



# Contents

Introduction | 2

## Disruptors

CIO as venture capitalist | 7

Cognitive analytics | 19

Industrialized crowdsourcing | 31

Digital engagement | 45

Wearables | 59

## Enablers

Technical debt reversal | 73

Social activation | 85

Cloud orchestration | 95

In-memory revolution | 107

Real-time DevOps | 121

---

Exponentials | 133

Appendix | 145

# Introduction

**W**ELCOME to Deloitte's fifth annual *Technology Trends* report. Each year, we study the ever evolving technology landscape, focusing on disruptive trends that are transforming business, government, and society. Once again, we've selected 10 topics that have the opportunity to impact organizations across industries, geographies, and sizes over the next 18 to 24 months. The theme of this year's report is *Inspiring Disruption*.

In it, we discuss 10 trends that exemplify the unprecedented potential for emerging technologies to reshape how work gets done, how businesses grow, and how markets and industries evolve. These disruptive technologies challenge CIOs to anticipate their potential organizational impacts. And while today's demands are by no means trivial, the trends we describe offer CIOs the opportunity to shape tomorrow—to inspire others, to create value, and to transform “business as usual.”

The list of trends is 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 alliance partners, industry analysts, and competitor positioning
- Crowdsourced ideas and examples from our global network of practitioners

As in prior years, we've organized the trends into two categories. Disruptors are areas that can create sustainable positive disruption in IT capabilities, business operations, and sometimes even business models. Enablers are technologies in which many CIOs have already invested time and effort, but that warrant another look because of new developments, new capabilities, or new potential use cases. Each trend is presented with multiple examples of adoption to show the trend at work. This year, we've added a longer-form *Lesson from the front lines* to each chapter to offer a more detailed look at an early use case. Also, each chapter includes a personal point of view in the *My take* section.

Information technology continues to be dominated by five forces: analytics, mobile, social, cloud, and cyber. Their continuing impact is highlighted in chapters dedicated to wearables, cloud orchestration, social activation, and cognitive analytics. Cyber is a recurring thread throughout the report: more important than ever, but embedded into thinking about how to be secure, vigilant, and resilient in approaching disruptive technologies.

For the first time, we've added a section dedicated to exponential technologies, working with Singularity University to highlight five innovative technologies that may take longer than our standard 24-month time horizon for businesses to harness them—but whose eventual impact may be profound. Examples include artificial intelligence, robotics, and additive manufacturing (3-D printing). The research, experimentation, and invention behind these “exponentials” are the building blocks for many of our technology trends. Our goal is to provide a high-level introduction to each exponential—a snapshot of what it is, where it comes from, and where it's going.

From a Consumer Products lens, we provided industry sector specific perspective on majority of the topics including CIO as a venture capitalist (how to leverage brand categories perspective for portfolio planning), crowdsourcing (specific strategies including crowdfunding, flexible workforce and data analysis contests), wearables (discussing the Empowered Employee and the Persistently Connected Consumer) and digital engagement (Omnichannel Brand Engagement, Ubiquitous Sensors and other topics).

Each of the 2014 trends is relevant today. Each has significant momentum and potential to make a business impact. And each warrants timely consideration—even if the strategy is to wait and see. But whatever you do, don't be caught unaware—or unprepared. Use these forces to inspire, to transform. And to disrupt.

We welcome your comments, questions, and feedback. And a sincere “thank you” to the many executives and organizations that have helped provide input for Tech Trends 2014; your time and insights were invaluable. We look forward to your continued innovation, impact, and inspiration.



Al Langhals  
Principal  
Deloitte Consulting LLP



Matt Law  
Principal  
Deloitte Consulting LLP



Karl Rupilius  
Principal  
Deloitte Consulting LLP



Darwin Deano  
Senior Manager  
Deloitte Consulting LLP



# Disruptors



# CIO as venture capitalist

## Trading on IT's assets, talent, risk, and results

**CIOs who want to help drive business growth and innovation will likely need to develop a new mindset and new capabilities. Like venture capitalists, CIOs should actively manage their IT portfolio in a way that drives enterprise value and evaluate portfolio performance in terms that business leaders understand—value, risk, and time horizon to reward. CIOs who can combine this with agility and align the desired talent can reshape how they run the business of IT.**

CIOs have historically focused on core delivery and operations with a budget and operating model built around low risk—buying enterprise-class software, building a talent base that could support a well-defined future state, driving for efficiencies in light of constant cost pressures. More and more CIOs, faced with disruptive forces such as crowdsourcing,<sup>1</sup> mobile only,<sup>2</sup> big data,<sup>3</sup> and cybersecurity,<sup>4</sup> are shifting from a world of known problems into one filled with unknowns. To make matters worse, organizational governance has become more complex as barriers for other parts of the business to enter the technical arena have fallen.

CIOs are seeing this divergent behavior—and realizing that their current tools for managing risk and leveraging assets may not work in this new world. Instead, many are beginning to manage their technology portfolios in ways that drive enterprise value, actively monitor the performance of the portfolios, and communicate the portfolios' positions in language the business can grasp. To do this, CIOs are borrowing from the playbook of today's leading venture capitalists (VCs). As a result, they are reshaping how they run the business of IT.<sup>5</sup>

### Thinking like a VC

Effective VCs are often shrewd businesspeople who operate across a range of intertwined capabilities. They manage portfolios of investments, continually evaluating individual and aggregate performance in terms of value, risk, and reward. They deliberately attract entrepreneurial talent with technical skills and business savvy—as well as vision, passion, and the intangible spark of leadership. And they cultivate agile organizations to anticipate and respond to changing market conditions—open to decisions to exit, take public, reinvest, or divest. These capabilities are closely related to the CIO's leadership role in today's growth-oriented organization.

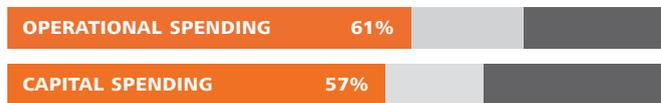
**Portfolio investment strategy.** CIOs today juggle an ever-growing portfolio of projects, ranging from long-term strategic initiatives to keeping the lights on. CIOs need clear lines of sight across their portfolio of programs and projects—the objectives, dependencies, status, finances, associated resources, and risk profiles. But in-flight initiatives are only one piece of their balance sheet. CIOs should also understand their assets—hardware, software, facilities, delivery model (the way work gets

## Capabilities map for CIOs

### Portfolio management<sup>1</sup>

As IT budgets continue to increase, it is more important to manage them closely. In 2013, 38% of organizations created a portfolio approach to IT.<sup>2</sup>

**● Increase**   **● Maintain**   **● Decrease**



### Talent alignment<sup>3</sup>

IT needs the right skillset to maintain systems and innovate.

**● Business skill gaps within IT**   **● Technical skill gaps**



### Agile<sup>4</sup>

CIOs are adopting agile methods to expedite delivery times and improve business alignment. Organizations using agile have seen promising results:

**● Improve**   **● Maintain**   **● Worsen**



83% of businesses have future plans to implement agile, an increase from 59% last year.



done), contracts, vendors, and people. The portfolio of IT is a complex one. But that complexity is no excuse for flying blind.

**Valuation.** An effective portfolio view enables the CIO to continually evaluate the strategic performance of each asset, project, and vendor in terms that business leaders understand. A CIO with a VC mindset doesn't just report on the organization's to-do list or inventory of assets; the CIO communicates the quantitative and qualitative value the IT organization contributes to the business. This means delineating the strategic importance of programs, projects, and assets. What initiatives are mission-critical for the business? What is the confidence level around on-time, on-budget delivery? How deliberately are business case results tracked? Which hardware and software assets are identified for growth? For sunseting? For active retirement? How "heavy" a balance sheet do you want to carry?

**Handicap.** In many emerging areas, there are no clearly identifiable winners. How much do you know about the product roadmap of your existing providers? Are you actively scanning small and emergent players? No part of your portfolio should be off-limits—software, hardware, services, talent, data, methods, and tools. Do you have the skills and the discipline to evaluate and predict how the landscape will evolve—not only in the market but, more importantly, for your company, for your customers, and for your business partners? Make sure you are getting what you need in order to provide what the business wants from IT. And be ready to reevaluate in light of market shifts, M&A events, or leadership transitions.

