

## BCG TECHNOLOGY ADVANTAGE

- TRANSFORMING THE BUSINESS THROUGH TECHNOLOGY: AN INTERVIEW WITH DARRYL WEST, GROUP CIO AT HSBC
- JEFF KEISLING ON THE SUCCESSFUL TRANSFORMATION OF PFIZER'S IT ORGANIZATION
- ORGANIZING FOR A DIGITAL FUTURE
- THE BUILD-OR-BUY DILEMMA IN AI
- TAKING THE RISK OUT OF DIGITAL PROJECTS
- GOING ALL IN WITH DEVOPS
- METADATA ISN'T JUST FOR TECHIES ANYMORE

TOWARD A  
MODEL FOR  
PUBLIC-PRIVATE  
COLLABORATION IN  
CYBERSECURITY

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# Preface



If you've seen the classic movie *The Wizard of Oz*, you probably remember the frightened chant "lions and tigers and bears—oh my!" But we've been transported not to the Land of Oz but to a new digital world, where the lurking threats are not lions and tigers and bears but botnets and breaches and hacks. The concerns that keep top executives awake at night are cyberpredators that are infiltrating data repositories, unleashing ransomware, and potentially corrupting AI-driven systems. Cyberattacks pose vast economic, brand, and societal risks. They could even have life-threatening consequences. And as digitization expands, placing more and more data and processes into the cybersphere, it follows that the volume of data and processes at risk also grows.

The solution is not the one that worked in Oz: to click our heels together and go back whence we came. That would mean abandoning the benefits of our new digital world. Rather, the solution is cyberresilience. Building cyberresilience—not just technologies but people and leaders with the right knowledge and leadership skills to anticipate and repel cyberattacks—will require collaboration between organizations, both public and private.

Cross-sector collaboration is the topic of our feature article, which is drawn from a comprehensive report—that was itself written in collaboration, with the World Economic Forum. The report looks at how to establish policies around information sharing, cross-border data flows, and more.

What else are executives thinking about? Digital, of course, is top of mind for many. Articles in this issue of *BCG Technology Advantage* look at organizing and derisking digital initiatives. AI is also a topic of the moment; in this issue, we look at why build-or-buy decisions in AI are different from similar decisions in other fields. Other topics: expanding the value of DevOps to optimize agile and extending the use of metadata to all functions within an organization.

We also hear directly from two executives: Darryl West, CIO at HSBC, and Jeff Keisling, CIO at Pfizer.

What's on your mind? Let us know at [Technology.Advantage@bcg.com](mailto:Technology.Advantage@bcg.com).

Ralf Dreischmeier  
*Global Leader, Technology Advantage practice*

# Contents

FEATURE	
Toward a Model for Public-Private Collaboration in Cybersecurity	2
Q&A	
Transforming the Business Through Technology: An Interview with Darryl West, Group CIO at HSBC	5
Q&A	
Jeff Keisling on the Successful Transformation of Pfizer's IT Organization	7
FOCUS	
Organizing for a Digital Future	9
FOCUS	
The Build-or-Buy Dilemma in AI	15
FOCUS	
Taking the Risk Out of Digital Projects	20
VIEWPOINT	
Going All In with DevOps	27
VIEWPOINT	
Metadata Isn't Just for Techies Anymore	33

# TOWARD A MODEL FOR PUBLIC-PRIVATE COLLABORATION IN CYBERSECURITY

by Walter Bohmayr, Stefan Deutscher, and David Mkrtchian

**M**ANY WILL REMEMBER 2017 as the year of the big hack: two major cybersecurity events made headlines and put millions of people and their data at risk. The first was the WannaCry ransomware attack in May. Among other things, it froze operations at multiple hospitals in the UK's National Health Service and caused hundreds of millions of dollars in damages. The second, in September, was the Equifax credit bureau breach in which more than 140 million individual records were compromised.

Policymakers and business leaders have begun to recognize the need for more and better collaboration between the public and private sectors on issues related to cybersecurity, including encryption, data sharing, and data localization. On many of these topics, persistent misunderstandings over both policy and technical issues have created and exacerbated tension among public- and private-sector leaders.

To promote action-oriented and productive collaboration between the public and private sectors, The Boston Consulting Group supported the World Economic Forum in developing its report *Cyber Resilience: Playbook for Public-Private Collaboration*. The Forum and a cross-industry working group identified the policy issues where collaboration is imperative and presented 12 case studies that illustrate key technical and policy concepts. For each issue, the Forum's working group de-

scribed all of the available policy options and their implications, rather than promoting one particular policy approach above others.

Countries will continue to pursue their own cybersecurity policies; every country has unique capabilities, risks, and values that shape its approach. Security policy is often mired in prolonged indecision. The Forum's report brings a clear-eyed view to help expedite policy development.

## Key Policy Topics

The Forum's report identifies 14 key policy issues with respect to cybersecurity:

- **Research, Data, and Intelligence Sharing.** What is the government's role in sharing threat intelligence and promoting its dissemination?
- **Zero-Days.** To what extent should the government be involved in the research, collaboration, and purchase of zero-day vulnerabilities and exploits? To what extent should the government share these vulnerabilities with the private sector?
- **Vulnerability Liability.** Who is liable for securing software, and what are the tradeoffs associated with different liability regimes? How should liability shift when products reach the end of their useful life?

- **Attribution.** How should governments engage with the private sector when the private sector publicly alleges that a particular actor is responsible for an attack?
- **Botnet Disruption.** What should be done to prevent the proliferation of botnets? How should existing botnets be researched and studied? How should actors throughout the ecosystem disrupt botnets?
- **Monitoring.** To what extent should different actors be able to monitor internet traffic and enforce security protocols? What traffic should nonusers be able to monitor in order to promote security and other national interests?
- **Assigning National Information Security Roles.** Which entities and organizations should serve in national information security roles?
- **Encryption.** Who should be able to access sensitive data and communications?
- **Cross-Border Data Flows.** What are the security and nonsecurity implications when countries exert control over data?
- **Notification Requirements.** When should companies be required to notify relevant stakeholders that they have been breached or have otherwise experienced a cyberincident? What sanctions should policymakers apply to compromised organizations?
- **Duty of Assistance.** How should public resources be drawn upon in the wake of a cyberincident?
- **Active Defense.** What technical measures should the private sector be empowered to use to deter and respond to cyberthreats?
- **Liability Thresholds.** What is the reasonable duty of care that an organization should have? Who should bear the residual damages resulting from cyberincidents when an organization has sufficiently invested in security controls?
- **Cyberinsurance.** What incentives, if any, should be offered to obtain cyberinsurance? Which entities should be prioritized for these incentives?

## Common Themes and Approaches

Across these topics, there are multiple linkages and interdependencies. For example, an effective intelligence-sharing policy helps constrain the spread of malicious software, and wider adoption of encryption may limit the ability to monitor and police network traffic. In practice, what these cross-topic connections mean for business leaders and policymakers is that cybersecurity policy-making efforts should be more collaborative and deliberative. Policy should stem from an ongoing iterative process, not from ad hoc and crisis-driven responses that lead to patchwork legislation. The report makes five recommendations on how to pursue collaborative policies.

First, the acceptable scope of action for the public and private sectors should be more clearly defined. For example, current policy around data and intelligence sharing is hindered by the absence of clear guidance on what constitutes protected industry collaboration. And in the public-private context, the private sector is often reluctant to share data with the public sector owing to concerns that the data will one day serve as the basis for regulatory actions.

Second, the boundaries of permissible activity for security practitioners need to be well described. In many jurisdictions today, legitimate cybersecurity researchers—colloquially called “white hat” hackers, as opposed to the malicious “black hat” hackers—are uncertain as to the techniques and tools they are legally empowered to use when they test systems.

Third, the policy decisions made in national contexts should consider international implications—cyberspace recognizes no geographic boundaries. To predict the longer-term effects of a policy position, it is useful to consider the impact of a symmetric international policy response.

Fourth, policies to promote compliance, and thus security, should strike an appropriate balance between outlining regulatory objectives and specifying actual security controls, because the latter can result in undue compliance cost burdens. In an effort to develop cybersecurity governance structures, policymakers and, in particular, regulators have begun to specify exhaustive processes and technologies for organizations to implement. But improved compliance by itself will not necessarily advance cyberresilience.

Last, security policy should focus on preventive efforts to minimize the frequency of the more contentious tradeoffs that are made in response to security issues. For example, significant debate and intellectual energy have been devoted to the question of how software vulnerabilities should be disclosed. Considerably less attention has been given to software-coding quality standards. More secure software would reduce the stakes of the debate.

**C**YBERRISK will continue to be one of the most pressing challenges in the fourth industrial revolution. Leaders across the public and private sectors appreciate that mitigating this risk requires continued collaboration. The Forum's report (<https://www.weforum.org/reports/cyber-resilience-playbook-for-public-private-collaboration>) helps all stakeholders move toward that goal.

***Walter Bohmayr** is a senior partner and managing director in the Vienna office of The Boston Consulting Group and the global leader for cybersecurity. You may contact him by email at [bohmayr.walter@bcg.com](mailto:bohmayr.walter@bcg.com).*

***Stefan Deutscher** is an associate director in the firm's Berlin office and the global topic leader for cybersecurity. You may contact him by email at [deutscher.stefan@bcg.com](mailto:deutscher.stefan@bcg.com).*

***David Mkrtchian** is a consultant in BCG's New York office, on secondment with the World Economic Forum. You may contact him by email at [mkrtchian.david@bcg.com](mailto:mkrtchian.david@bcg.com).*

# TRANSFORMING THE BUSINESS THROUGH TECHNOLOGY

AN INTERVIEW WITH DARRYL WEST, GROUP CIO AT HSBC

*When Darryl West took the helm as group CIO at HSBC in 2015, he was tasked with transforming both the way that IT operated and how it interfaced with the overall business. Over the two and a half years that West has been heading up the bank's technology function, his department not only brought in new tools and reshaped the way HSBC uses technology but also developed new ways of improving the customer experience and the business.*

*With more than 30 years of experience, West, who is based in Hong Kong, leads a global team of 40,000 who are working to transform HSBC's technology and become the world's leading financial services technology team.*

*As IT becomes more and more critical to the world of banking, the partnership between technology and the business has become one of the most important facets of operations. Darryl West continues to drive a series of strategies that are helping to bring HSBC to the forefront of technology.*

**What were some of your biggest goals when you took over IT for HSBC?**

My mandate was to take hold of the IT function and turn it into a high-performing team of technology people, partnering with the business to help transform the company. This was not just an IT transformation; it was actually the enablement of a business transformation.

We worked in close collaboration with the business to determine what programs it needed to implement in the transformation and to build new customer channels for all the businesses.

In parallel, we reconfigured how we deliver IT. We transformed our own team and set about the journey of

simplifying the architecture of a complex, 150-year-old global banking group. We had a number of different applications and infrastructures that had been built up from our various acquisitions and needed to be simplified. Those complexities were causing issues in terms of our time to market, our cost to support, and our cost to deliver. So we set about transforming the IT function to enable that larger business transformation to take place.

**What steps did you take in implementing such a large-scale transformation in such a short time frame? What challenges did you face?**

## DARRYL WEST

### A FEW KEY LESSONS FROM CIO DARRYL WEST:

- Getting the right operating model is an important first step.
- Short time frames can offer some of the biggest opportunities.
- Learn to leverage the newest technologies.
- Technology is critical to the future of business.
- Honest assessments of strengths and goals early on are vital to large-scale transformations.



Getting IT organized in the right way was the first step. We organized into a cohesive global team, properly interfacing with the businesses and the functions, recruiting the right people or putting the right people in place to be credible partners for the business.

Part of what we did was move resources around between locations. We are a global company with resources in over 70 countries. As part of our transformation, we looked at optimizing our operating model. This included a review of where our staff were located and how they could be deployed most effectively.

serious assessment of your capability to do that. Ask yourself whether you have the right organization structure. Do you have the right people? Are you using the right methods? Really examine the way you do things, because that's going to be the core element of the transformation.

We also started adopting agile and DevOps to help improve the way our IT operates and to transform the business. It's been a big journey of unifying development and operations, toward having more of a vertical where you've got IT people—architects, developers, security individuals—and the business

sumed through those channels as well as our physical locations.

Big data is obviously something we need to be getting really good at. We're now able to take large amounts of data for analysis, identifying insights and trends to enhance the customer experience.

We've also come to the conclusion that partnering with world-class cloud providers—like Google, Amazon, and Microsoft—allows us to utilize the technologies that they are good at, enabling us to focus more on managing our customers and creating better experiences.

Technology today is an essential enabler of everything we're doing. At the core of the company is a technology function that's producing solutions and outcomes for customers. We recognize that technology is at the center of all of that, and that the world is changing around us. The environment is changing quickly, and our customers are demanding that we use the newest technology available to them as consumers. Whether they are corporates or small businesses or individuals, they are consuming these services in a much different way than they used to. So I think technology is going to play a pivotal role in the way we do our business going forward; it will be a key differentiator in what our customers are looking for.

*Nadja Yousif is a partner and managing director in the London office of The Boston Consulting Group. You may contact her by email at [yousifnadja@bcg.com](mailto:yousifnadja@bcg.com).*

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“Big data is obviously something we need to be getting really good at.”

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The harder part of our two and a half years of transformation has been the fundamental architectural changes we had to make. If you're ripping out systems and replacing them with new ones, or if you're taking ten versions of something and then trying to consolidate them into one or two, that's a much tougher task to do in a short time frame.

