

Tech Trends 2016

Innovating in the digital era



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Introduction



In a business climate driven by powerful digital forces, disruption, and rapid-fire innovation, *every* company is now a technology company. Whereas technology was traditionally confined largely to operations and execution, its digital expression now informs all aspects of business, from ideation to delivery. We witness daily how it drives product design, upends venerable business models, and rewrites competition.

The ascendance of exponential technologies to a place of strategic primacy has occurred within a turbulent context. Globalization is driving borderless growth across established and emerging markets. Barriers to entry are being lowered, if not demolished. In this climate, new entrants focused on niches, specific functions, and overlooked domains can make meaningful impacts on a global stage traditionally dominated by the world's biggest players.

At the same time, customers are demanding evolved methods of engagement that are personalized, contextual, and tailored for individual usability and utility. Likewise, the very nature of employment is evolving as new skill sets become bargaining chips. Talent scarcity complicates efforts to rethink operating and delivery models across functions and domains.

To help make sense of it all, we present Deloitte's seventh *Technology Trends* report, our annual in-depth examination of eight trends that are likely to disrupt businesses in the next 18–24 months. From blockchain and augmented reality to the Internet of Things and the socially responsible applications of technology, these trends embody the macro forces fueling innovation: digital, analytics, cloud, and the changing role of IT within the enterprise. We balance our coverage of each trend by also considering the implications of cyber risk in the areas of security, privacy, regulatory mandates, and compliance. We intentionally examine cyber risk not as a separate topic, but as an enterprise discipline embedded in the planning, design, and realization of each individual trend.

The theme of this year's report is *innovating in the digital era*, which is inspired by the opportunities today's CIOs—across industries, geographies, and company sizes—have to shape tomorrow for every corner of their organizations by transforming “business as usual.” These leaders are in a rare position to imagine a future, and then harness innovation to build it responsibly from the realities of today.

Tech Trends features perspectives from client executives, industry and academic luminaries, and our global network of Deloitte professionals, all exploring major trends that are helping organizations innovate in the digital era. We also examine the roadmaps and investment priorities of start-ups, venture capitalists, and leading technology vendors.

As you read the following chapters, we challenge you to think beyond the “what” of digital innovation—the shiny objects, applications, and capabilities—to the “so what”—how you will harness emerging trends, innovation, and disruption to create real business value. Viewing the horizon through this paradigm, recognize that the precision to which we’ve all become accustomed may no longer be a given; in the age of digital innovation, we are exploring largely uncharted territory. Moreover, any digital transformation journey should also address the more practical realities of today—reimagining core systems, industrializing analytics capabilities, building autonomic platforms—which are by no means trivial.

Over the next 18–24 months, the only constant may be the specter of constant change. Amid this turmoil, organizations that can confidently and purposefully harness technology trends will find great opportunities to refocus, to revitalize, or even to inspire. Think beyond incremental adoption patterns. Look not only for ways to do familiar things differently, but also to do fundamentally different things. Launch new processes, products, and services, and seek out new ways to compete. No matter what the scope, the time for you to act is now. Build tomorrow, starting today.

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Right-speed IT

Living between black and white

Many IT organizations are progressing beyond the traditional single-speed delivery models that work well for high-torque enterprise operations but not for high-speed innovation. While some do have needs at both ends of the speed spectrum, they often find that bridging the gap between the two is difficult. A growing number of CIOs are building capabilities that link the two edge points or operate along the continuum, with targeted investments in process, technology, and talent to reengineer the business of IT, enabling delivery at the right speed for the business.

A long-standing phenomenon has garnered much mindshare in recent years: the essential tension between stability and agility in IT. On one side are the predictability and controls necessary to manage risk while delivering large-scale enterprise IT with reliability, scalability, security, and other “ilities.”¹ On the other is the push to drive discovery and experimentation around new features, tools, and technologies. Popular memes have oversimplified the conflict between these extremes, suggesting a bifurcated, either/or proposition, while offering little guidance on managing the unavoidable gap between the two priorities.

There are also several unfortunate misconceptions linked to the bimodal theory. First, there’s the fallacy that the pivot point is solely around speed, trading “high torque” for scale versus “high speed” for responsiveness. This paints traditional enterprise delivery with the plodding caricature that plagues many IT departments. Second, the debate

is often framed between waterfall and agile delivery methods, as if agile techniques were the mythical savior of digital innovation and growth, yet inappropriate for larger enterprise-delivery models. For most organizations, speeding up the development process is only part of the equation to accelerate time to value.

Leading organizations are building on the simple two-speed IT mindset and recognizing they must be able to support a continuum of speeds in order to dial in the right approach for a specific initiative, with the underlying disciplines, capabilities, platforms, and talents to appropriately support the actual breadth of business needs. The speed of IT should be as fast as possible, balancing business value, risks, and technical feasibility. Critically, the approach must handle the governance around the appropriate speed as well as the inevitable collision between teams and efforts running at different speeds. This *transmission* turns out to be the essential ingredient missing in other constructs. It helps identify the appropriate

treatment for a given initiative, assists in finding solutions, and navigates what controls are required.

Right-speed IT must address three broad categories: procedural, architectural, and organizational. Let's move beyond rhetoric and dig into each area.

Procedure beyond process

Many IT transformation prescriptions portray delivery methodology as the hero of the story. For this reason, bimodal is often misinterpreted as a waterfall-versus-agile

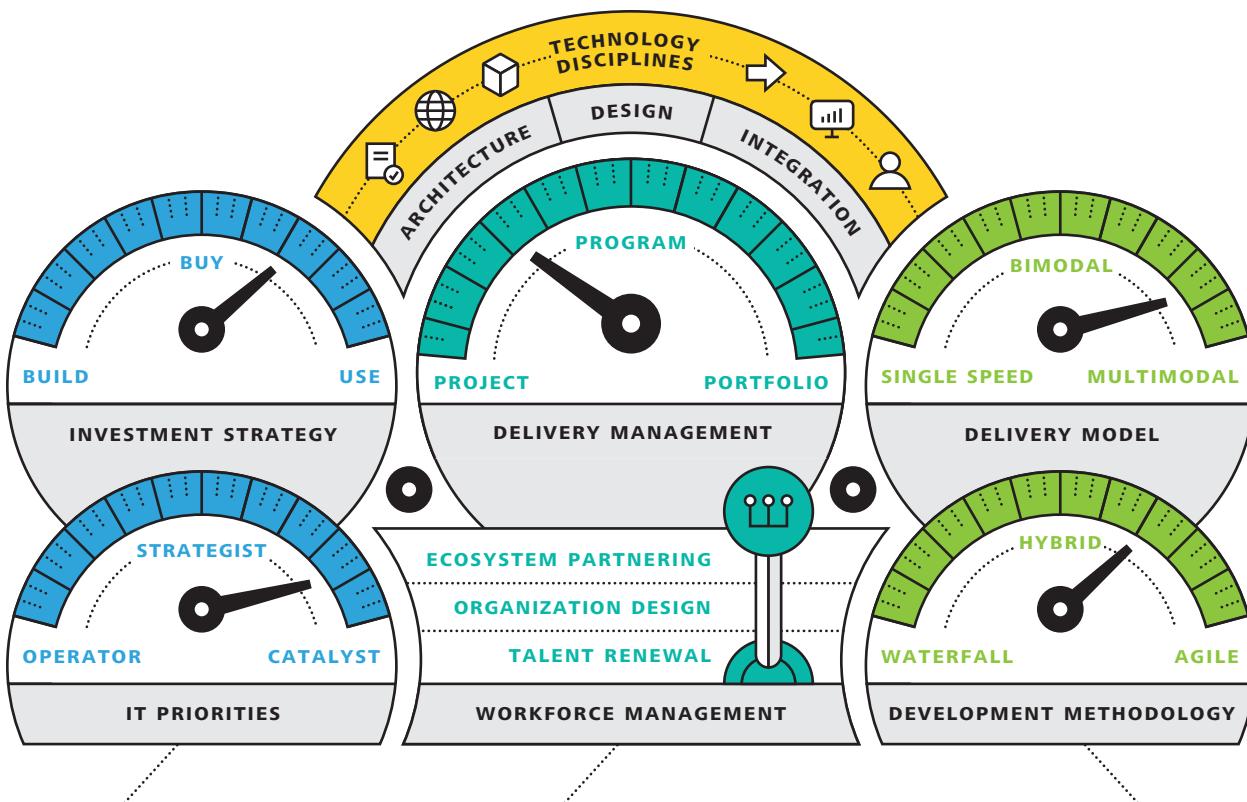
showdown. Delivery is an important ingredient, but upstream capabilities are actually just as important when codifying right-speed IT.

Consider how building reach and rigor in the following IT capabilities may help organizations reach the right speed for the job at hand:

- Finance management:** Budgeting, prioritization, allocations, and accounting treatments all need more flexibility than annual appropriations, rigid planning cycles, and depreciation schedules do.

Figure 1. Right-speed IT operating model dashboard

Finding a balance between high-torque enterprise IT and high-speed innovation IT can allow companies to optimize technology operations. CIOs can calibrate the interrelated core capabilities below to find a point along the spectrum between the two models that meets the needs of a given program, project, or product.



Failure to address the differences in time-consuming finance management processes as part of an overall right-speeding initiative is a missed opportunity. Addressing these differences can increase efficiencies upstream in finance and downstream in IT processes.

- **Procurement and sourcing:** Similarly, multi-month RFP processes, drawn-out vendor assessments, and sourcing strategies focused on cost takeout are sometimes appropriate. But they also are not the only game in town. Codify paths to adopt open-source solutions such as platforms, libraries, and code-bases that could jump-start efforts across the continuum. Consider alternative talent pools, from crowdsourcing to code-a-thons to academia to externships. The underlying building blocks need to be available so you can shift gears to accommodate the needs of individual initiatives.
- **Vendor and contract management:** Revisit nondisclosures, intellectual property protection clauses, and traditional segmentation of provider tiers. Consider creating new categories of engagement that can be deployed against efforts beyond simple fixed-scope and traditional service-level agreements. Encourage value-based arrangements where vendors are compensated based on outcomes, potentially along with co-investment scenarios involving joint solution development and go-to-market arrangements beyond traditional supplier/vendor or contractor/consultant relationships. Revisit nondisclosures, intellectual property protection clauses, and traditional segmentation of provider tiers that may unnecessarily constrain potential partnering arrangements.
- **Solution shaping:** Beyond determining the recommended end-to-end architecture, ascertain the appropriate speed for a

given project or product. Offer the team guardrails as they combine governance, controls, delivery model, enabling processes, and stage gates to balance business impact, technical vision, and risk.

- **Stakeholder communications and expectation management:** Don't hold back for a large periodic release. Instead, increase the number of releases or user previews to demonstrate progress. Gamify testing and reward members of the user community for providing feedback. Even if these releases are not destined to be put into production immediately, providing users and stakeholders with evidence of tangible progress can make the process seem quicker.
- **DevOps:** Try to determine the granularity of control points, formality of reviews, and the appropriate level of automation that will be needed for the effort. Right-speed IT efforts often coincide with investments in autonomic platforms² that can help move more of IT's underlying workload to labor-free, seamless tasks (or at least introduce automation to eliminate waste in the end-to-end lifecycle). The scope could include environment management, requirements management, testing automation (regression and beyond), and configuration, build, and release management. Importantly, that also includes the ability to roll back deployed solutions from production.

Architecture is destiny

Right-speed IT should also be informed by overarching principles and programs that form the underpinnings of responsive, fungible IT capabilities. These are, after all, the same principles and programs that will also inform future architectures and applications. As such, it is important to create an engineering culture in IT and a product management mind-set: Both can help IT leaders balance tradeoffs

of opposing constraints and find the best solutions for problems at hand.³ Specifically, consider focusing on three main domains: design, master data and integration, and building to run.

- **Design as a discipline:**⁴ Emphasize user engagement and a persona-based approach to project delivery. Regardless of speed or mode, solutions should approach problems from the user down, respecting but not being constrained by systems and data implications. Detailed behavior studies, journey maps, user personas, storyboards, wireframes, prototypes, and other techniques for creating intuitive, simple designs may not be appropriate for every initiative. But by placing some techniques and associated artifacts into your arsenal, usability will be part of the DNA of future projects.
- **Master data and integration:** Individual projects should be expected to reuse underlying services and data. Likewise, designing new capabilities specifically for eventual reuse can help expand the library of APIs and extend the reach of data management efforts. Though expectations will vary based on the size and mode of the project, adherence to existing data and interface standards should be a universal mandate.
- **Building to run:** Embed tools geared toward ongoing monitoring and maintenance of solutions. Instrumentation, management consoles and script, and hooks for in-line monitoring of system and higher-level business performance should be considered. Coverage and granularity of controls need to be able to scale up or down depending on the mode of delivery. But a playbook of potential options, supported by shared libraries and code snippets, will help make adoption systematic.

Organizational realities

The third right-speed category involves talent and organizational constructs. As sometimes happens, getting the procedural and architectural aspects right might be the easy part. Indeed, it's often the people side that can be more unpredictable and harder to influence. Changing IT's reputation as a static, sluggish organization to one that delivers solutions dynamically and at the right speed requires a purposeful focus on four key areas:

- **Mind-set/culture:** Author Nilofer Merchant wrote, "Culture drives innovation and whatever else you are trying to accomplish within a company—innovation, execution, whatever it's going to be. And that then drives results . . . It's the people, the leadership, and the ideas that are ultimately driving the numbers and the results."⁵ When it comes to successfully increasing the speed of the processes your IT organization uses to deliver solutions, instilling an engineering culture that emphasizes both accountability and flexibility is critical. Your employees' mind-sets will drive them to learn new ways of working and delivering business value.
- **Leadership:** Culture starts with leaders, and it is shaped by your leaders' actions and decisions. In right-speeding IT, the leaders will define and reinforce the mind-set needed to make the right decisions about where on the "right-speeding continuum" a specific initiative should fall. Leaders will mentor their people to work differently and more flexibly to both provide the right project controls and deliver faster. If you don't have leaders who understand the right-speeding strategy and goals, and if your leaders are not driving and supporting your people, it is unlikely you will be successful in changing how IT delivers solutions.
- **Talent:** Recognize that different personalities and skill sets will be better

suites for different modes of right-speed IT. Blanket assumptions around generational dispositions are not enough here. Rather, this situation requires a deeper understanding of your talent pool—each individual's capabilities, passions, aspirations, work styles, and attitudes. Rotational assignments that transition workers through project and delivery types can help broaden employee skill sets. But recognize that some of your people will be best served by being given relatively static assignments. That's OK, assuming there is enough demand for those types of assignments in your overall portfolio. Develop learning and development programs to help acclimate the workforce around right-speed IT nuances, as well as to nurture new capability building and knowledge transfer across the organization. Consider partnering with outside entities that have experience and expertise in aspirational delivery modes. For example, veteran Scrum masters or UX engineers are invaluable as you shift to agile development or user-centric design patterns.

- **Organizational structure:** With their reporting models and career incentives split between the P&Ls and their jobs, IT

workers are no strangers to highly matrixed environments. Orienting evaluations and formal feedback around project objectives can help remove confusion and align everyone working together around common goals. Use departmental assignments to build scale and common standards, methods, and tools. At the same time, eliminate barriers that could prevent individuals from making the best decisions, taking action immediately, and driving project goals. Another component of right-speed IT involves holding daily stand-up or triage meetings in which department and domain leads converge not merely to hear pending design decisions or project issues, but to take immediate action on them. This cadence alone can help eliminate bottlenecks and alleviate employee frustration.

- **Incentives:** What gets measured gets done. Rethink metrics and measurements across the board, from project tracking to individual performance management. Create explicit goals that teams can rally behind, ideally linked to product accomplishments or business outcomes versus tactical behaviors that address empty organizational constructs.

Lessons from the front lines

Thinking is believing

During HP's historic 2015 split into two companies, Neeraj Tolmare led the end-to-end separation of more than 1,500 of the company's global applications. To complete this gargantuan task within an accelerated six-month time frame, Tolmare's teams worked at different speeds, following guidelines tailored to their individual tasks. In this model, some teams completed tasks in a matter of hours, while others worked for days, using a variety of techniques and approaches, to accomplish more complex goals. "It took teams a couple of months to become comfortable working at varying speeds, but eventually most did," he says. "They all understood there would be no Day 2 unless we all got to Day 1."

Tolmare is now driving efforts to transform the digital imprint of HP Inc.—the post-division entity that sells PCs and printers. Part of this broad-ranging initiative involves reinventing the way the company develops technology products. "Our existing model was too rigid; it could take us six months to engineer and launch a solution," says Tolmare, who serves as HP Inc.'s vice president and head of Digital Transformation & IT Applications, Global eCommerce, P&L Management. "We realized that if technologists are going to have a seat at the table and participate fully in strategic decision-making, we would need to create a flexible, fluid product development model that would empower them to respond to the dynamic needs of the business."

The development model Tolmare and his colleagues are creating is designed to "infuse new thinking" into development teams accustomed to working primarily within standard systems development lifecycle (SDLC) models. To support the model, the company is reskilling existing talent by helping them to grow and diversify their individual skillsets, as well as to become familiar with agile techniques.

Working within the new model, teams comprising existing and new talent along with a functional expert—typically a system architect who knows a specific space—are assigned to work in pockets of fast-paced development throughout the enterprise. In an effort to find the right mix of skills and abilities for each type of project and to expose developers to different methods and tactics, the company also regularly moves talent around, assigning individuals to work on various teams. "Sometimes team members struggle with the idea that a project is no longer strictly waterfall or agile, but a combination of the two," says Tolmare, "but over time we're seeing them adjust their thinking, and work very differently than they have in the past."⁶

Collaborating at the right speed

For integrated technology solutions provider CDW, finding the "right speed" for its IT organization within a dynamic environment is more than a trend—it is a tested strategy for success in a sector defined by near-constant disruption. CDW has deployed a model in which IT collaborates with the business to develop solutions that meet its customers' evolving needs—with each team working at a tempo that fits each project's specific goals and circumstances. Some teams sprint, others walk at a measured pace, but each is guided by a solution framework defined not by the speed of the delivery model, but by approaches to architecture, security, controls, deployment, and associated metrics.

This collaborative development strategy has not only helped CDW turn technology into a competitive advantage; it has informed IT's approach to meeting its mission, says Jon Stevens, CDW's senior vice president of operations and chief information officer. "For IT to be truly agile and responsive, our development teams tailor their efforts to meet

the distinctive needs of each business group. In this environment, one size does not fit all.”

For example, CDW’s e-commerce group has organized its teams into product groups that work in a way that reflects its approach to business: iterative, innovative, and fast-moving. Each team includes a business leader, product managers, and a technology leader who, together, continually build upon successes or fail fast and move on to the next idea. Team members work closely with the DevOps team, which shepherds new products and enhancements through security and regression testing, and then onto a release platform.

Meanwhile, other parts of the CDW IT organization approach development differently. Teams supporting finance, for example, follow a different methodology and governance model that allow them to move at an appropriate pace for maintaining compliance within systems that must meet specific regulatory requirements.

Regardless of approach, all IT efforts share core business value drivers: revenue, lower SG&A, higher gross profit, great customer experience, and co-worker engagement. And regardless of the development methodology or processes followed, IT engages with other groups—business, audit, and security, for example—so stakeholders are in lockstep and there are no surprises. These groups are not looked at as separate departments with process-laden boxes to check. Instead, they are embedded across the lifecycle—from ideation through ongoing operations.

The techniques CDW’s IT organization deploys to help the company achieve results continually evolve as new technologies emerge and market dynamics shift. Yet amid this change, the philosophy underpinning CDW’s collaborative, flexible approach to IT remains constant. “It’s ultimately about the partnerships you build with the business and with your external partners,” Stevens says. “Not too long ago the question was, ‘How do you get a seat at the table?’ Now, it’s about working as a team,

always thinking about how technology can drive innovation and competitive advantage.”⁷

Super-regional transformation

Since its founding in 1921, State Auto Insurance Companies has embraced the independent agency system as the best way to meet policyholder needs. To this day, independent agents within the regional underwriter’s network strive to provide highly personalized service to customers who, in many instances, are friends and neighbors.⁸

That legacy is actively being transformed by technology. The company is building a more competitive cost structure, launching analytics-informed products, shifting to digital customer engagement, and revamping the sales process. According to State Auto CIO Greg Tacchetti, “There’s not a single thing we’re not changing.”

Importantly, Tacchetti is charged not only with transforming IT, but also with developing overall business strategy. To this end, he is working with product teams to define the product roadmap and make sure they have the right architecture to support it.

IT is being transformed along several dimensions. A modular architecture standardizes interfaces and data definitions. Tacchetti is aligning programs to reduce redundant effort and divergent investments across business lines. He’s also carving out sandboxes, tools, and platforms to allow the business to experiment and spin up new environments to vet ideas—scaling those that show promise, and decommissioning those that do not.

Also, as part of the larger transformation effort, Tacchetti is crafting a long-term plan to build a multi-modal IT organization. His vision is for an IT organization that can work across the enterprise, not only as technologists, but also as business strategists who can create the systems architecture and revamped business processes needed to increase efficiencies, lower costs of system ownership, and make State Auto’s offerings





more profitable. A key part of that change is a focus on design and usability—creating an emphasis on end-user experience and journey maps. This focus extends throughout IT's value chain: program design, product design, project design, development, and post-go-live. Case in point: State Auto is in the midst of a platform transformation effort that is scheduled to go live later this year. Its scope is much more than replacing the core policy engine; the platform will serve as the backbone for new products and capabilities, including customer self-service and an overhauled CSR experience.

Tacchetti envisions the day when 12-month projects are a thing of the past. “A year from now, I want to be talking about rapid experimentation and agile techniques. We've started conversations about weekly releases,” he says. With its focus on speed and strategy, State Auto's IT organization is on a journey to help drive and realize the business agenda—not just execute on defined requirements.⁹

Architecture-led, services everything

Cisco's reputation for technology innovation applies to its internal IT organization, which is on an ambitious transformation journey to digitize IT and drive faster delivery of business outcomes. At the same time, Cisco IT must continue to improve operational excellence, security, compliance, resiliency, and quality. Clearly, this is an ambitious effort that defies simple transformation models.

For Guillermo Diaz, Jr., senior vice president and CIO of Cisco Systems, “There's only one right speed for IT: faster and more secure.” To meet Diaz's expectation on this front, Cisco has transformed key capabilities, beginning with release management. Historically, system changes were limited to four major and twelve smaller releases per year. By creating a continuous delivery mind-set, adopting agile methodology, and automating the development process, Cisco has realized

a fivefold increase in the number of release opportunities year over year—a staggering achievement, albeit one Diaz and his team view as “still not good enough.”

As part of the continuous delivery program, the company consolidated its fragmented approaches to agile development. Six quarters ago, 62 percent of projects were delivered using traditional waterfall methodologies. As of the last fiscal quarter, over 82 percent of projects were developed using agile; the remainder were developed using hybrid techniques that condense and accelerate the traditional enterprise application development cycle. “We've learned some great lessons, and we have made great strides shifting our culture to a mindset of innovation, visualization, and rapid feedback. Faster IT requires a culture of increased accountability to quality while focusing on developer productivity with technology and automation,” says Diaz.

Cisco continues to invest in architecture and is working to extend its cloud footprint by digitizing its foundational platforms for source control, build, review, and deployment. The company is also investing heavily to weave APIs into the network, and to deploy containers and middleware components to abstract, encapsulate, and execute on its overall vision.

Importantly, Cisco has created a continuous delivery model on this digital foundation. “Right-speed IT is about applying the amount of rigor and diligence that is appropriate for each business application,” says Diaz. For example, high levels of rigor are needed when working with ERP, whereas less complex applications may not require the same level of intensity. “We've implemented the digital architecture that makes it possible for us to move at the speed of the business while also working appropriately with each business applications and ensuring security,” says Diaz.

Diaz reports that since embarking on this transformation journey, Cisco's IT organization has seen a 97 percent increase in project velocity, a 92 percent improvement in quality,

and, notably, a 79 percent increase in timely closure of security vulnerabilities. “We wanted to drive agility, simplicity, and speed, but not at

the cost of ensuring our business is secure,” he says. “Our ultimate vision is to enable business value faster.”¹⁰



MY TAKE

MARCY KLEVORN

*Vice president and CIO
Ford Motor Company*

Ford Motor Company is building on its 112-year-old legacy, driving new offerings in connectivity, mobility, autonomous vehicles, and the customer experience, along with big data and analytics. With technology-based innovation fueling investments in new products, services, and customer engagement models, IT is evolving to embrace emerging technologies that could potentially disrupt the way we design and manufacture products or understand and engage customers.

That means investing in our 11,000-person IT organization to better support the kind of nimble, accelerated product exploration and development we need to lead in our current disruptive technological climate. We recognized early on that a continuum of delivery models was needed, so we simplified the story to think about IT delivery in two modes. Enterprise mode covers mature core businesses where risk needs to be fiercely managed—the processes for how we design, manufacture, and service our vehicles. The emerging mode (“Mode 2”) encompasses areas where we are learning, experimenting, and iterating with new technologies.

We determine the right mode of delivery by risk, not speed. We strive to deliver every project as quickly as is appropriate, following the same overarching process. If projects meet certain conditions, they can take “happy paths”—an accelerated process that abbreviates certain requirements and controls. Our modes don’t translate into waterfall versus agile delineations. While Mode 2 projects largely use agile, they often have interfaces into core systems, which requires taking a hybrid approach. And more than half of enterprise-mode projects are now delivered with agile.

Although our transformation journey is unfolding, we can share a few lessons we’ve learned so far. First, no one-size-fits-all; your company’s culture influences the speed and reach of change. Regardless of mode, we depend on team members to exercise their own judgment. We have a program affectionately called “You Drive” in which we empower team members to speak out and share ideas for improving project outcomes.

We are also constantly looking for new ways of working. For example, our senior IT managers are

available for an hour every day for a triage meeting. During this hour, project teams can raise problems and work through them with the management team. Increasingly, senior business leaders take part in these proceedings as well. What’s more, team interaction and collaboration are replacing traditional siloed mind-sets and formal processes for issue tracking and remediation.

“...No one-size-fits-all; your company’s culture influences the speed and reach of change.”

It is important not to underestimate the impact all of this can have on traditional IT talent models. Will you risk losing long-time IT employees? Maybe. Will you find it challenging to recruit individuals with needed development skills in a market where competition for talent is heating up? Probably. Given the scale and complexity of Ford’s IT ecosystem, these two prospects occasionally keep me awake at night. But we’re making progress. We’ve made key external hires and entered into new partnerships in order to acquire specific skills and experiences. We have also made a commitment to reskill our employees, creating a program called “Power Up” that offers opportunities to learn new skills and recharge existing ones. We rotate our people between emerging and enterprise projects—we can’t have two different classes of citizens in IT, and we are very careful not to disenfranchise our base.

Finally, I believe IT works best when driven by core principles. At Ford, vertically focused development sometimes had the unintended effect of emphasizing corporate needs—which is inconsistent with our company’s guiding principle of placing customers at the center of everything we do. In our bimodal approach, development is horizontal, driven foremost by the impact any new product will have on the customer. It is an ambitious vision, but we are learning and making progress each day.

CYBER IMPLICATIONS

A sophisticated understanding of risk can prove invaluable as CIOs build new IT delivery models and assign optimum development speeds for new initiatives. With detailed knowledge of security, privacy, risk, and compliance, CIOs can weave these disciplines into the fabric of all development and operations. This is a lofty goal, even in the most cyber-focused of IT organizations. But it can be achieved by making “secure by design” a part of any broader right-speed IT transformation.

Cybersecurity can’t just be focused on compliance and executed using dated controls and one-size-fits-all stage gates. Right-speed IT requires agility up, down, and across project lifecycles—from ideation to budgeting and from planning to delivery. Security and privacy concerns can undermine any initiative, particularly those focused on new business opportunities or built on emerging technologies. But cybersecurity does not have to impede innovation. Indeed, leading organizations are involving progressive cyber professionals throughout the development process to evolve designs and approaches in ways that help balance functionality, time to value, and underlying security, privacy, regulatory, and compliance needs. At the same time, right-speed concepts can be applied to cybersecurity efforts by introducing shared platforms or tools that make it possible to leverage, self-assess, escalate, and certify against protocols and control points.

IT organizations can transition to a secure-by-design mind-set in three stages:

- **Secure:** Start with tactical steps to create highly virtualized, templated stacks. This establishes a sound, standards-based way to build cybersecurity into the fabric of the IT environment, with infrastructure automatically inheriting patches, configurations, and cyber-solution elements.
- **Vigilant:** Build a cohesive monitoring/threat intelligence platform that makes it possible for

IT to establish operational baselines. Then, from a cybersecurity standpoint, determine what “normal” looks like for user behavior, server loads, data exchange, access, and external connectivity. Understanding what normal is can help IT identify elevated risk situations when they occur and react accordingly.

- **Resilient:** Is your environment safe enough to restore normal operations following an attack? If the answer is “no,” you have a problem. If the answer is “I don’t know,” you have a bigger problem. Proactively create plans for recovering from various attack scenarios, test them often, and be sure to incorporate lessons learned back into your operational plans to further accelerate detection and reduce impact in the future.



According to Deloitte’s 2015 global CIO survey, only 18 percent of CIOs surveyed see cybersecurity as a top business priority. Yet, by the same token, 58 percent of respondents said the investments they are making now in cybersecurity and data privacy will have a significant impact on the business within the next two years.¹¹ The CIO’s challenge is to convince the entire enterprise—from IT, to the business, and then rippling out to the C-suite—that “secure by design” should be treated by the business as a business priority.

This forward-looking approach to the cyber risk agenda can be a fantastic component of the CIO’s legacy. The board and the C-suite have cyber implications on their minds. Progressively building cybersecurity responses into reconstituted IT delivery and operating models should be a part of how right-speed IT initiatives are positioned.

When it comes to cybersecurity, there is no “going back to normal,” no matter how much we wish we could. The question becomes how organizations can best understand risk, control for it to the extent possible, and then prepare for and respond to the inevitable.

Where do you start?

Pieces of right-speed IT are likely already in play in many organizations. Once there, the trick becomes bundling individual initiatives into a more prescriptive whole, and evolving in-flight bimodal programs to include nuanced capabilities across more than a dualistic spectrum. Consider how the following lessons learned by early adopters might help you on both fronts:

- **Balance sheet of IT:** Do you have visibility into the various assets that make up IT? What about programs and projects underway and the backlog of business needs? Beyond basic inventories, is there strategic positioning of IT's balance sheet according to value, committed resources, and risk? Do you have a service catalog that delineates the capabilities being delivered throughout IT—what they are, key measurements, and how to engage? These and other foundational elements of any IT department are critical to the success of any right-speed IT initiative. The balance sheet and service-catalog constructs provide a backdrop for allocating specific projects and programs to appropriate delivery models.
- **Cool kids syndrome:** Bimodal constructs often create a “haves” and “have nots” caste system that divides IT workers by area of focus and work mode. Right-speed IT sidesteps this outcome by creating rotational constructs and offering a wide range of speed, platform, and delivery methodology combinations. Even so, be up front with your employees about the skills that will be prized in the future. As part of that same discussion, offer workers opportunities to learn new skills and develop expertise. Also, accept that not everyone can or will want to be a part of the right-speed journey.
- **Distributed innovation:** Everyone should innovate, not simply to create breakthrough new products or services, but also to drive continuous improvement of delivery or incremental enhancements to existing offerings. To foster a culture of innovation, consider creating a cadence of product roadmap briefings with established vendor partners, as well as discovery sessions with venture capital firms, start-ups, incubators, and local academic hubs. Incent teams to explore emerging technologies and file patents. All of these steps can make “innovating” a key requirement of each person’s job.
- **Marketing:** IT is historically awful at self-promotion. Right-speed IT can help CIOs shift their organization’s mind-set about IT and how it engages the other groups. To help stakeholders both inside and outside of IT embrace this perspective, consider launching a full-fledged marketing campaign to bolster IT’s reputation and drive awareness of the changes afoot. Implement dashboards and provide full transparency into not only the service catalog, but also IT’s progress addressing the business’ goals. Use KPIs focused on business impact at the shareholder-value level to effectively track project health and expected return on spend.
- **Informal collaboration:** Unplanned and impromptu interactions between team members can bring together different perspectives and shine new light on problems and possible solutions. Invest in collaboration tools that make it possible for project teams to share ideas, brainstorm new ones, and tap into collective wisdom.¹²
- **Hold the line:** Determine the appropriate speed for any given project, and enforce strict compliance with your decision. In the early stages, it is easy to let project speeds fluctuate based on paths of least resistance or institutional inertia. Don’t let teams follow their instincts. Hold employees accountable for following the new IT delivery model at all times.