Sources: <sup>1</sup> Computer Economics, *IT spending and staffing benchmarks 2013/2014*, chapter 1, <http://www.computereconomics.com/page.cfm?name=it%20spending%20and%20staffing%20study>, accessed January 3, 2014. <sup>2</sup> CIO Magazine, *2013 state of the CIO survey*, January 2, 2013, <http://www.cio.com/slideshow/detail/79671>, accessed January 3, 2014. <sup>3</sup> Deloitte MCS Limited, *The Deloitte CIO Survey 2013. Reconnect. Rebuild. Reimagine. Redeliver.*, 2013. <sup>4</sup> VersionOne, *Seventh annual state of agile development survey*, 2013, <http://www.versionone.com/state-of-agile-survey-results>, accessed January 3, 2014.

**Hedge.** What emerging investments are you making, whether in broad technologies or with specific entities? At what stage are you getting involved? How will you incubate, invest, divest? If you build dependencies on start-ups or niche players, you will need to evaluate not only the technology but the founders and their business models. Build a concession architecture that allows you to port assets to different players or to shutter underperforming investments or partnerships in order to move on to the next opportunity.

**Promotion.** The brand of IT is maligned in some organizations, with the CIO viewed as the operator of the company's technology assets but not as a strategist or catalyst for innovation.<sup>6</sup> Rethinking the role as a VC gives the CIO a backdrop for the business to elevate the understanding—and appreciation—of his or her function. There's no overnight fix. Understand your current brand permission, then build awareness about IT's mission, effectiveness, and vision. Internally, this is important in order to enhance IT's charter. IT should be a board-level topic—recognized as one of the crown jewels of the company. Externally, it's important to attract talent—and attention. Even some leading VCs have launched PR and marketing efforts.<sup>7</sup> Don't assume that once it's built, they will come.

**Talent brokering.** The portfolio mindset extends to talent management as well. Talent scarcity is a universal concern, but it has a particular impact on IT. Consider the skills and capabilities that will be needed to deliver

on strategic initiatives, as well as those required to maintain existing systems and processes. Where are the gaps? Which capabilities can be grown from existing staff? Which should be acquired? How can top talent be identified, developed, and hoarded—regardless of title or tenure? How can external talent be tapped? Think beyond consultants, agencies, and contractors. Can you leverage the crowd—either transactionally<sup>8</sup> or by finding a way to activate customers and hobbyists?<sup>9</sup> CIOs need doers and thinkers just like VCs, but they also need leaders. Use this age of innovation as a means to launch initiatives to reward (and retain) demonstrated talent with the curiosity and horsepower to help lead growth areas. Demand for talent is outstripping supply in many shops—and expected time to value is shrinking.

**Agility.** Disruption is a given in technology today, and is extending into many aspects of the business. The balancing act is delicate—driving for more nimble, responsive delivery while maintaining architectural integrity and making solutions built to run.

In this new world, the CIO's role should expand from enabling operations with technical services to building a technology footprint that fuels, and can be responsive to, the executive team's growth and investment strategy. Integration, data, and architecture capabilities should be developed into disciplines, serving as the core pillars of business agility.

## Consumer Products Perspective

There has been a recent resurgence of interest by Consumer Product (CP) CIOs on the topic of IT portfolio management strategy. While it certainly helps that most CP business stakeholders are attuned to thinking in terms of brand categories and portfolios of brands, another recent contributing factor has been the emergence of innovative technologies spurring interest from CP business executives in the complex business of IT. CP CIOs may want to adopt some of the nomenclatures, practices, and discipline of venture capitalists. The following are some key tenets that CP CIOs should review and consider adopting:

- **Think in terms of investment portfolios** - CP CIOs and IT professionals should constantly guard against the prevailing mindset within many IT organizations that the value from IT projects and programs is hard to quantify or measure. Extolling the success of the organization in reaping value from the “marketing and branding strategy process,” could be one way to encourage IT managers to adopt value measurement and tracking practices.
- **Identify the right portfolio buckets** – it is certainly critical to figure out the right portfolio buckets that would be relevant for the organization. For some, the brand categories might make sense; while for others, geographies may be more important to use within their portfolio strategy. Additionally, using “tiers of portfolios,” such as Tier 1 for Brand Categories and Tier 2 for Geographies, can provide a flexible way for IT organizations to group and measure their IT spend.
- **Don’t do it alone** – Finding the right business stakeholders and executives, who agree to act as stewards of these different portfolios, will be critical to the success of thinking as VCs. Influential executives, up and coming stars, and geography leaders may be good choices, but think about the portfolio design before finding the right portfolio leaders who can partner with IT.
- **Strengthen and align IT strategic planning processes with these portfolio buckets** – As most portfolios are relevant for at least 3-4 years, it is important that the IT projects and programs within the portfolios are well thought through and aligned to strategic business drivers such as revenue lift, cost reduction, and risk reduction. It is important that during the strategic planning process CP CIOs align the right portfolios with the right IT-enabled efforts.
- **Develop portfolio managers** – A critical element of thinking like venture capitalists for CP CIOs is to attract and retain talent that is attuned to the agile, new way of thinking about IT investment. It takes time and effort to develop good IT portfolio managers who can help CIOs maintain their portfolios in top shape. Making a conscious effort during IT organizational redesign efforts is critical to developing a valuable niche and space for these portfolio managers.
- **Make some noise!** – And certainly make some noise, as successes within the portfolios start to emerge. This can beget more support for this process – a virtuous cycle.

# Lessons from the front lines

## Growth and change

Cisco's IT organization uses a three-tiered model to drive its mission: Run the business—focusing on efficiency, quality, and optimization of cost performance; grow the business—helping to drive investments that impact business performance; and change the business—transforming how the organization operates and the markets in which it competes. At Cisco, line-of-business CIOs are encouraged to drive more of their investment portfolio towards growth and change. This doesn't mean that total cost of ownership isn't emphasized, but the "better, faster, cheaper" mindset is not just applied to the business of IT—it's just as important to the business of the business. Technology spend is anchored in running or changing the business—which requires not just bilateral commitment, but ongoing education and teaming between IT and the business.

Line-of-business CIOs look at initiatives as vehicles for tech-enabled business growth and see their roles as orchestrators and shapers. At the financial level, this means actively managing a portfolio of assets with an understanding of cost, return, risk, and strategic importance. More than just inventorying and reporting, it means helping to set priorities, translating the potential of disruptive technologies and making them meaningful, and setting up the organization for speed and agility. Traditional waterfall methodologies have given way to agile—fast, iterative deployments where the business is fully engaged. At the technology level, orchestration is about creating a seamless experience across a technology landscape that is growing more diverse and complex, bringing together a mix of on- and off-premises solutions—and making sure employees, customers, and business partners aren't exposed to behind-the-scenes complexity. Integration and architecture have been established as key disciplines fueling immediate investments in sales effectiveness, digital marketing across devices/channels, and the technical backbone behind the Internet of Everything.

Cisco has also started to engage more directly with the venture capital and start-up communities. Corporate CIO Rebecca Jacoby has established a company-wide reference architecture covering business, operational, systems, and technology aspects. Emerging solutions that comply with the reference architecture are actively pursued—often in response to specific problems or opportunities the company is trying to address. Like other IT investments, though, an assessment of the solution is made not just on its ability to change the business, but on the ongoing impact on running the business. Like a venture capitalist, the IT organization measures the portfolio in absolute terms—potential value weighed against total cost of service. Cisco emphasizes measurement of vision, strategy, and execution according to the needs of the business. Because of these approaches, Cisco is prepared to deal with whatever the future brings—acquisitions, product innovation, and investments in adjacent services and solutions.

## A view from the Valley<sup>10</sup>

Founded in 1989, Hummer Winblad Venture Partners (HWVP) was the first venture capital fund to invest exclusively in software companies. HWVP has deployed over \$1 billion of cumulative capital in software investments starting at the first venture round of over 100 enterprise software companies. As such, HWVP has a singular perspective into not just what it takes to effectively manage an investment portfolio, but also into how Fortune 100 companies are responding to this seminal time in the history of technology. Unlike those who see innovation as a crescendo steadily building over time, HWVP sees a different, bumpier reality—defined by periods of disproportionate change, embodied by today's era of technology disruption.

Historically, large enterprises have encouraged new software vendors to focus on “embracing and extending” in-place software infrastructure. This approach can work if innovation is gradual, but can break down if innovation impacts overall business strategies. We are at a major disruption point where legacy systems likely cannot be extended. The digitization of the customer experience across industries—driven by mobile, social, cloud, and big data—is changing the nature of data itself, as businesses shift their focus from products to customers. Siloed systems aren't equipped to handle behavioral data, sentiment, and largely unstructured context. Digital requires a different horizontal stack.

