

Tech Trends 2015

The fusion of business and IT



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Introduction

WE have it on good authority that the only constant in life is change. Yet, given the magnitude of the change we witness daily and the staggering pace at which it now unfolds, the term “constant” seems inadequate as we attempt to define and understand the highly mutable world around us.

For example, 10 years ago, who could have foreseen that aircraft manufacturers would be able to “print” replacement parts onsite in hangars rather than manufacturing them on distant assembly lines? Or that doctors would harness artificial intelligence to improve cancer diagnosis and treatments? Or that preventative maintenance systems featuring sensors and robotics would virtually eliminate unanticipated mechanical breakdowns?

In many cases, such changes are being driven by a confluence of business and technology forces fueled by innovation. On the business front, globalization continues apace, with new markets and new customer tiers swollen by billions of people rising out of poverty. Barriers to market entry are collapsing as entrepreneurs with low capital investment needs challenge established market players.

Meanwhile, on the technology front, five macro forces continue to drive enormous transformation: digital, analytics, cloud, the renaissance of core systems, and the changing role of IT within the enterprise. These forces are not just fueling innovation and giving rise to new business models. They are also enabling historic advances in materials, medical, and manufacturing science, among many other areas.

To help make sense of it all, we offer Deloitte’s sixth *Technology Trends* report, our annual in-depth examination of eight current technology trends, ranging from the way some organizations are using application programming interfaces to extend services and create new revenue streams, to the dramatic impact connectivity and analytics are having on digital marketing; and from the evolving role of the CIO to changing IT skill sets and delivery models.

Over the next 18–24 months, each of these trends could potentially disrupt the way businesses engage their customers, how work gets done, and how markets and industries evolve.

The theme for this year’s report is *the fusion of business and IT*, which is broadly inspired by a fundamental transformation in the way C-suite leaders and CIOs collaborate to leverage disruptive change, chart business strategy, and pursue potentially transformative opportunities.

The list of trends we spotlight has been developed using an ongoing process of primary and secondary research that involves:

- Feedback from client executives on current and future priorities
- Perspectives from industry and academic luminaries
- Research by technology alliances, industry analysts, and competitor positioning
- Crowdsourced ideas and examples from our global network of practitioners

As in last year's report, we have also included a section dedicated to six "exponential" technologies: innovative disciplines evolving faster than the pace of Moore's Law whose eventual impact may be profound.

Over the next 18–24 months, CIOs and other executives will have opportunities to learn more about these trends and the technologies that could potentially disrupt their IT environments and, more broadly, their company's strategies and established business models.

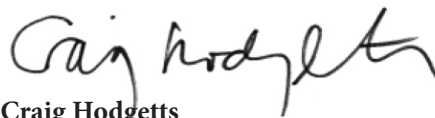
In the coming fiscal year or next, how will you apply what you learn to develop a response plan, and how will you act on your plan? More importantly, how can you leverage these trends and disruptive technologies to help chart your company's future?

The time to act is now . . . don't be caught unaware or unprepared.



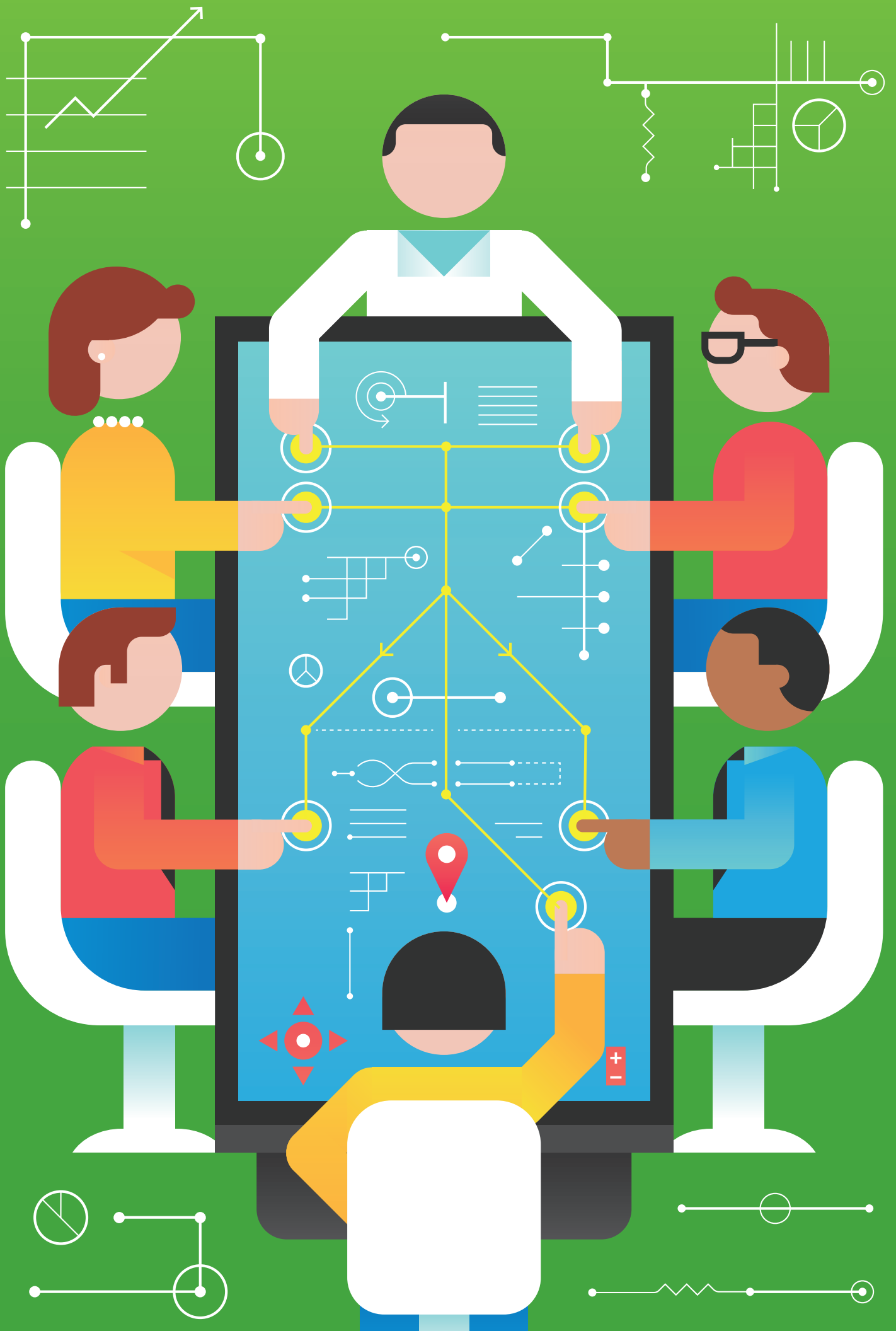
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CIO as chief integration officer

A new charter for IT

As technology transforms existing business models and gives rise to new ones, the role of the CIO is evolving rapidly, with integration at the core of its mission. Increasingly, CIOs need to harness emerging disruptive technologies for the business while balancing future needs with today's operational realities. They should view their responsibilities through an enterprise-wide lens to help ensure critical domains such as digital, analytics, and cloud aren't spurring redundant, conflicting, or compromised investments within departmental or functional silos. In this shifting landscape of opportunities and challenges, CIOs can be not only the connective tissue but the driving force for intersecting, IT-heavy initiatives—even as the C-suite expands to include roles such as chief digital officer, chief data officer, and chief innovation officer. And what happens if CIOs don't step up? They could find themselves relegated to a "care and feeding" role while others chart a strategic course toward a future built around increasingly commoditized technologies.

FOR many organizations, it is increasingly difficult to separate business strategy from technology. In fact, the future of many industries is inextricably linked to harnessing emerging technologies and disrupting portions of their existing business and operating models. Other macro-level forces such as globalization, new expectations for customer engagement, and regulatory and compliance requirements also share a dependency on technology.

As a result, CIOs can serve as the critical link between business strategy and the IT agenda, while also helping identify, vet,

and apply emerging technologies to the business roadmap. CIOs are uniquely suited to balancing actuality with inspiration by introducing ways to reshape processes and potentially transform the business without losing sight of feasibility, complexity, and risk.

But are CIOs ready to rumble? According to a report by Harvard Business Review Analytic Services, "57 percent of the business and technology leaders surveyed view IT as an investment that drives innovation and growth."¹ But according to a Gartner report, "Currently, 51 percent of CIOs agree that the torrent of digital opportunities threatens both

business success and their IT organizations' credibility. In addition, 42 percent of them believe their current IT organization lacks the key skills and capabilities necessary to respond to a complex digital business landscape."²

To remain relevant and become influential business leaders, CIOs should build capabilities in three areas. First, they should put their internal technology houses in order; second, they should leverage advances in science and emerging technologies to drive innovation; and finally, they need to reimagine their own roles to focus less on technology management and more on business strategy.

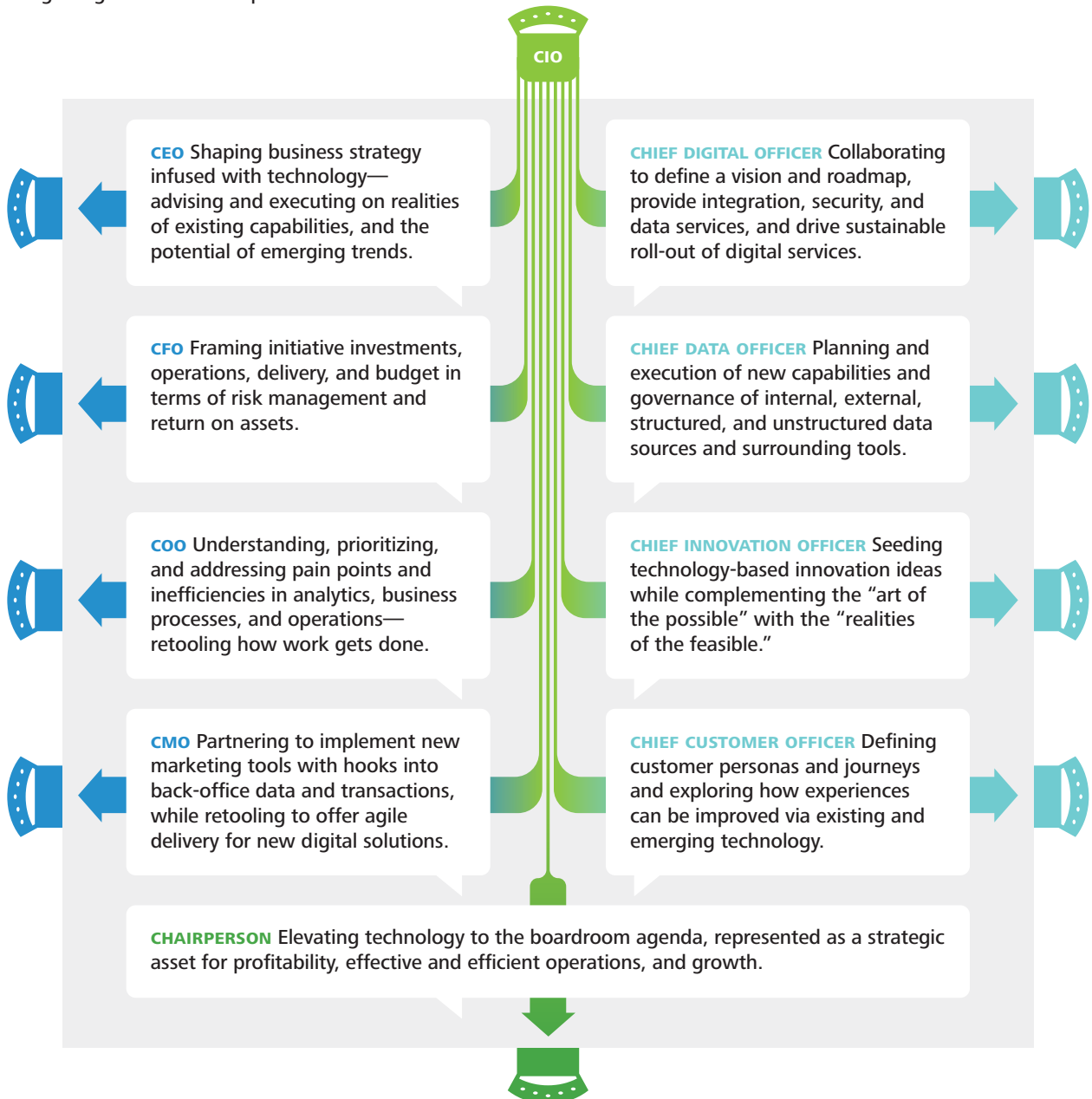
In most cases, building these capabilities will not be easy. In fact, the effort will likely require making fundamental changes to current organizational structures, perspectives, and capabilities. The following approaches may help CIOs overcome political resistance and organizational inertia along the way:

- **Work like a venture capitalist.** By borrowing a page from the venture capitalist's playbook and adopting a portfolio management approach to IT's balance sheet and investment pool, CIOs can provide the business with greater visibility into IT's areas of focus, its risk profile, and the value IT generates.³ This approach can also help CIOs develop a checklist and scorecard for getting IT's house in order.
- **Provide visibility into the IT "balance sheet."** IT's balance sheet includes programs and projects, hardware and software assets, data (internal and external, "big" and otherwise), contracts, vendors, and partners. It also includes political capital, organizational structure, talent, processes, and tools for running the "business of IT." Critical to the CIO's integration agenda is visibility of assets, along with costs, resource allocations, expected returns, risks, dependencies, and an understanding of how they align to strategic priorities.
- **Organize assets to address business priorities.** How well are core IT functions supporting the day-to-day needs of the business? Maintaining reliable core operations and infrastructure can establish the credibility CIOs need to elevate their missions. Likewise, spotty service and unmet business needs can quickly undermine any momentum CIOs have achieved. Thus, it is important to understand the burning issues end users face and then organize the IT portfolio and metrics accordingly. Also, it's important to draw a clear linkage between the balance sheet, today's operational challenges, and tomorrow's strategic objectives in language everyone can understand. As Intel CIO Kim Stevenson says, "First, go after operational excellence; if you do that well, you earn the right to collaborate with the business, and give them what they really need, not just what they ask for. Master that capability, and you get to shape business transformation, not just execute pieces of the plan."
- **Focus on flexibility and speed.** The business wants agility—not just in the way software is developed, but as part of more responsive, adaptive disciplines for ideating, planning, delivering, and managing IT. To meet this need, CIOs can direct some portions of IT's spend toward fueling experimentation and innovation, managing these allocations outside of rigid annual budgeting or quarterly planning cycles. Business sponsors serving as product owners should be embedded in project efforts, reinforcing integration between business objectives and IT priorities. Agility within IT also can come from bridging the gap between build and run—creating an integrated set of disciplines under the banner of DevOps.⁴

For CIOs to become chief integration officers, the venture capitalist's playbook

New boardroom discussions

With digital now a key boardroom topic, companies are addressing new technology needs in different ways. A recent Forrester survey found that “37 percent of firms place ownership of digital strategy at the ‘C’ level, with a further 44 percent looking to a senior vice president (SVP), executive vice president (EVP), or similar role to direct digital plans. However, less than a fifth of firms have or plan to hire a chief digital officer (CDO), meaning that digital accountability lives with an incumbent role.”^a CIOs can either fill these new digital needs themselves or serve as the connective tissue integrating all tech-related positions.



Source: ^a Martin Gill, *Predictions 2014: The Year Of Digital Business*, Forrester Research, Inc., December 19, 2013.

can become part of the foundation of this transformation—setting up a holistic view of the IT balance sheet, a common language for essential conversations with the business, and a renewed commitment to agile execution of the newly aligned mission. These capabilities are necessary given the rapidly evolving technology landscape.

Harness emerging technologies and scientific breakthroughs to spur innovation

One of the most important integration duties is to link the potential of tomorrow to the realities of today. Breakthroughs are happening not just in IT but in the fields of science: materials science, medical science, manufacturing science, and others. The Exponentials at the end of this report shine a light on some of the advances, describing potentially profound disruption to business, government, and society.

- **Create a deliberate mechanism for scanning and experimentation.** Define processes for understanding the “what,” distilling to the “so what,” and guiding the business on the “now what.” As Peter Drucker, the founder of modern management, says, “innovation is work”—and much more a function of the importing and exporting of ideas than eureka moments of new greenfield ideas.⁵
- **Build a culture that encourages failure.** Within and outside of IT, projects with uncharted technologies and unproven effects inherently involve risk. To think big, start small, and scale quickly, development teams need CIO support and encouragement. The expression “failing fast” is not about universal acceptance and celebrating failure. Rather, it emphasizes learning through iteration, with experiments that are designed to yield measurable results—as quickly as possible.⁶

- **Collaborate to solve tough business problems.** Another manifestation of “integration” involves tapping into new ecosystems for ideas, talent, and potential solutions. Existing relationships with vendors and partners are useful on this front. Also consider exploring opportunities to collaborate with nontraditional players such as start-ups, incubators, academia, and venture capital firms. Salim Ismail, Singularity University’s founding executive director, encourages organizations to try to scale at exponential speed by “leveraging the world around them”—tapping into diverse thinking, assets, and entities.⁷

An approach for evaluating new technology might be the most important legacy a CIO can leave: institutional muscle memory for sifting opportunities from shiny objects, rapidly vetting and prototyping new ideas, and optimizing for return on assets. The only constant among continual technology advances is change. Providing focus and clarity to that turmoil is the final integration CIOs should aspire to—moving from potential to confidence, and from possibility to reality.

Become a business leader

The past several years have seen new leadership roles cropping up across industries: chief digital officer, chief data officer, chief growth officer, chief science officer, chief marketing technology officer, and chief analytics officer, to name a few. Each role is deeply informed by technology advances, and their scope often overlaps not only with the CIO’s role but between their respective charters. These new positions reflect burgeoning opportunity and unmet needs. Sometimes, these needs are unmet because the CIO hasn’t elevated his or her role to take on new strategic endeavors. The intent to do so may be there, but progress can be hampered by credibility gaps rooted in a lack of progress toward a new vision, or undermined by historical reputational baggage.

- **Actively engage with business peers to influence their view of the CIO role.** For organizations without these new roles, CIOs should consider explicitly stating their intent to tackle the additional complexity. CIOs should recognize that IT may have a hard time advancing their stations without a positive track record for delivering core IT services predictably, reliably, and efficiently.
- **Serve as the connective tissue to all things technology.** Where new roles have already been defined and filled, CIOs should proactively engage with them to understand what objectives and outcomes are being

framed. IT can be positioned not just as a delivery center but as a partner in the company's new journey. IT has a necessarily cross-discipline, cross-functional, cross-business unit purview. CIOs acting as chief integration officers can serve as the glue linking the various initiatives together—advocating platforms instead of point solutions, services instead of brittle point-to-point interfaces, and IT services for design, architecture, and integration—while also endeavoring to provide solutions that are ready for prime time through security, scalability, and reliability.

Lessons from the front lines

Look inside IT

When asked recently about the proliferation of chiefs in the C-suite—chief digital officer, chief innovation officer, etc.—and the idea that CIOs could assume the role of “chief integration officer” by providing the much-needed connective tissue among many executives, strategies, and agendas, Intel Corp.’s CIO Kim Stevenson offered the following opinion: “The CIO role is unique in that it is defined differently across companies and industries. No two CIOs’ positions are the same, as opposed to chief financial officers, legal officers, and other C-suite roles. I don’t like it when people try to rename the CIO role. It contributes to a general lack of understanding about the role—and about what companies should expect from their CIOs.”

Monikers aside, Stevenson occasionally offers the following advice to CEOs and boards who are pondering the future amid tremendous technology-driven disruption: “If you need all those C-suite roles, you probably don’t have the right CIO.”

The “right CIO” is one who first achieves operational excellence by keeping the lights on, all critical IT positions filled, and all systems running at peak performance. At Intel, operational excellence of core business processes—satisfying day-to-day needs—has earned IT the right to collaborate with business leaders to identify solutions needed to achieve their goals.

It is through such collaboration that CIOs can elevate and broaden their roles. That means working with business leaders to not just give them what they ask for but helping them figure out what they really need. “Your internal customers have to want what IT is selling,” Stevenson notes, and to achieve this, CIOs should work with business leaders to create shared objectives and to

expand expectations beyond incremental improvements to helping drive transformation. In one meeting with a senior vice president (SVP), Stevenson received the feedback: “We’re happy with everything you are doing right now.” When Stevenson and the SVP discussed where the function was strategically headed, several critical efforts were identified—new capabilities that likely couldn’t be delivered without IT. Because of the trust earned through more tactical collaboration, a more ambitious set of priorities was agreed upon.

Intel also tries to measure IT’s success not on its ability to provide a needed solution by a specific deadline but on the shared outcome of the initiative. The goal is for IT and its customer to be held responsible for achieving the same outcome—aligning priorities, expectations, and incentives.

Finally, through collaboration defined by shared objectives and outcomes, CIOs earn the right to influence how their companies will take advantage of disruptive change. At Intel, Stevenson recognized such an opportunity with the company’s mobile system-on-a-chip (SOC). The team looked at the product life cycle, from requirements to production, analyzing the entire process to understand why it took so long to get the company’s SOCs to market compared with competitors. Working closely with business units and the organization that oversees SOC production, Stevenson and her IT team identified bottlenecks and set their priorities for increasing throughput. The business units chose 10 SOCs to focus on, and IT came up with a number of improvements, ranging from basic (determining whether there was enough server space for what needed to be done) to complex (writing algorithms).

The outcome of this collaborative effort exceeded expectations. In 2014, the company

saw production times for the targeted SOC products improve for one full quarter, in some cases for almost two. “That was huge for us,” said Stevenson. “The SOC organization set high expectations for us, just as we did for them. In the wake of our shared success, their view of IT has gone from one of ‘get out of my way’ to ‘I never go anywhere without my IT guys.’”

From claims to innovation

Like many of its global peers, AIG faces complex challenges and opportunities as the digital economy flexes its muscles. At AIG, IT is viewed not just as a foundational element of the organization, but also as a strategic driver as AIG continues its transformation to a unified, global business. AIG’s CEO, Peter Hancock, is taking steps to integrate the company’s IT leaders more deeply into how its businesses are leveraging technology. Shortly after assuming his post, Hancock appointed a new corporate CIO who reports directly to Hancock and chairs the company’s innovation committee. Previously, the top IT role reported to the chief administration officer.

AIG’s claim processing system, OneClaim™, is emblematic of the more integrated role IT leaders at the company can play. Peter Beyda, the company’s CIO for claims, is replacing AIG’s many independent claims systems with a centralized one that operates on a global scale. The mandate is to be as global as possible while being as local as necessary. Standardized data and processes yield operational efficiencies and centralized analytics across products and geographies. However, IT also responds to the fast-paced needs of the business. In China, for example, package solutions were used to quickly enter the market ahead of the OneClaim deployment—reconciling data in the background to maintain global consistency and visibility. AIG has deployed OneClaim in 20 countries and anticipates a full global rollout by 2017. The project is raising the

profile of IT leadership within the company and the critical role these leaders can play in driving enterprise innovation efforts.


The OneClaim system also forms the foundation for digital initiatives, from mobile member services to the potential for augmenting adjusters, inspectors, and underwriters with wearables, cognitive analytics, or crowdsourcing approaches. IT is spurring discussions about the “art of the possible” with the business. OneClaim is one example of how AIG’s IT leadership is helping define the business’s vision for digital, analytics, and emerging technologies, integrating between business and IT silos, between lines of business, and between the operating complexities of today and the industry dynamics of tomorrow.

Digital mixology

Like many food and beverage companies, Brown-Forman organizes itself by product lines. Business units own their respective global brands. Historically, they worked with separate creative agencies to drive their individual marketing strategies. IT supported corporate systems and sales tools but was not typically enlisted for customer engagement or brand positioning activities. But with digital upending the marketing agenda, Brown-Forman’s CIO and CMO saw an opportunity to reimagine how their teams worked together.

Over the last decade, the company recognized a need to transform its IT and marketing groups to stay ahead of emerging technologies and shifting consumer patterns. In the early 2000s, Brown-Forman’s separate IT and marketing teams built the company’s initial website but continued to conduct customer relationship management (CRM) through snail mail. As social media began to explode at the turn of the decade, Brown-Forman’s marketing team recognized that closely collaborating with IT could be the winning ingredient for high-impact, agile





marketing. While the external marketing agencies that Brown-Forman had contracted with for years were valuable in delivering creative assets and designs, marketing now needed support in new areas such as managing websites and delivering digital campaigns. Who better to team with than the IT organization down the hall?

IT and marketing hit the ground running: training, learning, and meeting with companies such as Facebook and Twitter. It was the beginning of the company's Media and Digital group, which now reports to both the CMO and IT leadership. And more importantly, it was the creation of a single team that brought together advantages from both worlds. IT excelled at managing large-scale, complex initiatives, while marketing brought customer knowledge and brand depth. Their collaboration led to the development of new roles, such as that of digital program manager, who helped instill structure, consistency, and scale to drive repeatable processes throughout the organization.

As the teams worked together, new ideas were bootstrapped and brought to light. Take, for example, the Woodford Reserve Twitter Wall campaign, which originally required heavy investment dollars each year with a third party. The close interaction between marketing and IT led to the question: "Why can't we do this ourselves?" Within a week, a joint IT-marketing team had used a cloud

platform and open-source tools to recreate the social streaming display, promptly realizing cost savings and creating a repeatable product that could be tweaked for other markets and brands.

Fast-forward to today. Marketing and IT are teaming to provide Brown-Forman with a single customer view through a new CRM platform. Being able to share customer insight, digital assets, and new engagement techniques globally across brands is viewed as a competitive differentiator. The initiative's accomplishments over the next few years will be contingent upon business inputs from the marketing team and innovation from IT to cover technology gaps.

The "one team" mentality between IT and marketing has put Brown-Forman on a path toward its future-state customer view. Along the way, the organization has reaped numerous benefits. For one, assets created by creative agencies can be reused by Brown-Forman's teams through its scalable and repeatable platforms. Moreover, smaller brands that otherwise may not have had the budget to run their own digital campaign can now piggyback onto efforts created for the larger brands. The relationship fostered by IT and marketing has led to measurable return on investment (ROI)—and a redefined company culture that is not inhibited by the silos of department or brand verticals.

My take

Pat Gelsinger, CEO
VMware

I meet with CIOs every week, hundreds each year. I meet with them to learn about their journeys and to support them as they pursue their goals. The roles these individuals play in their companies are evolving rapidly. Though some remain stuck in a “keep the lights on and stick to the budget” mind-set, many now embrace the role of service provider: They build and support burgeoning portfolios of IT services. Still others are emerging as strategists and decision makers—a logical step for individuals who, after all, know more about technology than anyone else on the CEO’s staff. Increasingly, these forward-thinking CIOs are applying their business and technology acumen to monetize IT assets, drive innovation, and create value throughout the enterprise.

CIOs are adopting a variety of tactics to expand and redefine their roles. We’re seeing some establish distinct teams within IT dedicated solely to innovating, while others collaborate with internal line-of-business experts within the confines of existing IT infrastructure to create business value. Notably, we’ve also seen companies set up entirely new organizational frameworks in which emerging technology-based leadership roles such as the chief digital officer report to and collaborate with the CIO, who, in turn, assumes the role of strategist and integrator.

What’s driving this evolution? Simply put, disruptive technologies. Mobile, cloud, analytics, and a host of other solutions are enabling radical changes in the way companies develop and market new products and services. Today, the Internet and cloud can offer start-ups the infrastructure they need to create new applications and potentially reach billions of customers—all at a low cost.

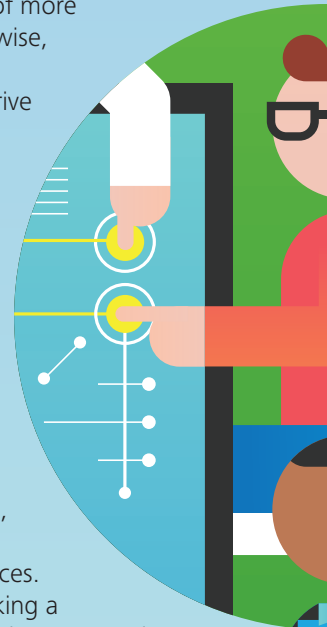
Moreover, the ability to innovate rapidly and affordably is not the exclusive purview of tech start-ups. Most companies with traditional business models probably already have a few radical developers on staff—they’re the ones who made the system break down over the weekend by “trying something out.” When organized into small entrepreneurial teams and given sufficient guidance, CIO sponsorship, and a few cloud-based development tools, these creative individuals can focus their energies on projects that deliver highly disruptive value.

VMware adopted this approach with the development of EVO:RAIL, VMware’s first hyper-converged infrastructure appliance and a scalable, software-defined data-center building block that provides the infrastructure needed to support a variety of IT environments. To create this product, we put together a small team of developers with a highly creative team leader at the helm. We also provided strong top-down support throughout the project. The results were, by any definition, a success: Nine months after the first line of code was written, we took EVO:RAIL to market.

Clearly, rapid-fire development will not work with every project. Yet there is a noticeable shift underway toward the deployment of more agile development techniques. Likewise, companies are increasingly using application program interfaces to drive new revenue streams. Others are taking steps to modernize their cores to fuel the development of new services and offerings. Their efforts are driven largely by the need to keep pace with innovative competitors. At VMware, we are working to enhance the user experience.

Having become accustomed to the intuitive experiences they enjoy with smartphones and tablets, our customers expect us to provide comparable interfaces and experiences. To meet this expectation, we are taking a markedly different approach to development and design, one that emphasizes both art and technology. Our CIO has assembled development teams composed of artists who intuit the experiences and capabilities users want, and hard-core technologists who translate the artists’ designs into interfaces, customer platforms, and other user experience systems. These two groups bring different skill sets to the task at hand, but each is equally critical to our success.

As CIOs redefine and grow their roles to meet the rapidly evolving demands of business and technology, unorthodox approaches with strong top-down support will help fuel the innovation companies need to succeed in the new competitive landscape.



My take

Stephen Gillett
Business and technology C-suite executive

CIOs can play a vital role in any business transformation, but doing so typically requires that they first build a solid foundation of IT knowledge and establish a reputation for dependably keeping the operation running. Over the course of my career, I've held a range of positions within IT, working my way up the ranks, which helped me gain valuable experience across many IT fundamentals. As CIO at Starbucks, I took my first step outside of the traditional boundaries of IT by launching a digital ventures unit. In addition to leveraging ongoing digital efforts, this group nurtured and executed new ideas that historically fell outside the charters of more traditional departments. I joined Best Buy in 2012 as the president of digital marketing and operations, and applied some of the lessons I had learned about engaging digital marketing and IT together to adjust to changing customer needs.



My past experiences prepared me for the responsibilities I had in my most recent role as COO of Symantec. When we talked about business transformation at Symantec, we talked about more than just developing new product versions with better features than those offered by our competitors. True transformation was about the customer: We wanted to deliver more rewarding experiences that reflected the informed, peer-influenced way the customer was increasingly making purchasing decisions. Organizational silos can complicate customer-centric missions by giving rise to unnecessary technical complexity and misaligned or overlapping executive charters. Because of this, we worked to remove existing silos and prevent new ones from developing. Both the CIO and CMO reported to me as COO, as did executives who own data, brand, digital, and other critical domains. Our shared mission was to bring together whatever strategies, assets, insights, and technologies were necessary to surpass our customers' expectations and develop integrated go-to-market systems and customer programs.

Acting on lessons I learned in previous roles, we took a "tiger team" approach and dedicated resources to trend sensing, experimentation, and rapid prototyping. This allowed us to explore what was happening on the edge of our industry—across processes, tools, technology, and talent—and bring it back to the core. CIOs can lead similar charges in their respective organizations as long as their goals and perspectives remain anchored by business and customer needs. They should also be prepared to advocate for these initiatives and educate others on the value such projects can bring to the business.

My advice to CIOs is to identify where you want to go and then take incremental steps toward realizing that vision. If you are the captain of a ship at sea, likely the worst thing you can do is turn on its center 180 degrees—you'll capsize. Making corrections to the rudder more slightly gives the boat time to adjust—and gives you time to chart new destinations. Pick one or two projects you know are huge thorns in the sides of your customers or your employees, and fix those first. We started out at Symantec by improving mailbox sizes, creating new IT support experiences, and fixing cell phone reception on campus. We moved on to improving VPN quality and refreshing end-user computing standards by embracing "bring your own device," while simultaneously building momentum to complete an ERP implementation. By solving small problems first, we were able to build up the organizational IT currency we needed to spend on bigger problems and initiatives.

When CIOs ask me about how they can get a seat at the table for big transformation efforts, I ask them about the quality of their IT organizations. Would your business units rate you an A for the quality of their IT experience? If you try to skip straight to digital innovation but aren't delivering on the fundamentals, you shouldn't be surprised at the lack of patience and support you may find within your company. A sign that you have built up your currency sufficiently is when you are pulled into meetings that have nothing to do with your role as CIO because people "just want your thinking on this"—which means a door is opening for you to have a larger stake in company strategy.

Cyber implications

In many industries, board members, C-suite executives, and line-of-business presidents did not grow up in the world of IT. The CIO owns a crucial part of the business, albeit one in which the extended leadership team may not be particularly well versed. But with breaches becoming increasingly frequent across industries, senior stakeholders are asking pointed questions of their CIOs—and expecting that their organizations be kept safe and secure.

CIOs who emphasize cyber risk and privacy, and those who can explain IT's priorities in terms of governance and risk management priorities that speak to the board's concerns, can help create strong linkages between IT, the other functions, and the lines of business. No organization is hacker-proof, and cyber attacks are inextricably linked to the IT footprint.⁸ Often, CIOs are considered at least partially to blame for incidents. Strengthening cyber security is another step CIOs can take toward becoming chief integration officers in a space where leadership is desperately needed.

Part of the journey is taking a proactive view of information and technology risk—particularly as it relates to strategic business initiatives. Projects that are important from a growth and performance perspective may also subject the organization to high levels of cyber risk. In the haste to achieve top-level goals, timeframes for these projects are often compressed. Unfortunately, many shops treat security and privacy as compliance tasks—required hoops to jump through to clear project stage gates. Security analysts are put in the difficult position of enforcing standards against hypothetical controls and policies, forcing an antagonistic relationship with developers and business sponsors trying to drive new solutions. As CIOs look to integrate the business and IT, as well as to integrate the development and operations teams within IT, they should make the chief information security officer and his or her team active participants throughout the project life cycle—from planning and design through implementation, testing, and deployment.

The CIO and his or her extended IT department are in a rare position to orchestrate awareness of and appropriate responses to cyber threats. With an integrated view of project objectives and technology implications, conversations can be rooted in risk and return. Instead of taking extreme positions to protect against imaginable risk, organizations should aim for probable and acceptable risk—with the CIO helping business units, legal, finance, sales, marketing, and executive sponsors understand exposures, trade-offs, and impacts. Organizational mind-sets may need to evolve, as risk tolerance is rooted in human judgment and perceptions about possible outcomes. Leadership should approach risk issues as overarching business concerns, not simply as project-level timeline and cost-and-benefit matters. CIOs can force the discussion and help champion the requisite integrated response.

In doing so, chief integration officers can combat a growing fallacy that having a mature approach to cyber security is incompatible with rapid innovation and experimentation. That might be true with a compliance-heavy, reactive mind-set. But by embedding cyber defense as a discipline, and by continuously orchestrating cyber security decisions as part of a broader risk management competency, cyber security can become a value driver—directly linked to shareholder value.

Where do you start?

There are concrete steps aspiring chief integration officers can take to realize their potential. Start with taking stock of IT's current political capital, reputation, and maturity. Stakeholder by stakeholder, reflect on their priorities, objectives, and outcomes, and understand how IT is involved in realizing their mission. Then consider the following:

- **Line of sight.** Visibility into the balance sheet of IT is a requirement—not just the inventory but the strategic positioning, risk profile, and ROI of the asset pool. Consider budgets, programs, and projects; hardware and software; vendor relationships and contracts; the talent pool, organizational structure, and operating model; and business partner and other ecosystem influencers. Compare stakeholder priorities and the business's broader goals with where time and resources are being directed, and make potentially hard choices to bring IT's assets into alignment with the business. Invest in tools and processes to make this line of sight systemic and not a point-in-time study—allowing for ongoing monitoring of balance-sheet performance to support a living IT strategy.
- **Mind the store.** Invest in the underlying capabilities of IT so that the lights are not only kept on but continuously improving. Many potential areas of investment live under the DevOps banner: environment provisioning and deployment, requirements management and traceability, continuous integration and build, testing automation, release and configuration management, system monitoring, business activity monitoring, issue and incident management, and others. Tools for automating and integrating individual capabilities continue to mature.

But organizational change dynamics will likely be the biggest challenge. Even so, it's worth it—not only for improving tactical departmental efficiency and efficacy, but also to raise the IT department's performance and reputation.