Bottom line

Right-speed IT is an acknowledgement that IT departments need more ammunition to organize, interact, and deliver value to the business. Bimodal constructs often strike a chord with their simplistic framing.¹³ But projects often require additional gears that meet their specific needs and cadences. With investments in foundational and flexible procedural, architectural, and organizational domains, right-speed IT can help turn simplistic models and philosophical discussions into concrete value.

Authors



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Endnotes

1. Predictability, maintainability, interoperability, capacity management (that is, high performance), resiliency, and flexibility, among others.
2. Deloitte Consulting LLP, *Tech Trends 2016: Autonomic platforms*, 2016.
3. Mark A. Campbell, “Saying goodbye to bimodal IT,” *CIO Insight*, January 13, 2016, <http://www.cioinsight.com/it-management/innovation/saying-goodbye-to-bimodal-it.html#sthash.4pPTfxVH.dpuf>, accessed January 26, 2016.
4. Deloitte Consulting LLP, *Tech Trends 2013: Design as a discipline*, 2013.
5. Nilofer Merchant, “Culture trumps strategy, every time,” *Harvard Business Review*, March 22, 2011, <https://hbr.org/2011/03/culture-trumps-strategy-every>, accessed January 26, 2016.
6. Neeraj Tolmare (vice president and head of digital transformation & IT applications, global eCommerce, P&L management, HP, Inc.), interview with the authors, December 2015.
7. Jon Stevens (senior vice president of operations and chief information officer, CDW), interview with the authors, September 2015.
8. State Auto Insurance Companies, <https://www.stateauto.com/about/page.aspx?id=86>, accessed January 21, 2016.
9. Greg Tacchetti (chief information officer, State Auto Insurance Companies), interview with the authors, January 11, 2016.
10. Guillermo Diaz (CIO and senior vice president, Cisco Systems), interview with the authors, January 13, 2016.
11. Khalid Kark, Mark White, and Bill Briggs, *2015 global CIO survey*, Deloitte University Press, November 3, 2015, <http://dupress.com/articles/global-cio-survey/>, accessed December 30, 2015.
12. Rob Cross, Peter Gray, Shirley Cunningham, Mark Showers, and Robert J. Thomas, “The collaborative organization: How to make employee networks really work,” *MIT Sloan Management Review*, October 1, 2010, <http://sloanreview.mit.edu/article/the-collaborative-organization-how-to-make-employee-networks-really-work/>, accessed January 26, 2016.
13. Gartner Inc., “Gartner says CIOs need bimodal IT to succeed in digital business,” press release, November 10, 2014, <http://www.gartner.com/newsroom/id/2903717>, accessed January 26, 2016.



Augmented and virtual reality go to work

Seeing business through a different lens

The future of mobile is tilting increasingly toward wearables, especially as augmented reality and virtual reality solutions hit the market. Long the objects of sci-fi fascination, the looming potential of AR and VR technologies lies in the enterprise with capabilities that could potentially reshape business processes, or fundamentally recast customer experiences. While the consumer world waits for the dominant AR and VR players to emerge, the enterprise can fast-track adoption—and begin the process of fundamentally reimagining how work gets done.

Until recently, augmented reality and virtual reality (AR and VR) technologies have served primarily as inspiration for fiction writers and Hollywood special-effects teams. Yet increasingly, both are finding more practical application in the enterprise. And while the hype surrounding each—particularly in the realms of entertainment and gaming—makes for good headlines, the real story in the coming months will likely be AR and VR's disruptive potential to recast long-standing business processes and tasks while opening a door to fundamentally new experiences.

VR makes it possible for users to immerse themselves in manufactured surroundings that depict actual places or imaginary worlds. Meanwhile, AR overlays contextual information on the immediate physical environments users see before their eyes, thus blending digital components and experiences with real life. Both allow us to deploy

technology in ways that would have been previously infeasible or even impossible.

The transition from client-server and web-based technologies to mobile has been transformative, partly because it has made it possible to deploy solutions at the actual point where business takes place and decisions are made. It also represented a long-overdue move toward more simple, intuitive interactions: Point-click-tab-type gave way to touch-swipe-talk. AR and VR take this a step further by offering experiences built around natural modes of interaction such as posture, gesture, and gaze, thus shifting attention from a glass screen in our hands to the real or simulated world around us.

Already, the disruptive impact of AR and VR is being felt across consumer technologies as dozens of new products enter the market. More broadly, AR and VR are introducing new opportunities to transform the enterprise,

particularly in the areas of communication and collaboration, training and simulation, and field and customer service, as well as in the reinvention of employee and customer experiences. Device costs continue to decline, standards are being defined, and app ecosystems are beginning to emerge. The combination of these influences—along with a spate of high-profile acquisitions that are shining klieg lights on AR and VR possibilities—may represent a tipping point for AR and VR's business and technical implications—and, more importantly, for how we rethink the role of the individual in the workplace.

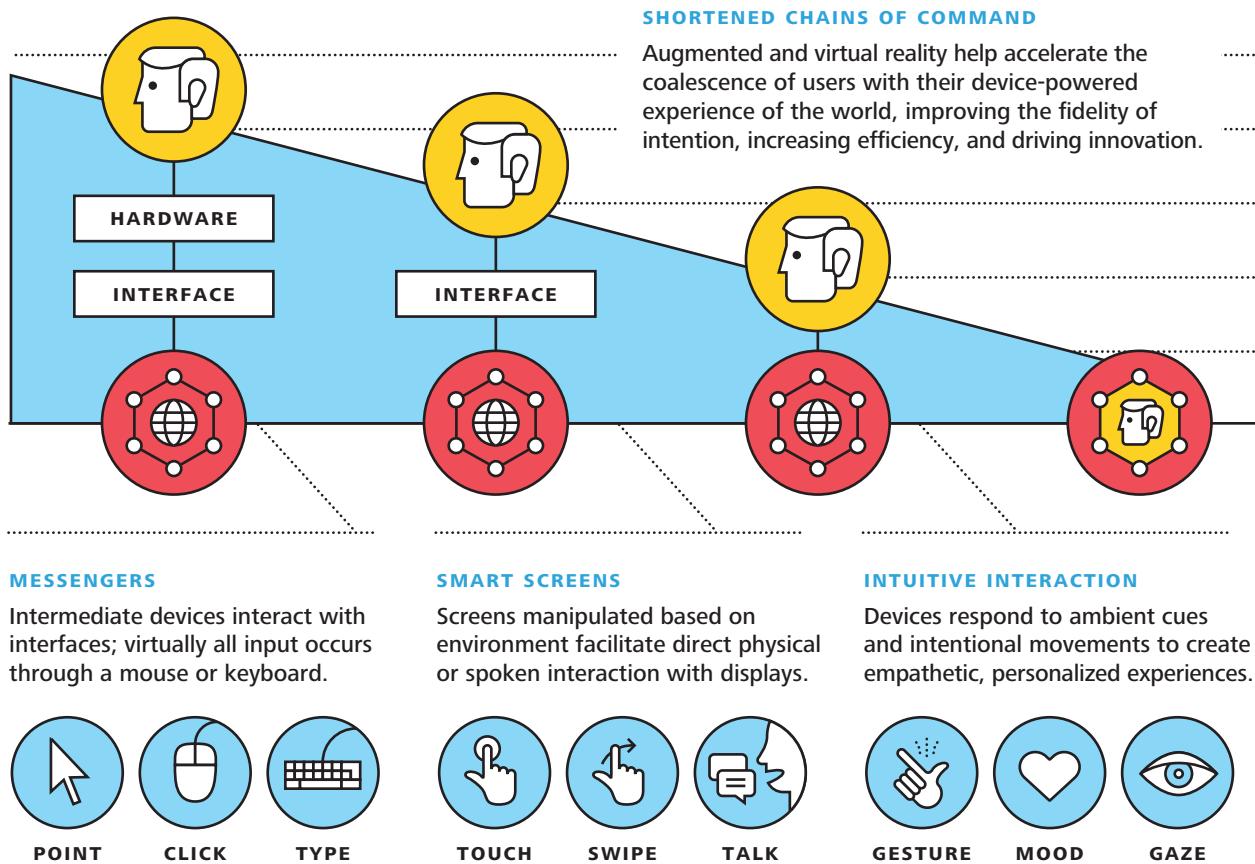
The process of rethinking begins by understanding the affordance of new interfaces and interactions, and their impact on business process and legacy enterprise technology.

Through this world view, the ways in which companies exchange data, execute tasks, share culture, and build the core of the business change dramatically.

A job with a view

Momentum around virtual and augmented reality grows with each new deployment. In particular, noncommercial prototypes are sparking curiosity across a wide spectrum of applications. For example, the Los Angeles Philharmonic immerses audiences in the world of Beethoven.¹ The British Museum invites visitors into a Bronze Age roundhouse containing both real and virtual artifacts of the period.² Psychologists at the University of Louisville are creating exposure therapies to help phobia patients confront and learn to contain their fears.³ Filmmakers are crafting

Figure 1. The evolution of interaction



first-person POV documentaries that place viewers in the middle of a Syrian refugee camp or an African village beset by Ebola.⁴

Meanwhile, businesses are taking the same technology and interaction paradigms to new heights across many industries, including construction, health care, and manufacturing. For example:

- **Communication and collaboration:** Virtual reality and augmented reality may soon accomplish what static and flat mediums for knowledge exchange failed to do: Replace real, one-to-one human interactions. AR and VR both offer IT opportunities to change how the business and its employees report and share information and take action. Marketing managers are already using AR to view retail shelf inventory and sales data. Engineering teams across the globe are deploying VR to collaborate in real time to test and refine a single design. What's more, virtual reality is transforming simple productivity tools like videoconferencing and live chats, enabling immersive face-to-face interactions that feature real facial expressions, physical gestures, and subtle nonverbal cues that are replicated in real time.
- **Training and simulation:** AR and VR will make it possible for IT to play an active role in retooling high-cost training and simulation environments, many of which exist to rehearse critical scenarios without the risk of real-world consequences. For example, manufacturers can replicate maintenance and repair scenarios in virtual environments. In fact, by creating parallel processes that leverage remote controls and robotics, they may be able to remove employees from dangerous, real-world analogs altogether. Executive teams are using simulated high-resolution stages to rehearse and refine their presentation skills. In the construction industry, commercial

developers can now walk through complete, full-scale computer-rendered structures—getting a sense of the width of a hallway or the impact of detailed design decisions—before touching shovel to dirt.

- **Field and customer service:** It is the IT department's responsibility to determine how AR and VR will be used in tandem with existing and other emerging technologies. Therefore, CIOs can lead efforts to redefine how field and customer service workers approach their jobs. For example, deploying augmented interfaces that pair with connected devices, sensing objects, and relational data can deliver task-specific information to workers in the field in context and on demand. Augmented solutions can overlay a jet engine's service hours, component temperature, and service panel details into an aircraft mechanic's field of vision. Likewise, virtual solutions can immerse customer service agents in collaborative scenarios featuring perceptive conversations and problem-solving. Remote experts can see what field reps see and provide guidance as they perform maintenance or mechanical tasks. Think of a sportscaster explaining a replay with diagrams superimposed on the screen; the same technique can be used as an overlay to the field rep's view of the task at hand.
- **Customer experience and interactive marketing:** AR and VR offer potential new ways to interact with products and services. Moreover, they offer companies opportunities to raise awareness, promote features, and inspire desire for their suites of goods. Travel, hospitality, and leisure firms are offering immersive, interactive samplings of cruises or hotel stays that allow potential guests to explore properties and preview amenities virtually. Some of these samplings go so far as to use wind machines and olfactory stimulants to replicate not just the sights, but also the

sounds and smells one might experience during a day at the beach.

Shifting focus

Designing user experiences for immersive environments is a fundamentally different process from creating experiences for flat screens. Immersive environments leverage cues derived from ambient sounds or a simple glance to drive both intentional and reflexive movements. In both AR and VR, the clicks and swipes that animate flat screen experiences are replaced by spoken words, gestures, fidgeting, grabbing, pushing, a nod, or even a blink.

Consider the notion of focus. Naturally, people have notoriously short attention spans. In the context of computing devices, we have dealt with this by shrinking, reflecting, and curving the displays. But in the context of behavioral interaction and productivity, focus becomes a different obstacle altogether. In virtual or augmented environments, what happens to objects when a user looks at them is as important as what the other objects are doing even when the user is not looking at them. A gaze becomes the new hover state, directing user intent and presenting options

not previously visible. Likewise, a gesture (for example, the snap of a finger or the blink of an eye) could be used to change the perception of both time and scale, pausing or stopping time, accelerating outcomes, or even changing the position and relationship of objects not bound by physical realities. This creates an opportunity for the enterprise to design environments that offer empathetic, personalized responses. For example, in a virtual environment, an avatar could act as a performance coach that analyzes the body language and speech patterns of individual employees to help them enhance their presentation skills.

Through AR and VR, organizations can create environments that can react to changes in posture, mood, and attention. For example, dynamically reordering how tasks are presented to account for a user who is sleepy or distressed can change the relationship between technology, behaviors, and outcomes, and compensate for a higher cognitive load in decision making. This, in effect, puts the enterprise at the core of human-centered design: design emphasizing comfort, health, safety, happiness, productivity, and growth.

Lessons from the front lines

The AR/VR consumer market heats up

Over the next 18 to 22 months, we expect to see augmented reality and virtual reality technologies transition from the science fiction ether to the more earthly, practical realms of business and government. However, enthusiasts will not have to wait for solid use cases to emerge before they can begin to enjoy AR and VR at home. The consumer AR/VR market is heating up as offerings from Samsung, Microsoft, Facebook Google, HTC, Motorola, Sony, and other leading technology brands near completion. Likewise, start-ups such as MagicLeap, Lensar, and NantMobile, among others, plan to launch their own compelling offerings in the near future.

Early use cases are focusing on familiar consumer scenarios: gaming, video entertainment (Hollywood, adult, and other programming), and social media/collaboration. Meanwhile, new product categories are emerging that focus primarily on the technology footprint required to make the virtual or augmented realities tick. Some solutions require a high-end PC to function; some use a smartphone as the processing core. Many are tethered to batteries, controls, or control units, while others are truly wireless. Several benefit from baked-in or, in some cases, locked-in development partners to help expand the breadth and utility of the platform. Others are either nascent plays or have closed-garden content models. Regardless of the approaches, expect to hear more about consumer augmented reality and virtual reality devices in the coming months. Existing products will evolve. New product categories will emerge. Welcome to the future.

AR in construction: The next best thing to building there

In a remote corner of west Texas, a field technician wearing a geotagged helmet equipped with AR technology gazes up at a 270-foot-tall telecom tower. Using hand gestures, he pulls a data overlay into his field of vision containing the technical and design data he will need to perform a thorough equipment review on this tower.

Connecting field workers to data in this way is one of many potential uses global engineering and construction company Black & Veatch envisions for AR technologies in the near future, says Dan Kieny, B&V's senior vice president and CIO. "In our more than 100 years of building critical human infrastructure, we have seen a lot of technology advancements, and AR has a compelling value proposition in our industry right now. We are looking at AR applications that provide individual operators with data they need to perform specific construction and maintenance tasks remotely."

Wearables are nothing new in the construction industry. Workers in the field regularly don protective goggles, vests, and helmets, along with tool belts and other items that help them perform specific tasks. Smart wearables, such as augmented and virtual reality tools, therefore, represent a natural progression. Black & Veatch is currently exploring applications of AR technologies such as helping to train unskilled labor remotely to perform highly technical tasks; providing mobile monitoring capabilities that display system-status details in real time; and using smart helmets that are geotagged to provide location-relevant information to field workers.

The company is also looking for ways in which VR tools can be utilized to create immersive environments, providing visibility





to large-scale designs. This capability could make it possible for owners and operators to vet design decisions and consider the operational implications to layout, equipment placement, and other factors that impact maintenance. Longer term, artificial intelligence and machine learning can help Black & Veatch refine the information that field workers receive, and enhance the AR interface between people and data.

Behind the scenes, Black & Veatch is already laying the foundation for these and other scenarios. For example, it is deploying sensor and beacon technologies at construction sites to provide a backdrop of tool, supply, and personnel data. Efforts are under way to capture and contextualize these new data sources for use in AR and VR experiences, as well as to enable exploration and analysis of hidden trends and business implications. “Data will never be fully structured, and that’s OK,” says Kieny, emphasizing the shift in focus from aggregation and stewardship to harnessing increasingly dynamic data to enhance human interaction in a number of ways. These include creating more intuitive interfaces with systems and data, and enabling more engaging dialogues with customers and partners.

According to Black & Veatch CTO Brad Hardin, the company is initially focusing on AR opportunities. He also sees eventual opportunities to use VR technology in areas like remote robotic welding and providing security training simulations for power plants and other vulnerable infrastructure. “In exploring opportunities to use smart wearables, we are ultimately trying to create more value for the company and our clients,” says Hardin. “But we are also trying to disrupt our business model before we get disrupted.”⁵

Can virtual reality help deliver the goods?

Even as automation increasingly disrupts long-established operational models

throughout the parcel delivery industry, the process of sorting packages for delivery worldwide remains labor-intensive. At one global package-delivery company, training workers to operate and maintain massive pieces of sorting equipment that can be half a football field long traditionally required flying them to remote training centers where they would receive several weeks of intensive instruction. The problem with this approach is that many workers don’t retain learned skills unless they use them regularly. In a high-velocity performance environment in which equipment must run at top speed 24/7, the inability to address all mechanical problems quickly and efficiently can cost the company dearly.

The organization is currently prototyping a 3D simulation solution that has been designed to be leveraged via VR to provide virtualized worker training on an ongoing basis, in any location. In this solution, workers wearing VR headsets would be immersed in a virtual 3D production environment that features simulated versions of equipment in use. A training program, using both visuals and sound, would take users step by step through detailed maintenance and repair processes.

The company envisions several ways in which the VR training solution could be deployed. In addition to providing just-in-time instruction on how to perform specific maintenance and repair tasks, it could also embed 3D simulations into mid-level e-learning programs for experienced workers. So, for example, a user might click on a prompt to bring up a new page that includes a 3D simulation depicting how to complete a specific task. The company could also create VR training courses in which new hires could learn five basic tasks in a virtual environment. When they complete those five tasks, they can advance to the next five, and so on, until they complete an entire entry-level course.

MY TAKE

CHRIS MILK

*Co-founder and director
Vrse and Vrse.works*

At Vrse and its sister company, Vrse.works, we create fully immersive 360° video and VR cinematic experiences. But really, we tell stories. And every story should (and does) dictate how it's to be told. Naturally, we're staying up to date on all the new advancements in technology and the great work other people in the field are doing. But we can't wait around until all the bumps are smoothed out, and neither should you.

Virtual reality as an artistic medium—and, increasingly, as a tool for innovation in business, health care, and other areas—is in its first growth spurt, and we're proud to be adding to the innovations. We create and pioneer a lot of the technology we use, and every progressive iteration is inspired by a storytelling choice. We like to take on challenges and find creative solutions. That's how cinema got from the proscenium wide shot to where the art form is today. Mistakes tell us as much as successes about the future of VR.

Our first foray into VR was the *Sound and Vision* experience I did with Beck a few years back. We wanted to reimagine the concert and create something organic and inclusive. Traditional concerts are a battle: The audience faces one way, the band another; sound clashes in the middle. Video captured this brilliantly for years, but we wanted to try a different shape—the circle. The concert-going experience is so round and immersive that we needed to try our hands at a new technology if we were going to effectively capture Beck and the musicians' magic. The event was being billed as an experiment in immersion, so my ultimate goal was to capture and preserve the moment for a later broadcast in VR. This was more than three years ago, though, and VR mostly only existed in research labs. Luckily, this was right around the time that Palmer Luckey and the guys at Oculus were making waves, so we started a conversation. The result is what the viewer experiences in *Sound and Vision*: fully immersive 360°

virtual reality, captured from various perspectives, painting the full portrait of the experience and not just tightly squeezed snippets.

“...We want to keep reevaluating how people experience familiar stories.”

I've always been interested in the intersection between emotion and technology. Studying people's experiences while inside VR gave me the confidence and curiosity to bring like minds to Vrse. We've found that VR, when exercised with precision, can tap into a viewer's sense of empathy. In short, VR is a teleportation device. It can take you into a conflict, instead of just showing you one. It can bring you face to face with a child in a refugee camp or a band on a stage, and the emotional response has been measured to be similar to actually experiencing those interactions. For the UN experiences we've created, UNICEF has taken to the streets with VR headsets in an effort to raise money for faraway causes. When people on the street experienced VR, they were twice as likely to donate. And we're talking monthly donations, not just one-offs.

We're continuing to create stories in VR that mean something to us. We've had the great fortune of caring a whole lot about every experience we've put out, and we want to keep that going. We want to keep reevaluating how people experience familiar stories.

And you? Now is the time for exploration. All previous art forms were built on mounds of trial and error, and VR is no different. Sometimes storytellers need to travel down the long and winding road a hundred times in order to find the highway.

CYBER IMPLICATIONS

Even with the “virtual” nature of augmented and virtual reality, these two technologies introduce very real cyber risk concerns. Though quite different, AR and VR share several common security and privacy considerations.

The devices themselves need to be tracked, managed, and hardened to control access to underlying data and applications and to entitlement rights to the gear. As they do with mobile devices and wearables, companies should mitigate different risk scenarios involving data and services at rest, in use, or in flight. They should also consider adopting existing cyber protocols from mobile-device, application, and data management programs to create the necessary management and controls around AR and VR efforts.

Controlling the associated digital assets should be a priority. Virtual reality and augmented reality introduce new and different intellectual property that may contain sensitive information requiring controls for security and privacy, regulatory and compliance issues, and competitive advantage. High-definition 3D renderings of facilities, detailed tracking of property and equipment location and controls, and associated beacons, sensors, and connected footprints all need appropriate protection, from encryption and access controls to rights and asset management. Likewise, protecting the information being presented in an AR/VR world and ensuring its integrity becomes critically important. What if data appearing in a cockpit AR display were to become compromised, and consequently, a jet veers off course? The possible implications could be tragic.

Yet beyond these considerations, each technology presents its own unique cybersecurity and cyber privacy challenges. For example, AR requires many more data points than VR to drive content for GPS and positioning, tagging, shared metadata, and facial recognition. Moreover, to enhance and tailor the augmented experience of an individual user, AR systems may also integrate data from a host of sensors tracking that person and from other personal sources like health and fitness monitors. This raises a number of security and privacy concerns about the data sources to which individuals have access, and whether combinations of data being aggregated by AR may compromise personally identifiable information (PII) or payment card industry (PCI) data.



With VR, when you recreate the physical world in a VR environment, you also recreate its problems and vulnerabilities. Virtual representations of your company’s assets may add another layer of risk by providing detailed blueprints to potential weaknesses. How will you protect these soft spots? And what new governance approaches will be needed to protect user identities in the virtual world?

The flip side of the AR/VR cyber risk coin is that these two technologies show promise as tools that may help organizations boost their overall security and privacy strategies. VR, for example, can be used in disaster recovery efforts and war room simulations. Scenario planning around incident response can be taken to another level with experiences closely resembling real-life events. Likewise, AR may help companies better visualize the cyber threats they face.

Where do you start?

The world of AR and VR should be an extension of an organization's digital strategy, applying new technologies to transform customer engagement and employee empowerment. While AR and VR may reek of "shiny object syndrome," in both cases, the underlying promise is exceptionally grounded. AR can help to seamlessly integrate technology with the real world; VR provides immersive simulated environments that help model complex, unsafe environments that are infeasible to explore in real life. Both can potentially create efficiencies and drive innovation that impacts shareholder value. As an added benefit, harnessing these tools at the bleeding edge of consumer hype can also help cement a CIO's reputation in the C-suite and throughout the enterprise as a purveyor of futuristic solutions that are grounded in business realities.

Consider the following points as you begin your AR/VR journey:

- The time is now:** The consumer market is becoming crowded in both categories. It will take time for dominant players to emerge, but once they do, third-party developers will be able to focus their efforts on building surrounding ecosystems. For now, companies can begin to justify their AR/VR use cases around single purposes with measurable impact and value. Expect the market to evolve; as it does, companies can then move forward on point decisions that have self-contained positive ROI, design to allow portability, and reevaluate the field with each new initiative to determine where to place the next bet. Volatility will be the name of the game for some time. However, this volatility may also drive rapid feature expansion, lower price points, and more creative arrangements with vendors eager to partner with leading organizations.

- Behind the looking glass:** Designing for AR and VR requires embracing new patterns and perspectives along with a wholly different design vocabulary. It also requires new enabling tools and services to bring the experiences to life and make them work in the real world. High-definition 3D image capture and mapping equipment are emerging, accelerating developers' abilities to recreate real-world physical environments within new AR/VR tools. Gaming engines are gaining a new purchase in the enterprise, with Unreal, Unity, and others being used to create simulations and virtual environments for AR and VR interaction.

- Side jobs:** As companies deploy AR/VR solutions, they may need to install beacons, sensors, or even QR tags around facilities and equipment to guide the context of augmented scenarios, especially for equipment on the move. Likewise, they might also need to construct wireless and cellular infrastructure to support AR/VR connectivity in remote areas. Finally, emerging middleware platforms can help abstract device-specific interaction from the underlying data and rules.

- New horizons:** As many enterprises learned during the first mobile technology wave, systems designed around previous-generation technology can't simply be ported to a new form factor. In fact, it took years for many organizations that were constrained by incrementalist thinking to evolve from a "mobile maybe" to a "mobile first" mind-set. The most compelling examples of this transition have been "mobile only," centered on experiences that would not have been possible without smartphones and tablets. Luckily, AR and

VR lend themselves to more imaginative thinking. Begin with ambitious scenarios that look beyond yesterday's use cases.

Given that these tools are brand new, accept that experimentation is not only necessary,

but essential to help everyone—IT, business executives, and end users alike—understand what they can do and how they should be applied to drive value.

Bottom line

Emerging technologies that invoke futuristic, seemingly fictional realities can spark a backlash within the enterprise. Executives raised on Gene Roddenberry, George Lucas, and Michael Crichton may be at once curious and dubious about what augmented reality and virtual reality are and, more importantly, how they might impact business. But know that AR and VR are here; their benefits to the enterprise will likely outpace consumer adoption cycles, which is notable given that the market may swell to \$150 billion annually by 2020.⁶ It's time to put AR and VR to work—and bring enterprise IT back to the future.

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Nelson Kunkel oversees the growth of Deloitte Digital's experience design teams across a network of digital studios. His purpose is to help peers and clients see the world—and their challenges—from a different perspective. Kunkel has spent his career building brands and solving creative problems through empathy and understanding. More importantly, he works daily to bring divergent perspectives together, enabling designers and companies to do their best, most creative work.



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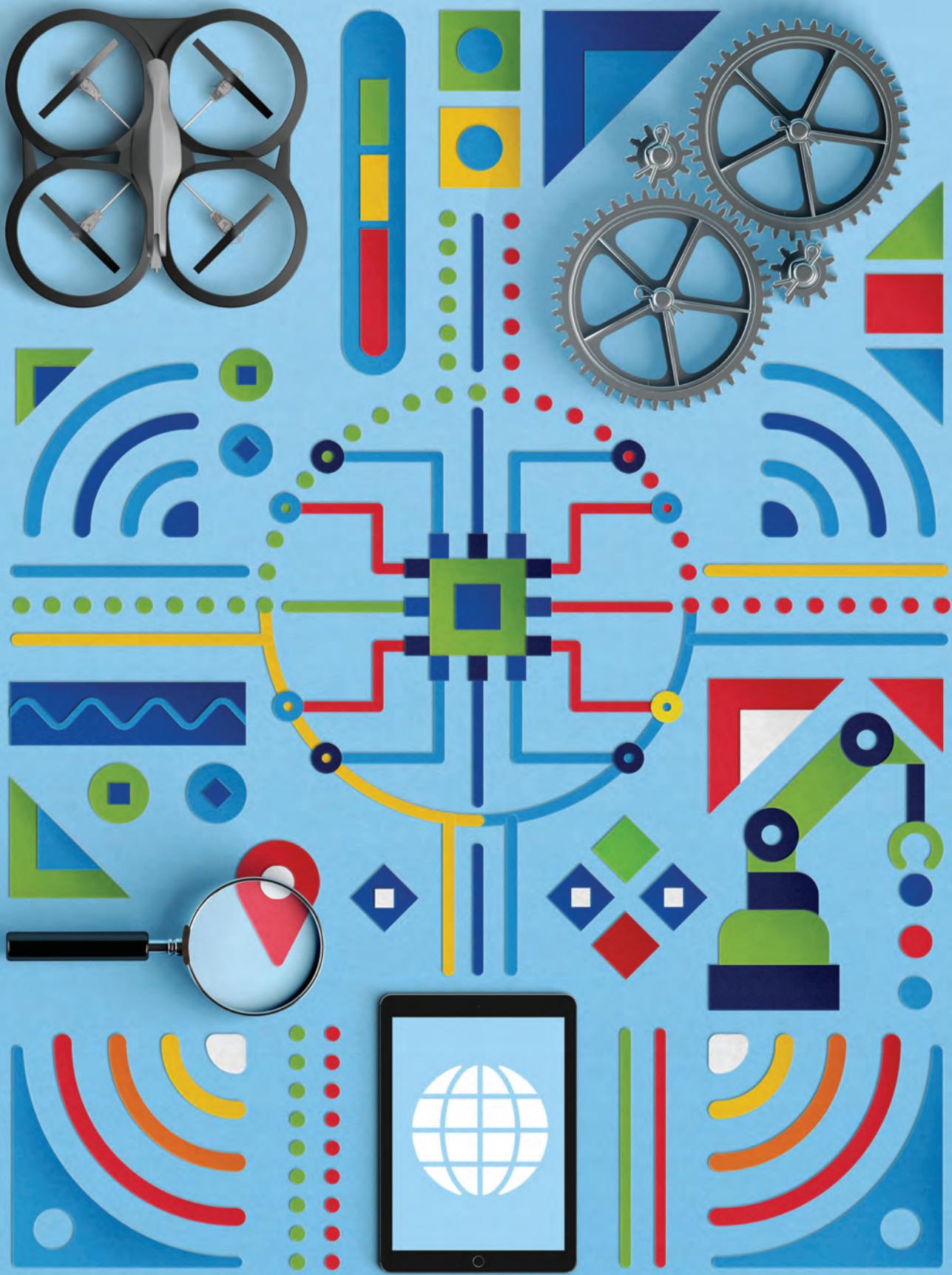


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Endnotes

1. David Ng, "L.A. Philharmonic's Van Beethoven takes virtual reality for a classical spin," *Los Angeles Times*, September 24, 2015, <http://www.latimes.com/entertainment/arts/la-et-cm-los-angeles-phil-vr-20150924-story.html>, accessed January 16, 2016.
2. Maev Kennedy, "British Museum uses virtual reality to transport visitors to the bronze age," *Guardian*, August 4, 2015, <http://www.theguardian.com/culture/2015/aug/04/british-museum-virtual-reality-weekend-bronze-age>, accessed January 16, 2016.
3. Erin Carson, "10 ways virtual reality is revolutionizing medicine and health care," *TechRepublic*, April 8, 2015, <http://www.techrepublic.com/article/10-ways-virtual-reality-is-revolutionizing-medicine-and-healthcare/>, accessed January 16, 2016.
4. Scott Hartley, "The innovative technology that's changing the way we watch movies," *Inc.*, September 1, 2015, <http://www.inc.com/scott-hartley/how-the-united-nations-is-telling-stories-in-virtual-reality.html>, accessed January 16, 2016.
5. Dan Kieny (senior vice president and CIO, Black & Veatch) and Brad Hardin (CTO, Black & Veatch), interview with the authors, November 2015.
6. Digi-Capital blog, "Augmented/virtual reality to hit \$150 billion disrupting mobile by 2020," April 2015, <http://www.digi-capital.com/news/2015/04/augmentedvirtual-reality-to-hit-150-billion-disrupting-mobile-by-2020/#.VinUMH6rSM9>, accessed January 16, 2016.



Internet of Things: From sensing to doing

Think big, start small, scale fast

Increasingly, forward-thinking organizations are focusing their Internet of Things (IoT) initiatives less on underlying sensors, devices, and “smart” things and more on developing bold approaches for managing data, leveraging “brownfield” IoT infrastructure, and developing new business models. Meanwhile, others are developing human-impact IoT use cases for boosting food production, cutting carbon emissions, and transforming health services. What impact will IoT have on your business and on the people around you? Rapid prototyping can help you find out.

