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The business value of APIs

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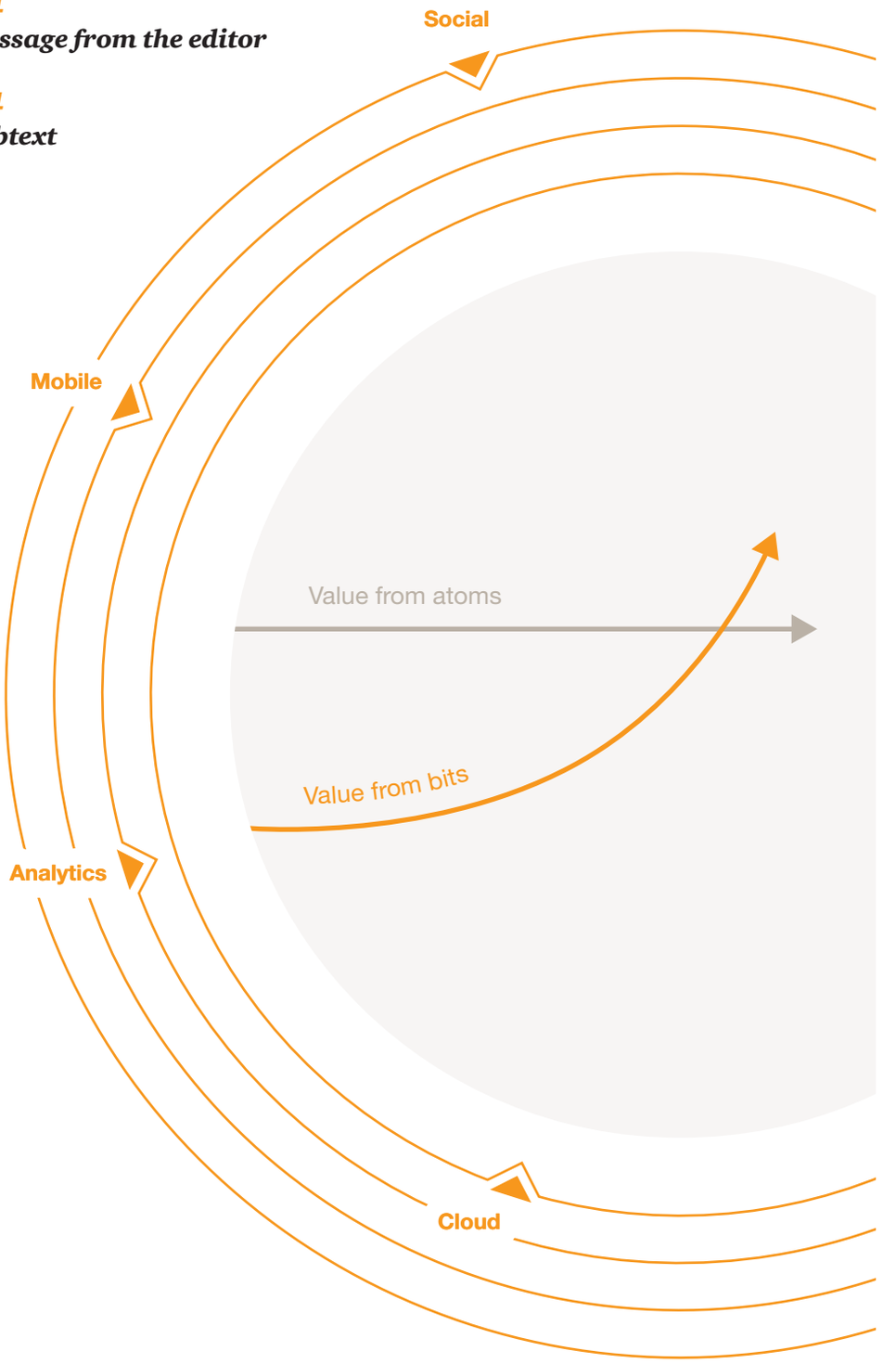

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Industry perspectives

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Resurgence of APIs: super-linear scaling in digital ecosystems

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Message from the editor

Successful businesses grow almost by definition. But what comes with being larger? Certainly there are benefits, the most prominent being economies of scale. But size has its downside. The enterprise R&D function has been a frequent target of research in academia because of its well-known pattern of becoming less productive (fewer patents) on a per dollar basis as it grows larger.[1] Creating benefits from scale seems to be automatic in some circumstances, but creating waste from scale seems just as automatic in others.

Dr. Geoffrey West and his colleagues at the Santa Fe Institute have published insightful results on the way many different domains scale. He charts the relationship between size and metabolic rate across species to convincingly demonstrate that doubling in size requires only 75 percent more energy rather than a doubling of energy.[2] In a totally different domain, West found a similar pattern with gas stations in cities—doubling the size of the city results in only 75 percent more gas stations. This is *sub-linear scaling*. It appears to be true in a city context across almost all of a city's infrastructure.

But cities also produce *more* than linear scaling in other domains. West found that whenever a city doubles in size, many measures of economic activity, such as construction spending, wealth, patents, and bank deposits, increase by approximately 15 percent per capita.[3] In other words, cities become more productive as they grow. This is called *super-linear scaling*.

West lays this all at the feet of networks. The power of networks can produce sublinear scaling and superlinear scaling. Neither is inherently better—some things you want less of, and other things you want more of as you grow.

This issue of the *Technology Forecast* examines the question of scaling in the context of four major disruptions penetrating enterprise operations simultaneously—social computing, mobile computing, advanced analytics, and cloud computing (in short, SMAC).

1 Wesley M. Cohen and Steven Klepper, "Firm Size and the Nature of Innovation within Industries: The Case of Process and Product R&D," *The Review of Economics and Statistics 78,* no. 2 (May 1996): 232–243.

2 http://www.ted.com/talks/geoffrey_west_the_surprising_math_of_cities_and_corporations.html

3 http://www.nytimes.com/2010/12/19/magazine/19Urban_West-t.html?pagewanted=all

Our use of the term SMAC includes the four technologies called out here as well as related emerging technologies that take advantage of them, such as the Internet of Things.

Individually, these disruptions are themselves about scale. Social computing scales business collaboration from a few to hundreds or thousands of others. Mobile computing scales process and data management into almost any business context. Advanced analytics—with big data, terabytes of in-memory databases, and visualization—scales business intelligence into every aspect of business operations. And cloud computing promises more compute power than ever before.

These disruptions are all delivered over digital networks as digital services, usually from outside the enterprise. For many business and IT executives, the potential value of engaging with these four trends is transparent. The challenge is scaling their integration with traditional IT. In the best of circumstances, internal legacy systems integrate well with each other. But they rarely were designed to rapidly integrate with digitally delivered external services.

That's job one. Job two is recognizing that offering digitally delivered services is a big opportunity, very often through the co-creative efforts of third parties. Almost certainly these services will force a rethink of vertical business processes. Refining tightly coupled end-to-end processes into loosely coupled, modular activities creates the building blocks third parties are looking for as they build new businesses. But business partners and consumers of those services expect the same rapid, seamless setup already demonstrated in web-centric digital ecosystems. Otherwise the services go wanting for customers.

In short, the rise of digital business ecosystems is creating superlinear scaling effects; doubling the number of digital services will more than double the business value created. As West would say, it's because of the network effect. And digital business ecosystems can grow businesses in terms of revenue and profits much faster than headcount and expenses.

We call it building the permeable enterprise, where business capabilities are abstracted as open programmable interfaces and scaling integrations in a digital ecosystem is incorporated into strategic thinking so that value scales in superlinear ways while cost scales in sublinear ways. The reemergence of application programming interfaces (APIs) in general and the rise of the RESTful style of integrations in particular bring this promise by providing an architecture and systematic approach to engaging with SMAC and other emerging technologies.

This issue of the *Technology Forecast* examines how enterprises can engage with the challenges and opportunities stemming from SMAC trends by scaling integrations and participating in expanding digital ecosystems.

The article, "Exploiting the growing value from information," on page 06 examines how creating open interfaces to engage a growing digital ecosystem will empower enterprises to build a digital operating model and progress toward becoming a permeable enterprise.

"Consumerization of APIs" on page 34 explains why a new generation of tools based on RESTful APIs scales the ability to make digital connections by sharply reducing the cost and complexity of integrations in digital ecosystems.

The article, "Embracing open IT," on page 54 examines how, by positioning IT capabilities as a platform composed of open, self-describing, modular services, CIOs can manage challenges from SMAC and enable the permeable enterprise.

This issue also includes interviews with executives at enterprises that are leading the practice of tapping value in information, having a digital operating model, and enabling permeability:

- John Donovan, Sanjay Macwan, and Jacob Feinstein of AT&T detail how the API program is a driver of speed in their innovation efforts.
- David Zanca and Thomas Wicinski of FedEx Services describe how FedEx taps value in information with a digital operating model.
- Mark Noworolski and Peter Leiser of Streetline share how they are transforming the parking ecosystem with SMAC technologies using RESTful APIs.
- Sam Ramji of Apigee explains why APIs are the first digital indirect channel.
- Devon Biondi of Mashery describes how APIs allow businesses to engage with customers in their context.
- Laura Merling and John Musser of Alcatel-Lucent share how creating platforms from existing assets can unlock new value.
- Brian Katz of Sanofi discusses why enterprise IT should treat users as partners.

Please visit pwc.com/techforecast to find these articles and other issues of the *Technology Forecast* online. If you would like to receive future issues of this quarterly publication as a PDF attachment, you can sign up at pwc.com/techforecast/subscribe.

As always, we welcome your feedback and your ideas for future research and analysis topics to cover.

Exploiting the growing value from information: Creating an operating model for permeability

Creating open interfaces to engage a growing digital ecosystem will empower enterprises to systematically embrace emerging technology trends and to benefit from the accelerating information value expectations of their customers.

By Vinod Baya, Galen Gruman, and Bo Parker

Streetline, a startup based in Foster City, California, uses mobile sensors, web applications, and analytics to collect, transmit, and analyze data from parking meters and parking spaces. The company is transforming parking operations into digital ecosystems to the benefit of the cities, the drivers, parking lot operators, and local merchants.

At FedEx, an evolving digital operating model allows customers to stay in continuous contact with their packages and to initiate changes to their shipments and other orders previously viewed as strictly internal operations. The operating model also supports the efforts of business partners to create new services using FedEx information.

And AT&T is transforming its network into a permeable digital platform with software interfaces that third-party developers can use to tap into network capabilities to create applications and services that add value for customers, the third parties themselves, and AT&T.

All three examples (detailed later) illustrate how leading companies are capitalizing on digital ecosystems that are expanding due to the confluence of social networks, mobile computing, analytics, and cloud computing (SMAC).[1] SMAC challenges enterprises to take advantage of the positive disruptions it portends, while they operate at the rapid pace of innovation and change that SMAC demands.

SMAC and other emerging technologies create the possibility for new ways to develop products, interact with customers, partner with others, compete, and succeed. More than a strategy for any individual technology trend or for combining more than one of them, companies need a systematic approach to engage with these technologies. Companies that have the most success engaging with SMAC are, in PwC's view, rethinking their business and enterprise architectures and emphasizing three fundamental changes.

1 Our use of the term SMAC includes the four technologies called out here as well as related emerging technologies that take advantage of them, such as the Internet of Things.

What is an API?

When talking to colleagues in the IT organization or to technology providers about ways to participate in the digital ecosystem, you'll hear the term *API.* It is the acronym for *application programming interface,* a technology term that means the specifications for how software programs are able to exchange information with each other even if designed and run by different organizations.

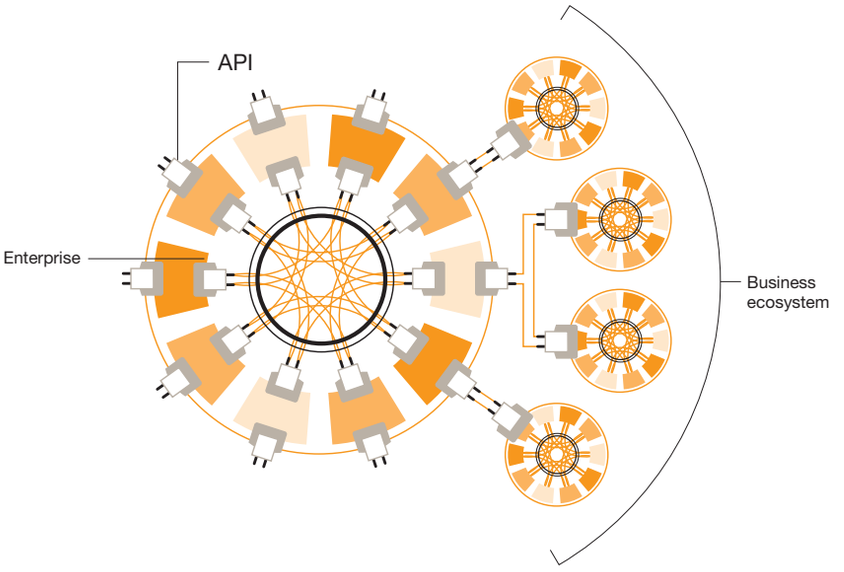
APIs are everywhere. The Google Maps API, for instance, is an interface used by developers to add content on a map of any region. Businesses can also embed the maps in their applications or services.

There are several types of APIs, but the one worth noting to a business audience today is a RESTful API, which stands for *representational state transfer API.* Although not appropriate in all use cases, RESTful APIs have changed the economics of performing software integrations by sharply reducing the associated cost and complexity. This change creates the potential to rethink IT architectures for scaling integrations and pursuing strategies that take advantage of them.

Today, web companies and social networking providers are heavy providers and users of RESTful APIs, which is how they quickly connect to so many data sources and services and let others rely on the data and services they provide. Google, Facebook, and Twitter are examples of companies that quickly became providers beyond their own services through the use of RESTful APIs.

By using and offering APIs, you do not forgo the ability to control or manage users of them. An API may be exposed internally or externally, and designed so only those with valid credentials can transact through them.

Figure 1: A permeable enterprise exposes modular capabilities with open software interfaces to enable interactions (internally and externally) in digital ecosystems.



First, they acknowledge the SMAC trends are the strongest signal yet that business ecosystems are becoming more digitized, where information content accounts for a rising proportion of the entire value of any product or service. Second, they understand that successfully tapping the new drivers of value requires a digital operating model, a model attuned to participating in or integrating with expanding digital ecosystems. And third, successful companies are adjusting their business and enterprise architectures to become what PwC calls the *permeable enterprise*.

Permeable means the use of open software interfaces on modular capabilities to allow easy digital connections with other capabilities, the way web-based companies do. (See Figure 1.) Specifically, leading companies use application programming interfaces (APIs)—especially RESTful, or representational state transfer, APIs (see the sidebar, "What is an API?" on this page)—as interface-oriented abstractions of enterprise capabilities. In doing so, they rethink their assets as platforms for co-creation, maintain persistent digital relationships with customers and partners, and reorganize for speed.

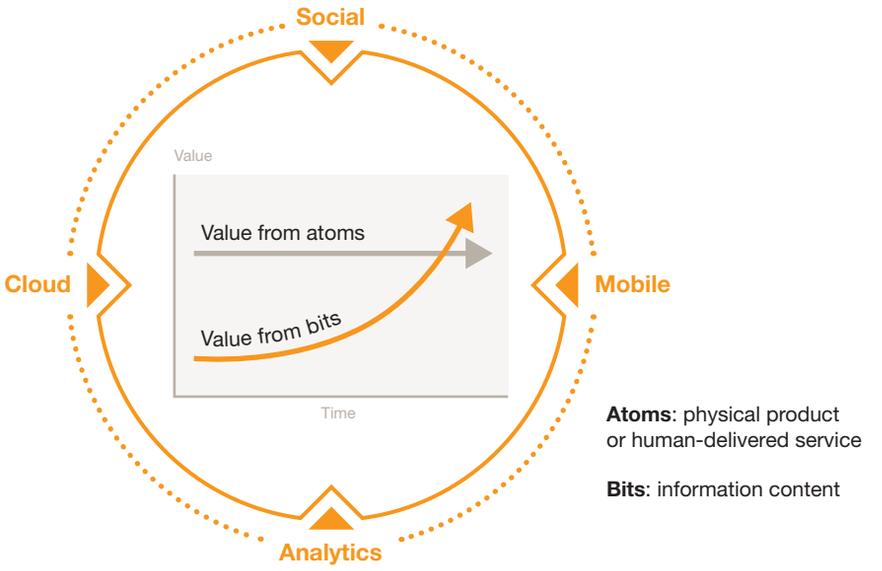
Permeability and successful engagement with SMAC improves overall performance. PwC's fourth annual survey of enterprises' digital IQ—the way companies use digital technology and channels to meet customer needs as well as the needs of employees and business partners—finds that top-performing[2] US organizations show greater mastery in how they leverage the digital technologies of SMAC to plan, innovate, measure results, interact with customers, and ultimately create value.[3]

This issue of the *Technology Forecast* describes ways that enterprises can engage with SMAC trends by using RESTful APIs to become a permeable enterprise and participate in digital ecosystems. The issue details the rise of RESTful API management technology

2 Top-performing organizations are defined as those rated in the highest quartile for annual revenue, growth, profitability, and innovation as well as those that have revenue growth of more than 5 percent in the last 12 months.

3 *Raising your digital IQ,* PwC's 4th annual digital IQ survey, 2012, http://www.pwc.com/us/digitalIQ.

Figure 2: The confluence of SMAC trends creates a shift in value drivers, as the value from bits (information content) grows faster than the value from atoms (the physical product or human-delivered service).



from new vendors (see the article, "Consumerization of APIs," on page 34) and examines how the CIO should think about permeability as it impacts the IT organization (see the article, "Embracing open IT," on page 54).

Digital transformation of ecosystems: How bits increasingly complement atoms

The notion of the digital company has been around for years. Gains in operational efficiency can be credited to a more expansive use of IT to make the business run faster and more effectively. That's a powerful benefit of IT. However, few companies outside the pure web space have become truly digital companies in which information and the ability to act on it creates significant economic and competitive value.

The examples of Streetline, FedEx, and AT&T suggest what a company can do when it starts to realize that information itself is a product or service. Some, including Rob Carter, CIO of FedEx, use bits and atoms as an analogy to highlight the growing value of information (bits) to complement the value of the physical product or human-delivered analog service (atoms).[4] The confluence of SMAC trends is driving this shift in business value. PwC anticipates that information associated with products and services will increasingly account for a rising share in the customer's experience of value delivered, as illustrated in Figure 2.

Streetline uses bits to transform a business built on atoms

Parking spaces and parking meters have always been part of the atoms world. One space was available to one car, and a meter was a simple device with a coin slot, a timer, and sometimes a credit card capability. The user and the owner dealt with the meter in a one-to-one relationship and had to be physically present to use or manage it.

Now, Streetline[5] digitally manages parking spaces and meters in Los Angeles, Indianapolis, and several other cities. It embeds sensors in parking

4 Rob Carter, CIO of FedEx, keynote address at Location and Beyond Summit, 2010, http://www.youtube.com/watch?v=Ljs28Rokwnk.

5 http://www.streetline.com/manage-parking/for-cities/

Social, mobile, analytics, and cloud (SMAC) trends are the strongest signal yet that business ecosystems are becoming more digitized, where information content accounts for a rising proportion of the entire value of any product or service.

Figure 3: The Parker app from Streetline helps customers navigate to open parking spots.

Source: Streetline

spaces on the street and in municipal and privately owned garages to collect information about availability and wirelessly transmit the data via a mesh network to Streetline's servers. "We use this information to create a smart parking ecosystem," says Mark Noworolski, CTO of Streetline.

The bits bring new value to a formerly atoms-only parking ecosystem. Drivers can use Parker, a mobile application available from app stores, to identify and navigate to an open spot, get alerts on meter expiration, or reserve spaces. (See Figure 3.) Parking enforcement officers no longer need to patrol for violations; they can go directly to the spot of an expired meter. Cities can implement demand-responsive pricing[6] and establish federated payment systems across jurisdictions.