The need to keep pace with new business and technological realities could be a great backdrop for CIOs to shift focus from cost, compliance, and maintenance to being in the business of “new.” CIOs should be a strategy anchor for big companies: a board-level

position that doesn't just enable but is a catalyst for growth.

HWVP doesn't have a “VC handbook” that guides its investments. And neither will CIOs. HWVP co-founder Ann Winblad believes we are entering an era where companies should take risks: They should swim in the river of innovation and be prepared to make multiple bets to discover what innovation really means for their company. It could lead to near-term competitive disadvantage—especially as large organizations react to the exploding population of small vendors that are defining tomorrow. Firms that CIOs may not have heard of with a small operating footprint may become essential partners.

Large companies should not wait for new market leaders to emerge. That means performing your own market analysis and increasing the value of existing partners and alliances—asking them to broker introductions or co-invest in early prototyping. Instead of asking small players to go through qualifying paces, create low-cost, low-risk prototypes and pilots to experiment with their technologies to solve business problems. Many CIOs of large companies use start-ups to enable lines of businesses—and help jointly own the investment in tomorrow.

HWVP is in the business of identifying—and sometimes provoking—patterns. It's the “venture” part of venture capital. With the customer as the business's new cerebral cortex and growth moving at the speed of digital, CIOs should act more like VCs. Not every bet will be a winner, but by keeping a portfolio of investments, moving ahead of tested (and sometimes stale) market trends, and keeping a mindset towards engagement, big companies can be poised to compete in these unprecedentedly exciting times.

## My take

### Charles Weston, SVP and chief information officer (retired), Bloomin' Brands

There are multiple drivers for why CIOs need to think like a venture capitalist. The first is the incredible pace of technological change. CIOs need to place bets—like VCs do—that a given product or service is going to hit the market at the right time and fill a niche that others don't. It's often no longer acceptable to use one vendor for all your technology needs. Second, given all the information now accessible to everyone, it's hard to gain a competitive advantage. VCs try to create a competitive advantage by investing in companies to make a profit—and CIOs try to create a competitive advantage by investing in services and capabilities to reap the benefits before competitors can. And third, to avoid trailing your competitors, CIOs need to take risks. VCs take balanced risks, conducting market research, and being thoughtful about selection and the company's fit with the team. Taking risks is the hardest part for CIOs; we've all seen the damage failed projects can do to the IT department's reputation. But taking risks means accepting not just the potential, but the inevitability of failure. In my judgment, if you're too afraid of that, your company will likely always trail your competitors. The key is to work with the rest of the C-suite to recognize that some level of risk is part of the ground rules. And if you're going to fail, fail fast—cutting your losses and moving on to the next bet.

In addition to my role as CIO of Bloomin' Brands, I also serve on the CIO advisory board for Sierra Ventures, a venture capital firm. Having that exposure into a VC firm has influenced my behavior as a CIO. When I first joined Bloomin' Brands, one of my priorities was to focus on where the market was going to be three years out and find something that would allow us to get out in front. At that time, we weren't yet a

cloud organization, but I knew we eventually would be, and invested in a cloud-based integration product. Some in my IT organization were nervous at the time, knowing the integration would be challenging, but we knew it would also be challenging for our competitors—and we were able to be an early adopter and gain the advantage.

I have also adapted my approach to vendor and talent management. The current landscape changes how you deal with vendors. You're working with both large, established companies and the new set of entrants, many of whom are entrepreneurs who sometimes have never done an enterprise contract before. On the talent side, we increasingly hire for agility. We look for people who can be nimble and move at the same pace as the business. We recruit those who learn based on principle rather than by rote syntax and command so they can more easily move from one product to another.

As much as there are similarities between VCs and today's CIOs, there are also some tenets of venture capitalism that don't necessarily make sense for a CIO to adopt. The first is the size of your investment portfolio. While the VC can have 15–25 investments at once, the CIO may be able to balance only a handful. The second is the breadth of the portfolio. The VC can afford to go after multiple spaces, but the CIO's lens is rightfully constrained by the company's industry and the needs of the business. There may be some interesting capabilities you need to turn down because they just aren't the right fit.

To start on the path of CIO-as-venture-capitalist, try to open your mind to becoming more of a risk taker and to look at technology solutions that are less established. Work through your own risk profile—with the rest of your C-suite—and determine how much risk you are willing to take on. Then, align yourself with folks who can help you start to venture into this space and take advantage of some of the early-stage solutions.



## Where do you start?

**M**ASTERING VC capabilities may challenge many CIOs whose traditional role has been to meet business demands for reliable, cost-efficient technologies. And even if the capabilities could materialize overnight, earning the credibility that is required to become active participants in strategic leadership conversations will likely be a gradual process for many CIOs.

To complicate matters, new technology shifts—especially those powered by analytics, mobile, social, cloud, and cyber—intensify talent shortages and process constraints. These gaps make creating a balanced portfolio across traditional and emerging IT services even more difficult. As business users bypass IT to adopt cloud-based point solutions, organizational technology footprints are becoming more and more complex. Visibility into, and control of, the portfolio becomes harder to attain. CIOs have an imperative to get ahead of the curve.

This is especially true in M&A, where change is constantly disruptive. Many industries are rife with potential investments and divestitures. But few organizations can acquire, sell, or divest with surgical precision without reinventing the wheel with each transaction. Seventy percent of mergers and acquisitions fail to meet their expectations. The value from mergers, acquisitions, and divestitures is more directly linked to getting IT right than anything else.<sup>11</sup>

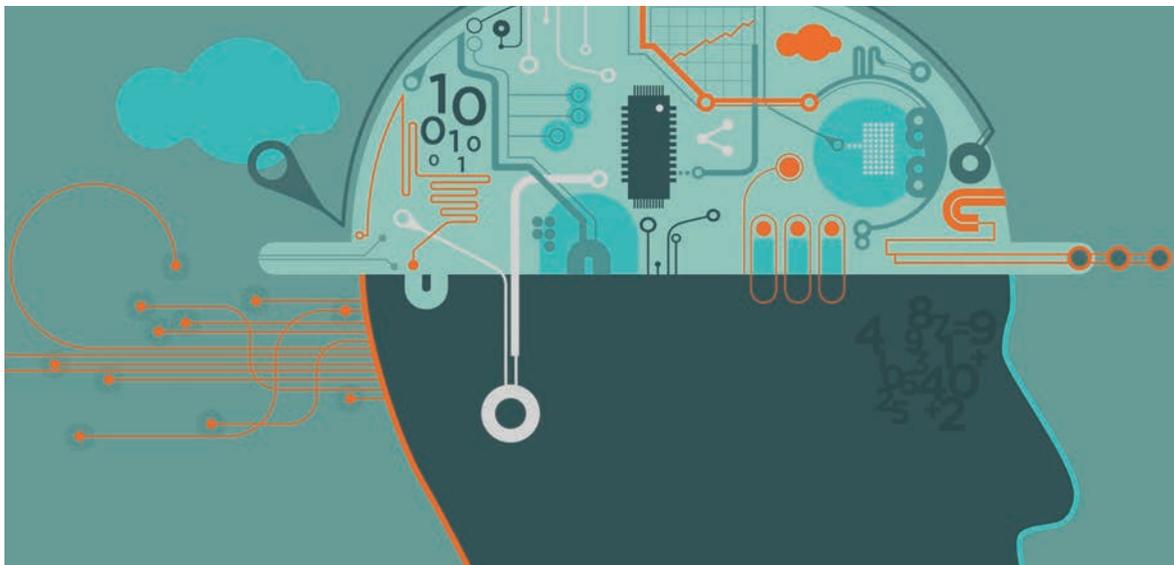
Transformation takes time, but small first steps can make a difference:

- **Inventory the technology portfolio.** What technologies does your organization deploy today? Focus on the full range, including solutions procured outside of IT. What projects are in play? What vendors do you depend on? What assets are in use, and

where are they located? How does each asset contribute to the business mission, and what is its useful remaining life? It's not enough to rationalize your assets. Create a model to describe the categories of assets and investments, and use that to guide priorities. Many organizations use Gartner's Pace-Layered Application Strategy, breaking down their IT landscape into systems of record, systems of differentiation, and systems of innovation. Inventorying and classification is just an enabling step, though. What matters is how you use the visibility to direct focus and capital, balancing across the categories in a way that enables (and amplifies) your business strategy. Budgeting cycles typically run like *Shark Tank*—with funds allocated by the business based on its priorities.