**What advice can you offer on this kind of large-scale transformation?**

My advice to people would be to get the right operating model agreed upon with the business. Be really clear about what they're trying to deliver, be really clear about the program of work that they need you to deliver, and then do a

all on the same team, highly optimized for delivery.

The speed at which a team moves is also critical to the transformation. Technology can be a major conduit for changes that optimize a cost base, or improve controls, risk assessments, and risk management systems. A lot of these rely on the speed at which the IT team can deliver the solutions.

**What are some of the most important changes you hope to see through on the business and IT sides?**

We're seeing an increasing shift toward the use of mobile channels and devices in the retail and wealth businesses. This has meant adapting our services to be con-

# JEFF KEISLING ON THE SUCCESSFUL TRANSFORMATION OF PFIZER'S IT ORGANIZATION

*Jeff Keisling became the CIO of Pfizer after the company's 2009 acquisition of Wyeth, where he'd held the same position. Since then, he has overseen a complete transformation of the combined company's business technology department—taking Pfizer from a position as one of the highest spenders on IT as a percentage of revenues in the pharma business to one of the lowest. Now SVP and senior information officer at Pfizer, Jeff spoke with Craig Lawton, a senior partner and managing director in The Boston Consulting Group's New York office, about the factors behind the company's IT transformation and the tremendous value that transformation has created. The following is an edited version of that conversation.*

**Jeff, thanks for taking the time to talk about the merger of Pfizer and Wyeth. Based on industry benchmarks of the large global pharma companies, Pfizer's built a low-cost and high-capability IT organization. What have been the key enablers of your success?**

We have an exceptionally talented team that is deeply integrated with

the business lines. They have seats at the table. That's been a core part of our strategy, and the way that we select those leaders is mutual. It's a 50% share vote that I have, and 50% share vote of our business line leaders. We have those leaders now at multiple levels. It's not just at the top tier of the company, which I'm very proud of. It's now just the way that we operate. It's just a natural thing that we do, where, many years ago, I had to pitch that, or ask permission, or convince people to do it. It's just the way things now happen at Pfizer.

We started in a position where we were a high spender. As a percent of revenue, we were at least among the highest spenders in the pharma industry. We had much broader aspirations, or better aspirations than that. Today we find ourselves, for large pharma, to be among the lowest spenders to revenue ratio players, if not the lowest.

**You have recently completed an on-time and on-budget, single-instance, global SAP rollout. That's a mouthful. What are the keys to pulling that off?**

The kernel of the ERP strategy was the same kernel that we've used repeatedly over 40 times with our enterprise systems approaches. And that is, that it's not an IT project.

We started very strongly with business leadership, business ownership, and an ownership culture that we have at Pfizer in general. So, a lot of people would say, "good governance." Well, we have that. That's not enough, in my view. We want people that own the results of the implementations. And not only do they participate, or tell us what they need, or what the requirements are in very traditional IT terms, they're a full-time part of the team. They are accountable for the results.

**Now that you have an implemented, global, single instance of SAP, where do you see the business value coming from, and how do you capture it?**

Again, very proud of our ERP team, combined with the business leaders around the world that have been a part of this, both in the markets and in the plants, the supply chain, procurement. So this

is a very large scale, very large scope ERP program. It wasn't just finance, or it wasn't just manufacturing, like so many are. This is truly ERP, first of all. That added some challenge and some complexity to it.

Key to our ability to innovate, while we drive value from a cost perspective, we consider to be an "and" proposition versus an "or" proposition. At the center of that is really the confidence that we have with our business partners, our business

And I think that's a self-defeating proposition. We ran the table. So we looked at everything from top to bottom, stratified it, even things that we thought that we had passed over, finished. We continuously looked at the next opportunity.

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“Our leaders are comfortable with being uncomfortable. That doesn't make this easy.”

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What I can say is, we set out a budget and a set of economic goals to attain throughout the program's life. We report out on those things, up to our audit committee at the board, at least two times per year. In the early stages of the project, four times per year. Very clear and transparent accountability, as I mentioned before.

I'm proud to say that we have blown away the economic value that we originally set out. And we have maintained the budget over a multiyear program.

**How have you approached balancing building those new capabilities, like digital and data analytics, while continuing to bring down IT spend as a percent of revenue?**

lines, research, manufacturing, and our functions throughout the company. If you deliver on your commitments, you keep your promises, you deliver on those values, you earn the right to have the conversation to be a thought leader. If you don't get those fundamentals right, I believe, you stay in the world of infrastructure, you stay in the world of operational acuity. And we've been able to move the conversation beyond that.

So I'd say our leadership team, and again leaders at all levels, are comfortable with being uncomfortable. That doesn't make this easy. It's very easy to be dismissive and say, "As a leadership team, we've already done that. We've already touched that ground. We're past that, we have to find new ideas."

Now we realized that the home runs, per se, were pretty much consumed in the first three, four, five years of the transformation. So we got very comfortable looking for singles and doubles, and maybe an occasional triple, which means we had to do more of them to get to the target. Again, proud to say that we've never missed.

*Craig Lawton is a senior partner and managing director in the Atlanta office of The Boston Consulting Group. You may contact him by email at [lawton.craig@bcg.com](mailto:lawton.craig@bcg.com).*

# ORGANIZING FOR A DIGITAL FUTURE

by Gabrielle Novacek, Rashi Agarwal, Sonya Hoo, Steve Maaseide, Benjamin Rehberg, and Liza Stutts

**D**IGITAL IS ON THE CEO agenda of established companies, and many CEOs approach the topic by asking two initial questions:

- Who should be in charge of digital?
- What is the best model for organizing digital?

These are relevant questions, but answering them too quickly will likely send a company down the wrong path. In their rush to go digital, companies often dive into a mix of projects and activities without having first developed a clear understanding of what they want to accomplish and how they plan to achieve those goals.

Companies are better off establishing a few overarching goals, selecting a digital model that is in tune with their current organization and capabilities, and then embedding digital carefully and strategically throughout the organization. To jump into the future too quickly is to risk frustration, failure, and waste.

Digital does not change the principles of organizational design and governance. But because the capabilities and cadence of digital work can differ so significantly from traditional ways of working, leaders must be thoughtful in their approach. Below, we offer a practical guide to establishing a digital orga-

nizational model and governance structure—including such issues as whether to separate digital into a standalone unit and whether to name a chief digital officer—for companies that began life in a brick-and-mortar world.

## Acting with Deliberate Dispatch

Once digital is on a CEO's radar, the urge to act swiftly—for example, by appointing a chief digital officer with an ill-defined portfolio—is understandable. After all, accountability, responsibility, and momentum drive performance. But fast moves can backfire.

Digital covers a wide range of customer-facing, back-office, and shop-floor activities, including (among others) algorithmic decision making, microtargeting of customers through artificial intelligence, use of software bots to automate clerical deskwork, and self-learning robots. Without clear goals, companies are likely to chase shiny objects that look exciting but may turn out to be subscale, redundant, or off point.

The same need for deliberation applies to organizational and governance issues. A company that fails to establish digital roles and decision rights is likely to end up with several of its teams pursuing similar incremental goals. And if the company establishes a digital operating model in a vacuum, it will inevitably generate friction among existing teams and

functions. Accountability and oversight are common casualties when a company fails to think through organizational issues.

In other words, to say that a company wants to become digital is to start a conversation about a set of choices and decisions. Answers to three key questions—one involving strategy and the others focusing on organization and leadership—will help shape and inform that evolutionary journey. (See Exhibit 1.)

### What Are the Company’s Digital Strategy and Ambitions?

In the early days of electrification, companies retained factory layouts built around the original site of the steam engine, even though they no longer needed the old engine’s mechanical connections to run machinery. History is now repeating itself. Many companies are digitizing the belts and pulleys of legacy processes when they should be thinking deeply and creatively about how to use digital to operate and organize in new ways that create new opportunities.

Powered by the exponential growth of processing power, bandwidth, and storage, digital differs fundamentally from earlier, linear business developments. It’s not enough to sprinkle digital pixie dust here and there and declare victory. Companies must clearly define the ends that they are trying to achieve

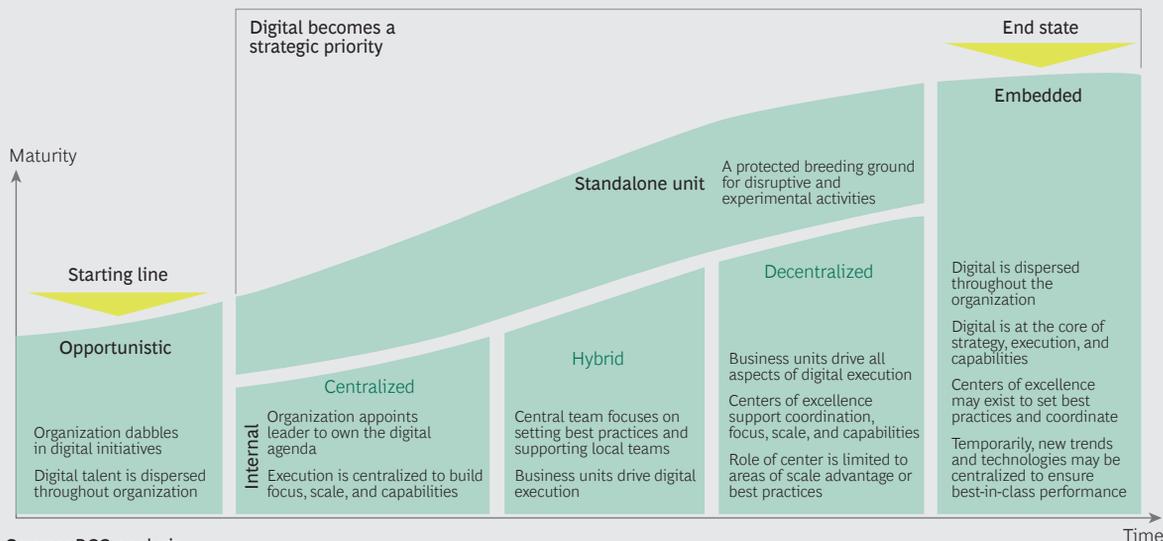
by digital means. At the beginning of this process, three subsidiary questions are especially important:

- **What is the company’s overall ambition as an enterprise?** Digital should act in the service of that agenda, not as an effort tangentially or not at all related to it.
- **In what critical areas will digital most effectively accelerate or enable corporate objectives?** Most companies cannot immediately go digital across the entire organization. Instead, they need to establish priorities that reflect opportunity or (conversely) anticipate danger from disruption.
- **How digitally mature is the company in those critical areas today?** The company must have the right capabilities in place if digital is to work effectively. Digital skills are not fungible. A digital marketing specialist cannot manage robots on the factory floor.

### Should the Company Build Digital Capabilities Within Its Business?

Once a company has defined its digital strategy, the next key question is organizational and relates to integration versus separation of digital activities: Should digital activities reside within or outside the current organization?

**EXHIBIT 1 | The Evolutionary Path to a Digital-Everywhere Organization**



Source: BCG analysis.

Building digital capabilities internally, within an existing hierarchy, is generally the easiest way to integrate digital activities into a company's strategy, execution, and talent development. If one goal is to embed digital in the company's fabric as quickly as possible, the internal option is the best—and most common—approach. But committing to the internal option leads to myriad related choices about where and how best to locate digital activities.

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Companies that decentralize are mirror opposites of those that favor centralization.

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Often, the first question about digital organization that CEOs ask is whether they should appoint a chief digital officer. (See the sidebar “The Role of a Chief Digital Officer.”) But that question is actually subordinate to a broader question involving three options: Does the company want to centralize its digital activities, distribute them throughout its businesses, or split the difference and create a hybrid model? (See Exhibit 2.)

If a company's strategy requires significant coordination and cooperation across businesses and functions, or if the company needs a big digital push, centralization may make more sense for digital activities and other functions. Likewise, if the company's current expertise or scale in digital is weak, centralizing probably makes sense. Finally, businesses that run on a command-and-control model tend to gravitate toward centralization.

A centralized approach has strong visibility with senior leaders, meaning that the digital team will likely have the resources and people it needs to create new capabilities and develop scale and global practices. On the other hand, if it establishes a central team, a company runs the risk that line leaders elsewhere in the organization will view that team as an ivory tower out of touch with the grind of business. To avoid this perception, the team must constantly engage with line leaders and work on initiatives that those leaders consider relevant.

The profile of companies that decentralize digital is the mirror opposite of those that favor centralization. A decentralized strategy

## THE ROLE OF A CHIEF DIGITAL OFFICER

The idea of having a chief digital officer is popular these days. Giving a single executive accountability for digital activities is appealing, but the success of a CDO depends on the organizational context. If a company's digital activities are highly centralized, having a CDO is likely to make sense; but establishing roles, responsibilities, and relationships with line businesses remains critical. Even if the company sets strategy centrally, execution will probably occur within the businesses, so upfront discussions about how to make the matrix work are essential. Such discussions are even more critical in companies that adopt a hybrid model in which line businesses have a strong say in digital strategy.