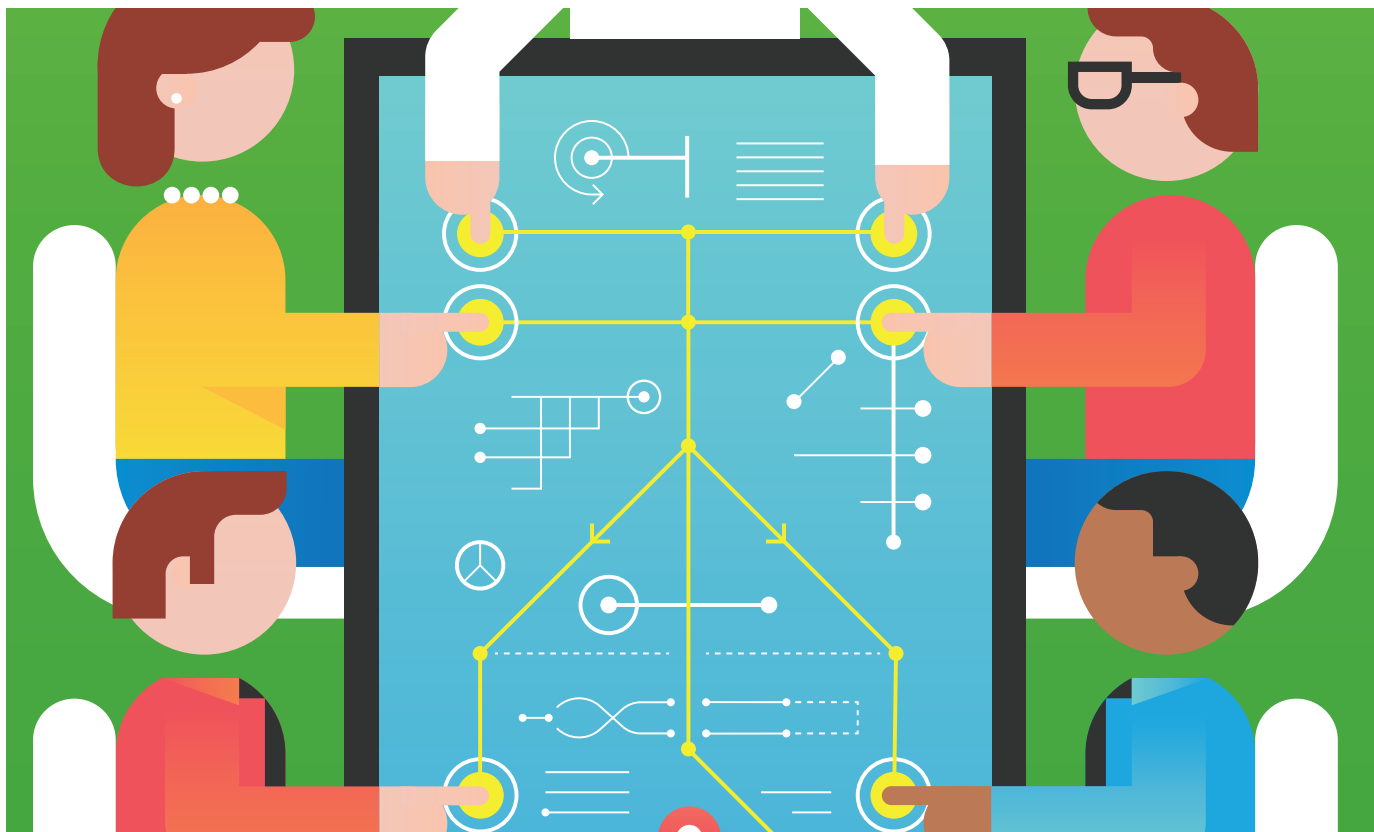
- **All together now.** Engage directly with line-of-business and functional leaders to help direct their priorities, goals, and dependencies toward IT. Solicit feedback on how to reimagine your IT vision, operating, and delivery model. Create a cadence of scheduled sit-downs to understand evolving needs, and provide transparency on progress toward IT's new ambitions.
- **Ecosystem.** Knock down organizational boundaries wherever you can. Tap into your employees' collective ideas, passions, and interests. Create crowd-based competitions to harness external experience for both bounded and open-ended problems. Foster new relationships with incubators, start-ups, and labs with an eye to obtaining not just ideas but access to talent. Set explicit expectations with technology vendors and services partners to bring, shape, and potentially share risk in new ideas and offerings. Finally, consider if cross-industry consortia or intra-industry collaborations are feasible. Integrate the minds, cycles, and capital of a broad range of players to amplify returns.
- **Show, don't tell.** As new ideas are being explored, thinking should eclipse constraints based on previous expectations or legacy technologies. Interactive demos and prototypes can spark new ways of thinking, turning explanatory briefings into hands-on discovery. They also lend

themselves better to helping people grasp the potential complexities and delivery implications of new and emerging techniques. The goal should be to bring the art of the possible to the business, informed by the realm of the feasible.

- **Industrialize innovation.** Consider an innovation funnel with layers of ideation, prototyping, and incubating that narrow down the potential field. Ecosystems can play an important role throughout—especially at the intersections of academia, start-ups, vendors, partners, government, and other corporate entities. Align third-party incentives with your organization’s goals, helping to identify, shape, and scale initiatives. Consider coinvestment and risk-sharing models where outsiders fund and potentially run some of your endeavors. Relentlessly drive price concessions for

commoditized services and offerings, but consider adjusting budgeting, procurement, and contracting principles to encourage a subset of strategic partners to put skin in the game for higher-value, riskier efforts. Evolve sourcing strategies to consider “innovators of record” with a longer-term commitment to cultivating a living backlog of projects and initiatives.

- **Talent.** CIOs are only as good as their teams. The changes required to become a chief integration officer represent some seismic shifts from traditional IT: new skills, new capabilities and disciplines, new ways of organizing, and new ways of working. Define the new standard for the IT workers of the future, and create talent development programs to recruit, retain, and develop them.



Bottom line

TODAY'S CIOs have an opportunity to be the beating heart of change in a world being reconfigured by technology. Every industry in every geography across every function will likely be affected. CIOs can drive tomorrow's possibilities from today's realities, effectively linking business strategies to IT priorities. And they can serve as the lynchpin for digital, analytics, and innovation efforts that affect every corner of the business and are anything but independent, isolated endeavors. Chief integration officers can look to control the collisions of these potentially competing priorities and harness their energies for holistic, strategic, and sustainable results.

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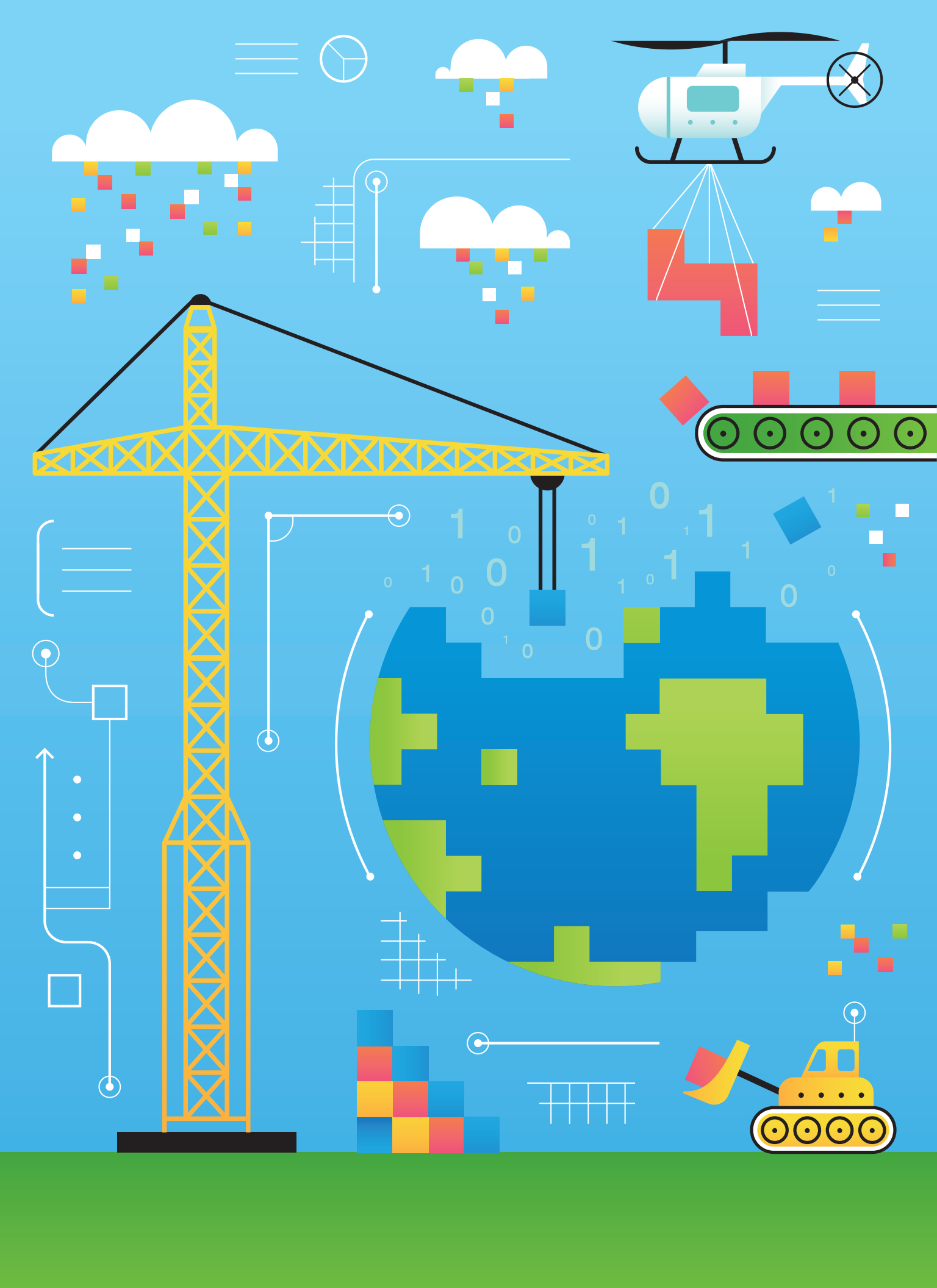


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API economy

From systems to business services

Application programming interfaces (APIs) have been elevated from a development technique to a business model driver and boardroom consideration. An organization's core assets can be reused, shared, and monetized through APIs that can extend the reach of existing services or provide new revenue streams. APIs should be managed like a product—one built on top of a potentially complex technical footprint that includes legacy and third-party systems and data.

APPPLICATIONS and their underlying data are long-established cornerstones of many organizations. All too often, however, they have been the territory of internal R&D and IT departments. From the earliest days of computing, systems have had to talk to each other in order to share information across physical and logical boundaries and solve for the interdependencies inherent in many business scenarios. The trend toward integration has been steadily accelerating over the years. It is driven by increasingly sophisticated ecosystems and business processes that are supported by complex interactions across multiple endpoints in custom software, in-house packaged applications, and third-party services (cloud or otherwise).

The growth of APIs stems from an elementary need: a better way to encapsulate and share information and enable transaction processing between elements in the solution stack. Unfortunately, APIs have often been treated as tactical assets until relatively recently. APIs, their offspring of EDI and

SOA,¹ and web services were defined within the context of a project and designed based on the know-how of small groups or even individual developers. As the business around them evolved, APIs and the rest of the legacy environment were left to accrue technical debt.²

Cut to today's reality of digital disruption and diverse technology footprints. In many industries, creating a thriving platform offering across an ecosystem lies at the heart of a company's business strategy. Meanwhile, the adoption of agile delivery models has put an emphasis on rapid experimentation and development. In addition, the application of DevOps³ practices has helped accelerate technology delivery and improve infrastructure quality and robustness. But interfaces often remain the biggest hurdles in a development lifecycle and the source of much ongoing maintenance complexity. Leading companies are answering both calls—making API management and productization important components of not just their technology roadmaps, but also their business strategies. Data and services are the currency that will

fuel the new API economy. The question is: Is your organization ready to compete in this open, vibrant, and Darwinian free market?

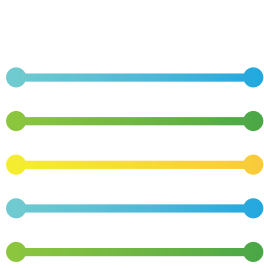
Déjà vu or brave new world?

The API revolution is upon us. Public APIs have doubled in the past 18 months, and more than 10,000 have been published to date.⁴ The revolution is also pervasive: Outside of high tech, we have seen a spectrum of industries embrace APIs—from telecommunications and media to finance, travel and tourism, and real estate. And it's not just in the commercial sector. States and nations are making budget, public works, crime, legal, and other agency data and services available through initiatives such as the US Food and Drug Administration's openFDA API program.

What we're seeing is disruption and, in many cases, the democratization of industry. Entrenched players in financial services are exploring open banking platforms that unbundle payment, credit, investment, loyalty, and loan services to compete with new entrants such as PayPal, Billtrust, Tilt, and Amazon that are riding API-driven services into the payment industry. Netflix receives more than 5 billion daily requests to its public APIs.⁵ The volume is a factor in both the rise in usage of the company's services and its valuation.⁶ Many in the travel industry, including British Airways, Expedia, TripIt, and Yahoo Travel, have embraced APIs and are opening them up to outside developers.⁷ As Spencer Rascoff, CEO of Zillow, points out: "When data is readily available and free in a

The evolution of APIs

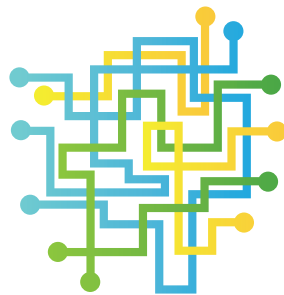
The idea behind APIs has existed since the beginning of computing; however in the last 10 years, they have grown significantly not only in number, but also in sophistication. They are increasingly scalable, monetized, and ubiquitous, with more than 12,000 listed on ProgrammableWeb, which manages a global API directory.⁸



1960–1980

Basic interoperability enables the first programmatic exchanges of information. Simple interconnect between network protocols. Sessions established to exchange information.

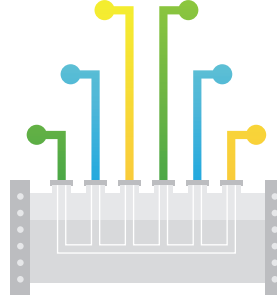
TECHNIQUES
ARPANET, ATTP, and TCP sessions.



1980–1990

Creation of interfaces with function and logic. Information is shared in meaningful ways. Object brokers, procedure calls, and program calls allow remote interaction across a network.

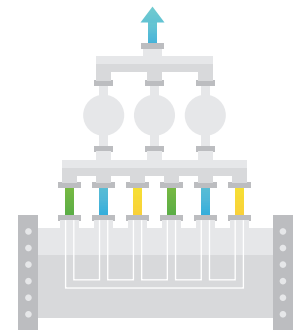
TECHNIQUES
Point-to-point interfaces, screen scraping, RFCs, and EDI.



1990–2000

New platforms enhance exchanges through middleware. Interfaces begin to be defined as services. Tools manage the sophistication and reliability of messaging.

TECHNIQUES
Message-oriented middleware, enterprise service bus, and service-oriented architecture.



2000–today

Businesses build APIs to enable and accelerate new service development and offerings. API layers manage the OSS/BSS of integration.

TECHNIQUES
Integration as a service, RESTful services, API management, and cloud orchestration.

Source: ⁸ ProgrammableWeb, <http://www.programmableweb.com>, accessed January 7, 2015.

particular market, whether it is real estate or stocks, good things happen for consumers.”⁸

Platforms and standards that orchestrate connected and/or intelligent devices—from raw materials to shop-room machinery, from HVACs to transportation fleets—are the early battlegrounds in the Internet of Things (IoT).⁹ APIs are the backbone of the opportunity. Whoever manages—and monetizes—the underlying services of the IoT could be poised to reshape industries. Raine Bergstrom, general manager of Intel Services, whose purview includes IoT services and API management, believes businesses will either adopt IoT or likely get left behind. “APIs are one of the fundamental building blocks on which the Internet of Things will succeed,” he says. “We see our customers gaining efficiencies and cost savings with the Internet of Things by applying APIs.”

Future-looking scenarios involving smartphones, tablets, social outlets, wearables, embedded sensors, and connected devices will have inherent internal and external dependencies in underlying data and services. APIs can add features, reach, and context to new products and services, or become products and services themselves.

Amid the fervor, a reality remains: APIs are far from new developments. In fact, they have been around since the beginning of structured programming. So what’s different now, and why is there so much industry energy and investor excitement around APIs? The conversation has expanded from a technical need to a business priority. Jyoti Bansal, founder and CEO of AppDynamics, believes that APIs can help companies innovate faster and lead to new products and new customers. Bansal says, “APIs started as enablers for things companies wanted to do, but their thinking is now evolving to the next level. APIs themselves are becoming the product or the service companies deliver.” The innovation agenda within and across many sectors is rich with API opportunities. Think of them as indirect digital channels that provide access to IP,

assets, goods, and services previously untapped by new business models. And new tools and disciplines for API management have evolved to help realize the potential.

Managing the transformation

Openness, agility, flexibility, and scalability are moving from good hygiene to life-and-death priorities. Tenets of modern APIs are becoming enterprise mandates: Write loosely coupled, stateless, cacheable, uniform interfaces and expect them to be reused, potentially by players outside of the organization.

Technology teams striving for speed and quality are finally investing in an API management backbone—that is, a platform to:

- Create, govern, and deploy APIs: versioning, discoverability, and clarity of scope and purpose
- Secure, monitor, and optimize usage: access control, security policy enforcement, routing, caching, throttling (rate limits and quotas), instrumentation, and analytics
- Market, support, and monetize assets: manage sales, pricing, metering, billing, and key or token provisioning

Many incumbent technology companies have recognized that API management has “crossed the chasm” and acquired the capabilities to remain competitive in the new world: Intel acquired Mashery and Aepona; CA Technologies acquired Layer 7; and SAP is partnering with Apigee, which has also received funding from Accenture.

But the value of tools and disciplines is limited to the extent that the APIs they help build and manage deliver business value. IT organizations should have their own priorities—improving interfaces or data encapsulations that are frequently used today or that could be reused tomorrow. Technology leaders should avoid “gold-plated plumbing” exercises isolated within IT to avoid flashbacks

to well-intentioned but unsuccessful SOA initiatives from the last decade.

The shift to “product management” may pose the biggest hurdle. Tools to manage pricing, provisioning, metering, and billing are backbone elements—essential, but only as good as the strategy being deployed on the foundation. Developing disciplines for product marketing and product engineering are likely uncharted territories. Pricing, positioning, conversion, and monetization plans are important elements. Will offerings be à la carte or sold as a bundle? Charged per use, per subscription window, or on enterprise terms? Does a freemium model make sense? What is the roadmap for upgrades and new features, services, and offerings? These decisions and others may seem like overkill for early experimentation, but be prepared to mature capabilities as your thinking on the API economy evolves.

Mind the gap

Culture and institutional inertia may also be hurdles to the API economy. Pushing to share IP and assets could meet resistance unless a company has clearly articulated the business value of APIs. Treating them like products can help short-circuit the resistance. By targeting a particular audience with specific needs, companies can build a business case and set priorities for and limits to the exercise. Moreover, this “outside-in” perspective can help keep the focus on the customer’s or consumer’s point of view, rather than on internal complexities and organizational or technology silos.

Scope should be controlled for far more than the typical reasons. First, whether meant for internal or external consumption, APIs may have the unintended consequence of exposing

poorly designed code that was not built for reuse or scale. Second, security holes may emerge that were previously lying dormant in legacy technical debt. Systems were built for the players on the field; no one expected the fans to rush the field and start playing as well—or for the folks watching at home to suddenly be involved. Finally, additional use cases should be well thought out. API designs and decisions about whether to refactor or to start again, which are potentially tough choices, should be made based on a firm understanding of the facts in play.

Mitigating potential legal liabilities is another reason to control scope. Open source and API usage are the subject of ongoing litigation in the United States and other countries. Legal and regulatory rulings concerning IP protection, copyright enforcement, and fair use will likely have a lasting impact on the API economy. Understanding what you have used to create APIs, what you are exposing, and how your data and services will be consumed are important factors.

One of the most important rationales for focus is to enable a company to follow the mantra of Daniel Jacobson, vice president of Edge Engineering at Netflix (API and Playback): “Act fast, react fast.”¹⁰ And enable those around you to do the same—both external partners and internal development teams. Investing in the mindset and foundational elements of APIs can give a company a competitive edge. However, there is no inherent value in the underlying platform or individual services if they’re not being used. Companies should commit to building a marketplace to trade and settle discrete, understandable, and valuable APIs and to accelerate their reaping the API economy’s dividends.

Lessons from the front lines

Fueling the second Web boom

APIs have played an integral role in some of the biggest cloud and Web success stories of the past two decades. For example, Salesforce.com, which launched in 2000, was a pioneer in the software-as-a-service space, using Web-based APIs to help customers tailor Salesforce services to their businesses, integrate into their core systems, and jump-start efforts to develop new solutions and offerings.¹¹ Moreover, Salesforce has consistently used platforms and APIs to fuel innovation and broaden its portfolio of service offerings, which now includes, among others, iForce.com, Heroku, Chatter, Analytics, and Salesforce1.

In 2005, Google introduced the Google Maps API,¹² a free service that made it possible for developers to embed Google Maps and create mashups with other data streams. In 2013, the company reported that more than a million active sites and applications were using the Maps API.¹³ Such success not only made APIs standard for other mapping services, but helped other Web-based companies understand how offering an API could translate into widespread adoption.

In 2007, Facebook introduced the Facebook Platform, which featured an API at its core that allowed developers to build third-party apps. Importantly, it also provided widespread access to social data.¹⁴ The APIs also extended Facebook's reach by giving rise to thousands of third-party applications and strategic integrations with other companies.

By the late 2000s, streamlined API development processes made it possible for Web-based start-ups like Flickr, Foursquare, Instagram, and Twitter to introduce APIs within six months of their sites' launches. Likewise, as development became increasingly standardized, public developers were able to rapidly create innovative ways to use these


API-based services, spawning new services, acquisitions, and ideas. As some organizations matured, they revised their API policies to meet evolving business demands. Twitter, for example, shifted its focus from acquiring users to curating and monetizing user experiences. This shift ultimately led to the shuttering of some of its public APIs, as the company aimed to more directly control its content.

APIs on demand

In 2008, Netflix, a media streaming service with more than 50 million subscribers,¹⁵ introduced its first public API. At the time public, supported APIs were still relatively rare—developers were still repurposing RSS feeds and using more rudimentary methods for custom development. The Netflix release provided the company a prime opportunity to see what public developers would and could do with a new development tool. Netflix vice president of Edge Engineering, Daniel Jacobson, has described the API launch as a more formal way to “broker data between internal services and public developers.”¹⁶ The approach worked: External developers went on to use the API for many different purposes, creating applications and services that let subscribers organize, watch, and review Netflix offerings in new ways.

In the years since, Netflix has gone from offering streaming services on a small number of devices to supporting its growing subscriber base on more than 1,000 different devices.¹⁷ As the company evolved to meet market demands, the API became the mechanism by which it supported growing and varied developer requests. Though Netflix initially used the API exclusively for public requests, by mid-2014, the tool was processing five billion private, internal requests daily (via devices used to stream content) versus two million daily public





requests.¹⁸ During this same period, revenues from the company's streaming services eclipsed those of its DVD-by-mail channel, a shift driven in large part by Netflix's presence across the wide spectrum of devices, from set-top boxes to gaming consoles to smartphones and tablets.¹⁹

Today, roughly 99.97 percent of Netflix API traffic is between services and devices. What was once seen as a tool for reaching new audiences and doing new things is now being used tactically to "enable the overall business strategy to be better."²⁰

In June 2014, the company announced that in order to satisfy a growing global member base and a growing number of devices, it planned to discontinue its public API program. Critics have pointed to this decision as another example of large technology companies derailing the trend toward increased access by rebuilding walls and declining external developer input.²¹ However, as early as 2012, Jacobson had stated, "The more I talk to people about APIs, the clearer it is that public APIs are waning in popularity and business opportunity and that the internal use case is the wave of the future."²² Like any other market, the API economy will continue to evolve with leading companies taking dynamic, but deliberate approaches to managing, propagating, and monetizing their intellectual property.

Empowering the Beltway—and beyond

On March 23, 2010, President Barack Obama signed into law the Affordable Care Act (ACA), which reforms both the US health care and health insurance industries. To facilitate ACA implementation, the government created the Federal Data Services Hub, a platform that provides a secure way for IT systems from multiple federal and state agencies and issuers to exchange verification, reporting, and enrollment data.

The Hub acts as a single common entry point into federal, state, and third-party data sources without actually storing any data. As an example of how the Hub works, under the ACA, states are required to verify enrollee eligibility for insurance affordability programs. The Hub connects the state-based insurance exchanges to federal systems across almost a dozen different agencies to provide near-real-time verification services, including Social Security number validation, income and tax filing checks, and confirmation of immigration status, among others. State exchanges also use the Hub as a single entry point for submitting enrollment reports to multiple federal agencies.

The intent of the Hub's technical architecture is to include scalable and secure Web services that external systems invoke via APIs. This system is designed to provide near-real-time exchange of information, which enables states to make benefits eligibility determinations in minutes instead of in days and weeks with the previous batch-based process and point-to-point connections. Moreover, with a growing repository of data and transactional services, the Hub can accelerate the development of new products, solutions, and offerings. And with common APIs, states are able to share and reuse assets, reducing implementation overhead and solution cost. The FDSH can also help agencies pay down technical debt by standardizing and simplifying integration, which has historically been one of the most complex factors in both project execution and ongoing maintenance.

Our take

Ross Mason, founder and vice president, product strategy
Uri Sarid, chief technology officer
MuleSoft

Over many years, companies have built up masses of valuable data about their customers, products, supply chains, operations, and more, but they're not always good at making it available in useful ways. That's a missed opportunity at best, and a fatal error at worst. Within today's digital ecosystems, business is driven by getting information to the right people at the right time. Staying competitive is not so much about how many applications you own or how many developers you employ. It's about how effectively you trade on the insights and services across your balance sheet.

Until recently, and for some CIOs still today, integration was seen as a necessary headache. But by using APIs to drive innovation from the inside out, CIOs are turning integration into a competitive advantage. It all comes down to leverage: taking the things you already do well and bringing them to the broadest possible audience. Think: Which of your assets could be reused, repurposed, or revalued—inside your organization or outside? As traditional business models decline, APIs can be a vehicle to spur growth, and even create new paths to revenue.

Viewing APIs in this way requires a shift in thinking. The new integration mindset focuses less on just connecting applications than on exposing information within and beyond your organizational boundaries. It's concerned less with how IT runs, and more with how the business runs.

The commercial potential of the API economy really emerges when the CEO champions it and the board gets involved. Customer experience, global expansion, omnichannel engagement, and regulatory compliance are heart-of-the-business issues, and businesses can do all of them more effectively by exposing, orchestrating, and monetizing services through APIs.

In the past, technical interfaces dominated discussions about integration and service-oriented architecture (SOA). But services, treated as products, are what really open up a business's cross-disciplinary, cross-enterprise, cross-functional capabilities. Obviously, the

CIO has a critical role to play in all this, potentially as the evangelist for the new thinking, and certainly as the caretaker of the architecture, platform, and governance that should surround APIs.

The first step for CIOs to take toward designing that next-generation connected ecosystem is to prepare their talent to think about it in the appropriate way. Set up a developer program and educate staff about APIs. Switch the mindset so that IT thinks not just about building and testing and runtimes, but about delivering the data—the assets of value. Consider a new role: the cross-functional project manager who can weave together various systems into a compelling new business offering.

We typically see organizations take two approaches to implementing APIs. The first is to build a new product offering and imagine it from the ground up, with an API serving data, media, and assets. The second is to build an internal discipline for creating APIs strategically rather than on a project-by-project basis. Put a team together to build the initial APIs, create definitions for what APIs mean to your organization, and define common traits so you're not reinventing the wheel each time. This method typically requires some adjustment, since teams are used to building tactically. But ultimately, it forces an organization to look at what assets really matter and creates value by opening up data sets, giving IT an opportunity to help create new products and services. In this way, APIs become the essential catalyst for IT innovation in a digital economy.



Cyber implications

APIs expose data, services, and transactions—creating assets to be shared and reused. The upside is the ability to harness internal and external constituents' creative energy to build new products and offerings. The downside is the expansion of critical channels that need to be protected—channels that may provide direct access to sensitive IP that may not otherwise be at risk. Cyber risk considerations should be at the heart of integration and API strategies. An API built with security in mind can be a more solid cornerstone of every application it enables; done poorly, it can multiply application risks.

Scope of control—who is allowed to access an API, what they are allowed to do with it, and how they are allowed to do it—is a leading concern. At the highest level, managing this concern translates into API-level authentication and access management—controlling who can see, manage, and call underlying services. More tactical concerns focus on the protocol, message structure, and underlying payload—protecting against seemingly valid requests from injected malicious code into underlying core systems. Routing, throttling, and load balancing have cyber considerations as well—denials of service (where a server is flooded with empty requests to cripple its capability to conduct normal operations) can be directed at APIs as easily as they can target websites.

Just like infrastructure and network traffic can be monitored to understand normal operations, API management tools can be used to baseline typical service calls. System event monitoring should be extended to the API layer, allowing unexpected interface calls to be flagged for investigation. Depending on the nature of the underlying business data and transactions, responses may need to be prepared in case the underlying APIs are compromised—for example, moving a retailer's online order processing to local backup systems.

Another implication of the API economy is that undiscovered vulnerabilities might be exposed through the services layer. Some organizations have tiered security protocols that require different levels of certification depending on the system's usage patterns. An application developed for internal, offline, back-office operations may not have passed the same rigorous inspections that public-facing e-commerce solutions are put through. If those back-office systems are exposed via APIs to the front end, back doors and exploitable design patterns may be inadvertently exposed. Similarly, private customer, product, or market data could be unintentionally shared, potentially breaching country or industry regulations.

It raises significant questions: Can you protect what is being opened up? Can you trust what's coming in? Can you control what is going out? Integration points can become a company's crown jewels, especially as the API economy takes off and digital becomes central to more business models. Sharing assets will likely strain cyber responses built around the expectation of a bounded, constrained world. New controls and tools will likely be needed to protect unbounded potential use cases while providing end-to-end effectiveness—according to what may be formal commitments in contractual service-level agreements. The technical problems are complex but solvable—as long as cyber risk is a foundational consideration when API efforts are launched.

Where do you start?

AT first glance, entering the API economy may seem like an abstract, daunting endeavor. But there are some concrete steps that companies can take based on the lessons learned by early adopters.

- **What's in a name?** APIs should have the clarity of a well-positioned product—a clear intention, a clean definition of the value, and perhaps more important, a clearly defined audience. Is it a small set of known developers, a large set of unknown developers, or both? What is the trust zone? Public, semi-private, or private? How do these essential facts inform the scope and orientation of the service?
- **Who's on first?** Top-down or bottom-up? Or more to the point: What will drive the API charge...business model innovation or technical services? The latter may be easier for an IT executive to champion, especially if the API is launched as part of a broader IT delivery transformation, technical debt reversal, or DevOps program. Placing the effort under an IT executive can also simplify the path forward and the expected outcomes by focusing on service calls, performance, standard adherence, shrinking development timelines, and lower maintenance costs. Planting the seed of how business services and APIs could unlock new business models may be trickier. But the faster the initiative is linked to growth and innovation, the better. In the early days of Amazon, Jeff Bezos reportedly issued a company-wide mandate requiring all technical staff, without exception, to embrace APIs. The mandate served as the foundation for the EC2 cloud computing

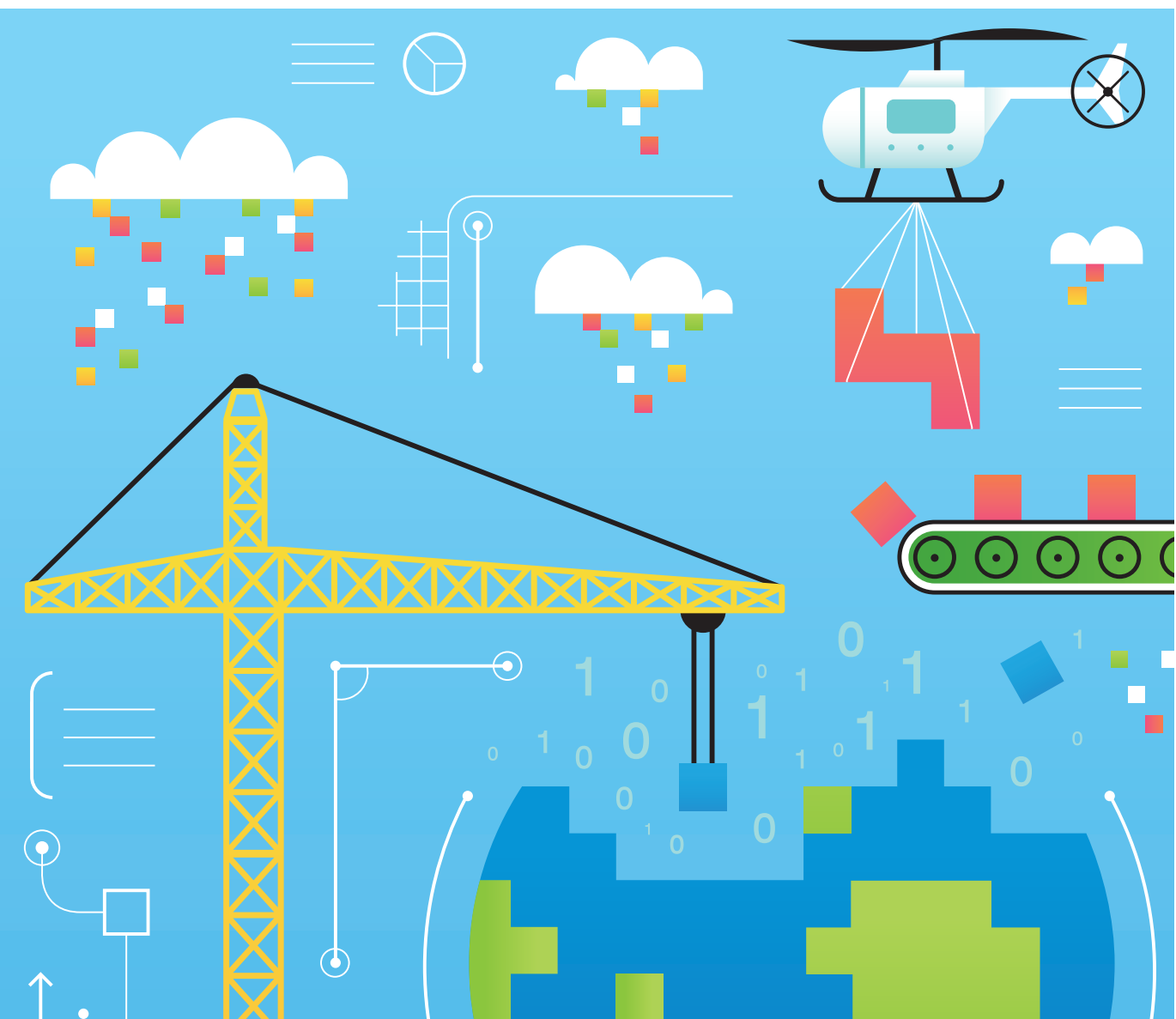
platform, S3 storage cloud, warehouse management and fulfillment services, Mechanical Turk, and other initiatives.²³

- **Embrace the bare necessities.** Organizations should consider what governance model they should establish based on the intended consumers (internal, partners, public at large) and whether the program is being driven by IT or the business. Tools such as API management platforms can provide a dashboard-like view into the inner workings of a solution landscape. The visibility provides a better handle on dependencies and performance of the core services across legacy systems and data.
- **Avoid technology holy wars.** There are many decision points, and they can become distracting. REST or SOAP for the service protocol? JSON or XML for the data formatting? Resource or experience-based design philosophy? Versioning via path segment, query string, or header (or none of the above)? OAuth2.0 or OpenID Connect security? What API management platform vendor should be used? These are all good questions that lack a single good answer. One size likely won't fit all, and further consolidation and change in the vendor landscape is likely to continue. Companies should make appropriate decisions to guide shorter-term needs with a focus on pragmatism, not doctrinaire purity.
- **Easy does it.** Opportunities leveraging cross-industry cooperation may be tempting right out of the gate. However, businesses should decide if the payoff

trumps the extra complexity. Companies should plan big, but start small. Ideally, they should use open, well-documented services to accelerate time to prototype. Expecting constant change and speedy execution is part of the shift to the API economy. Enterprises can use their first endeavors to anchor the new “business as usual.”

- **Build it so they will come.** If you are trying to launch external-facing APIs or platforms for the first time, you should

ready yourself for a sustained campaign to drive awareness, subscriptions, and support. Beyond readying the core APIs and surrounding management services, companies shouldn't forget about the required ancillary components: documentation, code samples, testing and certification tools, support models, monitoring, maintenance, and upkeep. Incentives and attempts to influence stakeholder should be tied to the target audiences and framed accordingly.



Bottom line

WE'RE on the cusp of the API economy—coming from the controlled collision of revamped IT delivery and organizational models, renewed investment around technical debt (to not just understand it, but actively remedy it), and disruptive technologies such as cognitive computing,²⁴ multidimensional marketing,²⁵ and the Internet of Things. Enterprises can make some concrete investments to be at the ready. But as important as an API management layer may be, the bigger opportunity is to help educate, provoke, and harvest how business services and their underlying APIs may reshape how work gets done and how organizations compete. This opportunity represents the micro and macro versions of the same vision: moving from systems through data to the new reality of the API economy.