- **Evaluate the portfolio.** Define the risk, value, and strategic importance of each portfolio item. Identify where costs/risks outweigh value. Pinpoint potential trouble spots, such as contracts with unclear service-level agreements or data ownership provisions. Understand each vendor's viability—not just in terms of capital and capacity, but also how well the vendor's roadmap aligns with your company's vision. Look for portfolio clusters: Is the proportion of investments in maintenance and upkeep appropriate when compared with investments in new strategic opportunities? Are there gaps that could hold the organization back? Strive for balance between extending legacy systems and investments in innovation. Aim for transparency, letting your business counterparts appreciate the exhaustive demand curve as well as the thinking that defines priorities.

- **Double down on winners.** And fold the losers. VCs expect some assets to underperform, and they are willing to cut their losses. CIOs should encourage intelligent risk-taking within the organization. Failure due to poor execution is unacceptable, but setbacks resulting from exploring innovative ideas are inevitable for organizations that want to compete in a high-growth environment. Borrow from the VC playbook—intentionally being conservative in initial funding to inspire creativity and creating more natural checkpoints. In either case, be prepared to recommend that the organization pull the plug when a project isn't delivering.
- **Direct line of sight to revenue.** Come up with an approach to vet technologies and their companies to better identify and evaluate winners and losers. Share your accomplishments and goals in terms that the business understands. Openly discuss the state of the projects and assets in which the business has invested. While few CIOs today have the sole power to initiate or withdraw substantial investments, many should develop the ability to evaluate the portfolio objectively. The first few wins can become the centerpiece of your campaign for change.



## Bottom line

At first blush, comparisons between CIOs and venture capitalists may seem like a stretch. For example, CIOs can't shoot from the hip on risky investments. They provide critical services that the business simply can't do without, where the risk of getting it wrong could be catastrophic. At the same time, there's a lot to learn from the portfolio mindset that VCs bring to their work: balancing investments in legacy systems, innovation, and even bleeding-edge technologies; understanding—and communicating—business value; and aligning talent with the business mission. Venture capitalists operate in a high-stakes environment where extraordinary value creation and inevitable losses can coexist inside a portfolio of calculated investments. So do CIOs.

## Authors



**Tom Galizia, principal, Deloitte Consulting LLP**

Tom Galizia is the national leader of Deloitte Consulting LLP's Technology Strategy and Architecture practice that focuses on enabling new IT capabilities to successfully navigate changing market dynamics, delivering IT-enabled business strategy and transformation, and driving efficient IT operations.

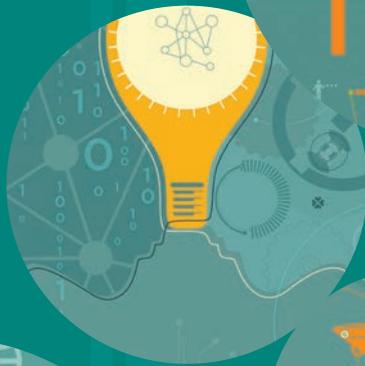


**Chris Garibaldi, principal, Deloitte Consulting LLP**

Chris Garibaldi is a principal in Deloitte Consulting LLP's Technology Strategy and Architecture practice and leads the Project Portfolio Management practice. With 20 years of experience in business strategy, Chris possesses a unique perspective on the evolution of business and IT management.

## Endnotes

1. Deloitte Consulting LLP, *Tech Trends 2014: Inspiring disruption*, 2014, chapter 3.
2. Deloitte Consulting LLP, *Tech Trends 2013: Elements of postdigital*, 2013, chapter 2.
3. Deloitte Consulting LLP, *Tech Trends 2013: Elements of postdigital*, 2013, chapter 6.
4. Deloitte Consulting LLP, *Tech Trends 2013: Elements of postdigital*, 2013, chapter 9.
5. Deloitte Consulting LLP, *Tech Trends 2013: Elements of postdigital*, 2013, chapter 10.
6. CIO Journal by Wall Street Journal, “The four faces of the CIO,” October 28, 2013, <http://deloitte.wsj.com/cio/2013/10/28/the-four-faces-of-the-cio/>, accessed December 19, 2013.
7. Nicole Perloth, “Venture capital firms, once discreet, learn the promotional game,” *New York Times*, July 22, 2012, [http://www.nytimes.com/2012/07/23/business/venture-capital-firms-once-discreet-learn-the-promotional-game.html?pagewanted=all&\\_r=1&](http://www.nytimes.com/2012/07/23/business/venture-capital-firms-once-discreet-learn-the-promotional-game.html?pagewanted=all&_r=1&), accessed December 19, 2013.
8. Deloitte Consulting LLP, *Tech Trends 2014: Inspiring disruption*, 2014, chapter 3.
9. Deloitte Consulting LLP, *Tech Trends 2014: Inspiring disruption*, 2014, chapter 7.
10. Ann Winblad (co-founder of Hummer Winblad Venture Partners), discussion with the author, January 9, 2014.
11. Janice M. Roehl-Anderson, *M&A Information Technology Best Practices* (New Jersey: Wiley, 2013).



# Exponentials

## One more thing . . .

**E**ACH year, this report analyzes trends in technology put to business use. To be included, a topic should clearly demonstrate its potential to impact businesses in the next 18 to 24 months. We also require a handful of concrete examples that demonstrate how organizations have put the trend to work—either as early adoption of the concept or “bread crumbs” that point toward the fully realized opportunity. Our criteria for choosing trends keeps us on the practical side of provocative, as each trend is relevant today and exhibits clear, growing momentum. We encourage executives to explore these concepts and feed them into this year’s planning cycle. Not every topic warrants immediate investment. However, enough have demonstrated potential impact to justify a deeper look.

Because we focus on the nearer-term horizon, our *Technology Trends* report typically only hints at broader disruptive technology forces. This year, in collaboration with leading researchers at Singularity University, we have added this section on “exponential” technologies, the core area of research and focus at Singularity

University. The fields we chose to cover have far-reaching, transformative impact and represent the elemental advances that have formed technology trends both this year and in the past. In this section, we explore five exponentials with wide-ranging impact across geographies and industries: artificial intelligence, robotics, cyber security, additive manufacturing, and advanced computing.

In these pages we provide a high-level introduction to each exponential—a snapshot of what it is, where it comes from, and where it’s going. Each exponential stems from many fields of study and torrents of research. Our goal is to drive awareness and inspire our readers to learn more. Many of these exponentials will likely create industry disruption in 24 months or more, but there can be competitive opportunities for early adoption. At a minimum, we feel executives can begin contemplating how their organizations can embrace exponentials to drive innovation. Exponentials represent unprecedented opportunities as well as existential threats. Don’t get caught unaware—or unprepared.

## My take

**Peter H. Diamandis, MD**

**Co-founder and executive chairman, Singularity University**

**Chairman & CEO, XPRIZE Foundation**

**Author, *Abundance: The future is better than you think***

In 2012 the world experienced what I call “the new Kodak moment.” A moment in time when an exponential technology put a linear thinking company out of business. Kodak, the company that invented the digital camera in 1976, and had grown to a 145,000-person,<sup>1</sup> 28-billion-dollar global company at its peak, ultimately filed for bankruptcy in 2012 as it was put out of business by the exponential technology of digital imagery. In stark contrast, another company—also in the digital imagery business—called Instagram, was acquired in that same year by Facebook for \$1 billion. Instagram’s headcount: 13 employees.

These moments are going to be the norm as exponentially thinking startups replace linear businesses with unprecedented products and services. Although a daunting challenge, exponential technologies offer extraordinary opportunities to the businesses that can keep pace with them.

The lessons learned from Kodak are the consequences of failing to keep up with what I call the “six Ds.” The first D is digitization. Technology that becomes digitized hops on Moore’s Law and begins its march up the exponential growth curve. Like many companies, Kodak was blindsided by the next D—deceptive growth. When a product, such as imagery, becomes digitized, it jumps from a linear path to an exponential trajectory. The challenge is that early exponential doublings are deceptive. The first Kodak digital camera was only 0.01 megapixels. Even though it was doubling every year, when you double 0.01, to 0.02, 0.04, 0.08, 0.16, this doubling of small numbers near zero looks to the mind like linear growth, and is dismissed. It’s only when you continue forward past what is called the “knee of the curve” that it begins to change. Double seven times from “1” and you get to 128. Twenty-three more doublings (a total of 30) gets you to 1 billion. Business leaders often perceive the early stages as slow, linear progress. Until, of course, the trend hits the third D—disruption.