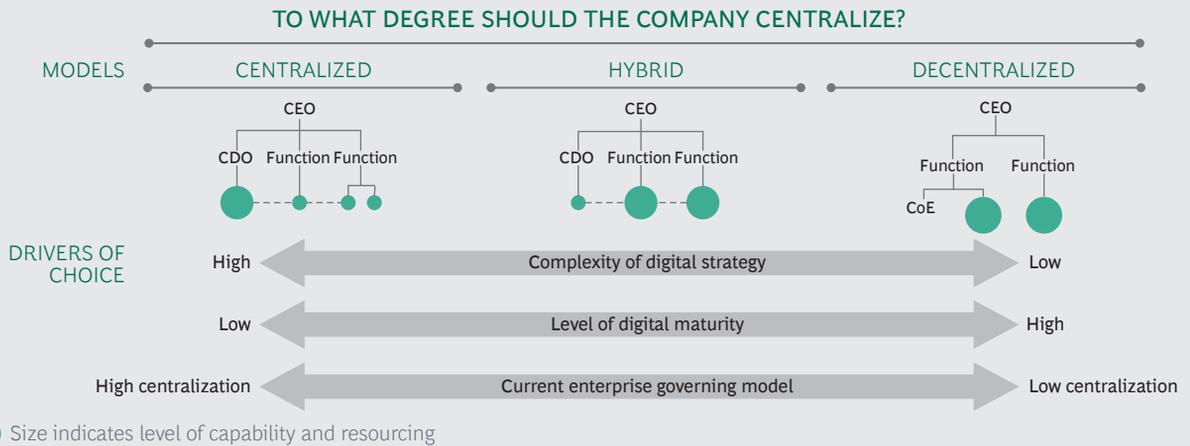
Other questions involve the CDO's portfolio. Many companies limit their CDO's

initial focus to commercial functions in order to drive impact quickly. A CDO who has unduly wide latitude may cover too much ground and risk losing effectiveness and focus.

A company with decentralized digital activities, on the other hand, is unlikely to benefit from naming a CDO to set digital strategy, since line businesses make those decisions. Within a decentralized company, a CDO could conceivably run digital shared services or centers of excellence, but it is unclear whether the company would need a C-suite executive for that role.

Figuring out these issues upfront will accelerate a company's digital activities in the future.

## EXHIBIT 2 | How to Think Through Digital Centralization Versus Decentralization



Source: BCG analysis.

Note: CDO = chief digital officer or head of a business unit; CoE = digital center of excellence.

does not rely on coordination across boundaries, and organizational decision making is distributed across the company. Line businesses are responsible for their digital activities, with support from one or more centers of excellence.

When digital becomes more fully embedded in the organization, businesses throughout the company will find it easier to develop a digital culture and to recruit digital team members rather than digital specialists who are unaccustomed to having front-line responsibilities. The downside to this decentralized approach is that digital may not have an advocate in the executive suite, putting digital at a disadvantage in competition with other company priorities. In addition, global practices and organizational standards may fail to develop.

Integration is not the only option. A standalone digital unit can make sense.

Under a hybrid approach, line businesses continue to run digital activities, but they work closely with the center on best practices and other forms of support. Digital has support at the top, and—if the center is responsive—the

company can maintain a good balance between global consistency and local initiative. As in the decentralized model, however, digital in a hybrid system is at risk of competing with and losing out to other priorities.

Companies that adopt a hybrid approach need to create effective reporting lines and a clear delineation of decision rights and accountability. Each part of the matrix must have a clear organizational mandate for digital activities.

### How Should the Company Organize a Standalone Unit?

Integration is not the only option. Some companies create a standalone digital unit that operates independently of the day-to-day business. This makes sense when a company's digital ambitions require entirely new business models and capabilities or when those ambitions are disruptive to the core business. A standalone digital unit may also make sense when the main organization resists change or when the company is unlikely to attract digital talent to its core.

The standalone option has some positive attributes. It can act as a breeding ground for new ways of thinking and working, and it can enable companies to move quickly at the start, with less risk of failure. Digital integration with a standalone unit takes longer, but

that may be the price of moving forward if the core business is initially inhospitable.

Standalone digital units may look very different from one another. Although companies deliberately set up these units outside the hierarchy, the units may still mirror the hierarchy's traditional structures, processes, and incentives. The standalone approach makes sense when the digital activities are unlikely to take root at scale within the hierarchy.

At the other extreme, some companies deliberately design standalone units to function as digital natives. Consequently, these units tend to adopt the policies and practices of a startup rather than of an incumbent. This approach makes sense when a company wants to build a business or a set of activities that the company is unlikely in the medium term to fold into a line business.

## Embedding Digital in an Organization's DNA

To some degree, the digital organizational and governance issues described earlier are transitional. In the long run, companies should aim to fully embed digital in day-to-day operations. This is what digital natives such as Spotify and Zappos have done since birth and what ING, a traditional global bank headquartered in the Netherlands, has implemented with its agile approach. Discussions about digital strategy and digital capabilities will fade away as digital strategy becomes a company's strategy, and digital talent will spread throughout the organization rather than residing within a priesthood of experts. The CEO will be the de facto leader of digital efforts. Digital will be so central to the company's strategy and execution that it will seem invisible. (See the sidebar "BBVA's Journey.")

### BBVA'S JOURNEY

In 2006, Francisco González, the chairman and CEO of BBVA, a Spanish bank, declared his vision to "build the best digital bank of the 21st century." (See *The Power of People in Digital Banking Transformation*, BCG report, November 2015.) As González wrote in the *Financial Times*, "Banks need to take on Amazon and Google or die."

The resulting transformation has traveled from the top of the organization to the bottom. The president and CCO, for example, formerly ran the bank's digital unit, and many executive-committee heads have extensive digital experience. Today, digital is embedded in all of BBVA's major business units.

BBVA's transformation journey comprised several stages. First, the IT department focused on modernizing business systems. The bank created several digital centers of excellence to address such high-priority issues as mobile banking, big data, and advanced analytics. In 2012, the digital business unit reporting to the CEO came to life. Although the unit did not have P&L responsibility, its mission was to lead the

digital agenda across the business and the bank.

In 2015, the bank pushed the digital agenda to its business units. In order to present a unified end-to-end customer experience, the bank created a customer solutions unit that uses an innovation lab to conduct real-time customer trials.

Organizations become digital not to catch a fad but to improve customer experience, financial performance, and competitive advantage. On all three fronts, the transformation has paid off for BBVA. Digital transactions make up 15% to 26% of the bank's total transactions, depending on the geographic market. Costs for these transactions are lower by nearly half, and satisfaction, as measured by net promoter scores, has risen.

If history is any guide, however, the journey to organize for digital will be an ongoing one. Companies will continue to swing between centralization, when they want state-of-the-art capabilities, and decentralization, when they want wider dispersion of expertise and capabilities. In the digital age, we anticipate that this accordion will continue to play as new trends and technologies emerge.

**Gabrielle Novacek** is a partner and managing director in the Chicago office of The Boston Consulting Group and a member of the firm's global digital transformation leadership team. She has worked extensively in the consumer industry, focusing on retail strategy, transformation, organizational design, and change management. You may contact her by email at [novacek.gabrielle@bcg.com](mailto:novacek.gabrielle@bcg.com).

**Rashi Agarwal** is an associate director of the People & Organization practice in the firm's New York office. She is an expert in digital transformation, shared services, and organizational design. You may contact her by email at [agarwal.rashi@bcg.com](mailto:agarwal.rashi@bcg.com).

**Sonya Hoo** is a principal in BCG's Washington office and is active in the Consumer and People & Organization practices. She has worked extensively in the areas of strategy, organizational design, and change management. You may contact her by email at [hoo.sonya@bcg.com](mailto:hoo.sonya@bcg.com).

**Steve Maaseide** is a senior partner and managing director in the firm's Washington office and a core member of the Consumer and People & Organization practices. He has worked extensively for packaged goods, consumer services, and retail companies and has led large transformation, restructuring, and cost reduction efforts. You may contact him by email at [maaseide.steve@bcg.com](mailto:maaseide.steve@bcg.com).

**Benjamin Rehberg** is a partner and managing director in BCG's New York office and the global leader of the software and agile transformation topic. He specializes in technology and operational issues in the financial services industry. You may contact him by email at [rehberg.benjamin@bcg.com](mailto:rehberg.benjamin@bcg.com).

**Liza Stutts** is a principal in the firm's Boston office. She focuses on people and organization topics, with a specialty in leadership and talent issues. You may contact her by email at [stutts.liza@bcg.com](mailto:stutts.liza@bcg.com).

# THE BUILD-OR-BUY DILEMMA IN AI

by Philipp Gerbert, Sylvain Duranton, Sebastian Steinhäuser, and Patrick Ruwolt

**A**S COMPANIES IN ALL industries explore the rising power of artificial intelligence (AI), they face a familiar dilemma: Should we build or buy? This is rarely an either-or choice. AI vendors have attracted most of the AI talent, so companies are compelled to work with them. At the same time, AI vendors rely heavily on data that only their customers can provide, so such vendors need to work more closely with clients than they may be accustomed to doing.

Consequently, companies have several challenges. They must decide how to select and work with AI vendors both efficiently and in ways that strengthen rather than sacrifice competitive advantage. And they should have a plan for building their internal AI capabilities in an era of short-term scarcity.

## Why AI Is Different

Recent computing advances—fostered by Moore’s law and its corollaries, as well as big data and algorithmic advances—have caused AI business applications to mushroom. Many of them also take advantage of recent advances in vision and language by machines. (See “Competing in the Age of Artificial Intelligence,” BCG article, January 2017.) Machine vision, for example, is a core component of robots, drones, and self-driving vehicles, while speech recognition and natural language pro-

cessing are integral to document processing, chatbots, and translation devices.

But until recently, AI was largely relegated to an academic niche. As a result, few seasoned professionals currently work in the field—and still fewer of them understand business processes, such as supply chains, or have experience interacting with business executives. This supply-and-demand imbalance will eventually self-correct as academic institutions around the world, including those in China and Eastern Europe, respond to market demand by churning out greater numbers of AI-trained graduates. Until that happens, the question remains how—not whether—to work with AI vendors.

Vendors play a distinct role in an AI world. That’s because AI learns inductively—through trial and error, best guesses, and feedback. Vendors, therefore, need to train their AI tools using data, which often includes sensitive information from their clients. As a result, vendors normally cannot sell plug-and-play applications; they need to work closely with their clients on AI training both during and after the run-time deployment. (See the sidebar.)

AI can bring both enormous benefits and disruption. With such high stakes, companies cannot afford to play a passive role. If they are careless, for example, they may share

## GETTING SMART ABOUT AI

Companies that pursue AI strategies should have a grounded understanding of how the field differs from other technological endeavors and how they should approach their decisions about what tasks to outsource, what things to do in-house, and what skills to develop.

### Data and Tools

Most AI algorithms are available for free, and by themselves they are rarely a source of competitive strength. They need to be trained on data. Vendors should be measured by their ability to help companies manage the interplay of data and tools and by their ability to work side by side with business executives. At the same time, business executives should develop a practical and intuitive understanding of AI in order to maximize the effectiveness of their supplier relationships.

### Bias

Because AI is inductive, looking for similarities in the training data, the algorithms are subject to three biases: observation bias, selection bias, and model or forecasting bias. In particular, when the training data is not carefully scrutinized, companies can inadvertently discriminate against minorities, run afoul of regulators, or be exposed

to “black swan” events. This aspect of data-tool interdependence is absent from most other technological domains; it requires companies to understand, adjust, and potentially complement the data feeding their AI engines.

### Black Box

The use of inductive learning essentially makes AI an “intuition machine.” As a result, it is often hard to understand in hindsight why an algorithm generated a particular answer. Remedies to this black-box problem constitute an active field of research. For the practitioner, a simple rule of thumb is to build transparency into the upfront design specification. This is especially relevant in regulated industries and situations in which liability issues can arise.

### Cybersecurity

Since AI always involves partial or full automation of decision making and action, and often includes highly sensitive data and cloud-based architecture, cybersecurity becomes a top priority. When choosing a vendor or platform, companies should make sure that their data will be protected from a potential breach.

valuable intelligence that weakens their competitive position. And if they don’t build internal capabilities, they risk becoming dependent on vendors.

When assessing AI’s potential, executives should be familiar with the current capabilities, limitations, and potential of what we call the AI building blocks. These blocks, such as machine vision, are functioning units that contribute to creating an operational application. Every use of AI incorporates one or more of these building blocks, and each block relies on a collection of algorithms, application programming interfaces, and often pre-trained data. (See “The Building Blocks of Artificial Intelligence,” BCG article, September 2017.)

## Dissecting the Build-or-Buy Dilemma

Companies can work with AI vendors in many ways, ranging from outsourcing an entire process to buying selected services, seeking help in building in-house solutions or training internal staff. Executives should view these options in light of two questions:

- How valuable is the process or offering to your future success?
- How strong is your ownership, control, or access to high-quality, unique data, relative to the AI vendor?

By analyzing the AI landscape in this way, companies will discover that their AI efforts land in

one of four groups. While the boundaries may be fuzzy, and assessments may shift over time, each of these groups shares similar sets of challenges and opportunities. (See the exhibit.)

**Commodities.** This area is the closest to an off-the-shelf solution and a great entry portal into AI for companies. They can share data with vendors without fear of losing competitive differentiation. If they manage their relationship with vendors properly, they can lower costs and improve the performance of such processes as HR, finance, IT infrastructure, and maintenance. It is the proverbial low-hanging fruit of AI.

Business process outsourcers are revising their business models to take advantage of these opportunities. Infosys, for example, recently required all employees to undergo intensive design-thinking training in order to spur them to come up with ways both to automate their current jobs and to offer clients creative AI-technology-enabled solutions.