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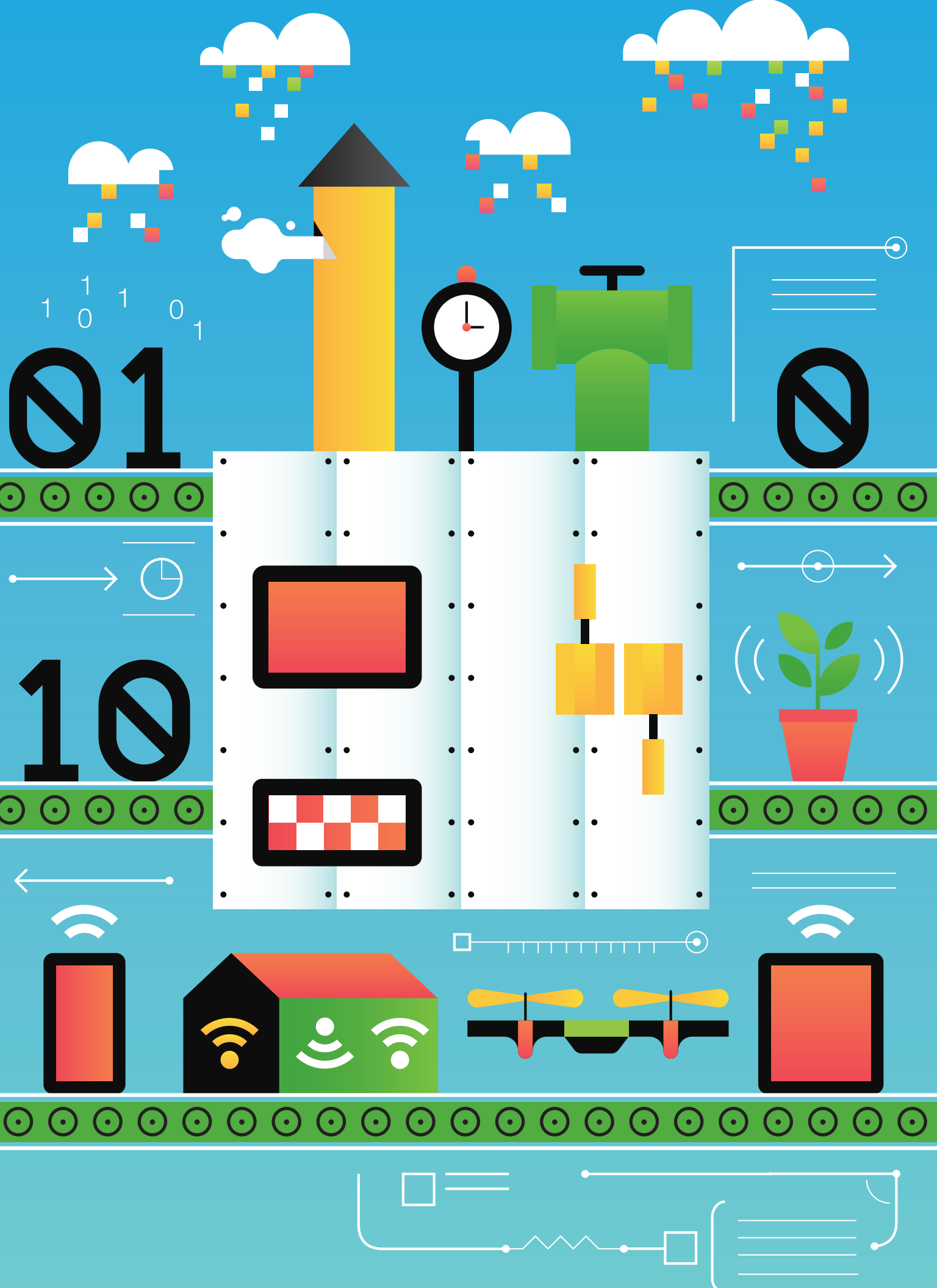
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Ambient computing

Putting the Internet of Things to work

Possibilities abound from the tremendous growth of embedded sensors and connected devices—in the home, the enterprise, and the world at large. Translating these possibilities into business impact requires focus—purposefully bringing smarter “things” together with analytics, security, data, and integration platforms to make the disparate parts work seamlessly with each other. Ambient computing is the backdrop of sensors, devices, intelligence, and agents that can put the Internet of Things to work.

THE Internet of Things (IoT) is maturing from its awkward adolescent phase. More than 15 years ago, Kevin Ashton purportedly coined the term he describes as the potential of machines and other devices to supplant humans as the primary means of collecting, processing, and interpreting the data that make up the Internet. Even in its earliest days, its potential was grounded in business context; Ashton’s reference to the Internet of Things was in a presentation to a global consumer products company pitching RFID-driven supply chain transformation.¹ And the idea of the IoT has existed for decades in the minds of science fiction writers—from the starship *Enterprise* to *The Jetsons*.

Cut to 2015. The Internet of Things is pulling up alongside cloud and big data as a rallying cry for looming, seismic IT shifts. Although rooted more in reality than hype, these shifts are waiting for simple, compelling scenarios to turn potential into business impact. Companies are exploring the IoT, but

some only vaguely understand its full potential. To realize that potential, organizations should look beyond physical “things” and the role of sensors, machines, and other devices as signals and actuators. Important developments, no doubt, but only part of the puzzle. Innovation comes from bringing together the parts to do something of value differently—seeing, understanding, and reacting to the world around them on their own or alongside their human counterparts.

Ambient computing is about embracing this backdrop of sensing and potential action-taking with an ecosystem of things that can respond to what’s actually happening in the business—not just static, pre-defined workflows, control scripts, and operating procedures. That requires capabilities to:

- Integrate information flow between varying types of devices from a wide range of global manufacturers with proprietary data and technologies

- Perform analytics and management of the physical objects and low-level events to detect signals and predict impact
- Orchestrate those signals and objects to fulfill complex events or end-to-end business processes
- Secure and monitor the entire system of devices, connectivity, and information exchange

Ambient computing happens when this collection of capabilities is in place—elevating IoT beyond enabling and collecting information to using the fabric of devices and signals to do something for the business, shifting the focus from the novelty of connected and intelligent objects to business process and model transformation.

What is the “what”?

The focus on the “things” side of the equation is natural. Manufacturing, materials, and computer sciences continuously drive better performance with smaller footprints and lower costs. Advances in sensors, computing, and connectivity allow us to embed intelligence in almost everything around us. From jet engines to thermostats, ingestible pills to blast furnaces, electricity grids to self-driving freight trucks—very few technical constraints remain to connect the balance sheets of our businesses and our lives. The data and services available from any individual “thing” are also evolving, ranging from:

- **Internal state:** Heartbeat- and ping-like broadcasts of health, potentially including diagnostics and additional status reporting (for example, battery level, CPU/memory utilization, strength of network signal, up-time, or software/platform version)
- **Location:** Communication of physical location via GPS, GSM, triangulation, or proximity techniques
- **Physical attributes:** Monitoring the world surrounding the device, including altitude, orientation, temperature, humidity, radiation, air quality, noise, and vibration
- **Functional attributes:** Higher-level intelligence rooted in the device’s purpose for describing business process or workload attributes
- **Actuation services:** Ability to remotely trigger, change, or stop physical properties or actions on the device


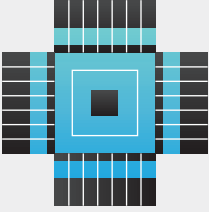





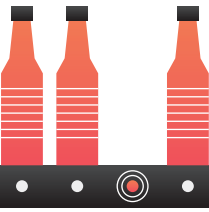

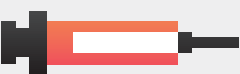


New products often embed intelligence as a competitive necessity. And the revolution is already well underway. An estimated 11 billion sensors are currently deployed on production lines and in power grids, vehicles, containers, offices, and homes. But many aren’t connected to a network, much less the Internet.² Putting these sensors to work is the challenge, along with deciding which of the 1.5 trillion objects in the world should be connected and for what purpose.³ The goal should not be the Internet of Everything; it should be the network of *some* things, deliberately chosen and purposely deployed. Opportunities abound across industries and geographies—connected cities and communities, manufacturing, retail, health care, insurance, and oil and gas.

Beyond the thing

Deliberate choice and purpose should be the broader focus of ambient computing. Analytics is a big part of the focus—turning data into signals and signals into insight. Take transportation as an example. Embedding sensors and controls in 24,000 locomotives, 365,000 freight cars, and across 140,000 miles of track supporting the United States’ “Class I” railroads only creates the backdrop for improvement. Moving beyond embedding, companies such as General Electric (GE) are creating predictive models and tools for trains and stockyards. The models and tools optimize trip velocities by accounting for weight, speed,

From the Internet of Things to ambient computing: A concentric system

The Internet of Things lives through sensors and actuators embedded in devices interacting with the world physically and functionally. Ambient computing contains this communication at the core, and harnesses the environment for business processes and insights.

 <p>Sensors & connectivity</p> <p>Underlying components allowing intelligence and communication to be embedded in objects.</p>		<p>SENSORS Temperature, location, sound, motion, light, vibration, pressure, torque, electrical current.</p> <p>ACTUATORS Valves, switches, power, embedded controls, alarms, intra-device settings.</p> <p>COMMUNICATION From near- to far-field: RFID, NFC, ZigBee, Bluetooth, Wi-Fi, WiMax, cellular, 3G, LTE, satellite.</p>	
 <p>Device ecosystem</p> <p>New connected and intelligent devices across categories making legacy objects smart.</p>		<p>CONSUMER PRODUCTS Smartphones, tablets, watches, glasses, dishwashers, washing machines, thermostats.</p> <p>INDUSTRIAL Construction machines, manufacturing and fabrication equipment, mining equipment, engines, transmission systems, warehouses, smart homes, microgrids, mobility and transportation systems, HVAC systems.</p>	
 <p>Ambient services</p> <p>The building blocks of ambient computing and services powered by sensors and devices.</p>		<p>INTEGRATION Messaging, quality of service, reliability.</p> <p>ORCHESTRATION Complex event processing, rules engines, process management and automation.</p> <p>ANALYTICS Baselining and anomaly monitoring, signal detection, advanced and predictive modeling.</p> <p>SECURITY Encryption, entitlements management, user authentication, nonrepudiation.</p>	
 <p>Business use cases^a</p> <p>Representative scenarios by industry to harness the power of ambient computing.</p>		<p>BASIC Efficiency, cost reduction, monitoring and tuning, risk and performance management.</p> <p>ADVANCED Innovation, revenue growth, business insights, decision making, customer engagement, product optimization, shift from transactions to relationships and from goods to outcomes.</p>	
 <p>LOGISTICS Inventory and asset management, fleet monitoring, route optimization.</p>	 <p>HEALTH & WELLNESS Personalized treatment, remote patient care.</p>	 <p>MECHANICAL Worker safety, remote troubleshooting, preventative maintenance.</p>	 <p>MANUFACTURING Connected machinery, automation.</p>

Source: ^a Deloitte Development LLC, *The Internet of Things Ecosystem: Unlocking the business value of connected devices*, 2014, <http://www2.deloitte.com/us/en/pages/technology-media-and-telecommunications/articles/internet-of-things-iot-enterprise-value-report.html>, accessed January 7, 2015.

fuel burn, terrain, and other traffic. The gains include faster-rolling trains, preemptive maintenance cycles, and the ability to expedite the staging and loading of cargo.⁴

The GE example highlights the need for cooperation and communication among a wide range of devices, vendors, and players—from partners to competitors, from customers to adjacent parties (for example, telecommunication carriers and mobile providers). The power of ambient computing is partially driven by Metcalfe's Law, which posits that the value of a network is the square of the number of participants in it. Many of the more compelling potential scenarios spill across organizational boundaries, either between departments within a company, or through cooperation with external parties. Blurry boundaries can fragment sponsorship, diffuse investment commitments, and constrain ambitions. They can also lead to isolationism and incrementalism because the effort is bounded by what an organization directly controls rather than by the broader analytics, integration, and orchestration capabilities that will be required for more sophisticated forays into ambient computing. Ecosystems will likely need to evolve and promote industry standards, encourage sharing through consortia, and move away from proprietary inclinations by mandating open, standards-based products from third parties.

Ambient computing involves more than rolling out more complete and automated ways to collect information about real-world behavior. It also turns to historical and social data to detect patterns, predict behaviors, and drive improvements. Data disciplines are essential, including master data and core

management practices that allow sharing and provide strategies for sensing and storing the torrent of new information coming from the newly connected landscape. Objects can create terabytes of data every day that then need to be processed and staged to become the basis for decision making. Architectural patterns are emerging with varying philosophies: embedding intelligence at the edge (on or near virtually every device), in the network, using a cloud broker, or back at the enterprise hub. One size may not fit all for a given organization. Use cases and expected business outcomes should anchor the right answer.

The final piece of the puzzle might be the most important: how to put the intelligent nodes and derived insights to work. Again, options vary. Centralized efforts seek to apply process management engines to automate sensing, decision making, and responses across the network. Another approach is decentralized automation, which embeds rules engines at the endpoints and allows individual nodes to take action.

In many cases, though, ambient computing is a sophisticated enabler of amplified intelligence⁵ in which applications or visualizations empower humans to act differently. The machine age may be upon us—decoupling our awareness of the world from mankind's dependency on consciously observing and recording what is happening. But machine automation only sets the stage. Real impact, business or civic, will come from combining data and relevant sensors, things, and people so lives can be lived better, work can be performed differently, and the rules of competition can be rewired.

Lessons from the front lines

From meters to networks

ComEd, an Exelon company that provides electricity to 3.8 million customers in Northern Illinois,⁶ is in the midst of a \$2.6 billion smart grid project to modernize aging infrastructure and install smart meters for all of its customers by 2018.⁷ The primary goals of this undertaking are to enhance operational efficiency and to provide customers with the information and tools to better manage their energy consumption and costs. Featuring advanced meter infrastructure (AMI), the new meters reduce electricity theft and consumption on inactive meters, reduce the number of estimated electric bills, minimize energy loss, and reduce the need for manual meter reading. Numerous operational efficiencies and benefits are emerging. For example, on Chicago's south side, AMI meter reading has increased the percentage of meters read from 60 percent to 98 percent. Last year, ComEd was given the green light by the Illinois Commerce Commission to accelerate its smart meter installation program, thus making it possible to complete the project three years ahead of schedule.⁸

The smart grid effort will also improve ComEd's ability to maintain its overall infrastructure. Real-time visibility into transformers, feeders, and meters will help the company detect, isolate, and resolve maintenance incidents more efficiently. Other smart grid components will improve communications among field services technicians, operators, and even customers. Analytics, residing atop integration and event processing layers, will form an integral part of the company's ambient computing platform. Security and privacy capabilities will help protect against attacks to critical infrastructure by providing the company with remote access to individual meters and

visibility into usage for any given residence or commercial location.

ComEd is also developing a suite of services that will make it possible for customers to view their own energy usage (including itemized energy costs per appliance). The goal of these services is to help individuals proactively regulate their own power consumption and achieve greater efficiency during periods of peak power usage.

As the smart grid project progresses, ComEd leaders remain strategic and flexible. When opportunities to accommodate future technological advances emerge, they adapt their approaches accordingly. For example, when it installed a network of AMI access points, the company decided to place the network physically higher than needed at the time. Why? Because doing so could make it possible to repurpose the existing residential mesh network, should the opportunity ever arise. And one year later, the company is piloting new LED streetlights powered by the repurposed mesh network.

With ambient computing advancing more rapidly each year, ComEd's leaders are keeping their options open and the new smart grid system as flexible as possible in order to take advantage of new improvements, devices, and opportunities that may emerge.

Home sweet conscious home

The makers at Nest Labs view embedded sensors and connectivity as a means to an end, not as ends unto themselves. Their vision is one of a "conscious home" that emphasizes comfort, safety, and energy savings. Many products in the broader Internet of Things space focus on raw technology features. However, Maxime Veron, Nest's head of product marketing, downplays the technology aspects of Nest's offerings, noting: "The



fact that your device is connected does not automatically make it a better product.”

A case in point is the Nest Learning Thermostat—a next-generation wall thermostat that uses occupancy sensors, on-device learning, cloud-based analytics, and Web services to learn an occupant’s schedule and integrate into his or her life. The company designs customer experiences that focus on usability from the point of installation: The thermostat features snap connectors for wiring, includes a carpenter’s level built into the base of the unit to ease finishing, and comes with a multi-head screwdriver to help installers more easily replace legacy hardware. The thermostat’s operation similarly evokes the qualities of ambient computing in that the complexity of sensing, learning from occupant behavior, and self-tuning settings remains largely invisible to the user. Veron notes, “We don’t want to give you something to program.”

Nest Labs is looking beyond any single device toward broader platforms and services. The company launched a partner program to allow third-party products to interact with Nest products. The goal is to create more intuitive ways to learn about and respond to specific user behavior and preferences. For example, your car can alert the Nest Thermostat to begin cooling your home at a certain point during your evening commute. Upon your arrival, the house is comfortable, but you haven’t wasted energy cooling it all day long. Nest Labs’ second product, Nest Protect, is a smoke and carbon monoxide alarm that can send a message to a mobile device about what it has detected, turn off heating by a gas furnace when it detects a possible CO leak (if the customer has a Nest Thermostat as well), and link to the company’s Dropcam video camera to save a clip of what was happening when the alarm initiated.

These scenarios involve not just connectivity and interoperability, but also advanced levels of orchestration and analytics, as well as sophisticated but simple user

experiences. Nest Labs, acquired by Google in 2014, has kept the majority of its development in-house, believing that applying the same standards and rigor to its design process from beginning to end—including hardware, software, external data inputs, sensors, and app development—will ultimately result in a more powerful experience for customers inhabiting a “conscious home.”

No more circling the block

Many of us have had a parking experience so bad that we avoid the area in the future, opting for restaurants or stores that do not require a frustrating parking lot tour. And because parking tickets and meter fees are often considerable sources of revenue for cities overseeing public parking and for organizations that own parking lots and structures, opportunities to address commuter frustration, pollution, and lost sales revenue through better parking regulations may be mismanaged or ignored altogether. Enter Streetline, Inc., a San Francisco Bay-area company that helps to solve parking-related challenges from the ground up (literally) through its mesh networking technology, real-time data, and platform of parking applications.

The Streetline approach is composed of three layers. First, when deploying its platform in a new location, Streetline installs sensors which determine space occupancy or vacancy in individual parking spaces. The second layer is a middleware learning platform that merges real-time and historical sensor data to determine the validity of a parking event (a true arrival or departure) and relays the current status of each space to the system’s backend. An inference engine weeds out false positives such as a garbage can left in a space, or a driver pulling into a parking spot for a moment and then leaving. Finally, there is the application layer that includes a variety of mobile and Web-based tools that deliver up-to-the-minute parking information to

commuters, business owners, city officials, and parking enforcement officers in or near the deployment area.

Streetline's Parker™ app guides motorists to open parking spaces, which can decrease driving times, the number of miles traveled, and motorist frustration. Through integration with leading mobile payment providers, the Parker app enables drivers to “feed” parking meters electronically—without the hassle of searching for quarters. Furthermore, motorists can add time to their meter remotely before time expires to avoid parking tickets. ParkerMap™ makes it possible for companies to create online maps of available parking spaces in a given area, along with lot hours and parking rates. Using the ParkerData™ Availability API, cities can publish parking information on dynamic signage, strategically placed around a city. Combined, these different methods of way-finding help consumers find parking more quickly, increasing parking space turnover—and thereby potentially driving increases in foot traffic and sales among local merchants. In fact, studies have revealed that smart parking systems can improve the local economy, as evidenced by a 12 percent increase in merchant sales tax revenue in one of Streetline's customer cities.⁹ Moreover, the cities, universities, and companies that own parking in a given area can get access to information about utilization and consumer trends, as well as recommendations for better parking policies and pricing. Law enforcement also has access to similar information, helping enforcement officers increase their productivity and efficiency by as much 150 percent.¹⁰

Streetline's products are deployed in 40 locations globally, and the company is currently exploring ways to increase the pace of adoption through new use cases, sponsorships, and a monetized API. It is also exploring the capture of new data types including ground surface temperature, noise level, air quality, and water pressure, to name a few.

What began as a desire to make life a little easier for motorists in the congested streets of San Francisco is quickly becoming a foundational layer for the emergence of smarter cities and the Internet of Things worldwide.

Products to platforms

Bosch Group knows a thing or two about disruptive technologies and their business potential. As the world's third-largest private company, it manufactures a wide range of products, from consumer goods to industrial equipment, including some of the building blocks of ambient computing—shipping roughly 1 billion microelectromechanical systems (MEMS) sensors in 2014. Recognizing the potential of the Internet of Things (IoT), its vision has been embedding connectivity and intelligence in products across its 350-plus business units.

In 2008, the company launched Bosch Software Innovations (Bosch SI), a business unit dedicated to pioneering IoT and ambient computing solutions for industrial environments. “We are trying to bring 130 years of manufacturing experience to connectivity,” says Troy Foster, Bosch SI CTO Americas. Bosch SI approaches its mission from an enterprise software perspective—looking beyond the device to enable the kind of business intelligence, processes, and decision making that drive value from data.

To that end, Bosch SI's IoT platform is composed of four primary software components: a machine-to-machine layer, business process management, business rules management, and an analytics engine. The IoT system was designed to accommodate growing data volumes as sensors get smaller and cheaper, spurring wider deployment. Configurable rules allow evolving, actionable insights to be deployed.

For example, Bosch SI is currently developing preventative maintenance



My take

Richard Soley, PhD
Chairman and CEO, Object Management Group
Executive director, Industrial Internet Consortium

As head of the Object Management Group, one of the world's largest technology standards bodies, I'm often asked when standards will be established around the Internet of Things (IoT).¹¹ This common question is shorthand for: When will there be a language to ease interoperability between the different sensors, actuators, and connected devices proliferating across homes, business, and society?

In developing IoT standards, the easy part is getting bits and bytes from object to object, something we've largely solved with existing protocols and technologies. The tricky part relates more to semantics—getting everyone to agree on the meaning and context of the information being shared and the requests being made. On that front, we are making progress industry by industry, process area by process area. We're seeing successes in use cases with bounded scope—real problems, with a finite number of actors, generating measurable results.

This same basic approach—helping to coordinate industrial players, system integrators, start-ups, academia, and vendors to build prototype test beds to figure out what works and what doesn't—is central to the charter of the Industrial Internet Consortium (IIC).¹² The IIC has found that the more interesting scenarios often involve an ecosystem of players acting together to disrupt business models.

Take, for example, today's self-driving cars, which are not, in and of themselves, IoT solutions. Rather, they are self-contained, autonomous replacements for drivers. However, when these cars talk to each other and to roadway sensors and when they can use ambient computing services like analytics, orchestration, and event processing to dynamically optimize routes and driving behaviors, then they become headliners in the IoT story.

The implications of self-driving cars talking to each other are profound—not only for taxicab drivers and commuters, but also for logistics and freight transport. Consider this: Roughly one-third of all food items produced today are lost or wasted in transit from farm to table.¹³ We could potentially make leaps in sustainability by integrating existing data on crop harvest schedules, grocery store inventory levels,

and consumer purchasing habits, and analyzing this information to better match supply with demand.

The example that excites and scares me the most revolves around maintenance. The IoT makes it possible to reduce—and potentially eliminate—unexpected maintenance costs by sensing and monitoring everything happening within a working device, whether it be a jet engine, medical device, or distribution system. Rather than reacting to mechanical or system breakdowns, engineers could work proactively to address problems before they become full-blown malfunctions. Companies could deploy systems in which nothing fails. Imagine the impact on industry. Business models based on replenishment/replacement cycles would need to be overhauled. Manufacturers of spare parts and providers of repair services might potentially disappear completely, as the focus of maintenance shifts from objects to outcomes. The list of possible ramifications is staggering.

When the future-state level of interconnectivity is realized, who will own each step along the supply chain? End-to-end control affords significant opportunity, but it is rarely achieved. When the IoT evolves, I imagine it will resemble the newly integrated supply chains that emerged in the 1980s and 1990s. While no one controlled the entire supply chain, it was in everyone's interest along that chain to share and secure information in ways that benefited all parties.

My advice to companies currently considering IoT investments is, don't wait. Begin collaborating with others to build prototypes and create standards. And be prepared—your IoT initiatives will likely be tremendously disruptive. We don't know exactly how, but we do know this: You can't afford to ignore the Internet of Things.



Cyber implications

Enabling the Internet of Things requires a number of logical and physical layers, working seamlessly together. Device sensors, communication chips, and networks are only the beginning. The additional services in ambient computing add even more layers: integration, orchestration, analytics, event processing, and rules engines. Finally, there is the business layer—the people and processes bringing business scenarios to life. Between each layer is a seam, and there are cyber security risks within each layer and in each seam.

One of the more obvious cyber security implications is an explosion of potential vulnerabilities, often in objects that historically lacked connectivity and embedded intelligence. For example, machinery, facilities, fleets, and employees may now include multiple sensors and signals, all of which can potentially be compromised. CIOs can take steps to keep assets safe by considering cyber logistics before placing them in the IT environment. Ideally, manufacturing and distribution processes have the appropriate controls. Where they don't, securing devices can require risky, potentially disruptive retrofitting. Such precautionary steps may be complicated by the fact that physical access to connected devices may be difficult to secure, which leaves the door open to new threat vectors. What's more, in order to protect against machines being maliciously prompted to act against the interests of the organization or its constituencies, IT leaders should be extra cautious when ambient computing scenarios move from signal detection to actuation—a state in which devices automatically make decisions and take actions on behalf of the company.

Taking a broad approach to securing ambient computing requires moving from compliance to proactive risk management. Continuously measuring activities against a baseline of expected behavior can help detect anomalies by providing visibility across layers and into seams. For example, a connected piece of construction equipment has a fairly exhaustive set of expected behaviors, such as its location, hours of operation, average speed, and what data it reports. Detecting anything outside of anticipated norms can trigger a range of responses, from simply logging a potential issue to sending a remote kill signal that renders the equipment useless.

Over time, security standards will develop, but in the near term we should expect them to be potentially as effective (or, more fittingly, ineffective) as those surrounding the Web. More elegant approaches may eventually emerge to manage the interaction points across layers, similar to how a secured mesh network handles access, interoperability, and monitoring across physical and logical components.

Meanwhile, privacy concerns over tracking, data ownership, and the creation of derivative data using advanced analytics persist. There are also a host of unresolved legal questions around liability. For example, if a self-driving car is involved in an accident, who is at fault? The device manufacturer? The coder of the algorithm? The human “operator”? Stifling progress is the wrong answer, but full transparency will likely be needed while companies and regulators lay the foundation for a safe, secure, and accepted ambient-computing tomorrow.

Finally, advanced design and engineering of feedback environments will likely be required to help humans work better with machines, and machines work better with humans. Monitoring the performance and reliability of ambient systems is likely to be an ongoing challenge requiring the design of more relevant human and machine interfaces, the implementation of effective automation algorithms, and the provisioning of helpful decision aids to augment the performance of humans and machines working together—in ways that result in hybrid (human and technical) secure, vigilant, and resilient attributes.

Where do you start?

MANY don't need to be convinced of ambient computing's opportunities. In a recent survey, nearly 75 percent of executives said that Internet of Things initiatives were underway.¹⁴ Analysts and companies across industries are bullish on the opportunities. Gartner predicts that "by 2020, the installed base of the IoT will exceed 26 billion units worldwide; therefore, few organizations will escape the need to make products intelligent and the need to interface smart objects with corporate systems."¹⁵ Other predictions measure economic impact at \$7.1 trillion by 2020,¹⁶ \$15 trillion in the next 20 years,¹⁷ and \$14 trillion by 2022.¹⁸ But moving from abstract potential to tangible investment is one of the biggest hurdles stalling progress. Below are some lessons learned from early adopters.

- **Beware fragmentation.** Compelling ambient computing use cases will likely cross organizational boundaries. For example, retail "store of the future" initiatives may cross store management, merchandising, warehouse, distribution center, online commerce, and marketing department responsibilities—requiring political and financial buy-in across decision-making authorities. Because the market lacks end-to-end solutions, each silo may be pursuing its own initiative, offering at best incremental effect, at worst redundant or competing priorities.
- **Stay on target.** Starting with a concrete business outcome will help define scope by guiding which "things" should be considered and what level of intelligence, automation, and brokering will be required. Avoid "shiny object syndrome," which can be dangerously tempting given how exciting and disruptive the underlying technology can seem.
- **User first.** Even if the solution is largely automated, usability should guide vision, design, implementation, and ongoing maintenance plans. Companies should use personas and journey maps to guide the end-to-end experience, highlighting how the embedded device will take action, or how a human counterpart will participate within the layers of automation.
- **Eyes wide open.** Connecting unconnected things will likely lead to increased costs, business process challenges, and technical hurdles. Be thoughtful about funding the effort and how adoption and coverage will grow. Will individual organizations have to shoulder the burden, or can it be shared within or across industries and ecosystems? Additionally, can some of the investment be passed on to consumers? Although business cases are needed, they should fall on the defensible side of creative.
- **Network.** With the emphasis on the objects, don't lose sight of the importance of connectivity, especially for items outside of established facilities. Forrester Research highlights "a plethora of network technologies and protocols that define radio transmissions including cellular, Wi-Fi, Bluetooth LE, ZigBee, and Z-Wave."¹⁹ Planning should also include IPv6 adoption,²⁰ especially with the public IPv4 address space largely exhausted and the aforementioned billions of new Internet-enabled devices expected in the next 10 years.
- **Stand by for standards.** Standards help create collaborative and interoperable ecosystems. We expect that IoT standards for interoperability, communication, and security will continue to evolve,

with a mix of governmental bodies, industry players, and vendors solving some of the challenges inherent in such a heterogeneous landscape. Several IoT-focused standards bodies and working groups including the AllSeen Alliance, Industrial Internet Consortium, Open Interconnect Consortium, and Thread Group have formed in the last two years.²¹ Having preliminary standards is important, but you shouldn't hold off on investing until all standards are finalized and approved. Press forward and help shape the standards that impact your business.

- **Enterprise enablement.** Many organizations are still wrestling with smartphone and tablet adoption—how to secure, manage, deploy, and monitor new devices in the workplace. That challenge is exponentially exacerbated by ambient computing. Consider launching complementary efforts to provision, deploy policies for, monitor, maintain, and remediate an ever-changing roster of device types and growing mix of underlying platforms and operating systems.



Bottom line

AMBIENT computing shouldn't be looked at as just a natural extension of mobile and the initial focus on the capabilities of smartphones, tablets, and wearables—though some similarities hold. In those cases, true business value came from translating technical features into doing things differently—or doing fundamentally different things. Since ambient computing is adding connectivity and intelligence to objects and parts of the world that were previously “dark,” there is less of a danger of seeing the opportunities only through the lens of today's existing processes and problems. However, the expansive possibilities and wide-ranging impact of compelling scenarios in industries such as retail, manufacturing, health care, and the public sector make realizing tomorrow's potential difficult. But not impossible. Depending on the scenario, the benefits could be in efficiency or innovation, or even a balance of cost reduction and revenue generation. Business leaders should elevate discussions from the “Internet of Things” to the power of ambient computing by finding a concrete business problem to explore, measurably proving the value, and laying the foundation to leverage the new machine age for true business disruption.

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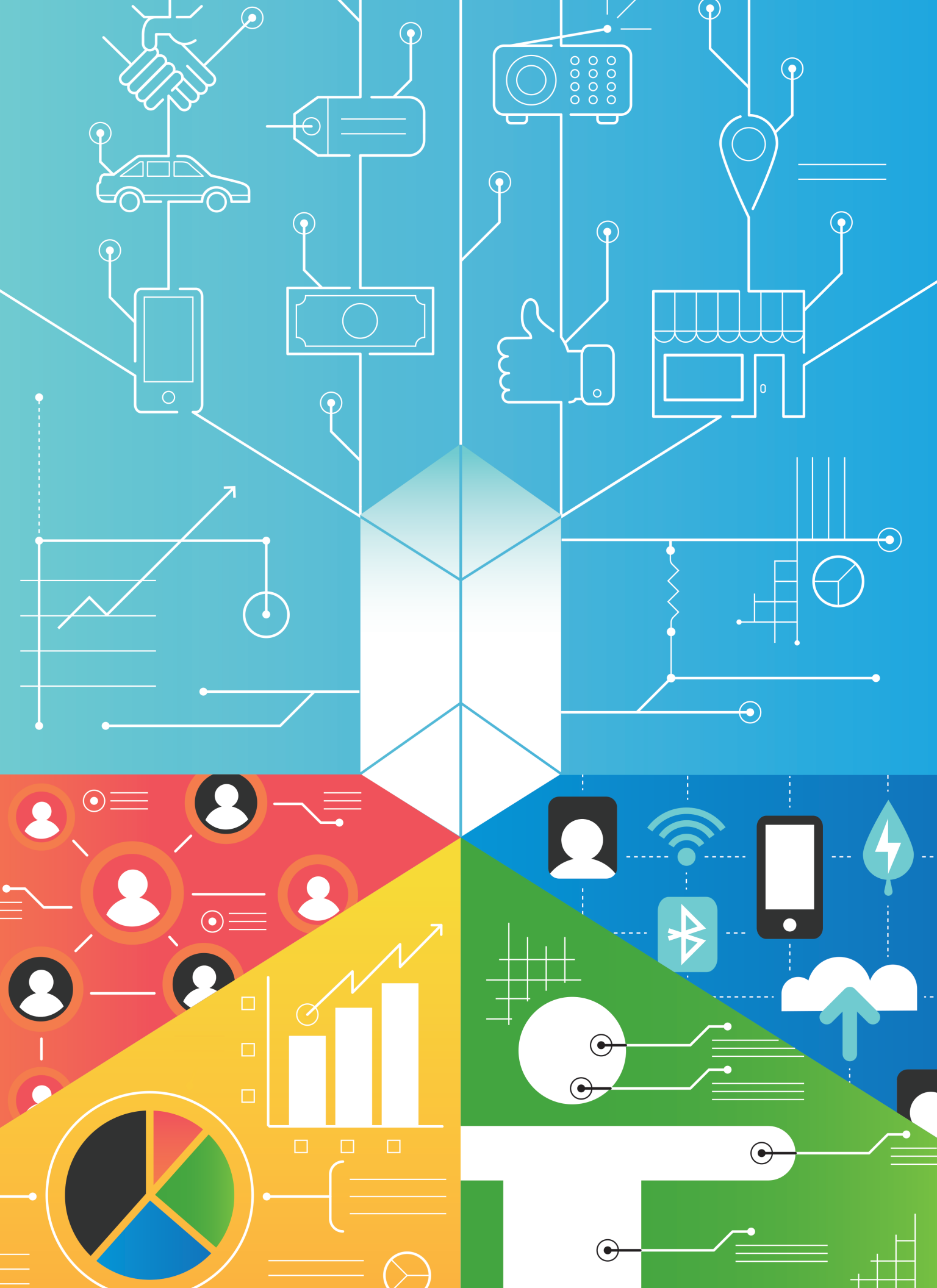


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Dimensional marketing

New rules for the digital age

Marketing has evolved significantly in the last half-decade. The evolution of digitally connected customers lies at the core, reflecting the dramatic change in the dynamic between relationships and transactions. A new vision for marketing is being formed as CMOs and CIOs invest in technology for marketing automation, next-generation omnichannel approaches, content development, customer analytics, and commerce initiatives. This modern era for marketing is likely to bring new challenges in the dimensions of customer engagement, connectivity, data, and insight.

ACCORDING to MBA textbooks, marketing is the “art and science of choosing target markets and getting, keeping, and growing customers through creating, delivering, and communicating superior customer value.”¹ This core mission hasn’t changed. However, marketing has evolved significantly in the last five years, driven by the rapid convergence of customer, digital, and marketing technologies. Marketers have access to an unprecedented amount of data to inform targeted marketing campaigns. Channel access is ubiquitous, as are touchpoints of all kinds—offline and on. Consumer messaging has morphed into social engagement, allowing companies to view their brands from the outside in.

The result is a magnification of customer expectations in terms of relevancy, intimacy, delight, privacy, and personal connections. Increasingly, organizations no longer market to masses. They are marketing to individuals and their social networks. Indeed, marketing itself has shifted from the broadcast of messages

to engagement in conversations, and now to the ability to predict and rapidly respond to individual requests. Organizations are increasingly able to engage audiences on their terms and through their interests, wherever and whatever they are. And customers are learning to expect nothing less, from both B2C and B2B enterprises.

What does all of this mean for the CMO? And the CIO? To begin with, CIOs and CMOs should embrace the reality that the marketing levers of the past no longer work the same way, if at all. The front office of marketing has been recast around connectivity and engagement—seamless contextual outreach tailored to specific individuals based on their preferences, behaviors, and purchase histories. At the same time, marketing’s back office has been transformed by new technologies for accelerating and automating campaigns, content, and positioning—fueled by data and analytics. Together, these new dimensions are ushering in a new breed of marketing: *dimensional marketing*.

The four dimensions

In simpler times, linear constructs such as the four Ps (product, price, promotion and place) served us well as the foundational ingredients of marketing strategies. In the era of dimensional marketing, however, many companies are adding four new dimensions to the original marketing mix: engagement, connectivity, data, and technology. The concept of dimension is important. It reflects how the levers are now integrated and interrelated.