Like a wildfire racing across a dry prairie, the Internet of Things (IoT) is expanding rapidly and relentlessly. Vehicles, machine tools, street lights, wearables, wind turbines, and a seemingly infinite number of other devices are being embedded with software, sensors, and connectivity at a breakneck pace. Gartner, Inc. forecasts that 6.4 billion connected things will be in use worldwide in 2016, up 30 percent from 2015, and that the number will reach 20.8 billion by 2020. In 2016, 5.5 million new things will get connected to network infrastructure *each day*.¹

As IoT grows, so do the volumes of data it generates. By some estimates, connected devices will generate 507.5 zettabytes (ZB) of data per year (42.3 ZB per month) by 2019, up from 134.5 ZB per year (11.2 ZB per month) in 2014. (A zettabyte is 1 trillion gigabytes). Globally, the data created by IoT devices in 2019 will be 269 times greater than the data being transmitted to data centers from

end-user devices and 49 times higher than total data center traffic.²

Even as businesses, government agencies, and other pioneering organizations at the vanguard of IoT take initial steps to implement IoT’s component parts—sensors, devices, software, connectivity—they run the risk of being overwhelmed by the sheer magnitude of the digital data generated by connected devices. Many will focus narrowly on passive monitoring of operational areas that have been historically “off the grid” or visible only through aggregated, batch-driven glimpses. To fully explore IoT’s potential, companies should think big, start small, and then scale fast.

Many enterprises already have unused IoT infrastructure built into their manufacturing machinery and IT software. We call these dormant components “brownfields”: Like roots, bulbs, and tubers in the soil, they need a good “rain” and a bit of tending to begin to thrive. Activating and connecting

these brownfield components may help companies leapfrog some implementation steps and give their IoT initiatives a needed boost. In contrast, “greenfields”—enterprise environments with no preexisting IoT infrastructure—require basic seeding and a lot of tending over time to yield a new crop.

The value that IoT brings lies in the information it creates. It has powerful potential for boosting analytics efforts. Strategically deployed, analytics can help organizations translate IoT’s digital data into meaningful insights that can be used to develop new products, offerings, and business models. IoT can provide a line of sight into the world outside company walls, and help strategists and decision makers understand their customers, products, and markets more clearly. And IoT can drive so much more—including opportunities to integrate and automate business processes in ways never before possible.

Often overlooked is IoT’s potential for impacting human lives on a grand scale. For example, in a world where hunger persists, “smart farming” techniques use sensor data focused on weather, soil conditions, and pest control to help farmers boost crop yields. Meteorologists are leveraging hazard mapping and remote sensing to predict natural disasters farther in advance and with greater accuracy. The health care sector is actively exploring ways in which wearables might help improve the lives of the elderly, the chronically ill, and others. The list goes on and will continue to grow. We are only beginning to glimpse the enormity of IoT’s potential for making lives better.³

Sensing and sensibility

With so few detailed use cases, the sheer number of IoT possibilities makes it difficult to scope initiatives properly and achieve momentum. Many are finding that IoT cannot be the Internet of *everything*. As such, organizations are increasingly approaching IoT as the Internet of *some* things, purposefully

bounded for deliberate intent and outcomes, and focused on specific, actionable business processes, functions, and domains.

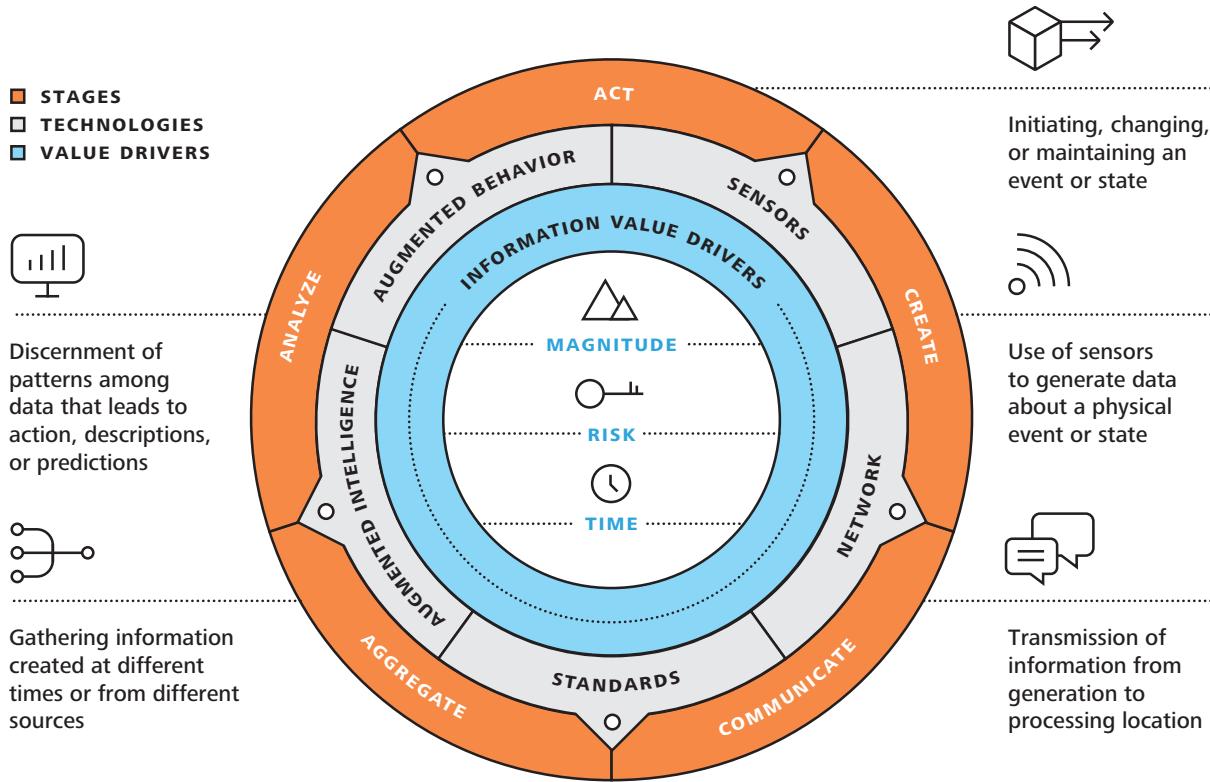
The time has come for organizations to think more boldly about IoT’s possibilities and about the strategies that can help them realize IoT’s full disruptive potential. To date, many IoT initiatives have focused primarily on sensing—deploying and arranging the hardware, software, and devices to collect and transmit data. These preliminary steps taken to refine IoT approaches and tactics are just the beginning. The focus must shift from sensing to doing. How do inputs from sensors drive closed-loop adjustments and innovation to back-, middle-, and front-office business processes? Where can those processes become fully automated, and where can the core be reconfigured using feedback from connected devices and instrumented operations? What future IoT devices might open up new markets? To yield value, analytics-driven insights must ultimately boost the bottom line.

One strategy involves harnessing the information created by the IoT ecosystem to augment worker capabilities, a process modeled in the Information Value Loop. When built to enhance an individual’s knowledge and natural abilities and deployed seamlessly at the point of business impact, IoT, in tandem with advanced analytics, can help amplify human intelligence for more effective decision-making. For example, the ability to monitor the vital signs of elderly patients remotely and in real time will empower medical personnel to make more accurate care decisions more quickly. Even more profound, automated drug delivery systems may be triggered to respond to complicated signals culled from several parts of the care network.

Likewise, companies may harness data-driven insights to augment or amplify operational activity in the form of transforming business processes, reimagining core systems and capabilities, and automating controls. Eventually, robotic process automation and advanced robotics will monitor events, aggregate sensor data

Figure 1. The Information Value Loop

Information gathered by the Internet of Things enables businesses to create and capture new value by providing insight to optimize actions. Modified actions in turn give rise to new information, starting the cycle anew. Value drivers determine how much value is created; their relevance and importance depend on the specific use case.



Source: Michael E. Raynor and Mark J. Cotteleer, "The more things change: Value creation, value capture, and the Internet of Things," *Deloitte Review* 17, July 27, 2015, <http://dupress.com/articles/value-creation-value-capture-internet-of-things>.

from numerous sources, and use artificial intelligence capabilities to determine which course of action they can take to deliver the most desirable outcome.⁴

Take manufacturing, for example. At a Siemens facility in Amberg, Germany, machines and computers handle roughly 75 percent of the value chain autonomously, with some 1,000 automation controllers in operation throughout the production line. Each part being manufactured has its own product code, which lets machines know its production requirements and which steps to take next. All processes are optimized for IT control, which keeps failure rates to a minimum. In this facility, employees essentially oversee production and technology

assets, handling any unexpected incidents that may arise.⁵

Risks and rewards

As organizations work to integrate vast, disparate networks of connected devices into core systems and processes, there will likely be new security and privacy concerns to address. These concerns could be particularly acute in industries like health care—which may be aggregating, analyzing, and storing highly personal data gleaned from sensors worn by patients—or in manufacturing—where risks may increase as heavy industrial equipment or infrastructure facilities become increasingly connected. More data, and more sensitive data,

available across a broad network means that risks are higher and that data breaches could pose significant dangers to individuals and enterprises alike.

With IoT, data security risks will very likely go beyond embarrassing privacy leaks to, potentially, the hacking of important public systems. Organizations will have to determine what information is appropriate for IoT enablement, what potential risks the assets and information may represent, and how they can ensure that solutions are secure, vigilant, and resilient.⁶

Similarly, as companies add additional inputs to their IT and IoT ecosystems, they will be challenged to create new rules that govern how action proceeds and data is shared. Opening up IoT ecosystems to external parties via APIs will give rise to even more risk-related considerations, particularly around security, privacy, and regulatory compliance.

Acting on the information created by the IoT—putting intelligent nodes and derived insights to work—represents the final, and most important, part of the IoT puzzle. Options for achieving this vary. Centralized efforts involve creating orchestration or process management engines to automate sensing, decisioning, and response across a

network. Likewise, a decentralized approach typically focuses on automation: Rules engines would be embedded at end points, which would allow individual nodes to take action. In still other scenarios, IoT applications or visualizations could empower human counterparts to act differently.

Ultimately, the machine age may be upon us—decoupling our awareness of the world from the need for a human being to consciously observe and record what is happening. But machine automation only sets the stage; real impact, business or civic, will come from bringing together the resulting data and relevant sensors, things, and people to allow lives to be lived better, work to be done differently, and the rules of competition to be rewired.

With this in mind, organizations across sectors and geographies continue to pursue IoT strategies, driven by the potential for new insights and opportunities. By thinking more boldly about these opportunities and the impact they could have on innovation agendas, customer engagement, and competitiveness (both short- and long-term), companies will likely be able to elevate their IoT strategies beyond sensing to a more potentially beneficial stage of doing.

Lessons from the front lines

Caterpillar embraces the Internet of Big Things

At a remote mining region of western Australia, the IoT's lofty potential meets the ground in a fleet of Caterpillar mining trucks—each boasting a 240-ton payload—that operate autonomously, 24 hours a day. These giant, driverless machines are outfitted with a variety of sensors that transmit information on oil pressure, filters, and other truck components via wireless connections (such as satellite, cellular, and others) back to Caterpillar headquarters in Peoria, IL, where an advisor monitors the equipment's vital signs and can, when needed, make maintenance recommendations to the fleet's owner.⁷

Though Caterpillar has been embedding sensors in its products for decades, only in the last few years has the global construction machinery and heavy equipment manufacturer begun exploring their potential application within the context of IoT. Today, IoT—or as they call it at Caterpillar, the “Internet of Big Things”—is a major strategic and technological focus, with the company exploring ways to mine IoT data that can then be used to develop predictive diagnostics tools, design products, and improve product performance.

For example, when compiled over time and analyzed, data generated by sensors embedded in construction-site machinery may be able to help engineers design heavy equipment that can accomplish more work with fewer passes. Fewer passes translates to reduced idle time, less operator fatigue, and lower fuel consumption. Ultimately, operating efficiently can help owners of Caterpillar equipment better serve their own customers.

Importantly, this information—combined with Caterpillar's domain knowledge about heavy equipment and analytics—may help the company more accurately predict how specific pieces of equipment will perform in different environments and on specific types of jobs.

To this end, Caterpillar recently announced it had entered into a technology agreement with analytics vendor Uptake to develop a predictive diagnostics platform to help customers monitor and optimize the performance of their fleets.⁸ Looking forward, Caterpillar expects IoT to help redefine business processes, drive better engagement with its customers, and evolve its products, services, and offerings.

Expanding the horizons of connected care

Some companies in the health care industry—including health plans, providers, medical device manufacturers, and software vendors—are testing the IoT waters with a number of sensor-driven big data initiatives that could transform the way patients and their providers manage acute health conditions.

One leading health care delivery system is currently developing a suite of mobile applications to track, record, and analyze biometric data generated by Bluetooth-enabled sensing devices worn by patients. These apps, each configured to monitor a specific medical condition, will share a common digital platform and feature APIs to encourage external development. Once deployed, they will be able to analyze sensor data and pair them with electronic medical records and other clinical information to help caregivers make faster—and more informed—decisions for patients. For example, a diabetic patient's glucose readings would be streamed from a monitoring device to a mobile app on his or her phone or tablet, and then on to an integrated big data repository. Care coordinators would be alerted to unusual changes in the patient's glucose levels so that they can take appropriate action, such as bringing the patient into the hospital for closer examination or adjusting his or her medications.





The organization piloted its diabetes monitoring application with almost 40,000 diabetic patients, demonstrating the viability of the platform. Next on the agenda: Expanding adoption of the diabetes pilot and extending the platform to support other conditions such as congestive heart failure, chronic obstructive pulmonary disease (COPD), and high blood pressure, among others.

Living on “The Edge”

It's morning in Amsterdam. An employee leaves her desk, walking casually toward a break room in the office building where she works. As she approaches, a custom app on her smartphone engages sensors embedded in a coffee machine, which immediately begins dispensing the employee's preferred blend, complete with the add-ins she desires. When the employee arrives at the break room, her custom brew is waiting.

Welcome to life in “The Edge,” a futuristic office structure widely known as “the world's smartest building.”⁹ Completed in 2014, The Edge—which is home to Deloitte Netherlands—is a showplace for leading-edge deployments of green architecture and advanced technology, including IoT applications. The innovative, connected lighting panels do more than sip minute amounts of voltage—they contain some 28,000 sensors that detect motion, light, temperature, humidity, and even carbon dioxide levels. It's these sensors, providing real-time data, that make The Edge occupant-friendly.

The sensors allow facility managers to assess how and when certain parts of the building are being used. “In our building, IT and facilities management are a combined function,” explains Tim Sluiter, property manager, IT and Workplace Services, Deloitte Netherlands. In the short term, collected information can be used to determine where cleaning is and is not necessary on a given evening. Long term, emerging patterns showing light use in certain locales on certain days can lead to

rooms or even entire floors being closed off to save energy.

IoT's reach within this building extends far beyond lighting sensors. When employees approach The Edge's high-tech garage, sensors identify their vehicles and then point them to available parking spots. Throughout the garage, sensor-equipped LED lights brighten and dim as drivers arrive and leave.

And that miraculous coffee app? It doubles as a digital office administrator that can assign daily workspaces that best fit users' preferences and allows them to control the brightness of the lighting above their work surfaces and adjust the climate of their particular areas. It can direct people throughout the building—reading a meeting location from one's online calendar, for example, and suggesting a route to get there. Employees can even use the app to track their progress in the on-site gym, where some of the fitness equipment actually feeds generated wattage into the building's power grid.

Sluiter stresses that personal data generated by sensors and the app cannot be accessed by managers or anyone else. Privacy laws ensure that nobody can track a person's whereabouts, monitor how many meetings he or she has missed, or see what times he or she is using the garage. “This building offers the technology to do certain things that would make tenants' lives even easier,” Sluiter says. “But at the same time, it's extremely important to protect people's privacy and conform to the law.”

Those minimal barriers aren't hindering The Edge's reputation. “Our aim was to make The Edge the best place to work,” says Erik Ubels, director of IT and Workplace Services, Deloitte Netherlands. “Our meeting areas are filling up because every client and employee wants to experience this building. It's not too small yet, but the economy is growing and the building is getting crowded. It's possible we made it too popular.”¹⁰

MY TAKE

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At Toyota, we are all about mobility. I'm not talking just about car ownership. Mobility also includes public transportation, ridesharing, hoverboards, walking—anything that can get people from place A to place B more efficiently and safely. Mobility is truly multi-modal.

Toyota sees the IoT as an enabler of mobility, and we are moving very quickly to embrace its potential. Big data generated by sensors located throughout our cars will help engineers develop automobiles that think for themselves. Likewise, Dr. Gill Pratt, the chief executive officer of the Toyota Research Institute (TRI), and other researchers at TRI, will leverage IoT data to advance the science of *intelligent* cars as we move into the future mobility of autonomous vehicles. Progress in these areas will likely deliver autonomous connected cars that are reliable, safe, and fun to drive when you want to. The benefits that these innovations may eventually provide to everyday drivers, drivers with special needs, and to seniors could be life-enabling.

Toyota is no stranger to connected vehicle technologies; Lexus began offering connected vehicles in 2001. Today, all Lexus vehicles are connected, which enables services like Destination Assist, which links drivers to live agents who can provide directions for getting from point A to point B. Lexus also offers sensor-driven "car health" reports on current tire pressure, oil levels, and maintenance needs.

These IoT applications are just the beginning. Cars are mechanical products built with mechanical processes. Sensors are so small that we can place them virtually everywhere on cars. And what if you extend the same sensor technologies that monitor tires and brakes to the machines used to build vehicles on the manufacturing floor? These sensors could alert production leaders that there is a problem at a particular station, and that the parts manufactured at this station within a specific time frame will have to be rebuilt.

As for new offerings, it's sometimes hard for companies to wrap their heads around the value

of data. For example, early on, everyone assumed consumers wanted apps in cars. Very quickly, the auto industry realized that what customers actually wanted was for the apps *on their phones* to work *in their cars*. Across industries and sectors, strategists, designers, and decision makers typically believe that current approaches and systems are just fine. It takes vision—and a considerable amount of courage—to break with the way things have been done for the last 100 years and embrace some exotic technology that promises to deliver new opportunities.

"...In this era of historic technological innovation, all companies must work aggressively to reinvent themselves by embracing new opportunities and compelling visions of the future."

But in this era of historic technological innovation, all companies must work aggressively to reinvent themselves by embracing new opportunities and compelling visions of the future. This is exactly what Toyota is doing with IoT and mobility.

I'm a car guy. In high school, I loved working under the hood of my car, which was the embodiment of leading-edge technology at that point in my life. For the last 15 years, we amateur mechanics have been distracted by other mechanical wonders—the kind everyone now spends their days staring at and speaking into. That's about to change. Connectivity and cool new services are going to make cars come alive. All those people who've developed relationships with their smartphones are about to fall in love with cars all over again.

CYBER IMPLICATIONS

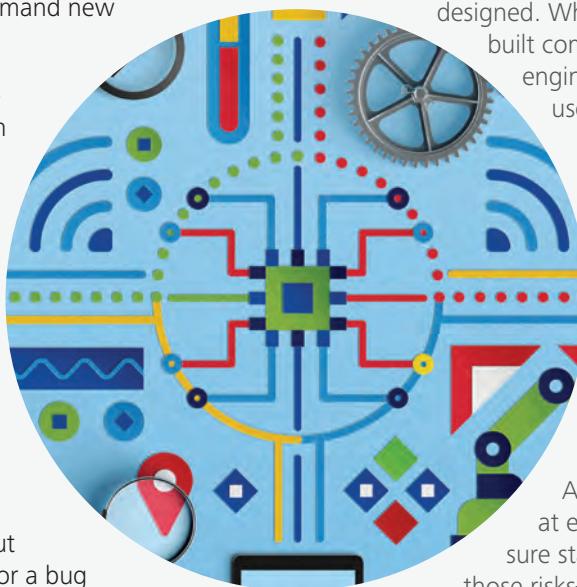
The IoT connects critical infrastructure that has been previously unconnected. As organizations begin harnessing these connections to create value, they may also add functionality to IoT networks that will make it possible to take control of devices and infrastructure remotely, and to automate monitoring and decision-making within certain parameters based on sensory data.

Make no mistake: As companies put IoT to work, the smart, connected objects they deploy offer tremendous opportunities for value creation and capture. Those same objects, however, can also introduce risks—many of them entirely new—that demand new strategies for value protection.

For example, every new device introduced in an IoT ecosystem adds a new attack surface or opportunity for malicious attack, thus adding additional threat vectors to a list that already includes protecting devices, data, and users. Likewise, identity spoofing—an unauthorized source gaining access to a device using the correct credentials—may present problems. And even if devices aren't directly compromised but experience a hardware failure or a bug in the code, they should be able to fail in a safe way that doesn't create vulnerabilities.

Moreover, the ecosystem structures that organizations often rightfully deploy can give rise to vulnerabilities. For example, IoT applications typically depend on the closely coordinated actions of multiple players, from vendors along the supply chain to clients, transport agencies, the showroom, and end-use customers. Vulnerabilities exist within each node and handoff seam between sensors, devices, or players. It should not be assumed that partners—much less customers—have robust mechanisms in place to maintain data confidentiality and guard against breaches.

In the face of these and other challenges, companies can take several steps to safeguard their ecosystems.¹¹



- **Work to define standards for interoperability:** Internally, define data and service standards to guide consistent rollout within your organization's boundaries. Also consider getting involved with consortia like the IIC¹² to develop broader standards and ease connectivity and communication.
- **Refactor with care:** Retrofitting or extending functionality of old systems may be exactly what your IoT strategy needs. But when doing so, understand that there may be potential security, performance, and reliability implications, especially when pushing legacy assets into scenarios for which they weren't designed. Whenever possible, use purpose-built components for the refactoring, engineered specifically for the use case.
- **Develop clear responsibilities for the players in your ecosystem:** Rather than sharing responsibility across a diffuse ecosystem, players should know where their responsibilities begin and end, and what they are charged with protecting. Assessing potential risks at each point—and making sure stakeholders are aware of those risks—can help make a solution more secure.
- **Get to know your data:** The quantity and variety of data collected via IoT—and the fact that so much of that data is now held by third parties—can make it difficult for companies to know if their data has been breached. When dealing with tremendous volumes of IoT data, small, virtually unnoticeable thefts can add up over time. Companies can address this threat by developing a deep understanding of the data they possess and combining this knowledge with analytics to measure against a set "normal." By establishing a baseline of access and usage, IT leaders can more readily and reliably identify possible abnormalities to investigate further.

Where do you start?

As IoT gains momentum, many organizations find themselves paralyzed by the sheer volume of vendor promises, the number of novelty examples being imported from the consumer realm, and by an overarching conviction that something real and important—yet frustratingly out of focus—is waiting to be tapped into.

To maximize value, reduce risk, and learn fast, those just beginning their IoT journey should follow three innovation principles: “Think big, start small, scale fast”:

Think big

- **Ideate:** Analyze the big ideas and use cases in your industry. Move beyond sensing to doing. Also, explore opportunities for achieving greater consumer and human impact with IoT.

Start small

- **Take stock:** Before investing in new equipment, conduct an inventory of all the sensors and connected devices already on your balance sheet. Find your brownfields. How many sit dormant—either deactivated or pumping out potentially valuable information into the existential equivalent of /dev/null?
- **Get to know the data you already have:** Many organizations have troves of raw data they've never leveraged. By working with data scientists to analyze these assets before embarking on IoT initiatives, companies can better understand their data's current value. Likewise, they may also be able to enhance this value by selectively installing sensors to plug data gaps.
- **Pilot your ecosystem:** Pick proven IoT partners to quickly pilot ideas, try new things, and learn quickly from failures.

Many aspects of IoT cannot be tested or proven in laboratories but only with real enterprise users and outside customers.

- **Get into the weeds:** At some point, IoT initiatives require low-level expertise around the underlying sensors, connectivity, embedded components, and ambient services required to drive orchestration, signal detection, and distributed rules. The difference between a provocative “proof of concept” and a fully baked offering lies in a host of nuanced details: understanding the precision and variability of underlying sensing capabilities; MEMS sourcing, pricing, and installation; and wireless or cellular characteristics, among others. To fill knowledge gaps in the short term, some organizations leverage talent and skill sets from other parts of the IT ecosystem.

Scale fast

- **Adopt an agile approach:** Go to market and iterate often. One benefit of all the investment being made in and around IoT is that the underlying technology is constantly improving as existing products evolve and new categories emerge. As you explore possible IoT strategies and use cases, consider using lightweight prototypes and rapid experimentation. This way, you can factor in feasibility concerns, but you won't be saddled—at least for the time being—with the burden of “enterprise” constraints. As compelling ideas gain momentum, you can then shape your solution, refine the business case for it, and explore it at scale.
- **Enhance your talent model:** Just as aircraft manufacturers hire aeronautical engineers to design products and software vendors

employ legions of coders with specific skills, so too must companies pursuing IoT strategies hire the right people for the job. Does your IT organization currently include talent with the hardware expertise needed to operate and maintain thousands of connected devices? Most don't. Before pursuing an IoT strategy, consider enhancing your talent model not only to bring in new skills from the outside, but also to reskill current employees.

- **Bring it home:** Remotely deployed assets and equipment often have starring roles in IoT use cases. But call centers, manufacturing floors, and corporate offices also offer considerable IoT potential. Consider how creating an “intranet of things” might lead to improved workplace conditions and enhanced comfort and safety at individual work stations. Moreover, how might reimagining employee experiences in this way help your company attract new employees and retain existing ones?

Bottom line

The Internet of Things holds profound potential. It is a futuristic fantasy made real—the connected home, connected workplace, and connected government come to life. The sheer scope of IoT carries countless implications for business, both finite and abstract. To sidestep such distractions, focus on solving real business problems by creating bounded business scenarios with deliberate, measurable value. For example, how can you use IoT to get closer to customers or increase efficiency in your manufacturing operations or supply chain? Look for hidden value in your brownfields. Move from strategy to prototyping as quickly as possible. Only real data, actual users, and sensors that respond with actions can demonstrate the remarkable value proposition of IoT.

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Endnotes

1. Gartner Inc., “Gartner says 6.4 billion connected ‘things’ will be in use in 2016, up 30 percent from 2015,” press release, November 10, 2015, <http://www.gartner.com/newsroom/id/3165317>, accessed December 9, 2015.
2. Cisco, “Cisco Global Cloud Index: Forecast and methodology, 2014–2019,” October 28, 2015, http://www.cisco.com/c/en/us/solutions/collateral/service-provider/global-cloud-index-gci/Cloud_Index_White_Paper.html, accessed December 9, 2015.
3. Satish Tembad, “How the Internet of Things can change the India we live in on its head,” *Business Insider India*, September 8, 2015, <http://www.businessinsider.in/How-the-Internet-of-Things-can-change-the-India-we-live-in-on-its-head/articleshow/48871985.cms>, accessed February 12, 2016.
4. Jonathan Holdowsky, Monika Mahto, Michael E. Raynor, and Mark J. Cotteleer, *Inside the Internet of Things*, Deloitte University Press, August 21, 2015, <http://dupress.com/articles/iot-primer-iot-technologies-applications/>, accessed December 9, 2015.
5. Kevin O’Marah, “The Internet of Things will make manufacturing smarter,” *Industry Week*, August 14, 2015, <http://www.industryweek.com/manufacturing-smarter>, accessed December 21, 2015.
6. Irfan Saif, Sean Peasley, and Arun Perinkolam, “Safeguarding the Internet of Things: Being secure, vigilant, and resilient in the connected age,” *Deloitte Review* 17, July 27, 2015, <http://dupress.com/articles/internet-of-things-data-security-and-privacy/>, accessed December 22, 2015.
7. Micah Maidenber, “Why Caterpillar is letting its geek flag fly,” *Crain’s Chicago Business*, July 4, 2015, <http://www.chicagobusiness.com/article/20150704/ISSUE01/307049995/why-caterpillar-is-letting-its-geek-flag-fly>, accessed January 12, 2016.
8. Caterpillar, “Caterpillar and Uptake to Create Analytics Solutions,” press release, March 5, 2015, <http://www.caterpillar.com/en/news/corporate-press-releases/h/caterpillar-and-uptake-to-create-analytics-solutions.html>, accessed January 12, 2016; Craig Brabec (chief of analytics, Caterpillar Inc.) and Dan Henderson (director of research and advanced engineering, Caterpillar Inc.), interview with the authors, December 18, 2015.
9. Tom Randall, “The smartest building in the world,” *Bloomberg Business*, September 23, 2015, <http://www.bloomberg.com/features/2015-the-edge-the-worlds-greenest-building/>, accessed February 8, 2016.
10. Deloitte, *2015 Global Report*, 2016, <http://www2.deloitte.com/global/en/pages/about-deloitte/articles/global-report-2015.html>.
11. Saif, Peasley, and Perinkolam, “Safeguarding the Internet of Things.”
12. Industrial Internet Consortium, <http://www.iiconsortium.org>, accessed January 11, 2016.



Reimagining core systems

Modernizing the heart of the business

Core systems that drive back, mid, and front offices are often decades old, comprising everything from the custom systems built to run the financial services industry in the 1970s to the ERP reengineering wave of the 1990s. Today, many roads to digital innovation lead through these “heart of the business” applications. For this reason, organizations are now developing strategies for reimagining their core systems that involve re-platforming, modernizing, and revitalizing them. Transforming the bedrock of the IT footprint to be agile, intuitive, and responsive can help meet business needs today, while laying the foundation for tomorrow.

IT’s legacy is intertwined with the core systems that often bear the same name. In a way, the modern IT department’s *raison d’être* can be traced to the origins of what is now dubbed “legacy”—those heart-of-the-business, foundation-of-the-mission systems that run back-, mid-, and front-office processes. Some include large-scale custom solutions whose reach and complexity have sprawled over the decades. Others have undergone ERP transformation programs designed to customize and extend their capabilities to meet specific business needs. Unfortunately, the net result of such efforts is often a tangle of complexity and dependency that is daunting to try to comprehend, much less unwind.

Meanwhile, core upkeep and legacy modernization lay claim to inordinate amounts of IT budget. Deloitte’s *2015 global CIO survey*¹ found that core-related expenditures are the single biggest line item in IT investment dollars. This leads to an internal PR problem for the core: High cost is seen as low

value. When asked to rank the technology investments they think will have significant impacts on their business, survey respondents cited analytics, digital, and cloud.

Clearly, it’s easy to overlook the fact that these and other emerging technologies are highly dependent on the underlying data and processes the core enables.

Broad systems transformation involves bringing together sales, operations, supply chain, and service information to redefine underlying processes and inform new products, services, and offerings. As such, efforts to reimagine core systems can form the foundation upon which higher-order, “shinier” initiatives are built. Reimagining the core can also help companies establish a modern baseline for improved efficiency, efficacy, and results. With this in mind, leading organizations are evolving their systems roadmaps to approach the core not as an anchor, but as a set of customer-focused, outcome-driven building blocks that

can support the business in the digital age and beyond.

The time is now

The pace of change and innovation in technology is continuing to accelerate at an exponential pace, offering ripe opportunities to rewire the way we work and rewrite the rules of engagement. The rate at which data is produced by devices, sensors, and people is accelerating—and that data is being harnessed in real time by advanced predictive and prescriptive analytics to expertly guide business decisions once ruled by instinct and intuition. Digital has unlocked new ways of engaging customers and empowering employees—not just making it possible for old jobs to be done differently, but also creating fundamentally new and different patterns of interaction. Mobile and tablet adoption served as a clarion for wearables, the Internet of Things, and now augmented and virtual reality. Competitive dynamics are also driving change. Start-ups and companies without strong ties to legacy systems will find themselves increasingly able to innovate in service delivery, unhindered by decades of technical debt and legacy decisions.

At the same time, significant external forces are redrawing core roadmaps. ERP vendors have invested heavily in next-generation offerings and are aggressively positioning their modernized platforms as the answer to many enterprise system challenges. Cloud players are offering a rapidly growing catalog of back- and mid-office solutions. At the same time, expertise in COBOL and other mainframe programming languages is growing scarce as aging programmers retire—a situation that weighs heavily in more and more replatforming decisions.² Against this backdrop, a steady drumbeat of hype touting emerging technologies casts legacy as a four-letter word in the minds of C-suite executives and line-of-business leaders.

All of these factors make it more important than ever for CIOs to define a deliberate

core strategy based on the needs and goals of the business. Start with existing business processes. Does the core IT stack help or hinder users with their daily tasks across departments, processes, and workloads? How is the strategy of each function evolving, and what impact will those strategies have on the core? How is the broader business positioning itself for growth? What are the key constraints and enablers for business growth today? Implications for the core will no doubt follow, but specific needs will differ depending on plans for organic growth in existing markets, business model innovation, mergers, acquisitions, and divestitures, among others.