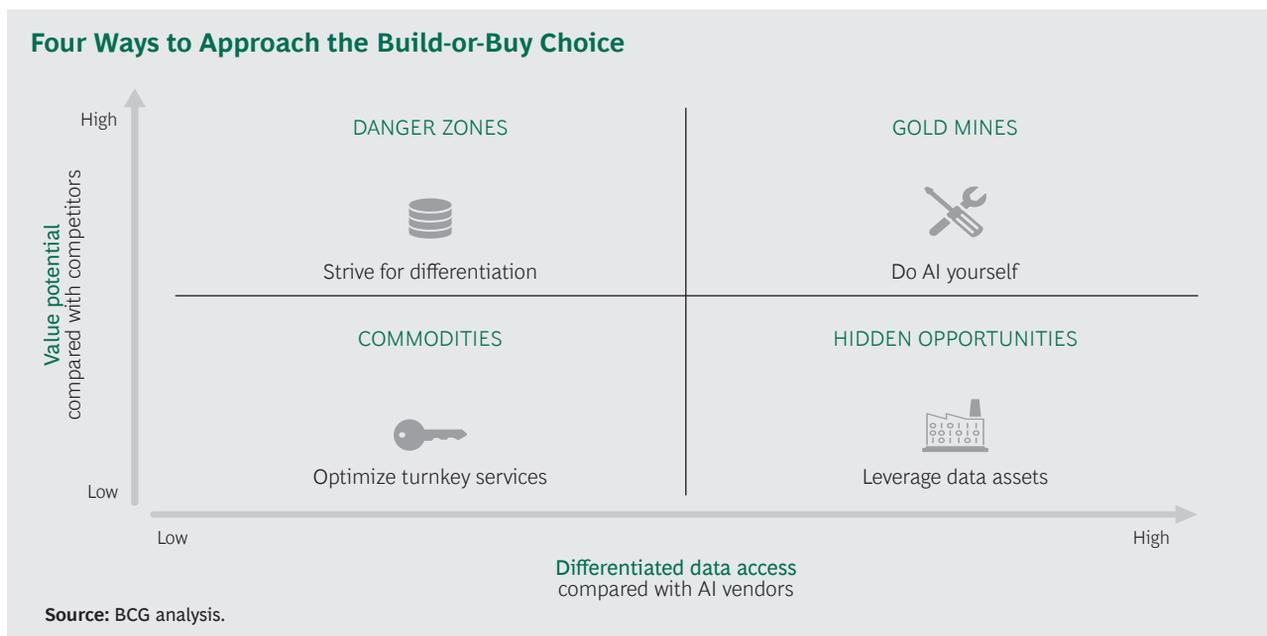
Many smaller vendors offer turnkey AI services for specific subprocesses. For example, HireVue screens job candidates for Goldman Sachs on the basis of such characteristics as word choice and facial expression, which an AI engine analyzes. HireVue currently has a database of more than 20 million video interviews—a data trove that an individual user company would be challenged to duplicate.

Before entering into negotiations with a vendor, companies should do their homework to understand the value of these AI-enabled offerings and the vendor’s distinctive contribution. A wind park operator, for example, conducted proof-of-concept work internally before negotiating with an AI turbine vendor on a predictive maintenance contract. By establishing a new baseline of what it could achieve without the help of the vendor in terms of greater uptime and lower maintenance of its turbines, the operator managed to strike a better deal.

Many smaller vendors offer turnkey AI services for specific subprocesses.

**Hidden Opportunities.** Sometimes companies have access to data sources in areas that are not critical to competitive advantage. These data sources provide an opportunity for companies to tap into the technological expertise of AI suppliers and to generate quick wins and insights.

Woodside Energy, for example, worked with IBM Watson to make 30 years of expert knowledge gained from oil platform operations accessible to all employees in the com-



pany. The company relied on Watson’s natural language processing technology to analyze and classify all data, including 38,000 written documents. Users can ask simple questions, such as “What is the maximum weight of a helicopter landing on the platform?” Although Woodside worked with IBM Watson on the project, it maintained proprietary control of the underlying data.

These approaches can pay dividends in several ways. Often companies can uncover a hidden treasure in massive collections of data and gain skill and experience in training AI algorithms. More ambitiously, companies could conceivably partner with a data-constrained AI vendor to sell application services, pretrained on the company’s data, to other companies in related fields. These arrangements could be exclusive, or several companies could work on a data-sharing pool with a vendor.

**Danger Zones.** Danger zones pose both perils and opportunities. The perils arise because vendors have better access to data than the companies themselves in strategically critical areas. When companies are in a danger zone, they should take care to limit their dependency on the vendor and minimize the possible loss of competitive differentiation. But if companies can manage the relationship well and develop or acquire their own competitive sources of data, danger zones can morph into gold mines—areas of strong competitive importance and data differentiation.

For health care providers, machine diagnosis of radiological images is a danger zone. By working with hospitals, research organizations, and others, a vendor could conceivably create a comprehensive, high-quality database of images that would trump the capability of any single provider. For instance, a company called Arterys is building an AI system in the cardiovascular field that protects patient privacy and is continually improving.

Arterys is a small company. But at scale, automated diagnostics can fundamentally alter industry dynamics and value creation for health care providers, medical technology companies, and insurers. All these companies

need to develop strategies that take advantage of the transformative capabilities of AI.

A large metals producer recently took those steps when it recognized that competitors, suppliers, and other vendors within its industry could pool data and gain a powerful edge. The company began to acquire data on prices, suppliers, and materials from a wide variety of public, research, and industry sources. This database will allow the company to accelerate both its AI and R&D efforts and its success in the market. It can potentially open new business opportunities by providing complementary services to other industry participants.

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Companies can uncover a hidden treasure in massive collections of data.

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Companies in a similar situation should have data-acquisition strategies that will support their AI activities. They need to find ways to acquire differentiated data, create a novel data mashup from multiple sources, or even acquire suppliers of data in areas critical to their competitive advantage. Without a distinct collection of data to feed into their AI engines, they will be stuck in a bad place.

**Gold Mines.** Companies need to do AI themselves when they have a gold mine. Vendors and experts can be brought in to accelerate development but only in supportive roles.

A global tire manufacturer followed this approach when it developed an AI platform to predict demand at individual stores for individual models of tires based on anticipated tire wear. The tool, whose development BCG Gamma supported, relies on more than 1.6 billion public and private data points and helped to increase overall sales and reduce inventory levels at dealers.

Many of the most promising gold mines will necessarily involve managing complex “freemium” relationships with suppliers. In the

self-driving vehicle market, for example, all manufacturers deal with the leading AI vendors for various services. In such an environment, companies must have a sharp sense of what they should manage in-house, when they must look externally for data or expertise, and how to protect their competitive position. Ultimately the greatest value may emerge through cooperation. By partnering with other companies, vehicle manufacturers could conceivably create a global platform that facilitates self-driving vehicles more effectively than any of them could do on their own.

More so than for the other three groups, gold mines require strong in-house talent and the right mix of vendors providing expertise and project management. Robust negotiation and vendor management skills are critical, as are the transfer of knowledge and the training of in-house staff.

**T**HE analysis outlined here should help companies become more efficient and effective in structuring and sourcing AI applications and capabilities. Decisions such as whether to build or buy an AI product or service are too important to be approached haphazardly, but uncertainties should not stand in the way of progress. Companies should make decisions within the context of a coherent data strategy, the pursuit of competitive advantage, and a recognition that boundaries will continually shift over time. Areas of competitive differentiation will evolve, and data pools that are distinctive today may lose their value as data continues to proliferate. In this dynamic environment, acting systematically, intelligently, and decisively will itself help secure the future.

**Philipp Gerbert** is a senior partner and managing director in the Munich office of The Boston Consulting Group and a BCG fellow. He leads the firm's AI initiative and supports companies' efforts to take advantage of AI in business. You may contact him by email at [gerbert.philipp@bcg.com](mailto:gerbert.philipp@bcg.com).

**Sylvain Duranton** is a senior partner and managing director in the firm's Paris office and the leader of BCG Gamma, an advanced data analytics team. You may contact him by email at [duranton.sylvain@bcg.com](mailto:duranton.sylvain@bcg.com).

**Sebastian Steinhäuser** is a principal in BCG's Munich office and a member of the Industrial Goods and Strategy practices. He has extensive experience in digital strategy, analytics, and artificial intelligence. You may contact him by email at [steinhaeuser.sebastian@bcg.com](mailto:steinhaeuser.sebastian@bcg.com).

**Patrick Ruwolt** is a consultant in the firm's Munich office and an ambassador for the BCG Henderson Institute. He focuses on creating advantage through artificial intelligence. You may contact him by email at [ruwolt.patrick@bcg.com](mailto:ruwolt.patrick@bcg.com).

# TAKING THE RISK OUT OF DIGITAL PROJECTS

by Jon Brock, Rash Gandhi, and Sesh Iyer

**A**GILE HAS REVOLUTIONIZED THE software development world. And for good reason. With its characteristic rapid-fire iteration and continuous-feedback loops, agile has helped companies compress the length of time from development to release. What once took years now takes only months—even weeks. But if companies don't have the right conditions in place before they adopt agile, digital projects can go awry—at great cost. A pure agile approach may not be sufficient if there are too many moving parts: a technology architecture that isn't decoupled, significant project dependencies (such as hard deadlines), or development processes that are not automated. In such situations, the risk level escalates and along with it, the potential for delay or failure.

Through a hybrid approach called programmatic agile, companies that are not burdened with these preconditions can avoid such negative outcomes. This approach overlays traditional program management practices on agile methods. Programmatic agile, as part of a five-lever approach, helps companies take the risk out of digital projects and transition to modern applications, systems, and platforms deftly and flexibly. Once the levers take effect, risks abate, and delivery dependencies shrink, companies can relax the program management controls and shift to a pure agile approach and self-managing teams.

## Why Digital Leaders Succeed with Agile

Agile by itself is not sufficient for digital neophytes. Their technology is coupled with the data, there are too many dependencies, and they have not adequately invested in automation. Digital leaders, however, have overcome these conditions.

**Decoupled Technology.** Digital leaders decouple the data from the business logic. They make their data available with prebuilt application programming interfaces (APIs). Developers that are building new digital applications don't need to know how the underlying applications or databases work; they simply develop to standardized APIs to access the data. Decoupling allows for the independent—and much faster—development, testing, and deployment of the data and logic. It also means that developers can later add new features, release applications, and issue software patches in a rapid, plug-and-play manner.

**Minimal Dependencies.** The activities, events, and deadlines of the various IT and business teams do not interfere with one another. Because projects have few dependencies, either technical (such as having to create new interfaces to access data in systems) or activity based (such as a go-live date for a new web-based product), they can succeed—or fail—fast.

Decoupled technology and the lack of dependencies foster a pure agile approach and set the stage for investment in automation.

**Investment in Automation.** Digital leaders invest heavily in automating their development, testing, and operations activities in order to dramatically reduce the timescales for releases.

By contrast, when the technology is coupled or significant dependencies exist, an agile approach is insufficient. The effort is often vastly underestimated. Risks crop up along the way, and teams miss critical deadlines. Consequently, projects suffer lengthy delays, require extensive rework, and incur escalating costs.

## The Five Levers

So, when there are too many moving parts, how can a company, regardless of its digital dexterity, make sure to strip risk from its digital projects? We've identified five levers that are essential for eliminating risk. Rather than employing a step-by-step approach, organizations should apply the five levers in parallel.

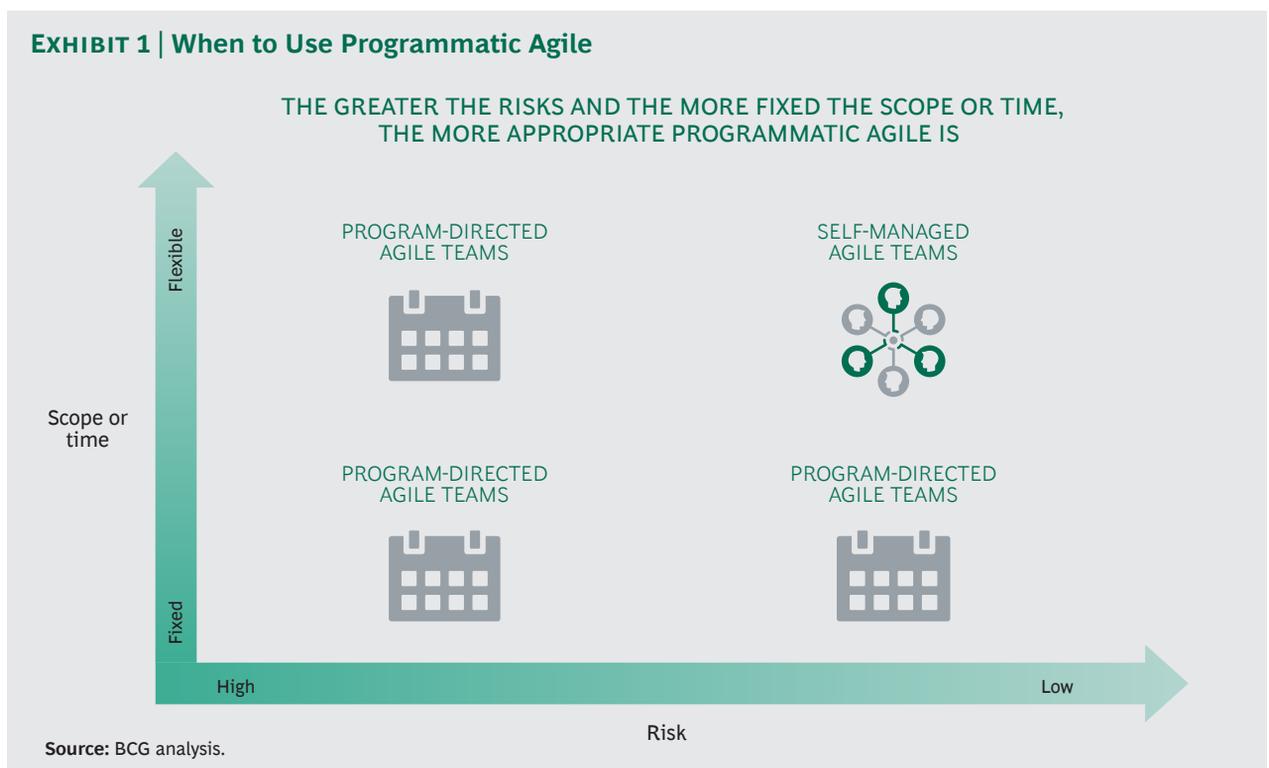
### LEVER ONE: PROGRAMMATIC AGILE

For digital neophytes, derisking digital proj-

ects calls for a gradual transition to agile development. Programmatic agile blends aspects of agile development (such as user stories, scrums, and sprints) with elements of traditional program management, including detailed planning, the definition of requirements and design up front, and active project management, reporting, and oversight that are linked to the plans, timetables, and organization dependencies.