Because the information is no longer trapped in the meter, local businesses can become value-added partners by paying to give their customers priority access to nearby meters or by subscribing to the meter data for inclusion in navigation services. The app also reduces traffic and pollution as fewer drivers need to circle for parking. All this new value emanates from the world of bits made possible by digitally transforming the parking ecosystem and liberating analog information from the atoms world.

Today, many everyday products and services, such as shoes, wristbands, golf clubs, appliances, and cars, include sensors to collect and transmit information that can enhance the user experience in a digital ecosystem. For example, Nike augments select running shoes with an embedded sensor—called the Nike+ system[7]—that allows athletes to track running habits, assess progress against personal goals, collaborate with other runners, and improve performance, thereby enhancing the running experience. A wristband from Basis[8] has multiple sensors to track heart rate, physical activity, sleep patterns, and galvanic skin response (through perspiration) for personalized tracking and feedback on physical conditioning.

Why new value will be increasingly driven from bits

Where should a company look to create value from information? Figure 4 shows a high-level taxonomy of potential sources of value spanning atoms and bits. A general way to think about information value-add is that it directly engages the customer's experience of the product or service by surfacing data about that experience. Once data has been collected, it can be used for multiple purposes by the customer, the vendor, or other interested parties.

> *"We use this [parking spot availability and payment] information to create a smart parking ecosystem."*
>
> —Mark Noworolski, Streetline

6 http://sfpark.org/how-it-works/pricing/

7 http://nikeplus.nike.com/plus/

8 https://mybasis.com/

Figure 4: The emerging domains of value are driven more by bits (information content) than atoms (physical product).

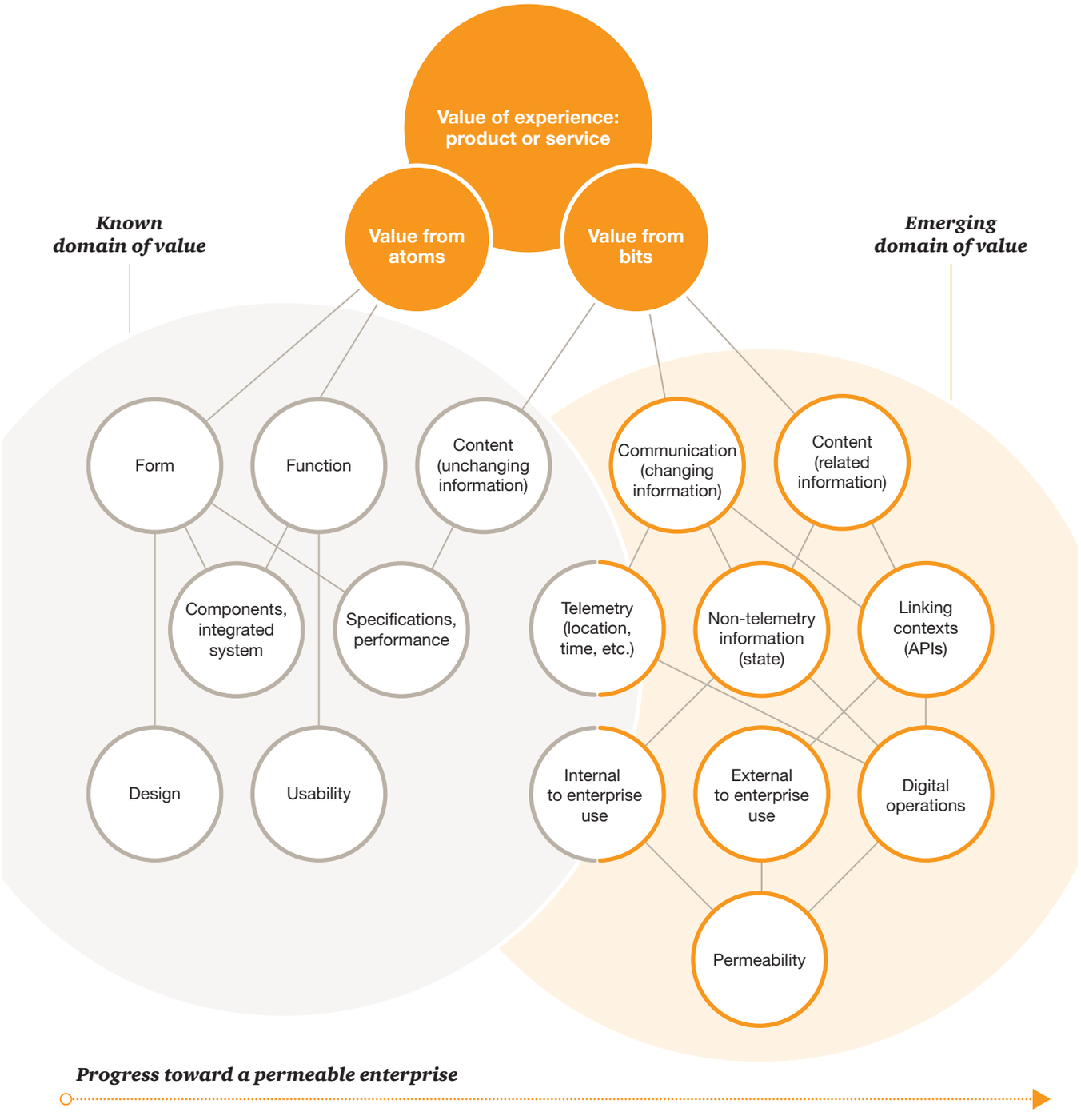
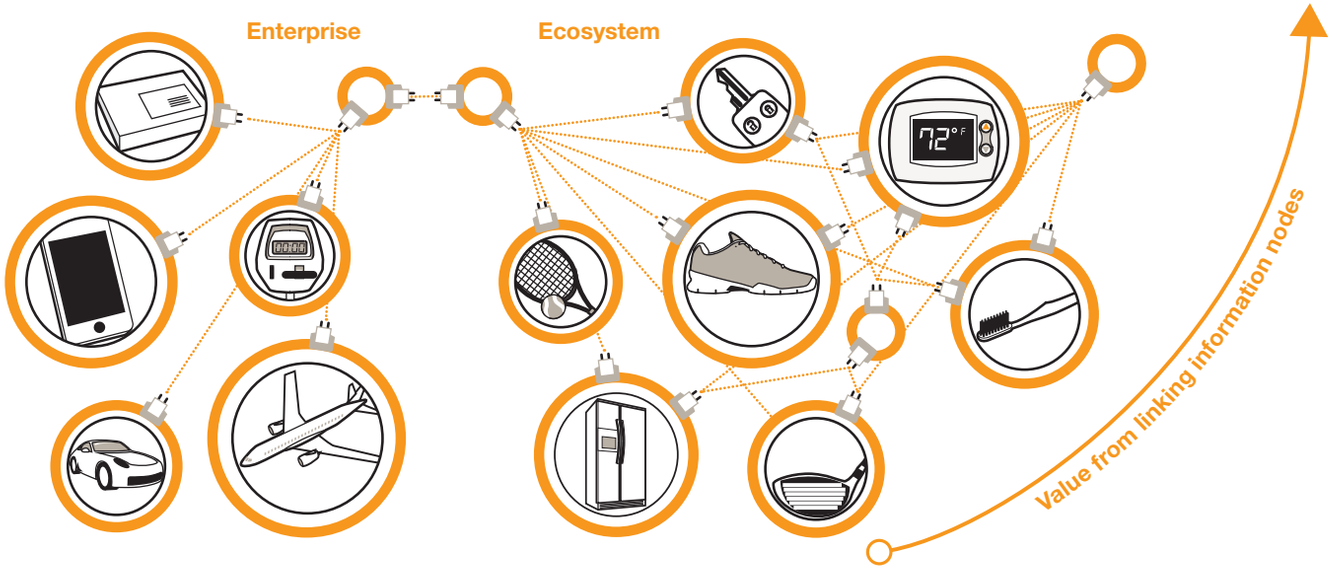


Figure 5: The ability to link information nodes (bits) in an information network means value rises quickly as the number of nodes increases (Metcalfe's Law).

An impact of SMAC is that more and more processes and activities will create a digital footprint and surface new information. The ability to link this information to create an information network provides the potential to grow new value exponentially.



There are many reasons why emerging domains of value are based more on bits than on atoms. Some reasons include the following:

- ***Bits are increasing—***With a phenomenon such as the Internet of Things,[9] products become smarter through embedded sensors, which produce digital representations of the analog activities. Sensors convert any type of analog signal, such as temperature, pressure, or acceleration, into electrical signals that digitize that information. These sensors are increasingly ubiquitous, and their usage grows as they continue to become cheaper and smaller. According to the Semiconductor Industry Association, sensors and actuators are the smallest semiconductor market segment but showed the highest year-to-year growth of any segment, at 15.5 percent to $8 billion in 2011.[10] Today, sensors are in a wide range of devices and environments, including wristbands, toothbrushes, appliances, cars, homes, and parking meters. This increasing instrumentation, connectivity, and digitization deliver more and more bits into the value system.[11]

- ***Bits are fungible and limitless—***They can be repurposed, reused, duplicated, or deployed in any number of use cases without being "used up." This flexibility multiplies the options created by bits for ongoing innovation and value extraction. The value of the bits increases the more that multiple parties exploit them, as demonstrated by Streetline.

- ***Bits can be linked—***As RESTful API technologies gain wider adoption, an information network made of information nodes likely will develop internally and externally to an enterprise, much like the network of devices on the Internet. (See Figure 5.) ProgrammableWeb, which tracks externally published APIs, already reports more than 6,000 APIs, and the number is quickly increasing. (See Figure 6.) Such growth manifests the advantage of Metcalfe's Law,[12] which recognizes that the value of a network is proportional to the square of the entities in the network.

- ***Bits persist over time—***Whereas a consumer eventually replaces a car or shoes, the information accumulated around that product will persist beyond the life of the atoms. As new hardware endpoints arrive, bits can be adapted to new values and new endpoints. The value accumulates over time.

9 http://en.wikipedia.org/wiki/Internet_of_Things

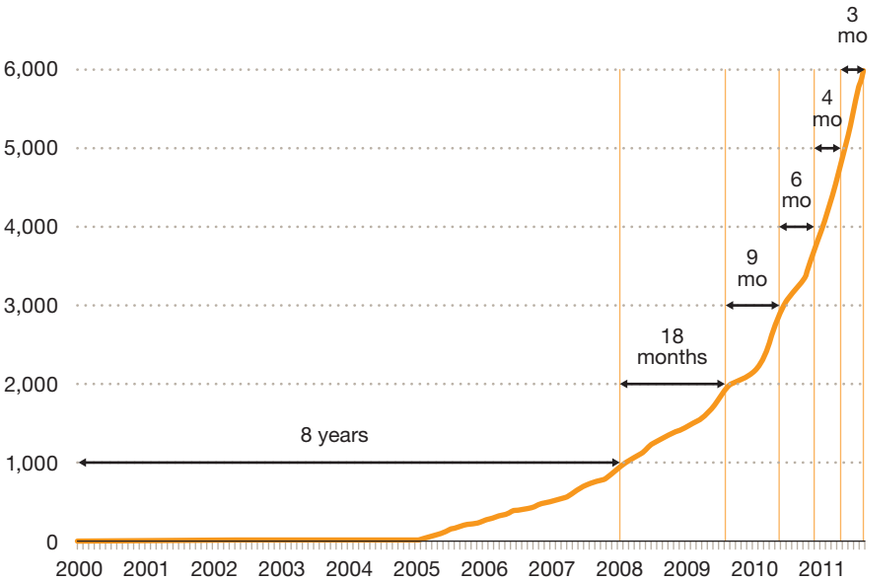
10 Caroline Kazmierski, "Semiconductor Industry Posts Record-Breaking Revenues Despite 2011 Challenges," Semiconductor Industry Association, February 6, 2012, http://www.sia-online.org/news/2012/02/06/global-sales-report-2012/semiconductor-industry-posts-record-breaking-revenues-despite-2011-challenges/.

11 See the article, "Consumerization of APIs," on page 34 for more details on sensors.

12 Although initially defined in relation to telecommunications networks, Metcalfe's Law today applies to all networks, and it states that the value of a network is proportional to the square of the number of nodes in the network. See http://en.wikipedia.org/wiki/Metcalfe's_law for more details.

Figure 6: Use of APIs to interact in digital ecosystems has been growing and has accelerated in the past few years.

Growth in number of APIs over time



Source: ProgrammableWeb

Scaling integrations requires a digital operating model

While each SMAC technology has its own unique impact, the technologies are complementary in support of work getting done. The cloud increasingly contains more of the information and applications that people use. Mobile devices give people access to the cloud, to other data sources, and to each other. Analytics help them make actionable sense of all that data. Social media helps people find colleagues with whom to collaborate and co-create. The collective impact of SMAC on the enterprise operating model is so broad that it helps to think about the SMAC technologies as an integrated whole from a strategic viewpoint. (See Table 1.)

But as a collective whole they also represent an unusual, perhaps unprecedented challenge: how to embrace the comprehensive challenge they create at a technological level without being overwhelmed. Leading companies are overcoming this challenge by adopting what PwC calls a *digital operating model*. This model is inspired by the open linking tradition evident in the web marketplace that is accelerating, driven by SMAC trends.

Table 1: The interdependent and complementary roles of SMAC in doing work

Trend	Relationship with work
Social	Who we work with
Mobile	How we get to work
Analytics	What we work on, the meaning of work
Cloud	Where we do the work

Despite decades of technology investments, most companies do not have a digital operating model today.

Scalable integration strategy: Why most companies don't have a digital operating model—yet

Having adopted IT solutions to drive automation and efficiencies for decades, many companies will argue that they are already digital. Their back-office processes, in particular, are likely to be highly digital, and they pay increasing attention to digitizing information about customers and suppliers. However, at most companies the digital footprint is uneven.

Extending digitization depends on making connections digital, which in turn depends on integrating tasks, activities, and processes. Therefore, the central issue that keeps IT from meeting the demands of social, mobile, analytics, and cloud (SMAC) or having a digital operating model is the long lead time and high cost of integrating one piece of software with another. IT investments of the past did not anticipate the need for scaling integrations.

For this reason, lessons from web companies are relevant. With business motivations to integrate with as many other web companies as possible—and with limited resources—web companies have naturally moved to a low-maintenance, self-describing, open communication style of integration facilitated by RESTful APIs, which are a scalable way to integrate.

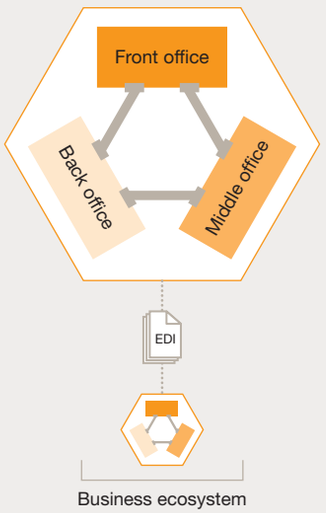
Using a loose taxonomy of back-office, front-office, and middle-office systems and applications, Figure A depicts how, as integration scales, digitization can spread in an enterprise. Historically, the integration technologies were entirely point to point, as shown in Figure A1. These integration points grew organically without concerns or considerations for reuse, consistent architecture, or agility. They also required external documentation, demanded a deep understanding of data types and logic on both sides of the connection, and moved data in binary form unreadable to programmers. As the integrations proliferated to number in the hundreds, a new approach became necessary.

This need led to the emergence of an approach to internal integration that adopts architectural principles, usually referred to as a service-oriented architecture (SOA). (See Figure A2.) Adoption of SOA can address many of the issues surfaced in Figure A1 by conforming to its principles of loose coupling, abstraction of services, modularity, and reusability. While this approach has greatly reduced the unintended complexity of the early days of integration, scaling for and coordinating with a digitizing business ecosystem remains burdensome as SOA has largely remained internally focused.

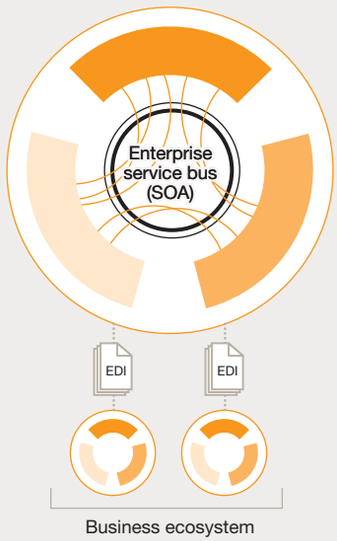
RESTful APIs, an architectural and programming model that sharply reduces the cost and complexity of integrations, deliver a scalable approach for both internal and external use. (See Figure A3.) Many companies will start by exposing data and services using RESTful APIs to their external digital ecosystem of partners and customers. But a RESTful API approach for internal integration creates many of the same benefits of highly scalable linking and coordinating of business processes at very low cost.

Figure A: Despite decades of IT investments, most companies do not have a digital operating model because they could not scale integrations easily, an opportunity possible today with RESTful APIs.

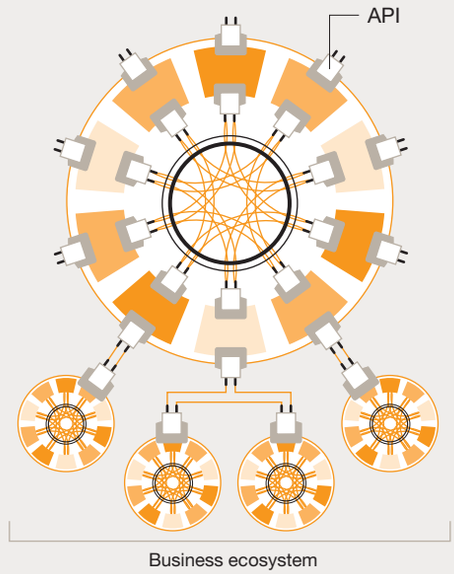
A1
Historically, the front, middle, and back offices of an enterprise were integrated point to point by tight coupling, suitable only for a small number of integrations.



A2
With SOA, enterprises adopted an architecture using a service bus for integration, creating loose coupling and the potential for reuse and flexibility. The complexity of integration meant use remained largely internal to the enterprise.



A3
The new architectural principle and programming model based on RESTful APIs reduces integration cost and complexity, so integrations can scale for many internal as well as external uses.



Companies embracing a digital operating model organize themselves around atoms plus bits as the source of new value.

To be successful, web companies had to solve a fundamental problem: linking to and being linked by other web properties at scale. The solution was open, self-describing APIs communicating over standard HTTP[13] protocols—in short, RESTful APIs.

Despite decades of technology investments, most companies do not have a digital operating model today. Many feel overwhelmed by the demands from SMAC trends. The problem for most companies is that they cannot scale their existing integration architecture and methods to the demands created by a digital ecosystem. (See the sidebar, "Scalable integration strategy," on page 14.)

So far, companies that have acted on the digital ecosystem in a big way tend to be web-native enterprises, such as Facebook, Google, and several other companies offering mobile or social apps. Web-native companies extend their capabilities and their reach almost as a matter of course by exposing their capabilities via APIs to others. In many ways, the web is the genesis of the SMAC trends. The web marketplace has become known for constant, unpredictable change, robust innovation, agility, modular capabilities, and co-creation of value. The web is inherently digital and organized around an architecture that facilitates these dynamics. With RESTful APIs, all companies have the opportunity to bring these capabilities to their operations. And this is the inspiration for a digital operating model, which should have the following key characteristics:

- ***Instrumentation to digitize operations—***The use of sensors transforms analog activities into digital representations to surface and use valuable information.

- ***Loosely coupled modular capabilities—***Internal capabilities and processes are broken into modular service components that have standard open interfaces. Loose coupling makes it possible to change the components without affecting the system, as long as the interface is kept stable.