Experience is all: The engagement revolution

Over 86 percent of Americans have Internet access.² Fifty-eight percent have smartphones, and 42 percent have tablets.³ Consumers are now using new technologies to research products and shop through a variety of channels. These connected consumers can buy from retailers regardless of geography or store opening hours. The consumer experience now demands a balance of form and function. Experiences should be personalized, contextual, and real-time to “me” in the environment and with the method that makes the most sense in the moment. This is a dramatic shift from the days of catering to broad demographics and customer segments. Organizations are armed with deep, granular knowledge of individuals; just as importantly, they have access to multiple channels through which to conduct personalized outreach. Gartner’s 2014 Hype Cycle for Web Computing found that “Many big data use cases are focused on customer experience, and organizations are leveraging a broad range of information about an individual to hyperpersonalize the user experience, creating greater customer intimacy and generating significant revenue lift.”⁴ Every experience reflects the brand, transcending campaigns, products, sales, service, and support across channels. User experience and great design should be cornerstones of every solution, which requires new skill sets, delivery

models, and interactions between the business and IT. Behind the scenes, content and digital access management are critical to a seamless integration of campaigns, sales, services, supply chains, and CRM systems.

Relationships are interactions: The connectivity revolution

One-way communication with consumers is a thing of the past. Marketers should build sustained relationships through a deep and meaningful understanding of individual customers. After all, effective relationships drive loyalty, build communities, and cultivate influencers. Meaningful relationships also require dialogue. The shift from omni-channel to omni-directional communication across channels is giving communities and individuals the opportunity to create new levels of engagement. A recent Deloitte study commissioned by eBay found that being broadly present across channels, and enabling each channel to serve the customer at any point through the purchase journey, raised brand awareness and drove loyalty.⁵ The study also found that leading retailers with a presence across store and non-store channels succeeded in capturing additional sales from non-store channels due to increased awareness of their products, expanded market share and/or a greater share of sales captured from competitors, and access to fast-growth channels. Social (both social technology and real-world social behavior) plays an important role by activating audiences and sustaining (or heightening) their interest through tailored, relevant content delivered on their own terms and in their own words.⁶

Intelligence is targeted: The information revolution

Deriving meaningful customer, sales, and product insights requires an appetite for enormous amounts of data and analytics. Gartner’s Hype Cycle for Digital Marketing found that “The hype around data-driven marketing is largely justified, and data-driven

marketing will help make marketing better, faster, and more cost-effective while better aligning marketers with the marketplace, not to mention enterprise objectives, through richer, more reliable metrics.”⁷ And a recent Teradata survey found that 78 percent of marketers feel pressure to become more data-driven, with 45 percent agreeing that data is the most underutilized asset in the marketing organization.⁸ Real-time analysis can drive adjustments and improvements to marketing campaigns and promotions. Intelligence gives us the technical capability to close the loop and measure real business results by providing multiple ways to interpret and make use of data. Better targeting and visibility across the full customer life cycle enhances

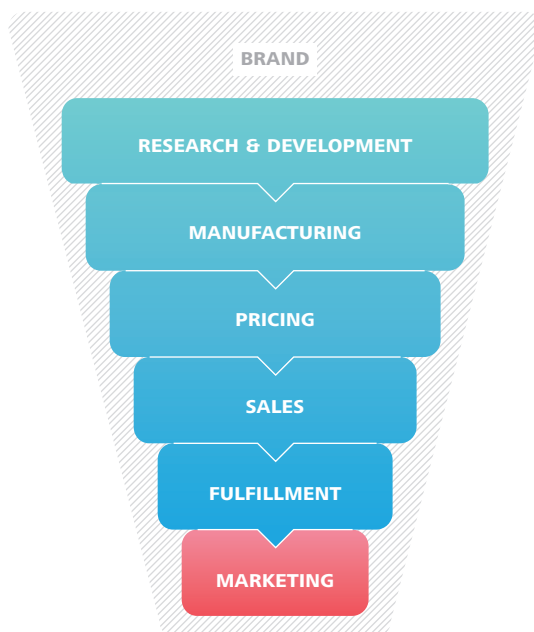
the use of standalone tools in areas such as campaign automation and bid management systems—indicative of the trend to understand individuals versus broad segments.

Channel orchestration is multidimensional: The technology revolution

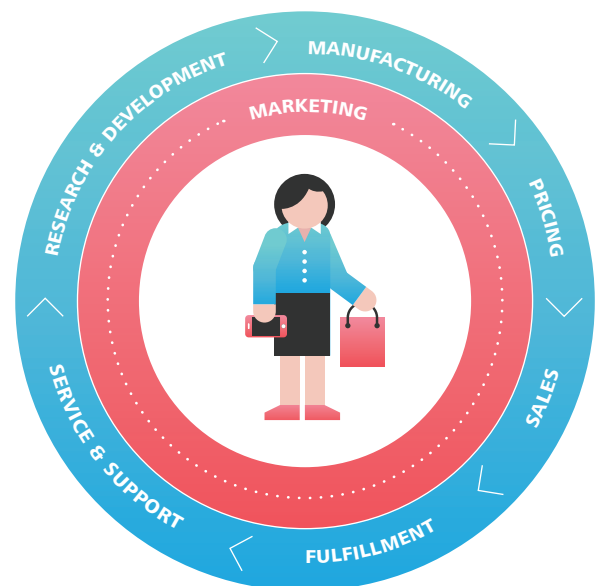
Channels and customer touchpoints are constantly multiplying. Marketers now own or manage the marketing platforms, architecture, and integration required to provide a consistent experience across channels. Although marketing has evolved from broadcast to interactivity and now finally to digital, many organizational capabilities still remain in silos. With dimensional

The evolution of marketing

THE TRADITIONAL MODEL Marketing began as an isolated step occurring at the end of a linear business process focused on brand and awareness. Core technology functions such as ERP, data, and analytics were bolted on to marketing as needed.



THE NEW MODEL Today’s marketing is a multifaceted entity with hooks into all steps of the business and product cycle. With the customer as the main actor, the business aims to integrate engagement, connectivity, information, and technology in order to create a personalized, contextualized experience.



marketing, traditional, digital, customer, and enabling business systems are converging into one integrated offering that operates simultaneously in harmony. This harmony demands platforms that are deliberately designed to accommodate multiple devices and touchpoints. Contextual architecture should provide data, images, video, and transactions dynamically—and be based not just on who the customers are, but where they are, what they've done, and what they're likely to want next.

A digital platform divided

The stage is set for technology and analytics to play a more impactful role in this new world—delivering seamless, contextual, and hyper-targeted customer and prospect experiences, and helping marketing departments repatriate duties from agencies through their own capabilities for automation, precision, and efficiency. CMOs, working in partnership with CIOs, should command a richer, data-driven, targeted repertoire of campaigns, promotions, and properties across multiple channels for varied customer types and objectives. Customer awareness, acquisition, conversion, and retention are top priorities and require attention and investment.⁹

Organization-wide platforms to target, provision, deploy, and measure digital assets are needed and should be integrated across:

- Channels: offline and online and across paid, earned, and owned media
- Context: based on the individual's behavior, preferences, location, and other cues
- Campaigns: pricing, promotions, and offers tailored to an individual in a specific point in time
- Content: internally and externally sourced, with increasing focus on social media and video, and optimized for mobile

CIOs should be prepared for a sizeable increase in marketing technology initiatives—akin to the wave of automation in the worlds of finance and supply chain. Marketing's expanded scope will likely require changes far beyond traditional marketing systems, with integration into CRM and ERP systems in areas such as pricing, inventory, order management, and product R&D. And, as analytics, mobile, social, and the Web become marketing's digital battleground, CIOs should expect aggressive pushes in these areas. These forays could affect the organization's enterprise strategy in each domain. CIOs should not settle for being responsive, informed parties as the revolution unfolds; they should be seen as a strategist and act as a catalyst.

Lessons from the front lines

Consumerized insurance

Amid growing competition in the insurance industry, some providers in the B2B space are taking steps to differentiate their brands and increase market share by adopting a more consumer-centric approach to marketing. In contrast to traditional product-centric strategies, this approach—which some industry trend watchers refer to as “the consumerization of B2B marketing”¹⁰—integrates different aspects of dimensional marketing such as customer experience, relationships, analytics, and technology to deliver seamless, personalized interactions across a variety of platforms.

One insurer, faced with increasing brand parity within retirement and insurance services, determined that it would need to improve its digital positioning and overall retention of assets under management to better differentiate its brand in the marketplace. The company developed a solution that featured a redesigned Web experience, a financial wellness scoring tool for customers, and a new CRM system. It also stopped trying to focus solely on educating people about product offerings and, instead, began emphasizing real testimonies from other customers. This new foundation of customer-centric marketing tools is expected to deliver a 40 percent increase in retention, as well as improved brand recall and purchase intent.

Another provider was looking to sell direct insurance to small businesses, an area traditionally underserved by large insurance providers due to the complexity involved (providing real-time, online quotes for these businesses requires considerable knowledge of unique risks and regulations that vary by geography and industry, as well as advanced analytics and predictive models to advise significant underwriting requirements). With this challenge in mind, the company set about

designing a website with a front end that would be sufficiently user-friendly to prevent potential customers from getting turned off by a complicated, lengthy quote process. The end result was a responsive, intuitive site with predictive models as the DNA of the process; the site also incorporates clean UX design principles on top of a REST service layer. Customers are now able to easily and independently navigate the quote process in addition to customizing, purchasing, and managing their policies through this site.

The impact of the trend toward the “consumerization of B2B marketing” is rippling beyond messaging and rebranding. As B2C companies expand into the enterprise market, enterprise customers are increasingly expecting the same highly engaging, intuitive approach across all interactions. For the insurance industry in particular, this means simplifying, streamlining, and humanizing their messaging and technology platforms in ways that reduce the frustration customers can feel when dealing with complicated financial instruments.

Dimensional platform

Traditionally, marketers focused on demographics, organizing channels into silos, and optimizing traditional metrics such as above- vs. below-the-line spend or working vs. non-working dollars. Media buying evolved into a process in which marketers perform audience analysis, establish segments, and target each segment with banner ads, offers, and other tailored content requiring considerable human involvement and expertise. With each new channel or segment, the process complexity and content permutations increase.

Enter Rocket Fuel Inc., which has developed a marketing platform featuring an artificial intelligence (AI) engine for





automated, programmatic media buying and placement. Instead of relying on static, predefined customer segments, algorithms make decisions on media buying and placement based on real-time information—blending audience analysis, campaign management, pricing optimization, and dynamic budget allocation.

Rocket Fuel also provides ways to link channels across a full customer lifecycle. A telecommunications customer using the platform can drive placement of banner ads timed to coincide with delivery of direct mail offers, or send a text-based offer to speak to a live customer service representative if a high-value customer visits the company's website multiple times in a day.

John Nardone, Rocket Fuel executive vice president and general manager, says, "The goal needs to be relevance, not personalization." Consumers may not respond to something simply addressed to them, but they will likely respond to something *relevant* to their lives, tastes, and desires. In a time of generic junk mail, spam, and ubiquitous banner ads, understanding who each consumer is, what motivates them, and what their unique needs are matters more than ever. Rocket Fuel's platform helps to drive contextual interactions across channels—online and off.

Digital first

Six years ago, Telstra, Australia's largest telecommunications and information services provider, needed to find a new strategy to remain competitive. In 2010, Telstra was facing declining revenues and narrowing profit margins. The overall market was changing, with customers dropping fixed-line services. The internal and external environment was shifting: the company had completed a multi-year privatization, competition was rising, and non-traditional competitors in the digital space were emerging.

"The company decided that focusing on customers should be our number-one priority,

and it has been ever since," says Gerd Schenkel, Executive Director, Telstra Digital. One of the other changes facing the industry was the increase of digital channels and service options for customers. "Our customers' digital choices continue to increase, so we needed to make sure we were offering digital solutions our customers valued."

Telstra's multifaceted approach for creating a high-quality online experience for customers leverages data, digital tools, and dimensional marketing techniques to transform customer engagement, service, and the traditional vendor-customer relationship. The first step—one that is ongoing—was to learn more about what customers wanted in a digital experience: specifically, how operational data can be turned into insights in ways customers find not just acceptable, but valuable. An example comes from smartphone users: As customers continue to consume more and more data, it is important to be transparent with customers about their usage to help prevent bill shock. Through digital channels, Telstra is in a position to proactively approach customers with early warnings of potential billing implications, as well as to trigger offers tailored to their individual needs. Doing this yielded a valuable insight: With dimensional marketing, traditional boundaries between marketing, sales, and service are disappearing. Almost every customer touchpoint presents opportunities to market, sell, and provide service. When service improves, customer satisfaction typically rises. Sales will likely follow.

On the service front, Telstra is taking a similar proactive, data-centric approach. By tracking and analyzing customer support data, Telstra discovered that customers often require additional support with billing and similar inquiries that depend on the company's legacy back-end systems. Telstra is now routinely measuring current and expected customer experiences, resolving issues, and proactively contacting the customer.

In sales, Telstra has launched the ability to push tailored offers to customers using the company website. It has also deployed several algorithms to proactively offer online customers live chat with a sales representative if it appears that they need help. The company plans to extend this capability to its service pages. A similar focus has been placed on connectivity. Telstra's "CrowdSupport"¹¹ community and "Mobile Insider" program are activating influencers and advocates, soliciting more than 200,000 pieces of user-created content for servicing, product demonstrations, and broader brand promotion.

Telstra's most recent initiative, "Digital First," will build a digital ecosystem designed to elevate customer engagement by empowering both the customer and the company. The ecosystem aims to consolidate customer data into a single, detailed profile available for any interaction across online and offline channels: website, call center, retail store, or a service

event. This would allow a Telstra representative to see a customer's history, usage, service issues, preferences, past interactions—and, with permission, even social media activity and a photograph. This broad, detailed view of the customer should help the company provide a more consistent experience and better satisfy customer needs. For example, rather than greeting customers with a generic "How may I help you?," having such data readily available could allow employees to greet them and provide an update on what is being done to address their specific concerns.

Schenkel says that, though Telstra is still in the early stages of its digital journey, its initiatives have already begun to pay off. "They've delivered significant value. What's more, Telstra customers continue to be happier with their online experiences, with all key digital satisfaction measures improving considerably in 2014."



My take

Ann Lewnes, chief marketing officer,
Adobe

Over the past few years, data and visibility into data have, in large part, transformed virtually *everything* about marketing. In this new customer-focused, data-driven environment, marketing is mission-critical: Adobe's overall success is partly contingent on marketing's ability to deliver personalized, engaging experiences across all channels.

The need to create such experiences has led us to develop an even deeper understanding of our customers, and to construct advanced platforms for creating, deploying, and measuring dynamic content.

Along the way, we've also pursued opportunities to leverage technology to improve marketing's back office, as well as to evolve our relationships with traditional agencies.



Roughly 95 percent of Adobe's customers visit our website, which translates to more than 650 million unique visits each month. A variety of applications make it possible for us to know who these customers are, what they do during each visit, and—through integration with social channels—whom they are connected with. We have applied personalization and behavioral targeting capabilities, which help us provide more engaging experiences based on individual preferences. We have also layered in predictive and econometric modeling capabilities, opening the door for assessing the ROI of our marketing campaigns. Whereas 10 years ago, marketing may have been perceived as something intangible or unquantifiable, we now have hard evidence of our contribution to the company's success.

Increasingly, companies are using marketing to drive digital strategies. Moreover, the expanding scope of dimensional marketing is driving increased connectivity among various enterprise groups. For example, at Adobe, marketing and IT are collaborating in ways that move the entire company forward. Historically, these two groups were isolated from each other; marketing bought its own technology and software and kept them relatively siloed, apart from the core. Today, marketing's systems integrate into corporate systems. If you want to develop a comprehensive, data-driven view of customers, you need access to customer data in CRM, financial databases, and other systems. And, while marketing has its own group that conducts Web analytics and insights, we rely on IT to provide integration, data platforms, visualization, and security.

It is critical to team with the CIO and the broader IT organization. Luckily, Adobe's IT organization very much wants to support marketing's strategies and efforts, which has helped the relationship between our two groups evolve into one of shared responsibility.

Digital marketing has fundamentally transformed the way we think about marketing's mission and the way we work to fulfill it. It took us a long time to get to where we are today, and the journey was not without challenges. Along the way, we had to retool the organization and reskill our people. But now we've arrived at a good place, and we have instilled a strong sense of confidence and motivation throughout the marketing organization. Though in the past we may have been somewhat of an organizational outlier, today we are proud to have our identity woven throughout the fabric of the Adobe organization.

Cyber implications

DIGITAL has changed the scope, rules, and tools of marketing. At the center are customers and the digital exhaust they leave as they work, shop, and play. This can be valuable information to drive the new dimensions of marketing: connectivity, engagement, and insight. But it also creates security and privacy risks.

“Fair and limited use” is the starting point—for data you’ve collected, for data individuals have chosen to share, for derived data, and for data acquired from third-party partners or services. There are questions of what a company has permission to do with data. Laws differ across geographies and industries, informed by both consumer protection statutes and broader regulatory and compliance laws. Liability is not dependent on being the source of or retaining data; controls need to extend to feeds being scanned for analytics purposes and data/services being invoked to augment transactions. This is especially critical, as creating composites of information may turn what were individually innocuous bits of data into legally binding personally identifiable information (PII).

Privacy concerns may limit the degree of personalization used for offerings and outreach even when within the bounds of the law. Even if the information is publicly available, customers may cry “Big Brother” if it seems that an inappropriate amount of personal information has been gleaned or a threshold level of intimacy has been breached. Derived data can provide insights into individual behavior, preferences, and tendencies, which in the hands of marketers and product managers is invaluable. In the context of cyber security, these insights can also help organizations identify potential risks. Organizations should clearly communicate to customers the policies and boundaries that govern what data is being collected and how it will be used.

Public policies, privacy awareness programs, and end-user license agreements are a good start. But they need to be joined with explicit governance and controls to guide, monitor, and police usage. User, system, and data-level credentials and entitlements can be used to manage trust and appropriate access to raw transactions and data. Security and privacy controls can be embedded within content, integration, and data layers—moving the mechanics into the background so that CMOs and marketing departments inherit leading practices. The CISO and CIO can bake cyber security into the fabric of how new services are delivered, and put some level of policy and controls in place.

Finally, understanding your organization’s threat beacon can help direct limited cyber security resources toward the more likely vectors of attack. Dimensional marketing expands the pool of potentially valuable customer information. Organizations that are pivoting their core business into digital assets and offerings only complicate the matter. Core product IP and the digital supply chain come into play as digital marketing becomes inseparable from ordering, provisioning, fulfillment, billing, and servicing digital goods and services.

Asset and rights management may be new problems marketing has not traditionally had to deal with, but the root issues are related to the implications described above. Organizations should get ready for the radical shift in the digital marketing landscape, or security and privacy concerns may slow or undermine their efforts.

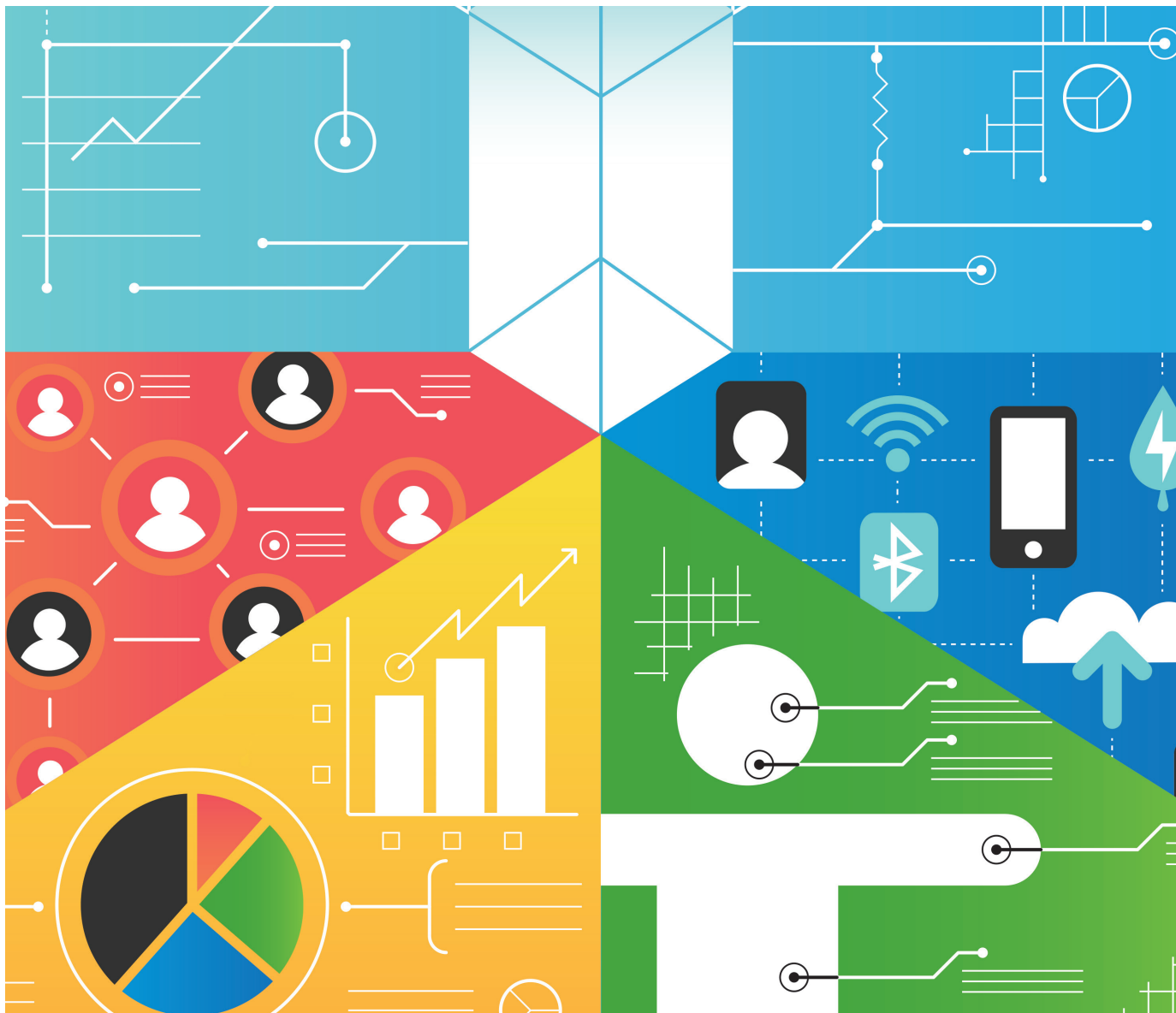
Where do you start?

DIMENSIONAL marketing has the potential to succumb to its own transformational promise. As with any massive undertaking, objectives, priorities, and expected outcomes should be clearly defined. Below are steps that many leading organizations are taking to prepare themselves to operate in this new environment:

- **Customer-led.** Digital agencies can spend too much time focusing on a single approach, or even self-serving tactics such as “storytelling.” If marketing focuses on what your company is saying rather than what customers are asking for, your organization may not be focused on the pillars of dimensional marketing: listening, being personal, and focusing on authentic engagement. Instead, you should anchor your efforts on the end-to-end customer journey by understanding customer needs, actions, and motivations, from awareness through retention, across channels. These insights should carry more weight than the pursuit of particular tactics. It would be better to disregard the notion of customer loyalty to a brand, and embrace the concept of a brand becoming loyal to the customer.
- **Data, data, data.** Capturing, correlating, and capitalizing on customer information is at the heart of dimensional marketing. Depending on their roots, marketing technology vendors tend to emphasize either current customers or the wider pool of prospects. But both are relevant. Early efforts should focus clearly on targets; next should come an analysis of the history, preferences, and context of those audiences. Don't limit yourself to today's marketing signals; determine how ambient computing,¹² wearables,¹³ and other trends may play into your ability to collect and interpret signals. Big data and predictive analytics should play a role in how you invest in specific audiences and targeted priorities.
- **All together now.** Marketing automation should mean much more than email campaign management. It is almost a given that a holistic approach requires Web, mobile, social, broadcast, and direct mail. Social graphs should source not just Facebook, Twitter, LinkedIn, and Instagram, but also specialized blogs and industry- or domain-focused communities. Analytics, digital offerings, and back-office marketing tools (from lead management to search engine optimization to pricing engines) should be geared toward omnichannel and cross-dimensional capabilities.
- **(Contextual) content is king.** As video, mobile, and other digital assets emerge as the building blocks of campaigns and servicing, content management becomes central to dimensional marketing. Many content management systems have a narrow focus on document management or just Web content management. This narrow focus leaves these systems ill-equipped to deal with the impending explosion of content types and deployment needs. Authoring, provisioning, and measuring usage and effectiveness need to be seamless processes. These should be combined with the ability to collaborate with in-house and contracted professionals, as well as with a mix of third-party agencies.

- **Social activation.** Social media topped the list in a recent survey of digital advertisers' spend and priorities.¹⁴ Organizations need to move from passive listening and impersonal social broadcasting to social activation:¹⁵ Social activation entails precise targeting of influencers, development of contextual outreach based on tangible, measurable outcomes, and cultivation of a global social content supply chain that

can create meaningful, authentic social campaigns. In short, social activation should inspire individuals to carry out the organization's missions in their own words, on their own turf, and on their own terms. Companies should build and nurture perceptions, instead of focusing on empty metrics such as volume or unfocused sentiment.





Bottom line

GARTNER'S 2014 CEO survey found that "CEOs rank digital marketing as the No. 1 most important tech-enabled capability for investment over the next five years."¹⁶ And with marketing's expanded scope likely including the integration of marketing systems with CRM and ERP systems in areas such as pricing, inventory, order management, and product R&D, IT's mission, if they choose to accept it, is to help drive the vision, prioritization, and realization of dimensional marketing. IT can potentially use its mission as a Trojan horse to reinvent delivery models, technology platforms, and IT's reputation across the business. Who better than the CMO to help change the brand perception of the CIO? And who else but the CIO can help deliver analytics, mobile, social, and Web while maintaining the enterprise "ilities"—security, reliability, scalability, maintainability, and interoperability? The stage is set. It is time for the next wave of leaders to deliver.

Authors



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Brinker's deep insights and experience enable him to understand the particular needs of a client's business, develop practical business solutions, and bring change that can produce results. In his 20-plus years at Deloitte, he has delivered solutions to clients in a variety of industries and applications, which has given him a balanced perspective across the complex technology landscape. He has served dozens of clients in the retail, hospitality, technology and media sectors.



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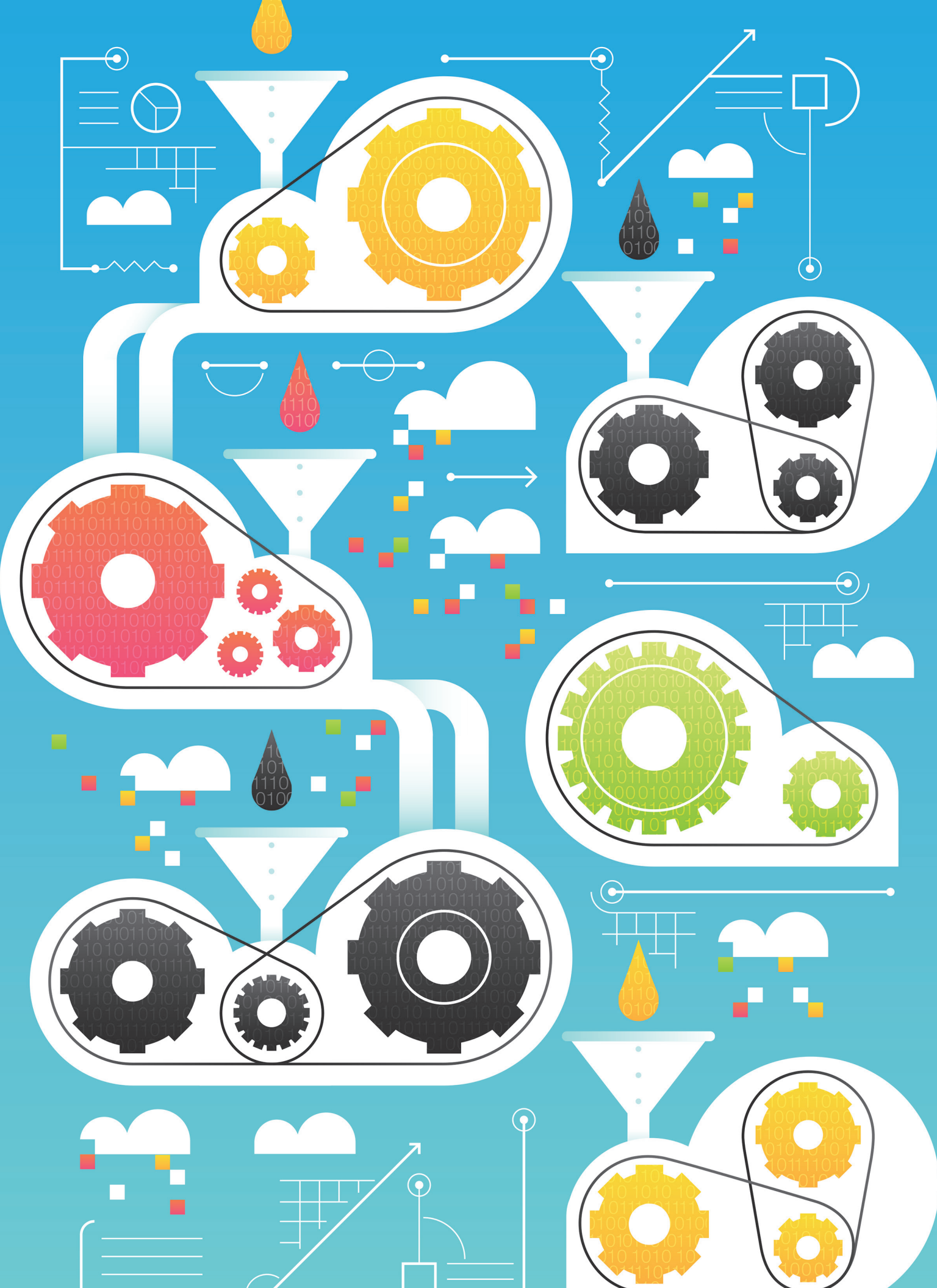


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Software-defined everything

Breaking virtualization's final frontier

Amid the fervor surrounding digital, analytics, and cloud, it is easy to overlook advances currently being made in infrastructure and operations. The entire operating environment—server, storage, and network—can now be virtualized and automated. The data center of the future represents the potential for not only lowering costs, but also dramatically improving speeds and reducing the complexity of provisioning, deploying, and maintaining technology footprints. Software-defined everything can elevate infrastructure investments, from costly plumbing to competitive differentiators.

VIRTUALIZATION has been an important background trend, enabling many emerging technologies over the past decade. In fact, we highlighted it in our very first *Technology Trends* report six years ago.¹ While the overall category is mature, many adoptions focused primarily on the compute layer. Servers have been abstracted from dedicated physical environments to virtual machines, allowing automated provisioning, load balancing, and management processes. Hypervisors—the software, firmware, or hardware that control virtual resources—have advanced to a point where they can individually manage a wide range of virtual components and coordinate among themselves to create breakthroughs in performance and scalability.

Meanwhile, other critical data center components have not advanced. Network and storage assets have remained relatively static,

becoming bottlenecks limiting the potential of infrastructure automation and dynamic scale.

Enter software-defined everything. Technology advances now allow virtualization of the entire technology stack—compute, network, storage, and security layers. The potential? Beyond cost savings and improved productivity, software-defined everything can create a foundation for building agility into the way companies deliver IT services.

Network building blocks

Software-defined networking (SDN) is one of the most important building blocks of software-defined everything. Like the move from physical to virtual machines for compute, SDN adds a level of abstraction to the hardware-defined interconnections of routers, switches, firewalls, and security gear. Though communication gear still exists to

drive the physical movement of bits, software drives the data plane (the path along which bits move) and, more importantly, the control plane, which routes traffic and manages the required network configuration to optimize the path. The physical connectivity layer becomes programmable, allowing network managers—or, if appropriate, even applications—to provision, deploy, and tune network resources dynamically, based on system needs.

SDN also helps manage changing connectivity needs for an increasingly complex collection of applications and end-user devices. Traditional network design is optimized for fixed patterns, often in a hierarchical scheme that assumes predictable volume between well-defined end points operating on finite bandwidth. That was acceptable in the early days of distributed computing and the Web. Today, however, many organizations must support real-time integration across multiple servers, services, clouds, and data stores, enable mobile devices initiating requests from anywhere in the world, and process huge and expanding volumes of internal and external data, which can cause traffic spikes. SDN helps manage that complexity by using micro-segmenting, workload monitoring, programmable forwarding, and automated switch configuration for dynamic optimization and scaling.

Software-defined everything

The network is not the only thing being reimaged. Software-defined storage (SDS) represents logical storage arrays that can be dynamically defined, provisioned, managed, optimized, and shared. Coupled with compute and network virtualization, entire operating environments can be abstracted and automated. The software-defined data center (SDDC) is also becoming a reality. A Forrester report estimates that “static virtual servers, private clouds, and hosted private clouds will

together support 58 percent of all workloads in 2017, more than double the number installed directly on physical servers.”²² This is where companies should focus their software-defined everything efforts.

Yet, as you determine scope, it is important to recognize that SDDC cannot and should not be extended to all IT assets. Applications may have deep dependencies on legacy hardware. Likewise, platforms may have hooks into third-party services that will complicate migrations, or complexities across the stack may turn remediation efforts into value eroders. Be deliberate about what is and is not in scope. Try to link underlying infrastructure activities to a broader strategy on application and delivery model modernization.

Show me the value

A recent Computer Economics study found that data center operations and infrastructure consume 18 percent of IT spending, on average.³ Lowering total cost of ownership by reducing hardware and redeploying supporting labor is the primary goal for many SDDC efforts. Savings come from the retirement of gear (servers, racks, disk and tape, routers and switches), the shrinking of data center footprints (lowering power consumption, cooling, and, potentially, facility costs), and the subsequent lowering of ongoing recurring maintenance costs.

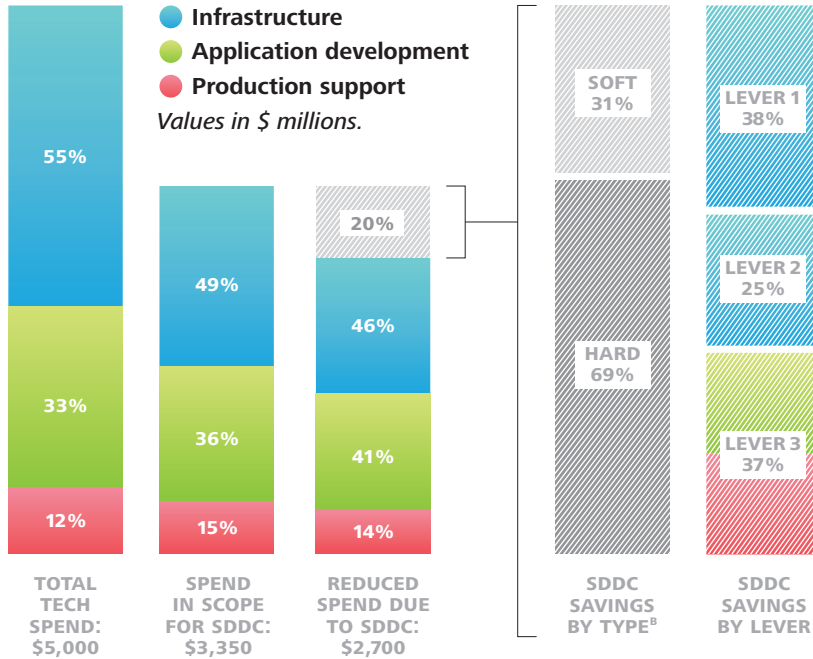
Moving beyond pure operational concerns and cost outlays can deliver additional benefits. The new solution stack should become the strategic backbone for new initiatives around cloud, digital, and analytics. Even without systemic changes to the way systems are built and run, projects should see gains through faster environment readiness, the ability to engineer advanced scalability, and the elimination of power/connectivity constraints that may have traditionally lowered team ambitions. Leading IT departments are

Software-defined savings^a

A Deloitte analysis of normalized data from software-defined data center (SDDC) business cases for *Fortune* 50 clients revealed that moving eligible systems to an SDDC can reduce spending on those systems by approximately 20 percent. These savings can be realized with current technology offerings and may increase over time as new products emerge and tools mature. Not every system is suited for migration; ideal candidates are those without tight integration to legacy infrastructure or bespoke platforms.

Company profile

REVENUE	\$25+ billion
TECHNOLOGY SPEND	\$5+ billion
EMPLOYEES	150,000+



LEVER 1: OPTIMIZE INFRASTRUCTURE

Taking advantage of economies of scale, better aligning demand and supply to reduce underutilized assets, and simplifying the environment by moving to standard platforms.

LEVER 2: ORCHESTRATE INFRASTRUCTURE LABOR

Automating labor tasks through automation and orchestration to reduce manual work, hand-offs, errors, and process bottlenecks.

LEVER 3: AUTOMATE OPERATIONS

Automating development operations, particularly production support-type activities, to increase productivity and reduce support costs.

Source: ^a Deloitte Consulting LLP proprietary research.