The governance and oversight that programmatic agile provides make it, in effect, an important insurance policy that gives executives the confidence to aim for and hit their milestones and the reassurance that in doing so, neither the technology nor the budget will blow up. Programmatic agile is designed to manage the execution risks that exist as a result of having many dependencies, manual development and testing processes, and little experience building a minimum viable product (MVP). This means that when these conditions are present, it is useful not only for digital neophytes but also for experienced digital professionals. (See Exhibit 1.)

Digital projects that, for example, require coordination of multiple development streams and new technical integration or that have



hard deadlines demand more rigorous management and oversight. Instead of relying on self-managed agile teams to plan and execute one sprint at a time—with hopes of achieving the complex deliverables—organizations can use programmatic agile to ensure that all the dependencies and risks are managed over multiple sprints and aimed at achieving a fixed outcome by a specific date.

A good candidate for programmatic agile might be, for example, new software that requires migrating and integrating data with other systems before the release. In such a case, aiming to avoid rework or integration problems down the line, multiple sprint and scrum teams would work out the design early on. Meanwhile, release managers would plan incremental releases on the basis of dependencies, including, for example, deadlines for the new product release and associated deadlines for marketing and advertising campaigns, as well as integration with internal order fulfillment software.

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Ideally, joint business and IT teams should be “joined at the hip.”

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Two other examples are a project with an externally imposed deadline, such as educational software for which there’s a set release date, and software with a fixed scope that includes a functional feature required by regulation. Such projects require considerable planning months in advance in order to meet their deadlines. With programmatic agile, a company can create detailed plans to reach major milestones and plan for having the most critical features built halfway or two-thirds of the way through the plan. Doing so will ensure sufficient latitude to hit delivery dates with key features in place.

#### **LEVER TWO: STRONG MULTIDISCIPLINARY BUSINESS AND IT TEAMS**

A crucial ingredient in digital development is a strong multidisciplinary business with IT teams that coordinate closely. Unlike the old way of working—in which the IT team was

off on its own, and the business team sat on the sidelines awaiting the results—the two teams work together from start to finish to design, develop, and deliver products and services.

Ideally, the two teams should be “joined at the hip,” working at the same location and communicating continuously so that they can change course quickly should project objectives shift. Developers should regularly demonstrate workable software to their business team peers to show that the project is on track and to set priorities for future releases.

In a well-functioning joint team, the product owner—the business leader, ever-mindful of the ultimate goal—articulates the project needs and acceptance criteria, approves the application functions that the scrum teams produce, and generally prioritizes tasks and goals. In parallel, the development leader ensures that his or her team is in constant communication with the product owner and flags problems and opportunities as they arise.

Cohesion isn’t the only requirement. Joint teams must have the right people in place to ensure the appropriate mix of deep business knowledge, technical skills, and managerial acumen. A product owner who lacks the ability to prioritize will slow project momentum and miss opportunities. One who micromanages runs the risk of annoying the IT team members (who prize autonomy) and, worse, chasing away valuable tech talent. At the same time, an IT team leader who lacks control or communication skills can end up delivering subpar work that requires rework and leads to delays and possibly product deficiencies. The subsequent and inevitable finger-pointing further undermines cohesion.

Team leaders must understand how to work together and respect their counterparts’ knowledge and abilities. Product owners need to be able to push back on developers. Development leaders and their teams, for their part, need to understand the customer in order to prioritize features and create an appropriate development plan. All of this can pose major challenges to organizations and cultures that are not used to working in this way.

### LEVER THREE: A MINIMUM VIABLE PRODUCT

In many cases, large projects fail because of their scale and complexity. It takes exhaustive planning to identify and control risk, and even the best of plans cannot anticipate the unforeseeable. The bigger the project, the more time it will take. Some critical problems don't surface until the eleventh hour. And at that point, the resulting application can easily end up being bloated with unnecessary features.

Leading digital companies approach scope in a fundamentally different way. Early on, they invest in the effort to define an MVP: an acceptable product with the fewest-possible and most essential features that will ensure basic functionality. After an MVP is released, the company can incrementally, and in order of priority, add functions on the basis of a product roadmap that is informed by customer feedback. In reducing the product's scope, companies can contain the risk of delay. They can change the scope as priorities shift.

But defining an MVP isn't easy. It bears repeating that the product must be both minimum and viable, and achieving that is no small feat. Only if a team has established a solid understanding of customer needs can it have confidence that the minimum features it has identified are indeed those that matter most to the most users. Determining what those features are should involve vigorous discussion and debate among team members from both the business and the IT sides. The teams should sketch a skeleton application and then rapidly code, release, test, and integrate it as a proof of concept. They should also craft a roadmap of new functionality for successive releases.

### LEVER FOUR: DEVOPS AUTOMATION

Automation is a critical evolutionary step in a company's digital transformation. DevOps—a way to develop and deliver high-quality digital projects quickly and with minimal risk—is the practice of having development and operations engineers work together throughout the service lifecycle, from design through support. It involves the automation of the development, integration, testing, and deployment

processes—processes that once involved scores of manual tasks—and makes it possible to conduct these processes continually (generally, at least once a day) as development progresses. Cycle times are accelerated by orders of magnitude: Google, for instance, can deploy new software to a production system many times a day with minimal risk, keeping costs dramatically low. By freeing up resources and reducing time spent on labor-intensive, low-skill tasks, DevOps fosters a fruitful, test-driven culture. (See “Leaner, Faster, and Better with DevOps,” BCG article, March 2017.)

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Defining an MVP isn't easy.  
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both minimum and viable is  
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DevOps allows automation technologies and services to provision and configure infrastructure rapidly for each environment, from development and testing to preproduction and production. Developers code, release, and fix problems nearly in real time without the worry of glitches cascading into other work streams.

DevOps automation calls for a strong owner—clearly defined early in the process—and a team with the resources, engineering expertise, and authority to act. Because it demands high levels of skill, DevOps can require bringing in new talent. Testers become quality engineers, and working with scrum teams, they code automated tests that track errors and collect data that allows for fixing errors. Operators—traditionally the least skilled on the IT team—take on the role of reliability engineers, adding monitoring code and metrics to applications and conducting advanced analytics to spot and fix problems early. Operators not only improve an application's long-term reliability but also reduce maintenance costs. (For more on how one company successfully applied the derisking levers, see the sidebar, “Meeting a Launch Deadline with a Hybrid Agile Approach.”)

## MEETING A LAUNCH DEADLINE WITH A HYBRID AGILE APPROACH

Risk Management Solutions (RMS), a company that models catastrophe-linked risk for insurers and the public sector, decided to transform its software application into a cloud-based platform. The plan was to give customers capabilities that they had been clamoring for: integrated risk modeling along with scalable exposure and loss analytics. Ultimately, the move would also spawn new possibilities for the company.

In short, the new product, RMS(one), meant a transformation of the company's business.

According to CEO Hemant Shah, demonstrating RMS(one) to customers represented “a critical milestone.” When company leaders decided to launch the new platform at the RMS annual customer conference, the event was only ten months in the future. Given the many dependencies and integration requirements, Shah and his deputies agreed on several measures that would lower the risks. This entailed planning all the upfront work leading to the conference date—essentially, adopting programmatic agile.

The first step was getting the modeling, data science, and software engineers to agree on the most important application features. Starting with several scenarios, the team hammered out the elements of a minimum viable product (MVP).

Once comfortable with their technical choices, they were ready to begin development of an integrated prototype.

Next, RMS tackled the complex technical integration of its application components. The teams validated each of the individually chosen technologies and then built and tested the technical integration, connecting the company's original RiskLink software to the platform using application program interfaces (APIs).

They next added the minimum functionality needed to deliver a coherent product at the customer conference, prioritizing the development of the most critical features during the first seven months of the development plan and allowing for any contingency.

For team members who were used to working in silos—and pointing fingers when problems arose—collaboration was a completely new experience.

Team leaders opted for a loosely coupled model execution framework that allowed them to harness the existing engines. Team members worked together on design and implementation, learning from one another and leveraging one another's distinct strengths.

In another critical move, RMS replaced manual testing with automated tests conducted in parallel with the MVP development. The company recruited new talent and, to build automated deployment, formed a DevOps team within the development group.

When it was time for the customer conference, RMS was ready to debut fully working software. Release 1.0 was in customers' hands shortly afterward. And because all the components worked together, it was possible to add new features later, sequentially, on the basis of the product roadmap and in response to customer feedback. RMS was also able to move quickly to monthly code releases. (See “How a Software Company Derisked Its Move to the Cloud,” a BCG interview with RMS executives, February 2018.)

## LEVER FIVE: A NEXT-GENERATION DIGITAL AND DATA PLATFORM

Few today would doubt the necessity of a modern digital and data platform. But many overlook its overwhelming importance in taking the risks out of digital projects. A modern digital and data platform is a crucial lever because it facilitates development of multiple digital products—such as a bank balance inquiry tool, mortgage tracker, and retail store payment app—that can be created, tested, and launched in one place rather than through discrete, separate infrastructures. DevOps tools are embedded in the platform, so it is easy to begin developing new products. And companies can reuse components, thus minimizing error and vastly accelerating their overall digital transformation.

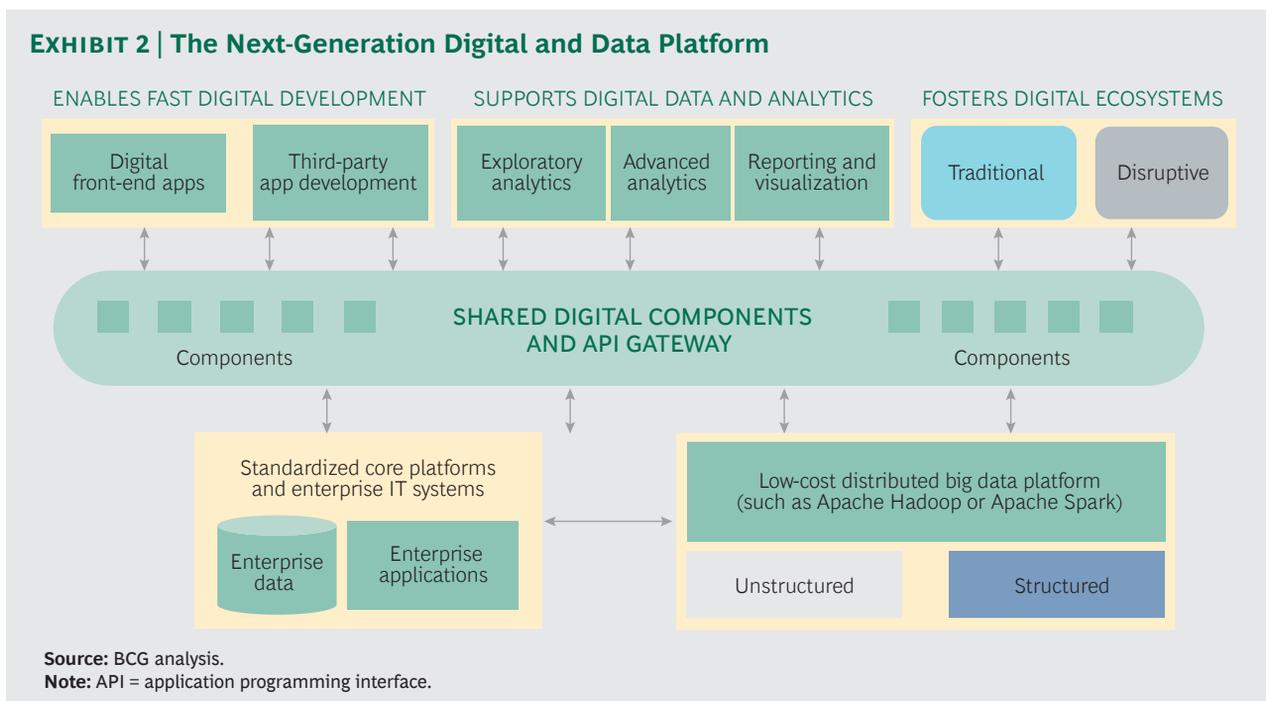
Exhibit 2 illustrates the following defining characteristics of a next-generation digital and data platform:

- **It enables rapid digital development.** A modern platform relies heavily on standardized APIs (Representational State Transfer, or RESTful, services) to separate digital product creation from the data and functions in traditional IT systems. Using such a system, companies can create many new microservice-based components—for example, customer identity management

and promotional campaign management components—that can be reused across many different products and front-end devices. The standardization allows for the development of new components by third parties, thus expanding and accelerating innovation.