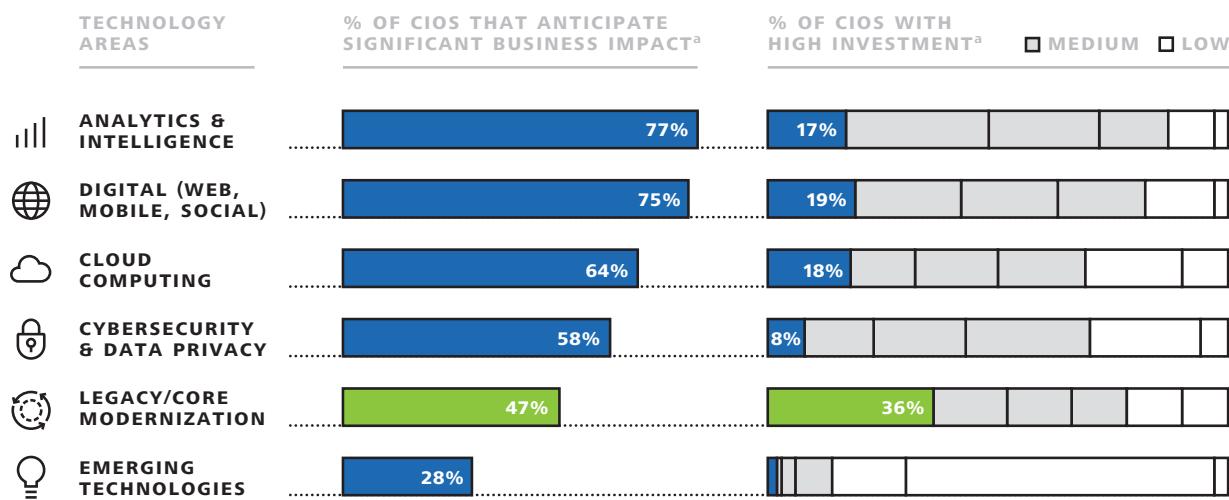
Next, examine technology-driven factors by putting their potential impacts in a business context. For example, translate abstract technical debt concerns into measurable business risks. Technical scalability can be represented by inhibitors to growth due to limits on the number of customers, orders, or payments that can be transacted. Translate reliability concerns into lost revenue or penalties for missing SLAs due to outages or service disruptions. Immature integration and data disciplines can have concrete impacts in terms of project delays—and the extent to which they may hobble digital, analytics, and cloud efforts.

Go big, go bold

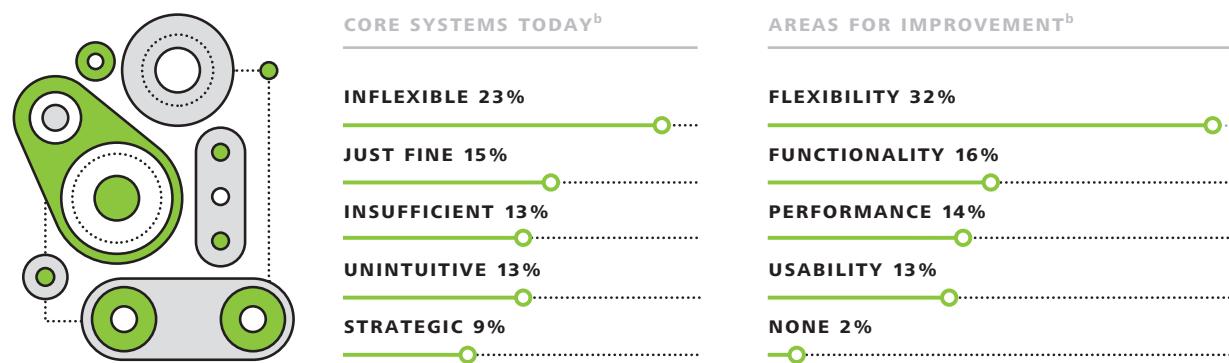
Approach reimaging the core with a transformational lens—it is, after all, a chance to modernize much more than the underlying technology. Challenge the business to imagine how functions and processes should and could operate based on today's realities, not yesterday's constraints. How is digital eliminating physical location constraints in your business? What if complex analysis could be deployed across all of your organization's data in an instant? Where are business ecosystems blurring or obliterating lines between competitors, partners, and customers? How is cloud offering a different way of procuring, building, integrating,

Figure 1. Impact, investment, and potential of core systems revitalization

In Deloitte's 2015 *global CIO survey* of more than 1,200 technology leaders, respondents ranked core modernization second to last as a technology area that will have a significant business impact in the next two years. However, in CIOs' investment breakdowns, core modernization has the highest percentage of high-level investment. Because other technology efforts can depend on baked-in core modernization, it is often not perceived as strategic or impactful.



Based on two-year averages of Deloitte Dbriefs webcast polls in 2014 and 2015 of more than 2,000 and 1,000 participants respectively, businesses largely see room for improvement in core systems. High-level investment in core modernization can transform legacy solutions into agile, intuitive, and responsive systems and drive untapped business value.



Sources: ^a Deloitte Development LLC, 2015 *global CIO survey*, 2015, <http://dupress.com/articles/global-cio-survey>, accessed November 25, 2015.

^b Deloitte Development LLC, *Core renaissance: What is the new normal for legacy core systems?*, Deloitte Dbriefs Technology Executives series, October 1, 2015; Deloitte Development LLC, *Core renaissance: The great systems revival*, Deloitte Dbriefs Technology Executives series, November 6, 2014.

and assembling services into systems? Core modernization can provide a path toward much more than reengineering; it may ultimately help the business reinvent itself.

Reimagining the core could also involve more modest ambitions. For example, for some core challenges, rote refactoring without enhancing capabilities, or making technical upgrades to underlying platforms without

improving process scope or performance, may be the appropriate response. Tactical execution can be an option, but only after thoughtful consideration; it should not be undertaken simply because it represents the path of least resistance. Regardless of direction, define an explicit strategy, create a roadmap based on a series of manageable intermediate investments,

and create a new IT legacy by reimagining core systems.

The five Rs

Roadmaps for reimagining the core should reflect business imperatives and technical realities, balancing business priorities, opportunities, and implementation complexity. Approaches may range from wholesale transformational efforts to incremental improvements tacked on to traditional budgets and projects. But they will likely involve one or more of the following categories of activities:

- **Replatform:** Upgrade platforms through technical upgrades, updates to latest software releases, migration to modern operating environments (virtualized environments, cloud platforms, appliance/engineered systems, in-memory databases, or others), or porting code bases. Unfortunately, these efforts are rarely “lift and shift” and require analysis and tailored handling of each specific workload.
- **Revitalize:** Layer on new capabilities to enhance stable underlying core processes and data. Efforts typically center around usability—either new digital front-ends to improve customer and employee engagements, or visualization suites to fuel data discovery and analysis. Analytics are another common area of focus—introducing data lakes or cognitive techniques to better meet descriptive reporting needs and introduce predictive and prescriptive capabilities.
- **Remediate:** Address internal complexities of existing core implementations. This could involve instance consolidation and master data reconciliation to simplify business processes and introduce single views of data on customers, products, the chart of accounts, or other critical domains. Another likely candidate is integration, which aims to make transaction and other business data available as APIs to systems outside of the core and potentially to partners, independent software vendors, or customers for usage outside of the organization. These new interfaces can drive digital solutions, improve the reach of cloud investments, and simplify the ongoing care and maintenance of core systems. Finally, remediation may mean rationalizing custom extensions to packages or simplifying the underlying code of bespoke solutions.
- **Replace:** Introduce new solutions for parts of the core. This may mean adopting new products from existing vendor partners. In some industries, it may involve revisiting “build” versus “buy” decisions, as new entrants may have introduced packages or cloud services performing core processes that previously required large-scale custom-built solutions. Ideally, organizations will use these pivots to revisit the business’s needs, building new capabilities that reflect how work should get done, not simply replicating how work used to get done on the old systems.
- **Retrench:** Do nothing—which can be strategic as long as it is an intentional choice. “Good enough” may be more than enough, especially for non-differentiated parts of the business. Weigh the risks, understand the repercussions, inform stakeholders, and focus on higher-impact priorities.

Lessons from the front lines

Driving core transformation

The Texas Department of Motor Vehicles (TxDMV) had a problem. The legacy mainframe system it used to register almost 24 million vehicles annually³ was becoming, as they say in Texas, a bit long in the tooth. The registration and title component, built on ADABAS/Natural database, had been online since 1994. Its COBOL-based vehicle identification system had been active for almost as long. Other components were, at best, vintage.

After years of heavy use, these systems were becoming costly and challenging to maintain. Their lack of agility impeded significant business process improvements. On the data front, users struggled to generate ad hoc reports. The kind of advanced analytics capabilities the agency needed to guide its strategy and operations were nonexistent. What's more, the entire TxDMV system had become vulnerable to maintenance disruption: If IT talent with the increasingly rare skills needed to maintain these legacy technologies left the organization, it would be difficult to replace them.

"It was as if our system was driving our processes rather than the other way around," says Whitney Brewster, TxDMV's executive director. "We realized that, in order to make the changes needed to serve our customers better, we were going to need a more agile system."

In 2014, TxDMV launched a core modernization initiative designed to update critical systems, address technical debt, and help extract more value from long-standing IT investments by making them more agile. Because they didn't have the budget to "rip and replace" existing infrastructure, agency IT leaders took a different approach. Using a set of specialized tools, they were able to automatically refactor the code base to a new

Java-based platform that featured revamped relational data models.

This approach offered a number of advantages. It allowed TxDMV to transition its legacy ADABAS, Natural, COBOL, and VSAM applications to a more modern application platform more quickly, with higher quality, and at lower risk than it would have been able to do with traditional reengineering. End-user impacts were minimized because the refactored system retained the functional behavior of the legacy app while running on a stable, modern technology platform. According to TxDMV CIO Eric Obermier, relatively little code remediation was required. "We had to rewrite a couple of particularly complex modules so the refactoring engine could handle them, but for the most part, our efforts were focused on creating test cases and validating interfaces."

Thus far, TxDMV's efforts to reimagine its core systems have borne welcome fruit. End users can now develop and filter structured reports in a modern format. Moreover, the platform provides a stable base for adding more functionality in the future. "Our next step is to modernize our business processes and increase end-user engagement to help drive the future of the registration and titling system. Given how much we've learned already, those, along with future projects, will go much more smoothly," says Brewster. "This has been a real confidence-builder for our entire team."⁴

The art of self-disruption

In the highly competitive digital payments industry, warp-speed innovation and rapidly evolving customer expectations can quickly render leading-edge solutions and the core systems that support them obsolete.

To maintain a competitive edge in this environment, PayPal, which in 2014 processed 4 billion digital payments,⁵ has committed to a strategy of continuous self-disruption. Over



the last few years, the company has undertaken several major initiatives in its development processes, infrastructure, and core systems and operations.

One of the company's more significant undertakings involved transitioning from a waterfall to an agile delivery methodology, an effort that required retraining 510 development teams spread across multiple locations in a matter of months.⁶ The revamped approach applied to both new digital platforms and to legacy system enhancements. Though embracing agile was a needed change, PayPal knew the impact might be diminished if existing infrastructure could not become more nimble as well. So the company decided to re-architect its back-end systems, including transitioning its existing data center infrastructure into a private cloud using OpenStack cloud management software. The net result of deploying agile delivery and operating with a revitalized infrastructure was accelerated product cycles that provide scalable applications featuring up 40 percent fewer lines of code.⁷

Additionally, over the last few years, PayPal has acquired several mobile payment technology vendors whose innovations not only fill gaps in PayPal's portfolio of services, but also drive beneficial disruption within its core systems and operations. In 2013, PayPal acquired Chicago-based Braintree, whose Venmo shared payments products could potentially boost PayPal's presence in the mushrooming peer-to-peer (P2P) transaction space.⁸ In July 2015, the company announced the acquisition of Xoom, a digital money transfer provider, in order to grow its presence in the international transfers and remittances market.⁹

With a multifaceted approach to modernizing its systems and processes, PayPal has revitalized its existing platform, added new service capabilities, and transformed itself into a broad-reaching "payment OS for all transactions."¹⁰ This approach will certainly be tested as new firms enter the financial services

technology sector, each aiming to disrupt even the most innovative incumbents.

All aboard! Amtrak reimagines its core reservation system

What began in 2011 as a channel-by-channel effort to modernize Amtrak's legacy reservation system has evolved into what is now a major customer experience transformation initiative grounded in core revitalization.

Dubbed "EPIC," this initiative is creating an enterprise platform for new capabilities that can deliver a seamless and personalized customer experience across Amtrak.com, mobile, call centers, in-station kiosks, and third-party touchpoints. From a business perspective, the EPIC platform will enable Amtrak to respond to changing market conditions and customer needs more quickly, offer customers a fully integrated travel service rather than just a train ticket, and support distribution partners in ways that currently overload its systems.

The EPIC transformation is built on top of ARROW, the system at the heart of Amtrak's pricing, scheduling, and ticketing. Built 40 years ago, ARROW provides the foundation for processing transactions according to Amtrak's complex business rules. Instead of ripping out legacy core systems, Amtrak is modernizing them to enable new digital capabilities, which makes it possible for Amtrak to maintain operational stability throughout the transformation effort.

To achieve EPIC's full potential, Amtrak must first address a host of system challenges within ARROW. The ARROW system maintains reservation inventory and provides data to other Amtrak systems for accounting, billing, and analysis. Over the years, Amtrak IT has added useful custom capabilities, including automatic pricing, low-fare finders, and real-time verification of credit and debit cards.¹¹ But the customization didn't stop there, says Debbi Stone-Wulf, Amtrak's vice president of sales, distribution, and customer service.

"There are a lot of good things about ARROW, but there are items we need to address.

We've hard-coded business rules that don't belong there and added many point-to-point interfaces over the years as well. Changes take time. Our plan is to keep the good and get rid of the bad."

In anticipation of a 2017 rollout, IT and development staff are working to design EPIC's architecture and interfaces, and map out a training plan for business and front-end users. The solution includes a new services layer that exposes ARROW's core capabilities and integrations to both local systems and

cloud platforms. Amtrak is also looking for opportunities to leverage the EPIC platform in other parts of the organization, including, for example, bag tracking, which is currently a largely manual process.

"This project has helped us look at modern technology for our enterprise platform and implement it more seamlessly across legacy and new systems," says Stone-Wulf. "It has also helped us renew our focus on customers and on what Amtrak is delivering. In the past we would ask, 'How does it help Amtrak?' Now we ask, 'How does it help our customers?'"¹²



MY TAKE

KARENANN TERRELL

*Executive vice president, CIO
Wal-Mart Stores Inc.*

As CIO of Wal-Mart Stores Inc., my top priority is building and maintaining the technology backbone required to meet Wal-Mart's commitment to its customers, both today and in the future. Given our company's sheer size—we operate 11,500 stores in 28 countries—scale is a critical use case for every technology decision we make. And this burgeoning need for scale shows no sign of abating: In 2015, our net sales topped \$482 billion; [walmart.com](#) receives upward of 45 million visits monthly. As for our systems, there are probably more MIPS (million instructions per second) on our floor than any place on Earth. We've built a core landscape that combines custom-built solutions, packaged solutions we've bought and adapted, and services we subscribe to and use.

All of this makes the IT transformation effort we have undertaken truly historic in both complexity and reach. Over the last few years, technological innovation has disrupted both our customers' expectations and those of our partners and employees. We determined that to meet this challenge, we would modernize our systems to better serve Wal-Mart's core business capabilities: supply chain, merchandizing, store systems, point-of-sale, e-commerce, finance, and HR. As such, in all of these areas, we are working to create greater efficiencies and achieve higher levels of speed and adaptability.

“...Our IT strategy is not (and will never be) about reacting to the technology trend of the moment...”

From the beginning, three foundational principles have guided our efforts. First, we have grounded this project in the basic assumption that every capability we develop should drive an evergreen process. As technological innovation disrupts business models and drives customer expectations, modernization should be a new way of working, not an all-consuming, point-in-time event. Our goal has been to embed scope

into the roadmaps of each of our domain areas as quickly as possible to accommodate immediate and future needs. If we're successful, we will never have to take on another focused modernization program in my lifetime.

Second, in building our case for taking on such a far-reaching project now, we knew our ideas would gain traction more quickly if we grounded them in the business's own culture of prioritization. By focusing on enhanced functional capabilities, our efforts to reimagine the underlying technology became naturally aligned with the needs of the business. Within the larger conversation about meeting growing needs in our function areas, we deliberately avoided distinguishing or calling out the scope of modernization efforts. This approach has helped us build support across the enterprise and make sure modernization isn't viewed as something easily or quickly achieved.

Finally, we created strong architectural guidelines for our modernization journey, informed by the following tenets:

- Get started on no-brainer improvements—areas in which we have no regrets, with immediate mandate to take action and do it! For example, we had applications with kernels built around unsupported operating systems. We just had to get rid of them.
- Build out services-based platforms, aligned around customer, supply chain, and our other functional domains. Our “classic” footprint (a term I prefer to “legacy,” which seems to put a negative emphasis on most strategic systems) required decisions around modernization versus transition. We ended up with several platforms because of our scale and complexity—unfortunately, one single platform just isn't technologically possible. But we are building micro-services, then macro services, and, eventually, entire service catalogs.

- Create a single data fabric to connect the discrete platforms. The information generated across all touchpoints is Wal-Mart's oil—it provides a single, powerful view of customers, products, suppliers, and other operations, informing decision-making and operational efficiency while serving as the building block for new analytics products and offerings.

Is there a hard-and-fast calculus for determining which approach to take for reimagining core systems? Only to fiercely keep an eye on value. Our IT strategy is not (and will never be) about reacting to the technology trend of the moment. I'm sometimes asked, "Why don't you move everything to the

cloud?" My answer is because there's nothing wrong with mainframes; they will likely always play a part in our solution stack. Moreover, there's not enough dark fiber in the world to meet our transaction volumes and performance needs.

Business needs drive our embrace of big data, advanced analytics, mobile, and other emerging domains; we never put technology first in this equation. With that in mind, we're positioning our technology assets to be the foundation for innovation and growth, without compromising our existing core business, and without sacrificing our core assets. I'm confident we're on the right path.

CYBER IMPLICATIONS

Revitalizing core IT assets can introduce new cyber risks by potentially exposing vulnerabilities or adding new weaknesses that could be exploited. Technical debt in nonstandard or aging assets that have not been properly maintained, or legacy platforms that are given exceptions or allowed to persist without appropriate protections, allow threats that could otherwise be reasonably mitigated to persist, and expand risk.

Accordingly, efforts to reimagine the core can introduce both risk and opportunity. On the risk front, remediation efforts may add new points of attack with interfaces that inadvertently introduce issues or raise the exposure of long-standing weaknesses. Similarly, repurposing existing services can also create vulnerabilities when new usage scenarios extend beyond historical trust zones.

Yet, reimagining the core also presents opportunities to take stock of existing vulnerabilities and craft new cyber strategies that address the security, control, and privacy challenges in revitalized hybrid—or even cloud-only—environments. Companies can use core-focused initiatives as opportunities to shore up cyber vulnerabilities; insert forward-looking hooks around identity, access, asset, and entitlement management; and create reusable solutions for regulatory and compliance reporting.

We're moving beyond misperceptions about cloud vulnerabilities and the supposedly universal advantages of direct ownership in managing risk. Some companies operating legacy IT environments have mistakenly assumed that on-premises systems are inherently more secure than cloud-based or hybrid systems. Others have, in effect, decoupled security from major core systems or relied upon basic defensive capabilities that come with software packages. Core revitalization initiatives offer companies an opportunity to design security as a fundamental part of their new technology environments. This can mean major surgery, but in the current risk and regulatory environments, many organizations may have no choice but to proceed. Doing so as part of a larger core renaissance initiative can help make the surgery less painful.

Moreover, deploying network, data, and app configuration analysis tools during core renaissance discovery, analysis, and migration may also provide CIOs with greater insight into the architectural and systemic sprawl of legacy stacks. This, in turn, can help them fine-tune their core renaissance initiatives and their cyber risk management strategies.

Revitalizing core systems; deploying new analytics tools; performing open heart surgery—where will CIOs find the budget for efforts that many agree are now critical? Core renaissance can help on this front as well. Revitalizing and streamlining the top and bottom layers of legacy stacks may provide cost savings as efficiencies increase and “care and feeding” costs are reduced. Budget and talent resources can then be directed toward transforming security systems and processes. IT solutions increasingly focus either on built-in security and privacy features or on providing easy integration with third-party services that can address security and privacy needs. It is imperative that risk is integrated “by design” as opposed to bolted-on as an afterthought.

Approaches for addressing vulnerabilities will vary by company and industry, but many are crafted around the fundamental strategy of identifying cyber “beacons” that are likely to attract threats, and then applying the resources needed to protect those assets that are more valuable or that could cause significant damage if compromised.

As last year's cyber-attacks have shown, customer, financial, and employee data fit these risk categories.¹³ In addition to securing data and other assets, companies should also implement the tools and systems needed to monitor emerging threats associated with cyber beacons and move promptly to make necessary changes.

In the world of security and privacy there are no impregnable defenses. There are, however, strategies, tactics, and supporting tools that companies can utilize to become more secure, vigilant, and resilient in managing cyber risk. Efforts to reimagine the core are an opportunity to begin putting those ramparts in place.



Where do you start?

Core modernization is already on many IT leaders' radar. In a recent Forrester survey of software decision makers, 74 percent listed updating/modernizing key legacy applications as critical or high priority.¹⁴ The challenge many of these leaders face will be to move from an acknowledged need to an actionable plan with a supporting business case and roadmap. Reimagining the core could involve gearing up for a sustained campaign of massive scope and possible risk, potentially one that business leaders might not be able to understand or willing to fully support.

Yet, the fact is that CIOs no longer have a choice. In the same way that the core drives the business, it also drives the IT agenda. Consider this: What if that same legacy footprint could become the foundation for innovation and growth and help fuel broader transformation efforts?

The following considerations may help bring this vision more clearly into focus:

- **It's a business decision:** There should be a clear business case for modernizing core systems. Historically, business case analysis has tended to focus primarily on cost avoidance, thus rendering many proposed initiatives uneconomical. It's hard to justify rewriting a poorly understood, complex core legacy application based only on the prospect of avoiding costs. However, when companies frame the business case in terms of lost business opportunities and lack of agility, the real costs of technical debt become more apparent. Even then, however, it is important to be realistic when projecting the extent of hidden complexity, and how much work and budget will be required to meet the challenges that surround this complexity.
- **Tools for the trade:** Until recently, the process of moving off ERP customizations and rewriting millions of lines of custom

logic has been resource-intensive and issue-prone to the point of being cost-prohibitive. Why migrate that old COBOL application when it's cheaper to train a few folks to maintain it? Increasingly, however, new technologies are making core modernization much more affordable. For example, conversion technologies can achieve close to 100 percent automated conversion of old mainframe programs to Java and modern scripting languages. New tools are being developed to automate the scanning and analysis of ERP customizations, which allows engineers and others to focus their efforts on value-added tasks such as reinventing business processes and user interactions.

- **Shoes for the cobbler's children:** Leading CIOs caution against approaching core modernization as a project with a beginning and an end. Instead, consider anchoring efforts in a broader programmatic agenda.¹⁵ Keep in mind that core modernization efforts shouldn't be limited to data and applications—they should also revisit underlying infrastructure. As IT workloads migrate to higher levels of abstraction, the infrastructure will require deep analysis. Shifting simultaneously to software-defined environments and autonomic platforms¹⁶ can amplify application and data efforts. Similarly, higher-level IT organization, delivery, and interaction models will need to evolve along with the refreshed core. Consider undertaking parts of the right-speed IT model¹⁷ in conjunction with core modernization efforts.
- **Honor thy legacy:** Reimagining the core has everything to do with legacy. That legacy is entangled in a history of investment decisions, long hours, and careers across the organization. A portion of your workforce's job history (not to

mention job security) is embedded in the existing footprint. As such, decisions concerning the core can be fraught with emotional and political baggage. As you reimagine core systems, respect your

company's technology heritage without becoming beholden to it. Sidestep subjective debates by focusing on fact-based, data-driven discussions about pressing business needs.

Bottom line

Legacy core systems lie at the heart of the business. In an age when every company is a technology company, these venerable assets can continue to provide a strong foundation for the critical systems and processes upon which growth agendas are increasingly built. But to help core systems fulfill this latest mission, organizations should take steps to modernize the underlying technology stack, making needed investments grounded in outcomes and business strategy. By reimagining the core in this way, companies can extract more value from long-term assets while reinventing the business for the digital age.

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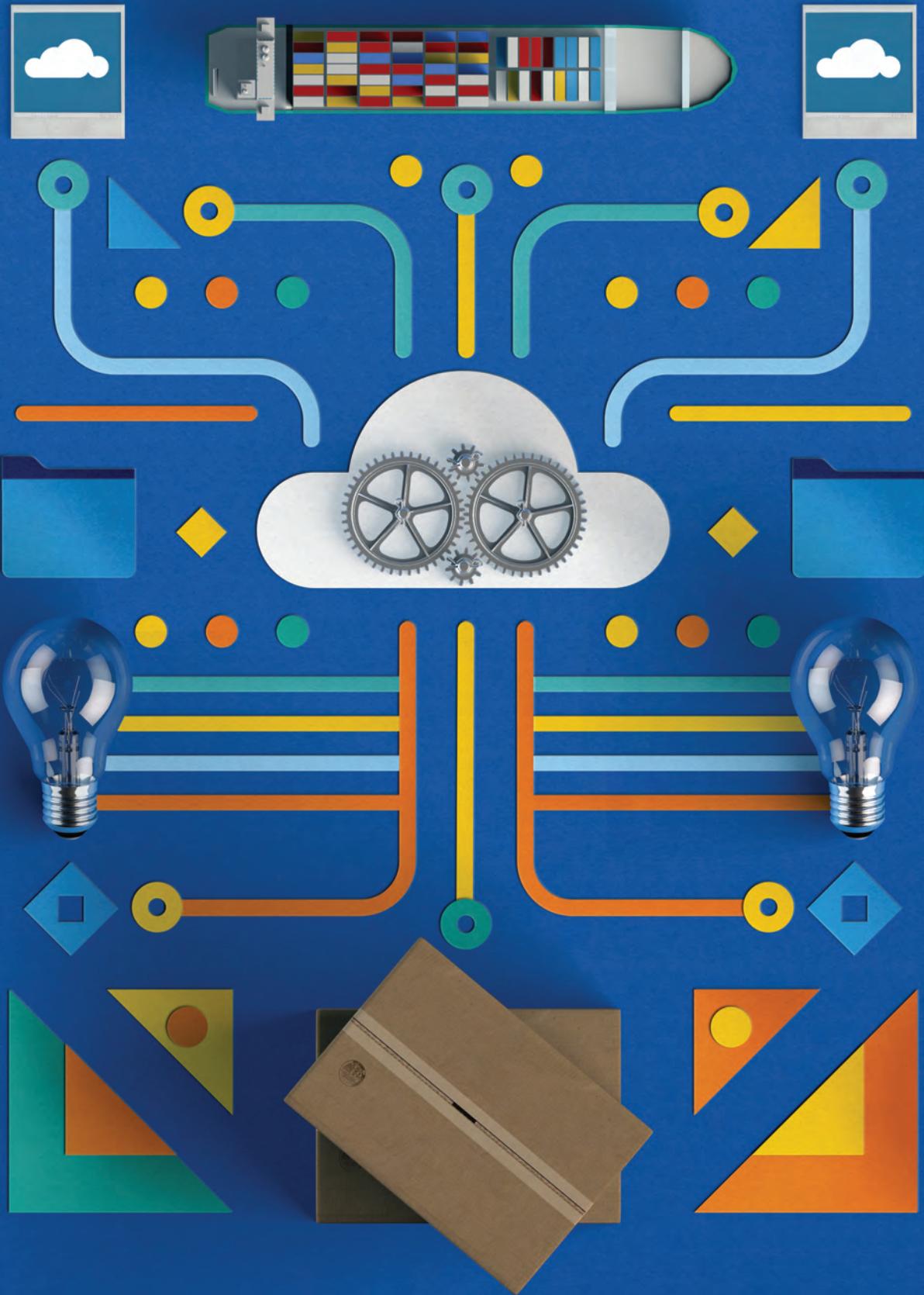


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Endnotes

1. Deloitte, *2015 global CIO survey*, <http://www2.deloitte.com/uk/en/pages/technology/articles/cio-survey.html>, accessed January 19, 2016.
2. Sharon Florentine, “Four ways businesses can close the legacy tech skills gap,” *CIO*, October 15, 2015, <http://www.cio.com/article/2993834/staff-management/4-ways-businesses-can-close-the-legacy-tech-skills-gap.html>, accessed January 19, 2016.
3. Texas Department of Motor Vehicles, <http://www.txdmv.gov/about-us>, accessed October 7, 2015.
4. Whitney Brewster (executive director, Tx-DMV) and Eric Obermier (CIO, TxDMV), interview with the authors, December 14, 2015.
5. PayPal corporate fact sheet, <https://www.paypal.com/us/webapps/mpp/about/>, accessed October 26, 2015.
6. Linda Tucci, “Four pillars of PayPal’s big bang agile transformation,” *Search CIO*, 2014, <http://searchcio.techtarget.com/feature/Four-pillars-of-PayPals-big-bang-Agile-transformation>, accessed November 17, 2015.
7. Charles Babcock, “PayPal revamps data center for agility,” *Information Week*, April 28, 2015, <http://www.informationweek.com/strategic-cio/executive-insights-and-innovation/paypal-revamps-data-center-for-agility/d/d-id/1319855>, accessed November 17, 2015.
8. Jenna Wortham, “Braintree, a payments company, buys Venmo for \$26.2 million,” Bits Blogs, *NYTimes.com*, August 16, 2012, http://bits.blogs.nytimes.com/2012/08/16/payments-start-up-braintree-buys-venmo-for-26-2-million/?_r=0, accessed October 26, 2015.
9. “PayPal to acquire Xoom,” *BusinessWire*, July 1, 2015, <http://www.businesswire.com/news/home/20150701006690/en/PayPal-Acquire-Xoom>, accessed October 26, 2015.
10. Ingrid Luden, “PayPal’s David Marcus: Braintree keeps its brand and ops intact; Venmo will be used for big P2P push,” *TechCrunch*, September 26, 2013, <http://techcrunch.com/2013/09/26/paypals-david-marcus-braintree-keeps-its-brand-and-ops-intact-venmo-will-be-used-for-big-p2p-push/>, accessed October 26, 2015.
11. National Railroad Passenger Corporation Major Information Systems, https://www.amtrak.com/ccurl/244/705/Amtrak-Major_Information_Systems-Oct2008-2.pdf, accessed January 12, 2016.
12. Debbi Stone-Wulf (vice president, sales, distribution and customer service, Amtrak), interview with the authors, December 15, 2015.
13. Paul Szoldra, “The 9 worst cyber attacks of 2015,” *Tech Insider*, December 29, 2015, <http://www.techinsider.io/cyberattacks-2015-12>, accessed February 8, 2016.
14. Paul D. Hamerman and Randy Heffner, *Don’t just maintain business applications, raise business responsiveness*, Forrester Research, Inc., October 23, 2015.
15. Chris Murphy, “Why Wal-Mart’s CIO calls legacy IT systems ‘classic’,” *Information Week*, May 6, 2015, <http://www.informationweek.com/why-wal-marts-cio-calls-legacy-it-systems-classic/a/d-id/1320286>, accessed January 19, 2016.
16. Deloitte Consulting LLP, *Tech Trends 2016: Autonomic platforms*, 2016.
17. Deloitte Consulting LLP, *Tech Trends 2016: Right-speed IT*, 2016.



Autonomic platforms

Building blocks for labor-less IT

IT may soon become a self-managing service provider without technical limitations of capacity, performance, and scale. By adopting a “build once, deploy anywhere” approach, retooled IT workforces—working with new architectures built upon virtualized assets, containers, and advanced management and monitoring tools—could seamlessly move workloads among traditional on-premises stacks, private cloud platforms, and public cloud services.

Autonomic platforms build upon and bring together two important trends in IT: software-defined everything’s¹ climb up the tech stack, and the overhaul of IT operating and delivery models under the DevOps² movement. With more and more of IT becoming expressible as code—from underlying infrastructure to IT department tasks—organizations now have a chance to apply new architecture patterns and disciplines. In doing so, they can remove dependencies between business outcomes and underlying solutions, while also redeploying IT talent from rote low-value work to the higher-order capabilities needed to deliver right-speed IT.³

To truly harness autonomic platforms’ potential, one must first explore its foundational elements.