^b Hard savings are those that result in direct bottom-line savings, and soft savings are those that result in improved productivity and efficiency and the redirection or redeployment of labor and resources.

reimagining themselves by adopting agile methodologies to fuel experimentation and prototyping, creating disciplines around architecture and design, and embracing DevOps.⁴ These efforts, when paired with platform-as-a-service solutions, provide a strong foundation for reusing shared services and resources. They can also help make the overall operating environment more responsive and dynamic, which is critical as organizations launch digital and other innovative plays and pursue opportunities related to the API economy, dimensional

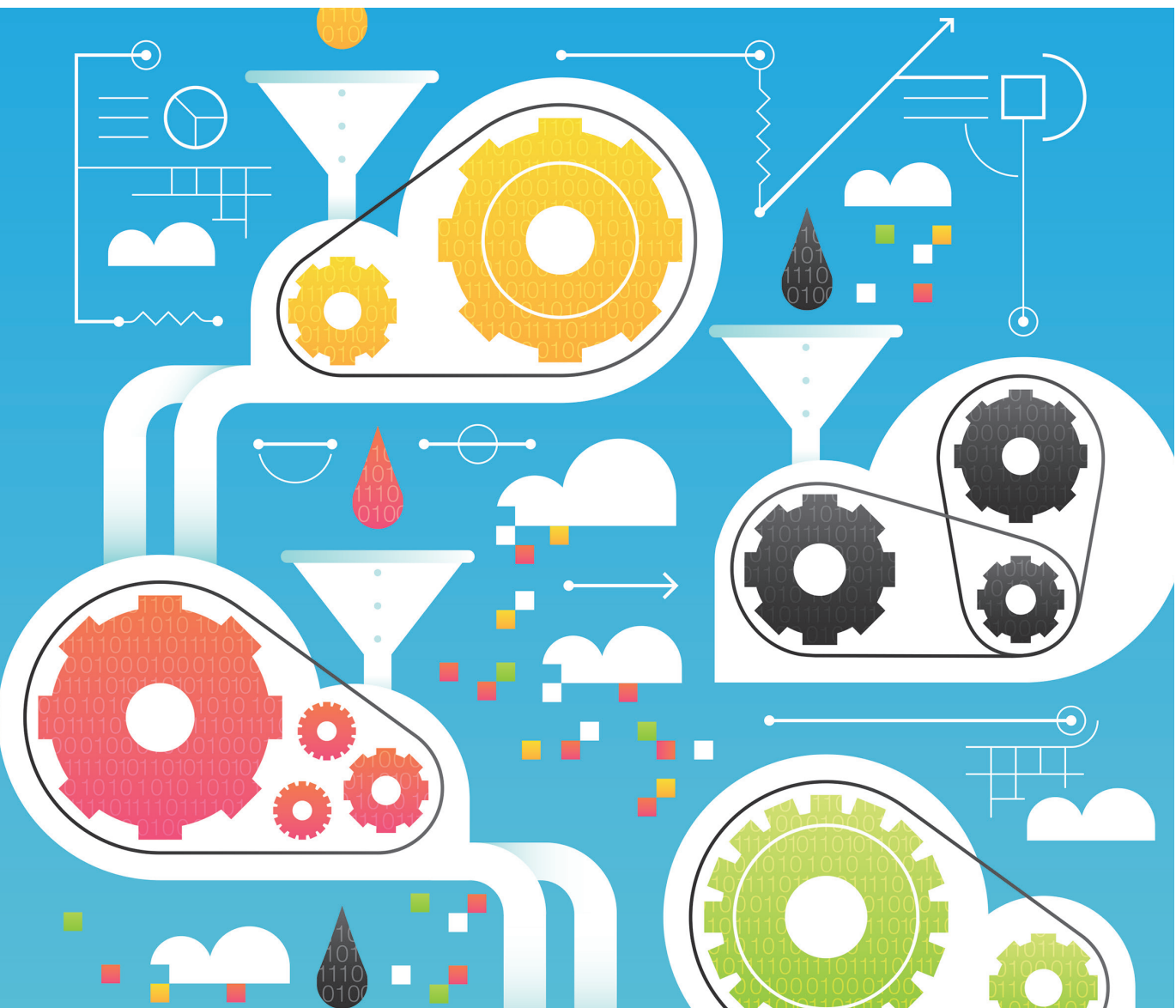
marketing, ambient computing, and the other trends featured in this report.

From IT to profit

Business executives should not dismiss software-defined everything as a tactical technical concern. Infrastructure is the supply chain and logistics network of IT. It can be a costly, complex, bottleneck—or, if done well, a strategic weapon. SDDC offers ways to remove recurring costs. Organizations should consider modernizing their data centers and

operating footprints, if for no other reason than to optimize their total cost of ownership. They should also pursue opportunities to build a foundation for tomorrow's business by reimagining how technology is developed and maintained and by providing the tools for disruptive digital, cloud, analytics, and other offerings. It's not just about the cloud; it's about removing constraints and becoming

a platform for growth. Initially, first movers will likely benefit from greater efficiencies. Yet, soon thereafter, they should be able to use their virtualized, elastic tools to reshape the ways their companies work (within IT, and more importantly, in the field), engage customers, and perhaps even design core products and offerings.



Lessons from the front lines

Driving tomorrow

Cisco Systems Inc. is currently developing a suite of products dubbed Application Centric Infrastructure (ACI), featuring tight integration between the physical and virtual elements. The goal is to move software-defined everything beyond hardware and infrastructure into applications and business operations. What's more, rather than only abstracting and automating network components, ACI provides hooks into compute and storage components, tools, service level agreements, and related services like load balancing, firewalls, and security policies. According to Ishmael Limkakeng, Cisco's vice president of sales, "ACI will enable cost efficiency, flexibility, and the rapid development and implementation of business apps that drive the bottom line."

As an alpha customer for its own technology, Cisco is currently in the midst of a three-year internal ACI roll-out. To date, IT teams have constructed ACI infrastructure in a number of data centers and have begun a multi-year journey of migrating the company's portfolio of 4,067 production applications.⁵ In deploying ACI internally, Cisco CIO Rebecca Jacoby is looking to achieve productivity gains by simplifying the provisioning, management, and movement of resources. At the heart of this strategy lies an innovative policy model in which approaches for configuring, using, reusing, and deploying the company's network become standardized.

Cisco's ACI deployment teams are working toward reducing overall IT operating expenses by 41 percent. This goal includes 58 percent cost savings in network provisioning and 21 percent cost savings in network operations and management. Moreover, they expect a fourfold increase in bandwidth, which, in turn,

could lead to a 25 percent savings in capital expenditures, a 45 percent reduction in power usage, and a physical footprint 19 percent smaller than it was before ACI deployment.

Finally, Cisco aims to improve the flexibility of the use of those resources—expanding from just productivity in IT, to productivity for the business. Cisco has already seen performance gains via its CITEIS private cloud—an implementation of the VCE Vblock architecture stack. And the ACI business case includes a potential 12 percent optimization of compute resources and a 20 percent improvement in storage capacity.⁶

Divvying up expertise with a PaaS⁷

AmerisourceBergen's IntrinsicQ unit is a leading provider of oncology-focused software. IntrinsicQ's applications automate nearly every element of oncology—from treatment options to drug prescriptions—and the software is onsite at more than 700 clinics across the United States and Canada. These installations are important for the company's physician clients, but installing and maintaining software across hundreds of locations comes with significant overhead.

To ease the overhead burden, IntrinsicQ opted to deploy a single-instance, multi-tenant application to reduce software development and long-term maintenance costs. The 80-person company, however, had no experience in multi-tenancy or in developing the underlying layers of a cloud-based application. Moreover, in moving to the cloud, IntrinsicQ had to demonstrate to its customers that the security of patient data would continue to be compliant with strict industry regulations.



To reduce costs, bolster innovation, and accelerate time to market, IntrinsicQ partnered with PaaS provider Apprenda. Apprenda's platform provided back-end functions including multi-tenancy, provisioning, deployment, and, perhaps most importantly, security. IntrinsicQ continued to focus on developing oncology applications, as well as incorporating the new private cloud offering into its IT delivery and support models.

The division of duties achieved the needed results. The company's oncology software specialists were able to work at high productivity levels by focusing on the application functionality and leveraging the PaaS software's out-of-the-box management tools. IntrinsicQ was able to collapse its development schedule and reduce its costs: The new customer-facing, cloud-based application hit the market 18 months earlier than planned. Additionally, the cloud-based solution has made IntrinsicQ more affordable for smaller oncology clinics—expanding the company's potential market.

The backbone of global connected commerce

Each day, eBay Inc. enables millions of commerce and payments transactions. eBay Marketplaces connects more than 155 million users around the world who, in 2014 alone, transacted \$83 billion in gross merchandise volume. And PayPal's 162 million users transacted more than \$228 billion in total payment volume just last year.⁸ For eBay Inc., scale is not optional: It is the foundation of all its operations and a critical component of the company's future plans.

Over the last decade, eBay Inc.'s platform and infrastructure group recognized that as the company grew, its infrastructure needs were also growing. The company's IT footprint now included hundreds of thousands of assets across multiple data centers. Product

development teams wanted to get from idea to release in days, but environments often took months to procure and “rack and stack” via traditional methods. Moreover, the scope of eBay Inc.'s business had grown far beyond online auctions to include offline commerce, payment solutions, and mobile commerce—all domains in which reliability and performance are essential.

The company decided to make infrastructure a competitive differentiator by investing in an SDDC to drive agility for innovation and efficiency throughout its operations while simultaneously creating a foundation for future growth. The company kicked off its SDDC efforts by tackling agility through the construction of a private cloud.

The first step to this process was one of standardization. Standardizing network design, hardware SKUs, and procedures helped create homogeneity in infrastructure that helped set the foundation for automation and efficiency.

Historically, the company had procured servers, storage, and network equipment on demand when each team or project requested infrastructure. Cloud solutions, on the other hand, made it possible to decouple the acquisition of compute, storage, and network resources from the provisioning cycles. This allowed for better partnership with the vendor ecosystem through disciplined supply-chain practices, and enabled on-demand provisioning for teams and projects that required infrastructure. Today, engineers are able to provision a virtual host in less than a minute and register, provision, and deploy an application in less than 10 minutes via an easy-to-use portal.

The infrastructure team took an end-to-end approach to automation, all the way from hardware arriving at the data center dock to a developer deploying an application on a cluster of virtual machines. Automation of on-boarding, bootstrapping, infrastructure lifecycle, imaging, resource allocation,

repair, metering, and chargeback were core to building on-demand infrastructure with economic efficiency.

Compute on demand was only the beginning of eBay Inc.'s SDDC strategy. Next, the company tackled higher-order functions like load balancing, object storage, databases-as-a-service, configuration management, and application management. By creating a portfolio of internal cloud computing services, the company was able to add software-defined capabilities and automate bigger pieces of its software development infrastructure. The infrastructure team now provides product teams with the software-enabled tools they need to work more like artists and less like mechanics.

Beyond creating agility, the software-defined initiative has also helped drive enforceable standards. From hardware engineering to OS images to control plane configuration, standardization has become an essential part of eBay Inc.'s strategy to scale. The development culture has shifted away from one in which people ask for special kinds of infrastructure. Now, they are learning how to build products for standard infrastructure that comes bundled with all the tools needed to provision, develop, deploy, and monitor applications, though all stages of development. IT still receives (and supports) occasional special requests, but the use of container technologies helps it manage these outliers. These technologies provide engineers with a “developer class of service” where they are able to innovate freely as they would in a start-up—but within components that will easily fit into the broader environment. Moreover, knowing beforehand which commodity will be provided has helped both development and operations become more efficient.

eBay Inc. is working to bring software-defined automation to every aspect of its infrastructure and operations. In the

company's network operating centers (NOCs), for example, advanced analytics are now applied to the 2,000,000 metrics gathered every second from infrastructure, telemetry, and application platforms. Traditionally, the company's “mission control” was surrounded by 157 charts displayed on half a dozen large screens that provided real-time visibility into that carefully curated subset of metrics and indicators engineers deemed most critical to system stability. These same seven screens can now cover more than 5,000 potential scenarios by only displaying those signals that deviate from the norm, thus making the detection of potential issues much easier than before. And, with software-defined options to segment, provision, and deploy new instances, engineers can take action in less time than it would have previously taken them to determine which of the screens to look at. Through its SDDC initiative, the company is now able to direct its energy toward prevention rather than reaction, making it possible for developers to focus on eBay Inc.'s core disciplines rather than on operational plumbing.

Next-generation infrastructure

Since joining Little Rock-based Acxiom, a global enterprise data, analytics, and SaaS company, in 2013, Dennis Self, senior vice president and CIO, has made it his mission to lead the organization into the new world of software-defined everything. “Historically, we've propagated physical, dedicated infrastructure to support the marketing databases we provide customers,” he says. “With next-gen technologies, there are opportunities to improve our time to deliver, increase utilization levels, and reduce the overall investment required for implementation and operational activities.”

In early 2014, Self's team began working to virtualize that infrastructure—including the network and compute environments. The



My take

Greg Lavender,
Managing director, Cloud Architecture and Infrastructure Engineering,
Office of the CTO
Citi

At Citi, the IT services we provide to our customers are built on top of thousands of physical and virtual systems deployed globally. Citi infrastructure supports a highly regulated, highly secure, highly demanding transactional workload. Because of these demands, performance, scale, and reliability—delivered as efficiently as possible—are essential to our global business operations. The business organizations also task IT with supporting innovation by providing the IT vision, engineering, and operations for new services, solutions, and offerings. Our investments in software-defined data centers are helping on both fronts.

With 21 global data centers and system architectures ranging from scale-up mainframes and storage frames to scale-out commodity servers and storage, dealing effectively with large-scale IT complexity is mission-critical to our business partners. We became early adopters of server virtualization by introducing automation to provisioning several years ago, and we manage thousands of virtual machines across our data centers. The next step was to virtualize the network, which we accomplished by moving to a new two-tier spine-and-leaf IP network fabric similar to what public cloud providers have deployed. That new physical network architecture has enabled our software-defined virtual networking overlays and our next generation software-defined commodity storage fabrics. We still maintain a large traditional fiber channel storage environment, but many new services are being deployed on the new architecture, such as big data, NoSQL and NewSQL data services, grid computing, virtual desktop infrastructure, and our private cloud services.

Currently, we are engaged in three key objectives to create a secure global private cloud. The first objective focuses on achieving “cloud scale” services. As we move beyond IT as separate compute, network, and storage silos to a scale-out cloud service model, we are building capabilities for end-to-end systems scaled horizontally and elastically within our data centers—and potentially in the not-too-distant future, hybrid cloud services. The second objective is about achieving cloud speed of delivery by accelerating environment provisioning, speeding up the deployment of updates and new capabilities, and delivering productivity gains

to applications teams through streamlined, highly automated release and lifecycle management processes. The results so far are measurable in terms of both client satisfaction and simplifying maintenance and operations scope. The final objective is to achieve ongoing cloud economics with respect to the cost of IT services to our businesses. More aggressive standardization, re-architecting, and re-platforming to lower-cost infrastructure and services is helping reduce technical debt, and will also help lower IT labor costs. At the same time, the consumption of IT services is increasing year over year, so keeping costs under control by adopting more agile services allows our businesses to grow while keeping IT costs manageable. Our new CitiCloud platform-as-a-service capabilities—which feature new technologies such as NoSQL/NewSQL and big data solutions along with other rapid delivery technology stacks—help accelerate delivery and time to market advantages. Packaging higher-level components and providing them to application teams accelerates the adoption of new technologies as well. Moreover, because the new technology components have strict compliance, security, and DevOps standards to meet, offering more tech stacks as part of platform-as-a-service provides stronger reliability and security guarantees.

By introducing commodity infrastructure underneath our software-defined architectures, we have been able to incrementally reduce unit costs without compromising reliability, availability, and scale. Resiliency standards continue to be met through tighter controls and automation, and our responsiveness—measured by how quickly we realize new opportunities and deliver new capabilities to the business—is increasing.

Focusing IT on these three objectives—cloud scale, cloud speed, and cloud economics—has enabled Citi to meet our biggest challenge thus far: fostering organizational behavior and cultural changes that go along with advances in technology. We are confident that our software-defined data center infrastructure investments will continue to be a key market differentiator—for IT, our businesses, our employees, our institutional business clients, and our consumer banking customers.

Cyber implications

RISK should be a foundational consideration as servers, storage, networks, and data centers are replatformed. The new infrastructure stack is becoming software-defined, deeply integrated across components, and potentially provisioned through the cloud. Traditional security controls, preventive measures, and compliance initiatives have been challenged from the outset because the technology stack they sit on top of was inherently designed as an open, insecure platform. To have an effective software-defined technology stack, key concepts around things like access, logging and monitoring, encryption, and asset management need to be reassessed, and, if necessary, enhanced if they are to be relevant. 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. Though software-defined infrastructure introduces risks, it also creates opportunity to address some of the more mundane but significant challenges in day-to-day security operations.

Security components that integrate into the software-defined stack may be different from what you own today—especially considering federated ownership, access, and oversight of pieces of the highly integrated stack. Existing tools may need to be updated or new tools procured that are built specifically for highly virtual or cloud-based assets. Governance and policy controls will likely need to be modernized. Trust zones should be considered: envelopes that can manage groups of virtual components for policy definition and updates across virtual blocks, virtual machines, and hypervisors. Changes outside of controls can be automatically denied and the extended stack can be continuously monitored for incident detection and policy enforcement.

Just as importantly, revamped cyber security components should be designed to be consistent with the broader adoption of real-time DevOps. Moves to 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. Governance, policy engines, and control points should be designed accordingly—preferably baked into new delivery models at the point of inception. Security and controls considerations can be built into automated approaches to building management, configuration management, asset awareness, deployment, and system automation—allowing risk management to become muscle memory. Requirements and testing automation can also include security and privacy coverage, creating a core discipline aligned with cyber security strategies.

Similarly, standard policies, security elements, and control points can be embedded into new environment templates as they are defined. Leading organizations co-opt infrastructure modernization with a push for highly standardized physical and logical configurations. Standards that are clearly defined, consistently rolled out, and tightly enforced can be a boon for cyber security. Vulnerabilities abound in unpatched, noncompliant operating systems, applications, and services. Eliminating variances and proactively securing newly defined templates can reduce potential threats and provide a more accurate view of your risk profile.

Where do you start?

THE potential scope of a software-defined everything initiative can be daunting—every data center, server, network device, and desktop could be affected. What's more, the potential risk is high, given that the entire business depends on the backbone being overhauled. To round matters out, an initiative may deliver real long-term business benefits, yet only have vague immediate impacts on line-of-business bottom lines (depending on IT cost models and charge-back policies). Given the magnitude of such an effort and its associated cost, is it worth campaigning for prioritization and budget? If so, where would you start? The following are some considerations based on the experiences of early adopters:

- **Creative financing.** When working within traditional budgeting channels, many organizations source efforts around SDDC as net-new, one-off investments. With this approach, allocations do not affect operating unit budgets or individual line-of-business. Increasingly, organizations are looking at more creative ways to financially engineer their SDDC/SDI investments. For example, some vendors are willing to cover the up-front costs, achieving ROI from the savings realized over time. Others pursue more long-term returns by looking for ways to monetize pieces of the platform build-out.
 - **Patterns.** Software-defined everything's flexibility makes it possible for each development team to potentially configure its own stack of virtual components tailored to its individual needs and circumstances, which can undermine efficiency gains. For this reason, companies should make standardization a design mandate from day one and utilize template-based patterns.
- Setting a cadence of commonality from the beginning will help ease maintenance complexity, allow for better terms in supplier negotiations for underlying components (assuming the templates are geared towards non-differentiated services), and support the creation of standard policies around security, controls, and monitoring that can be automatically deployed and enforced.
- **Meeting in the middle.** Drive the build-out of SDDC from the infrastructure organization, with suitably aggressive goals. In the meantime, engage with application teams to jointly determine how best to architect for new platforms and infrastructure services. New standards, patterns, and approaches will be required; by accelerating awareness, new applications can be compliant as soon as the environments are ready.
 - **Not as easy as “lift and shift.”** Architecture and development matter. Beyond the complexity of standing up and migrating the operating environment, the assets that run across the network, storage, and servers will likely require remediation. Direct references to network addresses, data structures, or server components should be redirected to the backplane. Virtualization management tools cannot dynamically scale or failover applications that single thread, block, or use primitive resource control constructs. Existing assets should be analyzed application by application and workload by workload to determine the technical considerations needed to support migration. The business needs should then be layered on—both the potential benefits from the new environment, and the long-term viability of the solution.

- **Commoditization and open stacks.** Intelligent controls and management capabilities in the software layer can also enable organizations to transition from large, expensive, feature-rich hardware components to low-end, standardized servers deployed in massively parallel configurations. Independent nodes at risk of failing can be automatically detected, decommissioned, and replaced by another instance from the pool of available resources. This ability has led to an explosive growth in the number of relatively new players in the server market—such as Quanta, which sold one out of every seven servers in 2013—as well as products from traditional large hardware manufacturers tailored to the low-end market. Various standards and implementation patterns have emerged in support of the movement, including the Open Compute Project, OpenStack, Open Rack, and Open Flow.
- **Beyond the data center.** Companies may realize numerous benefits by coupling SDDC initiatives with a broader transformation of the IT department. DevOps is a good place to start: By introducing automation and integration across environment management, and enhancing requirements management, continuous build, configuration, and release management approaches, among other tasks, development and operations teams can meet business needs more consistently and drive toward rapid ideation and deployment. Software-defined everything doesn't entirely hinge on a robust DevOps function. But together, they form a powerful bedrock for reimagining the “business of IT.”

Bottom line

In mature IT organizations, moving eligible systems to an SDDC can reduce spending on those systems by approximately 20 percent, which frees up budget needed to pursue higher-order endeavors.⁹ These demonstrated returns can help spur the initial investment required to fulfill virtualization's potential by jump-starting shifts from physical to logical assets and lowering total cost of ownership. With operational costs diminishing and efficiencies increasing, companies will be able to create more scalable, responsive IT organizations that can launch innovative new endeavors quickly and remove performance barriers from existing business approaches. In doing so, they can fundamentally reshape the underlying backbone of IT and business.

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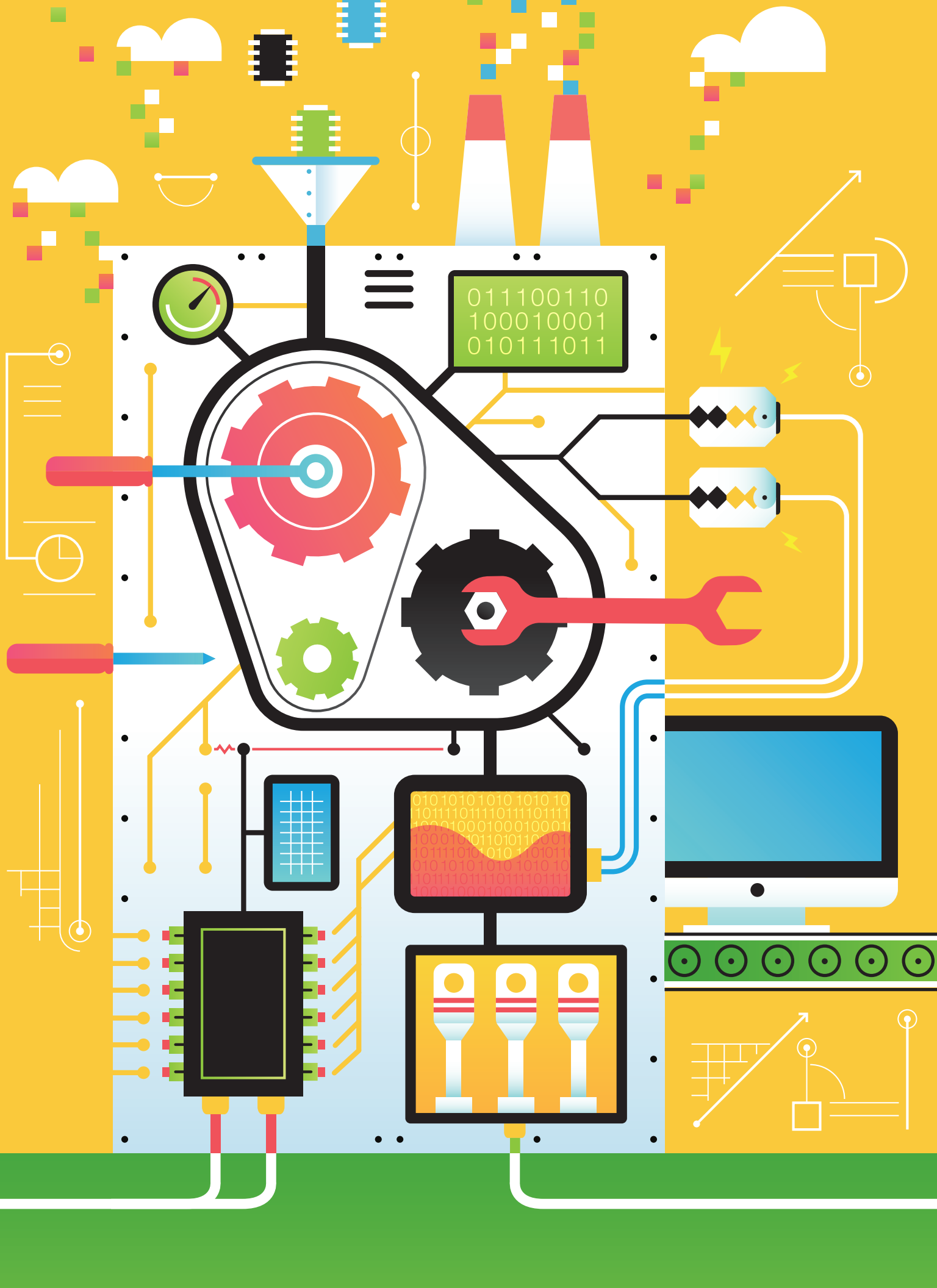


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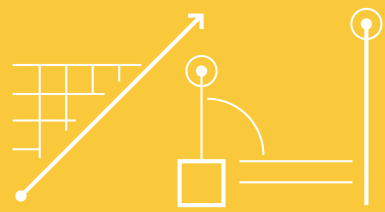
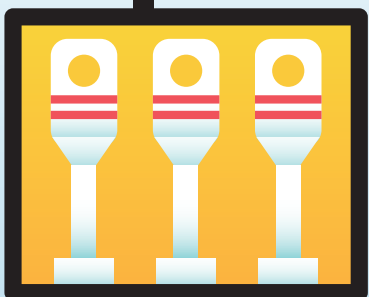
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Core renaissance

Revitalizing the heart of IT

Organizations have significant investments in their core systems, both built and bought. Beyond running the heart of the business, these assets can form the foundation for growth and new service development—building upon standardized data and automated business processes. To this end, many organizations are modernizing systems to pay down technical debt, replatforming solutions to remove barriers to scale and performance, and extending their legacy infrastructures to fuel innovative new services and offerings.

INVESTING in technologies that support the heart of the business has been IT's emphasis since its earliest days—policy administration, claims management, and billing in insurance; order management, resource planning, and manufacturing for consumer and industrial products; inventory management, pricing, and distribution for retail; and universal needs such as finance and human resources. Core systems drive process and data automation, standardization, and intelligence—and represent decades of investment in buying packages, building custom solutions, and integrating an increasingly hybrid environment.

It's not surprising that on average, 80 percent of time, energy, and budgets are consumed by the care and feeding of the existing IT stack.¹ Within the core, unwanted technical debt² and complexity likely exist, with systems at various stages of health, maturity, and architectural sophistication. But the core can also be a strategic foundation that enables experimentation and growth.

Leading organizations are building a roadmap for a renaissance of their core—focused not on painting their legacy as the “dark ages,” but on revitalizing the heart of their IT and business footprint.

Business first

Amid continuously evolving business pressures and technology trends, several questions arise: How will the core hold up? (Consider, first, the business angle.) How well do existing solutions meet today's needs? (Consider not just functional completeness, but increasingly relevant dimensions like usability, analytics insights, and flexibility to respond to changing business dynamics.) Does the core IT stack help or hinder the achievement of day-to-day goals across users, departments, processes, and workloads?

Of course, underlying technical concerns are also important. But their impact should be quantified in business terms. Translate the abstract specter of technical debt into business risks. Technical scalability can be measured in

terms of limitations on growth—thresholds on the number of customers, orders, or payments that can be transacted. Reliability concerns translate into lost revenue or penalties for missing service level agreements due to outages or service disruptions. A lack of integration or data management discipline can not only delay the backlog of projects aimed at improving existing services, but also result in opportunity costs by constraining efforts to build upon the core for new mobile, analytics, social, or cloud initiatives.

Most IT leaders understand the looming importance of addressing issues in the core. In a Forrester survey of software decision makers, 74 percent listed updating/modernizing key legacy applications as critical or high priority.³ But the challenge is shifting from acknowledging a potential issue to making an actionable recommendation with a supporting business case and roadmap.

More broadly, consider the organization’s evolving business strategy, be it organic growth, new product innovation, mergers and acquisitions, or efficiency plays. What role does the core play in seeing that strategy unfold? Also consider how to revitalize and extend current investments by using existing assets as foundational elements in the future.

One size does not fit all

Core renaissance efforts are born from this combined view of business imperatives and technical realities—balancing business priorities and opportunities with implementation complexity. Approaches will vary from wholesale transformational efforts to incremental improvements tacked on to traditional budgets and projects. But regardless of how systematic or tactical they are, core renaissance responses typically include a combination of the following five approaches:

Approaches to core renaissance



Replatform

- ▶ **MODERNIZE** the technology footprint of infrastructure to improve performance and ability to scale.
- ▶ **CONSOLIDATE** instances and environments.
- ▶ **UPGRADE** to current releases of applications and underlying technologies (libraries, (platforms, databases).

Remediate

- ▶ **ENCAPSULATE** data, interfaces, and business logic into reusable, extendable services.
- ▶ **REPAIR** technical debt by addressing development issues and architectural concerns.
- ▶ **CLEANSE** data quality issues, security, and compliance risks.

Revitalize

- ▶ **RESHAPE** the business’s transactional layer with digital extensions (Web, mobile, social) and user-centric process redesign.
- ▶ **IMPLEMENT** visualization and discovery tools to improve reporting and analytics on top of underlying systems.
- ▶ **INNOVATE** new ideas, products, and offerings, using core foundation.

Replace

- ▶ **MIGRATE** fulfillment of some functional areas to custom, best-of-breed apps or cloud services.
- ▶ **REDEFINE** business processes and “core” in the solution footprint, removing unnecessary dependencies.
- ▶ **RETIRE** superfluous or aging pieces of the technology landscape.

- **Replatform:** Replatforming efforts typically center on upgrading the core application or implementing new solutions on the underlying platform upon which the application runs. For ERP, replatforming could involve technical upgrades, migration to latest software releases, or instance consolidation. For any software solution, it might also include moving to modern operating environments (server, storage, or network), adoption of in-memory databases, or shifting to cloud infrastructure or platform services. While it may appear less invasive than other approaches, replatforming is rarely a simple “lift and shift” exercise. It typically requires a workload-by-workload analysis and surgical intervention to prepare for and achieve the shift.
- **Remediate:** Similar to replatforming, remediation shifts attention to the internal workings of systems. For custom solutions, this could involve rewriting chunks of code to reverse technical debt. For ERP, it might include unwinding customizations for capabilities now handled by out-of-the-box software, or updating modules to better manage master data by pointing to a common system of record instead of having everyone maintain a separate version of customer, product, or supplier data. For all software, it might involve rewriting or wrapping interfaces to promote reuse, making the necessary logical and architectural changes to allow core data and transactions to be exposed via mobile, social, or cloud apps.
- **Revitalize:** In some cases, the internal business logic and transactional capabilities are rock solid, but the usability of the systems causes pain points—for instance, because of poor user experience design, long response times, or a lack of mobile versions to support business when and where it actually occurs. Both analytical and transactional solutions can benefit from revitalization. Approaches start with a user-centric, persona-based focus—understanding customer, employee, and partner needs by observing them in the field. Existing processes, reports, or screens shouldn’t constrain new solutions. Instead, they should be built around how individuals actually should and could do their job, empowered by technology. Well-designed front-end solutions allow existing back-end services to be hooked into them without much effort; in many cases, however, some degree of remediation will be required to support revitalization goals.
- **Replace:** Sometimes, the right answer is to recast the solution landscape by replacing parts of the portfolio with new solutions. In industries like insurance and public sector, large-scale custom solutions were often necessary decades ago because of a lack of commercially viable packaged solutions. New entrants and offerings have closed many of these gaps, giving institutions a chance to revisit “build” versus “buy” decisions. Similarly, cloud offerings can be attractive to companies looking for improved agility and the potential to reallocate capital expenditure to operating costs. Importantly, IT needs to be a part of these discussions; otherwise, lines of business may make their own isolated investments.
- **Retrench:** Retrenchment, simply put, means doing nothing. This is likely a part of any core renaissance journey, especially for non-differentiating parts of the business and IT footprint. Being passive can be strategic, especially if not taking action is a deliberate decision made after careful analysis. This is not the same as ignoring an issue; it is weighing the risks, communicating the recommendation (and potential repercussions) to key stakeholders, and then deciding to focus on other priorities.



Beyond technology

For any of the techniques described above, the technology implications are only part of the renaissance of the core. Business processes need to evolve in line with modernized solution stacks, potentially requiring new talent with new skills as well as the development of existing staff. Likewise, IT organization structures and delivery models may need to change to put in place mechanisms to support new technologies and maintain commitments to modernized solutions. Every new system or bit of code can either be on-strategy or create the next generation of technical debt. IT should invoke a mantra of institutionally “doing no

harm” while also raising its game to help drive innovation and growth. Adoption of DevOps,⁴ agile, and industrialized approaches to fostering innovation can help. But just as essential is the alignment to broader business objectives—for even nuts-and-bolts technology investments to have some grounding in business priorities and outcomes. CIOs operating as chief integration officers⁵ should have that grounding. They can use core renaissance as a platform to manage the IT portfolio with eyes wide open, revitalizing and extending their existing assets to not just better meet the needs of today, but lay the groundwork for tomorrow’s breakthrough ideas.

Lessons from the front lines

Delivering the future

Sysco, a leading food marketing and distribution company, delivers more than a billion cases of food, equipment, and supplies each year to restaurants, hospitals, schools, and other customers. Like many businesses today, Sysco aims to execute its mission of providing fast, consistent, and reliable deliveries while simultaneously pursuing new growth opportunities made possible by emerging technologies.

“Building upon the company’s existing IT foundation in ways that support growth while maintaining critical services requires planning and balance,” says Wayne Shurts, Sysco’s chief technology officer. Shurts describes Sysco’s approach to core revitalization as resembling a triangle, with core systems forming the base. Sysco has dozens of systems that support everything from warehouse operations and delivery truck logistics to ERP and CRM. The company’s IT organization focuses on maintaining the reliability of core operations by minimizing the technical debt within these core systems through regular upgrades and routine “care and feeding.” Reliability and performance are IT’s mantra, given Sysco’s mission-critical, high-velocity operations. Moreover, these core systems yield a plethora of transactional data that can fuel new, strategic initiatives.

The second side of the triangle provides agility—the ability to react quickly to business and customer needs. Using a variety of cloud-based services, Sysco applies iterative development techniques to rapidly develop and deliver mobile and social apps to warehouses or restaurant floors. These apps are created specifically to add value where the work gets done. Because of this, speed is important: IT needs to test concepts quickly, discard those that don’t pan out, and rapidly scale those that do.

The third side of Shurts’s triangle provides analytics that help generate the insights needed to improve operations—spanning the company’s warehouses to its customers’ kitchens. By combining and analyzing data sourced from its own systems as well as from partners, customers, and third parties, Sysco is able to generate new insights across customers and markets, sales and marketing, and business operations. For example, the company helps restaurant owners better organize their menus, manage inventories, and run their operations. A company’s ability to deliver value-added services increases when its core systems are modernized and revitalized.

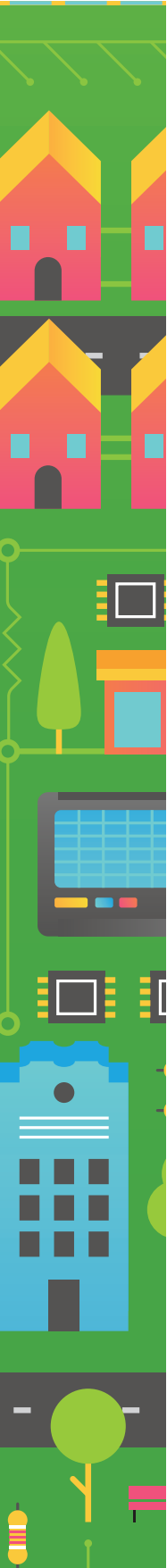
To help Sysco employees keep their skills current amid technological and operational changes, the company has developed a formal program that maps out competencies for current and future positions and helps workers create personalized development plans. It also provides training to help them better execute their current jobs and to prepare for future roles. Finally, the company emphasizes college recruiting to introduce new talent with different approaches into the workforce.

Shurts’s triangle strategy for core revitalization is delivering results. For example, using the agility side of the triangle, IT has built solutions used by the shared services organization to improve credit and dispute processing across multiple operating entities. And analytics is helping Sysco improve transportation logistics by improving fuel use and the selection of routes its trucks travel.

Engraving, printing, and modernization

The Bureau of Engraving and Printing (BEP) is the largest producer of security documents in the United States, printing billions of Federal Reserve notes, portions of US passports, materials for the Department





of Homeland Security, and naturalization certificates. The legacy technology at BEP resulted in operational inefficiency—a challenge made more difficult by non-unified systems that provided limited visibility into end-to-end operations. The bureau also used manual processes to reduce spoilage and improve accountability.