- **It supports digital data and analytics.** A platform stores (and makes accessible) many new forms of data, such as unstructured data and data from digital devices, in massive volumes. In effect, it serves as “data central,” capturing data from all channels and making it possible to perform analytics on it, cheaply and powerfully, through technologies such as Apache Hadoop.
- **It fosters digital ecosystems.** A modern platform permits secure and consistent interaction with third-party systems. It can connect to and foster new digital ecosystems of customers, partners, suppliers, and third-party developers. It thus goes far beyond a set of applications and can foster collaboration at new levels, creating new sources of value and disrupting traditional value chains.

At the very least, the platform connects participants. Ultimately, however, it enables or-



ganizations to own a new ecosystem. Think: Apple, which owns the iPhone app ecosystem; Uber, which now offers takeout-food delivery; and Amazon, which not only sells but now also delivers groceries, thus changing consumer behavior and transforming the retail grocery landscape. By retaining control of its data, a company has the potential to create new offerings (for example, selling aggregate customer data) while utilizing the data to continually improve and refine its existing offerings. Arguably, ecosystems are what digital is all about: companies working with an extended network to tap opportunity and create more value. (See “The Age of Digital Ecosystems: Thriving in a World of Big Data,” BCG article, July 2013.)

**I**f digital is the new imperative, going digital in the right way is crucial. By employing the five levers outlined here—adopting programmatic agile when appropriate, creating strong business-IT teams, defining MVP features, investing in DevOps, and establishing a next-generation digital and data platform—companies can speed development while minimizing risk. Eliminating delays, rework, and cost overruns, they can meet commitments to their customers, maintain goodwill, and keep their sanity as they harness bigger and ever-bolder value-creating opportunities.

***Jon Brock** is an associate director in the London office of The Boston Consulting Group. He leads the large-project derisking and recovery business of the Technology Advantage practice. You may contact him by email at [brock.jon@bcg.com](mailto:brock.jon@bcg.com).*

***Rash Gandhi** is a principal in the firm's London office and a member of BCG's Technology Advantage practice. He focuses on the technology and architecture of big data. You may contact him by email at [gandhi.rash@bcg.com](mailto:gandhi.rash@bcg.com).*

***Sesh Iyer** is a partner and managing director in BCG's Washington office and a member of the Technology Advantage practice; the Technology, Media & Telecommunications practice; and the Energy practice. In the Americas, he is the leader of lean services and operations in technology and IT and cloud computing, and he works with the IT Capability Maturity Framework. You may contact him by email at [iyer.sesh@bcg.com](mailto:iyer.sesh@bcg.com).*

# GOING ALL IN WITH DEVOPS

by Andrew Agerbak, Kaj Burchardi, Steven Kok, Fabrice Lebegue, and Christian N. Schmid

**F**OR TOO MANY COMPANIES, moving to agile software development is like finding the perfect new strain of grass seed—after months of searching—and then planting the new seeds in your old backyard. Your lawn may ultimately look a little better, but it will take longer and the results won't be as great as they would be if you had first removed the hidden tree roots, put in new soil, and rethought the irrigation system.

Many mainstream companies—in financial services, health care, manufacturing, consumer packaged goods, and other industries—have felt compelled to give agile software development a try. And they have waited expectantly for the benefits. In theory, agile's assignment of a business leader to development teams ensures that the most important software changes get done first, and its emphasis on short coding sprints ensures that the changes are implemented quickly. The fact that the quick part doesn't always happen has been discouraging. It has some agile newcomers wondering if there's something they're missing.

In many cases, there is. Agile does a good job of breaking down silos early in the software development process. But it can achieve only so much on its own. To turn themselves into digitally ready competitors, companies have to rethink the *entire* software development life cycle. They need agile, but they also need DevOps.

DevOps is an approach that integrates critical late-stage activities—like testing and deployment planning—into the code-writing part of software development. (See Exhibit 1.) With its emphasis on running multiple activities in parallel and on multifunctional teams, DevOps represents a break from the old “waterfall” model, in which planning, writing, testing, and deploying code were discrete steps managed by separate departments.

While many software companies use some form of the continuous software development and release that are the hallmark of DevOps, the approach (which continues to evolve and is starting to be referred to as DevOps 2.0 or BizDevOps by some of its more advanced practitioners) is a lot newer outside the

technology and internet services industries. Some traditional companies, notably in financial services, have some DevOps pieces in place, such as automated testing and mechanisms for provisioning hardware quickly. (See “Leaner, Faster, and Better with DevOps,” BCG article, March 2017.) But the scope of these practices is limited. The companies haven't made the overarching changes that would allow them to capture DevOps' full range of benefits.

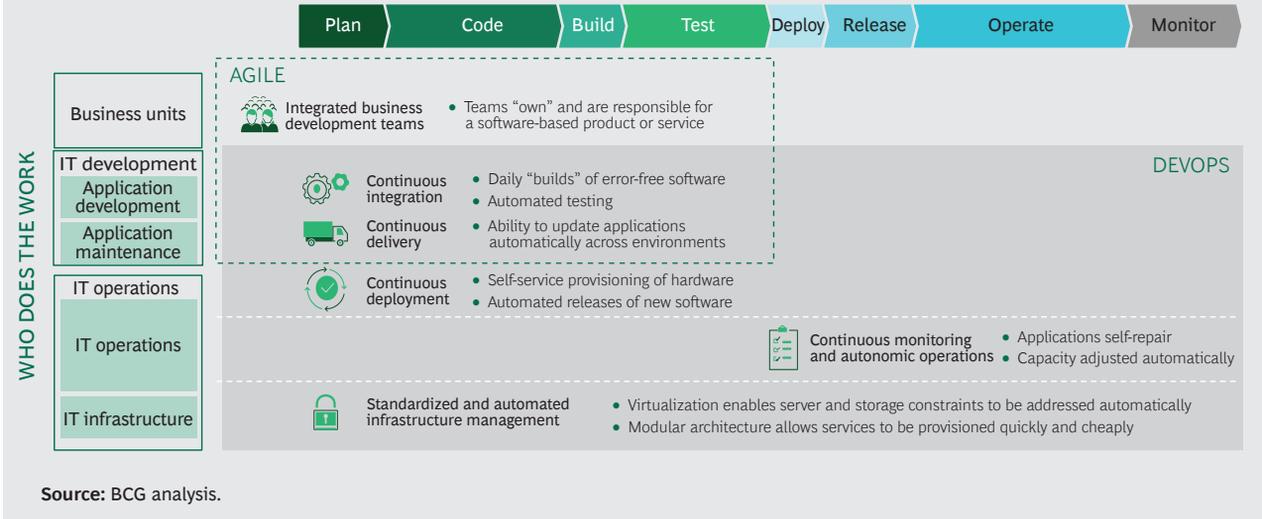
## Making DevOps Work

To get the most out of DevOps, companies must make changes in controls and governance, IT organization roles, and operating models.

### Rethink controls and governance.

Most big companies' approach to developing and releasing software reflects controls they put in place years ago to maintain quality and avoid costly mistakes. The controls may have made sense at the outset. But as the pace of technological change has accelerated, the controls have lost their relevance. Now they're just obstacles.

## EXHIBIT 1 | Where Agile and DevOps Fit in the Software Development Life Cycle



For instance, a control about infrastructure provisioning—one of the hurdles that must be surmounted before a development team can begin its work—may have been implemented in the days before virtualization. Today, virtualization makes computing and storage capacity available with less operational complexity than before and at far lower cost. But we still see companies taking a month and 50-plus emails just to provision hardware and gather all the necessary permissions.

Likewise, a control requiring multiple go-live approvals for new software may have been justified when there were only a few software updates a year and each one involved a critical part of a monolithic system. But it shouldn't require two dozen people to approve a minor tweak—like changing the color of the screen users see.

With software now a key way of addressing fast-changing business and customer needs, the prolonged delays caused by controls that have become irrelevant put companies at a fundamental competitive disadvantage. The delays can pose a reputational risk and even a survival risk if a company is the

target of a cyberattack. (See “Develop a Cybersecurity Strategy as If Your Organization’s Existence Depends on It,” October 2017.)

Governance is another area that requires adjustments in the move to DevOps. This includes adopting new approaches to funding. In agile, funding isn't allocated on a project basis: for a set period of time, against a defined set of deliverables. Instead, funding is allocated to critical “products”—like a mutual fund company's “my account” function or a retailer's order-and-ship system—that require the attention of teams for many months or even years. DevOps adds complexity by forcing companies to figure out how to allocate some application maintenance and infrastructure costs within the product-funding paradigm.

Another area where DevOps should trigger a governance change is in the decision rights related to cloud solutions. In the past, these decision rights belonged to the IT organization, and no one questioned that. But that's changing as more business units create software directly using cloud-based tools.

We saw questions about such decision rights at a company where digital product development teams were pushing for direct access to an Amazon Web Services account, and the IT operations group, concerned about standardization and security, was resisting. In truth, there is no single right answer to the question of where the decision rights should lie, for this company or any other. But it is an issue that must be tackled in DevOps, which redraws the boundaries of software development along multiple dimensions.

DevOps should also prompt a change in how companies deal with buggy software. At companies that haven't fully adopted DevOps, there isn't a “you built it, you own it” governance philosophy. Instead, if an issue arises involving software that has been released, IT support teams report it through a ticket system (such as ServiceNow), and the issue becomes the responsibility of an application maintenance team. But the original developer of the code, having gotten wind of a problem, may go back in and try to fix it. The net result is that sometimes both the development and maintenance teams end up working on

the same software, at the same time, resulting in inconsistencies, integration problems, and stability issues. By contrast, at companies that adopt DevOps practices, issues with released software automatically register on the backlog of the development teams, which are expected to make the fixes. There is no one further down the line who would even think of fixing the code, and no possibility of different departments touching the same code simultaneously and working at cross-purposes.

Ultimately, the best test of governance practices is cycle time. If companies can substantially reduce the time between when they plan software and when they release it in a reliable, high-quality form, that is a sign that their governance processes are working and that they have the technical capabilities they need.

**Redefine the role of the CIO and the IT organization.** If DevOps is to succeed, there must be changes—some subtle, some more dramatic—in the role of the chief information officer and the information technology organization. In companies that adopt agile models, the specifications for new software—and the coding work itself—become the implicit responsibility of business units. If this relieves the CIO of responsibility for individual lines of code, in most cases he or she still shoulders the larger burden of quality. That is, the CIO must still recruit and train software developers. He or she must also put in place a better delivery model, one that includes an operating environment—standards, services, processes, tools, and infrastructure—that allows developers to maximize their productivity. The CIO must also front-load more activities in the software development life cycle.

The term of art for this sort of front-loading is the “shift left,” referring to how one would diagram various activities on a software development life cycle chart. In DevOps, technical staff that would once have sat in the IT operations function—whose work kicks in later—are moved into the product development teams, where they have a say in how the code is built. There should also be input early on from those responsible for a company’s data architecture and cybersecurity. The shift left of activity and expertise is one way all the code that’s being created—often in many different business units—can get to market quickly and with the necessary level of security.

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Ultimately, the best test of governance practices is cycle time.

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A particularly important CIO responsibility with DevOps is the implementation of an optimal infrastructure environment. The business-oriented development teams need infrastructure-independent platforms so that they don’t have to worry about compatibility. In DevOps, managing this and providing the application development toolkit are significant parts of the IT organization’s responsibility.

Netflix, the global streaming video service, provides an example of the kind of benefits that can come from embracing DevOps. Netflix captures these benefits through the efforts of a central engineering operations group (a sort of specialty IT team) whose mandate is to maximize the performance of newly released software and to make software development teams more efficient.

At Netflix, developers benefit from a common set of tools, services, and infrastructure management capabilities—a “paved road,” as Netflix calls it—to traverse the normally bumpy path to new software creation. The paved road and the engineering operations group have been instrumental in helping Netflix release new code—secure, reliable code—to multiple geographic regions within minutes.

Assisting and speeding up software deployments in this way require IT staff to develop skills they didn’t need previously. For instance, enterprise architects must take a much stronger hand in defining IT architecture strategy, especially with respect to platform options.

And IT organizations must adopt technical mechanisms—like containers and microservices—that allow coding teams to write reusable software and to do it faster. (See the sidebar, “DevOps’ Technical Underpinnings.”)

IT organizations must also acquire some brand-new technical capabilities. For instance, they must hire or develop quality engineers. These engineers should be embedded in the software development team and should ensure that rigorous testing happens early in the process. The IT operations staff must likewise acquire or develop new expertise, such as reliability engineering and infrastructure service development. Without these capabilities, continuous delivery and continuous integration aren’t possible, making agile’s promised speed and reliability benefits hard to achieve.

## DEVOPS' TECHNICAL UNDERPINNINGS

IT staff must be familiar with various technical tools and approaches in order to implement DevOps. Here are seven of the most important.