13 HyperText Transport Protocol is the standard for transmitting information on the World Wide Web.

Table 2: Key characteristics of the digital operating model contrasted with the way many companies typically operate

Characteristic	Typical operating model	Digital operating model
Key source of value	Organized around atoms as the source of value	Organized around atoms plus bits as the source of new value
Extent of digitization	Mostly analog activities (except digital native companies)	Mostly instrumented, connected, digital activities
Asset strategy	Assets exist to fulfill a particular function and are not extensible	Assets are platforms and therefore extensible by others
Architecture	Largely closed and monolithic	Open, accessible, and modular
Responsiveness to change	Static, inflexible, slow to evolve	Dynamic, agile, evolving
Key performance indicator (KPI)	Efficiency-centric: resistance to new value creation	Customer-centric: increasing value to customer
Nature of interdependencies	Tight coupling among systems of coordination	Loose coupling among systems of coordination
Participants in value creation	Largely the enterprise itself	Co-creation and collaboration with the ecosystem
Business creation potential	High barrier to new business creation	Low barrier to new business creation

"Information about the package helps us run our business better. That comes from a digital operating model where all our assets are connected and surface information to increase overall value to us and the customer."

—David Zanca, FedEx Services

- ***Addressable platform with low interaction costs—***The capabilities are available for others to use by means of stable interfaces that have a low or no barrier to usage. Enabling technologies, including RESTful APIs and API management platforms, make addressability efficient.

- ***The ability to co-create in a digital ecosystem—***A co-creation strategy treats customers, channel partners, suppliers, and industry ecosystem participants as active agents who have permission to combine the modular capabilities exposed in a platform to create new experiences.

There are other characteristics, and Table 2 contrasts the prevalent traditional operating model to a digital operating model. Companies embracing a digital operating model organize themselves around atoms plus bits as the source of new value.

A culture of valuing information gives FedEx a digital operating model

FedEx has organized around information from its inception. "In the late 1970s, our founder and CEO Fred Smith said, 'The information about the package is just as important as the package itself,'" says David Zanca, senior vice president of IT, customer access, and revenue systems at FedEx Services. "It's a vision that has given our company a culture that values information, and that uses it in all we do."

FedEx's journey to a digital operating model is decades old. "Information about the package helps us run our business better. That comes from a digital operating model where all our assets are connected and surface information to increase overall value to us and the customer," Zanca says. "Almost every piece of our business is instrumented; it has some degree of intelligence and automation on it.

Our planes are all intelligent, and they tell us where they are. The trucks, the couriers, the knowledge workers, the hubs—almost everything has technology embedded in it and tells us where it is or what its state is."

FedEx has used a transportation logistics information system called COSMOS (Customer, Operations, Service Master On-line System) since 1979 to keep track of all packages. While it used the information to allow dynamic management of its delivery system, it also innovated many times to present an interface to its customers and bring them into the FedEx digital ecosystem.

In 1984, before the web, FedEx released PowerShip (now part of FedEx Ship), which used modems over circuit-switched telephone lines to allow high-volume customers to link with COSMOS, so they could place shipping orders electronically and print air bills. In 1994, fedex.com was the first site to give customers the ability to monitor shipments on the web.

FedEx also maintains a website for developers (FedEx Developer Resource Center[14]), where third parties can tap into FedEx capabilities offered as modular web services for shipping, office and print services, and other tasks.

FedEx layers the customer experience services on top of the enterprise services with the help of RESTful APIs.

14 http://www.fedex.com/us/developer/

With its new SenseAware product line, FedEx has recently driven the digital operating model deeper into the customer's context. "Not only do our customers want more information about the packages, but they also now want more interaction with FedEx and expect us to react to changes and resolve problems if they occur, " says Thomas Wicinski, vice president of digital access marketing for FedEx Services. Customers can request operational actions such as return shipment, reroute, reship, and repackage. Its digital operating model gives FedEx the flexibility to adapt to these requests.

Transformation to a permeable enterprise

The digital operating model enables what PwC calls the *permeable enterprise*, in which latent capabilities and assets inside the enterprise are permitted to reach outside and be combined with other assets and capabilities. External innovators also can reach into the enterprise and tap into its capabilities to create new value. Both are facilitated by the sharply lower cost of interactions in a digital ecosystem.

A company will need to develop many new capabilities to adopt a digital operating model and become a permeable enterprise. As Figure 7 shows, these new capabilities address partner strategies, assumptions about the frequency and intensity of customer engagement, and a business and enterprise architecture built for speed, all while balancing their use internally and externally.

> ***"Not only do our customers want more information about the packages, but they also now want more interaction with FedEx and expect us to react to changes and resolve problems if they occur."***
>
> —Thomas Wicinski, FedEx Services

"If you are going to operate at a pace at which the external market is moving, you have to take capabilities, industry specific or not, and make platforms from them."

—John Donovan, AT&T

Platform for co-creation: Scaling integrations

Until recently, organizational structures and IT systems were designed to support the enterprise as the sole creator of products and services. In a world of value co-creation, these structures and systems often do not work well. Too much knowledge about how processes work must be acquired before anything can be added. This barrier can be significant for third parties, even if huge latent value is inside the enterprise. Reducing the learning curve requires a new strategy. "If you are going to operate at a pace at which the external market is moving, you have to take capabilities, industry specific or not, and make platforms from them," says John Donovan, senior executive vice president of technology and network operations at AT&T. By allowing third-party developers to tap into its network capabilities, AT&T has transformed its network into a digital platform. (See the sidebar, "APIs: An architecture for speed," on page 21.)

The platform approach is a different way of thinking about value. It requires a step back from the product or service's obvious value and an assessment of how others might add value if they had access to attributes beyond the immediate ones. "The ability to create self-service interactions, enable co-creation, and provide a vehicle where information is flowing from a leaf node to every other leaf node radically transforms our ideas about how to organize production, innovation, and transactions," says Ted Shelton, managing director in the PwC Advisory practice. Product design, development, and customer service must take into account the growing possibilities for surfacing and using information.

In this context, the word *platform* means programmable interfaces or APIs. "APIs are the building blocks of the digital economy," says Laura Merling, senior vice president of the application enablement business unit at Alcatel-Lucent. APIs become the language with which interactions and communication occur in a SMAC-driven digital ecosystem, supporting permeability.

AT&T seeks to expand the value realized from its telecommunications network and associated services. Jacob Feinstein, executive director of new technology at AT&T, says AT&T asked itself, "If we architect our network so that it comprises a number of loosely coupled modules connected through open interfaces, could we expose those interfaces to third parties to foster openness in a broader sense, leading to greater innovation, and ultimately get more apps on more devices on our network?"

For example, because AT&T exposed its Internet Protocol telephony capabilities to web developers, its users can initiate an online phone session from a restaurant review website to make a reservation, potentially driving more business to AT&T's network. AT&T could provide access to different quality-of-service levels that provide a range of service options for third parties, letting them offer, for example, premium connections for a higher fee, in which AT&T might share the extra revenue.

Rethinking the customer relationship: Persistent digital engagement

Because of SMAC, a new consumer reality is emerging, defined by an anywhere/anytime/any device expectation of accessibility and engagement. Consumers have the ability to be online all the time and expect what PwC calls *persistent digital engagement* with whomever they conduct business. "To address the new consumer state of persistent digital engagement, companies will need to develop fluency in digital product development and social technologies, and they will need to create collaboration across groups that have often worked separately from one another," PwC's Shelton advises.

Figure 7: Enterprises will require a digital operating model to tap into the shift in value drivers that results from SMAC. The digital operating model on the inside will enable the permeable enterprise on the outside.

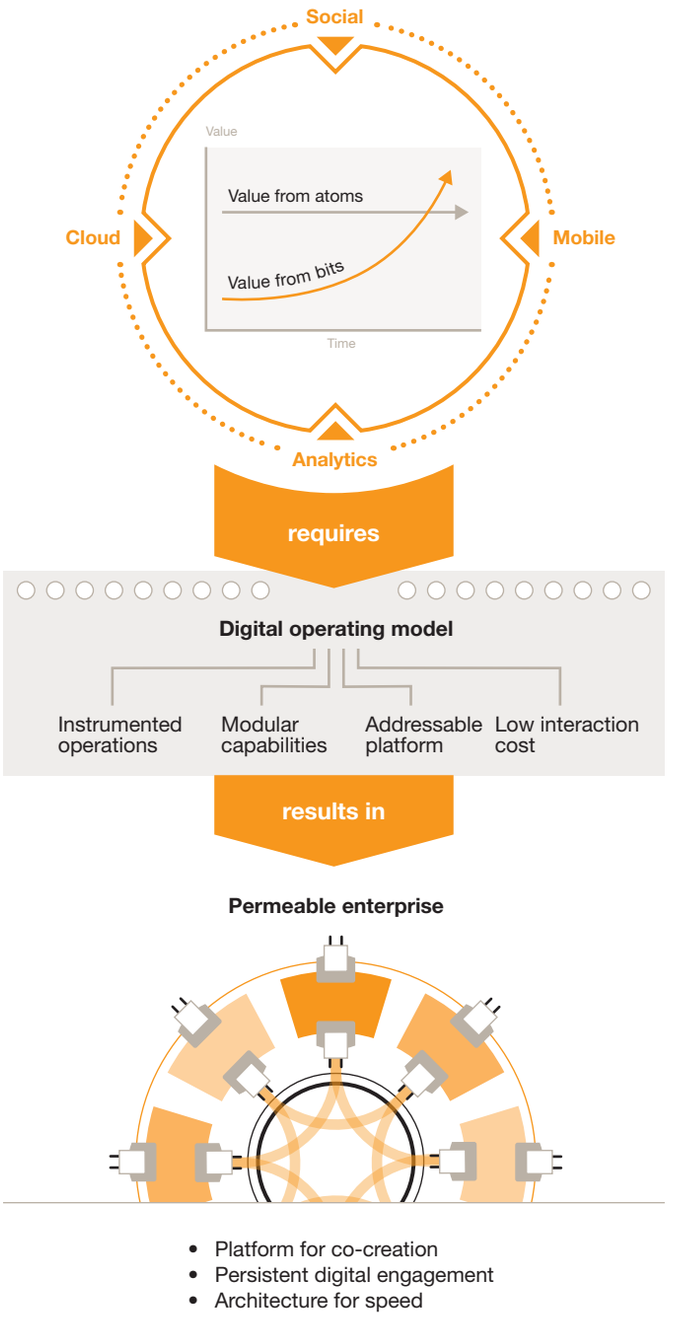
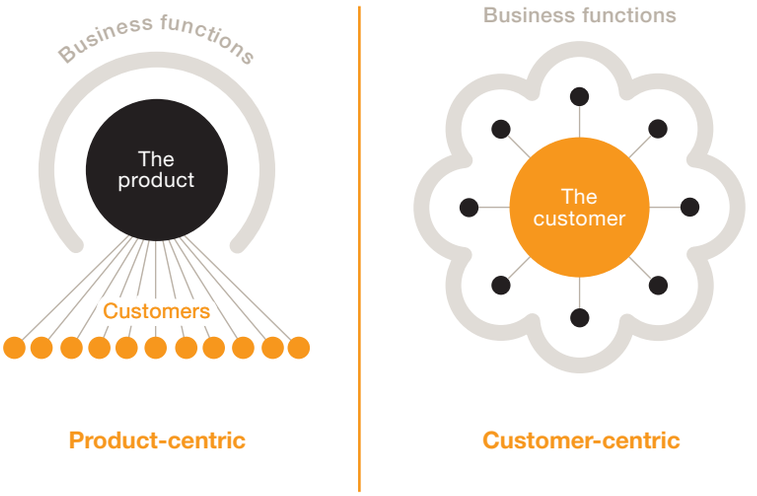


Figure 8: The digital operating model promotes a customer-centric approach over a product-centric one.



"Agility and accessibility will make the successful organization of the future."

—Ted Shelton, PwC

Enterprises must reorganize in a manner that puts customers at the center of the digital operating model, instead of thinking of them only as end-of-the-chain recipients of delivered value. Figure 8 shows this distinction between a product-centric and customer-centric enterprise.

Customers are already altering the dynamics of their relationships with providers through their rapid adoption of new technologies that move them toward the center. "The customer is able to have a tighter, longer-lasting relationship with the business even though the way they interact with that business might change," says Sam Ramji, vice president of strategy at API management solution vendor Apigee. Bits allow stickier relationships in the value network because their mutability means they can persist even as they are adapted to new services and use cases.

Architecture for speed

Speed is essential in the digital ecosystem to meet the pace with which the business environment is changing. Speed was a driving force in AT&T's RESTful API program, Donovan says. By exposing RESTful APIs, AT&T has cut the time it takes developers to place new capabilities on the network from months to hours. The API program is a key pillar in AT&T's broader innovation strategy. (See the sidebar, "APIs: An architecture for speed," on page 21.)

Establishing a business and IT architecture around RESTful APIs is not just about speed. It is the best way to prepare for future waves of change in technologies, products, and business strategies. "Agility and accessibility will make the successful organization of the future," Shelton says. "With APIs modularizing every function at the right level of granularity, one can enable more agility and more accessibility."

APIs: An architecture for speed at AT&T

John Donovan, Sanjay Macwan, and Jacob Feinstein of AT&T detail how the API program is a driver of speed in their innovation efforts.

Navigating the far-flung functional, organizational, and technical structure to bring new ideas to any large company can be slow and confounding. For a company the size of AT&T, this had the potential to create lengthy delays for developers seeking to test innovations against the network. Today, external innovators and developers access much of AT&T's network and other capabilities in a self-service manner, allowing them to bring new offerings to market three times faster than before.

This new speed is central to AT&T's innovation strategy. Whether ideas are generated internally or co-created with outside innovators, AT&T wants to match the pace at which the market is changing and innovating—particularly around mobile and cloud technologies.

"If you have infrastructure assets and are going to operate at a pace at which the external market is moving, you have to take capabilities—industry-specific or not—and make platforms from them. And then make them easy to address," says John Donovan, senior executive vice president of technology and network operations at AT&T.

The emphasis on speed extends beyond technology. Startups participate in "speed dating" sessions with AT&T executives, a fast-paced 20 minutes in which they have a deal or an understanding of why not. "We always have some of our top decision makers in the room—not just the technology leadership, but our business unit leaders, chief marketing officers for enterprise and consumer, and others. Because the key decision makers are listening to the pitch at the same time, we can decide whether to move forward immediately after the speed dating session," says Sanjay Macwan, assistant vice president in the AT&T chief technology office.

In 2011, AT&T met with more than 500 startups, and in early 2012, the company already has met with more than 150 startups. As a result of this outreach, 40 projects are in the works and 11 are deployed commercially, generating revenue for AT&T and its collaborators or delivering new efficiencies that benefit customers.

APIs are the key

The underlying enabler to increase the pace of innovation is the company's application programming interface (API) program. By opening up core horizontal and vertical capabilities through RESTful public APIs, AT&T has established a digital platform that drives an ecosystem of network-centric services. "It is an architectural choice one makes for speed," Donovan says.

When a company has the size and scale of AT&T, speed is not easy or a given. The API program removes organizational, functional, and technical barriers to accessing AT&T's network and information assets. Extensive documentation, sample code, immediate access to RESTful APIs, and sandboxes for testing are some of the features that reduce the friction for a thriving ecosystem of developers and innovators.

Consider the case of SundaySky, a company AT&T chose to work with after a speed dating session. Telecom bills can be difficult to understand for some customers, particularly when they start or change services. AT&T's billing system has more than 1,000 elements. Confusion stemming from a bill leads to high call volume to customer care. Using AT&T's billing API, SundaySky created a service that dynamically builds a custom video to address customers by name and walk them through their bills. In a trial of new subscribers for the IPTV service (U-verse), the call volume to customer care dropped by 20 percent among customers who had access to the video review service developed at the AT&T innovation center with SundaySky.

The result is a three-way win: cost savings from fewer or shorter calls into customer care for AT&T, new revenue opportunity for SundaySky, and increased satisfaction for the customer. AT&T and SundaySky co-created a solution facilitated by the transparency and ease of programming to the billing API. Without that, such an endeavor might have taken too long.

Making AT&T addressable: Network as a platform

AT&T has opened up several categories of RESTful APIs so far and processes about 4.5 billion API calls every month. AT&T has an aggressive road map to open new APIs across several service categories. This plan makes the network an intrinsic part of an innovation ecosystem and gives AT&T an opportunity for new monetization by serving consumers and business customers.

Ultimately, the goal of an API program is to make internal capabilities addressable by others. "Many people think API equals open and open equals free; that's not the case at all. What is needed is a thoughtful architecture that allows you to take layers above and below your platform, and make them modular and addressable," Donovan says. AT&T's goal is to make its network the most addressable network globally.

With APIs making capabilities addressable, the network becomes a platform that accrues many advantages. Developers save time and resources and build on top of AT&T's assets instead of investing in network and telecom equipment themselves. A platform approach positions legacy assets for the future by abstracting and combining them to increase their relevance to emerging trends in cloud, mobile, and social technologies. "APIs give you the ability to better manage the legacy environment and future-proof them," Donovan says.

A well-executed API program reorganizes capabilities to establish consistency and ease of use. It makes an organization's internal knowledge accessible in a

continues to next page ›

semantically consistent manner. "APIs simplify things architecturally and create a better story and capabilities for the developers by having a common taxonomy," says Jacob Feinstein, executive director of new technology. "If you have a more educated community, they'll think of new things that they might do with the network that they wouldn't have thought of doing."

The platform strategy extends beyond the network assets. "Our APIs cut across capabilities such as payment, device characteristics, location, messaging, speech recognition, and others," Macwan says. "Any developers who want to embed speech recognition in their services can just call a speech API to access our speech engine."

"Most of the things we do are candidates for the new architecture," Donovan says.

> *"[The API program] is an architectural choice one makes for speed."*
>
> —John Donovan, AT&T

External outreach changes internal operating model

Donovan cautions against the common notion that APIs are for giving away data free just to be nice. That thinking limits the internal potential of APIs. "The use of APIs and their impact is not just for outreach to the external developer community. It changes how you operate," he explains. "You literally put APIs everywhere. That's how you do internal development, that's how the IT shop works, that's how your provider should do development for you, that's how your offshore stuff lands into your environment, and that's how you build services."

AT&T is changing on the inside, too, as a result of the API program. The thinking and architecture the program represents are seeping deeper into company operations. Many teams now understand the change in thinking the API architecture requires. "People are applying an API lens whether they're in the labs, the network teams, or what traditionally have been finished product groups. They offer an API-centric view of their work," Feinstein says. As these diverse groups think about ways to support the API program, they reconstitute their work in a more modular, fungible, and co-creation–centric manner.

As a result, APIs are increasingly coming from all parts of the organization and not just from the API program group. The consumer marketing organization, the enterprise marketing organization, the product organization, and the emerging devices organization feed the API pipeline. Teams are also proposing APIs out of the gate with new solutions, including teams from AT&T's network equipment providers. "APIs are being thought of at the outset, and they influence the early ideation around network release and road map planning. Now we actively look at what the API opportunities are as we roll out each next generation of network technology," Feinstein says.

Speed is also a function of an organization's operating model. "We're pivoting toward thinking about architecting everything we do in a more API-centric way," Feinstein adds. APIs impose modular thinking on the enterprise. They have allowed AT&T to reconstitute its capabilities and assets in modular chunks with stable interfaces. They have digitized the operations that take place around the company's network and the value-added services it delivers. Being digital, these capabilities are easier to engage with and now operate at a faster pace with a large number of partners.

The single principle: Speed

Despite the size and scale of its infrastructure and operations, the architecture changes enabled by API thinking, API technology, and an API platform strategy can have a real impact on innovation, growth, and the AT&T bottom line. "We're getting faster, and one result is that the architecture is shifting to one that allows more partnerships. You'll see us do more technology partnerships and move faster, both at the pace of the market and in terms of innovating on our own. There will be efficiency benefits as well," Donovan says.

His advice on how to think about APIs: "Operate under one principle and then architect around it; ours was speed."

> *"APIs are the building blocks of the digital economy."*
>
> —Laura Merling, Alcatel-Lucent

Conclusion

The SMAC trends provide strong signals that business ecosystems are moving toward digital ubiquity. As this digital ubiquity evolves, information (bits) will make up a growing proportion of the overall value that customers experience from any product or service (atoms). Successful companies are adjusting their business and enterprise architectures to be more attuned to participating in or integrating with these expanding digital ecosystems. Companies leading in their engagements with SMAC are adopting a digital operating model, which supports the permeable enterprise.