In 2009, BEP launched a multi-year, enterprise-wide transformation initiative, referred to as the BEP Enterprise Network (BEN) program, to retire and modernize its older mainframe technology. Leadership saw this project as an opportunity to team with IT to introduce the latest capabilities in diagnostics, intelligence, and automation across the manufacturing spectrum at BEP.

The BEN project team took a mixed approach to modernizing its core systems. Team members replaced the mainframe manufacturing and financial systems with a set of open, tightly integrated, and scalable commercial off-the-shelf business applications. They also enhanced printing presses with embedded intelligence and instrumentation capabilities. These enhancements provide a custom front-end application to the production floor employees that includes automated dashboards with alarms and notifications for printing press status. Additionally, the centralized data warehouse reduces the time required to collect data across production areas, and has brought historically unavailable data online. With better data coming from these applications, the team was also able to introduce predictive analytics and near real-time data analysis.

The BEN project has enabled stronger collaboration among working teams and streamlined operations in a number of ways. For example, BEP has retired 23 disparate legacy applications while introducing industry-standard business processes and tools. The time required to report monthly financial results has been significantly reduced. Automated data entry processes

and preventative maintenance schedules have boosted the productivity and reliability of bureau resources. Finally, new security measures have improved the overall accountability and transparency of reports and production status.

Through what has been a truly transformative program, BEP has realized its goal of modernizing its systems while advancing the vision of becoming a more information-driven, 21st-century organization. Moreover, BEP plans to maintain its current momentum with BEN by introducing more features that can help uncover hidden data trends and produce graphically rich analyses.

Filling the gaps with best-of-breed

A leading semiconductor company realized recently that its core systems needed to be modernized in order to meet changing needs. The company's business had evolved considerably over the past several years, but many of its systems and processes relied on ad-hoc operational environment and suboptimal solutions.

To create greater consistency and efficiency across systems and processes, leadership set a goal of achieving 15 percent more efficiency and 15 percent less overhead. The company approached this and other strategic goals by adopting technologies like cloud, analytics, and mobile; by streamlining reporting processes; and, importantly, by revitalizing infrastructure to create a platform for adopting future technologies that could drive further optimization over the next decade.

As the company began drawing up plans for meeting leadership's targets, it identified four major areas that could, if upgraded with new technologies, potentially provide significant value: operations planning, supply chain, B2B customer service, and warehouse operations. Yet planners realized that a single enterprise solution likely would not meet all

requirements in these and other critical areas. Project leaders decided that, rather than be tied to one vendor, they should deploy several best-of-breed cloud-based solutions from boutique vendors to fill ERP functionality gaps in CRM, distributions, and demand planning, among others.

To revitalize its existing infrastructure, the company could easily have spent tens of millions on servers, databases, and other infrastructure components. Instead, project leaders opted to create a private cloud and to

virtualize much of the needed infrastructure capabilities, which cut the price tag roughly in half.


When the newly revitalized core and the other systems become fully operational later this year, the company expects they will provide the consistency, optimization, and efficiency it set out to achieve. Moreover, these components, working in tandem with an infrastructure that has been transformed by virtualization, can serve as a platform for future innovation efforts.



My take

**Terry Milholland, chief technology officer,
Internal Revenue Service**

2014 saw one of the smoothest filing seasons ever for the IRS. It's an encouraging sign that our efforts to turn the agency's IT department into a world-class organization are paying off. Beyond supporting the IRS's customer-centric transformation, we wanted to evolve IT to deal with the complexity of our operations. Budgeting processes are complicated and unpredictable. Tax implications of legislation like the Affordable Care Act need to be codified for the hard deadlines of the tax season. Decades-old technologies require modernization. But our team has risen to the challenge, and we're seeing tremendous results.



We've created a vision for IT to be on a par with *Fortune* 100 organizations, and that affects our people, process, and technology. At the center of the technical vision are data and services—allowing our core systems to interact with each other and keeping teams from repeating their efforts. We now have a logical and physical data model for the full submission process—more than 30,000 attributes manifested across our core. Coupled with a service-oriented architecture, we're creating a repeatable approach to building on top of our core—to be able to add new technology in a transformational way, responsive to mission needs.

Which is where process comes in. We're committed to an agile methodology—using our new standards to modernize and grow. We have selected a set of technology standards that the organization follows to increase productivity and quality; we're already at level 3 for CMMI and ITIL.⁶ The impact on quality has been very real, and has helped break down barriers between the different teams and pieces of the technical stack.

But it comes down to our people. I don't lead with a "thou shalt" attitude. Instead, we enlist leaders in the organization—the men and women who have influence in the work environment and can pave the path for others. We solicit their feedback on our direction, working with them to iron out the details, and being open about issues, ideas, and concerns. These "guild masters" can help convince their teams to believe in the vision, to do things differently, and to positively impact the culture. Openness has become part of our organization. On projects, anyone can raise an objective. We record it, then we disposition it. Their opinions are listened to and the "Oh, they never ask" attitude doesn't exist.

Whether private or public sector, IT departments face constraints when it comes to taking on projects—let alone modernizing legacy systems and tackling their technical debt. If I look back on the past fiscal year, we started with a 16-day government shutdown that meant we had 90 percent of our workforce out and created uncertainty about our annual budget. But we continue to push forward with our strategy to transform our legacy systems. We've only just begun our journey toward modernization. We are going to keep adding new technologies in a transformational way—despite, and in some cases because of, people and fiscal constraints. Our focus on technology, process, and more importantly, people will get us there.

Cyber implications

SOME organizations treat ownership and control as a proxy for managing risk. Because the “core” is often software built on-premises or bought, this approach suffers from a twofold misconception. The first is that the existing stack is reasonably secure. The second is that moving to new technologies, be they mobile, social, or cloud, inherently raises the risk profile. Neither is universally true, and both raise the need for strategic handling of cyber security concerns.

The notion that today’s IT footprints are secure enough is a dangerous one. Legacy projects may not have considered compliance, contractual, or risk-based requirements adequately, if at all. A lack of strategic focus and budget has relegated many security initiatives to compliance and control activities—adding scope or causing rework to address vulnerabilities discovered late in the development cycle. Reactionary measures are taken when high-profile breaches occur, typically targeting known threats linked to particular incidents. A more comprehensive approach to cyber security is needed, acknowledging that it could be exorbitantly costly to protect against every potential attack.

Organizations should identify the cyber “beacon” that is likely to attract threats. Resources should then be directed against assets that potential attackers may likely find most valuable, or those that, if compromised, could cause greatest damage. Beyond securing against attack, organizations should monitor emerging threats and potentially reallocate resources as their cyber beacons change—practicing vigilance, not just security. They should prepare for how to detect, contain, and respond to potential incidents. There may be no such thing as a hacker-proof organization, but you can still be resilient in the face of an attack. Hope and luck are not strategies; even if the core has not been compromised, that does not mean it is secure. Building out cyber security capabilities can help close the gap.

The misconception that emerging technologies are inherently riskier than legacy assets is common, as is the myth that on-premises solutions are always more secure than cloud alternatives. Privacy concerns typically dominate discussions around social—requiring policy, training, and monitoring to guide appropriate behaviors. Mobile concerns fall between security and privacy, especially as enterprises are embracing “bring your own device” and “bring your own app” strategies. The approach described above can help, with a mindset anchored in probable and acceptable risk. Prepare for strategies to secure information at the device, application, and, potentially, data level while being sensitive to the overall user experience. Security tops concerns about public cloud adoption, with the rationale that large infrastructure-as-a-service, platform-as-a-service, and software-as-a-service providers are obvious and lucrative targets for cyber criminals. But with the escalated potential bounty, public cloud vendors also typically have highly sophisticated security tools, procedures, and personnel that can be more effective than many company and agency in-house cyber defenses. Who is better prepared to win the cyber arms race? Cloud providers whose livelihood likely depends on their ability to prevent and respond to incidents? Or organizations that have historically had trouble justifying security and privacy budgets as a priority? Either way, the obligations of the organization as the acquirer and custodian of data do not go away. Leverage providers to help outsource risk if cyber isn’t a core strength, but recognize that your organization still retains responsibility for its security.

Again, there is no universal answer. Security and privacy should not be a blanket objection that curtails core renaissance, but they should be baked into the overall approach—setting the right foundation for a revitalized core and guiding new investments in areas that will form the core of tomorrow’s business.

Where do you start?

SPARKING a renaissance of your core can be a daunting pursuit for value—potentially expansive in scope and ripe with risk—that will likely require effort to put in terms the business will understand. Fearless leaders might savor the opportunity for legacy-building. But for the rest, is the payoff worth the strife?

The fact is, CIOs don't have a choice. As the stewards of the technical footprint, they are responsible for the core's care and feeding. Whether expressly labeled as “modernization” efforts or responses to unplanned incidents and outages, or embodied in extra project cost and complexity due to unforeseen technical debt, the core will continue to demand attention. The question becomes how proactively it will be addressed—and whether it will be enough. Here are some specific areas in which to potentially undertake initiatives:

- **So you're saying there's a plan.** Core and legacy concerns are found wherever IT investments exist. They inspire a sense of universality and inevitability—the enterprise equivalent of “death and taxes.” But they are not irreversible—and they don't have to be seen as an albatross. Aikido is a form of martial arts that uses the mass of the attacker to one's advantage. Core renaissance can trade off of the magnitude of existing investments in similar ways, but it will not come across surreptitiously. It requires an informed, thoughtful position that balances business needs with the limitations of existing systems and the potential of emerging technology.
- **Spark a light.** Massive investments can be tough to stomach, especially if the “so what” seems limited to behind-the-scenes machinations. Find a lingering opportunity or burning platform—ideally, one that resonates with a part of your business

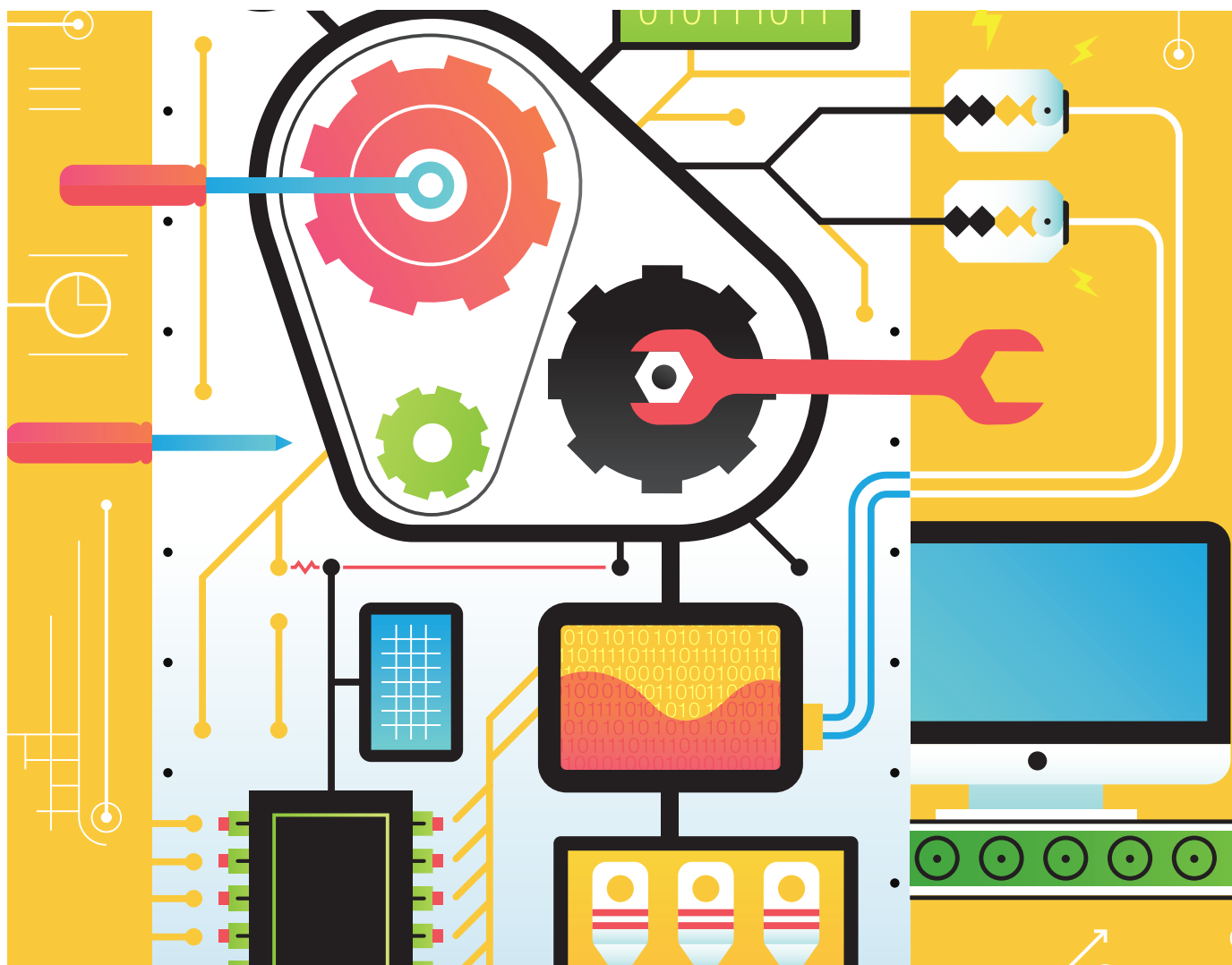
that is likely to become an advocate for broader goals. A bottom-up approach to new organizational structures, processes, and skill sets is an effective plan of attack—assuming enough of a direction has been established so that experiments are pointing toward where you want to go.

- **Plant the seed.** In Deloitte Transition Labs with newly appointed CIOs, leaders report that 63 percent of their time is focused on the care and feeding of the technology footprint. The complexity embedded in the core perpetuates the cycle. These same leaders desire the inverse, believing they could better serve their companies by focusing 66 percent of their time on being a strategist or catalyst for growth and innovation.⁷ Deliberate investments in revitalizing the core can help close this gap. It may take time, but will likely lead to lasting effects.
- **Don't go it alone.** Large enterprises have developed a healthy skepticism around emerging technologies. Vendor fatigue and aversion to “shiny object syndrome” are partially to blame. The age-old practice of circumventing IT to sell directly into the business is also still being felt, leading to “shadow” IT organizations and even more complexity in the core. But resistance to change is in many ways futile. Hunkering down will likely just reinforce the shadowy end run directly into the business. The cruel irony: New solutions will likely eventually find themselves back at IT's doorstep, either for enterprise-level support or because business processes require integration with the core. Instead, pick a few strategic vendors to partner with to enable core renaissance. This may involve co-investment (for example, sharing risk or

product roadmaps), proactively prototyping new ideas, providing briefings on industry (and cross-industry) leading practices, or brokering introductions to interesting new solutions for specific business scenarios.

- **Verbs, not just nouns.** Technical components are rightly critical parts of core revitalization, but pursuing core renaissance is also an opportunity to transform how you build and support solutions. Aim to embed design as a discipline⁸ into everything you do, working back from the user

experience, not up from the systems and data. Look to embrace pieces of DevOps: automated environment provisioning, requirements management, continuous build/configuration management, testing automation, one-touch deployment, and systems maintenance and monitoring solutions. Finally, create a living approach to architecture—guiding not just the solutions and platforms that are blessed, but their usability, integration, data, and security considerations.



Bottom line

DISRUPTIVE forces are reshaping industries: globalization, emerging technologies, new customer engagement requirements, diminishing competitive barriers to entry, evolving regulatory and compliance requirements, and persistent threats around security and privacy. All of these are inextricably linked to technology, moving the core to center stage. Some modernization will no doubt be needed to keep the lights on as the business scales up. But beyond table stakes, a revitalized core could become a strategic differentiator. A renaissance of the core amid an elevation of IT to support the heart of the business can lay the foundation for the organization to experiment, innovate, and grow.

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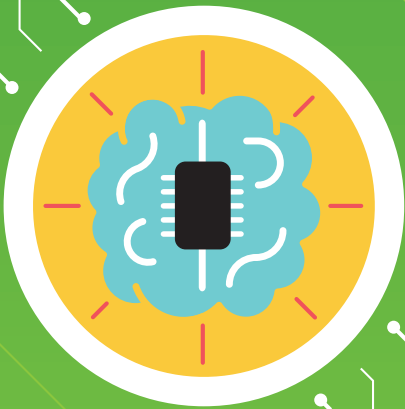
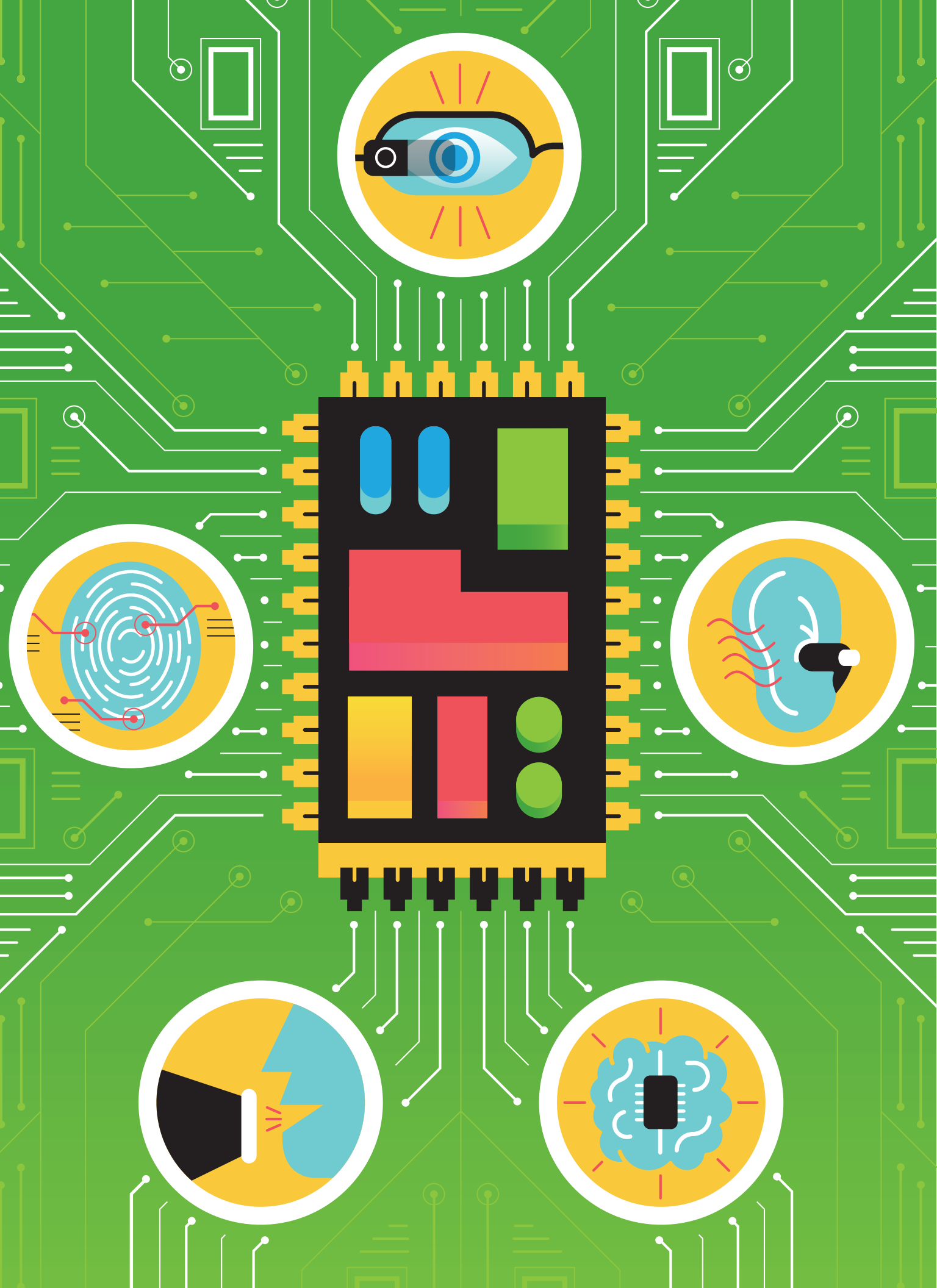


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Amplified intelligence

Power to the people

Analytics techniques are growing in complexity, and companies are applying machine learning and predictive modeling to increasingly massive and complex data sets. Artificial intelligence is now a reality. Its more promising application, however, is not replacing workers but augmenting their capabilities. When built to enhance an individual's knowledge and deployed seamlessly at the point of business impact, advanced analytics can help amplify our intelligence for more effective decision making.

TODAY'S information age could be affectionately called “the rise of the machines.” The foundations of data management, business intelligence, and reporting have created a massive demand for advanced analytics, predictive modeling, machine learning, and artificial intelligence. In near real time, we are now capable of unleashing complex queries and statistical methods, performed on vast volumes of heterogeneous information.

But for all of its promise, big data left unbounded can be a source of financial and intellectual frustration, confusion, and exhaustion. The digital universe is expected to grow to 40 zettabytes by 2020 through a 50x explosion in enterprise data.¹ Advanced techniques can be distracting if they aren't properly focused. Leading companies have flipped the script; they are focusing on concrete, bounded questions with meaningful business implications—and using those implications to guide data, tools, and technique. The potential of the machine is harnessed around measurable insights. But

true impact comes from putting those insights to work and changing behavior at the point where decisions are made and processes are performed. That's where amplified intelligence comes in.

Open the pod bay doors

Debate rages around the ethical and sociological implications of artificial intelligence and advanced analytics.² Entrepreneur and futurist Elon Musk said: “We need to be super careful with AI. Potentially more dangerous than nukes.”³ At a minimum, entire career paths could be replaced by intelligent automation and made extinct. As researchers pursue general-purpose intelligence capable of unsupervised learning, the long-term implications are anything but clear. But in the meantime, these techniques can be used to supplement the awareness, analysis, and conviction with which an individual performs his or her duty—be it an employee, business partner, or even a customer.

The motives aren't entirely altruistic . . . or self-preserving. Albert Einstein famously pointed out: "Not everything that can be counted counts. And not everything that counts can be counted."⁴ Business semantics, cultural idiosyncrasies, and sparks of creativity remain difficult to codify. Thus, while the silicon and iron (machine layer) of advanced computational horsepower and analytics techniques evolve, the carbon (human) element remains critical to discovering new patterns and identifying the questions that should be asked. Just as autopilot technologies haven't replaced the need for pilots to fly planes, the world of amplified intelligence allows workers to do what they do best: interpreting and reacting to broader context versus focusing on applying standard rules that can be codified and automated by a machine.

This requires a strong commitment to the usability of analytics. For example, how can insights be delivered to a specific individual performing a specific role at a specific time to increase his or her intelligence, efficiency, or judgment? Can signals from mobile devices, wearables, or ambient computing be incorporated into decision making? And can the resulting analysis be seamlessly and contextually delivered to the individual based on who and where they are, as well as what they are doing? Can text, speech, and video analytics offer new ways to interact with systems? Could virtual or augmented reality solutions bring insights to life? How could advanced visualization support data exploration and pattern discovery when it is most needed? Where could natural language processing be used to not just understand semi-structured and unstructured data (extracting meaning and forming hypotheses), but to encourage conversational interaction with systems instead of via queries, scripts, algorithms, or report configurators?

Amplified intelligence creates the potential for significant operational efficiencies and competitive advantage for an organization.

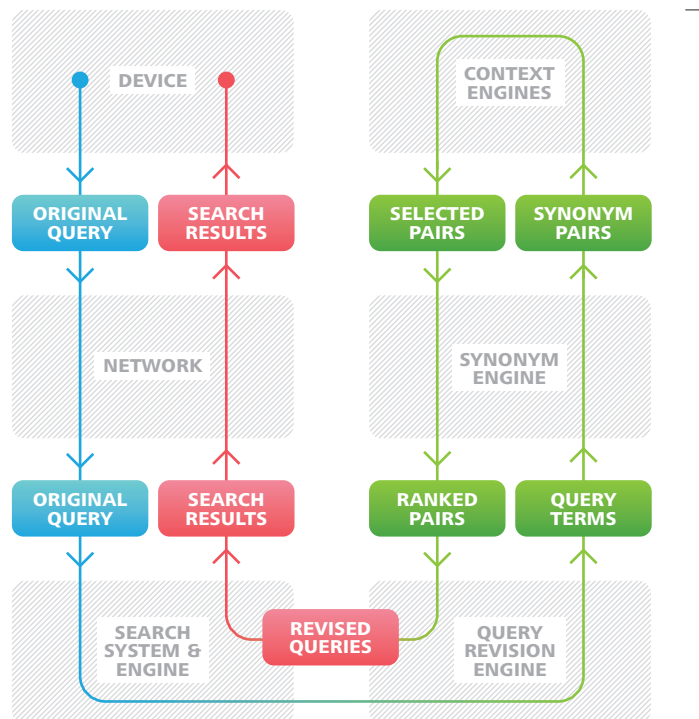
Discovery, scenario planning, and modeling can be delivered to the front lines, informed by contextual cues such as location, historical behavior, and real-time intent. It moves the purview of analytics away from a small number of specialists in back-office functions who act according to theoretical, approximate models of how business occurs. Instead, intelligence is put to use in real time, potentially in the hands of everyone, at the point where it may matter most. The result can be a systemic shift from reactive "sense and respond" behaviors to predictive and proactive solutions. The shift could create less dependency on legacy operating procedures and instinct. The emphasis becomes fact-based decisions informed by sophisticated tools and complex data that are made simple by machine intelligence that can provide insights.

Bold new heights

Amplified intelligence is in its early days, but the potential use cases are extensive. The medical community can now analyze billions of web links to predict the spread of a virus. The intelligence community can now inspect global calls, texts, and emails to identify possible terrorists. Farmers can use data collected by their equipment, from almost every foot of each planting row, to increase crop yields.⁵ Companies in fields such as accounting, law, and health care could let frontline specialists harness research, diagnostics, and case histories, which could arm all practitioners with the knowledge of their organization's leading practices as well as with the whole of academic, clinical, and practical experience. Risk and fraud detection, preventative maintenance, and productivity plays across the supply chain are also viable candidates. Next-generation soldier programs are being designed for enhanced vision, hearing, and augmented situational awareness delivered in real time in the midst of battle—from maps to facial recognition to advanced weapon system controls.⁶

The technology behind NLP and conversational interaction

Conversational interaction is the ability to understand and answer a string of questions in a dialogue. Analytics engines derive the structure of a query, as well as its intent, through parsing, semantic search, synonyms, and most importantly, context—building upon insight gained through previous queries and cues from behavior, surroundings, and knowledge of business processes.^a



THE CONVERSATIONAL SEARCH PROCESS



STEP 1 The synonym and context engines receive specific query terms and generate, sort, and rank potential synonyms for these terms using database rules and previous queries.



STEP 2 The revision engine then selects and uses the synonyms to create revised queries.^b Using synonyms and context to expand queries allows the system to offer the most relevant and useful responses to the conversation.

Sources: ^a Danny Sullivan, "Google's Impressive 'Conversational Search' Goes Live On Chrome," May 22, 2013, <http://searchengineland.com/googles-impressive-conversational-search-goes-live-on-chrome-160445>, accessed October 14, 2014. ^b Abhijit A. Mahabal et al, "United States Patent 8,538,984 B1: Synonym Identification Based on Co-occurring Terms," September 17, 2013, <http://www.google.com/patents/US8538984>, accessed October 14, 2014.

In these and other areas, exciting opportunities abound. For the IT department, amplified intelligence offers a chance to emphasize the role it could play in driving the broader analytics journey and directing advances toward use cases with real, measurable impact. Technically, these advances require data, tools, and processes to perform core data management, modeling, and analysis functions. But it also means moving beyond historical aggregation to a platform for learning, prediction, and exploration. Amplified intelligence allows workers to

focus on the broader context while allowing technology to address standard rules that can be codified and executed autonomously.

All together now

The emphasis on usability and deployment moves the information agenda from isolated data scientists to multidisciplinary teams. The agenda should focus on helping end users by understanding their journey, their context, and how to enhance and reshape their jobs. Like the revolution in user engagement

that transactional systems have recently experienced, amplified intelligence solutions start from the user down, not from the data model and analytics up. To start the process with users, organizations should identify a crunchy question that, if answered, could significantly improve how a specific individual does his or her job. The process should also understand how an answer could affect how the individual conducts business—where he or she would likely need the information, in what format, when, and via what channel.

Company leaders interested in improving their decision making can use machine learning and other amplified intelligence approaches to generate new growth ideas for their organizations. Amplified intelligence is becoming critical for competitive success around the world, across industries. US-based Uber uses big data to match passengers with car services.⁷ European grocer Tesco leverages big data to capture a disproportionate share of sales from new families and parents.⁸ Effective scenarios should be designed to be deployed for high impact. That impact should inform scope, solutions, and iterative development,

in which incremental solutions are tested in real-life scenarios.

The best outcomes will likely be from scenarios where technology or analytics were seen as infeasible or too difficult to take advantage of. New opportunities exist when companies expand information-based decisions beyond just the executive suite's purview into the field by giving managers, sales teams, service techs, case workers, and other frontline employees simple tools that harness exceptionally complex intelligence. And, ideally, computational intelligence will be refined and extended by collective intelligence, creating a feedback loop where people are also augmenting the advanced tools and models. Individual creativity and resourcefulness can and should continue to flourish. The goal, however, should be mutual elevation: As machine analytics are enhanced, users have the opportunity for more nuanced and valuable pursuits. As these pursuits become increasingly nuanced and valuable, they put important feedback into the system. The overall outcome: Artificial intelligence amplifies human intelligence to transform business intelligence.

Lessons from the front lines

Moving science from the lab to the digital age

The University of Minnesota (UMN) has been driving innovation in health informatics for over 50 years. As its health informatics-related research efforts continued to grow in response to trends such as the rise of technology and the growing demand for higher-quality and lower-cost health care, UMN realized that it needed a centralized, enterprise-wide biomedical health informatics (BMI) platform to more effectively and efficiently support the growing data needs of UMN's researchers and its medical and health science partners.

UMN's goal was to establish informatics as a bridge to accelerate the application of discoveries in clinical practice and to transform the science of health care delivery for better population health. The BMI platform could help UMN meet this goal, in part, by connecting clinical and translational science researchers to clinical data and biological samples, and by supplying easy access to biomedical integrated informatics resources and tools to conduct their studies.

In 2010, UMN's Institute for Health Informatics, in conjunction with the UMN Clinical and Translation Science Institute, embarked on a multiyear effort to create a biomedical informatics platform, which is based on a suite of analytical and data warehousing solutions that combine clinical, financial, and research data to enable observational studies and predictive analytics. The new platform provides access to acute and ambulatory information on more than 2.1 million patients from the local health system electronic medical record. The platform also offers productivity tools, including

straightforward interfaces to create queries of de-identified patient records, data capture tools to enter patient survey data, an integrated system to better manage clinical trials, and a secure social networking application for some 4,000 researchers across UMN and its partner facilities. In essence, the platform is intended to amplify the intelligence of each stakeholder by allowing them to work together through collaborative systems.

As awareness of the enterprise informatics platform grows, so does the number and level of sophistication of research requests. Researchers, non-clinical users, and IT staff understand data from a much broader perspective, which helps advance UMN's research agenda and its ability to improve health care by partnering with other health systems and universities.

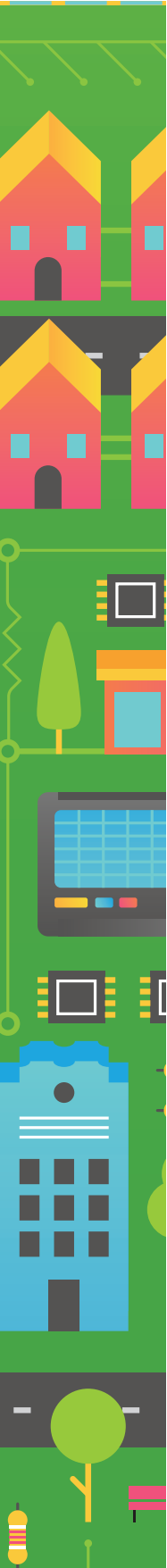
Visions of the future

Leveraging smart glass hardware, analytics, and back-office tools, a global oil and gas company created a pilot platform for amplifying the effectiveness of rig workers. The goal of this effort was to deliver hands-free job aids, decision support, and workflow automation to individuals working in remote locations.

The platform works as follows: When field equipment malfunctions on an oil rig, sensors detect the issue and proactively notify a nearby field service agent via smart glass. Analytics then delivers critical diagnostic information on the issue. This information, augmented by powerful analytics capabilities applied to sensor and other relevant back-office data, includes step-by-step instructions for repair.

Using a laptop or a cumbersome paper manual to triage and troubleshoot





malfunctioning equipment might require service agents to remove their gloves and step away as they look for answers. However, smart glass makes it possible for them to view needed information in real time and on the spot—thus enhancing worker efficiency, accuracy, and safety. Moreover, with a simple wave of the hand, the agent utilizes a gesture control armband to initiate a video conference with level-three support back at the home office. The remote expert can see what the agent sees, talk to him or her through the procedure, and even provide annotated instructions that appear on the agent's augmented display.

The agent can also send data to a central database. With a head nod or tilt, he or she can maintain a log or “checklist” of completed activities and create new notations via voice as the repair is being made. That repair log then becomes available to the next technician who services the field equipment. Critical information isn't lost in stacks of paperwork; it becomes digitally organized and accessible to those who need it.

Use cases for platforms like this are not limited to oil and gas field workers. At distribution centers, for example, drivers often conduct vehicle inspections prior to turning the ignition. In many instances, drivers must look for vehicle- and manifest-specific details—details that would be almost impossible to memorize without years of training. Virtual instructions accessed via smart glass can guide drivers through inspections, accelerating the entire process and increasing its accuracy and effectiveness.

The combined power of smart glass technology, analytics, and back-office systems (knowledge databases or warehouse management systems) can help organizations in almost any industry or sector realize the

vision of an amplified workforce by offering information whenever, wherever.

Solving crime in real time

In 2010, the data systems in the Los Angeles Police Department (LAPD) did not augment the intelligence of its nearly 10,000-strong force.⁹ Data were trapped in organizational silos, forcing members of the department to navigate multiple systems with limited means to quickly integrate and analyze the information available to them. Leads could easily become cold.

Crime analysts, for example, used a mainframe system to retrieve field interview data and another system for Department of Motor Vehicles information. A separate team was responsible for data in the automated license plate recognition system—LAPD patrol cars are outfitted with scanners that snap pictures of cars and their license plates as they drive by—and it could take several days for detectives to get the results of a search. The department couldn't aggregate 911 or police radio calls to create a real-time picture of crime. Reports had to be printed and physically delivered.¹⁰

To tackle these issues and augment the capabilities of its force, the LAPD launched an analytics and visualization effort to integrate and analyze data from multiple local, state, and federal sources. The initiative has added meaningful capability across the board to the LAPD's analysts, officers, detectives, and command staff—delivering insights tailored for their needs on crime scenes, during traffic stops, or at the station.

In one example, robbery victims could only remember part of the perpetrators' license plate number and that the car was a grey Cadillac—not much to go on in a city with

millions of vehicles. Using the new system, crime analysts narrowed down the number of possible cars, and the victims were able to identify the vehicle whose picture was in the automated license plate recognition system. Two days later, detectives spotted the car and followed it to what turned out to be another robbery attempt. The suspects were arrested on the spot.¹¹ Because of amplified intelligence in the field, the lead didn't have a chance to get cold.

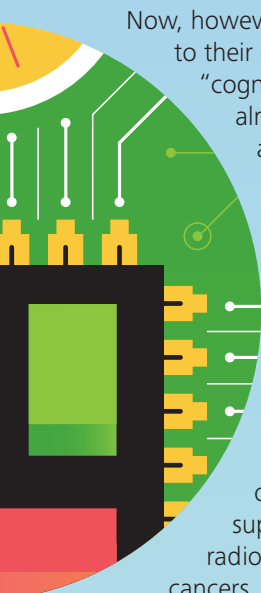
Successes such as these are fueling the growth of advanced analytics to fortify the effectiveness of the LAPD. The department is in the process of rolling out analytics across the organization and supporting the effort with rigorous training and ongoing support. Although the endeavor is not without its challenges and costs, it is helping the LAPD meet its mission to safeguard the lives and property of the city's residents and visitors.¹²



My take

Thomas H. Davenport
President's Distinguished Professor at Babson College
Visiting professor at Harvard Business School
Independent senior advisor to Deloitte Analytics

There is little doubt that computers have taken substantial work away from lower- and middle-skilled jobs. Bank tellers, airline reservations clerks, and assembly line workers can all testify to this effect. Thus far, however, high-end knowledge workers have been relatively safe from job encroachment. Computers have certainly changed knowledge work, but they have largely augmented human labor rather than replacing it.



Now, however, knowledge workers face a challenge to their own employment. Analytical and “cognitive computing” technologies can make almost any decision with a high degree of accuracy and reliability. From *Jeopardy!* questions to cancer diagnosis to credit risk decisions, there seems to be no decision domain that smart machines can't conquer.

Thus far, it's been rare for a manager, professional, or highly specialized worker to lose a job for this reason. The decisions automated have been relatively narrow, and only small parts of knowledge workers' roles have been supplanted. For example, while automated radiological image analysis can identify certain cancers, at most their use has been to supply a “second set of eyes” for a radiologist's diagnosis.

