could work with the mobility management companies and end-consumer businesses to enhance the user's experience. Social networks may further enhance the user experience by suggesting consumer preferences to shape the journey. And navigation providers will look to optimize routes using prime data from environment and weather companies.

For companies working in the current horizon to deliver the future of mobility, that means developing:

- **Mobility data collection.** This enables tailored route suggestions, including the ability to store and access vast amounts of information safely and reliably. Sensors can collect information on everything from intersection status and traffic jams to travel time measurement and CO_2 emissions. Value to the user will likely come through the integration of this information into smarter route suggestions.
- **Predictive analytics.** This technique can be used to match user preferences with travel recommendations. Mining vast quantities of real-time data on the environment as well as user habits will help orchestrate a seamless flow across the ecosystem.
- **User control.** This includes design and deployment of intuitive customer interfaces, although

the proliferation of apps may find this capability dispersed among the users themselves.

- **Automated procurement, vehicle tracking, and smart routing/scheduling.** This can help fleet operators deploy a range of vehicles to match user preferences, manage vehicle upkeep and storage, and autonomously match supply to demand.[18]

These and other *future of mobility* technologies will be grounded in many of the catalysts that drive digital transformation. For example, mobility adviser applications will create networks of transportation resources whose real-time interactions are made possible through advanced connectivity. Real-time data intelligence gleaned from divergent data sources will act as the lifeblood of mobility systems. And, of course, new approaches to cybersecurity will be critical as user data volumes grow dramatically and mobility networks redraw the boundaries of vendor and user trust zones. Experience innovations will offer highly personalized user interfaces and interactive digital capabilities that meet and anticipate unique user expectations. For example, your mobility adviser should be able to offer tailored route recommendations based on your travel history, current conditions (traffic, weather), time of day, and pricing preferences. Working with retailers, they could suggest stops along the way based on your preferences and offer targeted ads and coupons ("Your favorite coffee shop is just a three-minute detour away. Here's a coupon for $1 off. Would you like to stop?").

In the two-to-five-year time horizon, edge computing could be crucial for matching real-time supply (buses, rideshare vehicles, bikes) with demand (consumers). To the extent that mobility advisers can gather data and perform predictive analytics closer to the source, they may be able to provide a superior service (faster response times to consumers) and more efficiently manage the overall network. Facial recognition and biometrics could enable seamless ticketing across different modes of transportation, as well as access to shared driverless vehicles. Finally, smart contracts could be used to maintain multiparty relationships with the various mobility providers on the adviser's platform (rail operators, e-scooter services, ride-hailing providers, etc.), establishing the terms and conditions of participation and payment.[19]

CARE TRAFFIC CONTROL AND THE FUTURE OF HEALTH

The health care industry exemplifies how future-focused organizations can move beyond the frontier of technology hype by deploying disciplined digital transformation strategies.

The challenges and annoyances that many patients face as they seek medical care seem all too familiar. Long waits for appointments, frustrating registration procedures, gaps in care, unclear post-visit treatment plans—these and similar inefficiencies often conspire to make patient journeys feel like obstacle courses. Among numerous operational challenges fueling these inefficiencies is managing the volume of human and material resources required to provide effective patient care. Because actionable statistics on how these resources are deployed are often scarce in hospitals, clinics, and physicians' offices, improving utilization, shortening turnarounds, and lessening caregiver downtime can be daunting tasks.

The good news: The health care sector is poised to embark on a far-reaching digital transformation journey that could help providers reduce chronic operational inefficiencies and optimize the use of expensive resources. In one approach that is gaining traction with some providers, a care traffic control (CTC) platform uses cognitive analytics to monitor operational and performance data in real

time, predict risks, and recommend turnarounds. For example, it can predict congestion and make recommendations to certain front-line clinicians to prioritize discharges.

The CTC platform, which replicates best processes used in hotels and airlines to increase capacity and reduce variability, monitors data continuously to optimize the flow and utilization of resources. Importantly, the CTC system can coordinate moving parts to reduce operational variability before, during, and after patient visits.

- **Before the visit.** In some instances, physicians will be available to provide patient care remotely using telemedicine systems, eliminating the need for some patients to visit hospitals.

  Patients will be able to fill out short algorithmic questionnaires, helping clinicians proactively address concerns and determine whether a patient needs to schedule a visit with a physician. Nurses can then interpret results and triage accordingly. If a patient needs to come in, the clinician has more information available, reducing the amount of time needed for the visit.

  Meanwhile, some patients—particularly those requiring door-to-door assistance, wheelchair-accessible vehicles, and stretcher rides—may miss medical appointments because of transportation issues. With a CTC system, these rides, whether on-demand or scheduled, can be efficiently coordinated and integrated into workflows—for example, authorization, care coordination, and billing.
- **During the visit.** Once a patient is registered, a sensor-driven experiential wayfinding application on her mobile phone guides her from registration, to exam rooms, to labs and pharmacies, then back to her car. Along the way, the hospital might also use the patient's location within the care facility to initiate key operations. For example, when the system detects that a patient has entered the parking lot, it alerts the pharmacy to prepare an infusion kit, reducing clinician downtime and patient waiting time.

  Some patients may be at risk for exceeding their expected length of stay simply because they have not received the proper ancillaries, such as blood work or imaging. A care traffic control system can nudge clinicians and administrators via text or some other modality to prioritize ancillaries for patients scheduled to be discharged soon.