Few enterprises are completely ignoring SMAC developments. However, the demands SMAC creates on IT can overwhelm CIOs and other business executives. In part, that's because business executives are accustomed to viewing technology opportunities through the old lens of being responsible for all the end-to-end application logic and performance. This approach does not scale when engaging with SMAC, as described in the sidebar "Scalable integration strategy." They need a new model—one based on lower integration and interaction costs—similar to the one web companies have been using.

A key transformation is to make a company's value-add capabilities addressable in digital ecosystems. This transformation is possible by understanding and using RESTful APIs and API management technologies. (See the article, "Consumerization of APIs," on page 34.) Companies that apply modern APIs and PwC's proposed digital operating model thinking have the opportunity to gain competitive advantage through reduced friction in co-creating new value, building persistent digital engagements, and increased agility.

Leading software companies have long known that being the dominant platform for an ecosystem creates direct and indirect demand for their offerings and long-term competitive advantage. SMAC trends suggest that every company is, in part (or should try to be), like a software company in how it creates and engages with a digital ecosystem.

Establishing a platform in the center of a robust digital ecosystem requires a digital operating model, one that is appropriately permeable to third parties that can co-create new value from what a company and others have to offer. It means taking advantage of the interconnectedness and the rise of empowered customers who will engage actively with a company if it lets them. It's time for more companies to become like a software company within their habitat of the digital ecosystem. And perhaps in some new habitats.

Tapping value in information

David Zanca and Thomas Wicinski of FedEx Services describe how FedEx is a connected enterprise and provides digital access to its services on the customer's terms.

Interview conducted by Vinod Baya, Bo Parker, and Surajit Kar

David G. Zanca

David G. Zanca is the senior vice president of IT, customer access, and revenue systems at FedEx Services. Zanca is responsible for bringing market leadership across the customer-facing domains of all the FedEx operating companies. A primary focus for Zanca is the extension of a "connectedness" strategy that embeds FedEx services into mobile devices and applications that customers and partners use every day.

Thomas Wicinski

Thomas Wicinski is vice president of digital access marketing for FedEx Services. Wicinski and the digital access marketing team develop, manage, and launch market-leading software, web services, and fedex.com to enable customers and partners to access all business services offered by FedEx.

PwC: David, how are the mobility, cloud, and social technologies trends impacting your world?

DZ: What we are seeing is that these trends are making technology much more pervasive than before, and one significant shift is the changing customer behavior. It's a behavior shift in how customers interact, where they interact, and what they expect. During the past decade, the growth in e-commerce has been substantial, but it was from a small base of total retail. This past Christmas season we experienced a very different phenomenon. We clearly saw the shift from the consumer doing all the shipping of goods to the e-tailer shipping on behalf of the consumer. This shift suggests that consumers are doing less driving to a retail store, loading up the car, taking it home, and shipping the presents to their family. Instead, they window shop in local stores, go home and buy online, and the e-tailer ships it.

It's also very clear that the platform of choice for consumers has changed. The access from the mobile platform is showing strong momentum, and shipment tracking from mobile devices exploded this year. The ubiquity and convenience of mobile devices is resulting in more frequent lookups, so we have more continual interactions with our customers.

PwC: Thomas, you lead digital access marketing for FedEx. What are you seeing in this regard?

TW: From a marketing standpoint, one of the strategic pillars of our digital access program is providing access to FedEx services on customers' terms. Our capabilities should be accessible where customers are, and we have done that

> *"We keenly seek out new sources of information to increase connectivity and make relevant information available to customers in their context."*
>
> —David Zanca

from the very beginning of the company. For instance, in the past we have distributed desktop software, which would run on the dock at the end of a fulfillment line to generate a label. That's a production scenario, and we're fitting into the customer's context; in this case, somebody who's operating a fulfillment office and needs to generate a label.

Today it goes to the other extreme. As David said, we are becoming more relevant on mobile phones. Every package that gets sent has a recipient. Increasingly for all recipients, the mobile device is a device that they live on, as much as any other. I compare this to where we were in 1993 and 1994 when we were deeming the web as the next place for FedEx to be. We are growing in that same way now, as mobile and cloud and social will have some of the same implications.

PwC: FedEx has a long history of treating information about the package with the same importance as the package. How does this principle embody itself in your company?
DZ: That's right. In the late 1970s, our founder and CEO Fred Smith said, "The information about the package is just as important as the package itself." It's a vision that has given our company a culture that values information and that uses it in all we do. The vision embodied itself by seeding a connectivity DNA. Almost every piece of our business is instrumented; it has some degree of intelligence and automation on it. Our planes are all intelligent and they tell us where they are. The trucks, the couriers, the knowledge workers, the hubs—almost everything has technology embedded in it and tells us where it is or what its state is. Without the connectivity, we would not get the information about the package that we and our customers value so much.

Connectivity is core to our operating model, and we have become good at enabling, creating, and managing a connected world. Also, we keenly seek out new sources of information to increase connectivity and, as Thomas said, make relevant information available to customers in their context.

PwC: What are the fundamental characteristics of having the connectivity DNA?
DZ: We essentially operate two networks: the physical network of planes, vehicles, and packages, and the second network of information about the package. The information network is a digital equivalent of the physical movements of our assets and packages. Extending and combining the two networks is how we create value for our customers.

On the surface, you may think of the information as what we present to customers to track their packages. It is much more than that. Indeed, the customer wants to know where the package is, but the information about the package tells us all sorts of things about our internal quality, productivity, effectiveness, and operations. Information about the package helps us run our business better. That comes from a digital operating model where all our assets are connected and surface information to increase overall value to us and the customer. For example, over the years we added more and more scans on a package as it moved from pickup to delivery, which digitized more locations and increased the granularity of information we capture. A typical package, over its journey, gets scanned more than 25 times today, and we make a subset of these scans available to our customers.

Other characteristics also push us to be more and more digital. Although most people think of us as transporting documents, the company was founded on the notion of the fast cycle times necessary for critically needed goods, such as equipment and computer spare parts, that must be moved quickly to repair a broken-down machine or equipment. So speed and responsiveness are core to our operating model.

PwC: What is an example of where you are stretching the edge of connection?
DZ: Looking back, when most other sites were just rendering content, our tracking service was one of the first functional web applications. Fast-forward 20 years, and our first iPhone app was one of the first functional apps from a business perspective. Our web applications from 20 years ago and our mobile apps from today both stretch the connections between our enterprise and our customers. There is a lesson in innovation here: the ideas for both of these came from somebody in a cubicle playing with the web technology or the iPhone well before the web or building apps were popular. We encourage such experimentation with emerging technologies.

> ***"Our capabilities should be accessible where customers are, and we have done that from the very beginning of the company."***
>
> —Thomas Wicinski

As I said before, almost every piece of our business has embedded sensors and intelligence. Looking forward, where we haven't had the intelligence and will be adding it is on the package itself. The bar code provides some intelligence, but one must actively scan the package. This will change over time. One of our solutions, SenseAware, which we now use on a small percentage of our packages, makes the package intelligent. It's essentially a cell phone that calls home and tells us, "Here's where I am," and provides information about location, temperature, velocity, light, vibration, and so on.

With SenseAware, we push the edge of connection deeper into our operations, because the product location and sensor information is available continuously in real time as it moves in our system. At the same time, we get deeper in customers' contexts, as they are in constant touch with their packages and can take actions if necessary. I think in the next 10 years or so, you could see some type of intelligence being placed on all packages. It might be sensors, it could be tags, but clearly the technology is going to evolve and improve.

TW: That's right. SenseAware is a continuation of our accessibility strategy. With it, one gets accessibility to the next level of detail that customers are looking for. Tracking information gives great comfort to our customers. The market and competitive dynamic now suggests that not only do our customers want more information about the packages, but they also now want more interaction with FedEx and

"With SenseAware, we push the edge of connection deeper into our operations, because the product location and sensor information is available continuously in real time as it moves in our system."

"At the same time, we get deeper in customers' contexts, as they are in constant touch with their packages."

—David Zanca

expect us to react to changes and resolve problems if they occur. This is called intervention—customers are expecting it. They're trying to ensure successful delivery, not just know that something went wrong along the way. That's one of the fundamental business shifts that's causing us to need to provide more information than we ever did before.

PwC: So in some sense, the customer is becoming part of your operating environment, and you need to surface more information to bring that value to the customer?
TW: Absolutely. It allows us to have a closed-loop system with our customers. A very interesting thing about our business is that every transaction is high intensity. Customers anxiously await their packages. We recognize it is the most important thing to the person who's getting the package, so we try to build the experience and our operations with that notion in mind.

More information matters on packages because if something occurs, then we and the customer can do something about it. Right now, SenseAware gets used a lot for perishable items in the medical industry. If a temperature drops below a certain level, then that item could be damaged. The customer can drive an operational change, such as return, reship, reroute, or any other suitable action. From our viewpoint, it's an element of being in the customer's context by ensuring successful delivery.

PwC: How have the methods for making your capabilities accessible changed over time?
DZ: We have multiple platforms that we support to interface with our vast pool of customers, and our methods have surely evolved over time. We started in the 1970s, making our systems and information accessible by our customers. As Thomas indicated, the early methods were proprietary, and we gave customers software and sometimes hardware to access our transaction systems, generate shipping labels, and so on.

More recently, we are also using web services, and it is by far the fastest-growing platform right now. Customers call our APIs [application programming interfaces] or web services and access real-time information. In either case, we empower and engage millions of customers. Underneath all of that, we try to have a common code base all across, so you're not writing custom software for every channel each time. Your mobile device may have some native apps running, but they are calling web services that are the real brains for shipping, tracking, and so on.

TW: You could say that we have gone from a proprietary specification at the very beginning, distributing a piece of software, to now where we are migrating to a pure web services capability. We're seeing more of our partners move to using the web services, which basically gives them one less piece they need to worry about. We're definitely seeing a market shift there.

PwC: What are some changes you are seeing in terms of how IT operates?
DZ: One change I see is that we in IT don't have to do all the coding anymore. The key role for my group is to be the owner, producer, and platform of the services. Business units, even third parties, can use the services to develop a new capability; they can write the thin veneer of code around it and we don't have to do that. It's a win-win situation: less work gets added to an

> *"We in IT don't have to do all the coding anymore. The key role for my group is to be the owner, producer, and platform of the services."*
>
> —David Zanca

already full IT pipeline, and the new capability comes to market quickly. We may be involved in some code review, but we're going to end up concentrating on being a platform of core services.

And we're already experiencing this because we have third parties that take our software, couple it with their software, and then sell that as part of their capability in the marketplace.

PwC: So you are co-creating new capabilities? Is this an easy change to make?
DZ: Indeed, we are co-creating with the constituents we serve. And no, it's not an easy change to make. It's a big change and needs to be part of IT strategy and it takes some leadership. At the highest level, this is an architectural change. You need to architect your platform and environment for co-creation and treat APIs as products that you publish and maintain for long periods of time.

PwC: What are the technologies enabling this change?
DZ: We maintain a FedEx Developer Resource Center, where third-party developers from enterprises or commercial developers can find our web services in a WSDL [Web Services Definition Language] specification for shipping, office and print, and other capabilities.

We also have a continuously connected strategy where we create a thin layer of services, which are independent of end-user devices and use cases. We take our enterprise services and apply that thin layer of customer experience services on top, which in turn exposes our services as RESTful [representational state transfer] web services. Then we have all the different types of end-user devices flowing across the top.

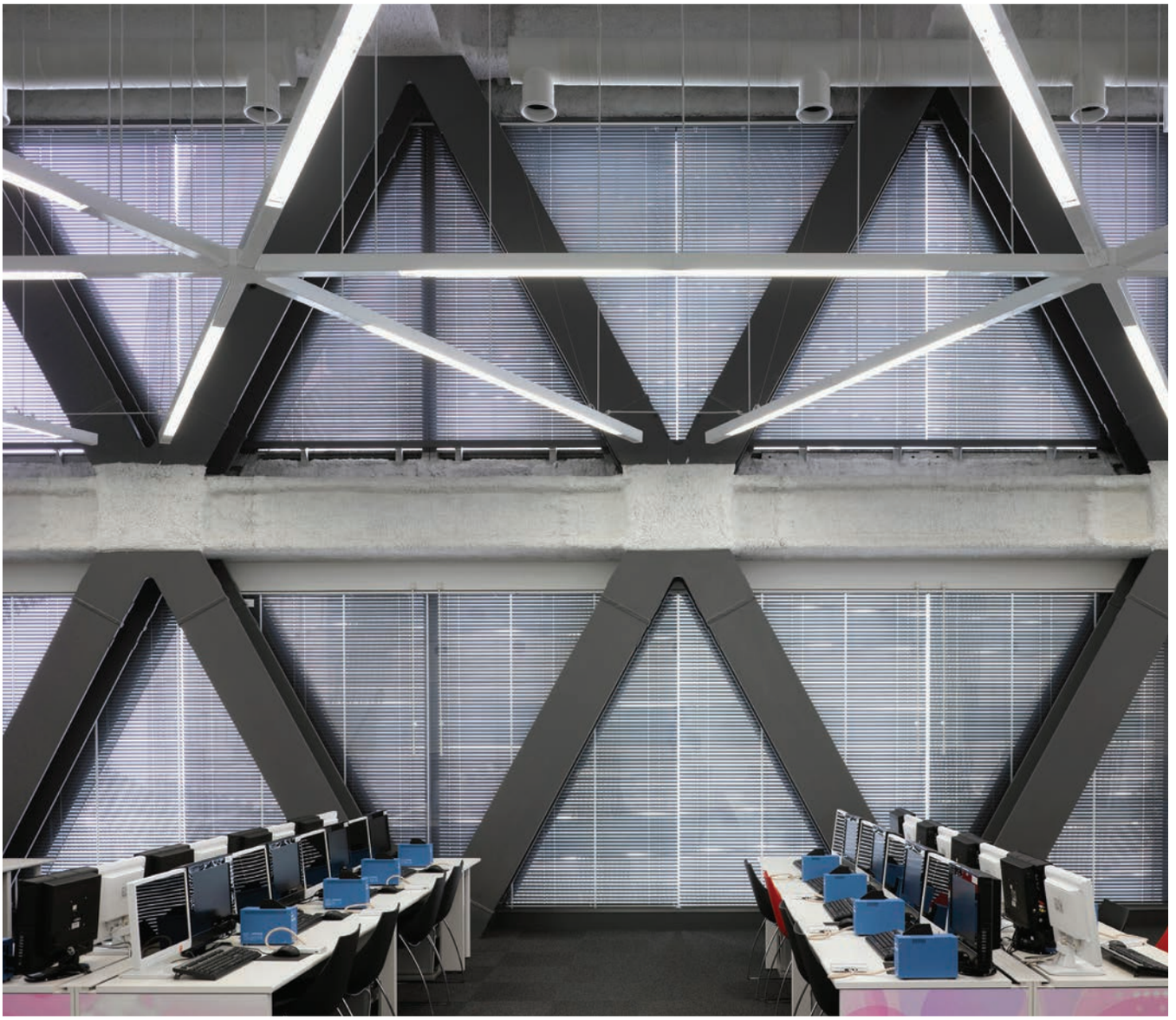
So, we're powering a new multitude of customer solutions that do not have to be fully developed by my IT shop. Thomas and other marketing leaders, as well as third parties, can create new solutions for our customers by using the services we expose. This expands the value universe a lot quicker than submitting the work and adding it to our queue.

PwC: One premise PwC has is that all sizable companies are becoming software companies, although it's not their core business. Do you think of yourself as a software company in some regard?
DZ: As we look at our API strategy, our web developer center, and how we share information with third parties, we are starting to think of it more that way. The question is what makes a software company. For us, that means: Are you thinking platforms? Are you thinking of allowing others to build new capability on top of your platform? Do you manage APIs as products? Are you thinking in terms of publishing APIs and making them available?

PwC: And are you driving an ecosystem?
DZ: Yes. And how do you manage the ecosystem? I think sophisticated enterprises are starting to think more like a software company—as a platform and an ecosystem.

TW: When I talk about the priorities in my digital access group, one of them is to think and act the way a best-in-class software company would, as a company that sells software for its own business. We have absolutely been implementing this. You called it a business model; I call them business processes. That would be very consistent with what a company does that sells its wares.

Between David's group and my group, we are a pretty big software company sitting inside of this big transportation company. Many of our activities are identical to what a big software company does. When I benchmark our group, I actually do it against the leading software vendors, long before I look at what our transportation competition does. So the idea of having a single platform that will support multiple customer interfaces—that's our mechanism to do it in an affordable manner.



"Many of our [IT and digital access group] activities are identical to what a big software company does. When I benchmark our group, I actually do it against the leading software vendors, long before I look at what our transportation competition does."

—Thomas Wicinski

The rising value of linked information

Mark Noworolski and Peter Leiser of Streetline detail how they are transforming the parking ecosystem with cloud, mobility, and analytics technologies using RESTful APIs.

Interview conducted by Vinod Baya, Bo Parker, and Bud Mathaisel

Mark Noworolski

Mark Noworolski is the CTO of Streetline. He has been working with low-power sensing technology for more than 15 years, and he co-founded Streetline to leverage low-power sensor design, mesh networking, and web technology to deliver valuable applications to cities.

Peter Leiser

Peter Leiser is vice president of engineering, platforms, and applications at Streetline.

PwC: Mark, can you tell us about your company?

MN: Sure. Streetline was founded about six years ago with the vision of applying wireless sensor technology to compelling problems. We were very excited about low-power mesh networking and all the applications it makes possible with region-wide connectivity and sensors. We explored many applications and chose to transform parking first. What excited us about parking was that it's an activity that occurs in a dense urban environment and with a large number of transactions. We often asked ourselves, "Where can I derive some value from the bits of information that I'm able to squeeze through a wireless mesh network?" We were looking for something where we can assign a value to each one of those bits of information.

At a high level, parking raises many challenges in almost every city. A one-year study of a 15-block area in Los Angeles found that about 30 percent of the traffic in the city is people looking for parking. That's almost 1 million miles of driving and about 50,000 gallons of wasted fuel.

We have digitized the process of parking and created new value for consumers, parking garage operators, and local governments concerned about parking enforcement and the impact that parking-seekers have on the quality of life in cities. We get two pieces of information from the field in real time: occupancy and payment information. We use this information to transform the parking process and create a smart parking ecosystem. [See Figure 1.]

Figure 1: Smart parking ecosystem enabled from Streetline's technologies and solutions

Source: Streetline

PwC: What's possible now that was not possible before?
MN: In our system, we address several use cases. The first innovation is to guide consumers to available parking spots. Parker is our consumer guidance application, available on iPhone and Android platforms. Parker takes the parking availability, policy, and pricing data, and displays it to drivers in real time so they can find parking quickly. We also have a mobile payment capability inside the Parker app, so you can set reminders for yourself to add new payment before the parking meter expires, thereby avoiding a fine. You can even take a picture of where you parked, and that picture will be marked with GPS. Then when you're done shopping, for example, and need to find your car, just pop up the picture and it will show you where to go.

One of our other solutions is ParkEdge, which is a parking management platform that is a self-service solution for private garage operators. Now a parking garage operator who has excess inventory in the middle of the day can access parking-seekers in real time with messages such as, "I have a special on parking right now near your location." There's also the ability to offer reserved parking. For example, if OpenTable[1] is integrated with the ParkEdge platform, a restaurant could offer a reserved parking space with dinner reservations. Similarly, if you're a merchant, you could validate parking for consumers shopping at your store. Many such use cases are now possible.

PwC: How does the system work?
PL: On the street, we have sensors in each parking spot and meter monitors, as well as wide area network gateway devices on lampposts. Everything is connected to everything. Information flows from the field and is posted to our data center. Our detection engine generates arrival and departure information in real time. This information is published onto a messaging queue to update the appropriate systems. We also aggregate information about payments from meters. We have a meter payment API [application programming interface] to aggregate information from different meter vendors that all have their own data semantics.

"We often asked ourselves, 'Where can I derive some value from the bits of information that I'm able to squeeze through a wireless mesh network?' We were looking for something where we can assign a value to each one of those bits of information."