**Containers.** A type of virtualization that keeps software running reliably when it is moved from one computing environment to another. By bundling new code with everything needed to run it, a container makes it possible for software development teams to ignore differences in operating systems and underlying infrastructure. Two open-source technologies that help with containerization are Docker and Kubernetes.

**Microservices.** A programming architecture that gives developers access to application functionality at a very granular level. Microservices make it easier to continually deliver and deploy large, complex applications.

**Code Repository.** A database containing the source code of an application. When centralized and actively managed, code repositories improve the consistency and stability of code, and

help avoid version control issues. Among the open-source tools used for code repositories are Bitbucket and GitLab.

**Continuous Integration.** A development practice that promotes single-source code management and comprehensive automated testing, allowing developers to add code to a common repository as often as several times a day, in a highly automated way. This ensures that all development teams are using the latest version of an application. Open-source versions include GitLab CI and Jenkins.

**Continuous Delivery.** A discipline for building software that enables the software to be moved to a staging area at any time. Continuous delivery tools include Bamboo and Jenkins.

**Continuous Deployment.** A practice that allows tested software to be released, sometimes with not much more than the push of a button. Continuous deployment sharply reduces overhead and can be an invaluable tool for resolving issues quickly.

**Remake the operating model through automation.** There is a huge benefit if, instead of going through a cumbersome approval process that might last weeks or months, a team can add a feature or plug a dangerous security hole with relatively little organizational oversight, and in the best case with just a few mouse clicks. Automation, one of the pillars of DevOps, makes that possible. But the decisions surrounding automa-

tion are complicated, and there is always the chance that a company will take a while to gain its footing. For this reason, the where and how of introducing automation is a key decision for any company moving to DevOps.

A good place to start is with test automation. In our experience, the benefits of covering more new code through automated testing can on its own justify a move to

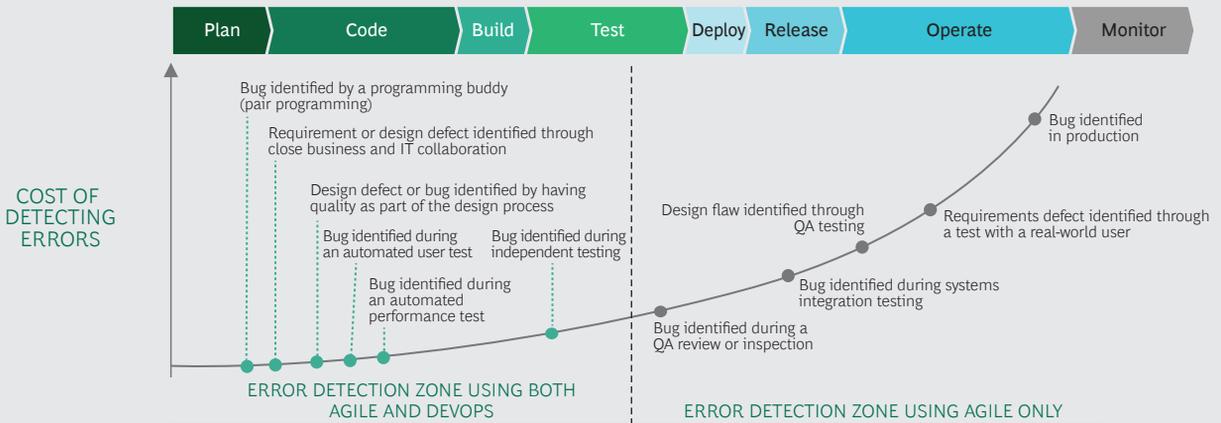
DevOps. Consider the ever-present risk of late-stage delays and the costs they create. With traditional waterfall and even sometimes with agile development, testing takes place once the code is complete. Significant problems may be discovered just as the code is supposed to go live. By contrast, in the DevOps paradigm, code is developed iteratively and tested regularly. This makes it less likely that coding issues will emerge at the last minute. (See Exhibit 2.)

Valuable as it is, automated testing must be rolled out in stages. Companies should start with the parts of their architecture where they have already started to transition to agile models. After they've had some success, they can use automation to cover more of their code.

Some of the companies that have set the pace in digital services, such as Google, have reliability targets well above 99%—meaning that they expect the software they release, with the help of automated testing, to work immediately and in pretty much all instances. Google, of course, was built to enable rapid software releases and service improvements. Non-digital natives don't need to ensure reliability on the same scale, but when it comes to digital services they can learn from Google and other digitally advanced companies—and they must. After all, a traditional company with a mission-critical digital application—like a financial services company rolling out a smartphone payment feature—can no more afford to release bad software than Google can.

With traditional companies' legacy systems, such as payroll or enterprise resource planning, the dynamics are necessarily a little dif-

## EXHIBIT 2 | With DevOps, Bugs Are Spotted Earlier and Fixed More Economically



Sources: Puppet, 2016 State of DevOps Report; BCG analysis.

ferent. Companies can still do automated testing of their legacy systems, and in many cases they already do. But in order to support the faster release cycles agile development teams expect, the tests should be synchronized with batch processes, including prescheduled data transfers and transactions. Since batch processes are often designed to take place overnight, the IT organization may want to run the automated tests overnight, too.

### Getting Started

Companies can't just brush aside their current software development practices and make a wholesale move to DevOps; it involves too much change and training and would create too much disruption with existing systems and products. DevOps needs to be phased in.

The first step should be to find an application that has low levels of dependency with other applications—perhaps a procurement portal for a manufacturing company or a savings platform for a bank—and run a pilot project to learn the DevOps model and fine-tune the practices.

In the pilot, a team of developers and IT engineers lays out a technical plan—establishing a central code repository and creating a testing framework so testing automation can start. Once this is in place, continuous integration and continuous delivery can begin. These processes make it possible for the development team to focus on writing code and not on manually checking for bugs and functionality problems.

At companies with complex legacy systems, continuous integration and continuous delivery are two separate phases. By contrast, at digital natives, both approaches are core to software development, and a digital native may already be thinking about other ways of enhancing the software release process. This explains why developers at the most digitally adept companies often see their code fixes go live within days, hours, or even minutes.

The DevOps pilot needn't go on indefinitely. Within six months, it should be possible to see benefits. These typically take the form of agility, which translates into more software releases per week; quality, which stems from increased

testing coverage; and efficiency, in the form of lower costs of rework and an overall increase in the number of automated processes. After an introductory period like this, the company can create a roadmap to start applying DevOps practices to other software and infrastructure platforms and to other parts of its technology environment. The roadmap should include a decision about the suite of tools to be used and the sequence in which DevOps will be implemented in other parts of the company and for other platforms.

### DevOps and the Customer

The example of a European travel company helps demonstrate why DevOps is turning into a must-have.

The company was unable to make pricing updates to its core booking system at the height of its main selling season. Previous updates had exposed the fragility of the system, and business managers had imposed a policy of no changes during peak periods.

There was nothing unusual about the company's monolithic software infrastructure or the policies to ac-

commodate it. However, the deliberate approach to software development had left the company unable to respond, at the most important time of year, to new pricing or product propositions from competitors. If a seven-day trip to Belize was suddenly being discounted to \$1,800 on other travel websites, it would still be going for \$2,100 on the company's site. Dynamic pricing updates required a software change, but the company's release process limited the speed at which such changes could be made.

Recognizing that its software development processes were hurting the business, the company adopted some DevOps practices, including continuous integration. As it did so, the quality of its software releases and the overall resilience of its system improved to such an

extent that management lifted the change freeze. Thereafter, the company was able to be much more responsive to competitors' moves during the industry's peak selling season.

Sooner or later, most companies are going to find themselves in a similar position. That is, they are going to see that one of their competitors is doing something faster, with fewer security and quality issues, and at lower cost. And they are going to need to take action to narrow the gap.

DevOps is a way to do this. The implementation of DevOps involves organization and process changes that take place well out of sight of most customers. But customers will be expecting the benefits. For companies that don't deliver, there may not be a second chance.

**Andrew Agerbak** is a director in the London office of The Boston Consulting Group. You may contact him by email at [agerbak.andrew@bcg.com](mailto:agerbak.andrew@bcg.com).

**Kaj Burchardi** is a managing director of BCG Platinion in Amsterdam. You may contact him by email at [burchardi.kaj@bcgplatinion.com](mailto:burchardi.kaj@bcgplatinion.com).

**Steven Kok** is a project leader in BCG's London office. You may contact him by email at [kok.steven@bcg.com](mailto:kok.steven@bcg.com).

**Fabrice Lebegue** is a managing director of BCG Platinion in Montreal. You may contact him by email at [lebegue.fabrice@bcgplatinion.com](mailto:lebegue.fabrice@bcgplatinion.com).

**Christian N. Schmid** is a principal in the firm's Munich office. You may contact him by email at [schmid.c@bcg.com](mailto:schmid.c@bcg.com).

# METADATA ISN'T JUST FOR TECHIES ANYMORE

by Rash Gandhi, Antoine Gourévitch, and Nic Gordon

**C**OMPANIES THAT PURSUE DATA-DRIVEN transformations often overlook a key ally: metadata. And little wonder. Metadata—essentially “data about data”—isn’t sexy, is often poorly understood, and tends to be treated as a purely technical topic, a sort of secret language for the folks in IT. But pigeonholing metadata is a mistake. Metadata, when integrated with business and operational perspectives, becomes far more powerful, helping companies extract the *full* value of their data.

An integrated approach to metadata helps companies classify information and ensure its consistency and trustworthiness. It lets them better understand the lineage of data—how a piece of information may have been manipulated or changed over time. It gives them a more complete—and more immediate—view of what data exists within the organization, what it means, and where it can be found.

This can boost efficiency and speed immensely. Data scientists can devote themselves to creating models that generate insights, for

example, instead of spending 70% to 80% of their time searching for and massaging data so that it can be used in a new way. When metadata is managed with both business and technical views in mind, companies no longer have to reinvent the wheel with each new data initiative. Transformations become more sustainable and more potent. Companies unlock value they were previously leaving on the table.

## Pitfalls and Unrealized Potential

Today, virtually every company is looking to data to drive its business forward. Information is at the heart of so many transformations. Ideally, a single piece of data could be used in different ways by different stakeholders across the company. But in practice, two main challenges hinder such multipurpose use:

- **A Proliferation of Data That Hasn’t Been Harmonized.** In this scenario, every business unit or function—such as marketing and customer support—is generating its own data and using its own termi-

nology to describe what the information means.

- **A Lack of Knowledge and Understanding of the Data That Exists Within the Organization.** The data that a business unit or function needs may indeed exist, but it is effectively invisible or unusable. Prospective users may not know that the information they seek has already been captured. Or they may not know its lineage—and as a result, they have little confidence in the data.

In many cases, these challenges come as an unpleasant surprise. Companies, after all, tend to put a lot of thought and effort into data-related issues: how they deploy technologies that use or generate data and how they address the concerns of customers and regulators. To be sure, these are important areas that warrant a company’s attention. But often, the data management piece gets short shrift—and inefficiencies and added complexity result.

This is a real problem that plays out across all industries. The ex-

amples of organizations that end up paying some kind of price—a lost opportunity, additional costs, or disappointing results from a new initiative—are numerous. Consider just a couple of real-world cases:

- Seeking to optimize its balance sheet, a financial company took a close look at how it performed its risk-weighted asset (RWA) calculation. The company discovered that it was holding far too much regulatory capital—funds that had to be set aside to cover potential losses. The reason: low confidence in the numbers produced by the RWA process. Why the lack of faith? Each business unit was performing its own RWA calculation in its own way using its own data sources—and then manually adjusting the resulting number to what was considered “correct.” All the nuances and manipulation made it hard, at a company level, to see the data lineage—how, exactly, each business unit came up with its figure. As a result, there was uncertainty regarding the enterprise-wide RWA number; to be safe, the company overallocated capital. The additional capital was now sitting on the sidelines instead of being used to generate revenue.
- A consumer goods company decided to replace its outdated CRM platform with a more modern one that could provide a comprehensive view of every customer (including all transactions the customer has had with the company). But because customer data was spread across multiple legacy systems, and often duplicated and inconsistent, the company had a poor understanding of

where specific information resided and what data should be integrated with the new platform and what data should be discarded. Consequently, the company was unable to tie together its data—and while the new CRM platform won raves for usability, it was unable to meet its prime objective of giving a 360-degree view of the customer.

panies to create databases that have the right data inserted in the right fields in the right tables. But it only goes so far in unleashing the value of data.

Integrated metadata—the kind that helps companies continually and fully extract value from information—includes business and operational perspectives as well. (See the exhibit.) It doesn’t just tell you

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## Data management requires companies to govern data from cradle to grave.

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Data management is no simple thing. It requires companies to govern data from cradle to grave: acquisition, modification, retention, and deletion. (See “How to Avoid the Big Bad Data Trap,” BCG article, June 2015.) It means managing access to the data—and ensuring that security and privacy are handled responsibly. Metadata management is just one piece of a holistic approach to data management, but it is especially important for two reasons: it is the piece that is most often overlooked, and it is the piece that specifically addresses the data challenges discussed above.

### Metadata Is the Who, What, When, and Where of Your Data

Many companies approach metadata from a technical perspective—and only from a technical perspective.