However, if my children were planning to become lawyers, doctors, accountants, journalists, teachers, or any of the many other fields for which automated or semi-automated offerings have already been developed, I would have some advice for them (which I am sure they would ignore!). I would advise the following actions:

- Closely monitor automation developments in their chosen field, and monitor which aspects of the profession are most likely to be automated. For example, I suspect that in journalism—already a difficult field because of the decline of print—the most likely candidates are those involving high levels of numerical reporting, such as sports and business journalism. Reporting on elections and political surveys might also be at risk. More investigative and human interest reporting is relatively safe, I suspect.
- Become an expert in their chosen field as quickly as possible. Entry-level jobs are most at risk from automation, but experts are usually still needed to handle the most difficult cases and to advise and develop new rules and algorithms.
- Develop an understanding of the technologies that are most likely to become important in the industry. For highly quantitative fields, machine learning is a strong candidate; for more textually oriented fields, Watson-like cognitive computing is more likely to be the automating technology.
- Most of all, I'd advise workers in fields where automation is coming to “make friends with their computers.” Learn how they work, what they are good at, and their areas of weakness. If possible, learn how to modify and improve them. Understand the implicit assumptions that underlie their models and rules, and under what conditions these assumptions might become invalid.

In the short run, knowledge workers are probably safe from substantial automation, but taking these steps will likely make for a more successful career. In the long run, all bets are off!

Cyber implications

CYBER security and data privacy considerations should be a part of analytics conversations, especially as amplified intelligence moves insights more directly into the heart of how, and where, business occurs. Information should be monitored and protected when it is at rest, in flight, and in use. These three scenarios feature different actors using different platforms and that require different cyber security techniques. Moreover, for each scenario, you must know how to manage misuse, respond to breaches, and circle back with better security and vigilance.

“At rest” is the traditional view of information security: How does one protect assets from being compromised or stolen? Firewalls, antivirus software, intrusion detection, and intrusion prevention systems are still needed, but are increasingly less effective as attackers rapidly evolve their tools and move from “smash and grab” ploys to long-dwell cybercrimes. Instead of an outright offense that may leave telltale signs, attackers gain access and lie dormant—launching incremental, almost imperceptible activities to discover vulnerabilities and gain access to valuable IP.

The additional emphasis on “in flight” and “in use” reflects a shift in how organizations put their underlying data to use. Information is increasingly consumed in the field via mobile, potentially on personally owned consumer devices. Encryption can help with transmission and data retention. Identity, access, and entitlement management can help properly control user actions, especially when coupled with two-factor authentication. Application, data, and/or device-level containers can protect against attacks on the network, hardware, or other resident apps. Again, though, these demonstrated techniques may not be enough, given the growing sophistication of criminal products, services, and markets.

Organizations should couple traditional techniques with advanced analytics, amplifying the intelligence of cyber security personnel. Leading cyber initiatives balance reactionary methods with advanced techniques to identify the coming threat and proactively respond. They take a fusion of information from a range of sources with differing conceptual and contextual scope, and combine it with human-centered signals such as locations, identity, and social interactions of groups and individuals. This approach has a number of implications. First, it creates the need to adopt a broader cyber intelligence mindset—one that leverages intel from both internal and external sources. Insight pulled from new signals of potentially hostile activities in the network can point to areas where security professionals should focus. Similar to how amplified intelligence informs approaches to business operations, this raw security data should be analyzed and presented in ways to augment an individual’s ability to take action.

Machine learning and predictive analytics can take cyber security a step farther. If normal “at rest,” “in flight,” and “in use” behavior can be baselined, advanced analytics can be applied to detect deviations from the norm. With training to define sensitivities and thresholds, security teams’ capabilities can be amplified with real-time visibility into potential risks when or before they occur. At first, this ability is likely to simply guide manual investigation and response, but eventually it could move to prescriptive handling—potentially enabling security systems to automatically respond to threat intelligence and take action to predict and prevent or promptly detect, isolate, and contain an event when it occurs.

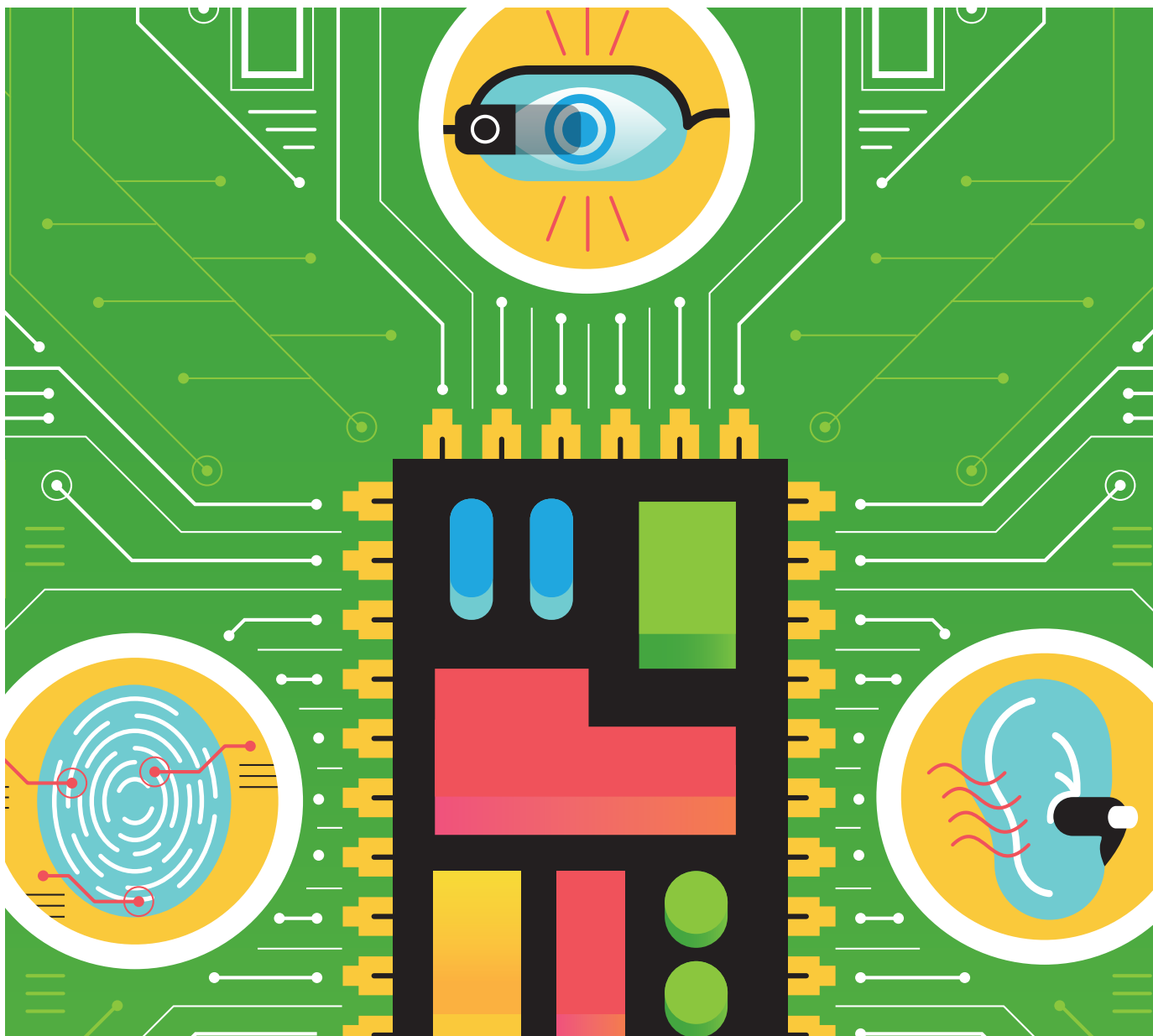
Where do you start?

THE information agenda is not without baggage. But hopefully that baggage includes the foundations needed for strides in amplified intelligence. One size likely won't fit all. Organizations will probably need a variety of approaches, tools, and techniques suitable to the question asked and the end users affected. They should also accommodate each scenario's requirements around data velocity, structure, analytics complexity, and user interface/deployment vehicles. While individual mileage will vary, some overarching steps can help guide the journey.

- **Set priorities by asking business questions.** Organizations can start by asking business leaders for the wish list of questions they would love to be able to answer—about their customers, products, processes, people, markets, facilities, or financials. Develop the wish list independent of constraints on what is knowable, answerable, or technically feasible. Use the questions to guide priorities and reveal what types of data might be needed—internal and external, structured and unstructured, information already captured versus information not currently measured or stored. Identify what problem-solving techniques may be required: in-memory or massively parallel processing for analyzing huge data volumes, deterministic or probabilistic modeling for advanced statistical modeling, visualization or querying environments for exploration and discovery, or predictive analytics and/or machine learning to automate the formulation of hypotheses.
- **Check your gut.** One of the only things worse than an unanswered question is investing in insights your organization is not prepared to act on. Ask the hard qualifying question up front: If we are able to answer the high-priority questions, does the organization have the institutional fortitude required to drive systematic changes? Long-standing assumptions may be challenged and require a different approach to markets, incentives, or behaviors. High potential is one thing, but the focus of early efforts should balance the opportunity against expected organizational resistance. It will likely take time to become a data-driven culture.
- **Design from the user down.** Amplified intelligence is about putting advanced analytics in the hands of the individual when he or she needs it. User experience should dictate the format, granularity, and decisiveness of how that insight should be provided:
 - *Format*—the channel, notification, and interaction method
 - *Granularity*—how much detail is needed and in what context
 - *Decisiveness*—whether responses are descriptive, predictive, or prescriptive, which can range from providing passive supporting detail to aid decision making to proactively recommending a response or taking action
- **Expect resistance (which is not futile).** A recent Gartner report found that “by 2020, the majority of knowledge worker career paths will be disrupted by smart machines in both positive and negative ways.”¹³ Investors are aggressively directing capital toward AI and robotics, and venture capital investments in AI have increased by more than 70 percent per year since 2011.¹⁴

Unions and labor groups could impede adoption. Unskilled labor categories may see greater impact, as robotics and machine learning continue to disrupt lines of employment. Transparency of intent will be important, along with programs to help retool and redeploy displaced workers. Prioritizing investments that

live up to the full potential of amplified intelligence means using the technology to enhance the value of the end worker. In a way, amplified intelligence initiatives are a direct investment in the individual that makes them even more valuable to the organization.



Bottom line

IT'S easy to get stuck on the “what?” of analytics—trying to define conceptual models for the enterprise’s wide range of information concerns. Leading companies, however, have aggressively pursued the “so what?”—prioritizing crunchy questions with measurable value as the focal points of their endeavors. Amplified intelligence represents the “now what?” of moving from theoretical exercises to deploying solutions where business decisions are actually made. Usability and outcomes should take their rightful place over platforms, tools, and data—important ingredients, to be sure, but only part of the recipe. While the machine continues to rise to impressive new heights, its immediate potential comes from putting it in the right hands, in the right manner, when it counts.

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IT worker of the future

A new breed

Scarcity of technical talent is a significant concern across many industries, with some organizations facing talent gaps along multiple fronts. The legacy-skilled workforce is retiring, and organizations are scrambling for needed skills in the latest emerging, disruptive technologies. To tackle these challenges, companies will likely need to cultivate a new species—the IT worker of the future—with habits, incentives, and skills that are inherently different from those in play today.

BROAD demographic and generational stereotypes often move to front and center when talk turns to employment trends and workforce motivation. Indeed, macro-level trends, including the aging workforce, will likely have an impact on the IT workforce of the future. By 2025, for example, it is anticipated that 75 percent of employees will fall under the “Millennial” banner—those born after 1983.¹ By 2020, retiring Baby Boomers are expected to leave 31 million positions open.² Gender inequality continues to plague the technology field—only 30 percent of technology positions are currently filled by women.³ Even though the number of STEM (science, technology, engineering, and mathematics) graduates has increased by some 100,000 during the past decade, more than half of these graduates don’t practice their STEM craft for a living. The trends have led the US Bureau of Labor Statistics to predict that one million US programming jobs will go unfilled by 2020.⁴

Although these patterns are important, they are only part of the story.

The new tech frontier

A handful of recent developments are having a dramatic impact on today’s IT workers. The pace of technological change has been the subject of our annual *Technology Trends* report since its inception. With each new topic comes the need for education and new capabilities. The needs, however, are straining formal learning methods and the ability to maintain relevant curricula in such a dynamic landscape.

Moreover, traditional credentials may not apply in this new world. Certifications and years of experience are irrelevant in nascent technologies. Accomplishments and hands-on capabilities, which may or may not be developed through traditional employment or academic avenues, may well trump credentials. A demonstrated propensity for and ability to learn new skills may become as important as one’s existing knowledge base. Most leading organizations will likely create a culture that supports and rewards continuous learning and helps direct IT employees toward emerging trends.

At the same time, exposure to and comfort with technology is reaching unprecedented levels, regardless of age, geography, or education level.⁵ The ubiquity of low- or no-cost technology coupled with a growing entrepreneurial spirit has given rise to the maker movement.⁶ The movement encourages hands-on learning with not just software development, but the blending of coding with hardware and hard science. One byproduct of the movement is The Raspberry Pi, a credit card-sized, all-in-one computer that sells for \$35 and teaches newcomers programming and product engineering, including the use of sensors, robotics, and other hardware add-ons. The maker movement encourages tinkering, experimentation, and prototyping, ideally in disciplines adjacent to workers' day-to-day responsibilities. Commercial successes from the movement include the Pebble Smartwatch, MakerBot's 3D printer, and Oculus Rift's VR headset.

But democratized innovation isn't just the domain of start-ups and incubators. It's also just as important to the war for talent as it is to the war for growth. Deloitte's annual Millennial Survey found that a company's reputation for fostering innovation is the single most important factor driving Millennials' employment decisions: It is a high priority for 78 percent of all global respondents, and for more than 90 percent of respondents in emerging markets such as China and India.⁷

Finally, the very nature of employment is changing. Despite a few high-profile bans on working from home by companies such as Yahoo,⁸ companies are increasingly providing virtual work arrangements that stress flexibility over traditional incentives. And a recent survey found that 53 percent of IT workers would take a 7.9 percent pay cut in exchange for the ability to work remotely.⁹ Technology such as virtual whiteboards, mobile robots, and video capability built into messaging platforms connect team members who may be continents apart. The adoption of crowdsourcing is rising

for both those participating in crowd labor pools and enterprises looking to the crowd for dynamic, scalable resources. Jobs can be task-oriented, tapping local or global pools of vetted talent to handle simple, sometimes menial work. Or they can focus on highly specialized areas such as software engineering, data science, creative design, or even management consulting.¹⁰ A Bersin & Associates¹¹ study found that more than 32 percent of positions were either part-time or contract-based. A growing number of these positions are being filled via crowdsourcing platforms such as GigWalk, Freelancer, oDesk, Kaggle, Tongal, and others.¹²

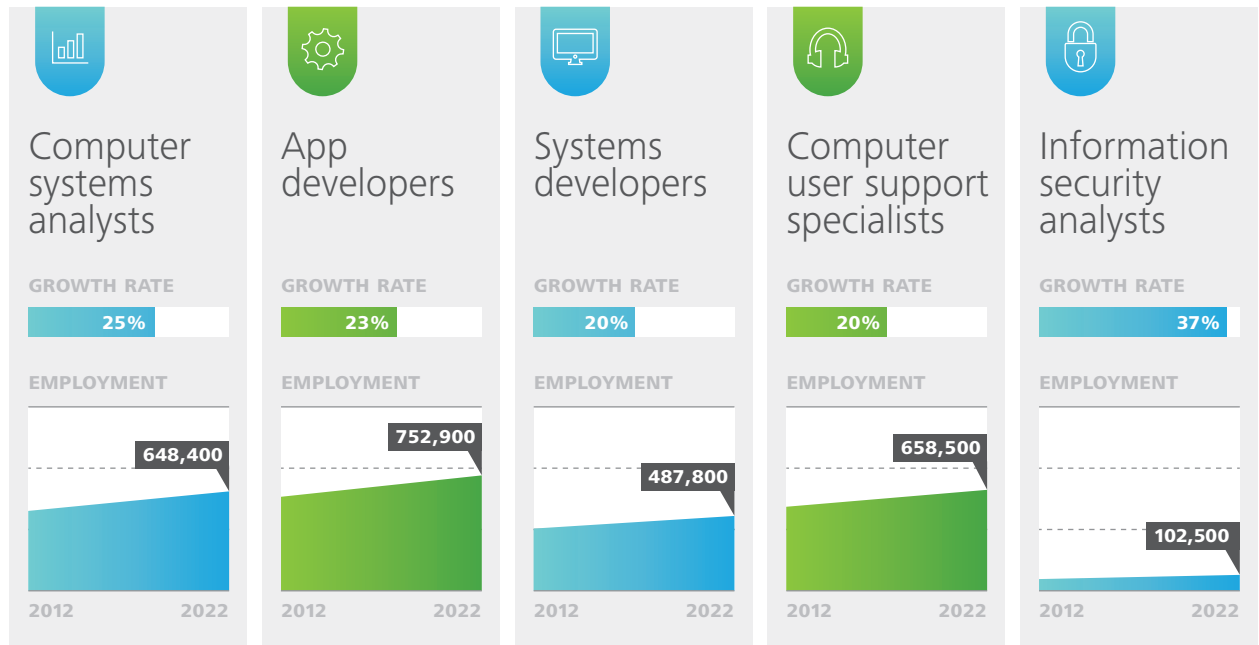
Design as a discipline

Design lies at the heart of the IT worker of the future. The emphasis on design may require new skill sets for the extended IT team—which may include graphic designers, user experience engineers, cultural anthropologists, and behavioral psychologists. IT leaders should add an “A” for fine arts to the science, technology, engineering, and math charter—STEAM, not STEM. Designing engaging solutions requires creative talent; creativity is also critical in ideation—helping to create a vision of reimagined work, or to develop disruptive technologies deployed via storyboards, user journeys, wire frames, or persona maps. Some organizations have gone so far as to hire science fiction writers to help imagine and explain moonshot thinking.¹³

Design can also underpin more agile, responsive techniques in IT management and delivery by instilling a culture focused on usability—not just concentrating on the look and feel of the user interface, but addressing the underlying architectural layers. Design can rally Dev and Ops around a shared vision of improved end-to-end design and end-user experience—responsiveness, reliability, scalability, security, and maintainability in streamlined and automated build and run capabilities.

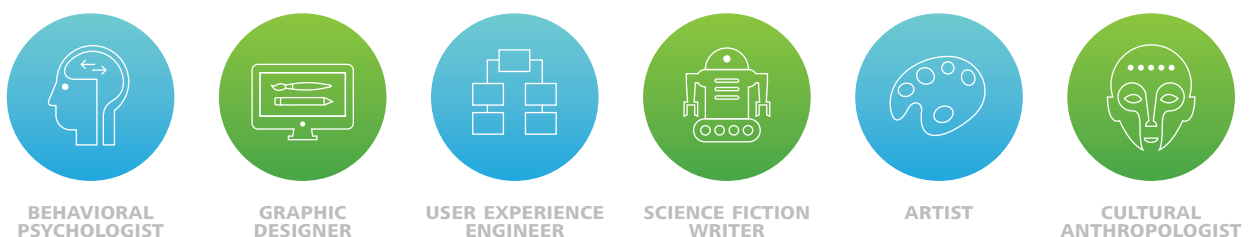
STEM occupations in high demand: 2012–2022 projected growth^a

The increasing demand for science, technology engineering, and math (STEM) workers underlines their growing importance for the business—between 2009 and 2012, the ratio of general job seekers to online job postings was 3.8 to 1; for STEM workers, it was 1 to 1.9.^b In addition, the Bureau of Labor Statistics projected STEM jobs would grow at a rate of 17 percent between 2008–2018, with non-STEM jobs at 9.8 percent.^c



STEAM: Adding arts skill sets to the IT team

The new IT worker is technical, functional, client-ready, and creative, and may have non-traditional skills.



Sources: ^a Dennis Vilorio, "STEM 101: Intro to tomorrow's jobs," *Occupational Outlook Quarterly*, spring 2014, <http://www.bls.gov/careeroutlook/2014/spring/art01.pdf>, accessed January 13, 2015. ^b Change the Equation, "What are your state's STEM vital signs?," July 2013, <http://changetheequation.org/sites/default/files/About%20Vital%20Signs.pdf>, accessed January 13, 2015. ^c United States Department of Commerce, "The state of our union's 21st century workforce," February 6, 2012, <http://www.commerce.gov/blog/2012/02/06/state-our-union%E2%80%99s-21st-century-workforce>, accessed January 13, 2015.

Bringing it home

Many IT organizations are improving their ability to sense and respond to emerging trends and modernize legacy systems and delivery models. Really understanding your workforce is important: Who do you have, what skills do they bring, and are they sufficiently forward-thinking in their use of technology to lead your organization in innovation? Consider the future IT worker's new skill sets and behaviors. A tactical example is the recent "bring your own device" trend. Seventy percent of Millennials admit to bringing their own applications from outside their enterprise to support their work¹⁴—a trend that will likely only grow as more cloud, mobile, and analytics offerings target the workplace. Organizations need to set policies that guide, govern, and support workers' evolving adoption of external devices, applications, data, and collaboration.

Cross-pollinating teams with both the young and old helps new hires gain practical experience with legacy systems and encourages established employees to broaden their skill sets into new areas. Isolated, commoditized skills will likely be outsourced or automated over time through machine learning, artificial intelligence, and advanced robotics that replace blue-collar, white-collar, and so-called "professional" jobs.¹⁵ With this shift, coders, architects, and engineers become even more important, and multiskilled players with deep institutional knowledge will continue to be critical. Identify, nurture, and seed the new breed, and introduce change team by team, project by project.

Spend your energy attracting, challenging, and rewarding the right kind of talent instead of succumbing to legacy organizational constructs that are no longer relevant—unleash the IT worker of the future on your business.

Lessons from the front lines

Insuring the future

AIG realizes that, in today's continually evolving digital era, leading IT organizations need to balance supporting the business's current operations with bringing in new perspectives and emerging technologies. Striking that balance means working and learning differently and fostering a next-generation workforce that can manage the old and new.

Mark DeBenedictus, SVP and head of AIG Global Services (AIGGS), is launching a program to do just that: the Technology Career Acceleration Program (TCAP). The program targets high-potential undergraduates by providing career development and personal growth through a non-traditional IT experience. The first program of its kind within AIG, TCAP has the goal of attracting young talent, teaching them the business, and creating a powerful learning and discovery opportunity.

The 28-month program identifies potential participants through the company's campus hiring and internship programs. TCAP then exposes participants to traditional internal and vendor-led training, self-paced e-learning, group assignments, simulation exercises, and multiple rotations to provide exposure to both the business units and IT. DeBenedictus' goal is to provide a program where learning is broad and deep, and where "hands on" development is emphasized over classroom training.

Working in cohorts, program members are challenged to develop their skills and knowledge every day through real-world experiences and structured coaching. To make the coaching effective, TCAP brings together individuals from across the organization, including AIGGS leadership, human resources, program advisors, technical capability leads, and peer-level buddies. Participants also gain valuable exposure to company leaders.

Since TCAP participants work side by side with experienced AIGGS employees, the program also benefits the current workforce, an integral goal of the effort. TCAP's predominantly Millennial demographic acts as a kernel for change that injects new knowledge and work styles into the organization, which gives experienced employees the opportunity to refresh their skills and explore new technologies—from social media and collaboration tools to cloud and wearable devices.

DeBenedictus understands that, when adopting new technologies, businesses can rarely afford to build all new systems and completely retire the old. IT organizations often must support a mix of legacy and new technologies. The TCAP program is designed to help AIGGS become a leading IT organization that can do both and that is also equipped to adapt to things that haven't even been foreseen yet. The first cohort of AIGGS's TCAP program launches in 2015—setting the foundation for AIG's IT workforce of the future.

Evolving the federal foundation

The United States General Services Administration (GSA) was created in 1949 when six agencies were consolidated into one large organization tasked with streamlining the administrative work of the federal government. Years of increasing responsibilities and expansion have resulted in an organization that is divided into bureaus and regions, each with its own leadership, infrastructure, and processes. GSA leaders recognize that, for the agency to fulfill its mission in the 21st century, it will need to operate more efficiently. Achieving this goal will likely require rethinking how GSA employees are organized, how they work and serve their



customers, and, equally as important, how the GSA IT organization can support new operational strategies.

On the technology front, Sonny Hashmi, GSA's CIO, developed a roadmap of seemingly minor investments that formed a new precedent for consolidation, standardization, and enhanced usability. Instead of attempting a sweeping overhaul, Hashmi focused on initiatives IT could spearhead, often in high-touch commodity areas. Email, document management, and collaboration suite projects yielded early wins. Many of these projects tapped cloud-based solutions that improved the user experience while also reducing cost and complexity. They also helped create a new technology environment—one driven by innovation and collaboration—that Hashmi now leverages to cultivate IT workers of the future. The agency proved to be an early adopter of cloud, open source, digital, and agile development—helping to lead the way for emerging technology adoption in the US federal government.

This groundwork is important as the GSA continues to modernize its IT footprint. A massive application modernization initiative, which includes a tenfold rationalization of more than 1,000 applications, is currently underway. Simplifying the core in this way frees resources that can be directed toward innovation and emerging technologies. Hashmi is also investing in retraining and reinvigorating the talent pool, preparing his people “for not just new tactical skills, but a new paradigm change in how IT is delivered.”

GSA IT teams now sit side by side with their internal customers, leveraging open platforms to iterate quickly. They use DevOps, UX, and cloud computing to build new capabilities that complement tried-and-true processes. The GSA has also begun transforming its office facilities by knocking down walls, eliminating assigned seating, and creating open meeting rooms. Rethinking the organization's workspace approach has led to

increased flexibility, agile work techniques, and cross-team collaboration. Using mobile technologies, workers can now connect to critical systems from anywhere at any time. This capability paid dividends during Hurricane Sandy, where field workers stayed operative wherever they could find an Internet connection—hotel lobbies, office parks, or public shopping centers. Hashmi also helped create a digital services agency called 18F—an internal innovation hub—which is composed of Presidential Innovation Fellows.

Finally, Hashmi is changing the GSA's approach to recruiting and hiring IT talent. Hashmi has had success recruiting former Silicon Valley players with the skills and experience needed to solve some of the government's toughest problems. His team now includes a dozen Silicon Valley technologists who are excited by the challenge, the potential impact, and the spirit of civic duty they find in their new roles.

Reorienting the IT organization

Deloitte LLP's information technology services (ITS) organization provides and maintains the infrastructure needed to support Deloitte's network of roughly 210,000 professionals. This global footprint comprises a wide range of applications consumed via a mix of corporate and employee-owned devices.

Over the last five years, Deloitte, like many of its clients, has been impacted by numerous technology trends, including the consumerization of IT, rising mobile adoption, cloud, and big data, among others. The rapid pace of technological change brought about by these trends has challenged ITS to transform its organization and operational models in ways that can help streamline and accelerate development projects. On the process side, this has meant adopting agile development techniques in which large investment programs are divided into small and mid-size releases, allowing small teams to work iteratively in

short sprints, making it easier to accommodate in-process design changes based on real-time feedback from customers and end users. Though more traditional waterfall techniques remain useful for some legacy projects and maintenance, ITS now approaches new initiatives from a “Why not agile?” perspective.

ITS has also shifted its resource mix from predominantly onshore resources, formerly organized in competency-based Centers of Excellence (CoE) and multitasking across multiple projects, to a new model in which teams of external, onshore, and offshore resources collaborate closely within autonomous delivery units—a studio model. Along with adopting the studio model, ITS has also altered its approach to recruiting new talent. Traditionally, fluency in English was a requirement for most offshore development roles, which limited the pool of potential candidates. In the studio model, only a small offshore mirror studio team—which regularly communicates with the onshore delivery management studio team—needs English proficiency. This frees ITS to hire leading candidates for specialized work, regardless of their language skills.

Additionally, ITS has begun hiring employees who bring more to the job than just technical degrees and IT experience. Prospective candidates are now expected to

possess three primary traits that can help teams create more user-centric designs: a focus on empathy, intellectual curiosity, and mastery of a particular craft (whatever that may be). Recent hires now come from a broad variety of backgrounds spanning 12 nationalities, 22 degrees, and dozens of majors, including computer science, information systems, graphic design, psychology, anthropology, art history, and sociology. Moreover, ITS now trains employees in non-traditional subjects, including the art of empathy and designing from a user-centric point of view, to better align with the design studio methodology. The result is a multidisciplinary team that blends creative, user experience, engineering, and functional knowledge to enhance creativity and innovation. Focusing on the end-user experience, the onshore studio teams conducts research and brainstorming to gain a deep understanding of customer needs, talks to end users to better understand their behaviors and motivations, looks at processes from end to end, understands the data involved, and seeks inspiration from existing paradigms in the external world.


Post-reorganization, on-time project delivery has risen from less than 70 percent to 94 percent, with corresponding increases in user adoption and engagement, and overall ITS organizational satisfaction.



My take

**Michael Keller, EVP and chief information officer,
Nationwide Mutual Insurance Company**

An important part of Nationwide's IT strategy is to become a learning-driven organization that anticipates and adapts to changes in business demand and technology trends. We know that the incredible pace of technology change means we need to rethink traditional, incremental approaches to workforce development and planning. We're committed to keeping an internal competency in IT, and we realize that the size and skill sets of our IT workforce will be substantially different in the future. To get from here to there, we're evaluating a variety of approaches, including how we recruit and train employees, manage suppliers, and form vendor alliances.



Nationwide IT has teamed with our company's human resources and sourcing and supplier management groups to take a fresh look at workforce needs, organizational optimization, and associate readiness for change. Together, we are working to better understand our workforce acquisition process and the way we deploy internal and external resources. Our goal is to become more efficient at measuring the success of our vendor partners and to develop support mechanisms that help associates and leaders strengthen their roles in the change process. With the engagement and involvement of our associates, we are focusing on career development opportunities. As a result of many of these efforts, we are experiencing higher retention, productivity, and loyalty. It's a two-way street that works for both our associates and Nationwide. It's about a commitment to our people—which is a core value for our organization.

Technology trends are creating significant changes in the way IT associates approach their jobs. For example, our move from custom-developed applications to package and SaaS-based solutions changes the way our application development teams work. Similarly,

the move from traditional server-storage-network infrastructures to highly virtualized, standardized, and automated cloud infrastructures is altering the way Nationwide's infrastructure teams design and support our technology towers.

Planning ahead will smooth the change for both the company and our associates. We identified the future skill mix needed in our nine IT professions, which are organized around technology domains such as architecture, application development, and project management. By understanding future IT needs and skills, we can create a roadmap, plan for the change, and educate our associates. Our leaders are refreshing career guides, leading formal training, facilitating lunch-and-learn sessions, and creating on-the-job opportunities. We also are exploring external opportunities to augment experiences and accelerate the ramp-up.

Making Nationwide a learning organization is central to creating the IT worker of the future. We are fostering the idea that learning is both an organizational and individual mandate. Hiring great people and giving them the right tools for lifelong learning is important, so we are developing a multifaceted learning approach that targets real-time learning across IT disciplines and keeps pace with technology change.

Managing talent needs isn't restricted to within the four walls of Nationwide. Here in Columbus, Ohio, I serve on the board of Columbus 2020, a non-profit partnership that brings together leaders from local businesses, academic institutions, and government entities to drive economic development. We are working together through the formation of the Columbus Collaboratory to increase the pipeline of talent in central Ohio and develop the skills of our current workforce in areas like cyber security and big data analytics. While there are many innovative ways to close IT talent gaps, it is critical to begin with a clear picture of your future IT workforce needs.

Cyber implications

TECHNOLOGY has entered an era of usability, openness, and convenience. End users expect solutions to be simple, intuitive, and easy to use, not just for the IT worker of the future, but for the entire workplace of the future.

At the same time, the stakes around cyber security and data privacy continue to increase, making cyber risk management a strategic priority across industries. Yet traditional techniques like complex passwords, containers, key fob two-factor authentication, and CAPTCHA verification can interrupt the end-user journey. Frustrated users may look for shortcuts or alternative means for carrying out their business. In doing so, they often bypass controls and introduce new vulnerabilities. Security protocols can only be effective if users follow them.

Therefore, it is critical to balance the need for security with a focus on user experience (UX) by creating a well-integrated, unobtrusive risk framework that is anchored around the end user's journey. Superior user experiences will have security attributes so tightly integrated that they are barely noticeable; they can quietly and unobtrusively guide users toward more vigilant and resilient behaviors. For example, technical advances in fingerprint authentication, facial recognition, and voice detection embedded into commonly used consumer devices make it possible to protect without sacrificing user interface flows.

This marriage of UX and cyber risk management has a dark side. New threat vectors target weaknesses of specific personas within your employee base—spoofing alerts to update mobile apps with malicious proxies or corrupted links posing as social media interactions. The response cannot just be more usable, intuitive, risk-managed systems—education and awareness are critical. Arm your employees with not only the “what,” but the “why” and the “so what.” Beyond enforcing compliance, make cyber risk management a strategic organizational pillar and a shared cultural concern embedded across solution life cycles and operational processes. A broader enterprise governance structure can help, communicating the intent and importance of cyber security measures. Your employees should be taught how to identify and handle risk, not just how to comply with the minutiae of policies and controls.

The combination of cyber-aware user experiences and education programs can elevate security and privacy beyond being reactive and defensive. And IT workers aren't just end users. They are also the creators and managers of the systems and platforms that drive the business. Cyber security and privacy should be tightly integrated into how software is delivered, how systems are maintained, and how business processes are executed. As new IT organizational and delivery models emerge, build muscle memory around modern approaches to security and privacy. The IT workers of the future can become the new front and back line of defense—informed, equipped, and empowered.

Where do you start?

CHANGE can be hard in any organization. For IT, balancing the demands of tomorrow with the realities of today can be daunting, especially given the care and feeding needed for the existing IT footprint at the core of the business. Describing the IT worker of the future may not be easy, but driving the organizational change needed to realize that vision can seem impossible. Below are some ways to embark on the process.

- **Find your leaders.** Establishing a culture where the IT worker of the future can thrive starts at the top. What is the reputation of the IT department in the business and market at large? Are deep technologists celebrated or commoditized? Role models should be put into leadership positions throughout the organizational chart and measured partially by how they activate communities around them. Hewing to hierarchies and reporting channels is less important than fostering connectivity, education, and growth anchored in the creative, design, and technical skills central to your strategy.
 - **Recruit differently.** Externships can put candidates quickly to work through “speed dating” versions of internships. They can also be used to vet the transfer of individuals within and across your organization—a “try before you decide” method that allows both parties to understand aptitude, fit, and interest. Similarly, some companies are hosting internal and external “hackathons,” day- or weekend-long competitions where participants rapidly explore, prototype, and demo ideas. Hackathons are no longer exclusively the domain of the tech-savvy startup or tech giant; state and municipal governments, as well as established
- companies such as 7-Eleven, Aetna, and Walgreens, are leveraging hackathons to unlock innovation.¹⁶ Hiring decisions can be based on demonstrated results instead of on resume depth and the ability to navigate a round of interviews. Finally, consider training employees with no technical background—38 percent of recruiters are actively doing so to fill IT positions.¹⁷ Graphic designers, artists, cultural anthropologists, behavioral psychologists, and other backgrounds are fantastic building blocks for user experience, mobile, data science, and other desperately needed skills. Adding “A” to the STEM priorities can be a key differentiator, especially as design rises as an important discipline needed in IT departments.¹⁸
- **Industrialize innovation.** Harness the energy of your people in previously untapped ways to give them an outlet and vehicle for exploring new and exciting skills. Not every organization can afford to give employees open-ended time for continuous innovation, as do Google¹⁹ and Netflix.²⁰ However, companies should have a mechanism for submitting, exploring, and potentially developing new ideas. From ongoing idea competitions to marketplaces that match interest and need around new technical skills, enterprises should encourage people to grow and find ways to put their passion to work.
 - **Embrace virtual.** Create a culture and provide tools that allow and support remote workers. Given the global nature of many teams, productivity, collaboration, and communication tools are essential. Companies should provide them to full- and part-time employees as well as selected third parties for specific durations.

To retain institutional experience, organizations should consider contract arrangements for aging employees that offer part-time packages at lower compensation and benefits.

- **Outside in.** To achieve positive results, organizations will likely need to participate in external talent ecosystems. Define a crowdsourcing strategy that guides the usage of crowd platforms to solve your organization's problems, and give employees permission to participate in crowd contests, on the job or off the clock. Incubators and start-up collaboration spaces are looking for corporate sponsors; they provide a chance to co-locate workers with inventors and entrepreneurs exploring new ground. Institutions such as Singularity University and the MIT Media Lab offer education programs and opportunities to collaborate with leading researchers in areas like advanced manufacturing, artificial intelligence, medicine, social computing, and big data. Deliberately seek out briefings and ideation sessions with your vendor and partner community to harness software, hardware, system integrator, and business partner thinking and research.
- **Light your talent beacon.** Your own people are critical to attracting the IT workers of the future. Seventy percent of Millennials learn about job opportunities from friends; 89 percent of software engineers are staying put, having applied for fewer than two jobs in the past five years.²¹ Leading organizations need to be a net importer of talent, and the front lines start with their people. Communicate your vision for the organization, commit to the talent strategy, and invest in incentives to drive retention and referrals.
- **Transform HR.** Not an insignificant task. Not every employee is being hired to retire, and the future worker of IT (and workers in other departments) will likely need a different set of services, support, and development than they receive today. HR can become a competitive weapon in the war for talent by shortening the time needed to develop the IT worker of the future.²² HR may need to be overhauled along with your IT organization by shifting its focus from people and policy administration to talent attraction and development. HR transformation initiatives should consider the IT worker of the future—not just the existing employee base.