By the time a company’s product or service is disrupted, it is difficult to catch up. Disruptive growth ultimately leads to the last three Ds—dematerialization, demonetization, and democratization, which can fundamentally change the market. The smartphone in your pocket has *dematerialized* many physical products by providing their virtual equivalents—a GPS receiver in your car, books, music, and even flashlights. Once these equivalents gain market traction, the established product’s commercial value can plummet. It becomes *demonetized*. iTunes®,<sup>2</sup> for example, is impacting the value of record stores. eBay is doing the same to specialty retailers. Craigslist has stripped newspapers of classified advertising revenue. Once products become dematerialized and demonetized, they become *democratized*—spreading around the world through the billions of connected devices we carry around.



Many business leaders confront exponentials with a stress mindset. They realize that the odds of survival aren't great. Babson College noted that 40 percent of the Fortune 500 companies in 2000 didn't exist 10 years later.<sup>3</sup> However, the other side of the coin is an abundance mindset—awareness of the limitless opportunity. Between now and 2020, the world's population of digitally connected people will jump from two to five billion.<sup>4</sup> That growth will also add tens of trillions of dollars in economic value.

To land on the opportunity side of the coin and avoid shocks down the road, companies can take two immediate steps:

- **Conduct an impact assessment:** Identify the top five strengths that differentiate your company. Then look at which exponentials could potentially erode those strengths. Also look at the flip side. What are the top five pain points that exponentials could eliminate? How?
- **Evaluate the threat:** Determine how your company's products or services could be dematerialized or demonetized. Exploiting market adjacencies is a key part of the equation. Google, for example, is focusing on autonomous cars and Microsoft continues to make forays into gaming. The goal is to not only figure out who might disrupt your business's pond but whose pond your company can disrupt.

Your competition is no longer multinational powerhouses in China or India. Your competition now is the hyper-connected startup anywhere in the world that is using exponential technologies to dematerialize and demonetize your products and services. Someone in New York can upload a new idea into the cloud, where a kid in Mumbai builds on it and hands it off to a Bangladeshi company to handle production and marketing. Companies need to make sure their plans are in sync with this world and its dynamics.

Lastly, companies should consider their strategy in the context of leveraging two types of exponentials: First, pure exponential technologies such as artificial intelligence, synthetic biology, robotics, and 3D printing; and second, what I call "exponential crowd tools": crowdsourcing, crowdfunding, and prized-based competition incentive models. If companies then marry this portfolio of exponential assets with the understanding that today's grandest societal and planet challenges are also today's most promising commercial market opportunities, it can truly be a formula for abundance.



## Exponential snapshots

### Artificial intelligence

Computer science researchers have been studying Artificial Intelligence (AI) since John McCarthy introduced the term in 1955.<sup>5</sup> Defined loosely as the science of making intelligent machines, AI can cover a wide range of techniques, including machine learning, deep learning, probabilistic inference, neural network simulation, pattern analysis, decision trees and random forests, and others. For our purposes, we focus on how AI can simulate reasoning, develop knowledge, and allow computers to set and achieve goals.

The ubiquity and low-cost access to distributed and cloud computing have fueled the maturity of AI techniques. AI tools are becoming more powerful and simpler to use. This maturity is the first part of the story: how AI is becoming democratized and can be applied across industries, not just in areas such as credit card processing and trading desks, where AI has been gainfully employed for 45 years. The next part of the story focuses on our desire to augment and enhance human intelligence.

We are increasingly overwhelmed by the flood of data in our lives—1.8 zettabytes of information are being created annually.<sup>6</sup> But we are saddled with an ancient computing architecture that hasn't seen a major upgrade in more than 50,000 years: the brain. We suffer from cognitive biases and limitations that restrict the amount of information we can process and the complexity of calculations we can entertain. People are also susceptible to affectations and social perceptions that can muddy logic—anchoring on first impressions to confirm suspicions instead of testing divergent thinking.

AI can help solve specific challenges such as improving the accuracy of predictions, accelerating problem solving, and automating administrative tasks. The reality is that with the right techniques and training, many jobs can be automated. That automation is underway through many applications in several fields, including advanced manufacturing, self-driving vehicles, and self-regulating machines. In addition, the legal profession is availing itself of AI in everything from discovery to litigation support. DARPA is turning to AI to improve military air traffic control as automated, self-piloted aircraft threaten to overrun air-spaces. In health care, AI is being used in both triage and administrative policies. The world's first synthetic bacterium was created using AI techniques with sequencing.<sup>7</sup> Energy firms are using AI for micro-fossil exploration in deep oil preserves at the bottom of the ocean. AI can also be leveraged for situational assistance and logistics planning for military campaigns or mass relief programs. In sum, AI represents a shift, a move from computers as tools for executing tasks to a team member that helps guide thinking and can do work.

Despite these successes, many of today's efforts focus on specific, niche tasks where machine learning is combined with task and domain knowledge. When we add biologically inspired computing architectures, the ability to reason, infer, understand context, develop evolving conceptual models of cognitive systems, and perform many different flavors of tasks becomes attainable.

In the meantime, AI faces barriers to its widespread adoption. Recognize that in developed nations, its use may encounter obstacles, especially as labor organizations

fight its increased use and its potential to decrease employment. The ethics of AI are also rightly a focus of attention, including the need for safeguards, transparency, liability determination, and other guidelines and mechanisms that steer toward responsible adoption of AI. But these realities should not curb the willingness to explore. Companies should experiment and challenge assumptions by seeking out areas where seemingly unachievable productivity could positively disrupt their businesses.

*Inspired by lectures given by Neil Jacobstein, artificial intelligence and robotics co-chair, Singularity University*

Neil Jacobstein co-chairs the artificial intelligence and robotics track at Singularity University. He served as president of Singularity University from October 2010 to October 2011 and worked as a technical consultant on AI research for a variety of businesses and government agencies.

## Robotics

Mechanical devices that can perform both simple and complex tasks have been a pursuit of mankind for thousands of years. Artificial intelligence and exponential improvements in technology have fueled advances in modern robotics through tremendous power, a shrinking footprint, and plummeting costs. Sensors are a prime example. Those that guided the space shuttle in the 1970s were the size of foot lockers and cost approximately \$200,000. Today, they are the size of a fingernail, cost about 10 cents, and are far more reliable.

Robotics is fundamentally changing the nature of work. Every job could potentially be affected—it's only a matter of when. Menial tasks were the early frontiers. Assembly lines, warehouses, and cargo bays have been enterprise beachheads of robotics. But that was only the beginning. Autonomous drones have become standard currency in militaries, first for surveillance and now with weapon payloads. Amazon fulfillment centers are

largely automated, with robots picking, packing, and shipping in more than 18 million square feet of warehouses.<sup>8</sup> The next frontier is tasks that involve gathering and interpreting data in real time. Eventually these tasks can be replaced by a machine, threatening entire job categories with obsolescence. Oxford Martin research predicts that 45 percent of US jobs will be automated in the next 20 years.<sup>9</sup>

On the not-so-distant horizon, for example, gastroenterologists won't need to perform colonoscopies. Patients will be able to ingest a pill-sized device with a camera that knows what to look for, photograph and, potentially, attack diseases or inject new DNA. Boston Dynamics is rolling out Big Dog, Bigger Dog, and Cheetah—robots that can carry cargo over uneven terrain in dangerous surroundings. Exoskeletons can create superhuman strength or restore motor functions in the disabled. Remote health care is coming. It will likely arrive first with robotics-assisted virtual consultation, followed by surgical robots that can interpret and translate a surgeon's hand movements into precise robotic movements thousands of miles away. Companies are also pursuing autonomous cars. Personal drone-based deliveries could disrupt retail. The limits are our imaginations—but not for long.

Robotics should be on many companies' radars, but businesses should expect workplace tension. To ease concerns, companies should target initial forays into repetitive, unpleasant work. Too often robotics is focused on tasks that people enjoy. Equally important, companies should prepare for the inevitable job losses. Enterprises should identify positions that aren't likely to exist in 10 years, and leverage attrition and training to prepare employees for new roles. The challenge for business—and society as a whole—is to drive job creation at the same time that technology is making many jobs redundant. Ideally, displaced resources can be deployed in roles requiring creativity and human interaction—a dimension technology can't replicate. Think of pharmacists. After as much as eight years of education, they spend the majority of their

time putting pills into bottles and manually assessing complex drug interactions. When those functions are performed by robots, pharmacists can become more powerful partners to physicians by understanding a patient's individual situation and modifying drug regimens accordingly.