Virtualization up

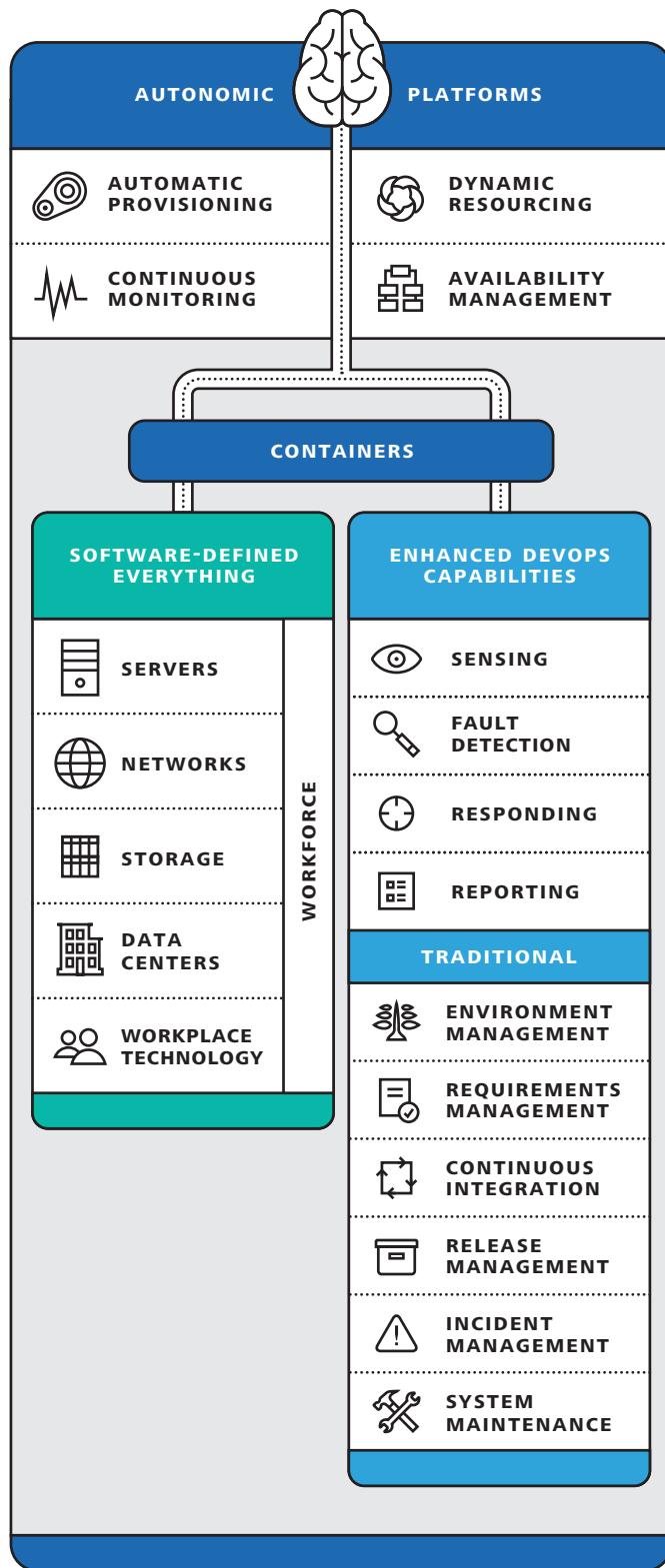
The kernel of software-defined everything (SDE) has been a rallying cry in IT for decades. The idea is straightforward: Hardware assets like servers, network switches, storage arrays,

and desktop facilities are expensive, difficult to manage, and often woefully suboptimized. Often procured and configured for single-purpose usages, they are sized to withstand the most extreme estimates of potential load. Moreover, they are typically surrounded by duplicate environments (most of them idle) that were created to support new development and ongoing change. In the mainframe days, such inefficiencies were mitigated somewhat by logical partitions—a segment of a computer’s hardware resources that can be virtualized and managed independently as a separate machine. Over the years, this led to virtualization, or the creation of software-based, logical abstractions of underlying physical environments in which IT assets can be shared.

Notably, virtualization shortened the time required to provision environments; rather than waiting months while new servers were ordered, racked, and configured, organizations could set up a virtual environment in a matter of hours. Though virtualization started at the server level, it has since expanded up, down,

Figure 1. Autonomic architecture

Autonomic platforms combine two important IT movements: software-defined everything across the technology stack and DevOps operating and delivery models. Both movements are further accelerated by robotics, process automation, and cognitive technologies.



and across the technology stack. It is now also widely adopted for network, storage, and even data center facilities. Virtualization alone now accounts for more than 50 percent of all server workloads, and is projected to account for 86 percent of workloads by the end of 2016.⁴

DevOps down

As virtualization was working its way up the stack, the methods and tools for managing IT assets and the broader “business of IT” were undergoing a renaissance. Over time, IT departments became saddled with manual processes, cumbersome one-size-fits-all software development lifecycle (SDLC) methodologies. Or they developed “over-the-wall engineering” mind-sets in which individuals fulfill their own obligations with little understanding or concern about the needs of downstream teams. This operational baggage has fueled tension between IT’s development group, which pushes for speed and experimentation with new features and tools, and its operations organization, which prizes stability, performance, and predictable maintenance.

To combat organizational inefficiency as well as any discord that has arisen among various parts of the IT value chain, many organizations are implementing DevOps,⁵ a new way of organizing and focusing various teams. DevOps utilizes tools and processes to eliminate some of the waste embedded in legacy modes for operating IT. In a way, it also extends the software-defined-everything mission into the workforce by instilling abstractions and controls across the tasks required to manage the end-to-end life cycle of IT. Scope varies by organization, but DevOps often concentrates on a combination of the following:

- **Environment management:** Configuration, provisioning, and deployment of (increasingly virtualized) environments
- **Requirements management:** Disciplines for tracking details and priorities of features

and specifications—both functional and nonfunctional

- **Continuous integration:** Providing the means to manage code updates across multiple developers and to validate and merge edits to resolve any conflicts, issues, or redundant efforts
- **Release management:** Bundling and deploying new solutions or editing existing solutions through staging environments into production
- **Event/incident management:** Tracking, triage, and resolution of system bugs or capability gaps
- **System maintenance/monitoring:** Ongoing tracking of overall solution performance across business and technical attributes, including network, servers, and storage components
- **Production support:** Managing and monitoring application performance in real time, including monitoring run-time activities, batch jobs, and application performance
- **Business command center:** Real-time management/monitoring of business transactions such as payment flows, inventory bottlenecks, and existential threats

Enter autonomic platforms

With the building blocks in place, the real fun can begin: automating and coordinating the interaction of these software-defined capabilities. That's where autonomic platforms come in, layering in the ability to dynamically manage resources while integrating and orchestrating more of the end-to-end activities required to build and run IT solutions.

When discussing the concept of autonomics, we are really talking about

automation + robotics, or taking automation to the next level by basing it in machine learning. Almost all traditional IT operations are candidates for autonomics, including anything that's workflow-driven, repetitive, or policy-based and requires reconciliation between systems. Approaches have different names: robotic process automation (RPA), cognitive automation, intelligent automation, and even cognitive agents. However, their underlying stories are similar—applying new technologies to automate tasks and help virtual workers handle increasingly complex workloads.

Virtualized assets are an essential part of the autonomics picture, as are the core DevOps capabilities listed above. Investments in these assets can be guided by a handful of potential scenarios:

- **Self-configuration:** Automatic provisioning and deployment of solution stacks include not only the underlying data center resources and requisite server, network, and storage requirements, but also the automated configuration of application, data, platform, user profile, security, and privacy controls, and associated supporting tools, interfaces, and connections for immediate productivity. Importantly, efforts should also be made to build services to automatically decommission environments and instances when they are longer needed—or, perhaps more interestingly, when they are no longer being used.
- **Self-optimizing:** Self-optimizing refers to dynamic reallocation of resources in which solutions move between internal environments and workloads are shifted to and between cloud services. The rise of containers has been essential here, creating an architecture that abstracts the underlying physical and logical infrastructure, enabling portability across environments. Note that this “build once, deploy anywhere” architecture also requires services to manage containers, cloud services, and the migration of build- and run-time assets.

- **Self-healing:** DevOps asked designers to embed instrumentation and controls for ongoing management into their solutions, while also investing in tools to better monitor system performance. Autonomic platforms take this a step further by adding detailed availability and service-level availability management capabilities, as well as application, database, and network performance management tools. These can be used to continuously monitor the outcome-based health of an end-to-end solution, anticipate problems, and proactively take steps to prevent an error, incident, or outage.

The journey ahead

The promise of autonomic platforms (like those of its predecessors, SDE and DevOps) can wither in the face of circumscribed initiatives and siloed efforts. Heavy segmentation among infrastructure and delivery management tool vendors does not help either. The good news is that established players are now introducing products that

target parts of emerging platforms and help retrofit legacy platforms to participate in autonomic platforms. Start-ups are aggressively attacking this space, bolstered by their ability to capture value through software enablers in segments historically protected by huge manufacturing and R&D overheads. Multivendor landscapes are the new reality—the arrival of an “ERP for IT” solution by a single vendor remains years away. Yet even without a single end-to-end solution, leading organizations are taking holistic, programmatic approaches to deploy and manage autonomic platforms. These often include taking tactical first steps to consolidate environments and solutions and to modernize platforms—steps that can help fund more ambitious enablement and automation efforts.

Furthermore, autonomic platforms can act as a Trojan horse that elevates IT’s standing throughout the enterprise. How? By boosting IT responsiveness and agility today and by providing the architectural underpinnings needed to support the next-generation solutions and operating environments of tomorrow.

Lessons from the front lines

Automating one step at a time

In support of the company's ongoing digital transformation, American Express continually strives to enhance the way it does business to meet changing customer needs. The financial services company's goal is engage new customer groups wherever they are, whenever they choose, using whatever device they prefer.

To this end, tech and business leaders have challenged themselves to accelerate their existing product development cycle. The technology organization took up the challenge by looking for a way to scale its infrastructure and operations to deliver across a large and often siloed ecosystem in new and innovative ways. Cost and speed complaints surfaced, with incremental plans for modest improvements leading to one executive observing, "We don't need a faster horse; what we really need is an automobile." In response, the group supporting the prepaid/mobile payments platform—which serves as the backbone for the company's digital products—rallied behind a "software-defined everything" strategy—from environments and platforms to operating and delivery models.

They first began working on reducing cost, improving time to market, and automating much of the prepaid/mobile payments platform. Then, they put tools in place that allowed developers to deploy their solutions, from development through production, without friction. Development teams are now incented differently—focused not only on speed to value, but also on building operationally manageable code. Such enhancements typically manifest in important ways, from the percentage of SCRUM scope reserved to pay down technical debt⁶ to creating expectations for embedded instrumentation for ongoing ops.

On the operations side, Amex's technology team adopted ITIL processes built around controls, checkpoints, and segregation of

duties. Metrics emphasized process compliance rather than what the process was trying to control or its impact to the business. To change the mind-set, infrastructure specialists were given training to help them hone their development skills and gain expertise in autonomic platforms and tools. These specialists were also charged with creating lower-level function automation and putting in place monitoring, maintenance, and self-healing capabilities functions focused on business process and activity monitoring, not on the performance of the underlying technology components.

Additionally, other product teams have begun transforming the systems that support other American Express products and platforms. In this environment, product development still relies upon more traditional software engineering methods, such as waterfall methodologies and manual testing and deployment. Developers have begun to tackle transformation in stages—introducing concepts from agile development such as regression testing, measuring legacy code quality, and establishing foundational hooks and automated routines for instrumentation and maintenance. In addition, they are working to help all team members become more versed in agile and DevOps processes and techniques.

Given the complexity of the existing multivendor, multiplatform IT ecosystem and the overarching financial regulatory requirements, American Express is taking a variety of approaches to automating and integrating its IT ecosystem—rolled out in phases over time. And while the existing team has taken impressive leaps, the company has also strategically inserted talent who "have seen this movie before." At the end of the day, the challenge is about fostering a culture and mind-set change—pushing a new vision for IT and revitalizing existing technical and talent assets to drive improved value for customers



and to differentiate American Express from the competition.⁷

Boosting productivity with DevOps

To keep up with exploding demand for cloud services in a marketplace defined by rapid-fire innovation, VMware's development operations team had become a beehive of activity. In 2014 alone, the company ran five release trains in parallel and brought 150 projects to completion.

Yet, the pace of development was becoming unsustainable. The process was beset by too many handoffs and downtimes for code deployments. Quality assurance (QA) was slowing release momentum. According to Avon Puri, VMware's vice president of IT, enterprise applications, and platforms, the company's approach to development—from requirements to release—needed an overhaul. “It was taking us 22 days to get a new operating environment up and running,” he says. “Also, because of our overhead, our projects were becoming increasingly expensive.”

So the company launched a nine-project pilot to explore the possibility of transitioning from traditional development to a DevOps model with a 70-member DevOps team, with the aim of bringing down costs, completing projects more quickly, and streamlining the QA process. The pilot took a three-pronged “people-process-technology” approach, and focused on the following parameters: resource efficiency, application quality, time to market, deployment frequency, and cost savings.

The people transformation component involved organizing key talent into a self-contained DevOps team that would own projects end-to-end, from design to release. To support this team, pilot leaders took steps to break down barriers between departments, processes, and technologies, and to help developers work more effectively with business units in early planning. Notably, they also deployed a multimodal IT working model in which process models and phase gates were

aligned to support both traditional and nimble IT teams. On the process front, key initiatives included creating a continuous delivery framework and implementing a new approach to QA that focused more on business assurance than quality assurance, and emphasized automation throughout product testing.

Finally, the pilot's technology transformation effort involved automating the deployment process using VMware's own vRealize suite, which helped address “last-mile” integration challenges. Pilot leaders deployed containers and created a software-defined stack across servers, storage, and the network to help reduce deployment complexity and guarantee portability.

Pilot results have been impressive; Resource efficiency improved by 30 percent, and app quality and time to market each improved by 25 percent. Puri says that results like these were made possible by aligning everyone—developers, admins, and others—on one team, and focusing them on a single system. “This is where we get the biggest bang for the buck: We say, ‘Here's a feature we want, this is what it means,’ someone writes the code, and after QA, we put it into production.”⁸

Innovation foundry

In downtown Atlanta, a software engineer shares an idea with his fellow team members for improving a product under development. Over the course of the morning, Scrum team members quickly and nimbly work to include the idea in their current sprint to refine and test the viability of the idea, generate code, and publish it to the code branch. Within hours, the enhancement is committed into the build, validated, regression-tested against a full suite of test scenarios, dynamically merged with updates from the rest of the team, and packaged for deployment—all automatically.

This is just another day in the life of iLab, Deloitte Consulting Innovation's software product development center, which builds commercial-grade, cloud-based, analytics-driven, software products designed to be

launched as stand-alone offerings. iLab was born out of a need to industrialize the intellectual property of the core consulting practice through software creation by dedicated product development teams, says Casey Graves, a Deloitte Consulting LLP principal responsible for iLab's creative, architecture, infrastructure, engineering, and support areas. "Today, our goal is to develop impactful products, based upon our consulting intellectual property, quickly and efficiently. That means putting the talent, tools, and agile processes in place to realize automation's full potential."

To support the pace of daily builds and biweekly sprints, iLab has automated process tasks wherever possible to create a nearly seamless process flow. "Because we use agile techniques, we are able to use continuous

integration with our products," Graves says. "Today we still deploy manually, but it is by choice and we see that changing in the near future."

iLab's commitment to autonomic platforms has upstream impacts, shaping the design and development of solutions to include hooks and patterns that facilitate automated DevOps. Downstream, it guides the build-out of underlying software-defined networks designed to optimally support product and platform ambitions. Moreover, supporting a truly nimble, agile process requires ensuring that product teams are disciplined to following the processes and have the tools, technologies, skills they need to achieve project goals, and to work effectively on an increasingly automated development platform.⁹



MY TAKE

JAMES GOUIN

CTO and transformation executive

AIG

AIG's motto, "Bring on tomorrow," speaks to our company's bedrock belief that by delivering more value to our 90 million insurance customers around the world today, we can help them meet the challenges of the future.

"This is not just any IT modernization initiative; the disruptive forces bearing down on the financial services sector are too fundamental to address with a version upgrade or grab bag of "shiny object" add-ons."

It also means reinventing ourselves in a market being disrupted by new players, new business models, and changing customer expectations. Enablement of end-to-end digital services is everything today. Our customers want products and services fast, simple, and agnostic of device or channel. To deliver that value consistently, we're working to transform our IT systems and processes. Our goal: to build the flexible infrastructure and platforms needed to deliver anytime, anywhere, on any device, around the globe—and do it quickly.

This is not just any IT modernization initiative; the disruptive forces bearing down on the financial services sector are too fundamental to address with a version upgrade or grab bag of "shiny object" add-ons. Insurance providers, banks, and investment firms currently face growing pressure to transform their business models and offerings, and to engage customers in new ways. This pressure is not coming from within our own industry. Rather, it emanates from digital start-ups innovating relentlessly and, in doing so, creating an entirely new operating model for IT organizations. I think of this as a "west coast" style of IT: building minimally viable products and attacking market niches at speeds that companies with traditional "east coast" IT models dream of.

Adapting a large organization with legacy assets and multiple mainframes in various locations around the globe to this new model is not easy, but it is a "must do" for us. Our goal is to be a mobile-first, cloud-first organization at AIG. To do that, our infrastructure must be rock solid, which is why strengthening the network was so important. We're investing in a software-defined network to give us flexible infrastructure to deploy anytime and anywhere—region to region, country to country. These investments also introduce delivery capabilities in the cloud, which can help us enter new relationships and confidently define a roadmap for sourcing critical capabilities that are outside of AIG's direct control.

Everything we're doing is important for today's business. But it is also essential in a world where the sensors and connected devices behind the Internet of Things have already begun changing our industry. Telematics is only the beginning. Data from sensors, people, and things ("smart" or otherwise) will give us unprecedented visibility into customer behavior, product performance, and risk. This information can be built into product and pricing models, and used to fuel new offerings. The steps we are taking to automate IT and create a flexible, modern infrastructure will become the building blocks of this new reality.

AIG's transformation journey is happening against a backdrop of historic change throughout the insurance industry and in insurance IT. Not too long ago, underwriters, actuaries, and IT were part of the back office. Now, IT also operates in the middle and front offices, and has taken a seat in the boardroom. Likewise, the consumerization of technology has made everyone an IT expert; executives, customers, and everyone in between now have extremely high expectations of technology—and of those who manage it within organizations like ours. The bar is high, but at the end of the day everyone is just reinforcing why we're here: to deliver great products and services for our customers.

CYBER IMPLICATIONS

Risk should be a foundational consideration as organizations create the infrastructure required to move workloads seamlessly among traditional on-premises stacks, private cloud platforms, and public cloud services. Much of this infrastructure will likely be software-defined, deeply integrated across components, and potentially provisioned through the cloud. As such, traditional security controls, preventive measures, and compliance initiatives will likely be outmoded because the technology stack they sit on top of was designed as an open, insecure platform.

To create effective autonomic platforms within a software-defined technology stack, key concepts around things like access, logging and monitoring, encryption, and asset management should be reassessed, and, if necessary, enhanced. There are new layers of complexity, new degrees of volatility, and a growing dependence on assets that may not be fully within your control. The risk profile expands as critical infrastructure and sensitive information is distributed to new and different players.

Containers make it possible to apply standards at the logical abstraction layer that can be inherited by downstream solutions. Likewise, incorporating autonomic capabilities within cyber-aware stacks can help organizations respond to threats in real time. For example, the ability to automatically detect malware on your network, dynamically ring-fence it, and then detonate the malware safely (and alert firewalls and monitoring tools to identify and block this malware in the future) could potentially make your organization more secure, vigilant, and resilient.

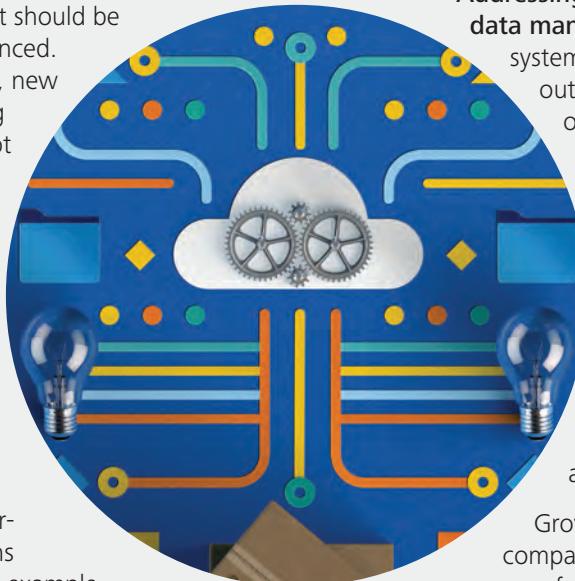
Revamped cybersecurity components should be designed to be consistent with the broader adoption of real-time DevOps. Autonomic platforms and software-defined infrastructure are often not just about cost reduction and efficiency gains; they can set the stage for more streamlined, responsive IT capabilities, and help address some of today's more mundane but persistent challenges in security operations.

Incorporating automated cyber services in the orchestration model can free security administrators to focus on more value-added and proactive tasks. On the

flip side, incorporating cyber into orchestration can give rise to several challenges around cyber governance:

- **Determining what needs to stay on-premises and what doesn't:** Every organization will have unique considerations as it identifies the infrastructure components that can be provisioned from external sources, but for many the best option will likely be a mix based on existing investments, corporate policies, and regulatory compliance. In any scenario, the security solutions should be seamless across on-premises and off-premises solutions to prevent gaps in coverage.

- **Addressing localization and data management policies:** As systems spread inside and outside corporate walls, IT organizations may need to create a map that illustrates the full data supply chain and potential vulnerabilities. This can help guide the development of policies that determine how all parties in the data supply chain approach data management and security.



Growing numbers of companies are exploring avenues for using virtualization to address these and other challenges while improving security control. At VMware, one approach leverages the emerging microsegmentation trend. "Microsegmentation is about using virtualization as a means to create a virtual data center where all the machines that enable a multi-tiered service can be connected together within a virtual network," says Tom Corn, senior vice president of security products. "Now you have a construct that allows you to align your controls with what you want to protect."

Corn adds that with microsegmentation, it is very difficult for an attacker to get from the initial point of entry to high-value assets. "If someone breaks in and has one key, that one key should not be the key to the kingdom; we need to compartmentalize the network such that a breach of one system is not a breach of everything you have."¹⁰

Where do you start?

Autonomic platforms typically have humble beginnings, often emerging from efforts to modernize pieces of the operating environment or the SDLC. Replacing siloed, inefficient components with siloed, optimized components no doubt has an upside. However, companies may achieve more compelling results by shifting from one-offs to any of the following integrated, orchestrated approaches:

- **Option 1:** A greenfield build-out of an autonomic ecosystem featuring cloud, software-defined everything, and agile techniques. Existing workloads can be moved to the greenfield over time, while new workloads can start there.
- **Option 2:** Move to the new autonomic platform world using containers. Simplify the environment and sunset redundant or useless components over time.
- **Option 3:** Move to the new world application by application, realizing that some applications will never make the journey and will have to die on the vine.

Before we drill deeper into these and other strategies, it is important to note that ongoing budget pressures and rising business expectations don't lend themselves to far-reaching transformation agendas—especially those targeting IT's behind-the-scenes trappings. That said, operations continue to dominate global IT budgets, accounting for 57 percent of overall spending, according to findings from Deloitte's *2015 global CIO survey*.¹¹ (Interestingly, only 16 percent of spending targets business innovation.) Addressing inefficiencies inherent to legacy infrastructure and IT delivery models can likely improve operations and reduce costs. That those same investments can also increase agility and business responsiveness may seem

too good to be true—a self-funding vehicle to build concrete capabilities for the IT organization of the future.

The following can serve as starting points in the journey to autonomic platforms:

- **Containers:** Though the hype around the container movement is largely justified, we remain in the early days of adoption. IDC analyst Al Gillen estimates that fewer than one-tenth of 1 percent of enterprise applications are currently running in containers. What's more, it could be 10 years before the technology reaches mainstream adoption and captures more than 40 percent of the market.¹² Consider adopting a twofold strategy for exploration. First, look at open-source and start-up options to push emerging features and standards. Then, tap established vendors as they evolve their platforms and offerings to seamlessly operate in the coming container-driven reality.
- **API economy:**¹³ In some modern IT architectures, large systems are being broken down into more manageable pieces known as microservices. These sub-components exist to be reused in new and interesting ways over time.¹⁵ For example, organizations may be able to realize autonomic platforms' full potential more quickly by deconstructing applications into application programming interfaces (APIs)—services that can be invoked by other internal or external systems. These modular, loosely coupled services, which take advantage of self-configuration, self-deployment, and self-healing capabilities much more easily than do behemoth systems with hard-wired dependencies, help reduce complex remediation and the amount of replatforming required

for legacy systems to participate in autonomic platforms.

- **Cloudy perspective:** Cloud solutions will likely play a part in any organization's autonomic platform initiatives. Increasingly, virtualized environments are being deployed in the cloud: In 2014, 20 percent of virtual machines were delivered through public infrastructure-as-a-service (IaaS) providers.¹⁶ However, don't confuse the means with the end. Ultimately, cloud offerings represent a deployment option, which may or may not be appropriate based on the workload in question. Price per requisite performance (factoring in long-term implications for ongoing growth, maintenance, and dependencies) should drive your decision of whether to deploy a public, private, or hybrid cloud option or embrace an on-premises option based on more traditional technologies.

- **Robotics:** While much of the broader robotics dialogue focuses on advanced robotics—drones, autonomous transportation, and exoskeletons—progress is also being made in the realm of virtualized workforces. RPA, cognitive agents, and other autonomic solutions are advancing in both IT operations and business process outsourcing. Their promise encompasses more than efficiency gains in mundane tasks such as entering data. Indeed, the most exciting opportunities can be found in higher-order, higher-value applications, such as virtual infrastructure engineers that can proactively monitor, triage, and heal the stack, or virtual loan specialists that help customers fill out mortgage applications.

Bottom line

IT has historically underinvested in the tools and processes it needs to practice its craft. Technology advances in underlying infrastructure now offer IT an opportunity to reinvent itself with revamped tools and approaches for managing the life cycle of IT department capabilities. By deploying autonomic platforms, IT can eliminate waste from its balance sheet while shifting its focus from low-level tasks to the strategic pillars of business performance.

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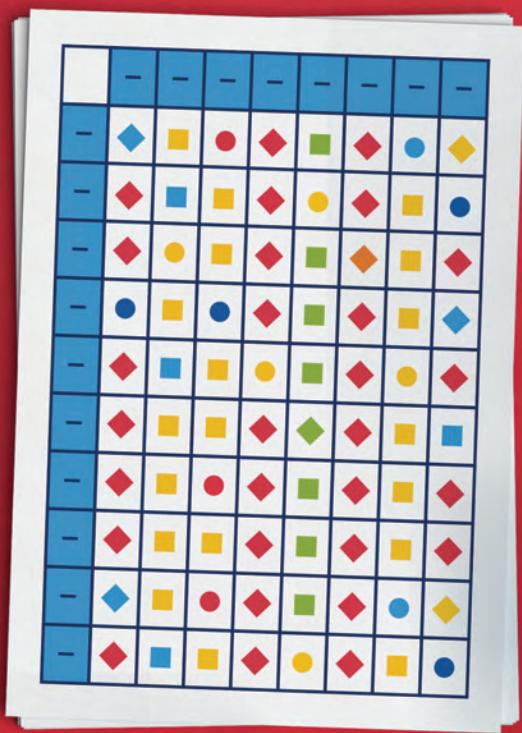
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Endnotes

1. Deloitte Consulting LLP, *Tech Trends 2015: Software-defined everything*, 2015.
2. Deloitte Consulting LLP, *Tech Trends 2014: Real-time DevOps*, 2014
3. Deloitte Consulting LLP, *Tech Trends 2016: Right-speed IT*, 2016.
4. Kent Weaver and Jim Gallagher, “The 2015 rules of data center migration,” *Baseline*, January 30, 2015, <http://www.baselinemag.com/infrastructure/the-2015-rules-of-data-center-migration.html>, accessed January 20, 2016.
5. Amy DeMartine, Eveline Oehrlich and Megan Doerr, “Brief: Join the DevOps craze, but start with the right business case,” *Forrester Research Inc.*, September 24, 2015.
6. Deloitte Consulting LLP, *Tech Trends 2014: Inspiring disruption*, 2014.
7. Rhushabh Mehta (vice president and software development leader, American Express) and Bo Gorham (vice president of global infrastructure, American Express Technology), interview with the authors, November 2015.
8. Avon Puri (vice president of enterprise applications and platforms, VMware), interview with the authors, November 2015.
9. Casey Graves (principal, Deloitte Consulting LLP), interview with the authors, January 7, 2016.
10. Sean Michael Kerner, “VMware plots a course for the future of security,” *eWeek*, April 20, 2015, <http://www.eweek.com/security/vmware-plots-a-course-for-the-future-of-security.html>, accessed December 29, 2015.
11. Deloitte, *2015 global CIO survey*, <http://www2.deloitte.com/uk/en/pages/technology/articles/cio-survey.html>, accessed January 20, 2016.

12. Brandon Butler, "Why (and how) VMware created a new type of virtualization just for containers," *CIO*, September 5, 2015, <http://www.cio.com/article/2983377/data-center/why-and-how-vmware-created-a-new-type-of-virtualization-just-for-containers.html>, accessed January 20, 2016.
13. Deloitte Consulting LLP, *Tech Trends 2015: API economy*, 2015.
14. Matt Miller, "Innovate or die: The rise of microservices," *Wall Street Journal (CIO Journal)*, October 5, 2015, <http://blogs.wsj.com/cio/2015/10/05/innovate-or-die-the-rise-of-microservices/>, accessed January 20, 2016.
15. Thomas J. Bittman, "Four trends changing server virtualization decisions," Gartner Inc., March 5, 2015.



Blockchain: Democratized trust

Distributed ledgers and the future of value

Trust is a foundational element of business. Yet maintaining it—particularly throughout a global economy that is becoming increasingly digital—is expensive, time-consuming, and, in many cases, inefficient. Some organizations are exploring how blockchain, the backbone behind bitcoin, might provide a viable alternative to the current procedural, organizational, and technological infrastructure required to create institutionalized trust. Though these exploratory efforts are still nascent, the payoff could be profound. Like the Internet reinvented communication, blockchain may similarly disrupt transactions, contracts, and trust—the underpinnings of business, government, and society.

Discussions of blockchain often begin with bitcoin, the cryptocurrency that gained notoriety as much for its novelty as for the volatility of its valuation. In a fog of media reports driven by bitcoin's associations with dubious use cases,¹ the far-reaching potential of blockchain—the technology underpinning bitcoin—remained largely obscured. Yet, that is changing. Organizations throughout the public and private sectors have begun exploring ways that blockchain might profoundly transform some of their most basic operations, from the way they execute contracts and carry out transactions to the ways they engage customers and more.