—Mark Noworolski

1 OpenTable is a real-time online restaurant reservation network, www.opentable.com.

> *" If I were starting a company now, or doing an application that had a mobile and web component at any enterprise, I can't think of any way to do it other than focusing on the platform that provides the RESTful APIs that the mobile and web client consumes from."*
>
> —Mark Noworolski

MN: Also, through our ParkEdge product, garage operators can enter their inventory into our system and indicate that some amount of capacity could be reserved. They can handle it any way they want: publish their charges, change pricing dynamically, offer valet parking, and so on.

PwC: So you instrumented parking spaces, surfaced new information, and digitized the parking process so that it can be transformed with cloud, mobile, and analytics technologies?
MN: Indeed, that is what we have done. The key for us, as I said before, has been to find information that we could assign value to. It was clear to us that real-time information about occupancy and payments is valuable to lots of constituents. You can probably appreciate that there's a lot of value to the real-time aspect of the data, but there's also a lot of value to the historical aspect of the data. This is where analytics comes in. It turns out that occupancy varies from day to day. The advantage of having sensors and real-time meter information is that you can then feed that into a back end that will allow you to look at historical trends over time. You can compare one city street to another, and if you have a true global reach to that data, then you can also compare how your city is doing to other cities.

PwC: You are using RESTful [representational state transfer] APIs to publish and share data. What is the strategy behind that?
MN: We've had an open business strategy from the beginning, and we've come to see RESTful APIs as a key enabler of that. We use them in our internal development as well as in how we interface externally. The openness applies to the sources from which we will consume data and to the way we share data via robust APIs. From relatively early in our company's history, we've taken the position that we don't need to limit ourselves to using only our own sensors. It does not matter where the data comes from; the value comes from how you aggregate and link data together.

PwC: What are some benefits you are seeing with an API-driven approach?
MN: One of the interesting things about our APIs is that the core data is the same. What changes is how the data gets used. Different use cases want parking data presented in different ways. For example, in Parker, if you're trying to do real-time guidance to empty parking spaces, you're not after historical data; you're after what's happening right now or what's likely to be happening by the time you get there.

Whereas if you're sitting in the parking department office and need to see what's going on out on the streets, that's a different API on the same data. In Los Angeles, we will cover close to a third of the city's entire metered parking spaces. A parking control officer now has a global view that shows how many violations there are in each individual city block and can be guided by that information to specific blocks. The officer can zoom in, and it shows where the parking violations are on that individual block. As the officer gets out and writes that ticket, it sends information back to the server, and that information then gets republished to all the other officers in the city.

> *"If you use this loosely coupled RESTful API approach, you accumulate less technical debt for every new piece of functionality created."*
>
> —Peter Leiser

PwC: Are there benefits outside of parking to what you are doing?
MN: Indeed, a key benefit we plan for is the extensibility of our platform. An example that we've considered that's not directly related to parking is to open up our sensor mesh network to collect other types of information from the environment. The idea being that you could then spur open development of different sensors.

Consider pollution sensors, for example. Let's say we weren't sure whether there was a market for those, but we opened up the APIs and we allowed somebody to build hardware that could use our already-deployed mesh network infrastructure to move pollution data from highly distributed sensors back to pollution control officers. Or because the APIs are open, we could get information from some other infrastructure entirely. That data can be published to our servers, and then it can be mashed up or brought into the Parker app. Anybody could use the open APIs to extend the parking experience to include pollution information or other environmental information.

PwC: How has the transition to RESTful APIs affected your software engineering practices, enterprise architecture consideration, and that side of things?
MN: If you think of everything you code as a module that has an API, it's much easier to run development. As a small startup company you have a few people who know the full software stack and all the interdependencies in that stack. Inevitably as you grow, fewer people know the entire stack and understand all the interdependencies. Just because of that, you need to do something like this. You need to become more API driven, because if you don't, you're going to have intricate dependencies.

PL: In the past, we ended up with big pieces of software. When you looked at it, you could determine what was shared and what had been added specifically for another application, but it's all one big soup. That becomes a maintenance nightmare, because there's always this problem where you change one thing over here and you've just broken something over there.

Now we have multi-tenant, system-of-record APIs. There are APIs for each use case: a parking status API, a meter payment API, a payment status API, and so on. It makes it much easier to organize and run engineering development and much, much easier to integrate with external code bases. We think API first now. We think, "What is the API contract based on the use cases?" and that helps us establish clear boundaries. Even with an internal application, the question is, "What data does that application need?" So you drive that through this API framing, which has the added benefit of not constraining other potential use cases.

PwC: Based on your experience, what would be your advice to CIOs considering a move to more openness and more focus on linking to other sources of value both internally and externally?
PL: Internally, we talk about our older practices as having created "technical debt." The longer you're in business and the more things you've built, the more technical debt you have. That technical debt is really like financial debt, where sometimes just servicing it ends up eating all your time and capital. I would advise CIOs to not be afraid to start over. If you use this loosely coupled RESTful API approach, you accumulate less technical debt for every new piece of functionality created.

With loose coupling, it's a lot easier to replace modules one by one, piece by piece. When you have an API contract, those systems that talk to your API don't need to worry about what goes on under the hood. What is important is to keep the API stable, so it needs to be managed like a product that would be maintained, supported, and evolved with good change management practices.

MN: Strategically, you need to take an educated guess about what information and APIs will add to business value. Technically, if I were starting a company now, or doing an application that had a mobile and web component at any enterprise, I can't think of any way to do it other than focusing on the platform that provides the RESTful APIs that the mobile and web client consumes from. This way, you can actually get to market fastest because you can have one built in parallel with the other.

Consumerization of APIs: Scaling integrations

A new generation of tools based on RESTful APIs will help enterprise IT embrace the opportunities and challenges from social, mobile, analytics, and cloud computing (SMAC) and consumerization of IT (CoIT).

By Carol Hildebrand, Patrick Shankland, and Vinod Baya

The confluence of social networking, mobile computing, analytics, and cloud computing (SMAC) creates a perfect storm of challenges for enterprise IT groups. Generational changes in the way people adopt and use technology further exacerbate this disruption. A parallel subtrend called the *consumerization of IT* (CoIT) is driving the convergence of these technologies in ways that contradict the traditional IT management methods of command and control, locked-down systems, systematic rollouts, and long cycle-time application development.

Over time, SMAC and CoIT will expand and deepen the digital operating model explored in the previous article, "Exploiting the growing value from information," on page 06. But these two trends present challenges that will require significant changes in how enterprise IT operates and enables business, which are issues examined in the next article, "Embracing open IT," on page 54. Fortunately, evolving approaches supported by emerging technologies can help achieve this transition to a permeable enterprise.

These emerging technologies represent a new generation of application programming interfaces (APIs), or code-based programming specifications that allow software components to communicate with each other in a distributed system. A relatively new style of APIs, called *representational state transfer (RESTful)* APIs, and emerging solutions to manage them, called *API management platforms,* provide mechanisms so enterprises can engage with SMAC in a strategic and systematic manner to assist the fulfillment of their digital ambitions. Together, they power the consumerization of APIs.

Previous issues of the *Technology Forecast* have covered the individual impact of social,[1] mobile,[2] analytics,[3] and cloud.[4] RESTful APIs and API management platforms are the key technologies that abstract above these individual pieces and support the integration of SMAC, thus making them the key tools for participating in the digital economy.

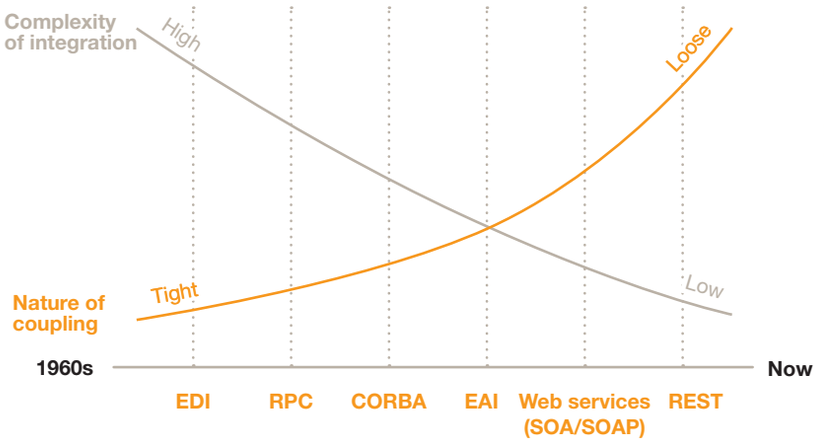
1 "Transforming collaboration with social tools," PwC *Technology Forecast* 2011, Issue 3.

2 "Unleashing enterprise mobility," PwC *Technology Forecast* 2011, Issue 1.

3 "The third wave of customer analytics," PwC *Technology Forecast* 2012, Issue 1.

4 "Driving growth with cloud computing," PwC *Technology Forecast* 2010, Issue 4.

Figure 1: A conceptual view of the relative trends in complexity of integration and the nature of coupling, in the evolution of software integration technologies over time



EDI	electronic data interchange
RPC	remote procedure call
CORBA	Common Object Request Broker Architecture
EAI	enterprise application integration
SOA	service-oriented architecture
SOAP	Simple Object Access Protocol
REST	representational state transfer

"When we step back to see what the big revolution is, we see that APIs are the first serious digital indirect channel."

—Sam Ramji, Apigee

RESTful APIs enable what PwC calls the *permeable enterprise,* in which capabilities and assets inside the enterprise are easily combined with assets and capabilities outside the enterprise. Once the sole province of highly experienced software developers with deep knowledge of the enterprise context, APIs are becoming the basis for creating digital value chains that access and act on information from traditional data stores, humans, and an increasing number of physical objects that contain digital content; in short, we're witnessing the consumerization of APIs.

The rise of RESTful APIs

APIs have been used as a mechanism for linking programs since the early days of software. However, API creation and design have significantly changed. Early methods were proprietary and created interdependent coupling among pieces of code and systems. If one side of the coupling required a code change, the other side was affected. Over time, APIs evolved to reduce the interdependency of tightly coupled interfaces, generally lowering the complexity of integration. (See Figure 1.) Table 1 describes the evolution of integration and interface technologies to create distributed systems.

Table 1: The evolution of integration and interface technologies in distributed systems

Electronic data interchange (EDI): In use before the 1970s, EDI is an electronic exchange of business information (such as invoices) in a standardized format. EDI connections are point to point and often use proprietary protocols.
Remote procedure call (RPC) or remote method invocation (RMI): In use since around 1980, RPC is an interprocess communication that allows a computer program to request a procedure to execute on a remote computer. In object-oriented software, RPC is called RMI. The details of the remote computer and procedure were hard-coded into the software and were platform dependent.
Common Object Request Broker Architecture (CORBA): Created around 1991, the CORBA standard was defined by the Object Management Group (OMG). It uses interface definition language (IDL) to enable distributed components to work together. IDL provides platform independence. CORBA is complex and requires an Object Request Broker (ORB) to facilitate communications.
Enterprise application integration (EAI): Gaining popularity in the mid-1990s, EAI is a mechanism to integrate applications within an enterprise. Integrations are complex, often point to point, and mediated by middleware. Integrations are tightly coupled and often need to be re-done with each upgrade of the application(s).
Service-oriented architecture (SOA)/web services: Gaining popularity since the late 1990s, SOA uses a service-based architectural approach in which software is developed as a collection of services that can be reused in multiple applications. Although SOA can be implemented using any integration technology, including RPC and CORBA, broad industry acceptance increased with the use of web services standards such as Simple Object Access Protocol (SOAP). Business functions or processes are rendered as web services software components. SOA use has been largely internal to the enterprise.
Representational state transfer (REST): In rising use since 2005, REST architecture builds from existing web protocols, allowing large pools of developers to easily and quickly build loosely coupled, accessible basic web services. Resource based rather than task based, REST tipped the balance from internal integration to external integration.

Within the last decade, enterprises began to expose APIs to allow external parties to build new functionality, something software companies did in the past. ProgrammableWeb maintains a catalog of these publicly facing APIs. (See Figure 2.) Its directory has topped 6,000 APIs, and RESTful interfaces far outpace other styles, such as Simple Object Access Protocol (SOAP).[5] (See Figure 3.) Today, communication on the web has evolved from the early days of using SOAP standards to using features of RESTful methods, making REST-compliant APIs a major class of web services.

Service-oriented architecture (SOA), which gained wide acceptance using web services built on SOAP, has been popular within organizations as a mechanism for sharing information across the enterprise.

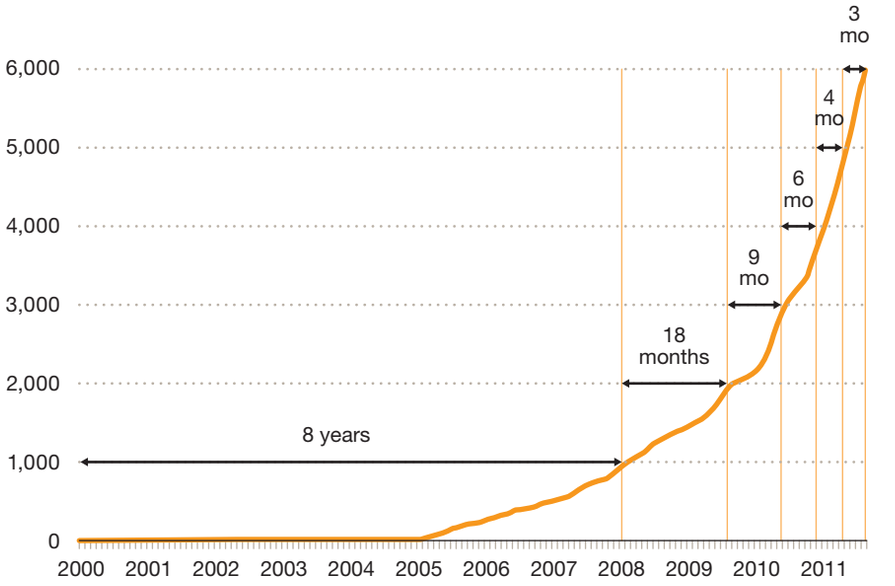
However, the use of a REST architecture, along with associated technologies such as JavaScript Object Notation (JSON), is accelerating the development and use of APIs. Some of the most popular services such as Twitter, Netflix, and Facebook are now processing API calls on the order of billions per day or month.

APIs are becoming the basis for creating digital value chains, including digital indirect channels previously established mainly by software companies and purely web-based companies. "When we step back to see what the big revolution is, we see that APIs are the first serious digital indirect channel," says Sam Ramji, vice president of strategy at Apigee, an API management vendor. "Although physical indirect channels have supported businesses for a long time, the equivalent in the digital domain has been unclear so far."

5 According to Wikipedia (http://en.wikipedia.org/wiki/SOAP): "SOAP is a protocol specification for exchanging structured information in the implementation of Web Services in computer networks."

Figure 2: Adoption of externally facing APIs is accelerating.

Growth in number of APIs over time



Source: ProgrammableWeb

"In the past, everything was a heavy integration. This meant that if there was a seemingly small need, the cost of integration was a barrier to fulfilling that need."

—Devon Biondi, Mashery

One big reason behind the successful adoption of RESTful APIs is developers' ability to build modular capabilities with lightweight interfaces that don't require heavy integration. "RESTful interfaces create a level of simplicity that didn't exist previously, and simplicity always speeds things up, making integrations cost-effective," says John Musser, founder of ProgrammableWeb.

The potential to lower cost expands the opportunities to integrate. "In the past, everything was a heavy integration. This meant that if there was a seemingly small need, the cost of integration was a barrier to fulfilling that need," says Devon Biondi, vice president of strategy services at Mashery, an API management vendor.

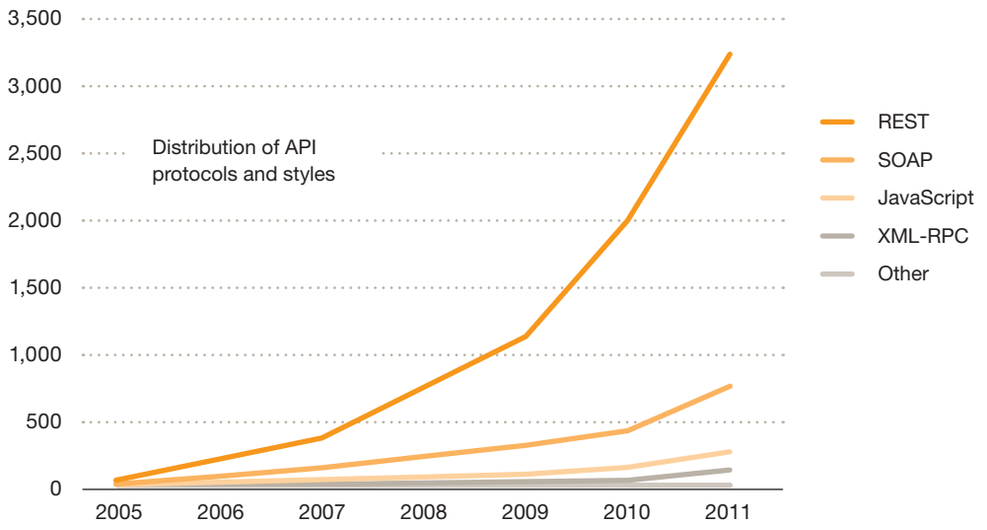
Despite rising adoption, integration via RESTful APIs is best regarded as a tool in the integration toolkit, and is not the right solution in all use cases. Each of the integration approaches in Table 1 have their advantages and disadvantages. For example, a REST architecture has added benefits such as being highly scalable and undeniably simpler, but depending on the protocols, clients, or servers used, it may have performance inferior to other integration styles, such as CORBA. Therefore, a cost-benefit analysis of specific IT use cases will determine the optimal integration style that must be implemented.

More about REST

As noted earlier, REST stands for *representational state transfer,* meaning that a client communicates with a server—not directly with the source of information on that server. This transfer is done through representations of the state of that resource. The REST architectural style for distributed systems was developed around 2000, and it is patterned after the HTTP[6]/1.1 Protocol. In RESTful designs, the client does not need to know about the implementation on the server. The server is free to store data as it likes, and the client can store the same information differently. This loose coupling means that as long as the interface is stable, the implementation on

6 HTTP is Hypertext Transport Protocol, the protocol used for communications on the World Wide Web.

Figure 3: RESTful APIs have been a driver of growth in API adoption.



Source: ProgrammableWeb

the client or the server can independently change. This independence creates flexibility in distributed software systems.

The REST architectural style requires that the following six constraints be met:

- ***Client/server loose coupling—***A clean separation of duty exists between client and server. The type of data storage does not matter to the client, and the client interface or client state does not matter to the server. With a stable interface, the client and server may be developed and replaced independently of each other.

- ***Stateless—***The interface that dictates how the client and server interact does not allow client states to be stored on the server. Information about client states is embedded in the messages the clients send to servers.

- ***Cacheable—***Clients can have the ability (and must let the server know whether they do or not) to temporarily store data received from the server.

- ***Layering—***Servers do not know whether there are layers of abstraction between themselves and the end client; for example, whether they are passed through multiple security policies, APIs, and so forth.

- ***Code on demand—***Servers are able to temporarily send custom functions as executable code to clients for them to execute.

- ***Uniform interface—***Servers and clients can interact, change, and be modified independently as long as the interface that binds them remains the same.

An API implemented using the preceding principles of REST and using standard HTTP communications protocols is a RESTful API, sometimes called a RESTful web service. Like any resource on the web, the RESTful API will need a Uniform Resource Identifier (URI), such as an http:// address.

> ***"RESTful interfaces create a level of simplicity that didn't exist previously, and simplicity always speeds things up, making integrations cost-effective."***
>
> —John Musser, ProgrammableWeb

RESTful API developers are increasingly using REST in conjunction with JSON, a resource-based data transfer mechanism, to further simplify the process of communication between the information seeker (the client), and the system containing the information to be consumed (the server). JSON is derived from the JavaScript scripting language, which is widely used in web browsers to enhance interfaces and build dynamic websites. Like REST, JSON is noted for its simplicity and usability. For instance, data is sent in plain text, which makes it easy to read and understand. Because so many web client programs are written in JavaScript, JSON data arrives ready to be consumed without needing further manipulation. At the same time, JSON lacks display capabilities and has a limited amount of development tool support. Hence, the decision to use JSON in an organization should depend on its intended use.