At the end of the day, there are two things robots can't help us with. The first is preservation of the human species, a concern more civic and philosophical than organizational. But the second is more practical—indefinable problems. For example, robots can't find life on Mars because we don't know what it might look like. Everything else is fair game. Be ready to open the pod bay doors of opportunity—before your competition does.

*Inspired by lectures given by **Dan Barry**, artificial intelligence and robotics co-chair, Singularity University*

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 licensed physician and his research interests include robotics, signal processing with an emphasis on joint time-frequency methods, and human adaptation to extreme environments.

## Cyber security

A few hundred years ago, a robbery consisted primarily of a criminal and an individual victim—a highly personal endeavor with limited options for growth. The advent of railroads and banks provided opportunities to scale, allowing marauders to rob several hundred people in a single heist. Today, cyber criminals have achieved astonishing scale. They can attack millions of individuals at one time with limited risk and exposure.

The same technological advances and entrepreneurial acumen that are creating opportunities for business are also arming the world's criminals. Criminal organizations are employing an increasing number of highly educated hackers who find motivation in the challenges of cracking sophisticated cyber

security systems.<sup>10</sup> These entrepreneurial outlaws are a new crime paradigm that is reaching frightening levels of scale and efficiency.

A few examples illustrate the daunting landscape: Hackers are available for hire online and also sell software capable of committing their crimes. A few years ago, for example, INTERPOL caught a Brazilian crime syndicate selling DVD software that could steal customer identities and banking information. The purveyors guaranteed that 80 percent of the credit card numbers pilfered through the software would be valid. Its customers could also contact a call center for support.

Cyber criminals are also leveraging the crowd. Flash Robs, for example, are becoming a new craze where social media is used to bring individuals to a specific store to steal goods before police can arrive. Another crowdsourced crime looted \$45 million from a pre-paid debit card network. Hackers removed the card limits. Thieves then bought debit cards for \$10 and withdrew what they wanted. In just 10 hours, the crowd made more than 36,000 withdrawals in 27 countries.

What looms on the horizon is even more daunting. With the Internet of Things, every car, consumer appliance, and piece of office equipment could be linked and ready for hacking. As fingerprints become the standard means of authentication, biometrics will become a powerful source of ingenious theft.

The experience of the US Chamber of Commerce portends the future. The organization's photocopiers, like many, are equipped with hard drives that store printed documents. In the past, industrial criminals disguised as repairmen removed the devices. However, when the chamber installed thermostats connected to the Internet, hackers could breach the copiers. Officials only discovered the attack through a defect that inadvertently sent the hackers' documents to the copiers.

There are steps that companies can take to combat cybercrime. The first is to establish risk-prioritized controls that protect against

known and emerging threats while complying with standards and regulations. Companies should also identify which of their assets would likely attract criminals and assess the impact of a theft or breach. Organizations should then become vigilant and establish situation risk and threat awareness programs across the environment. Security and information event management capabilities can be enhanced and new functionality can be mined from tools including endpoint protection, vulnerability assessment/patch management, content monitoring, data loss prevention, intrusion prevention, and core network services. The final step is building resilience: the ability to handle critical incidents, quickly return to normal operations, and repair damage done to the business.

Companies can also turn to the crowd. Security professionals have knowledge that can help investigations and warn of potential threats. The legal environment is also important. Business leaders should advocate for laws and policies that seek to contain cybercrime and also avail themselves of resources provided by federal agencies.

Cybercrime is accelerating at an exponential pace. In the not-so-distant future, everything from our watches to the EKG monitors in hospitals will be connected to the Internet and ready to be hacked. Companies should be prepared to survive in an environment where these threats are commonplace.

*Inspired by lectures given by **Marc Goodman**, chair for policy, law, and ethics and global security advisor, Singularity University*

Marc Goodman is a global strategist, author, and consultant focused on the disruptive impact of advancing technologies on security, business, and international affairs. At Singularity University, he serves as the faculty chair for policy, law, and ethics and the global security advisor, examining the use of advanced science and technology to address humanity's grand challenges.

## Additive manufacturing

The technology that supports additive manufacturing, or 3D printing, is more than 30 years old. Its recent popularity has been fueled in part by patent expirations which are driving a wave of consumer-oriented printers. Prices have fallen, putting the technology within the reach of early adopters. 3D printing is democratizing the manufacturing process and bringing about a fundamental change in what we can design and what we can create.

But the story goes much deeper than hobbyists and desktop models. The cost of a 3D printer ranges from a few hundred to a few million dollars. The machines can print with hundreds of materials, including nylons, plastics, composites, fully dense metals, rubber-like materials, circuit boards, and even genetic tissue. Breakthroughs in speed, resolution, and reliability demonstrate potential not only for scale but also for unlocking new possibilities.

The real exponential impact, however, is in the simplicity of the supporting tools. They provide a means to digitize existing objects, customize and tweak open source designs, or create brand new designs based on structural and industrial engineering know-how. Intuitive, easy-to-use tools allow “things” to be created, manipulated, and shared.

In essence, 3D printing makes manufacturing complexity free of charge, allowing otherwise impossible designs to be realized. Objects are built one layer at a time, depositing material as small as 100 nanometers exactly where and when needed. Mechanical items with moving parts can be printed in one step—no assembly required. Interlocking structures mimicking nature's design laws are possible with nearly unlimited geometrical freedom—no tooling, set-ups, or change-overs. Moreover, objects can be built just in time when and where they are needed. The capability unlocks business performance in a highly sustainable manner by reducing inventory, freight, and waste. 3D printing's value is not limited to complex objects.

On-site creation of investment castings or construction molds can supplement traditional manufacturing techniques.

3D printing is not just for prototypes and mock-ups. Many sectors already use the technology for finished parts and products. The aerospace industry, for example, has led the charge on additive manufacturing. Jet engine parts such as manifolds require more than 20 pieces that are individually manufactured, installed, welded, grinded, and tested into a finished product. The 3D printed alternative is easier to build and service and also reduces overall system weight. Medical devices use 3D printing to customize and personalize everything from dental crowns to hearing aids to prosthetics.

The potential doesn't end there. More fantastical use cases are starting to become a reality, such as mass customization of consumer goods, including personalized products ranging from commodities to toys to fashion, with "print at home" purchase options. Even food printers are entering the market, starting with chocolates and other sugar and starch staples, but moving toward meats and other proteins. Organs, nerves, and bones could be fully printed from human tissue, transforming health care from clinical practice to part replacement—and even life extension. Leading thinkers are exploring self-organizing matter and materials with seemingly magical properties. One example is already here: a plane built of composites with the ability to morph and change shape, ending the need for traditional flaps and their associated hydraulic systems and controls.

The enterprise implications are many—and potentially profound. First, organizations should take an honest look at their supply chain and market offerings—and identify where the technology could enhance or replace these offerings. As we discussed in the *Digital engagement* chapter, intellectual property and rights issues will emerge, along with new paths to monetize and disrupt. Finally, business leaders should embrace the

democratized creativity the technology is unleashing. Companies can use 3D printing to drive faster product innovation cycles, especially where it can push the boundaries of possibilities based on materials science and manufacturing techniques.

*Inspired by lectures given by **Avi Reichental**, co-chair for nanotechnology and digital fabrication, Singularity University*

Avi Reichental currently serves as faculty co-chair of the additive manufacturing program at Singularity University. He has been the president and chief executive officer of 3D Systems since September 2003.

## Advanced computing

Advances in raw computing power and connectivity are frequently the building blocks of our annual tech trends report. Core lessons that have guided us through the Internet revolution remain true today, and are steering us toward exponential advances in the future of computing.

The first lesson is the importance of early adopters and how they personally and commercially kick-start industries and adoption. Early adopters have an insatiable demand for improvement and for the doubling of performance. Moore's Law forecasts how many transistors per dollar could be put onto a chip wafer. Engineering curiosity and scientific prowess have fueled many advances in the field. Nonetheless, to build growth and feed customer demand, companies continue to invest in seismic performance improvements because they know there is a demand for products that are twice as good.

The second lesson is an open, hackable ecosystem with a cost contract that encourages experimentation through its lack of incremental accounting for network usage. From the system kits of the PC revolution to the open source movement to today's Arduino and Raspberry Pi hobbyists, a culture of innovation and personal discovery is driving

advances in open groups instead of proprietary labs. Lessons and learnings are being shared that accelerate new discoveries.