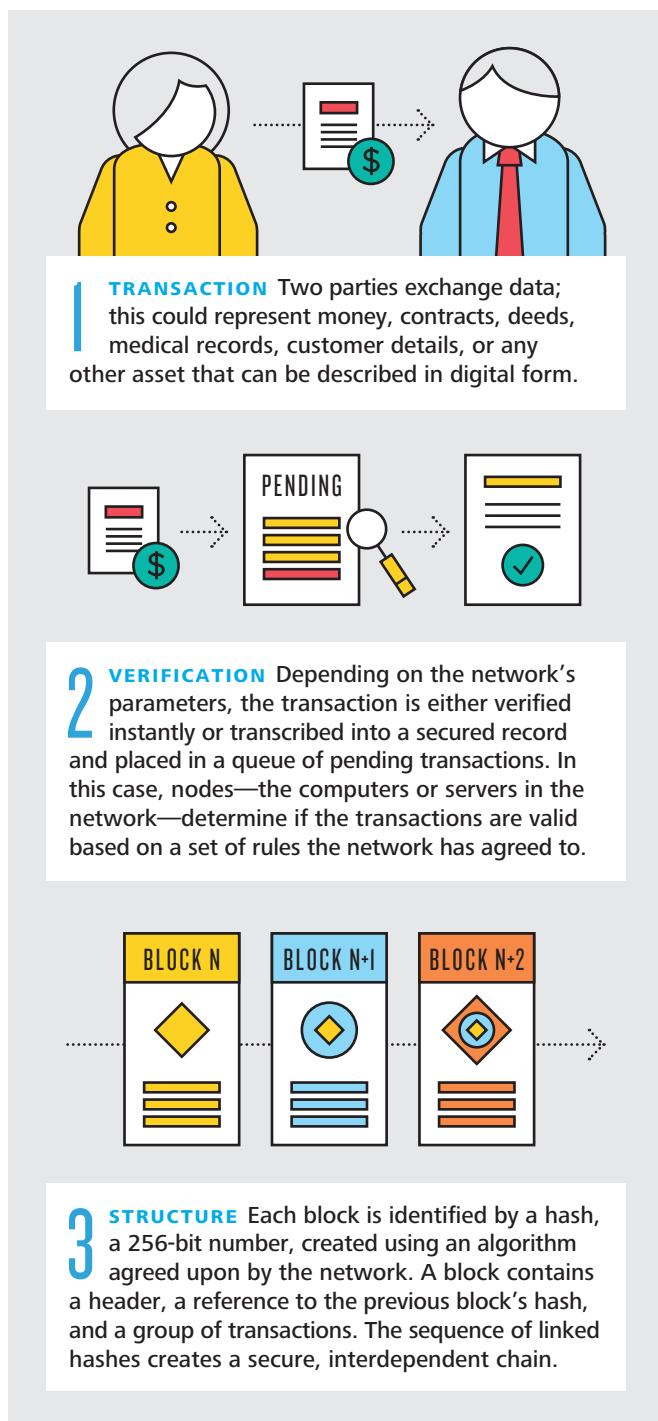
What is blockchain? Simply put, it is a distributed ledger that provides a way for information to be recorded and shared by a community. In this community, each member maintains his or her own copy of the information and all members must validate any updates collectively. The information

could represent transactions, contracts, assets, identities, or practically anything else that can be described in digital form. Entries are permanent, transparent, and searchable, which makes it possible for community members to view transaction histories in their entirety. Each update is a new “block” added to the end of the “chain.” A protocol manages how new edits or entries are initiated, validated, recorded, and distributed. With blockchain, cryptology replaces third-party intermediaries as the keeper of trust, with all blockchain participants running complex algorithms to certify the integrity of the whole.

It seems ironic that as digital transforms the world, one of its more promising building blocks is a throwback to our decidedly analog past. Blockchain is the tech-charged equivalent of the public ledgers that were once used in towns to record everything of importance: the buying and selling of goods; the transfer of property deeds; births, marriages, and

Figure 1. Blockchain: How it works

Blockchain allows for the secure management of a shared ledger, where transactions are verified and stored on a network without a governing central authority. Blockchains can come in different configurations, ranging from public, open-source networks to private blockchains that require explicit permission to read or write. Computer science and advanced mathematics (in the form of cryptographic hash functions) are what make blockchains tick, not just enabling transactions but also protecting a blockchain's integrity and anonymity.



deaths; loans; election results; legal rulings; and anything else of note. Instead of a bearded master wielding a long-stemmed stylus to record minuscule entries into an oversized book, blockchain uses advanced cryptography and distributed programming to achieve similar results: a secure, transparent, immutable repository of truth, one designed to be highly resistant to outages, manipulation, and unnecessary complexity.

Rewiring markets

Blockchain's ability to replace middlemen with mathematics is precisely why this technology matters. It can reduce overhead costs when parties trade assets directly with each other, or quickly prove ownership or authorship of information—a task that is currently next to impossible without either a central authority or impartial mediator. Moreover, blockchain's ability to guarantee authenticity across institutional boundaries will likely help parties think about the authenticity of records, content, and transactions in new ways. Consider, for example, the efficiencies that shared ledger technology might bring to the labyrinthine global payments market. Or how a secure, transparent, transactional environment might help developing countries reduce the estimated \$1.26 trillion they lose each year to corruption, bribery, theft, and tax evasion.²

The financial services industry (FSI) plays an important role as today's institutional authority of record for payments and remittances, the issuing and trading of securities and trading, and ownership of financial instruments. It comes as no surprise, then, that FSI organizations are aggressively pursuing blockchain investment and experimentation. Outside of the financial sector, organizations across industries are also ramping up their own blockchain programs and exploring opportunities,

with next-generation payments, loyalty and rewards platforms, smart contracts, asset management, and exchange scenarios leading the charge.

Meanwhile, venture capitalists have invested roughly \$1 billion in 120 blockchain-related start-ups—half of that investment taking place within the last calendar year.³ Investors recognize that the blockchain ecosystem lends itself to different use cases and technology enablers, from payment processors and digital wallets to cryptocurrency exchanges and blockchain-based platforms. Analysts at one investment bank commented on this trend recently, saying, “We expect venture capital flows to accelerate in 2016 and lead to further development of the foundational and infrastructure services necessary to create a fertile ‘plug and play’ ecosystem for entrepreneurs and innovation that may ultimately escalate enterprise adoption from a trickle in 2016 to a multi-year boom starting in 2017.”⁴

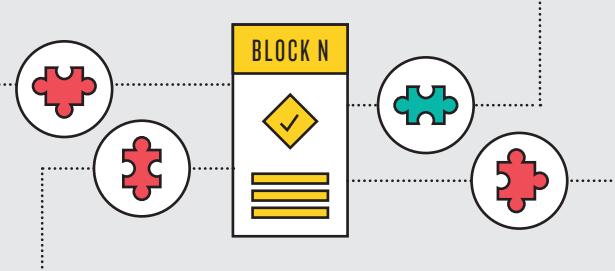
Blockchain consortiums are forming as well. For example, R3 CEV, representing more than 42 of the world’s largest banks, is creating a distributed ledger platform to power FSI’s foray into blockchain.⁵ The Digital Currency Group, sponsored by MasterCard, New York Life, and others, manages and operates a portfolio of blockchain and cryptocurrency investments.⁶ Enabling technology players are also getting involved. The Open Ledger Project, backed by IBM, Cisco, Intel, the Linux Foundation, and others, has created a standards-based, open-sourced blockchain platform to accelerate adoption and the development of surrounding services.⁷

Patterns of value

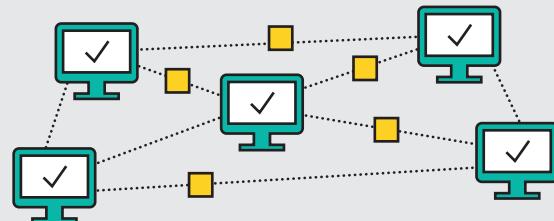
And we’re only getting started. With new use cases emerging weekly, it’s worth examining both the underlying benefits of blockchain⁸ as well as the operational areas in which blockchain may add little



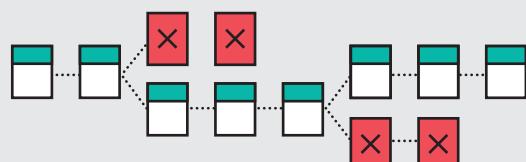
4 VALIDATION Blocks must first be validated to be added to the blockchain. The most accepted form of validation for open-source blockchains is proof of work—the solution to a mathematical puzzle derived from the block’s header.



5 BLOCKCHAIN MINING Miners try to “solve” the block by making incremental changes to one variable until the solution satisfies a network-wide target. This is called “proof of work” because correct answers cannot be falsified; potential solutions must prove the appropriate level of computing power was drained in solving.



6 THE CHAIN When a block is validated, the miners that solved the puzzle are rewarded and the block is distributed through the network. Each node adds the block to the majority chain, the network’s immutable and auditable blockchain.



7 BUILT-IN DEFENSE If a malicious miner tries to submit an altered block to the chain, the hash function of that block, and all following blocks, would change. The other nodes would detect these changes and reject the block from the majority chain, preventing corruption.

value. Blockchain often works best when the following conditions are met:

- **Transparency:** Ease of sharing and visibility are essential features of a blockchain; lack of one or the other of these is often a central driver of blockchain adoption. They become particularly critical in transactions in which more than one organization is making blockchain entries.
- **Trust:** The immutability of blockchain makes it nearly impossible for changes to be made once established, which increases confidence in data integrity and reduces opportunities for fraud.
- **Disintermediation:** With blockchain, peer-to-peer consensus algorithms transparently record and verify transactions without a third party—potentially eliminating cost, delays, and general complexity.
- **Collaboration:** Blockchain can be programmed to instigate specific transactions when other transactions are completed. This could help parties collaborate without increasing risk on transactions with multiple dependences, or those authored by different parties.
- **Security:** With private and public key cryptography part of blockchain's underlying protocol, transactional security and confidentiality become virtually unassailable. Trust zones can also be established, including open public ledgers and permission-based shared or private blockchains in which participation is limited to select entities.

Lessons from the front lines

Establishing trust in real time

With 16 million clients worldwide and operations in 40 countries, Royal Bank of Canada (RBC) executes large numbers of cross-border payment transactions each day, including bank-to-bank, business-to-business, and peer-to-peer remittances.⁹

The traditional process used throughout the banking industry to execute such transactions can be cumbersome, often involving multiple intermediaries, customer fees, and lengthy reconciliation tasks.¹⁰ Recognizing an opportunity to increase efficiency and lower operational costs, two years ago RBC began looking for technologies that could help it develop a new approach to cross-border transactions.

"At that time, many people in our industry were exploring possible uses for bitcoin," says Eddy Ortiz, RBC's vice president, solution acceleration and innovation. "As we came to understand more about the challenges we faced, we realized the underlying technology powering it was what was particularly exciting."

RBC's first step was understanding what blockchain was and, importantly, was not. Beyond technical and functional aspects, the RBC team needed to understand the business problems blockchain might help their organization solve. Cross-border payments emerged as a prime opportunity: Clearly, there was value in the ability to settle transactions in near-real time.

After researching numerous shared-ledger technology options, RBC settled on Ripple, a provider of global financial settlement and FX market-making software solutions. Ripple makes it possible for financial institutions to send and receive cross-currency payments more efficiently by connecting banks directly to each other via distributed financial technology. Because transactions are

immutable and carried out in real time (five seconds), Ripple can also help mitigate fraud, credit, FX, and counterparty risks.

Ripple and RBC are working on a limited-production proof of concept now. As much promise as blockchain represents, it is crucial to validate its scalability, reliability, security, and performance for a large-scale deployment. RBC looks to do just that before expanding into other areas.

Meanwhile, RBC is currently exploring other distributed ledger use cases as well. One option involves creating a loyalty platform¹¹ in which the bank engages customers in real time through a blockchain to help them better understand the points and rewards they are accruing as they use RBC products and services. Likewise, customers will also be able to engage directly with a variety of RBC partners via the blockchain for real-time redemption of reward points. "Our customers will be able to see their points accrue each time they use their RBC credit card," says Ortiz. "And the reward points become like liquid cash, enabled by blockchain."

Selling the idea within RBC of changing long-established cross-border payment processes with blockchain became its own challenge. "We either oversimplified our plan and senior leadership didn't see the value, or we went too technical and lost them," recalls Ortiz. By working with several RBC stakeholders to refine their pitch and focus more on the specific business problems to be solved, Ortiz and his team got the green light to proceed in exploring these opportunities with Ripple and other partners.

Whether cross-border payments, rewards programs, or more ambitious forays around smart contracts, RBC's exploration of blockchain technology comes down to use cases—the business problems that technology can help alleviate.¹²



No good deed goes unrecorded

To help stem long-standing corruption in Honduras' land title registry system, in 2011 the World Bank announced it would loan the Honduran government \$328 million to digitize title files and upgrade tools and processes.¹³ While subsequent efforts did help modernize and standardize the government's administrative capabilities, they also made it easier for corrupt players to hack into central databases and illegally alter digital land records.¹⁴

In May 2015, Factom, the organization that manages open source software for securely recording transactions through a distributed, decentralized protocol, announced that it would be working with Epigraph, a land title software vendor, to help the government of Honduras recreate its digital land title registry system in a blockchain. The goal of this effort is simple: Use blockchain technology to create a transparent land title registry system in which digitized records are tamper-proof.¹⁵

The system being developed addresses existing security vulnerabilities in several ways. First, individual land records are digitized—"hashed" or encoded with an immutable fingerprint—and stored permanently on the blockchain. The system then tracks and documents every change of ownership, every loan made against a single piece of land, and every contract made against mineral rights. Users can track the entire history of a land title instantly. They cannot, however, alter anything currently in the system. They can use a stored version to create a new document, but they will not be able to recreate or replace a hash once it is filed.

The Honduran blockchain initiative is in a pilot program for a single city, with a system built and capable of accepting entries. In the coming year, project leaders plan to roll out the pilot to additional municipalities.¹⁶

A Linq to the future

In 2014, blockchain technology made waves as the underpinning for the cryptocurrency

bitcoin. In 2015, it's making waves again, this time in the financial services market.

Currently, managing the issuance and exchange of shares in private companies is a paper-based, manual process. This can be cumbersome, time-consuming, and error-prone. Private companies typically handle sales and transfers of shares with informal mechanisms such as manually maintained spreadsheets. NASDAQ wants to replace that process with a system built on blockchain technology.

Earlier in October 2015, NASDAQ (MX Group Inc.) rolled out Linq, a blockchain-based platform and ledger system that manages the buying and selling of shares of private companies. Linq provides clients with a digital ledger that creates a record in the blockchain of every transfer of security among private users, providing improved auditing and increased transparency of ownership. Some of the first companies on the platform include Synack, Tango, and Vera.¹⁷

The experiment joins a slew of financial industry forays into bitcoin-related technology. While the innovation is an achievement in and of itself, it also represents the potential for future transformational change in the infrastructure of financial services. If the effort is deemed successful, NASDAQ, one of the world's largest stock markets, wants to adopt blockchain technology, which could shake up systems that have facilitated the trading of financial assets for decades.

While a completely revamped digital infrastructure for financial services markets will take some time, there are promising initiatives underway across the world. NASDAQ is preparing to roll out blockchain applications in Estonia, where it owns the Tallinn Stock Exchange and the Estonia Central Securities Depository.¹⁸ The applications will focus on improving the proxy voting process for companies as well as company registration and public pension registration, programs that NASDAQ manages for the government of Estonia.

Some things should remain private

An individual's digital medical records are often distributed across systems in physicians' offices, hospitals, insurance companies, or other organizations. As such, any one doctor or service provider may not have access to all of the information necessary to meet a person's health needs. Moreover, though these records contain highly personal, confidential information that should never be made public, no single authority controls them, thus making them vulnerable to cyber threats and unintentional leaks.

One global manufacturer of medical technologies is exploring how individuals might use blockchain technology to take control of their own medical records in a secure "distributed medical records system" similar to a bitcoin wallet. Though the model under development is still a prototype, its basic design spotlights the potential value blockchain may soon add in the arena of security and privacy.

Here's how it works: A doctor notices that a patient is due for a certain medical procedure or test. The doctor initiates a transaction marked with the patient's unique digital identity within the individual's blockchain

wallet. Then, via email, the doctor alerts both the patient and the relevant practitioner or specialist who will schedule and perform the required procedure. Upon completing the task, the relevant practitioner will assign a proof that the procedure has been administered to the patient's blockchain wallet. At the same time, smart contract logic built into the blockchain sends this proof to relevant third parties. These could include organizations like the Centers for Disease Control, which tracks vaccination rates (among other statistics), or the patient's insurance carrier, which will process payment or reimbursement. As the holder of the blockchain key, the patient—and only the patient—determines who else should receive this information.

Though this limited use case focuses exclusively on medical records, the ability for individuals to create digital identities and use them within distributed ledger systems to secure and manage personal information will likely underpin similar use cases going forward. The ultimate benefit? In the near future, individuals may be able to aggregate all of their personal information—such as their financial, medical, and purchase histories—into one secure ledger with a single digital identity, with full control over how and with whom credentials will be shared.



MY TAKE

BRIAN FORDE

*Director of digital currency
MIT Media Lab*

From the cover of the *Economist* to an eye-popping billion dollars invested in bitcoin-related start-ups, we are increasingly seeing companies explore business opportunities using bitcoin and other cryptocurrencies. The reason: This emerging technology could potentially disrupt the way people and organizations carry out a wide variety of transactions. For example, using cryptocurrencies, such as bitcoin, people can transfer money without a bank or write enforceable contracts without a lawyer or notary. Companies could make online payments more secure and inexpensive. In fact, similar to the Internet, which exponentially increased communication by reducing cost and friction to near zero, cryptocurrencies have the potential to exponentially increase transactions for the same reasons. Ultimately, new entrants will adopt this emerging technology and disrupt existing industries.

So what does this mean to your company right now? To understand the potential of cryptocurrencies, you should review how your company completes transactions with customers. Money transfer is one of the first types of transactions to think about. Identify the brokers and middlemen who are extracting fees from your transactions. Maybe it's a credit card processor or an intermediary involved in a wire transfer. These parties—and the transaction fees they charge—may no longer be needed when you carry out transactions with cryptocurrencies. At its core, this technology enables transactions between two parties without requiring a costly middleman.

“...We are seeing how the ability to transfer the ownership of assets directly from one party to another—safely, efficiently, and without an intermediary—can increase efficiency and reduce transaction costs for pioneering companies willing to experiment with this emerging technology.”

Consider other potential opportunities that are specific to your industry. The entertainment industry might leverage cryptocurrencies to manage event ticketing. By issuing concert tickets on the blockchain, fans can verify transfer of ownership from one digital wallet to another, rather than worrying whether the PDF of the ticket they received was sold to 10 other people. Financial services firms may be able to streamline legal and contractual interactions with customers. Media companies could transform their approaches to managing digital rights as well. In 2015, British musician Imogen Heap made headlines by demonstrating how a song could be released on the blockchain to manage who has the rights to listen to the song.¹⁹ Previously, artists have been forced to use more common proprietary digital rights management platforms. With the blockchain, the artist will receive his or her royalty payments sooner and you, as a customer, actually own the song and can resell it to others. With digital rights platforms, that's illegal.²⁰

The argument for embracing blockchain becomes more urgent given the risks associated with storing customers' personal information. For example, to prevent fraud, many online retailers require customers to provide their name, home address, and other personal information associated with their credit card—just to make a purchase. However, these data repositories become honeypots that, in today's world, increase the likelihood of a cybersecurity attack on your company. With bitcoin, you wouldn't need to ask for, or worse yet, store any personal information to complete a purchase. What's more, developers are now looking into using the blockchain for electronic medical records, educational transcripts, or other personal information stores that would benefit from better privacy and interoperability.

Today, we are seeing how the ability to transfer the ownership of assets directly from one party to another—safely, efficiently, and without an intermediary—can increase efficiency and reduce transaction costs for pioneering companies willing to experiment with this emerging technology. But before you embark on this journey, download a bitcoin wallet and try it for yourself. It might just spark a new idea for this nascent technology.

CYBER IMPLICATIONS

To a large degree, current interest in blockchain is fueled by the security benefits this emerging technology offers users. These benefits include, among others:

- The immutable, distributed ledger creates trust in bookkeeping maintained by computers. There is no need for intermediaries to verify transactions.
- All transactions are recorded with the time, date, participant names, and other information. Each node in the network owns the same full copy of the blockchain, thus enhancing security.
- Transactions are authenticated by a network of computer “miners” who complete complex mathematical problems. When all miners arrive at the same unique solution, the transaction is verified and recorded on the “block.”

The distribution of miners means that the system cannot be hacked by a single source. If anyone tries to tamper with one ledger, all of the nodes will disagree on the integrity of that ledger and will refuse to incorporate the transaction into the blockchain.

Though blockchain may provide certain security advantages over more traditional transactional systems that require intermediaries, potential risks and protocol weaknesses that could undermine the integrity of blockchain transactions do exist. In 2014, for example,

it was discovered that, in several instances, a single mining pool had contributed more than 50 percent of bitcoin’s mining. During these relatively brief periods, the pool had unprecedented power to circumvent the decentralization that differentiates bitcoin from traditional currencies. For example, the group had the ability to spend the same coins twice, reject competing miners’ transactions, or extort higher fees from people with large holdings.²¹ In a separate 2015 incident, Interpol cyber researchers issued an alert that it had discovered a weakness in a digital currency blockchain that would allow hackers to stuff the blockchain with malware.²²

Given that there is no standard in place for blockchain security, other potential cyber issues could emerge. For this reason, there currently exists an overreliance on crowdsourced policing.

Blockchain is a new technology, and therefore discussion of its potential weaknesses is somewhat academic. But what if your whole financial system fell apart because of some underlying vulnerability in blockchain that was discovered down the road or because computing power caught up, allowing someone to break the system? Though you should not let fear of such scenarios prevent your company from exploring blockchain opportunities, as with all leading-edge technologies, it pays to educate yourself, work with partners on cyber issues, and remain secure, vigilant, and resilient.



Where do you start?

Early adopters—largely within FSI—are piloting blockchain in innovation labs and by investing in technology start-ups. Organizations across industries should aggressively explore scenarios in which blockchain could reinvent parts of their operations, value chains, or business models. They should look for ways blockchain could help bring new efficiencies to costly, slow, or unreliable transactions and introduce new models for partnership and collaboration. Are there new products and offerings that can extend the blockchain platform? What about designing products that leverage shared-ledger technology? Whatever the specific play, it is time to dig in, gain understanding and experience, and determine if—or, more likely, where—blockchain can help in your organization.

Specific areas of focus may include:

- **Education:** Unlike other emerging technologies such as mobile, analytics, or even the cloud, blockchain can be confusing—what it is, how it works and, most importantly, why it matters. Moreover, some of the earliest and most public use cases involving bitcoin may be deemed irrelevant or underwhelming. Conceted education efforts are required, ideally coupled with a disciplined approach to innovation and a prototype demonstrating potential use cases specific to a given organization and industry.
- **Embrace the ecosystem:** The blockchain community is seeing considerable investment from established industry institutions, technology vendors, academia, venture capital firms, and start-ups, among others. Now is not the time to worry about which blockchain technologies or standards will dominate. That said, any solutions should include abstractions around

protocols and platform features to allow portability should it eventually become necessary to switch to a different standard.

- **Partner? Perhaps:** With the blockchain ecosystem growing, to accelerate ramp-up and adoption efforts, it may make sense to partner with one or more vendors. But before signing on the dotted line, try to understand what makes a prospective partner's offering unique. Is the partner willing to co-invest in solutions (or even in proofs of concept) that will meet your specific needs? Typical caveats apply for tapping start-ups: understanding the leadership team, board, VCs, funding level, and financial viability. Whether the partner is big or small, define the exit strategy up front to remove hard dependencies and imbalances in future negotiations. Given the nature of the blockchain, partnerships with peers and competitors might be options as well.
- **Know your trust zones:** Public, “private” (permission-based), or hybrid? The implications are more pronounced than they may immediately appear. Established players often create permission-based, tightly managed trust zones that basically impose legacy thinking about what constitutes “trust” on a new architecture. Remember, each case will likely be unique and thus require its own trust-zone variation. With blockchain, the most effective option may not always be permission-based.
- **Understand blockchain’s limitations:** Blockchain is not a cure-all, just as it is not simply a glorified shared database. The computational requirements to run the blockchain’s consensus algorithms²³ consume time and resources. The very

features that protect blockchain against theft and fraud could also drive overhead if not correctly implemented. As such, high-volume transactions with latency sensitivity may not be ideal candidates for blockchain.

- **Remember the miners:** With bitcoin, miners earn bitcoins for carrying out mining tasks. In your use cases, what economic incentives will you put in place to entice miners to perform the mining and recording tasks?
- **Regulation and compliance:** Here, there are two points to consider. With blockchain technology, progress is outpacing regulation, which may help users gain momentum with their blockchain initiatives in the short term. Eventually, regulation—and legal precedents that recognize blockchain transactions—will almost certainly catch up with this technology. Public blockchains will most likely be

subject to oversight by governing bodies similar to those overseeing various aspects of the Internet. Private blockchains will be managed under private agreements.

The second regulatory consideration is more interesting. Though costly and, in some places, inefficient, third-party clearing houses, exchanges, government agencies, and other central bodies play an important role in arbitration and conflict resolution. Each typically has authority to reverse transactions. Existing financial industry systems had very similar goals when they were introduced in the 1970s²⁴—improve efficiency and instill trust by overhauling outdated legacy systems and processes. Though the technological differences between those systems and blockchain are enormous, regulation designed to standardize open-ledger transactions could prove beneficial for the financial and legal systems as a whole, and for early adopters who have already embraced blockchain.

Bottom line

Business, government, and society are built on trust. Even cynics who argue for more fiscally driven motivations only reinforce this basic point. After all, money is only a concept whose value is linked solely to collective faith in its value as tender for debts, private or public. As such, any promise to use modern computing principles to transform how we achieve and apply trust is disruptive—perhaps on an historic scale. Will the eventual embrace of blockchain mean that venerable institutions of trust disappear? That seems unlikely. It does mean, however, that very soon they may have to transform themselves if they hope to continue participating, substantively and efficiently, in blockchain's brave new world.

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Endnotes

1. Bitcoin as a vehicle for funding terrorism: Stan Higgins, “ISIS-linked blog: Bitcoin can fund terrorist movement worldwide,” *CoinDesk*, July 7, 2014, <http://www.coindesk.com/isis-bitcoin-donations-fund-jihadist-movements>, accessed January 4, 2016; Bitcoin as the currency fueling criminal black markets: Joshua Bearman, “The rise and fall of the silk road,” *Wired*, May, 2015, <http://www.wired.com/2015/04/silk-road-1/>, accessed January 4, 2016.
2. Mark Prosser, “Today corrupt officials spend your money—tomorrow blockchain will stop them,” *SingularityHUB*, October 20, 2015, <http://singularityhub.com/2015/10/20/today-corrupt-officials-spend-your-money-tomorrow-blockchain-will-stop-them/>, accessed January 4, 2016.
3. Deloitte analysis and CoinDesk, “Bitcoin venture capital,” <http://www.coindesk.com/bitcoin-venture-capital/>, accessed January 4, 2016.
4. Spencer Bogart and Kerry Rice, “The blockchain report: Welcome to the Internet of value,” Needham and Company LLC, October 21, 2015, <http://storj.io/TheBlockchainReport.pdf>, accessed January 4, 2016.
5. R3 CEV, <http://r3cev.com>, accessed January 4, 2016.
6. Fitz Tepper, “Barry Silbert launches digital currency group with funding from MasterCard, others,” *TechCrunch*, October 27, 2015, <http://techcrunch.com/2015/10/27/barry-silbert-launches-digital-currency-group-with-funding-from-mastercard-others/>, accessed January 4, 2016.
7. Prableen Pajbhai, “IBM spearheads open ledger project, which uses blockchain technology,” NASDAQ, December 17, 2015, <http://www.nasdaq.com/article/ibm-spearheads-open-ledger-project-which-uses-blockchain-technology-cm555865>, accessed January 4, 2016.
8. David Schatsky and Craig Muraskin, *Beyond bitcoin*, Deloitte University Press, December 7, 2015, <http://dupress.com/articles/trends-blockchain-bitcoin-security-transparency/>, accessed January 4, 2016.
9. Royal Bank of Canada, “RBC at a glance—Q3/2015,” <http://www.rbc.com/investorrelations/pdf/rbcglance2015q3.pdf>, accessed December 15, 2015.
10. Nasreen Quibria, “Blockchain holds promise for cross-border payments,” *American Banker*, August 7, 2015, <http://www.americanbanker.com/bankthink/blockchain-holds-promise-for-cross-border-payments-1075902-1.html>, accessed December 15, 2015.
11. Robert Barba, “Legacy systems threaten banks more than startups: RBC head McKay,” *American Banker*, November 11, 2015, http://www.americanbanker.com/news/bank-technology/legacy-systems-threaten-banks-more-than-startups-rbc-head-mckay-1077775-1.html?utm_medium=email&ET=americanbanker:e5519242:3878862a:&utm_source=newsletter&utm_campaign=daily%20pdf-nov%202012%202015&st=email&eid=39d31f630245c3221274d20da0d72df7, accessed December 15, 2015.
12. Edison (Eddy) Ortiz (vice president, solution acceleration and innovation, Royal Bank of Canada), interview with the authors, December 2015.
13. “World Bank loans US\$32.8 million for land titles,” *Honduras Weekly*, July 1, 2011, [http://www.hondurasweekly.com/money/item/11518-world-bank-loans-us\\$328-million-for-land-titles](http://www.hondurasweekly.com/money/item/11518-world-bank-loans-us$328-million-for-land-titles), accessed December 19, 2015.
14. Gertrude Chavez-Dreyfuss, “Honduras to build land title registry using bitcoin technology,” Reuters, May 15, 2015, <https://uk.news.yahoo.com/honduras-build-land-title-registry-using-bitcoin-technology-162701917.html#ca9hqrJ>, accessed December 19, 2015.
15. Ibid.
16. David Johnston (chairman of the board, Factom) and Peter Kirby (CEO, Factom), interview with the authors, November 2015.
17. Samburaj Das, “NASDAQ launches Linq, a private blockchain-powered trading platform,” *Cryptocoin News*, October 28, 2015, <https://www.cryptocoinsnews.com/nasdaq-launches-linq-a-private-blockchain-powered-trading-platform/>, accessed January 4, 2016.
18. John McCrank, “Nasdaq says to develop blockchain services in Estonia,” Reuters, November 13, 2015, <http://www.reuters.com/article/us-nasdaq-blockchain-estonia-idUSKCN0T301H20151114#sbRj4SRy3O> F9yl3I97, accessed January 4, 2016.

19. Ian Alison, "Imogen Heap shows how smart music contracts work using Ethereum," *International Business Times*, October 4, 2015, <http://www.ibtimes.co.uk/imogen-heap-shows-how-music-smart-contracts-work-using-ethereum-1522331>, accessed November 19, 2015.
20. Mike Masnick, "ReDigi loses: You can't resell your MP3s (unless you sell your whole hard drive)," *Techdirt* (podcast), April 1, 2013, <https://www.techdirt.com/articles/20130401/11341622538/redigi-loses-selling-used-mp3s-online-infringes-first-sale-doesnt-apply-to-digital-transfers.shtml>, accessed January 26, 2016.
21. Cyrus Farivar, "Bitcoin pool GHash.io commits to 40% hashrate limit after its 51% breach," *Ars Technica*, July 16, 2014, <http://arstechnica.com/security/2014/06/bitcoin-security-guarantee-shattered-by-anonymous-miner-with-51-network-power/>, accessed December 28, 2015.
22. INTERPOL, "INTERPOL cyber research identifies malware threat to virtual currencies," press release, March 26, 2015, <http://www.interpol.int/News-and-media/News/2015/N2015-033>, accessed December 28, 2015.
23. Technically, pending updates are queued and processed by distributed nodes called miners, who are running algorithms performing puzzle-like hash routines that require brute-force effort to fulfill the conditions of the underlying rule set. Miners who successfully announce solving the puzzle provide a record of programmatic effort to validate that they genuinely completed the task. This explains why blockchain is sometimes referred to as a "proof of work" protocol.
24. Steven Melendez, "The future of bitcoin isn't bitcoin—it's bigger than that," *Fast Company*, October 13, 2015, <http://www.fastcompany.com/3051679/innovation-agents/the-future-of-bitcoin-isnt-bitcoin-its-bigger-than-that>, accessed January 4, 2016.



Industrialized analytics

Data is the new oil. Where are the refineries?

Data is a foundational component of digital transformation. Yet, few organizations have invested in the dedicated talent, platforms, and processes needed to turn information into insights. To realize data's full potential, some businesses are adopting new governance approaches, multitiered data usage and management models, and innovative delivery methods to enable repeatable results and scale. Indeed, they are treating data analysis as a strategic discipline and investing in industrial-grade analytics.

Over the past 10 years, data has risen from an operational byproduct to a strategic boardroom concern. Harnessing analytics has led to new approaches to customer engagement;¹ the ability to amplify employee skills and intelligence;² new products, services, and offerings; and even opportunities to explore new business models. In these times of talent scarcity, data scientists continue to be particularly prized—even more today than in 2012, when *Harvard Business Review* declared the data scientist role the “sexiest of the 21st century.”³

Analytics now dominates IT agendas and spend. In Deloitte’s 2015 global CIO survey, which polled 1,200 IT executives, respondents identified analytics as both a top investment priority and the IT investment that would deliver the greatest business impact. In a similar survey of a broader executive audience, 59 percent of participants either included data and analytics among the top five issues or considered it the single most important way to achieve a competitive advantage.⁴ Advances

in distributed data architecture, in-memory processing, machine learning, visualization, natural language processing, and cognitive analytics have unleashed powerful tools that can answer questions and identify valuable patterns and insights that would have seemed unimaginable only a few years ago. Perhaps Ann Winblad, senior partner at technology venture capital firm Hummer-Winblad, said it best: “Data is the new oil.”⁵

Against this backdrop, it seems almost illogical that few companies are currently making the investments needed to harness data and analytics at scale. Where we should be seeing systemic capabilities, sustained programs, and focused innovation efforts, we see instead one-off studies, toe-in-the-water projects, and exploratory investments. While they may serve as starting points, such circumscribed efforts will likely not help companies effectively confront daunting challenges around master data, stewardship, and governance.