> *"When you get an order of magnitude shift in the number of developers who have the skill and talent to be able to use something, then you end up with outsize network effects."*
>
> —Sam Ramji, Apigee

The early use of RESTful APIs has been concentrated in web companies, in companies active in mobile, in social applications, and in large enterprises leading the adoption of SMAC technologies. However, PwC expects this concentration to change; eventually all large enterprises with considerable data and information assets will use this technology internally and externally. Although SMAC applications motivate RESTful integration today, it is typically useful for any application-to-application integration.

Comparing REST and SOAP

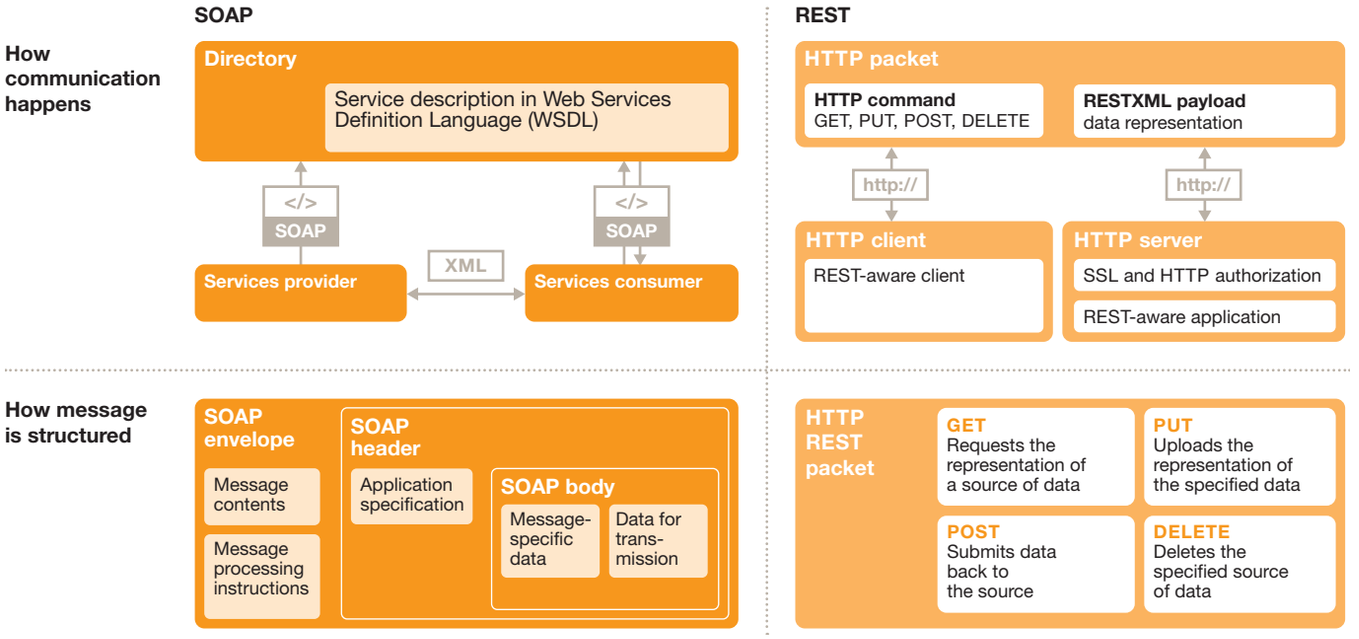
For many enterprises, the path to web services begins with the adoption of a service-oriented architecture (SOA), which uses SOAP as a method for exchanging information. In today's web service world, both SOAP and REST are used as methods of communication. There are several factors behind the popularity of REST when contrasted with SOAP.

Simplicity. REST uses simple HTTP and therefore standard commands—such as GET, PUT, POST, and DELETE—to coordinate communication between clients and servers. SOAP has no widely accepted methods corresponding to GET, PUT, POST, and DELETE, which leaves developers free to define their own semantics. But the result can be complex, proprietary mechanisms to connect components. Any programmer unfamiliar with these proprietary semantics will need time to learn them, slowing development. (See Figure 4.)

Familiarity. Since REST is closely related to web design, web developers do not face a steep learning curve. REST is also language and platform agnostic. On the other hand, SOAP requires a significant skill set in SOA-specific development and delivery tools. This impact can be substantial, as Ramji of Apigee explains: "When you get an order of magnitude shift in the number of developers who have the skill and talent to be able to use something, then you end up with outsize network effects."

Figure 4: Contrasting SOAP and RESTful mechanisms for web services communication

REST uses HTTP commands—such as GET, PUT, POST, and DELETE—to communicate content between clients and servers, and it uses HTTP for transport. In contrast, SOAP separates the content (data for transmission) and the protocol (SOAP), resulting in complex and proprietary mechanisms to connect components.



Efficient with bandwidth. The use of the existing web infrastructure eliminates the need for an additional messaging layer in RESTful APIs. Coupled with the fact that REST uses those short request and response sequences, these APIs consume considerably less bandwidth than SOAP-based APIs.

Scalability. With simpler component implementations and reduced complexity in the connection semantics, RESTful services can scale—as evident from several services that register more than 1 billion API calls each month.Although REST has many benefits, in some situations—such as stateful operations where state needs to be continued, or for applications expecting a guaranteed level of security or reliability, or requiring formal contracts with rigid specification of the interaction—SOAP would be a more appropriate choice over REST, as it has standards to ensure certain requirements are met.

Managing the APIs

As simple as RESTful APIs are to build, they still require management and maintenance. And although it is easy to manage a single API, all enterprises will inevitably have several APIs that internal developers, strategic partners, and public developers use to build applications across diverse platforms. This increase in APIs has led to the need for tools and services that help companies create, publish, manage, operate, and analyze APIs. Such solutions, often called API management platforms, are now offered by several vendors, including 3Scale, Apigee, Layer 7 Technologies, Mashery, and others. Alcatel-Lucent also provides API management solutions but with a focus on the telecommunications vertical, enabling service providers to make their networks addressable by others.

API management platforms bring a wealth of new functionality to API publishing and operations. The following paragraphs describe their key characteristics.

Developer community engagement. Engaging with the developer community is a significant first step to building an API ecosystem; internal and external developers must be aware of exposed services and the APIs to use them. Some API management platforms are free tools for those just getting started, while others are complete developer portals that support easy access to APIs and accompanying documentation, such as wikis, blogs, and discussion forums, to promote developer collaboration. Some companies also offer outreach and marketing programs designed to make the development community aware of their APIs.

Security. API management platforms offer several facets of security, starting with new developer approvals and developer authorization to access specific APIs. Many companies support the open security standards or OAuth 2.0 for authentication and key management. More sophisticated API management platforms support multi-tier access control methods that specify which developers can access which APIs. Usage monitoring is also part of this multi-tier access control capability. API management platforms should be able to integrate with existing enterprise security systems and protect against external security threats by using encryption, threat detection, and analysis.

Analytics and reporting. Analytics help companies understand and improve the value of their APIs. Value-driven analytics gauge API adoption by measuring traffic, purchases, and registrations. Partner-focused analytics help companies better understand who is using their APIs and via which partner channel they are accessing it, informing an appropriate response. For example, companies might segment audiences by top developers and applications, or they might analyze usage by API method. Operational analytics and reporting tools give visibility into the API platform to improve efficiency. Customers can use such tools to troubleshoot problems, improve or maintain service quality, measure latency, analyze load statistics, monitor transaction data and traffic flow, or identify underlying API problems.

Traffic control. For companies that maintain their API platform in house, traffic control is important to protect back-end systems from overload. API traffic control tools can set platform-wide rate limits, set limits by other rules such as client or IP [Internet Protocol] address, or create tiered systems to allow priority customers to consume more API data. With API traffic control tools, companies can define and enforce levels of partner access to data consumption.

Performance and scalability. API management platforms address performance and scalability issues associated with API platform growth. They also can manage scalability issues and limit lag time and latency when a large number of developers, applications, devices, or end users concurrently use the APIs.

API optimization. Although the use of RESTful APIs is on the rise, sometimes companies must support other methods. Companies can help drive API adoption by offering APIs that use protocols the partner or developer prefers, and API management platforms provide protocol translators to streamline the process. They can optimize API content and format to fit the requirements of specific mobile platforms or devices, and then institute and enforce API version control.

Platform outsourcing. Companies can offload the entire API management task to external service providers via cloud-based services or global API networks. They can also tap these solution providers to take over API management when traffic must remain on the premises.

Table 2: Capabilities of API management platforms

Capabilities expected from all vendors	Capabilities available from leading vendors	Capabilities to expect in the future
Free developer tools and tutorials	Developer community portals—proactive community building through wikis and forums	Face-to-face or personalized developer outreach—for example, organized hackathons
Tools for developer access management and authorization	Analytical tools for usage trends, customer analysis, and brand awareness	API/business strategy analysis
Traffic control and management	External threat management	SOA governance aligned with API management for private enterprise APIs
Operational reporting tools	Performance/scalability protection	Data hosting, monetization, and management
Version control	API optimization	Data and API marketplaces
Protocol mediation/translation	Partner portals	
	On-premises and SaaS solution	

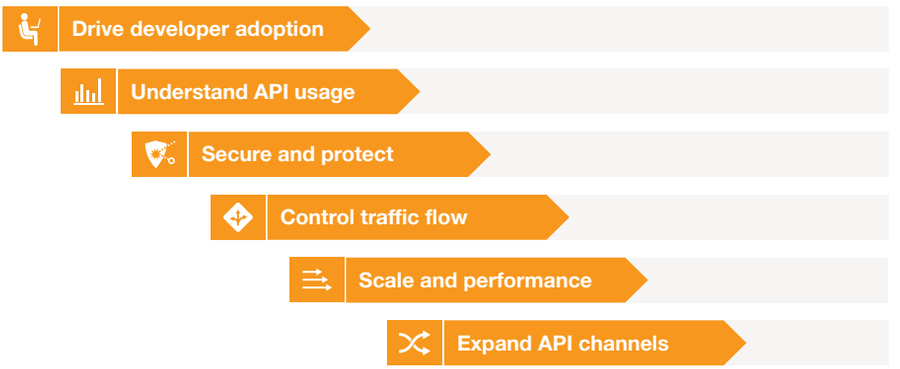
Table 2 shows the broader group of capabilities and how they are evolving.

Life cycle of API use

As discussed in the article, "Exploiting the growing value from information," on page 06, the adoption of RESTful APIs creates significant new opportunities for enterprises to transform internally to a digital operating model and to engage externally with the evolving digital ecosystems. Strategically, any API program will start by analyzing an enterprise's opportunities to take advantage of data and information assets, turning them into platforms, and facilitating their extension by internal or external developers. Once under way, the program must recognize that the use of APIs is like all other programs in that they will have a life cycle of their own. This API life cycle must be understood and managed, so ongoing changes and refinements can be made.

A typical life cycle of an API program moves from driving developer adoption to using APIs to expand channels, as illustrated in Figure 5. API management platforms provide support along the entire life cycle. One best practice is to treat APIs like products and staff them with the roles and infrastructure typically put in place for any other product. "It is important to keep the API stable, so it should be managed like a product that would be maintained, supported, and evolved with good change management practices," says Mark Noworolski, CTO of Streetline, a global provider of smart parking solutions.

Figure 5: Life cycle for adopting and benefiting from APIs



Source: Apigee

Table 3: A sampling of services that illustrate the use of sensors and smartphones to digitize activities

Company name	Activity	How it works	What is the digital transformation?
Fitbit	Health and personal care	This wireless device tracks calories burned, steps taken, distance traveled, and sleep quality and uploads reports to a website. A Wi-Fi–based smart scale tracks weight, body mass index (BMI), and percentage of body fat.	Digitizes fitness information and tracks activity continuously, and correlates with outcomes such as weight and BMI
Ginger.io	Healthcare	This mobile app collects data from a smartphone sensor and analyzes the data for subtle signals of behavior change that could signal changes in health status.	Digitizes health information, including psychosocial state, with automated and self-reported data
GreenGoose	Internet of Things	Users apply sensors to everyday things such as a toothbrush or garden rake. The company analyzes the data for behavior patterns. The data translates into points, which then can be used in games on the GreenGoose website.	Finds value in everyday activities through a sensor embedded in data collection and analysis
Jawbone	Health and personal care	A sensor embedded in a wristband measures physical activity and sleep patterns and sends data to the user's iPhone.	Records actions automatically; provides the ability for users to also self-report some information
SenseAware℠—powered by FedEx	Shipping and transportation	Multiple sensors in a package give near-real-time data such as location, temperature, light exposure, relative humidity, and barometric pressure about a particular shipment via integration with a collaborative web-based application.	Facilitates finer control of sensitive shipments by using sensor-driven data collection
Shopkick	Retail shopping	With this sensor-driven mobile commerce app, users collect "kick" rewards for walking into participating stores or for scanning product bar codes. Kicks can be redeemed for rewards.	Creates a digital record of customer shopping behavior in a brick-and-mortar store
Streetline	Public sector	The app uses sensors and a real-time parking data feed to collect and distribute real-time parking availability information to drivers via text and smartphone apps. The app also uses real-time data analytics to adjust meter and garage prices to reflect supply and demand.	Creates an entirely new field of data collection, as it would be prohibitively labor intensive to manually collect such data

The confluence of social, mobile, analytics, and cloud technologies is disrupting the business environment to an extent not seen since the early days of the Internet.

API opportunity in digital transformation

Thus far, this article has discussed APIs as a mechanism to link capabilities provided in distributed software components to RESTful web services in traditional computing environments. However, the use of APIs extends beyond that. "The homogeneous world of PCs, Macs, or web browsers is transitioning to a heterogeneous world where almost anything can have an IP address and be open to collaboration," says Ramji of Apigee. Coordination across such a diverse and pervasive system requires an easy mechanism to connect and communicate. "That is why APIs are important. They provide such a mechanism in a digital ecosystem," Ramji continues.

Ramji is referring to what is called the *Internet of Things* (IoT), a term first used by Kevin Ashton in 1999, referring to the growing tendency to build inanimate objects that have the capability to generate digital information without human intermediation.

IoT is seeding an analog-to-digital transformation of everyday activities by making a greater portion of a person's environment more digital. Today it is becoming possible to capture information from data points as diverse as a toothbrush, home appliances, a thermostat, a car, or a home. Every object can be equipped with sensors that digitize the information about the object's state, location, and other relevant data.

APIs then make it possible to access and monitor that data in a standard way. Companies such as Cosm and ThingSpeak provide open source platforms for real-time access, for the sharing and manipulation of information, and for the development of applications that take advantage of IoT. Typical applications automate the everyday environment, such as turning off the HVAC system or lights when a person leaves the home. Applications are also used in enterprise contexts. For example, FedEx SenseAware collects a wide range of information as a shipment moves from its origin to delivery.

While IoT may focus on inanimate objects, the growing use of smartphones and the role they can play in collecting data from sensors creates opportunities to further digitize human actions without active attention from the individual. (See Table 3.) For example, UP from Jawbone uses an iPhone app and a sensor embedded in a wristband to track meals, physical activity, and sleep patterns to later display it to the user to promote healthy habits. Smartphones today have sensors for location, acceleration, orientation, and so on. Many services that collect, link, and analyze this new data are emerging; Table 3 lists a sample of them.

Conclusion

The confluence of social, mobile, analytics, and cloud (SMAC) technologies is disrupting the business environment to an extent not seen since the early days of the Internet. SMAC represents a pace and degree of change that is overwhelming to the current IT approach of owning the end-to-end experience. Today's methods do not scale to address the challenges that SMAC presents: too many variations in use cases and too many endpoints. In addition to understanding and having strategies for these individual SMAC technologies, enterprises should look at abstractions that bring together these technologies where they intersect.

RESTful APIs and API management platforms are just such an abstraction and should be added to the existing integration toolkit. The best way to manage the upcoming challenges stemming from the confluence of SMAC is to use emerging IT tools around RESTful APIs. Combining these tools presents a model where central IT provides a platform for participation with the digital ecosystem. "In the future, the way to increase the barrier to competition will be to lower the barrier to participation," suggests Biondi of Mashery.

The collective impact of these technologies makes the pursuit of a permeable enterprise an imperative. With the rise of RESTful APIs and API management platforms comes the opportunity for enterprises to extend and deepen their digital footprint by making it possible to easily access and combine data from many more sources than previously possible.

The digital indirect channel

Sam Ramji of Apigee explains why APIs are of strategic importance to all businesses.

Interview conducted by Vinod Baya and Ted Shelton

Sam Ramji

Sam Ramji is vice president of strategy at Apigee. Prior to Apigee, Ramji led open source strategy across Microsoft. He was a founding member of BEA's AquaLogic product team. He also led the Ofoto engineering team through its acquisition by Kodak. He holds positions on the boards of the Outercurve Foundation for open source and the Open Cloud Initiative, and he is a contributing editor to the ACM's journal *Ubiquity.*

PwC: APIs [application programming interfaces] are something the software industry has known and used since their inception. Why are they more important now?

SR: A key challenge to business always has been how to build bigger and bigger systems of coordination, because the bigger the system, the greater the power and the more things it can do. This led me to be interested in distributed computing. What is well known is that to create distributed intelligence, one needs to collaborate. Over the years, the barrier to collaboration has decreased dramatically with Internet and digital technologies, which is a significant change. More recently is this Cambrian explosion of devices. It's not just a mobile device, but it's a TV, a car, or an appliance, and almost anything when you look at what is being called the Internet of Things. Industry estimates forecast 15 billion mobile Internet-connected devices by 2015 and orders of magnitude more non-mobile Internet-connected devices.

Another change is that the homogeneous world of PCs, Macs, or web browsers is transitioning to a heterogeneous world where almost anything can have an IP address and be open to collaboration. How will such a large system be coordinated? To collaborate, they all need an easy mechanism to connect and communicate. That is why APIs are important. They provide such a mechanism in a digital ecosystem.

The winners in the current digital indirect platform era are those who can take the interaction costs to zero.

PwC: Why is that important to business?
SR: What is happening is that we have started to expand the software supply chain. Today, a third party—sometimes multiple third parties—is involved in getting your signal all the way to the edge where the customer is. If you want to get your signal to an end consumer who is using an Android tablet, you'll need to expose digital signals from your business in a way that a third party with the expertise in designing a really satisfying experience for that market niche can include your signal.

When we step back to see what the big revolution is, we see that APIs are the first serious digital indirect channel. Although physical indirect channels have supported businesses for a long time, the equivalent in the digital domain has been unclear so far.

PwC: How is this different from the web so far?
SR: The winners in the current digital indirect platform era are those who can take the interaction costs to zero. Interaction costs became much lower with the web, but the reason they were low is because a very smart actor—a human—was on the far side of the browser.

Humans are adaptable, and that created a couple of issues. For example, if for competitive reasons the marketing department changed the website interface—the way you engaged with the customer—that was OK, because the customer would adapt. In this digital indirect world, the actor at the other end is not that smart. It's a piece of software, it can be brittle, it's as it was written. Now if you change the interface, you break the software, which raises the need for companies to manage the interfaces—the APIs.

PwC: The focus on the developer community seems different from before. Why is that?
SR: One impact of the proliferation of devices is that it results in so many use cases that enterprise developers can't possibly build fast enough to keep up with the demands of businesses and consumers. It helps to look at the numbers. Today there are about half a million enterprise developers. With modern-day methods based on RESTful [representational state transfer] and JSON [JavaScript Object Notation] interfaces that are easy to use, loosely coupled, and coarsely grained, there is an addressable audience of about 5 million developers.

When you get a step function like that—an order of magnitude shift in the number of developers who have the requisite skill and talent—you end up with outsize network effects, capable of meeting the demand created by the proliferation of devices and the Internet of Things.

"What is happening is that we have started to expand the software supply chain. Today, a third party—sometimes multiple third parties—is involved in getting your signal all the way to the edge where the customer is."

"The API game is about unlocking latent value in data and information assets by combining them with other internal or external assets."

All of this feeds back directly to the question, what is the economic basis? It is unlike the web, where 1 billion web-connected humans were mediated by half a million developers. In the future, probably 5 billion device-connected humans will be mediated by about 5 million developers. The value of each developer just went up by a factor of 20 to 50, and those developers are able to build many apps in their lifetime.