The third lesson is that the magical ingredient of the Internet is not the technology of packet switching or transport protocols. The magic is that the network is necessarily “stupid,” allowing for experimentation and new ideas to be explored on the edges without justifying financial viability on day one.

On the computing side, we are at a fascinating point in history. Rumbblings about the end of Moore’s Law are arguing the wrong point. True, chip manufacturers are reaching the theoretical limits of materials science and the laws of physics that allow an indefinite doubling of performance based on traditional architectures and manufacturing techniques. Even if we could pack in the transistors, the power requirements and heat profile pose unrealistic requirements. However, we have already seen a shift from measuring the performance of a single computer to multiple cores/processors on a single chip. We still see performance doubling at a given price point—not because the processor is twice as powerful, but because twice the number of processors are on a chip for the same price. We’re now seeing advances in multidimensional chip architecture where three-dimensional designs are taking this trend to new extremes. Shifts to bio and quantum computing raise the stakes even further through the potential for exponential expansion of what is computationally possible. Research in the adjacent field of microelectromechanical systems (MEMS) and nanotech is redefining “hardware” in ways that can transform our world. However, like our modest forays into multi-core traditional architectures, operating

systems and software need to be rewritten to take advantage of advances in infrastructure. We’re in the early days of this renaissance.

The network side is experiencing similar exponential advances. Technologies are being developed that offer potentially limitless bandwidth at nearly ubiquitous reach. Scientific and engineering breakthroughs include ultra-capacity fiber capable of more than 1 petabit per second<sup>11</sup> to heterogeneous networks of small cells (micro-, pico-, and femtocells<sup>12</sup>) to terahertz radiation<sup>13</sup> to balloon-powered broadband in rural and remote areas.<sup>14</sup>

Civic implications are profound, including the ability to provide education, employment, and life-changing utilities to the nearly five billion people without Internet access today. Commercially, the combination of computing and network advances enable investments in the Internet of Things and synthetic biology, fields that also have the ability to transform our world. Organizations should stay aware of these rapidly changing worlds and find ways to participate, harness, and advance early adoption and innovation at the edge. These lessons will likely hold true through this exponential revolution—and beyond.

*Inspired by lectures given by **Brad Templeton**, networks and 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.

## Authors



**Bill Briggs, director, Deloitte Consulting LLP**

Bill Briggs is the chief technology officer of Deloitte Consulting LLP and global lead of Deloitte Digital. He helps clients address their technology challenges—and anticipate the impact that new and emerging technologies may have on their business in the future.

*With contributions from Singularity University faculty and leadership and Marcus Shingles, principal, Deloitte Consulting LLP.*

## Endnotes

1. Economist, “The last Kodak moment?,” January 14, 2012, <http://www.economist.com/node/21542796>, accessed January 24, 2014.
2. *Tech Trends 2014* is an independent publication and has not been authorized, sponsored, or otherwise approved by Apple, Inc.
3. Babson College, “Welcome from the dean,” <http://www.babson.edu/program/graduate/Pages/dean-message.aspx>, accessed January 24, 2014.
4. Doug Gross, “Google boss: Entire world will be online by 2020,” *CNN*, April 15, 2013, <http://www.cnn.com/2013/04/15/tech/web/eric-schmidt-internet/>, accessed January 20, 2014.
5. Andrew Myers, “Stanford’s John McCarthy, seminal figure of artificial intelligence, dies at 84,” *Stanford News*, October 25, 2011, <http://news.stanford.edu/news/2011/october/john-mccarthy-obit-102511.html>, accessed January 24, 2014.
6. Lucas Mearian, “World’s data will grow by 50X in next decade, IDC study predicts,” *Computerworld*, June 28, 2011, [http://www.computerworld.com/s/article/9217988/World\\_s\\_data\\_will\\_grow\\_by\\_50X\\_in\\_next\\_decade\\_IDC\\_study\\_predicts](http://www.computerworld.com/s/article/9217988/World_s_data_will_grow_by_50X_in_next_decade_IDC_study_predicts), accessed January 24, 2014.
7. J. Craig Venter Institute, *Venter Institute scientists create first synthetic bacterial genome*, January 24, 2008, <http://www.jcvi.org/cms/research/%20projects/synthetic-bacterial-genome/press-release/>, accessed January 24, 2014.
8. Singularity Hub, “An inside look into the Amazon.com warehouses (video),” April 28, 2011, <http://singularityhub.com/2011/04/28/an-inside-look-into-the-amazon-com-warehouses-video/>, accessed January 24, 2014.
9. Aviva Hope Rutkin, “Report suggests nearly half of US jobs are vulnerable to computerization,” *MIT Technology Review*, September 12, 2013, <http://www.technologyreview.com/view/519241/report-suggests-nearly-half-of-us-jobs-are-vulnerable-to-computerization/>, accessed January 24, 2014.
10. Marc Goodman, “What business can learn from organized crime,” *Harvard Business Review*, November 2011, <http://hbr.org/2011/11/what-business-can-learn-from-organized-crime/ar/1>, accessed January 24, 2014.
11. Phys.org, “One petabit per second fiber transmission over 50 km,” <http://phys.org/news/2012-09-petabit-fiber-transmission-km.html>, accessed January 27, 2014.
12. Scott Reeves, “Pros and cons of using femtocells,” *TechRepublic*, November 11, 2013, <http://www.techrepublic.com/blog/data-center/pros-and-cons-of-using-femtocells/#.>, accessed January 24, 2014.
13. Tim Wogan, “New tuner could bring terahertz to the masses,” *PhysicsWorld*, June 12, 2012, <http://physicsworld.com/cws/article/news/2012/jun/12/new-tuner-could-bring-terahertz-to-the-masses>, accessed January 24, 2014.
14. Google, Inc., “What is Project Loon?,” <http://www.google.com/loon/>, accessed January 24, 2014.

# Appendix

# Authors

## Bill Briggs

Chief technology officer  
Director, Deloitte Consulting LLP  
wbriggs@deloitte.com

## Disruptors

### CIO as venture capitalist

Tom Galizia, principal, Deloitte Consulting LLP  
tgalizia@deloitte.com

Chris Garibaldi, principal, Deloitte Consulting LLP  
cgaribaldi@deloitte.com

### Cognitive analytics

Rajeev Ronanki, principal, Deloitte Consulting LLP  
rronanki@deloitte.com

David Steier, director, Deloitte Consulting LLP  
dsteier@deloitte.com

### Industrialized crowdsourcing

Marcus Shingles, principal, Deloitte Consulting LLP  
mshingles@deloitte.com

Jonathan Trichel, principal, Deloitte Consulting LLP  
jtrichel@deloitte.com

### Digital engagement

Christine Cutten, principal, Deloitte Consulting LLP  
ccutten@deloitte.com

Barbara Venneman, principal, Deloitte Consulting LLP  
bvenneman@deloitte.com

### Wearables

Shehryar Khan, principal, Deloitte Consulting LLP  
khans@deloitte.com

Evangeline Marzec, specialist master, Deloitte Consulting LLP  
emarzec@deloitte.com

## Enablers

### Technical debt reversal

Scott Buchholz, director, Deloitte Consulting LLP  
sbuchholz@deloitte.com

David Sisk, director, Deloitte Consulting LLP  
dasisk@deloitte.com

### Social activation

Dave Hanley, principal, Deloitte Consulting LLP  
dhanley@deloitte.com

Alicia Hatch, principal, Deloitte Consulting LLP  
ahatch@deloitte.com

### Cloud orchestration

Andy Main, principal, Deloitte Consulting LLP  
amain@deloitte.com

John Peto, principal, Deloitte Consulting LLP  
jpeto@deloitte.com

### In-memory revolution

Mike Brown, principal, Deloitte Consulting LLP  
mikbrown@deloitte.com

Doug Krauss, specialist leader, Deloitte Consulting LLP  
dkrauss@deloitte.com

### Real-time DevOps

Ayan Chatterjee, principal, Deloitte Consulting LLP  
aychatterjee@deloitte.com

Alejandro Danylyszyn, principal, Deloitte Consulting LLP  
adanylyszyn@deloitte.com

## Exponentials

Bill Briggs, Chief technology officer  
Director, Deloitte Consulting LLP  
wbriggs@deloitte.com

*With contributions from Singularity University faculty and leadership and Marcus Shingles, principal, Deloitte Consulting LLP.*