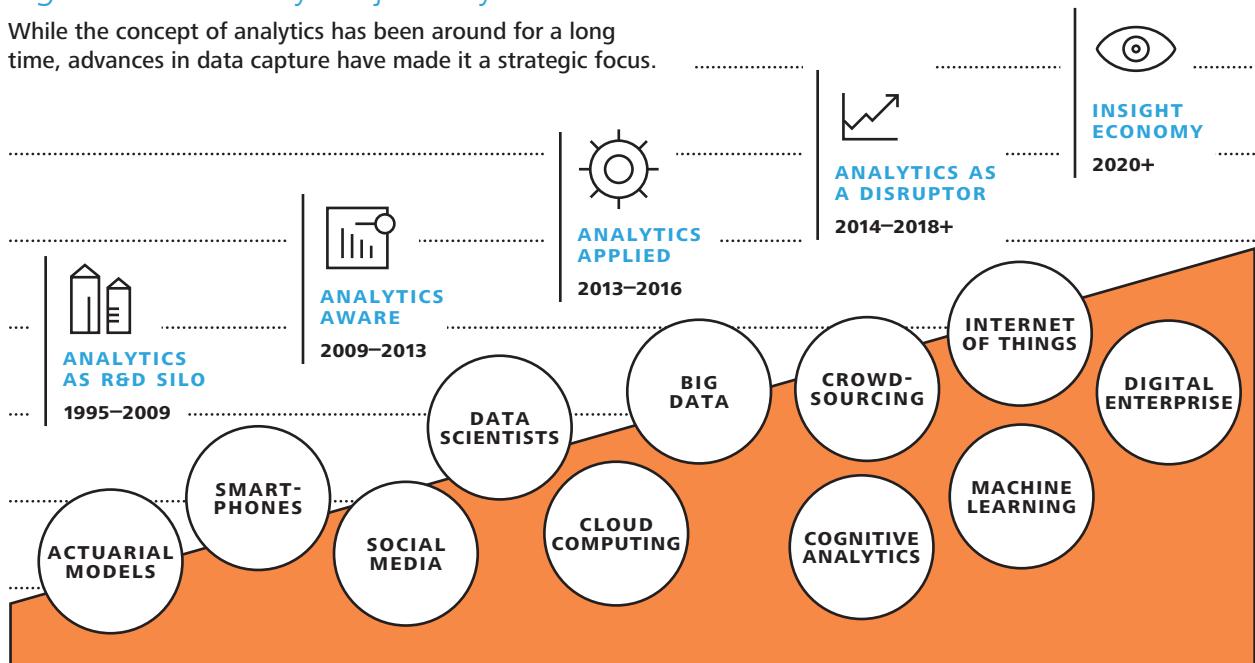
It's time to take a new approach to data, one in which CIOs and business leaders deploy the talent, data usage and management models, and infrastructure required to enable repeatable results and scale. By "industrializing" analytics in this way, companies can finally lay the foundation for an insight-driven organization⁶ that has the vision, underlying technology capabilities, and operating scale necessary to take advantage of data's full potential.

Thinking boldly

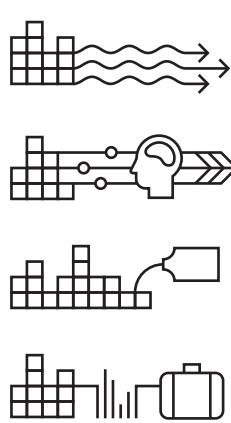
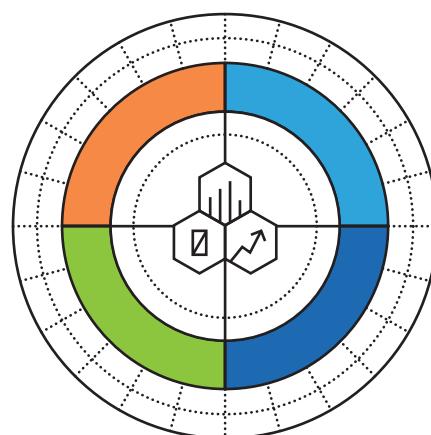
Beyond enabling scale and predictability of outcome, industrializing analytics can also help companies develop a greater understanding of data's possibilities and how to achieve them. Many data efforts are descriptive and diagnostic in nature, focusing primarily on what happened and why things happened the way they did. These are important points, but they only tell part of the story. Predictive analytics broadens the approach by answering

Figure 1. The analytics journey

While the concept of analytics has been around for a long time, advances in data capture have made it a strategic focus.



The taxonomy of a strong data analytics program



INFORMATION ACQUISITION & CURATION

Data stores support downstream processes by providing cleansed data for value-added apps.

INFORMATION DELIVERY

The provisioning of data to end users supports business analysis and decision making.

INFORMATION TO INSIGHTS

Tagged logical or physical representations of data simplify access for business users.

INSIGHTS TO ACTIONS

A set of tools improves control over data accessed by the enterprise for business needs.

the next obvious question—“what is *going* to happen?” Likewise, prescriptive analytics takes it one step further by helping decision makers answer the ultimate strategic question: “What should I do?” Business executives have been trained to limit their expectations to the “descriptive” analytics realm. Education and engagement may help inspire these leaders to think more boldly about data and their potential. It could lead them to embrace the advanced visualization tools and cognitive techniques they’ll need to identify useful patterns, relationships, and insights within data. Most importantly, it could help them identify how those insights can be used to drive impact and real business outcomes.

Any effort to industrialize analytics should set forth the data agenda and delineate its strategic aspirations. This agenda can help define a company’s vision for data usage and governance and anchor efforts around key performance indicators that matter to the business. Moreover, it can help line up stakeholder support by clearly describing how an overarching analytics strategy might benefit individual groups within the enterprise. Demos and proofs of concepts that illuminate how analytics, dashboards, and advanced data analysis techniques can help drive strategy and communicate intent can be especially powerful here.

The times they are a-changin’

In addition to thinking more boldly about analytics’ and data’s potential, companies should rethink their current approaches for deploying and managing analytics. Many data efforts follow a well-worn path: Identify what you want to know. Build a data model. Put the data into a data warehouse. Cleanse, normalize, and then, finally, analyze the data. This approach has long been sufficient to generate passive historical reports from batch-driven feeds of company-owned, structured, transactional data.

Today, analyzing exploding volumes of unstructured data from across the value

chain requires a different approach—and a different architecture. The way businesses should operate in today’s data-rich world is to acquire the data first, and *then* figure out what they may be able to do with it. Reordering the process in this way can lead to new approaches to data storage and acquisition, including distributed data solutions, unstructured data repositories, and data lakes. It also lends itself to applying advanced visualization, machine learning, and cognitive techniques to unearth hidden patterns and relationships. Or, in extreme cases, it makes it possible for decisions to be made and actions taken without human intervention—or even without human comprehension.⁷

This doesn’t mean that traditional “extract, transform, load” techniques are no longer valid. Data warehouses, business intelligence, and performance management tools still have a role to play. Only now, they can be more effective when complemented with new capabilities and managed with an eye toward creating repeatable enterprise platforms with high potential reuse.

Especially important are several long-standing “best practice” concepts that have become mandates. Master data management—establishing a common language for customers, products, and other essential domains as the foundation for analytics efforts—is more critical than ever. Likewise, because “anarchy doesn’t scale,”⁸ data governance controls that guide consistency and adoption of evolved platforms, operating models, and visions remain essential. Finally, data security and privacy considerations are becoming more important than ever as companies share and expose information, not just across organizational boundaries, but with customers and business partners as well.

Who, where, and how

The way a company organizes and executes around analytics is a big part of the industrialized analytics journey. The analytics function’s size, scale, and influence will evolve

over time as the business view of analytics matures and the thirst for insight grows. Consider how the following operating models, tailored to accommodate industry, company, and individual executive dynamics could support your analytics initiatives:

- **Centralized:** Analysts reside in one central group where they serve a variety of functions and business units and work on diverse projects.
 - **Consulting:** Analysts work together in a central group, but are deployed against projects and initiatives that are funded and owned by business units.
 - **Center of excellence:** A central entity coordinates the activities of analysts across units throughout the organization and builds a community to share knowledge and best practices.
 - **Functional:** Analysts are located in functions like marketing and supply chain where most analytical activity occurs.
 - **Dispersed:** Analysts are scattered across the organization in different functions and business units with little coordination.
- Regardless of organizational structure, an explicit talent and development model is essential. Look to retool your existing workforce. Modern skill sets around R programming and machine learning routines require scripting and Java development expertise. Recruit advocates from the line of business to provide much-needed operational and macro insights, and train them to use tools for aggregating, exploring, and analyzing.

Challenge consultant and contractor relationships to redirect tactical spend into building a foundation for institutional, industrialized analytics capabilities. Likewise, partner with local universities to help shape their curricula, seeding long-term workforce development channels while potentially also immediately tapping into eager would-be experts through externships or one-off data “hackathons.”

Developing creative approaches to sourcing can help with short-term skill shortages. For example, both established and start-up vendors may be willing to provide talent as part of a partnership arrangement. This may include sharing proofs of concept, supporting business case and planning initiatives, or even dedicating talent to help jump-start an initiative. Also, look at crowdsourcing platforms to tap into experts or budding apprentices willing to dig into real problems on your roadmap. This approach can not only yield fresh perspectives and, potentially, breakthrough thinking, but can also help establish a reliable talent pipeline. Data science platform Kaggle alone has more than 400,000 data scientists in its network.⁹

The final piece of the puzzle involves deploying talent and new organizational models. Leading companies are adopting Six Sigma and agile principles to guide their analytics ambitions. Their goal is to identify, vet, and experiment rapidly with opportunities in a repeatable but nimble process designed to minimize work in progress and foster continuous improvement. This tactic helps create the organizational memory muscle needed to sustain industrialized analytics that can scale and evolve while driving predictable, repeatable results.

Lessons from the front lines

Anthem's Rx for the customer experience

With an enrollment of 38.6 million members and growing, Anthem Inc. is one of the United States' leading health insurers and the largest for-profit managed health care company in the Blue Cross and Blue Shield association.¹⁰

The company is currently exploring new ways of using analytics to transform how it interacts with these members and with health care providers across the country. "We want to leverage new sources of data to improve the customer experience and create better relationships with providers than we have in the past," says Patrick McIntyre, Anthem's senior vice president of health care analytics. "Our goal is to drive to a new business model that produces meaningful results."

From the project's earliest planning stages, Anthem understood that it must approach big data in the right way if it hoped to generate useful insights—after all, incomplete analysis adds no value. Therefore, beginning in 2013, the company worked methodically to cleanse its data, a task that continued for 18 months. During this time, project leaders also worked to develop an in-depth understanding of the business needs that would drive the transformation initiative, and to identify the technologies that could deliver the kind of insights the company needed and wanted.

Those 18 months were time well-spent. In 2015, Anthem began piloting several differentiating analytics capabilities. Applied to medical, claim, customer service, and other master data, these tools are already delivering insights into members' behaviors and attitudes. For example, predictive analytics capabilities drive consumer-focused analytics. Anthem is working to understand its members not as renewals and claims, but as individuals seeking personalized health care experiences.



To this end, the company has built a number of insight markers to bring together claim and case-related information with other descriptors of behavior and attitudes, including signals from social and "quantified self" personal care management sources. This information helps Anthem support individualized wellness programs and develop more meaningful relationships with health care providers.

Meanwhile, Anthem is piloting a bidirectional exchange to guide consumers through the company's call centers to the appropriate level of service. Data from the exchange and other call center functions have been used to build out predictive models around member dissatisfaction. Running in near-real time, these models, working in tandem with text mining and natural language processing applications, will make it possible for the company to identify members with high levels of dissatisfaction, and proactively reach out to those members to resolve their issues.

Another pilot project uses analytics to identify members with multiple health care providers who have contacted Anthem's call center several times. These calls trigger an automated process in which medical data from providers is aggregated and made available to call center reps, who can use this comprehensive information to answer these members' questions.

To maximize its analytics investments and to leverage big data more effectively, Anthem recently recruited talent from outside the health care industry, including data scientists with a background in retail. These analysts are helping the company think about consumers in different ways. "Having them ask the right questions about how consumers make health care choices—choices made traditionally by employers—has helped tremendously," says McIntyre. "We are now creating a pattern-recognition and micro-segmentation model for

use on our website that will help us understand the decision-making process that like-minded consumers use to make choices and decisions.”

McIntyre says Anthem’s analytics initiatives will continue to gain momentum in the coming months, and will likely hit full stride some time in 2017.¹¹

Singing off the same sheet of data

In 2014, Eaton Corp., a global provider of power management solutions, began laying the groundwork for an industrial-scale initiative to extend analytics capabilities across the enterprise and reimagine the way the company utilizes transaction, sales, and customer data.

As Tom Black, Eaton’s vice president of enterprise information management and business intelligence, surveyed the potential risks and rewards of this undertaking, he realized the key to success lay in building and maintaining a master data set that could serve as a single source of truth for analytics tools enterprise-wide. “Without a solid master data plan, we would have ended up with lot of disjointed hypotheses and conjectures,” he says. “In order to make analytics really sing, we needed an enterprise view of master data.”

Yet creating a master data set in a company this size—Eaton employs 97,000 workers and sells its products in 175 countries¹²—would likely be no small task. “Trying to aggregate 20 years of transaction data across hundreds of ERP systems is not easy,” Black says. “But once we got our hands around it, we realized we had something powerful.”

Powerful indeed. Eaton’s IT team has consolidated many data silos and access portals into centralized data hubs that provide access to current and historic customer and product data, forecasting, and deep-dive reporting and analysis. The hubs also maintain links to information that may be useful, but is not feasible or necessary to centrally aggregate, store, and maintain. This framework supports large strategic and operational analytics

initiatives while at the same time powering smaller, more innovative efforts. For example, a major industrial organization could be an original equipment manufacturer providing parts to Eaton’s product development group while at the same time purchasing Eaton products for use in its own operations.

Advanced analysis of master data can reconcile these views, which might help sales reps identify unexplored opportunities.

To maintain its mission-critical master data set and to improve data quality, Eaton has established a top-down data governance function in which business line owners, data leads, and data stewards oversee the vetting and validation of data. They also collaborate to facilitate data security and to provide needed tool sets (for example, visualization and click view). At the user level, technology solution engagement managers help individuals and teams get more out of Eaton’s analytics capabilities and coordinate their analytics initiatives with others across the company.

Eaton recognizes the need to balance centralized analytics efforts with empowering the organization. In this way, the company harnesses industrialized analytics not only for efficiencies and new ways of working, but to also help fuel new products, services, and offerings.¹³

Pumping analytics iron

Describing the variation in analytics capabilities across the industries in which he has worked, Adam Braff, Zurich Insurance Group’s global head of enterprise data, analytics, and architecture, invokes the image of the humble fiddler crab, a semi-terrestrial marine creature whose male version has one outsized claw. “Every industry has one mature, heavily muscled limb that informs the dominant way the organization uses analytics. In insurance, analytics has traditionally been about pricing, underwriting, and their underlying actuarial models,” he says.

Because his industry has this mature analytics arm, Braff sees opportunities to look to underdeveloped analytics spaces that include indirect channels, customer life-cycle valuation, and operations excellence, among other areas. In the latter, “The challenge is identifying outliers and taking action,” says Braff. “Once you put data together and prioritize use cases, that’s where you can find success.”

Zurich is on a journey to identify analytics opportunities and then put the data resources, systems, and skill sets in place to pursue them. The first step is a “listening tour”—engaging leaders from the business side to understand the challenges they face and to explore ways that analytics might remedy those challenges. A dedicated “offense” team will then translate those needs into rapid data and analytics sprints, starting small, proving the solutions’ value, and scaling soon after.

The “defense” side, meanwhile, focuses on foundational elements such as data quality. Today, Zurich has decentralized analytics organizations and data stores. By performing a comprehensive data maturity assessment, the

company is developing a better understanding of the quality and potential usefulness of its data assets. Meanwhile, Zurich is assessing how effectively different groups use data to generate value. It will also increase data quality measurement and accountability across all data-intake channels so data used downstream is of consistently high quality.

A third major step involves developing the organization and talent needed to industrialize analytics. In this environment, IT workers will need three things: sufficient business sense to ask the right questions; a background in analytical techniques and statistical modeling to guide approaches and vet the validity of conclusions; and the technical knowledge to build solutions themselves, not simply dictate requirements for others to build. “Working with the business side to develop these solutions and taking their feedback is a great way to learn how to apply analytics to business problems,” says Braff. “That iterative process can really help people build their skills—and the company’s analytics muscles.”¹⁴

MY TAKE

JUSTIN KERSHAW

*Corporate vice president and CIO
Cargill, Inc.*

For Cargill Inc., a leading global food processing and agricultural commodity vendor and the largest privately held company in the United States, industrializing analytics is not an exploratory project in big data usage. Rather, it is a broadly scoped, strategically grounded effort to continue transforming the way we collect, manage, and analyze data—and to use the insights we glean from this analysis to improve our business outcomes. At Cargill, we are striving to have a more numerically curious culture, to utilize analytics in more and more of our decisions, and to create different and better outcomes for customers.

“It is important to remember that bad data yields bad insights.”

Cargill’s commodity trading and risk management analytics capabilities have always been strong, but that strength had not spread throughout all company operations. As we continue to digitize more of our operations, the opportunity to achieve a higher level of analytical capability operationally is front and center. This is not only in our production but also in all our supporting functions. The IT team has been transformed over the last two years, and much of this change was made possible by outcomes and targets derived from analytics. Our performance is now driven more numerically. Cargill is creating a more fully integrated way of operating by transitioning from a “holding entity” structure—comprising 68 business units operating on individual platforms—to a new organizational structure (and mind-set) in which five business divisions operate in integrated groups. This is giving rise to different ways of operating and new strategies for driving productivity and performance—more numerically, and with more capability from analytics.

As CIO, one of my jobs is to put the tools and processes in place to help both the company and IT better understand how they perform, or in some cases could perform, with integrated systems. To generate the performance insights and outcomes we want, we took a fresh approach to data management and analysis, starting with IT.

Cargill’s IT operation can be described as a billion-dollar business within a \$135 billion operation. We run IT like a business, tracking income, expenses, and return on assets. We strive to set an example for the entire organization of how this business group uses analytics to generate critical insights and improve performance. To this end, we boosted our analytics capabilities, created scorecards and key performance indicators, and deployed dashboards to put numbers to how we are delivering.

In using analytics to build a more numerically driven culture, it is important to remember that bad data yields bad insights. Improving data quality where the work actually happens requires that leaders drive a comprehensive cultural shift in the way employees think about and use data and how they take responsibility for data. Companies often address the challenge of data quality from the other end by spending tons of money to clean messy data after it gets in their systems. What if you didn’t have to do that? What if you could transform your own data culture into one that rewards quality, tidiness, and disciplined data management approaches? That’s where rules help; they can support an outcome that gets rewarded. You can hire data scientists to help you better understand your data, but lightening their load by cleaning the data before they begin working with it can make a big difference. Then you can double down on your efforts to create a culture that prizes individuals who are mathematically curious and more numerically driven, who frame and satisfy their questions with data rather than anecdotes, and who care about accuracy at the root, making sure they know where the data enters the systems and where the work is done.

When I talk to business executives about the acquisitions or investments they are considering, I often share this advice: Before moving forward, spend a little money to train the individuals operating your systems and share steps they can take to improve data quality. Reward data excellence at the root. In the end, the investment pays off: Better data quality leads to better planning, which, in turn, leads to better execution.

CYBER IMPLICATIONS

As companies create the governance, data usage, and management models needed to industrialize their analytics capabilities, they should factor cyber security and data privacy considerations into every aspect of planning and execution. Keeping these issues top of mind every step of the way can help heighten a company's awareness of potential risks to the business, technology infrastructure, and customers.

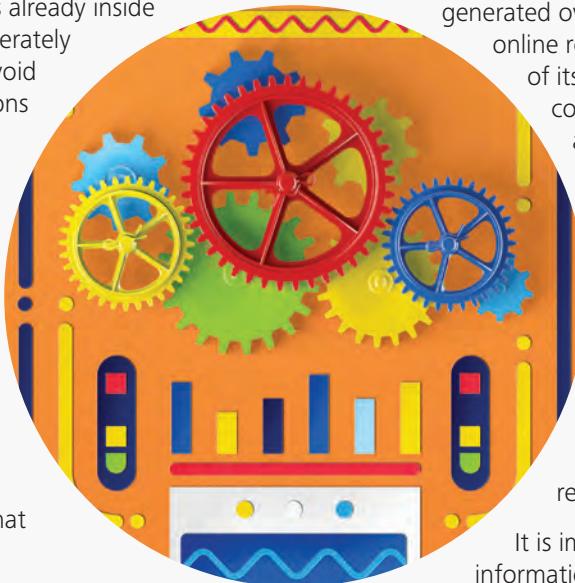
It may also help an organization remain focused on the entire threat picture, which includes both external and internal threats. Effective cyber vigilance is not just about building a moat to keep out the bad guys; in some cases there are bad guys already inside the moat who are acting deliberately to compromise security and avoid detection. Then there are legions of otherwise innocent players who carelessly click on an unidentified link and end up infecting their computers and your company's entire system. Cyber analytics plays an important role on these and other fronts. Analytics can help organizations establish baselines within networks for "normal," which then makes it possible to identify behavior that is anomalous.

Until recently, companies conducted analysis on harmonized platforms of data. These existed in physical data repositories that would be built and maintained over time. In the new model, data no longer exists in these repositories, but in massive data lakes that offer virtualized views of both internal and external information.

The data lake model empowers organizations and their data scientists to conduct more in-depth analysis using considerably larger data sets. However, it may also give rise to several new cyber and privacy considerations:

- **In a virtual environment, not all sources are created equal.** Companies transitioning to a data lake model should determine how best to stratify trust, given that some sources live within the company's firewall and can be considered safe, while external sources may not be. As part of this process, companies should also develop different approaches for handling data that have been willfully manipulated versus those which may just be generally unclean.

- **Derived data come with unique risk, security, and privacy issues.** By mining customer transaction data generated over the prior three months, an online retailer determines that one of its customers has a medical condition often treated with an array of products it sells. The company then sends this customer coupons for the products it believes she might need. In the best-case scenario, the customer uses the coupons and appreciates the company's targeted offerings. In the worst case, the company may have violated federal privacy regulations for medical data.



It is impossible to know what information analytics programs will ultimately infer. As such, companies need strong data governance policies to help manage negative risk to their brand and to their customers. These policies could set strict limits on the life cycle of data to help prevent inaccuracies in inferences gleaned from out-of-date information. They might also mandate analyzing derived data for potential risks and flagging any suspicious data to be reviewed. Just as organizations may need an industrialized analytics solution that is scalable and repeatable, they may also need an analytics program operating on an enterprise level that takes into account new approaches to governance, multilayered data usage and management models, and innovative delivery methods.

Where do you start?

The expansive reach of data and analytics' potential makes them a challenging domain. Ghosts abound in the machine—in legacy data and ops, as well as in some stakeholders' dearly held convictions about the relative importance of data across the business. Perhaps even more challenging, the C-suite and other decision makers may lack confidence in IT's ability to deliver crunchy, actionable business insights. But although the deck may seem stacked against success, the very act of attempting to industrialize analytics can help frame these issues, building support for streamlining delivery and tapping analytics' full potential. To get the ball rolling, consider taking the following steps:

- **Air grievances:** Though it may be uncomfortable, it is important to get the “state of the state” out in the open before launching any transformation effort. Solicit constructive feedback from all quarters on how well existing analytics and data needs are being met and how these needs may change as business evolves. Address issues and perceptions, including those that are fact-based and those driven by misunderstandings and bias. Learn where inaccurate metrics or expectations are creating challenges and where redundant or outdated activities no longer add value. Likewise, examine instances in which overly simplistic models, overconfident analysts, lack of clarity on outcomes, or inaccurate assumptions have led to incorrect results. The emphasis should be on lighting candles versus cursing the darkness. Work to build the analytics agenda while setting a vivid baseline against which progress can be measured.
- **Communicate clearly and purposefully:** Don't let analytics efforts get bogged down

in a swamp of jargon, complicated tables, and overly indexed statistics. More often than not, the results with the greatest impact are those that are communicated clearly and concisely.

- **Revitalize the data core:** Many organizations have made long-standing investments in multiple areas across the industrialized analytics charter. Using those areas to industrialize analytics can accelerate the journey, but such an approach can also be risky. Legacy design choices can color your vision of the road ahead. Likewise, the technical debt and poor organizational constructs that accompany legacy systems can stifle progress and undermine project value.
- **Educate and lead:** The bigger and older the organization, the more difficult it is to drive a cultural change for analytic transformation. Don't underestimate the need for education, communication, learning, and reinforcement, both within and beyond the direct analytics team. Moreover, becoming an insights-driven organization requires some level of buy-in across departments and hierarchies. To this end, senior leadership support is crucial, but no more so than clearly articulating the journey. Providing concrete details of what the transformation means at an individual level, along with examples of how early adoption can drive tangible results, can also help overcome wariness among staff. Finally, though it may not be necessary to have one executive explicitly “own” the initiative, some organizations have created “chief data officer” and “chief analytics officer” positions as a means to galvanize—and hold themselves accountable for—their analytics ambitions.

- **Tailor your efforts:** The results of industrialized analytics initiatives will vary by organization. With this in mind, project leaders should tailor their aspirations and roadmaps to reflect the specific DNA of their own organization—taking into account executive personalities and passions as much as operational and organizational dynamics.
- **Rethink your talent strategies:** Respect the scarcity of talent in the data science and analytics fields, but don't let it be an excuse for lack of progress. Explore vendors, startups, service providers, academia, and the crowd to bolster a nontraditional sourcing strategy—especially as you formalize your analytics vision and overarching strategies.
- **Blaze new trails:** Optimizing current spend levels around the data and information space should definitely be a part of planning. But industrialized analytics should be about more than just cost containment and efficiency gains. Discovering new ways to harness data and activate insights could lead to breakthroughs across domains and functions.

Bottom line

“Data is the only resource we’re getting more of every day,” said Christina Ho, deputy assistant secretary at the US Department of the Treasury recently.¹⁵ Indeed, this resource is growing in both volume and value. Properly managed, it can drive competitive advantage, separating organizations that treat analytics as a collection of good intentions from those that industrialize it by committing to disciplined, deliberate platforms, governance, and delivery models.

Authors

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David Pierce has almost 20 years of experience implementing solutions to improve marketing and finance performance through better access to information. He advises clients on ways to realize value from information management by utilizing new technologies and more effectively coordinating enterprise activity. Pierce has worked on all elements of analytic programs, from strategy to design, implementation, and sustainment.

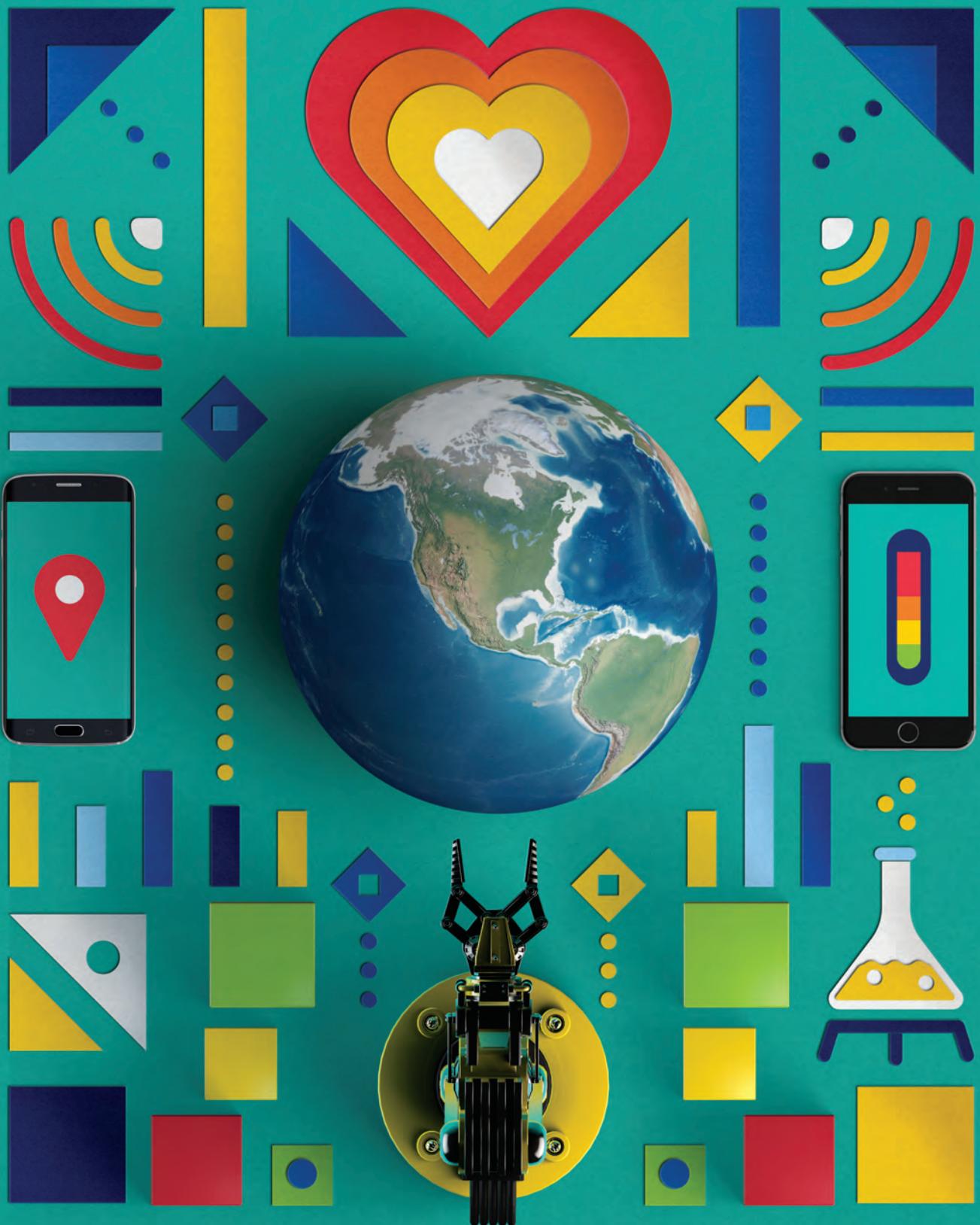
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Mark Shilling leverages foundational and disruptive technologies and techniques to help clients become insight-driven organizations. Working across all industries, he has 20 years of experience advising clients on large-scale, global data and analytics programs, helping them drive efficiency and effectiveness in core areas of cost reduction, operational risk, performance management, asset efficiency, and regulatory reporting. His technical focus spans data management, information delivery, performance management, and advanced analytics.

Endnotes

1. Deloitte Consulting LLP, *Tech Trends 2015: Dimensional marketing*, 2015.
2. Deloitte Consulting LLP, *Tech Trends 2015: Amplified intelligence*, 2015.
3. Thomas H. Davenport and D.J. Patil, “Data scientist: The sexiest job of the 21st century,” *Harvard Business Review*, October 2012, <https://hbr.org/2012/10/data-scientist-the-sexiest-job-of-the-21st-century/>, accessed January 18, 2016.
4. Gil Press, “6 observations for a new survey on the state of big data analytics,” *Forbes*, September 4, 2015, <http://www.forbes.com/sites/gilpress/2015/09/04/6-observations-from-a-new-survey-on-the-state-of-big-data-analytics/>, accessed January 18, 2016.
5. Perry Rotella, “Is data the new oil?,” *Forbes*, April 2, 2012, <http://www.forbes.com/sites/perryrotella/2012/04/02/is-data-the-new-oil/>, accessed January 18, 2016.
6. Tom Davenport, “The insights-driven organization: Management of insights is the key,” Deloitte University Press, August 26, 2015, <http://dupress.com/articles/insight-driven-organization-insight-management/>, accessed January 18, 2016.
7. See examples in *Tech Trends 2016: IoT: From sensing to doing*, 2016.
8. Terradata, “Anarchy doesn’t scale: Why your data lake needs a government,” *Forbes*, June 4, 2015, <http://www.forbes.com/sites/teradata/2015/06/04/anarchy-doesnt-scale-why-your-data-lake-needs-a-government/>, accessed January 18, 2016.