PwC: Much of REST and JSON adoption seems to be among digital-native and Internet businesses. What is the relevance to non-digital-native businesses?
SR: The API game is about unlocking latent value in data and information assets by combining them with other internal or external assets. The winners in the API game overall are going to be the smartest legacy businesses, because they have an unfair advantage of decades of transaction data as well as other information and data assets. They may have only a decade that's worthwhile, but they have that. In this market, if companies can overcome their organizational inertia, incumbents actually have every opportunity to be the big winners in each industry with APIs.

PwC: What is the impact on the software engineering practices of organizations that need to adopt and offer their capabilities via RESTful APIs?
SR: Since APIs really promote co-creation dynamics, where you create new value directly or indirectly with third parties, the engineering and R&D burden is shared with the digital supply chain. For instance, Netflix uses APIs to get its services quickly on all the devices from which you are able to access them. The company did not need to perform all the R&D to learn how to build the software for each of those different devices. Instead, Netflix said, "Here are our APIs, here are the metadata APIs where people can log in and discover content, here is the Netflix-branded partner-restricted media, and here is the codec to do license management." Netflix was in the role of being QA; no engineering required.

So API use shifts not just the cost but it also changes the agility, because the ecosystem has changed from a vertically integrated monolithic business concept to a distributed business where winners and losers can establish themselves in the market without you over-investing in any single one.

PwC: How do trends we have talked about impact the IT organization of any enterprise?
SR: There is clearly an impact at the edge of the IT organization. The web taught business self-service. By making information and transactions open and accessible, businesses found that customers could serve themselves.

The next level of self-service is self-service on the data, both for internal and external use. It is about opening data. For example, let's say a marketing professional has $150,000 at the end of the quarter and gets an ad agency to build a mobile app to influence the competitive dynamics in the marketplace. How will they enable it to get access to corporate data and transactions? How can they do anything with it if access to corporate data is not easy? How long will it take? When an IT

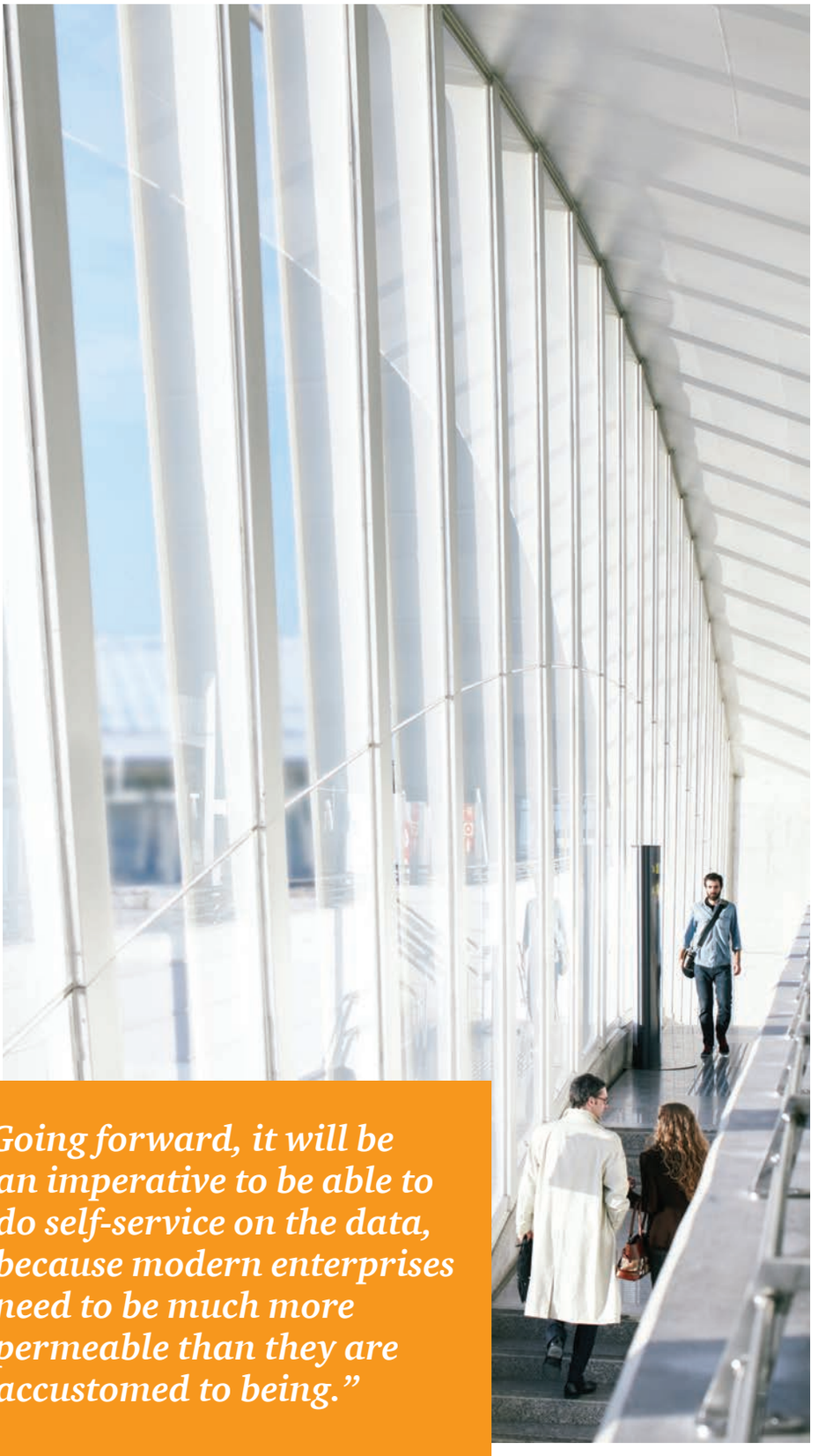
department is closed and its whole focus is on securing and locking everything, then that opportunity doesn't exist.

Going forward, it will be an imperative to be able to do self-service on the data, because modern enterprises need to be much more permeable than they are accustomed to being. Protecting the data appropriately is essential while allowing self-service. So IT will increasingly focus on security, availability, and reliability. IT organizations must get away from feeling like they are responsible for building all the things the business wants and instead enable the organization to be agile by providing self-service on data.

PwC: What should CIOs of enterprises do to take advantage of APIs?

SR: The real opportunity for CIOs is to develop the strategy for how the enterprise participates in the digital indirect channel. The fact that they're a CIO at a major enterprise means they already understand and have the capability to conduct channel-based business. They need to get the channel leadership, marketing leadership, and technology leaders in one room and say, "We have a new channel."

The new channel is a capability, usually an app, built by third-party developers. Understand the channel, segment it, and figure out which segment points most effectively to the markets most strategic or the most under threat. Together develop an ecosystem model that can be supported with a technology and business platform. It's a strategy for a new channel.



"Going forward, it will be an imperative to be able to do self-service on the data, because modern enterprises need to be much more permeable than they are accustomed to being."

Getting into the customer's context

Devon Biondi of Mashery details how APIs allow businesses to engage with customers in their context.

Interview conducted by Vinod Baya and Bo Parker

Devon Biondi

Devon Biondi is vice president of strategy services at Mashery. She helps e-commerce, media, and technology companies align their API programs with broader business strategies. Prior to Mashery, Biondi served as executive strategist to the CEO at Tibco Software.

PwC: Devon, what are some of the trends you're seeing?
DB: An important trend is how ubiquitous connectivity is becoming. The latest research suggests that 30 countries now have 100 percent ubiquitous connectivity; that is, there's at least more than one Internet connection at any given time for every person in that country. And more countries are following. We're certainly far from the days where you had to wait to get to your hotel room and plug in to the connection; now you're just connected everywhere.

Related to this trend is the diversity of devices, which is driving the requirements for significantly faster development of digital services. Previously, companies had a corporate mandate that they would support PCs and a brand of smartphones, but now in almost all enterprise environments, IT departments need to support non-sanctioned devices.

PwC: Why is that important to business?
DB: If you look at the history of business, the competitive dynamics have been changing. James Governor of RedMonk has said, "20th-century IT was about raising barriers to entry for competitors. 21st-century IT is about lowering barriers to participation." In the future, the way to increase the barrier to competition will be to lower the barrier to participation. Digital data and digital interactions are becoming the next fertile ground for competing, creating, and growing companies. This impacts all companies, whether they are digital or not.

"In the future, the way to increase the barrier to competition will be to lower the barrier to participation."

PwC: Mashery offers API [application programming interface] management solutions. Why are APIs important to businesses now?
DB: I think it helps to understand the analogy of APIs to the evolution of the distribution of hard goods. One hundred years ago, if you were a manufacturer, you probably also had a store and a relationship with the customer, and that was the way you sold goods. Over time, new channels developed and intermediation happened. Then manufacturers could distribute their goods through their own stores, through co-branded experiences inside another store, or through third-party retail stores.

Today, apps [as on mobile devices and tablets] are creating a new role in between the business and customer. There always have been new channels in between the business and the customer, and now apps are the new ones. Some of those apps will be built by you, some of those apps will be built by your strategic partners, and some of those apps will be built by people you have no relationship with at all.

The API is a recognition of the reality that there are just too many niches and too many ways that customers need to be served. No business will be able to do all of the scenarios. In a digital world, an API is your interface to enable other distributors.

PwC: How are APIs impacting customer relationships?
DB: Previously, the interaction between companies and customers almost always took place in the context of the business—in the store, at the website, or in the service. Now the customer is taking control of the context, and the business must get into that context.

In fact, customers are creating new context. For example, Best Buy is one of the point redemption partners for the Citi rewards program through Citibank. If I'm standing in Best Buy, which is part of my context, and I scan the bar code of a product, the app will tell me how many Citi rewards points I need to buy that product. Since I am a Citi rewards member, it is looking up my Citi rewards account and letting me know if I have enough.

Because Best Buy had an API to its catalog, it was easy for Citibank to just link to it and be in the in-store shopping context. Also, from the Citibank rewards website, customers can look up the inventory at the Best Buy store near them without going to the physical store—all through the API. By exposing APIs, Best Buy gets into the customer's context in other experiences.

Reduction in call volume that Bluefly experienced by integrating order status information to an IVR system using RESTful API integration.

PwC: How has integration changed?

DB: One of our customers tells us that they are being forced to create compelling user experiences that must be drawn on assets and services across many groups in their company. In the past, these types of integrations took six to eight months. The integrations were custom and rarely reusable later. They essentially performed a project specification and then the integration. Then they would perform the next project specification, and so on. That is six to eight months every time. That approach doesn't scale, and the reality is that businesses fall behind on integrations.

Another difference is that everything was a heavy integration. If there was a seemingly small need, the cost of integration could not be justified. For example, one of our customers, Bluefly, an e-commerce discount store, has an API program. For a long time the company saw that its call centers needed to answer a lot of questions about order status, because customers had no way to get updates on their orders. Bluefly built an API for order status so it could be called by the company's IVR [interactive voice response] system, and Bluefly cut its call volume by 20 percent overnight. It would have been difficult for Bluefly to justify a multi-month project, but a lightweight approach addressed the need squarely.

Statistics we have collected suggest that using APIs reduces the development time by 50 to 75 percent or more. What previously took six to eight months to integrate can now require hours or days.

PwC: What are some adoption patterns you have seen with APIs?

DB: We see a wide spectrum of adoption patterns. Some companies have remnants of APIs from prior efforts, because certain things are close to being exposed and they just aren't documented. Technically they are APIs, and the company just needs to clean things up. So they can reuse past efforts and refresh them with new methods.

Companies can have big API initiatives or they can start as seeds based on a particular application. One of our customers, *USA Today,* came to us when the iPad was to be released. The publication wanted its content on the device when it was launched. *USA Today* didn't have the necessary capabilities and identified a development firm to help.

The mobile team needed to get motivated and run really quickly. To provide access to its assets and capabilities, *USA Today* exposed a few APIs to this development firm. The result was that the publication's content was then on the iPad when it launched. The *USA Today* app became the No. 1 news app from the beginning, and the publication's overall digital presence, its Alexa ranking,[1] went from 40 to 19 over time.

1 Alexa Internet (www.alexa.com), a subsidiary of Amazon.com, provides traffic data, global rankings, and other information on thousands of websites.

"The best designed APIs are designed for a public audience, even though the most value in terms of consumption will be with strategic partners. You want to design with the broadest audience in mind so you can still get value among the long tail of developers."

"Another best practice is to look at APIs as products and at your own developers, your strategic partners, and long tail developers as customers."

Use of APIs started with an iPad project, and now all the publication's mobile efforts are being driven by APIs because the organization has seen how it can develop quickly with APIs. Also, APIs do not need to be public at first. For *USA Today,* it started as a small project for an internal use case, and now the organization has since released a number of public APIs.

PwC: Are customers changing their development practices?
DB: A key change is that those who are actually building the end-user experience will first ask, where's the API? Developers are increasingly expecting APIs in more and more places.

Also, we see that the API culture spreads gradually and virally. Someone doesn't need to start with aligning a lot of people to the API way of doing things. In many cases, two or three people decided to expose a private API on a few methods to one development partner. Once this was in place, they realized they could expose it to the next development, and then it spread from there.

PwC: What are some best practices in using APIs that you are learning?
DB: The best designed APIs are designed for a public audience, even though the most value in terms of consumption will be with strategic partners. You want to design with the broadest audience in mind so you can still get value among the long tail of developers.

Another best practice is to look at APIs as products and at your own developers, your strategic partners, and long tail developers as customers. So companies don't just release an API; they release a product line of APIs with different methods, access controls, service level agreements, terms of use, and so on that addresses the varying needs of this customer base.

PwC: Many companies fear opening up capabilities. How should they handle the risk?
DB: I too hear many times from clients, "There's no way I'll let my brand be exposed in that way." My view is that all companies are already open to some extent; some of their data is already out there. Someone can scrape their website for publicly available data, and there is a lot there. On a website, a lot of people are getting data through means that are not doing a service to your company. However, if you expose it as you would with an API program, with terms of service and controls on ways of use, you can start to build much healthier relationships. There is mitigation of some risk in being proactive and exposing information assets with appropriate terms and controls.

Embracing open IT: Enabling the permeable enterprise

By positioning IT capabilities as a platform composed of open, self-describing, modular services with reliable interfaces, CIOs can enable the permeable enterprise and create new strategic options in digital ecosystems.

By Bud Mathaisel, Patrick Shankland, and Vinod Baya

If CIOs are going to be successful in the new world of social, mobile, analytics, and cloud (SMAC) trends, they need to think differently. Legacy ways do not scale well to the possibilities of digital ecosystems. To increase the speed of development and co-create their futures with internal and external third parties, CIOs need to adopt a new mantra: go open. This co-creation mandates a new open platform enabled through application programming interfaces (APIs), especially representational state transfer (RESTful) APIs. More than a technology purchase, "go open" is an architectural transformation necessary to create and participate in digital ecosystems and to enable permeable enterprises. (See the article, "Exploiting the growing value from information," on page 06.)

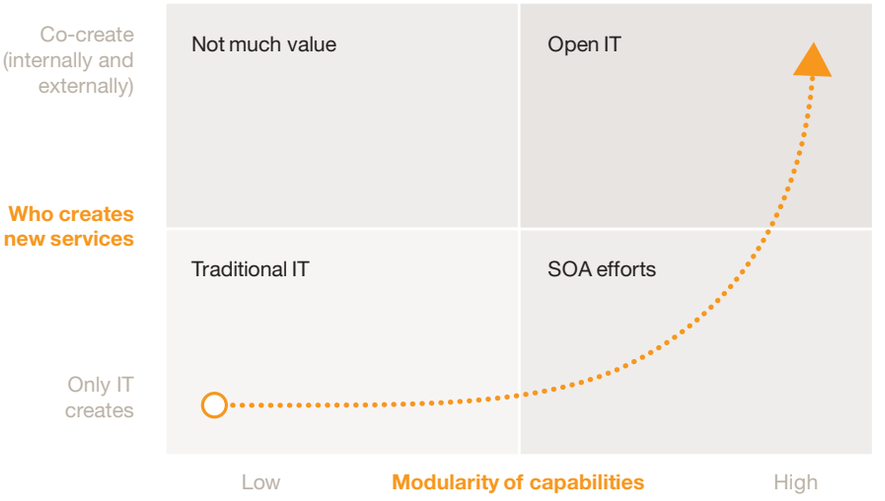
As business ecosystems become more digital, the value drivers increasingly come from the information (bits) augmenting the physical product or service (atoms) it represents. By engaging with emerging digital ecosystems, CIOs are tapping into these value drivers, seeding a digital operating model and creating new strategic options for their organizations.

RESTful APIs are the catalytic enablers for the open digital ecosystem. They are the self-describing interfaces and data packages organized in business-relevant and logical hierarchies, accessible via HTTP.[1] They define the idea of open, accessible, self-service interfaces, which are also important for engaging with the consumerization of IT trends. By making an organization more permeable, RESTful APIs establish a universal shared architecture and collaboration model for linking software and systems as networks, bringing the benefits of Metcalfe's Law[2] to software components.

1 HyperText Transport Protocol

2 Although initially defined in relation to telecommunications networks, Metcalfe's Law today applies to all networks and states that the value of a network is proportional to the square of the number of nodes in the network. See more details at http://en.wikipedia.org/wiki/Metcalfe's_law.

Figure 1: Open IT builds on prior or ongoing SOA efforts and reorganizes IT capabilities in modular chunks to allow co-creation with internal and external partners.



"Statistics we have collected suggest that using [RESTful] APIs reduces development time by 50 to 75 percent."

—Devon Biondi, Mashery

IT can take a quantum step to deliver on the promised value of information for both internal and external users. The key to delivering this value is RESTful APIs, which provide the technical underpinnings for loose coupling as detailed in the article, "Consumerization of APIs," on page 34. Without this loose coupling, the complex interdependencies of traditional systems integration generally lead to steep learning curves for programmers, less reliable software components, the possibility of very long development times, and user frustration over what is delivered. RESTful APIs are the major ingredients that have made the new digital ecosystem possible over the past five years. "It's a confluence of many things," says John Donovan, senior executive vice president of technology and network operations at AT&T. "It's the quality of the APIs; it's the skill set of the API developers; it's the evolution of the JavaScript; it's the evolution of how code is developed."

The time is right to take advantage of this confluence.

The open IT transformation

Open IT delivers information services that internal and external audiences build on rather than passively accept as the endpoint in an information supply chain. It requires a change from delivering and maintaining full, end-to-end applications to delivering a platform with modular capabilities expressed as reliable interfaces. (See Figure 1.) This change is now possible due to the sharply lower cost and complexity of integration during the development of new capabilities. "Statistics we have collected suggest that using [RESTful] APIs reduces development time by 50 to 75 percent. What used to take six to eight months to integrate now requires hours or days," says Devon Biondi, vice president of strategy services at Mashery, an API management vendor.

The combination of self-describing interfaces (RESTful APIs), identifiers (Uniform Resource Identifiers [URIs]),[3] and standard access methods (HTTP) helps mitigate the long lead times for development and high costs created by

3 In computing, a Uniform Resource Identifier (URI) is a string of characters used to identify a name or a resource. See Wikipedia: http://en.wikipedia.org/wiki/URI

tightly coupled, proprietary integration methods. AT&T, for instance, now exposes a growing catalog of RESTful APIs—such as billing, subscriber profiles, device characteristics, and messaging—that cut the time developers require to deploy their applications on AT&T's network from months to days.

IT organizations typically have long lists of projects proposed by internal customers—lists that seem to grow longer over time. SMAC trends are likely to exacerbate this issue, leaving business units even more frustrated. "When they take a request to IT, the answer is often 'no'," says Brian Katz, head of mobility industrialization and engineering at Sanofi, a global diversified healthcare leader. Such dynamics prevail where the IT function continues to operate as the sole provider of end-to-end application functionality. However, the world outside IT has changed. "A lot of employees today are savvier with IT, as they have grown up with the Internet and associated technologies and services. They want to be able to get their work done and have the capability to build or procure IT services," Katz says.