# Contributors

Aaron Sotelo, Abdi Goodzari, Adarsh Gosu, Amy Bergstrom, Andrew Luedke, Angel Vaccaro, Ann Perrin, Antonio Caroprese, Chad Clay, Chrissy Weaver, Dan LaCross, Dan McManus, Daniel Ledger, Daryl Jackson, Dennis Startsev, Derik Quinn, Ed Panzarella, Elizabeth Rielly, George Collins, Gina Marchlowska, Irfan Saif, Jarrod Phipps, Jeff Powrie, John Daab, John Keith, John Stefanchik, John Sprouse, Jon Wiesner, Jostin Darlington, Junko Kaji, Kavin Shelat, Keith Zalaznik, Kevin Weier, Kumar Chebrolu, Lisa Iliff, Maria Gutierrez, Martin Hougaard, Matt Lennert, Missy Hyatt, Navin Advani, Nicole Leung, Oliver Page, Paul Krein, Paul Roma, Paul Toler, Prabhu Kapaleeswaran, Rajeswari Chandrasekaran, Ram Venkateswaran, Rithu Thomas, Robert Kasegrande, Sandy Ono, Steven Bailey, Steven Shepley, Tara Newton, Travis Budisalovich, Trey McAdams, Troy Bishop, Vladimir Baranek, Yu Zhu

## Consumer Products Contributors

Darwin Deano, Richard Kupcunas, Matt Law, Russell McLean, Mukul Nagle, Oliver Page, Khelan Patel, Jarrod Phipps, Nitin Rao, Karl Rupilius, Shomic Saha

# Research

**Leads:** Tom Carroll, Chris Chang, Tore Dyvik, Justin Franks, Thomas Gleason, Rui He, Thomas Henry, Karthik Kumar, Nicole Leung, Simy Matharu, Abhishek Mishra, Jose Munoz, Paridhi Nadarajan, Akshai Prakash, Fatema Samiwala, Jeremy Young

**Team Members:** Jacob Artz, Anwar Ayub, Rachel Belzer, Simeon Bochev, Kevin Bojarski, Mark Brindisi, Alex Carlon, Felix Cheng, Judy Chiu, Eugene Chou, Ian Clasbey, Kyle Collins, Kevin Craig, Brian Cusick, Philip Davis, Michael Davis, Jefferson DeLisio, Zach Epstein, Inez Foong, Marjorie Galban, Leksi Gawor, Rachana Gogate, Calvin Hawkes, Taylor Hedberg, Dan Heinitsh, Dan Henebery, Seimi Huang, Sam Jamison, Simon Jo, Solomon Kassa, Rebecca Kim, Ryo Kondo, Adrian Kosciak, Ashish Kumar, Varun Kumar, Corey Lian, Alyssa Long, Pulkit Maheshwari, Ryan Malone, Tyler Martin, David Melnick, Akhil Modi, Alice Ndikumana, Kashaka Nedd, Brittany Neisewander, Ryan Pallathra, Aaron Patton, Lee Reed, Talal Rojas, Tammy Ross, Jaclyn Saito, Hugh Shepherd, Will Shepherdson, Andrea Shome, Kylene Smart, Sam Soneja, Gayathri Sreekanth, Xenia Strunnikova, Lindsey Tsuya, Peter Van, Jordan Weyenberg, Jenny Zheng

# Special thanks

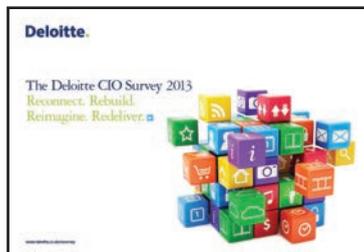
**Mariahna Moore**—for being the heart, soul, and “buck” of this year’s report—where every detail started and stopped, big or small. Your tireless leadership, spirit, and drive are truly inspirational and a singular reason we hit every ambition without compromising seemingly impossible deadlines.

**Cyndi Switzer, Stuart Fano, Jill Gramolini, Kelly Ganis, and Heidi Boyer**—the veteran dream team that makes Technology Trends a reality. Your passion, creativity, and vision continue to take the report to new heights. And your dedication, energy, and commitment never cease to amaze.

**Dana Kublin, Mark Stern, and Elizabeth Rocheleau**—for the tremendous impact made in your first year Tech Trending—from the phenomenal infographics to coordinating our volunteer army to jumping into the content fray.

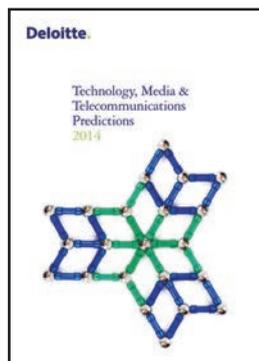
Finally, a special thanks to **Mark White**, the founder of our Technology Trends report series and an invaluable contributor, mentor, and friend. Thanks for all of your continued support as we build on your legacy.

# Recent Deloitte thought leadership



## The Deloitte CIO Survey 2013

[www.deloitte.co.uk/ciosurvey](http://www.deloitte.co.uk/ciosurvey)



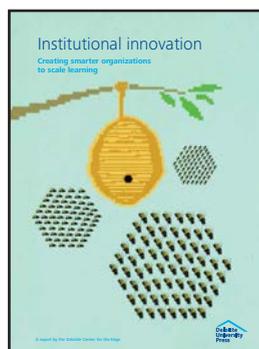
## 2014 Technology Media & Telecommunications Predictions

[www.deloitte.com/predictions2014](http://www.deloitte.com/predictions2014)



## From Exponential Technologies to Exponential Innovation

[http://dupress.com/articles/  
from-exponential-technologies-to-exponential-innovation/](http://dupress.com/articles/from-exponential-technologies-to-exponential-innovation/)



## Institutional Innovation: Creating smarter organizations to scale learning

<http://dupress.com/articles/institutional-innovation/>

## Stay connected with technology trends:

### **Subscribe to receive technology-related communications**

[www.deloitte.com/us/CIOSubscribe](http://www.deloitte.com/us/CIOSubscribe)

### **Subscribe to the Dbriefs webcast series for technology executives**

[www.deloitte.com/us/techdbriefs](http://www.deloitte.com/us/techdbriefs)

## Other trends reports:

### **Analytics Trends 2014**

[www.deloitte.com/us/analyticstrends](http://www.deloitte.com/us/analyticstrends)

### **Global Human Capital Trends 2014 (Coming in February)**

[www.deloitte.com/us/HRSubscribe](http://www.deloitte.com/us/HRSubscribe)

### **Business Trends 2014: Navigating the next wave of globalization (Coming in March)**

[www.deloitte.com/us/SOperspectives](http://www.deloitte.com/us/SOperspectives)



Follow @DU\_Press

Sign up for Deloitte University Press updates at [www.dupress.com](http://www.dupress.com).

## Learn more



Follow @DeloitteOnTech

[www.deloitte.com/us/techtrends2014](http://www.deloitte.com/us/techtrends2014)



### **About Deloitte University Press**

Deloitte University Press publishes original articles, reports and periodicals that provide insights for businesses, the public sector and NGOs. Our goal is to draw upon research and experience from throughout our professional services organization, and that of coauthors in academia and business, to advance the conversation on a broad spectrum of topics of interest to executives and government leaders.

Deloitte University Press is an imprint of Deloitte Development LLC.

This publication contains general information only, and none of Deloitte Touche Tohmatsu Limited, its member firms, or its and their affiliates are, by means of this publication, rendering accounting, business, financial, investment, legal, tax, or other professional advice or services. This publication is not a substitute for such professional advice or services, nor should it be used as a basis for any decision or action that may affect your finances or your business. Before making any decision or taking any action that may affect your finances or your business, you should consult a qualified professional adviser.

None of Deloitte Touche Tohmatsu Limited, its member firms, or its and their respective affiliates shall be responsible for any loss whatsoever sustained by any person who relies on this publication.

### **About Deloitte**

Deloitte refers to one or more of Deloitte Touche Tohmatsu Limited, a UK private company limited by guarantee, and its network of member firms, each of which is a legally separate and independent entity. Please see [www.deloitte.com/about](http://www.deloitte.com/about) for a detailed description of the legal structure of Deloitte Touche Tohmatsu Limited and its member firms. Please see [www.deloitte.com/us/about](http://www.deloitte.com/us/about) for a detailed description of the legal structure of Deloitte LLP and its subsidiaries. Certain services may not be available to attest clients under the rules and regulations of public accounting.

Copyright © 2014 Deloitte Development LLC. All rights reserved.  
Member of Deloitte Touche Tohmatsu Limited