9. Kaggle Inc., "The home of data science," <https://www.kaggle.com/>, accessed January 18, 2016.
10. Anthem, "Anthem reports fourth quarter and full year 2015 results," press release, January 27, 2016, <http://ir.antheminc.com/phoenix.zhtml?c=130104&p=irol-newsArticle&ID=2132574>, accessed February 1, 2016.
11. Patrick McIntyre (senior vice president, health care analytics, Anthem, Inc.), interview with the author, December 11, 2015.
12. Eaton Corp., "Company facts," <http://www.eaton.com/Eaton/OurCompany/AboutUs/index.htm>, accessed November 23, 2015.
13. Tom Black (vice president, enterprise information management and business intelligence, Eaton), interview with the author, November 2015.
14. Adam Braff, (executive vice president and global head, enterprise data, analytics, and architecture, Zurich Insurance Group), interview with the author, January 20, 2016.
15. Kenneth Corbin, "Feds advance open data roadmap despite challenges," *CIO*, September 3, 2015, <http://www.cio.com/article/2980133/government/feds-advance-open-data-roadmap-despite-challenges.html>, accessed January 18, 2016.



Social impact of exponential technologies

Corporate social responsibility 2.0

As strategic discussions increasingly focus on how business can evolve and capitalize on new innovation, it is important to recognize the enhanced role companies should play in the responsible use of disruptive technologies. Their challenge will be finding ways to design and architect models for driving transformative change and positive social impact—both for philanthropic good and for more commercial purposes. Harnessing exponentials for social impact can help build markets, drive adoption, and light a powerful beacon for attracting and retaining top talent. Beyond that, organizations should consider the ethics and morality of applying exponential technologies—beyond traditional risk concerns of security, privacy, regulatory, compliance, safety, and quality.

In the last several editions of *Tech Trends*, we've included a special feature on exponentials, exploring ways that the ever-increasing pace of technological innovation is driving an impending transformative—and potentially disruptive—shift in the existing business landscape. We've framed "exponentials" in two ways. First, we've documented the unprecedented speed and magnitude of advancement in fields blending science and technology—breakthroughs progressing at a pace with or exceeding Moore's Law. Second, we've examined their potential impact, featuring topics with the potential to positively affect billions of lives. Technologies such as 3D printing, artificial intelligence, advanced robotics, virtual and augmented reality, alternative energy systems,

biotechnology, and digital medicine evidence a renaissance of innovation, invention, and discovery.

This year, we've given several of these exponentials their own *Tech Trends* chapters as their mass adoption window has moved into the next 18 to 24 months. At the same time, we're seeing leading organizations harness emerging technologies for social good, while others have begun examining the potential impact exponentials may have on society, education, health care, and the environment.

Pandora's box

Around the globe, an emerging entrepreneur class is accessing, adopting, and experimenting with exponential technologies.

This phenomenon is presenting a wide array of opportunities and risks for market leaders, emerging players, and everyone in between. Organizations across sectors and geographies are now focusing on the potentially disruptive opportunities looming on the horizon. Clearly, "The times they are a-changing."

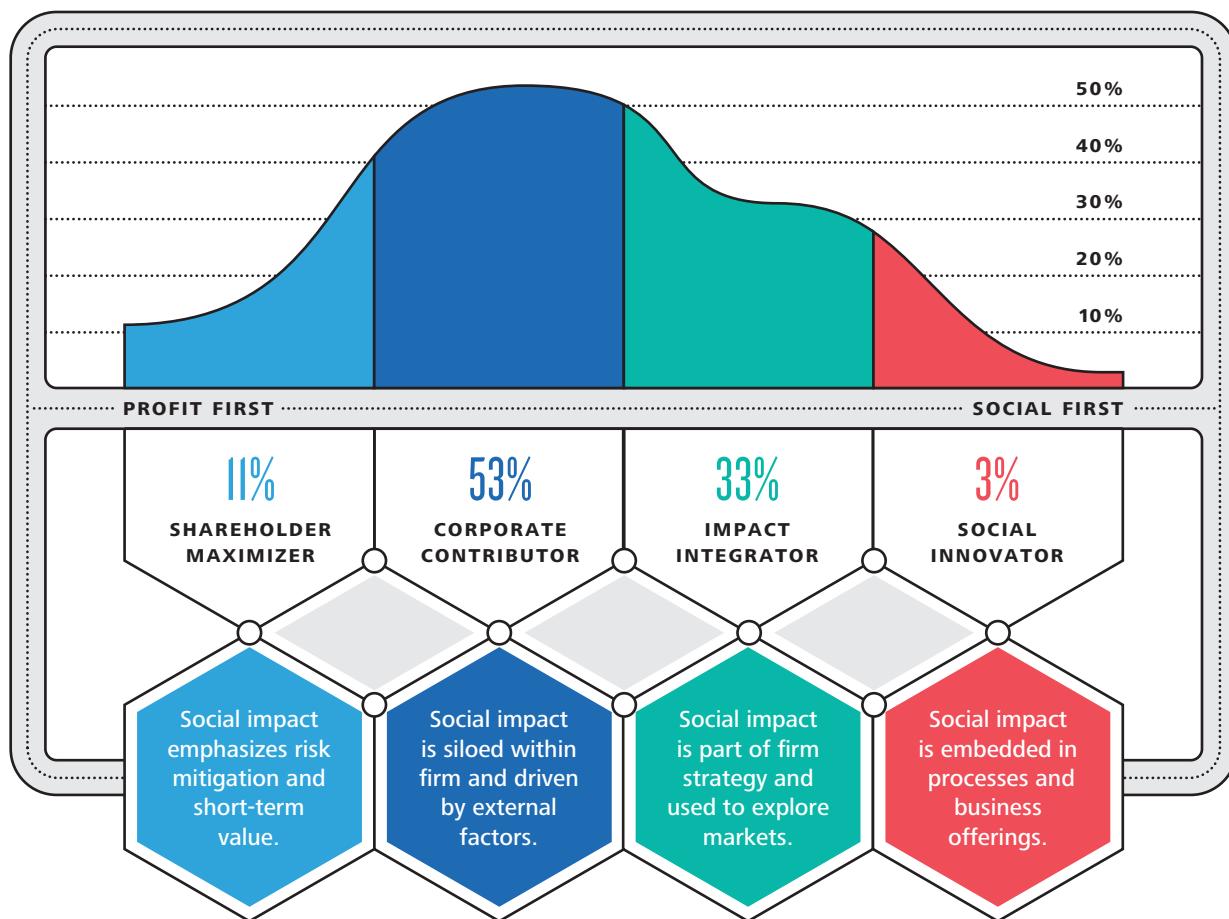
Yet at the same time, these forward-thinking organizations are also encountering opportunities to look beyond the purely

commercial implications of exponentials. The same forces driving innovation and growth in the commercial sector can also drive transformational change on a social level. Humanity's grandest challenges in education, health care, climate change, and even civil rights can all be viewed through a different lens as disruptive technologies energize creative problem-solving. What responsibility do companies have to expand

Figure 1. Corporate archetypes around social impact

Exponential technologies have the potential to create large-scale business model and social disruption. In order for companies to manage externalities and create value from this disruption, they should examine how they can best proceed with research and development not only responsibly, but as a catalyst for social change.

A Deloitte study examining the social impact practices of the 2014 Fortune 500 global public companies revealed four business archetypes. These archetypes help companies better understand where their social impact strategies stand and how they compare to their peers', so they can be intentional about maximizing value for their business and society at large



Source: Deloitte Development LLC, *Driving corporate growth through social impact: Four corporate archetypes to maximize your social impact*, 2015, <http://www2.deloitte.com/content/dam/Deloitte/us/Documents/strategy/us-strategy-operations-social-impact-corporate-archetypes.pdf>, accessed December 17, 2015.

their reach beyond their own walls, and to help leverage exponentials to drive greater good in society? Moreover, how will business and society address the ethical and moral questions around unequal access to new innovations and, more broadly, how these new innovations will be used?

"With great power comes great responsibility"

This famous quote has been credited to an array of luminaries, from Stan Lee, the writer of *Spider-Man*, to Franklin D. Roosevelt, and even Winston Churchill; the first literary record of this phrase appears to be attributed to Francois-Marie Arouet, also known as Voltaire.¹ Regardless of its original source, in the context of exponentials, this phrase takes on an entirely new meaning.

Technology is a universal ingredient across exponentials. This puts the CIO and IT in a unique position to help build awareness of the potential social impacts and opportunities of exponential technology initiatives. This can be a natural extension of the CIO's broader agenda around innovation and risk. But it may also help CIOs define their legacies, promote their personal brands to the CEO and the board, and instill a new sense of purpose in the IT organization.

Dr. Peter Diamandis has said, "The world's biggest problems are the world's biggest business opportunities. Want to be a billionaire? Impact a billion people!"² He is right. The technology needed for organizations to catalyze significant positive social change—while at the same time pursuing commercial ambitions—has never been more accessible. The world needs problem-solvers, and customers and employees are becoming increasingly aware of this fact each day. Organizations that identify innovative and creative methods to incorporate a social impact mission into their business strategies will likely be recognized and acknowledged, which could also translate into real growth and longevity.

Over the last 10 years, there has been a noticeable shift in the way public companies think about social impact as a strategic driver of value. Today, some companies are beginning to adopt a social impact mind-set to build differentiated products, explore new markets, secure a sustainable supply chain, attract and retain Millennial talent, and transform contentious regulatory relationships, among other tasks. In short, social impact is slowly evolving from a pure public relations play to an important part of corporate strategy to protect and create value.

A recent Deloitte study of the social impact practices of the Fortune 500³ found that 11 percent of organizations had made minimal investment in social impact programs; another 53 percent had invested modestly in programs focused on charitable donations and volunteer work. The study found that only 33 percent of companies could be considered "impact integrators": organizations that have made driving the types of change we're describing here central to their business strategies and goals.

This suggests there is considerable white space for companies to target with programs. The financial services industry, for example, might explore new ways for blockchain to democratize banking, enable micro-transactions, and simplify philanthropic donations. The consumer food industry could potentially leverage biotechnology to change the health benefits profile and affordability of their products. The entertainment industry might partner with educational leaders to leverage advances in augmented and virtual reality to revolutionize learning and education. By supporting the maker movement and exploring new ways to leverage 3D printing, manufacturers could help provide affordable housing and basic necessities to the world's underserved populations. Hospitals and the health care industry have opportunities to use digital medicine to reinvent and democratize prevention, diagnosis, and treatment.

Social good is good business

Globalization is raising the stakes around social impact. Even companies with a strong market presence are working to expand their reach into additional segments and countries, including second-tier markets and rural areas. Here, grand challenges exist: poverty, inadequate sanitation, water quality, and failures in the social infrastructure of housing, education, and health care. Resource constraints and environmental challenges loom, including energy costs, water quality, and pollution.

In these markets, solving fundamental social needs can lead to commercial opportunities, but it can also challenge business operations. Growing businesses need capable employees, reliable suppliers, a well-governed economy, and consumers with the means and confidence to buy. Dr. Judith Rodin, president of the Rockefeller Foundation, has said, “In much of the world, markets must be built before they can be served. Forward-looking business leaders who embrace this reality make explicit commitments to enter new global markets both as economic opportunity zones as well as community spaces requiring nurturing and support.”⁴ Applying advanced technology can expedite the journey and amplify the effect. From using artificial intelligence and cloud computing to run advanced analytics studies of clean water⁵ to deploying drones to deliver food and medicine to villages isolated after natural disasters,⁶ real progress is being made, to exponential effect.

Purpose, mission, and talent

Social impact initiatives are also helping create talent beacons in the market as employees become more socially conscious. Sound HR and business strategies should consider the expectations of talent and consumer pools as a whole, and with a particular focus on Millennials.

There has been a convergence between “social impact” and “innovation,” largely driven by Millennials, who account for \$1 trillion of current US consumer spending.⁷ As widely reported, Millennials’ decision-making processes are often influenced by a desire to have a larger purpose in life. This has made corporate social responsibility (CSR) an imperative and not an option.

CSR increasingly plays a huge role in shaping brand perception. According to one study of corporate social impact, when companies support social and environmental issues, Millennials respond with increased trust and loyalty, and are more likely to buy those companies’ products.⁸ Even more pointedly, in a recent survey of Millennials, more than 50 percent of 13- to 25-year-old respondents said they would refuse to work for an irresponsible corporation.⁹

But it’s not just about Millennials. A study by the Society for Human Resource Management found that 55 percent of companies with strong sustainability programs had better morale, 43 percent had more efficient business processes and a stronger public image, and 38 percent experienced higher employee loyalty.¹⁰ Social impact crosses generational bounds, and it can be a differentiating play in the war on talent—especially in the hyper-competitive battle for the IT worker of the future.¹¹

Lessons from the front lines

A virtual field trip of dreams

"At Google, innovation follows a natural order in which leading-edge engineering is applied in pursuit of a technology's potential, not its near-term commercial viability," says Jonathan Rochelle, product manager for Google Education.

This approach is providing Rochelle with the resources and creative leeway he needs to pursue his latest social impact project: Google Expeditions, a virtual reality platform built for the classroom. While its long-term ambitions are far-reaching, the first iteration takes aim at improving an educational mainstay: the field trip. Rochelle and his team are working with teachers and content partners from around the world to create more than 150 tours that will immerse students in new experiences and learning environments. Students are free to explore distant locales without ever leaving their desks. They can easily follow their teacher's lead—at least as long as the guided tour holds their interest. Factoids, notes, educational videos, and anything else that will help knowledge stick are also available to help kids dig deeper and learn more. And field trips are only the first frontier. Care to study shark anatomy? Immerse yourself in a virtual viewing tank for five minutes to study one up close. Organic chemistry? Become an explorer of the molecular machinations that make us who we are. Potential lies across the entire academic curriculum.

Expeditions was born during a hackathon in which two engineers blended VR concepts from the Google Cardboard viewer with document-sharing capabilities from the company's classroom application. The result was an app that made it possible for one leader to guide multiple people on a virtual journey. Their first iteration featured two panoramas: one a tour of the Taj Mahal, and the other a view from space. "When we tried this out

for the first time, we realized we were onto something unique: a virtual reality solution that delivers freedom for students and some basic level of control for teachers," says Rochelle. "I've never seen such immediate buy-in and agreement on the potential for a product. Everyone who tries it immediately gets excited."

Expedition is still in early days as a pioneer program. Engineers are working to streamline the process for creating immersive panoramas, which currently requires syncing an array of 16 GoPro cameras. Likewise, Rochelle and his team are testing the beta product in classrooms where teachers and students take it for a trial run and provide feedback. "We are not educators, but we want to be sure that educators guide the development of this product," says Rochelle, who adds that before Expeditions is available more broadly, hundreds of thousands of teachers and students from 10 countries will have tested it.

Expeditions is a feather in the Google VR development team's cap. But, says Rochelle, it is also proof that VR innovations can move forward without an immediately viable business model. "My goal is to take incredible technologies and make them useful for educators. If they work in that capacity, they will likely eventually work in other capacities, too."¹²

Set phasers to wellness

As a general rule, unmet consumer need drives innovation. Unfortunately, this rule doesn't always apply to the health care industry. In an age of tech-enabled individual empowerment, patients often have few opportunities to receive medical care without going to a clinic or hospital—a limitation that can create inefficiencies and drive up prices.

To help address this challenge, in 2012 Qualcomm Life, Inc., a subsidiary

of Qualcomm Incorporated, focused on wireless health solutions. Working through its philanthropic arm, the Qualcomm Foundation, and in collaboration with the XPRIZE Foundation, Qualcomm Life launched the Qualcomm Tricorder XPRIZE, a global competition in which teams compete to develop a portable, wireless device that accurately diagnoses a set of diseases, independent of a health care professional or facility, and provides a positive user experience. At the end of the five-year competition, the team with the best design and diagnostic performance will pocket a cool \$10 million.¹³

According to Rick Valencia, senior vice president and general manager at Qualcomm Life, the decision to support this competition was driven by Qualcomm's commitment to promoting innovation in health care. "Trying to address challenges in an area like diagnostics is not easy. But we strongly believe that mobile technology has a role to play in that effort," he says.

Inspired by a prop and concept from the *Star Trek* series, devices are expected to accurately diagnose 13 health conditions (12 diseases as well as the absence of conditions). They should also continuously monitor vital signs in real time, independent of a health care worker or facility, and in a way that provides a compelling consumer experience. The only design limitation is that the device must weigh under five pounds.

The Qualcomm Tricorder XPRIZE competition is currently underway. An initial field of roughly 300 entrants has been narrowed to seven finalists hailing from North America, Europe, and Asia. The finalists represent a wide array of backgrounds: a medical doctor with a PhD in engineering; two brothers who run their own medical device company; and a group of students from Johns Hopkins University. In the coming months, finalists will deliver at least 30 new prototypes that will be tested for consumer

use. The winning design will be announced in early 2017.¹⁴

Best foot forward

Since 2006, shoe seller TOMS has pioneered new approaches for harnessing the power of business and digital technologies to help others. Through its One for One program, every customer purchase made on TOMS.com helps provide shoes, eye care, water, safe birth, and bullying prevention services to people in need around the world. The company also collaborates with a network of "giving partners"—locally staffed and led social and charitable organizations with a long-term commitment to the regions in which they operate. Through these and other efforts, TOMS has, to date, given away roughly 10 million pairs of shoes and helped restore sight to more than 200,000 people.¹⁵

To grow its global network of giving partners and to enhance the online customer experience, TOMS built an e-commerce platform that supports additional TOMS sites in almost a dozen countries. The platform was designed with a scalable architecture to launch new sites rapidly, allowing TOMS to build online marketplaces that reflect the culture and shopping preferences of local constituencies. It also incorporates, among other features, responsive design capabilities, which enable the site to immediately recognize the type of device a customer is using and automatically adjust format, content, and performance accordingly. This is particularly useful in regions where feature phones dominate.

TOMS sites around the world now deliver a highly visual, personalized customer experience built on relevant content, helpful recommendations, and a faster, easier check-out process. Additionally, the company's business users now have better control over the customer experience, since they have the ability to target promotions, personalize content, customize search results

and recommendations, and update product information across multiple sites on the fly.

Notably, this solution provides a separate platform that small, local merchants who share TOMS' philanthropic vision—and who might not have an e-commerce platform of their own—can use to market products designed and manufactured in their own regions. The “Marketplace” platform, which is fully integrated into the TOMS e-commerce site, today features a wide variety of textiles, jewelry, houseware, and other items produced locally—and now, thanks to TOMS, marketed and sold worldwide.

Open Bionics offers a helping hand

Aware that staggering development costs had put prosthetics beyond the reach of many hand amputees, Joel Gibbard, an engineering major studying robotics, launched a project at his university to develop a low-cost robotic prosthetic. Within a year, he had built a working robotic prosthetic using a 3D printer.

Following graduation, Gibbard accepted a job with a global engineering and technology firm. Yet despite the opportunities this position presented, he couldn't stop thinking about his university project and the amputees everywhere who desperately needed prosthetics. Gibbard soon quit his new job, moved back in with his parents, and used all of his savings to buy a 3D printer.¹⁶

Today, Gibbard is CEO of Open Bionics, a UK startup that is using open-source



3D printing software, robotic sensors, and financial capital from crowdfunding efforts to create a bionic hand that is less costly to produce than some others on the market. Instead of months and hundreds of thousands of dollars, it takes Open Bionics days and thousands of dollars to build a robotic prosthetic, which means that its prosthetics are more accessible to amputees across the developing world. What's more, Open Bionics' prosthetic hands match more expensive prosthetics in terms of functionality, but are lighter and custom-made, and thus often more comfortable for the wearer.

Open Bionics' efforts are attracting attention worldwide—notoriety that has brought in additional funding and sparked potentially beneficial partnerships. Recently, the company took home a \$200,000 prize for a second-place win in Intel's “Make it Wearable” challenge.¹⁷ Likewise, in 2015, Open Bionics was accepted into Disney Accelerator powered by Techstars, a program designed to accelerate the growth of start-up companies from around the world. As part of this program, Gibbard and his team will create prosthetic hands and arms for kids—patterned after designs inspired by their favorite Disney characters.¹⁸

To date, Open Bionics engineers have worked on 10 prototypes, and they are currently developing an eleventh. Though the company's products—all of which are open source—are not currently available for sale, Gibbard estimates they should be commercially available within a year.¹⁹

OUR TAKE

MARCUS SHINGLES

CEO
XPRIZE Foundation

In the book *Abundance: The Future is Better Than You Think*,²⁰ there is a picture drawn of a future in which all 9 billion people on planet Earth have access to clean water, food, energy, health care, education, and everything else necessary to achieve a first-world standard of living. This feat is achieved thanks to exponential technologies and innovation. Yet questions remain: Will “abundance” be equally distributed? When will it be achieved? Will all nations and their populations, and all segments of society have equal access to this abundance at once? It’s worth pausing for a moment to contemplate these questions and the related social impacts.

“We are arguably heading toward a future in which we will have the knowledge and capabilities to make the “impossible” possible.”

The pace of invention and innovation is accelerating rapidly. The dematerialization, demonetization, and democratization of technology could potentially lead to a new definition of “haves” and “have-nots.” During the next couple of decades, there may well be turbulence during a period of “pre-abundance” in which the impact of exponential technologies will be unevenly distributed, thus resulting in a new paradigm shift as to the notion of human inequality and class division.

Exponential technologies such as artificial intelligence, robotics, and 3D printing will lead to massive transformation in the workforce and job displacement. Add the impact of other exponential technologies, such as infinite computing power, the Internet of Things, and synthetic biology, and we are arguably heading toward a future in which we will have the knowledge and capabilities to make the “impossible” possible. In the early stages of the exponential curve,

DR. PETER DIAMANDIS

Founder and executive chairman, XPRIZE Foundation
Co-founder and executive chairman, Singularity University

there will be a window of time in which the economics of a breakthrough for some innovations can only be afforded by either those who have the knowledge, or those who can afford to purchase what that knowledge produces. Such powerful capabilities may leave some segments of the population behind as other “super-haves” accelerate rapidly.

At what point do these scenarios create animosity, anxiety, envy, and jealousy between those with the knowledge and the means versus those who do not? What roles and responsibilities do governments, business leaders, and society at large have in this precarious pre-abundance period to facilitate the democratized access to these transformative technologies?

As exponentially accelerating technologies transition us toward an era of abundance, we need a new breed of leadership that can monitor and help minimize the potential for this growing divide. This new breed of technologically literate leaders will be needed in order to provide the education and knowledge to reassure and guide societies during a potentially very unstable period of disruptive change.

Our traditional “linear” institutions and leaders, religious and governmental, tend not to support rapid change and often seem wired to preserve the status quo, sometimes even at the expense of the trust of the people they serve. Tomorrow’s leaders will need to navigate these difficult transitions to help build a bridge to abundance. From luminary entrepreneurs to global CEOs to outspoken social visionaries, these leaders will individually and collectively need to rethink and reinvent today’s social contracts and social norms.

Where will these forward-thinking leaders come from? Our history teaches us that these types of leaders are rare, and often underappreciated at first glance. In this coming era of disruption, one thing is for certain: A new generation of “exponential” leadership is needed, and all parts of society will be required to participate.

CYBER IMPLICATIONS

In the current political climate, Oscar Wilde's adage "No good deed goes unpunished" still resonates. As we see frequently in both the domestic and international arenas, one group's pursuit of the social good can offend the sensibilities of others, leading to social media outrage, protests, and threatened boycotts.

Unfortunately, the consequences of social, political, or philanthropic activities can extend beyond boycott threats: Organizations identifying themselves with a particular social or political cause may also make themselves beacons for hackers bent on punishing them for their activism. For example, in 2011, French nuclear power generator EDF was fined €1.5 million by a Paris court for hacking into the computers of environmental group Greenpeace. Greenpeace had opposed EDF's plan to construct a new generation of nuclear reactors in France.²¹

As companies examine opportunities for using technology to promote the common good, they should factor in potential impacts—both positive and negative—of pursuing a particular course of action. They should also consider the full range of cyber threats they face, including "bad actor" events, as well as those involving well-intentioned employees who are oblivious to cybersecurity considerations. Finally, companies can explore opportunities for making their technologies and cyber expertise available to like-minded groups who share their social or philanthropic goals.

To understand more clearly how cybersecurity could impact your company's social agenda, consider the following questions:

- **How could getting involved affect your company's cyber beacon?** While organizations may have a good handle on the cyber threats their core business faces, they may not have as detailed an understanding of the cyber threats they could face as they expand into the arena of social responsibility. How might a company's involvement with certain causes or organizations potentially attract the attention of hackers? Beyond concerns

over a politically driven reaction by hackers to an official social policy, how might having numerous employees use company systems to engage with social or philanthropic organizations on, for instance, a crowdsourcing platform outside your firewall alter your company's risk profile? While social engagement likely presents no more risk than any other engagement with external entities, companies should take steps to include these and other scenarios in their existing cybersecurity, cyber privacy, and cyber risk policies.

- **How might sharing technology assets with others impact cyber risk?** By encapsulating assets and services as APIs, a global technology vendor shares the code for a potentially transformational product with the world. Through this act of generosity, the company may change the lives of millions. But it may also offer bad actors a new point of entry into its systems. As the open sourcing of assets for social and other reasons becomes more common, organizations considering this option should thoroughly examine how making previously confidential information widely available could potentially open up new risk avenues. They should then weigh the potential positives against cyber-related negatives to determine if this is the best strategy for achieving its social goals.



- **Cyber expertise as a gift?** Think about it. As discussed in the last two editions of *Tech Trends*, cybersecurity is itself an exponential. As your organization establishes its cybersecurity and cyber risk programs, how could you work with organizations that lack the resources in these areas to develop their own programs? Using your experience and tools to help a nonprofit tackle some of the same cyber risk challenges your own company faces could be one of the most beneficial contributions your company can make.

Where do you start?

Social impact is a big topic, extending far beyond the realm of IT. However, defining the role that exponential technologies play in corporate social impact programs is the responsibility of IT executives, particularly the CIO. Why? Because the convergence of R&D and social investments can lead to adoption of new products and offerings. It can also serve as a backdrop for experimenting with technologies before applying them to core business concerns. Given the sheer number of considerations and opportunities, formulating an actionable social impact plan that lays out a clear vision for the use of exponential technologies can be challenging.

Here are some potential places to start:

- **Frugal innovation:** Business strategies may call for achieving growth by addressing the needs of poor and aspirational market segments, which often requires offering more sustainable, affordable products. Rather than stripping existing products of features, shift your focus to leveraging exponential forces to invent something that is affordable and fills a basic need. For example, GE developed a portable ultrasound machine for China that not only decreased infant mortality rates, but created a new product category that led to widespread adoption.²²
- **Ecosystems:** In their social impact efforts, organizations will likely be partnering not just with competitors, but with NGOs and the public sector. Whereas once businesses and nonprofits viewed each other largely as antagonists, they are increasingly finding opportunities to bring complementary knowledge, experience, and skills to bear on social problems. Meanwhile, government can also play an important role as an anchor buyer, coordinator, and implementation partner for market-based solutions.
- **Mind-set change:** Making the business case for solving social needs requires a change in mind-set and new ways of doing business. Addressing the specific needs of underserved consumers, the social challenges facing local suppliers, and the limits of infrastructure and education requires a sustained commitment to serve a particular market. This might also require longer-term planning horizons, changes in the product development process, new forms of collaboration, and innovative business models.
- **Power to the people:** Challenge your stakeholders to help inform your social impact agenda. Hold company-wide contests to surface ideas from around the globe. Crowdsource concepts from customers, partners, and other interested third parties. Organize hackathons to quickly form teams and refine raw thinking into high-level designs, business cases, and roadmaps. The more people engage in social impact programs, the more beneficial the programs will likely become to everyone involved.
- **Ethics architecture:** Make it the responsibility of teams working with artificial intelligence, robotics, 3D printing, and other exponentials to consider both the ethics and unintended consequences of these technologies. Building risk intelligence across IT is a leading practice, but it needs to evolve beyond security, privacy, safety, quality, and regulatory concerns. It should also include thoughtful exploration of potential social and ethical impacts and, as needed, mitigations for those impacts.

Bottom line

By exploring how disruptive and relatively cheap emerging technologies can be optimized for both social and business gains, business and technology leaders may be able to help solve the world's grandest challenges—and build new markets along the way. Beyond helping to attract dedicated customers, suppliers, and employees, social impact programs also present a unique opportunity for leaders to build a legacy of lasting value for their companies, and potentially for the world.

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Endnotes

1. Wiki Answers, "Who said that with great power comes great responsibility?" http://wiki.answers.com/Q/Who_said_that_with_great_power_comes_great_responsibility, accessed January 14, 2016.
2. Peter Diamandis, "Think big" (video, 0:58), Singularity University, <https://exponential.singularityu.org/finance/want-to-be-a-billionaire-impact-a-billion-people>, accessed January 19, 2016.
3. Deloitte Consulting LLP, *Driving corporate growth through social impact*, 2015, <http://www2.deloitte.com/content/dam/Deloitte/us/Documents/strategy/us-strategy-operations-social-impact-corporate-archetypes.pdf>.
4. Deloitte Consulting LLP, *Business Trends 2014: Business and social impact*, Deloitte University Press, March 31, 2014, <http://dupress.com/articles/bus-trends-2014-business-social-impact/>, accessed January 14, 2016.
5. Samantha Klein, "The POWER of crowdsourcing," IBM, July 16, 2015, <https://www.ibm.com/blogs/social-business/2015/07/16/the-power-of-crowdsourcing/>, accessed January 14, 2016.
6. Tim Smedley, "Drones' new mission: Saving lives in developing countries," *Guardian*, January 9, 2015, <http://www.theguardian.com/sustainable-business/2015/jan/09/drones-tech-natural-disasters-medical-developing-countries>, accessed January 14, 2016.
7. Sarah Cahan, "Perceptions, Millennials and CSR: How to engage the new leaders of tomorrow," Cone Communications, <http://www.conecomm.com/csr-and-millennials>, accessed January 14, 2016.
8. Ibid.
9. Jeanne Meister, "Corporate social responsibility: A lever for employee attraction and engagement," *Forbes*, June 7, 2012, <http://www.forbes.com/sites/jeannemeister/2012/06/07/corporate-social-responsibility-a-lever-for-employee-attraction-engagement/>, accessed January 14, 2016.
10. Susanne Gargiulo, "Why everyone wants to work for the good guys," CNN, November 7, 2012, <http://www.cnn.com/2012/11/07/business/global-office-csr-volunteer/>, accessed January 14, 2016.
11. Deloitte Consulting LLP, *Tech Trends 2015: IT worker of the future*, 2015.
12. Jonathan Rochelle (product manager, Google Education), interview with the authors, January 15, 2016.
13. Qualcomm, "Qualcomm Tricorder XPRIZE," <http://tricorder.xprize.org/>, accessed December 18, 2015.
14. Rick Valencia (senior vice-president and general manager, Qualcomm Life), interview with the authors, December 2015.
15. TOMS, "About TOMS," <http://www.toms.com/about-toms#companyInfo>, accessed January 13, 2016.
16. James Dyson Foundation, "Open Bionics," <http://www.jamesdysonaward.org/projects/open-bionics/>, accessed January 13, 2016.
17. Open Bionics, "Open Bionics big win from Intel," press release, November 4, 2015, <http://www.openbionics.com/blog/open-bionics-big-win-from-intel>, accessed January 13, 2016.
18. Sarah Buhr, "Open Bionics creates Disney-inspired bionic hands for amputee kids," *TechCrunch*, October 9, 2015, <http://techcrunch.com/2015/10/09/open-bionics-creates-disney-inspired-bionic-hands-for-amputee-kids/>, accessed January 13, 2016.
19. Michelle Star, "3D-printed robotic prosthetic wins 2015 UK James Dyson Award," *CNET*, August 25, 2015, <http://www.cnet.com/news/3d-printed-robotic-prosthetic-wins-uk-james-dyson-award/>, accessed January 13, 2016.
20. Peter Diamandis and Steven Kotler, *Abundance: The Future is Better Than You Think* (New York; Free Press, 2012).
21. Thierry Leveque, "EDF fined for hacking into Greenpeace computers," *Reuters*, November 11, 2011, <http://www.reuters.com/article/us-edf-spying-f-idUSTRE7AA34920111111>, accessed January 3, 2016.
22. Jeffrey Immelt et al., "How GE is disrupting itself," *Harvard Business Review*, October 2009, <http://www.fast-bridge.net/wp-content/uploads/resources/How%20GE%20Is%20Disrupting%20Itself.pdf>, accessed January 14, 2016.

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