Bottom line

THE IT worker can be the bedrock of an organization's ability to compete in this era of exponential technologies. But beyond rhetorical remarks about talent scarcity, few organizations are investing in attracting, retaining, and developing their organizational capabilities. And while companies will secure commoditized skills through the most efficient means, innovation and growth will depend on workers with the skills and the vision needed to reimagine the art of the possible within the bounds of existing constraints such as the realities of existing systems and data and a limited understanding of emerging, cross-discipline technologies. While future technologies may not exist today, the need is clear, the potential is immense, and the time is now to start retooling your people to be the IT workers of the future.

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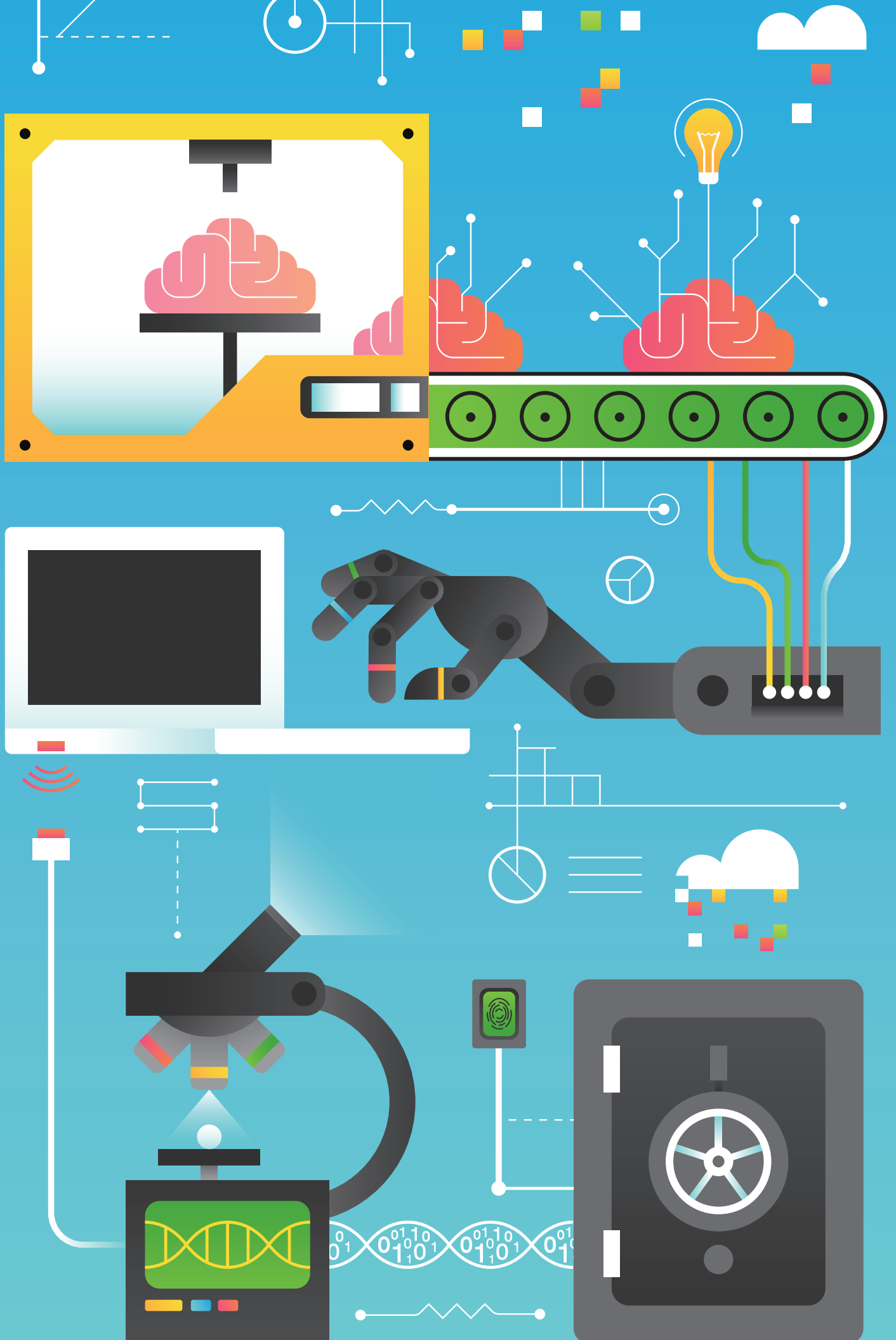
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Exponentials

Inspiring disruption

In our *Technology Trends 2014* report, we took a look at “exponentials” for the first time. In collaboration with faculty at Singularity University, a leading research institution—based in the heart of Silicon Valley and whose founders include Cisco, Google, and others—we explored innovations that are accelerating faster than the pace of Moore’s law, that is, technologies whose performance relative to cost (and size) doubles every 12 to 18 months. The rapid growth of exponentials has significant implications. Powerful technologies—including quantum computing, artificial intelligence (AI), robotics, additive manufacturing, and synthetic or industrial biology—are ushering in new and disruptive competitive risks and opportunities for enterprises that have historically enjoyed dominant positions in their industries. In this year’s *Technology Trends* report, we once again discuss exponentials to build awareness and share new knowledge about their trajectory and potential impact.

Exponentials bring a whole new meaning to an organization’s ecosystem strategy

There is significant hype surrounding exponentials, and we caution organizations not to pursue each exponential as the next new “shiny object.” For corporate executives who are crafting three- to five-year strategic plans, such a narrow focus could overshadow the broader issue: Significant change in industry landscapes will likely need much more than a technology strategy. The goal should be as much about developing organizational capabilities, particularly related to innovation intent, to navigate the pace of change as about understanding and determining the implications of any individual breakthrough.

A totally new type of “exponential entrepreneur” is emerging as exponentials usher in new players and alter market dynamics. The new breed is using crowdsourcing, crowdfunding, and cloud solutions to scale quickly. An army of

entrepreneurs enjoying diminishing barriers to entry and with an appetite for taking on significant risk pose new competition for established organizations. At the same time, they can provide new opportunities for market partnerships and alliances. The disruption theory of Singularity University's co-founder Dr. Peter Diamandis is playing out across industries: As technologies become digitized and thus able to dematerialize existing products and solutions, there is potential for them to become democratized, which could threaten the market positions and demonetize the margins of existing players. Exponentials are not solely the domain of research labs, start-ups, and incubators. Indeed, large global organizations can also harness these forces with dramatic effect. But doing so may likely require bold and imaginative thinking, discipline, and a commitment to reshaping business as usual.

Enough attention has been paid to innovation to debunk myths of spontaneous, breakthrough eureka moments. As Peter Drucker famously said, "Innovation is work rather than genius."¹ How do large enterprises, agencies, and organizations invoke and harness these forces? By establishing a deliberate, measurable approach to identifying, experimenting, and investing, while also cultivating an environment for organic and creative entrepreneurial-minded innovation.

Leading companies are crafting effective innovation strategies that encompass four dimensions: trend sensing, ecosystems, experimentation, and edge scaling.

Trend sensing

In trend sensing, organizations find ways to stay on top of new developments in technology, and to identify and understand the exponential forces and sustaining advances

affecting established fields. Establishing a culture of curiosity and learning in your organization helps, but it likely won't be enough, considering the pace of change and the complexity of emerging fields. To scope and scan, or "sense," and then participate in emerging technology and business trends, companies should consider several concurrent approaches. First, companies should leverage their existing set of partners, vendors, and alliances in order to get the pulse of their direct and closest collaborators. This can include holding joint innovation workshops to understand the variables directly impacting a company's organization. This can help CIOs and other strategists tap into new thinking and their legacy partners' roadmaps that can, in turn, spur new ideas. This can also start the process of collaboration within traditional circles while identifying and launching leading change agents.

In addition, many organizations are establishing internal research and development functions to explicitly monitor advances and imagine impacts to the business. Scenario planning techniques are then being used to turn these due diligence and discovery activities into potential real-life business opportunities or threats. For example, one retail company has hired science fiction writers to explore the future of retail.² Other organizations have incorporated demos, prototypes, and visual storyboards to bring R&D-originated concepts to life—using "show" instead of "tell" to break out of incremental thinking. Some leading companies are also forging new relationships and developing a broader ecosystem with non-traditional stakeholders—such as start-ups, scientists, incubators, venture investor communities, academia, and research bodies—which can lead to a wide range of fresh perspectives.

Ecosystems

New relationships indicate shifting ecosystems—the communal networks in which companies partner, compete, collaborate, grow, and survive. Historically, many organizations have created ecosystems characterized by traditional relationships—for instance, partnerships with long-standing vendors, suppliers, and customers. Or they might have forged alliances with complementary organizations to collaborate on sales and marketing efforts. With these partnerships come well-established operating protocols that foster consistency and predictability. For example, long-standing supplier and manufacturer ecosystems have been prewired for efficiency, with little margin for error.

When innovation is linearly paced, these ecosystems are effective. However, as the pace of change from disruptive technologies increases exponentially, traditional notions of an ecosystem may need to be redefined and, in many cases, flipped on their head. The mind-set for new ecosystems should be agile and adaptable instead of prewired and static. For companies that are accustomed to linear change but are planning for exponential change, the requirements gap may prove to be significant.

Consider an established automotive manufacturer with an ecosystem evolved from, and centered on, traditional manufacturing techniques to produce consistent products for a fairly constant set of customers. Then suddenly, due to exponentials such as AI, robotics, and sensors, the important parts of the automobile shift from engine performance to in-car technologies such as self-driving controls and augmented reality infotainment systems. Instead of manufacturing techniques,

on-board mini-supercomputers, analytics, and customer experiences have become competitive differentiators. At the same time, crowdsourcing is disrupting the consumer automobile market, for example, through services such as Uber, Zipcar, and Lyft. Combined, this perspective shift will likely need to be accompanied by the introduction of a new set of partners working in collaboration with a company's existing alliances and strategic partners—players from relevant adjacencies such as a new breed of entrepreneurs, start-ups, venture capitalists, scientists, and engineers, that have not been traditionally on an organization's radar.

Experimentation

In the third dimension, experimentation, organizations rewire planning, funding, and delivery models so they can explore new concepts and ideas. Most large enterprises have somewhat linear approaches to investing, predicated on thorough business cases built around concrete ROI and fixed timelines. For an exponential organization, a culture of critical mass experimentation should be fostered and embedded into the process of learning and growing—failing fast and cheap, yet moving forward. Doblin³ has defined 10 distinct types of innovation, many oriented around organizational structure, business model, channel, or customer experience.⁴ Strategies include: Think beyond incremental impacts. Moreover, don't constrain ideas to new products and business offerings. In early stages, forgo exhaustive business cases, and focus instead on framing scenarios around impact, feasibility, and risk. Consider co-investment models for emerging concepts that allow vendors and partners to more collectively shoulder the risk.

THE EXPONENTIAL ORGANIZATION

Salim Ismail,

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Lead author, *Exponential Organizations: Why New Organizations Are Ten Times Better, Faster, and Cheaper Than Yours (and What to Do About It)*

A new technology that scales quickly from one to a million users has become a common and straightforward phenomenon. Scaling an organization at exponential speed, however, is quite another matter. Organizational growth is usually linear—incremental and slow. In recent years, however, a new breed of exponential organizations (ExOs) such as Waze and WhatsApp have experienced dramatic growth trajectories and achieved multibillion-dollar valuations in just a few years.⁵

Unlike traditional businesses that combine assets and workforces within organizational boundaries and sell access to it, ExOs leverage the world around them, such as other people's cars and spare rooms. In our benchmarks, they outperform their competitors at least tenfold. A traditional consumer product company, for example, takes an average of 300 days to move a product from idea to store shelves. Quirky, an ExO that crowdsources new product ideas, can move products through the same process in 29 days.⁶

Most of the key drivers of this new breed of ExOs can be boiled down to two acronyms: SCALE and IDEAS. SCALE comprises the external mechanisms that ExOs use to fuel their growth:

- **Staff on demand:** ExOs leverage external resources instead of maintaining large employee bases.
- **Community and crowd:** ExOs build and join communities to achieve rapid scale.
- **Algorithms:** As the world turns to big data, ExOs excel in the use of algorithms and machine learning.
- **Leased assets:** ExOs access or rent assets to stay nimble. For example, Lyft doesn't own its cars.
- **Engagement:** Techniques such as gamification and incentive prizes are core to ExOs' ability to quickly engage markets.

IDEAS comprises the internal control mechanisms that ExOs use to increase their organizational velocity:

- **Interfaces:** ExOs configure interfaces for their external constituents. Uber, for example, has its own system to manage its drivers.
- **Dashboards:** To track and monitor performance, ExOs use real-time metrics and performance-tracking techniques like the Objectives and Key Results methodology.
- **Experimentation:** ExOs use approaches such as lean production for rapid experimentation and process improvements through fast feedback loops.
- **Autonomy:** ExOs are extremely flat organizations, sometimes with no management layers.
- **Social:** File sharing and activity streams drive real-time, zero-latency conversations across the organization.

There are currently between 60 and 80 ExOs that are delivering extraordinary results.⁷ Their rapid rise portends a new way of how businesses may be built and operate in the future. Established enterprises should consider these changes sooner rather than later.

Figure 1. Design principles

		DESIGN PRINCIPLES			
		Start How do you start?	Organize How do you mobilize the right resources?	Amplify How do you use disruption to grow?	Perform How do you measure success to improve?
LEVERS	Focus Maximize upside potential.	FOCUS on edges, and not the core, to find a potential initiative that can transform the business.	STAFF for passion before skills to enable change with driven individuals.	BREAK the dependency on core IT to enhance the ability to grow with minimal investments.	EMBRACE double standards to track metrics that are meaningful to the core and the edge.
	Leverage Minimize the investment required.	LOOK externally, not internally to avoid internal obstacles.	STARVE the edge to drive discipline and creativity.	MOBILIZE the passionate outside the firm to leverage external expertise.	MEASURE progress of the ecosystem to benchmark effectiveness.
	Accelerate Compress lead times.	LEARN faster to move faster to develop a constant feedback loop that accelerates learning.	REFLECT more to move faster to progress new thinking through a faster iteration cycle.	MOVE from dating to relationships to encourage collaboration amongst the ecosystem.	FOCUS on trajectory, not position, to evaluate the rate of learning and improvement.

Source: Deloitte Development LLP, *Scaling edges: A pragmatic pathway to broad internal change*, 2012.

Scaling edges

Enterprises should learn to scale at the edge. Even if they are conscious of looming disruptive forces, linear biases may cause company executives to underestimate exponentials' pace of change. In the early years, exponentials have little discernible impact. Their positive effect will likely be dwarfed by the impact of incremental changes to existing forces. Core businesses will likely continue to require care and feeding, even if they are under threat of longer-term disruption. On top of that, executives who attempt large-scale internal change and transformation may face a

great wall of resistance. John Seely Brown and John Hagel have conducted extensive research on achieving innovation at an institutional level.⁸ Their recommendation is to establish new teams on the fringes, or "edges," of the organization to foster exponential innovation.⁹ Design principles and strategic levers for the full life cycle of scaling edges are described in figure 1.

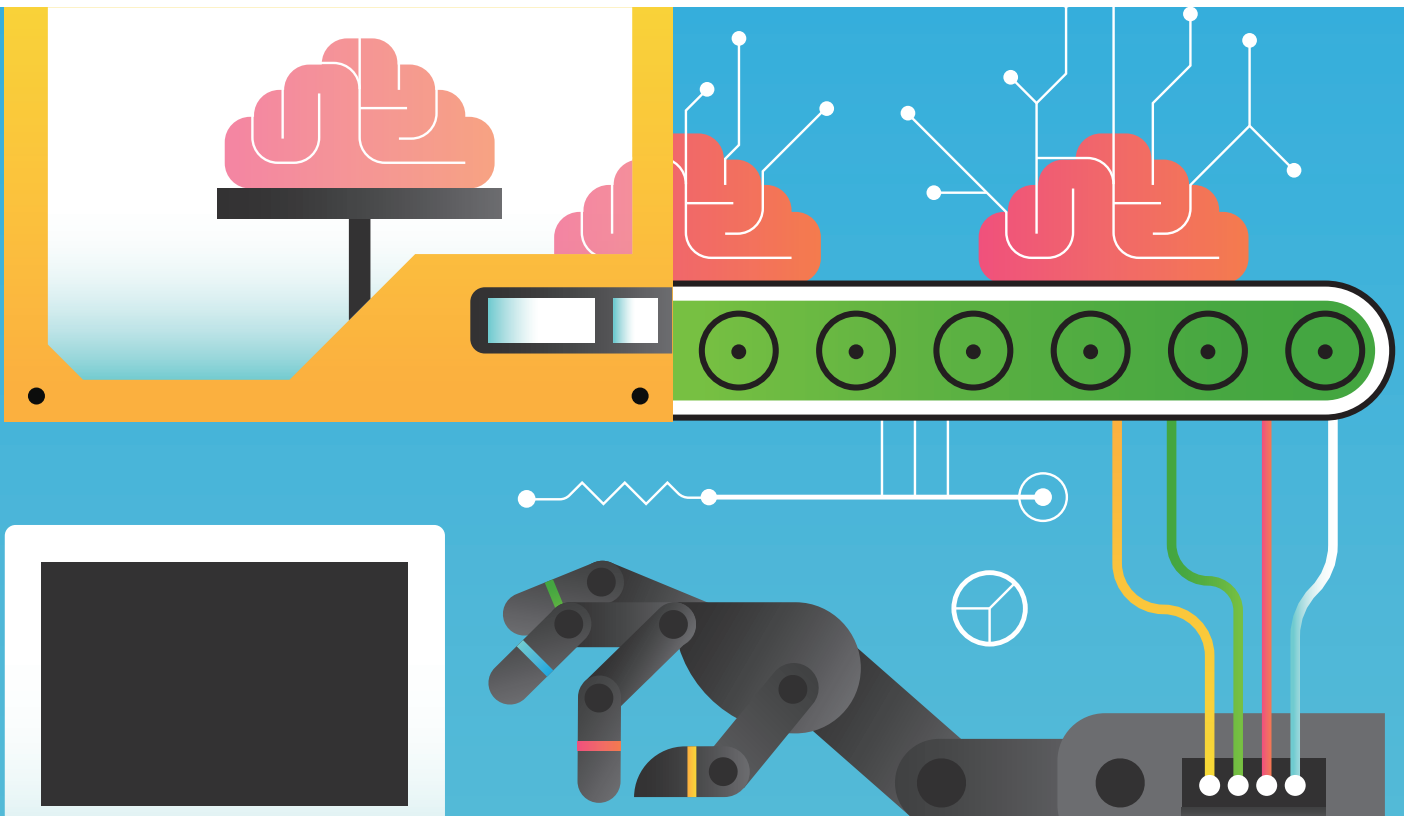
Exponentials will continue to change the landscape for many industries in the next decade. Beyond understanding the technologies coming online, organizations—particularly those that have been evolving

more linearly—need to understand the broader context of their industries, markets, and business models.

A continuum exists across sectors and geographies. On one extreme is the unprecedented opportunity for innovation and growth, as work is being reshaped, customers are being engaged with different technologies, and competitive fabrics are being reimagined. On the other lies the existential threat of disruption. These are conditions in which start-ups and entrepreneurial market makers can thrive. Large enterprises that have historically dominated their industries can also thrive in these conditions, but it is necessary to recognize the opportunities at hand (and their potential impacts), take deliberate action, and evolve into exponential organizations.

In this report, we provide a high-level introduction to six exponentials: **artificial intelligence, robotics, additive**

manufacturing, quantum computing, industrial biology, and cyber security. Each exponential is being propelled by significant investments and research across the public and private sectors. Our goal is to drive awareness by providing a snapshot of what each is, why it matters, and where it is going. Executives should consider how to embrace exponentials to innovate and disrupt their enterprises, agencies, and organizations—before they themselves are disrupted. Exponentials are deceptive by nature, as the doubling effect seems relatively minute in the early phases, but then the impact appears quite abruptly and powerfully, as the larger doublings double. By taking a more proactive stance on innovation as an organizational competency, companies have an opportunity to better understand and harness exponentials as building blocks so as not to be caught unaware—or unprepared.



Artificial intelligence

Although artificial intelligence (AI) may still conjure up futuristic visions of cyborgs and androids, it is becoming embedded in everyday life, and supporting significant strides in everything from medical systems to transportation. AI is augmenting human intelligence—enabling individual and group decision makers to utilize torrents of data in evidence-based decisions.

Since the first AI meeting in 1956, the field has developed along three vectors. The first, machine learning, emulates the brain's ability to identify patterns. The second, knowledge engineering, seeks to utilize expert knowledge in narrow domain and task-specific problem solving. Reverse engineering of the brain is the third. Tools such as electroencephalograms (EEGs) and functional magnetic resonance imaging are used to identify what parts of the brain perform specialized tasks. Researchers then attempt to replicate those tasks in software and hardware using similar principles of operation.

Although IBM's Watson has captured much of the AI attention, it is not the only recent breakthrough. In 2011, for example, the DARPA-sponsored Synapse program developed a neuromorphic, or cognitive computing, chip that replicates some neural processes with 262,000 programmable synapses. In 2014, IBM announced the True North architecture for neuromorphic computing and a chip that has 256 million configurable synapses and uses less power than a hearing aid. These chips could eventually outperform today's supercomputers. They also represent a dramatic increase in the processing power of a low-power chip and a significant shift in the architecture that can support AI.

The Deep Learning algorithm is a powerful general-purpose form of machine learning that is moving into the mainstream. It uses a variant of neural networks to perform

high-level abstractions such as voice or image pattern recognition. Pioneered in 2006 by Geoffrey Hinton, a professor at the University of Toronto and researcher at Google, Deep Learning is proving its metal across a diverse spectrum of challenges—from new drug development to translating human conversations from English to Chinese. Google is using Deep Learning with its Android phone to recognize voice commands and on its social network to identify and tag images. Facebook is exploring Deep Learning as a means to target ads and identify faces and objects.

A company called Deep Mind that was acquired by Google recently announced a Neural Turing Machine. This computing architecture utilizes a form of recurrent neural networks that can do end-to-end processing from a sensory perception data stream to interpretation and action. This system has been used to learn games from scratch, and in some cases has demonstrated better-than-human-level performance.

AI is expected to impact the world of work significantly. It can augment humans in complex work requiring creativity and judgment, and likely will increasingly substitute for routine labor. We are beginning to see task assistants and associate systems that, with the right interface, allow humans to delegate work to a computer.

Authored in collaboration with Neil Jacobstein, Artificial Intelligence & Robotics co-chair, Singularity University

In addition to Jacobstein's role at Singularity University, he is a distinguished visiting scholar in the Stanford University Media X Program and chairman of the Institute for Molecular Manufacturing. Jacobstein has served as a technical consultant on AI research and development for a variety of industry, nonprofit, and government organizations.

Robotics

Although mankind has been seeking to create mechanical devices that can perform simple and complex tasks for millennia, AI and exponential improvements in technology are bringing what were once futuristic visions into the mainstream of business and society.

Replacing menial tasks was the first foray, and many organizations introduced robotics into their assembly line, warehouse, and cargo bay operations. Since those initial efforts, the use of robotics has been marching steadily forward. Amazon, for example, has largely automated its fulfillment centers, with robots picking, packing, and shipping products in more than 18 million square feet of warehouses.¹⁰ Traditional knowledge work is the next frontier, and real-time gathering and interpretation of data is likely to be replaced by machines. Essentially, almost every job will be affected by robotics at some point.

Robotics replacing existing jobs, however, is only part of the picture. The International Federation of Robotics estimates that these devices will create between 900,000 and 1.5 million new jobs between 2012 and 2016. Between 2017 and 2020, the use of robotics will generate as many as 2 million additional positions.¹¹ A major factor in robotics-driven job growth is the simple fact that the combination of humans and machines can often produce better results than can either on their own.

An example is the 2009 emergency landing of a US Airways jet in the Hudson River. Confronted with complete engine failure, the pilot had to assess several risky options ranging from gliding to a nearby airstrip to landing in the river. AI could fly the plane, and one day it may be able to land one on water. The decision to do so, however, may always require an experienced pilot.

More prosaic examples are steadily emerging in business. Marlin Steel, for example, once employed minimum-wage workers to perform the dangerous task of bending long metal wires. Now robots do the work, which substantially increases the company's output and ability to grow demand by reducing its prices. As a result, workers can now earn more by maintaining and supervising a growing number of robots.¹²

Robotics should be on many companies' radar, and businesses should anticipate workplace tension as they are introduced. To ease the tension, companies should start by replacing repetitive, unpleasant work. Business leaders should then identify jobs that robotics will replace over the next 10 years and leverage attrition and training to prepare employees for new roles. The challenge for businesses—and society as a whole—is to drive job creation as robotics makes many jobs redundant. It certainly can be done.

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Dan Barry is a former NASA astronaut and a veteran of three space flights, four spacewalks, and two trips to the International Space Station. He is a physician and engineer (MD, PhD) and his research interests include robotics, signal processing with an emphasis on joint time-frequency methods, and human adaptation to extreme environments.

Additive manufacturing

The roots of additive manufacturing (AM) go back to 19th-century experiments in topography and photosculpture. Centuries later, the technology, commonly referred to as 3D printing, holds the potential of eliminating some long-standing trade-offs between cheap and good by potentially erasing the cost of complexity. Using AM, whole objects, including those with moving parts, can be created layer by layer, significantly lowering assembly costs. By applying the exact amount of material required for each layer, AM can also reduce waste in production processes. And by virtue of its ability to handle a broad range of geometric configurations, AM opens the door to radically new manufacturing designs. Because of its sweeping potential, AM is moving from a rapid prototyping tool to end-product manufacturing: Companies such as General Electric, Boeing, and Diametal have used AM to build end-user products, with positive results such as faster production runs and more durable products.¹³

Deloitte research found that many companies using AM typically travel along one of four paths based on how much, or how little, they choose to impact their supply chains or products.¹⁴ The first path, stasis, is often the entry point as businesses seek low-risk opportunities to improve current products and supply chains. For example, jewelry companies are using AM to create assembly jigs, and aerospace manufacturers are printing parts used in chroming and coating processes.¹⁵ Along the second path, enterprises are turning to AM to transform supply chains. For example, hearing aid producers are using the high level of customization available with AM to reduce the back and forth between the doctor's office and manufacturer.

Product innovation is the third path, and businesses are increasingly using AM to customize products. Footwear companies, for example, are starting to use the technology to manufacture running shoes based on customer biomechanics. Along the fourth path, companies alter both supply chains and products in pursuit of new business models. The bathroom fixture manufacturer Symmons is a case in point. It is interacting directly with its supply chain customers to design and create new custom-made fixtures.¹⁶

The choice of path should be anchored on a business case that compares AM against traditional manufacturing methods from the perspective of both direct costs and indirect factors. In terms of direct expense, AM can significantly reduce the costs of tooling. In one example, an aircraft manufacturer used AM to produce brackets that reduced the weight of an airliner by 22 pounds.¹⁷ Although the reduction may seem slight, it saved customers more than \$400,000 annually in fuel costs per plane.¹⁸ Businesses should consider the value to their customers when evaluating AM for their organization.

Authored in collaboration with Mark Cotteleer, research director, Deloitte Services LP

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My take

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With news of 3D printing projects appearing almost daily, it is easy to assume that the technology is a “big bang” disruption with overnight achievements. That is not the case. Like many disruptions, 3D printing took decades to develop. It finally stepped center stage because of Chuck Hull’s indefatigable vision.

Hull invented 3D printing in the 1980s and founded 3D Systems to commercialize the technology.

For the first 20 years, development was slow, extraordinarily expensive, and saddled with complicated user interface challenges.

In the early 2000s, despite its first mover advantage, the company nearly went bankrupt. Today, 3D Systems’ market cap is more than \$3 billion¹⁹.

Hull’s vision girded his confidence to fight the many battles encountered on the road to disruption. Like many entrepreneurs, Hull had to cope with investors, board members, employees, and customers who continually doubted the new idea. When a company is creating something disruptive and new, many people won’t believe it until they can hold it.

And even then, they might be skeptical about its market potential.

Hull’s commitment, courage, and capability helped him surmount these challenges and execute his vision. Conviction is needed to endure the experience of repeatedly failing and learning, and, ultimately, convincing and disrupting. It arguably underpins what Apple Inc. famously dubbed as “the crazy ones.” In its 1997 television commercial, the company pointed to Bob Dylan, Martin Luther King Jr., and Thomas Edison as exemplars whose visions and convictions fell outside the status quo and ultimately changed it.

Vision and conviction aren’t always enough by themselves, however. They need fluid organizations to achieve their impact. Businesses likely won’t be able to keep pace with exponentials, much less disrupt markets, if they stick to an incremental approach to innovation that is siloed in many departments. Exponential technologies, including these six, are simply too intertwined and advancing too rapidly for status quo organizations to keep pace.

3D printing, for example, is part of the larger exponential, robotics. Robots, in turn, are being endowed with AI, which will likely move them far beyond stocking shelves to running driverless cars and even performing surgery. By 2020, the Internet of Things exponential will connect more than 50 billion devices to the Internet.²⁰ IoT devices and trillions of sensors will connect to machines with sophisticated artificial intelligence. Finally, infinite computing power will combine with AI to transform the field of synthetic biology to create everything from new foods to new vaccines.

Vision breeds confidence, which, in turn, breeds conviction. Both are crucial to surmounting the obstacles of introducing the new. In an age of daunting uncertainty, being the first to disrupt the status quo should be a top agenda item. If you don’t disrupt yourself, a competitor eventually will.

Quantum computing

Computing, as we typically understand it, reflects our experience of the physical world and the mathematics behind it. Beneath that experience, however, is the complex and counterintuitive mathematical reality of quantum mechanics. Some 30 years ago, Paul Benioff, a scientist at Argonne National Laboratory, posed the idea that if computing could be based on quantum physics, it could gain unimaginable power and capability.²¹

The potential power of quantum computing stems from its ability to free computing from sequential binary operations. Even the most powerful computers rely on combinations of 0s and 1s and computations performed discretely. Quantum computing, on the other hand, encodes information as quantum bits, or qubits. Qubits mimic the reality of quantum physics where subatomic particles can exist in multiple states concurrently. As a result, qubits can represent not only 0s and 1s but everything in between at the same time. Thus, instead of a sequence of individual calculations, quantum computing can perform countless computations simultaneously. The potential is profound. By some estimates, quantum computers could solve problems that would take conventional machines millions of years to figure out.²² In theory, they could perform some calculations that conventional computers would take more than the life of the universe to complete.

Although no one has created a practical version of a quantum computer, D-Wave, in Vancouver, Canada, is researching an alternate model of quantum computing called quantum annealing.

Google is also investing in the technology. Google has been experimenting with D-Wave's computers since 2009 and recently opened its own labs to build chips similar to those of D-Wave.²³ Whether or not these efforts pan out is an open question. However, the attention

of technology industry giants underscores the lure.

Given the mounting volume and importance of big data, quantum computing's ability to solve complex mathematical problems opens astonishing vistas in everything from predicting the weather to developing new drugs. Nonetheless, the ability to solve complex mathematical problems is also a source of angst. Quantum computing may be able to factor extremely large numbers quite readily. Factoring, however, lies at the heart of virtually all public encryption systems. Current cryptography is deemed safe because it could take lifetimes for even the most powerful computers to crack the code. A quantum computer could conceivably crack it in minutes. Were that to happen, all financial transactions and authentications moving across the Internet could suddenly become vulnerable.

Authored in collaboration with Brad Templeton, Networks & Computing chair, Singularity University

Brad Templeton is a developer of and commentator on self-driving cars, software architect, board member of the Electronic Frontier Foundation, Internet entrepreneur, futurist lecturer, and writer and observer of cyberspace issues. He is noted as a speaker and writer covering copyright law, political and social issues related to computing and networks, and the emerging technology of automated transportation.

Industrial biology

Unlocking the complex logic of the genome has been a quest of scientists and businesses for decades. In the past, the high cost of experimentation has prevented organizations from pursuing industrial-strength genomics. The budget to first sequence the human genome, for example, was almost \$3 billion.²⁴

Today, however, digital technologies are fueling the field of industrial and digital biology, ushering in a renaissance in the ability to manipulate DNA, splice genes, and control genomes. Broad access to hardware, data, and tools is bringing costs down quickly. With CRISPRs (clustered regularly interspaced short palindromic repeats), for instance, researchers can edit a gene for less than \$1,000. On the not-so-distant horizon, desktop applications may drop that expense to a few dollars.

Costs have not been the sole barrier to the advancement of genomics, however. The public's concerns over genetic engineering have constrained research frontiers despite the value of many applications. Already in the 1990s, genomics saved Hawaiian papayas from near extinction. Similar efforts are underway to protect US orange trees from a deadly parasite that could turn a staple of American breakfast, orange juice, into a luxury item. Companies such as NatureWorks and Calysta are making notable progress in bioplastics to create environmentally sound plastics and fibers.

The tide of public opinion may turn as digital biology drives significant strides in human health. Such strides are already underway. Pharmaceutical companies are increasingly bringing genetically engineered drugs to market that target previously almost intractable conditions. Companies are also making advances in creating and controlling microbes. Soap, for instance, could be replaced with a microbial spray that contains good microbes to control harmful ones. Microbes can also be ingested to control weight and improve moods.

Digital biology's greatest impact on health may likely occur at the intersection of medical science and big data. That intersection holds the potential of genetic maps of our body's systems and wearable devices that sense when something is wrong in those systems. Google recently launched a major research project that will underpin the creation of such maps. In 2014, the company announced its Baseline Study that is crowdsourcing a genetic picture of human health to help medical professionals identify biomarkers of diseases early in their development. The project is collecting genetic and molecular data from 175 people, and Google plans to expand the research to include thousands of participants.²⁵

Google is using wearables to capture data such as how people metabolize food and how their hearts beat—for example, smart contact lenses that measure glucose levels. Companies such as Germany's Bragi are starting to commercialize wearables with similar capabilities. Bragi is developing tiny wireless earphones that not only store 4GB of audio files, but also monitor heart rate and oxygen consumption. Bragi's goal is to turn earphones into a platform with an overall sensor system for the body.

Industrial biology's combination of individual genetic maps and sensors that detect what may be amiss will drive vibrant new ecosystems. Technology, pharmaceutical, health care, and electronics companies may find themselves collaborating in new ways to bring industrial biology's potential to bear on the public's health.

Authored in collaboration with Raymond McCauley, Biotechnology & Bioinformatics chair, Singularity University

Raymond McCauley is a scientist, engineer, and entrepreneur working at the forefront of biotechnology. Raymond explores how applying technology to life—biology, genetics, medicine, agriculture—is affecting every one of us. In addition to his role at SU, McCauley is co-founder and chief architect of BioCurious.

Cyber security

Cybercrime has traditionally been a two-dimensional problem: individuals hiding behind computer screens and hacking into the world's information systems. That's about to change as cybercrime goes 3D. Today, the steady advance of exponential technologies, including robotics, artificial intelligence, additive manufacturing, and industrial biology, is adding a third dimension to the risks we face: our physical space.

Consider robotics. Drones, or robotically controlled aircraft, can deliver packages to our doors but can also carry firearms and explosives. Indeed, a few years ago, the FBI arrested an al Qaeda affiliate who was planning to use remote controlled drones to drop explosives on American government buildings.²⁶

Industrial biology is also on the cusp of becoming a threat. Advances in this field are moving rapidly with some research estimating the market will grow at a CAGR of 32.6 percent from 2013 to 2019.²⁷ Biology is rapidly becoming an information technology and as a result, genetic engineering will likely soon become a desktop application. When it does, bad actors may be able to create their own bio-viruses such as weaponized flu strains—computer-designed viruses that could permeate our physical world.

Perhaps, the more immediate threat on the horizon is the growth of the Internet of Things. As we transition from Internet Protocol version 4 to version 6,²⁸ the size of our global information grid is expected to explode in size. If today's Internet is the metaphorical size of a golf ball, tomorrow's will be the size of the sun. That means that nearly every car, computer, appliance, toy, thermostat, and piece of office equipment could be connected and online—and potentially vulnerable to hacking from anywhere on the planet.

Recently, for example, researchers and hackers have claimed that they can access a plane's satellite communications system

during commercial flights via Wi-Fi or the entertainment console.²⁹ Internet-connected thermostats at the US Chamber of Commerce were breached.³⁰ Webcams, insulin pumps, automobiles, and refrigerators have all been demonstrated as hackable in certain situations.³¹

The most effective means to combat cyber threats remain elusive and any successful approach will likely require a combination of technical, legal, entrepreneurial, and public policy collaboration. Traditional law enforcement efforts are often closed systems and siloed in individual countries. These efforts struggle to achieve global scale, while criminal networks easily subvert national boundaries in the Information Age. One development demonstrating potential is the use of crowdsourcing for the purposes of public safety and security. For example, in Latin America, citizens are helping the government fight narcotics-related murders by mapping the activities of drug dealers.³² Ultimately, the effective fight against cybercrime may well rest on the efforts of a global crowd helping to root it out. Organizations should realize that while no system is hacker-proof, the good news is, they can take steps to create a more secure, vigilant, and resilient enterprise information infrastructure.

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