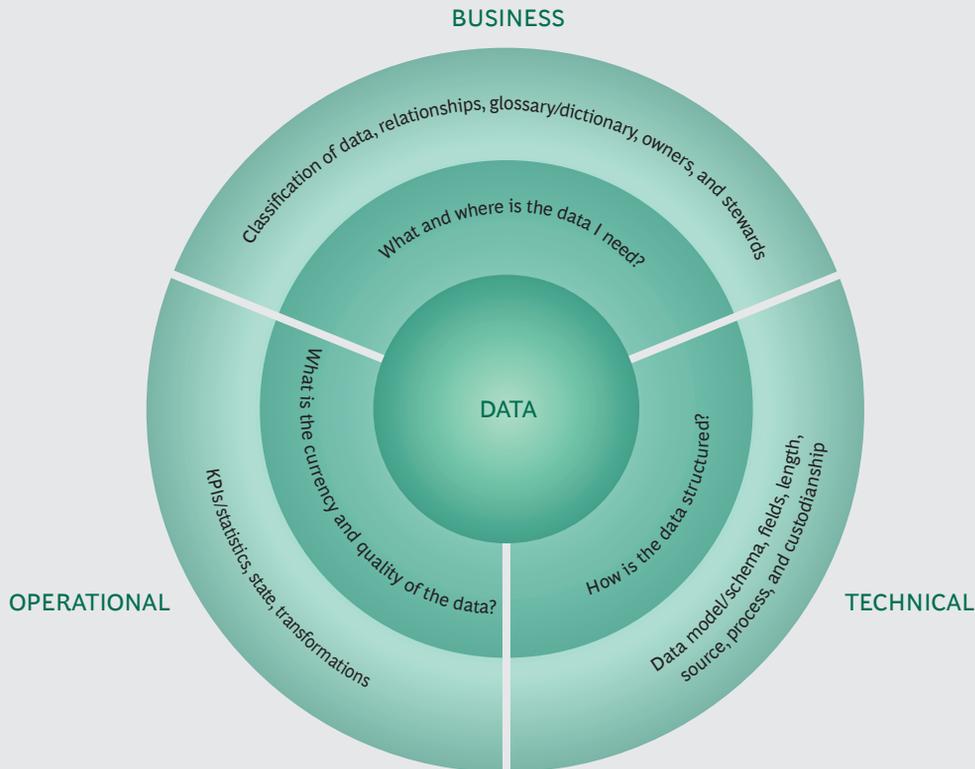
To be sure, technical metadata is essential stuff. It describes how data is structured, including its format (relational, hierarchical, or columnar, for example), its physical location, table and field names, and allowable values. It enables compa-

where you can find a certain piece of data, it also helps you trace the path the data has taken since it was first created—and see how it was transformed as it flowed across systems. This lineage is a key characteristic—and benefit—of good metadata management. It allows companies to know what calculations and manipulations were applied to the data and to determine whether the final value makes sense and can be trusted.

And by swinging the metadata pendulum from a purely technical to an integrated form, companies will mobilize their business and operational arms in generating value from data.

**About Business Metadata.** Business metadata provides a meaningful business context to the data: what the data is, who “owns” it, who can access it, and so on. It enables the various departments and business units of a company (and the data analysts, business analysts, and data stewards working with or within them) to understand, find, and use any piece of information stored anywhere in the organization. For example, one piece of data

## The Three Perspectives of Metadata



Source: BCG analysis.

might simply be a number: say, 229215941. Business metadata would reveal that this number is, in fact, a customer ID.

The key to using business metadata is consistency. This can be harder than it might seem—within a single company, different stakeholders will tend to use different terms for a common concept.

For example, within a bank, one business unit might refer to a “customer” while another might label the same individual a “consumer” and still other units might use “client,” “beneficiary,” “counterparty,” or “obligor.” So a starting point for metadata management is to gain agreement on the meaning of business data (here, for instance, all of the different labels refer to an individual with a product or service relationship with the bank). Companies can then create a mas-

ter glossary to map the different terms to a common definition.

This sort of “stitching” is no modest task, but the payoff can far outweigh the effort. Individual business units or departments can work the way they always have, using the terms they always have. Yet at the same time, their data becomes far more useful—and more readily available—to other stakeholders who might be able to extract value from it.

### About Operational Metadata.

Operational metadata describes characteristics such as data quality, lineage, and currency (incorporating time stamps, for example). This kind of metadata is of particular value to the data stewards and custodians who are playing an increasingly important role within businesses. It can enable notification methods to

alert interested parties as data elements are debated, agreed to, and potentially modified. It can also help identify—and correct—errors.

Consider, for example, a user who wants to know why only 50 customers were selected for a marketing campaign intended for 100 customers. Operational metadata would help guide that user through the underlying process—and discover where and why things went wrong. For example, say customers were to be selected if their age fell within a certain range. Tracing back through the metadata, one might see that in 50 instances, the data that was used contained an incorrect age—or was missing an age altogether. As a result, 50 customers mistakenly fell out of the targeted range. Quickly revealed, this error can be quickly addressed.

## Strategies and Best Practices

Metadata management is a complex and demanding undertaking. Indeed, that's one reason why companies avoid it. But there are ways to smooth the path. We've found the following practices to be particularly helpful.

**Don't boil the ocean—instead, take an incremental approach.** A sure-fire route to frustration—and often failure—is to try to capture metadata in a big-bang sort of way, looking at every piece of data throughout the organization. For most businesses, that's bound to be an onerous undertaking that will never reach a conclusion, with momentum lost somewhere along the way.

A better way to do it: take a more focused approach. Start small with a new initiative that creates or leverages data. Capture metadata for all the information within the scope of the initiative. Project by project, you'll build momentum in a disciplined way.

**Embed responsibilities into existing roles, instead of creating new roles (and hiring new employees).** Most organizations already have employees who specialize in data-related work—data stewards, data architects, and data administrators, for example. Instead of hiring new full-time employees to oversee metadata management and enforce policies, companies should integrate these new responsibilities into existing roles. This not only saves money, it puts metadata management into the hands of those who already have significant insight and knowledge regarding company data. It is often far more efficient to have the person who is already capturing data capture the metadata as well than to have a second individual tackle the job from scratch.

**Embed clearly defined processes.** Metadata needs to be managed throughout the life cycle of data. So, processes should be clear, and they should cover the capture, approval, registration, publishing, and use of metadata. They should ensure that data held across multiple sources is described completely, consistently, and unambiguously—and make it easy for users to rapidly identify and locate the data relevant to their needs. KPIs should be defined and employed not only to measure performance but also to create a culture where metadata capture is embedded across the organization.

**Leverage tools and structures to facilitate access to metadata.** Tools are available not only to capture metadata but also to work with it, making it easier for business users to find the data they need. By deploying such tools, companies can take an important step toward creating a self-service capability for users—a worthy goal.

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A sure-fire route to frustration: trying to capture data in a big-bang sort of way. Instead, focus.

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At the same time, organizations with legacy systems need to understand that while they may strive for a centralized metadata repository, the likely reality—at least for the short term—is that their metadata will be scattered across multiple local repositories (perhaps dozens or even hundreds of them). Instead of looking at all of these locations—an inefficient approach to working with metadata—companies should create an integrated metadata layer. This is an interface that links the different repositories and creates, in effect, a virtual centralized repository. The physical lo-

cation of metadata becomes irrelevant for the end user, who can see, in one place, all the company's metadata—even if that metadata is actually spread across the organization.

## Lessons from Early Adopters

An enterprise metadata repository can be implemented using internally developed databases or by purchasing a commercial solution. When requirements are not too complex, a homegrown solution can be implemented more quickly—and, in turn, deliver benefits more quickly—than a vendor's offering. Often, it can also prove less expensive to implement and maintain. An example: A major utility company built a bespoke solution to manage the petabytes of customer data stored in legacy systems—and believes that it achieved an 18- to 24-month lead on the industry as a result. Indeed, the effort was so successful that the company launched a subsidiary to

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take this technology to market.

But there's a flip side: a vendor solution can provide substantial out-of-the-box functionality. Most products include prebuilt meta-models; scanner functionality to capture metadata from traditional sources, such as database catalogs and generic spreadsheet-loading facilities; and front-end user interfaces (with the caveat that these will almost always require customization). Companies need to be careful, though, that as they adopt a vendor's solution they don't also adopt the vendor's view of their

business. No one, after all, understands your business better than you do.

How to successfully integrate a vendor's solution? The first step is to understand the metadata you want to capture. From a practical perspective, you won't be able to describe in metadata everything about every piece of data you possess. So don't try. Instead, focus only on the metadata you need, such as that which describes data elements that support a key business process (for example, customer gender for use in campaign management). Once you've done this, you should map specific requirements to product capabilities—and land only on a package that matches.

When carefully approached and implemented, an existing solution can work well. Netflix, for example, uses the open-source tool Metacat to edit metadata in a highly effective way. The company can

capture a user's last watched movie and then automatically update the metadata across various data repositories. And because Metacat's query interface can interact with other data platforms (such as Apache Hive and the Teradata database), it effectively creates a single integrated metadata management system.

**M**ETADATA is a long-term ally in generating value from your data. It ensures fast access by the right people to the right data and helps companies use their information—continually—in new and profitable ways. Managing metadata can be a complex and challenging task, and too many companies have put it low on their agenda. Resist the temptation. Give metadata the attention it deserves and it will give you a smoother path to implementing—and succeeding with—the technologies and business models that are at the top of your to-do list.

***Rash Gandhi** is a principal in the London office of The Boston Consulting Group. You may contact him by email at [gandhi.rash@bcg.com](mailto:gandhi.rash@bcg.com).*

***Antoine Gourévitch** is a senior partner and managing director in the firm's Paris office. You may contact him by email at [gourevitch.antoine@bcg.com](mailto:gourevitch.antoine@bcg.com).*

***Nic Gordon** was formerly an associate director in BCG's London office.*

# NOTE TO THE READER

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## For Further Contact

### Ralf Dreischmeier

*Senior Partner and Managing Director  
Global Leader, Technology Advantage  
practice*  
BCG London  
+44 20 7753 5353  
dreischmeier.ralf@bcg.com

### Rashi Agarwal

*Associate Director*  
BCG New York  
+1 212 446 2800  
agarwal.rashi@bcg.com

### Andrew Agerbak

*Director*  
BCG London  
+44 20 7753 5353  
agerbak.andrew@bcg.com

### Walter Bohmayr

*Senior Partner and Managing Director*  
BCG Vienna  
+43 1 537 56 80  
bohmayr.walter@bcg.com

### John Brock

*Director*  
BCG London  
+44 20 7753 5353  
brock.jon@bcg.com

### Kaj Burchardi

*Managing Director*  
BCG Platinion Amsterdam  
+31 20 548 4000  
burchardi.kaj@bcgplatinion.com

### Stefan A. Deutscher

*Associate Director*  
BCG Berlin  
49 30 28 87 10  
deutscher.stefan@bcg.com

### Sylvain Duranton

*Senior Partner and Managing Director*  
BCG Paris  
+33 1 40 17 10 10  
duranton.sylvain@bcg.com

### Rash Gandhi

*Principal*  
BCG London  
+44 20 7753 5353  
gandhi.rash@bcg.com

### Philipp Gerbert

*Senior Partner and Managing Director*  
BCG Munich  
+49 89 231 740  
gerbert.philipp@bcg.com

### Antoine Gourévitch

*Senior Partner and Managing Director*  
BCG Paris  
+33 1 40 17 10 10  
gourevitch.antoine@bcg.com

### Sonya Hoo

*Principal*  
BCG Washington  
+1 301 664 7400  
hoo.sonya@bcg.com

### Sesh Iyer

*Partner and Managing Director*  
BCG Washington  
+1 301 664 7400  
lyer.sesh@bcg.com

### Craig Lawton

*Senior Partner and Managing Director*  
BCG Atlanta  
+1 404 877 5200  
lawton.craig@bcg.com

### Fabrice Lebegue

*Managing Director*  
BCG Platinion Montreal  
+1 514 228 5900  
lebegue.fabrice@bcgplatinion-ma-ya.com

### Steven Kok

*Project Leader*  
BCG London  
+44 20 7753 5353  
kok.steven@bcg.com

**Steve Maaseide**  
*Senior Partner and Managing Director*  
BCG Washington  
+1 301 664 7400  
maaseide.steve@bcg.com

**David Mkrtchian**  
*Consultant*  
BCG Los Angeles  
+1 213-621-2772  
mkrтчian.david@bcg.com

**Gabrielle Novacek**  
*Partner and Managing Director*  
BCG Chicago  
+1 312 993 3300  
novacek.gabrielle@bcg.com

**Benjamin Rehberg**  
*Partner and Managing Director*  
BCG New York  
+1 212 446 2800  
rehberg.benjamin@bcg.com

**Patrick Ruwolt**  
*Consultant*  
BCG Munich  
+49 89 231 740  
ruwolt.patrick@bcg.com

**Christian N. Schmid**  
*Principal*  
BCG Munich  
+49 89 231 740  
schmid.c@bcg.com

**Sebastian Steinhäuser**  
*Principal*  
BCG Munich  
+49 89 231 740  
steinhaeuser.sebastian@bcg.com

**Liza Stutts**  
*Principal*  
BCG Boston  
+1 617 973 1200  
stutts.liza@bcg.com

**Nadja Yousif**  
*Partner and Managing Director*  
BCG London  
+44 20 7753 5353  
yousif.nadja@bcg.com

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E-mail: [bcg-info@bcg.com](mailto:bcg-info@bcg.com)

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The Boston Consulting Group, Inc.

One Beacon Street

Boston, MA 02108

USA

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