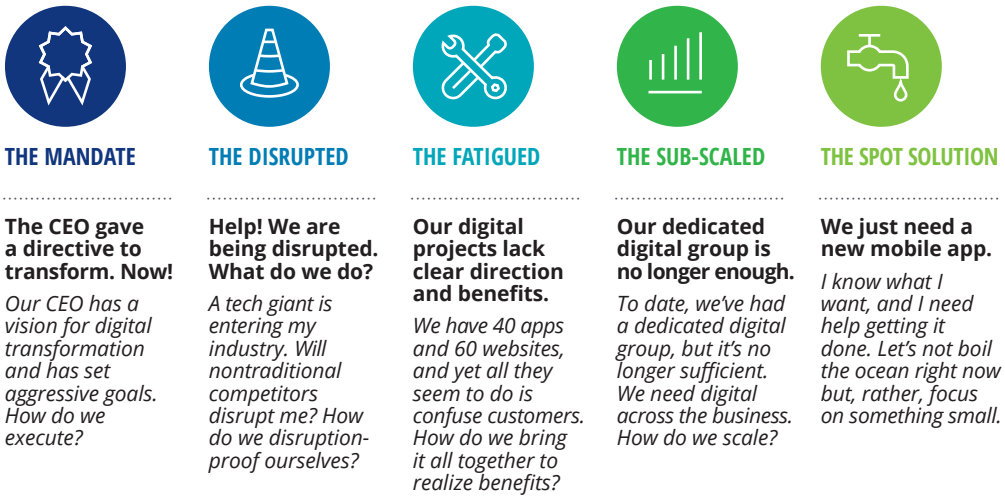
  During flu season, hospital emergency departments can quickly become overwhelmed by patients seeking treatment. Advanced analytics that leverage third-party data sources such as public health data or online searches can help predict surges in flu cases and accelerate discharges or transfers of noncritical patients from emergency care to accommodate a surge.
- **After the visit.** Positive outcomes often depend on patient adherence to treatment plans. Yet some treatment regimens can be complex and difficult to follow. In the near future, clinicians may use prescriptive analytics to analyze each patient's individual risk propensities—for example, medical history or social determinants—to determine whether that individual might struggle to follow post-discharge treatment plans. For those who are at risk, clinicians will be able to monitor patients more closely, personalize some treatment regimens to mitigate risk, or intervene as needed. A number of technologies might come into play here. Care-plan navigation tools might alert caregivers if a patient misses a treatment step. These tools range from mobile applications that guide patients through their regimens to chatbots that follow up with patients to identify why they missed the step, and offer guidance on how to get the treatment plan back on course.[20]

ARE YOU READY?

Clearly, there is a need to move faster, be bolder, and to elevate the concept of *digital* from empty wisdom to actual investments. Yet despite this strategic urgency, digital transformation efforts can lose momentum for any number of reasons. Many organizations don't feel confident they can execute against the digital agendas they develop. In the MIT/Deloitte survey, respondents cited risk aversion, ambiguity brought on by constant change, and buying the right technologies as among the biggest challenges affecting their companies' ability to compete in a digital environment.[21]

FIGURE 2

How do you feel about it?



Source: Deloitte analysis.

What does it take to succeed? Certain behaviors, attitudes, and actions can make the difference between a successful transformation and another shelved initiative:

- **Think exponential.** Set bold goals, and then work steadily to achieve them. Along the way, if you fail, fail fast and maintain your momentum. Eventually, bold goals become even bolder achievements.
- **Create agile execution.** Learn to develop and try ideas in short iterative sprints with empowered teams. Treat digital initiatives like R&D. *Agile* means more than a software delivery method—embrace enterprise agility in its fullest form.
- **Acquire capabilities to catalyze the culture.** M&A, partnerships, co-investment techniques, and creative hiring of edge teams can introduce new sparks of ideas and stem cells for needed expertise, especially in areas such as design thinking, creative skill sets, and emerging technology.

- **Protect the people.** Ring-fence digital teams from layers of bureaucracy, policies, or other compromises not found in a startup culture.
- **Build an inspiring environment.** Developing ideas that will fundamentally change your business is hard in a cubicle farm or windowless meeting room. A dedicated space that is flexible, open, and encourages collaboration helps bring out the best in your people.
- **Put the customer first.** Don't compromise on the customer experience. Make customer value and delighting the customer the number one priority, even for back- and mid-office-focused initiatives.
- **Stay open to change.** Beware institutional inertia and the status quo. Some of the most steadfast, seemingly immutable aspects of your business may be prime candidates for reinvention. New opportunities require an openness to ways of thinking and doing that can challenge the accepted wisdom of how things "should be done." Encourage all stakeholders to think beyond their silos, channels, and current market perspectives. Broader changes to your organization, processes, and platforms may be needed for maximum impact.
- **Design creatively.** Design thinking with an emphasis on human-centered experience is the new differentiator in digital and in business. Invest accordingly.
- **Focus on value.** Don't get distracted by digital shiny objects. Focus on revenue, key metrics, and follow the money. Dismiss ideas that digital transformation is beyond measurement and accountability. Embrace ideas that lend themselves to tangible, material, measurable results.
- **Leadership mandate.** Executives should be engaged in the definition, oversight, and communication of a vision and strategy. Moreover, they should empower teams to make decisions, giving them enough autonomy to experiment—and even fail-to-learn when needed.

When it's time to roll up your sleeves, IT and the business should work together to decide what technologies are needed across the enterprise and ecosystem. IT should make sure that technology decisions and innovative thinking can be scaled with minimal risk. Likewise, experienced technology professionals should confirm that the company's core systems can support a new technology before enthusiastic stakeholders enter into a licensing agreement. It's not enough to imagine a new tomorrow. You have to get there from the realities of today.

BOTTOM LINE

Mapping your digital future is no small order. But if you can be deliberate about sensing and evaluating emerging technologies, considering the nontechnology forces unlocking new opportunity, and creating a series of well-defined but aspirational ambitions, you can make the unknown knowable. And this can create the confidence and construct to embrace digital, while setting the stage to move beyond the digital frontier.

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