The central IT function is clearly responsible for delivering core systems and services. The distribution of responsibilities is shifting, however. "We in IT don't have to do all the coding anymore," says David Zanca, senior vice president of IT, customer access, and revenue systems at FedEx Services. "The key role for my group is to be the owner, producer, and platform of the services." With a RESTful-inspired architecture, IT can deliver robust and reliable interfaces against the core systems. Business unit leaders and their business-unit IT staff can take advantage of these interfaces by combining them with self-generated or sourced functionality to create new capabilities. Through this co-creation process, marketing, sales, and other internal groups can become full partners with the IT organization.

CIOs must make these investments. "If the CIO's team doesn't understand this market and is waiting for technologies to mature or standards to emerge, competitors are going to eat your lunch by being more nimble," warns John Musser, founder of ProgrammableWeb.

The good news is that the broad outlines of how to open IT are amply demonstrated on the consumer web, and enterprise-class tools and supportive infrastructure are becoming available. "CIOs historically haven't had the toolkit to provide open services," says Sam Ramji, vice president of strategy at Apigee, provider of an API management platform. API management solutions allow enterprises to take their existing IT assets and turn them into platforms that bring the enterprise into the digital ecosystem.

API interfaces: A new boundary to link IT with business

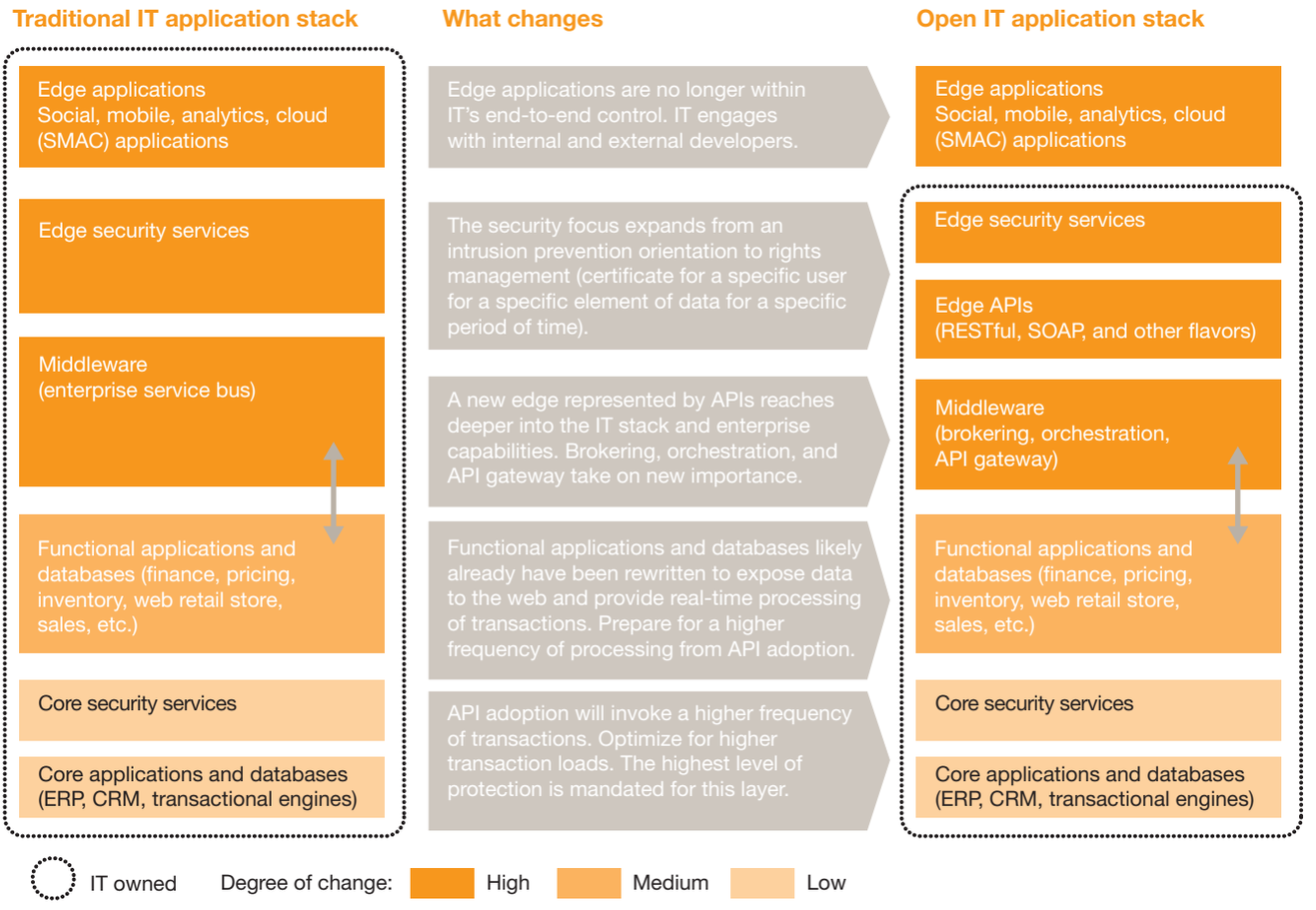
At many enterprises, a typical IT stack for applications might look like the example in Figure 2, composed of three layers. The core, enterprise resource planning (ERP), and other large enterprise-wide applications and associated data warehouses remain the foundation, and they are the source and repository for data for transactions. These data are the most precious enterprise assets. The middle layer contains the functional applications that use these data assets and support functions, such as pricing, inventory, finance, web retail store, and others. The third layer is at the edge, closer to engagement with employees and customers, and builds on the other two layers to provide role-specific solutions such as collaboration, reporting, and so on.

In traditional end-to-end ownership of IT, the information flows from the core systems to the edge applications accessed by employees and customers. The flow could be mediated by middleware, proprietary or internal

"A lot of employees today are savvier with IT, as they have grown up with the Internet and associated technologies and services. They want to be able to get their work done and have the capability to build or procure IT services."

—Brian Katz, Sanofi

Figure 2: The IT application stack in traditional IT and open IT and highlights of some of the changes necessary



APIs, service-oriented architecture (SOA) efforts, or other mechanisms. But central IT maintains full control and responsibility for the full stack from the core to the edge. In contrast, in open IT, the information flows between the core systems and the RESTful APIs and open APIs. These APIs, which represent a new edge or boundary, expose the capabilities across the IT stack of the enterprise and the related information assets as services, becoming the building block for new services. Central IT does not have responsibility for the end-user application at the edge, but has the responsibility to support the level of traffic and the service level agreement that API usage might entail. Figure 2 also highlights other key changes in each of the layers when transitioning from a traditional stack to an open IT stack.

RESTful APIs enhance the commercial value of enterprise data and information assets in a digital ecosystem. These interfaces even make it easier to organize IT in a manner synergistic with business, a challenge IT has faced all along. Streetline, for example, defines business requirements and API logic together as the company builds out its digital ecosystem for parking operations. "There are APIs for each use case: a parking status API, a meter payment API, a payment status API, and so on," says Peter Leiser, vice president of engineering, platforms, and applications at Streetline, a global provider of smart parking solutions.

Reorganizing and energizing the IT function for open IT is a key to the digital future. To realize the full potential of a digital operating model, there are four leadership opportunities for the CIO:

- Embrace a new architecture.
- Address a new audience: internal and external developers.
- Overcome new challenges from openness.
- Upgrade organizational skills.

A new architecture

A good layered IT architecture—distributed, client/server, object-oriented—has been important for more than 30 years, but not until today, with the emergence of web-based services and consumerization of IT, have enterprises had such a compelling reason to revisit their IT architecture.

Open IT, based on RESTful APIs, will require changes inspired by platform thinking and loosely coupled, self-describing, modular capabilities. "At the highest level, this is an architectural change. You need to architect your platform and environment for co-creation and treat APIs as products that you publish and maintain for long periods of time," advises Zanca of FedEx. The goal is an architecture designed for compatibility with emerging digital ecosystems. One characteristic of RESTful APIs consistent with this architecture is their readiness for a pull-centric world, where users invoke existing services and create new services, versus the traditional notion of IT pushing services.

Traditional architectures are optimized for batch calls against the core, usually high-volume electronic data interchange (EDI) or Extensible Markup Language (XML) format interchanges. This requirement is unlikely to change in the digital ecosystem. What will change is access calls through APIs that will put additional stress on the core. The new architecture should harden the core while providing more permeable binding for API requests.

Also influencing this architectural change is a higher pace of new application adoption in the enterprise caused by SMAC technologies. This adoption cycle lies in stark contrast to how fast core systems can or should be changed. An architecture that takes the core capabilities and makes them into platforms with modular interfaces

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>
> —David Zanca, FedEx Services

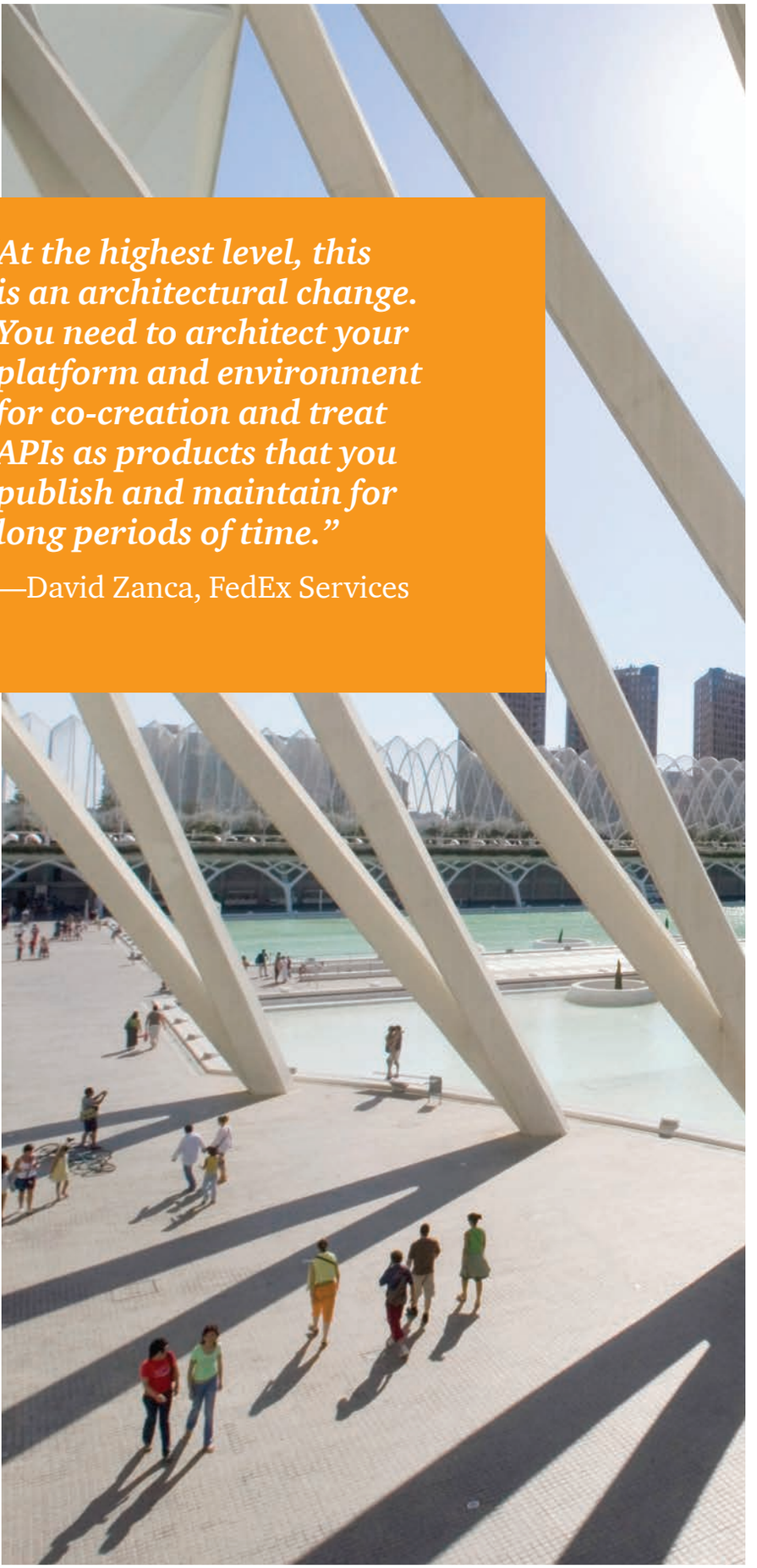
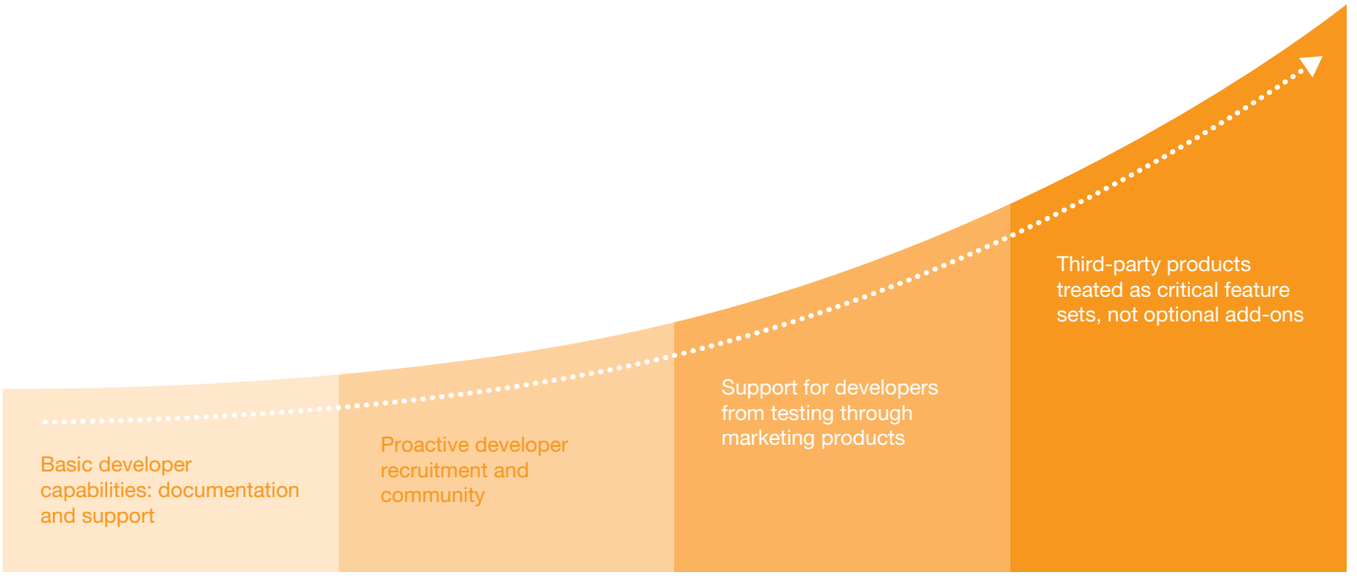


Figure 3: Stages of maturity in developing an internal- or external-facing developer program



allows a faster pace of application evolution at the edge. AT&T organized its API program to match this pace. "It is an architectural choice one makes for speed," says Donovan, explaining why AT&T created an API program.

In addition to publishing services for others to consume, most enterprises will also consume external services to enable their business. Also, all major enterprises do operate a large pool of vendor-bought solutions. The CIO organization therefore will become an orchestrator of services—across vendor capabilities, published services, and consumed services—a role that the new architecture will need to acknowledge and enable.

The growing number of devices used by employees and customers to access enterprise IT is also a consideration in the new architecture. "We also have a continuously connected strategy where we create a thin layer of services, which are independent of end-user devices and use cases," describes Zanca. FedEx created this thin layer of customer experience services on top of its enterprise services to expose them as RESTful web services.

An API-friendly architecture shift also has implications for IT security at two general levels. Security for the core is intrusion prevention oriented, and it may also be optimized around batch movement of data. Security in support of an API strategy is both intrusion prevention oriented and rights managed—a certificate issued to a specific user for a specific data element for a specific period of time.

New channel, new audience

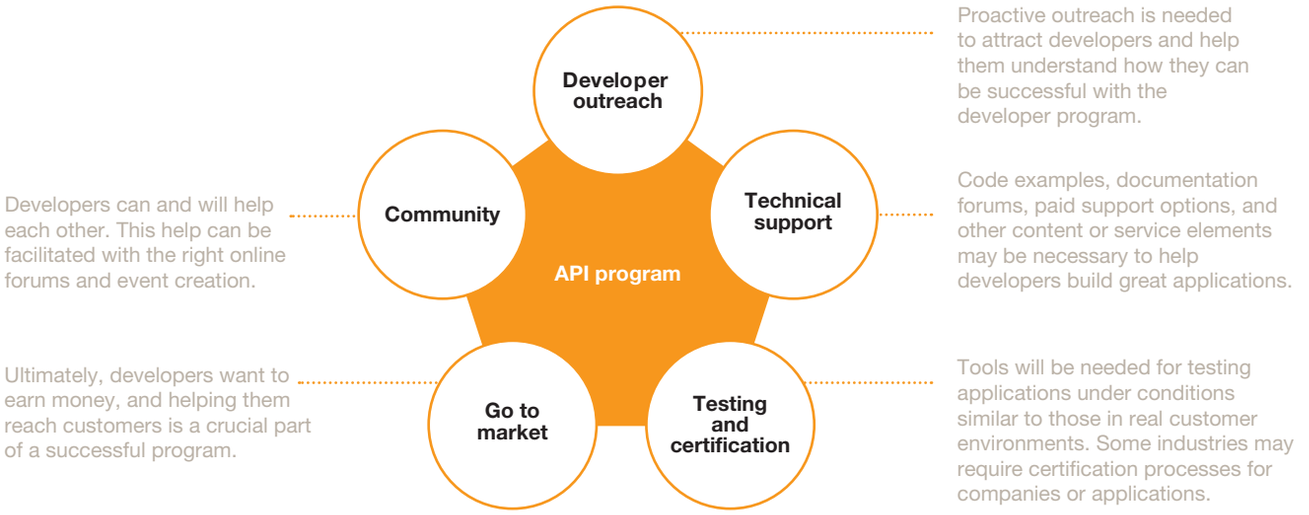
Open IT positions enterprise IT assets to engage with the digital ecosystem internally and externally. For many IT groups, this engagement will require a new competency—to work with a developer community outside the IT organization. With published APIs, third parties are encouraged to, and will, develop capabilities that will benefit the enterprise and the third parties. "The real opportunity for CIOs is to develop the strategy for how the enterprise participates in the digital indirect channel," says Ramji. For Ramji, the digital indirect channel is what APIs make possible by giving access to a large and growing pool of internal and external developers.

"[CIOs] need to get the channel leader, marketing leaders, and technology leaders in one room and say, 'We have a new channel,'" Ramji adds.

To expedite the adoption of open platforms, some IT organizations establish a developers' resource center or an API program by productizing the chosen capabilities and features as modular services with stable interfaces. Although AT&T has had a developer program for years, the company has accelerated its use of RESTful interfaces and related open architecture during the past two years. This transition allows AT&T and the developers to surface new opportunities to monetize AT&T's network assets. The intent is to make all of the network capabilities addressable by enterprise or commercial developers. "Where do you put APIs? You literally put them everywhere. That's how you do internal development; that's how the IT shop works; that's how your outsourcer does development for you; that's how you build services," suggests Donovan.

Such an undertaking is akin to shifting the role of the CIO to be more like the CEO of a software product company, one that provides the APIs and software

Figure 4: A successful developer program has many elements to achieve market objectives.



as part of a proprietary package for customers and developers. "When I talk about the priorities in my digital access group, one of them is to think and act the way a best-in-class software company would," says Thomas Wicinski, vice president of digital access marketing for FedEx Services. In addition to procuring and implementing vendor solutions, CIOs also need to design and architect a platform and interfaces that remain reliable over generations of use.

As an IT organization works to empower external developers, it may follow a maturity path as illustrated in Figure 3. The journey starts with exposing some basic capabilities and associated documentation. As a company matures, it will attract more developers and make more comprehensive capabilities available, creating a partnership-oriented business model. "We're getting faster, and one result is that the architecture is shifting to allow more partnerships," says AT&T's Donovan. AT&T today exposes APIs for location, messaging, speech, device capabilities, and billing, and many other APIs are in the future road map.

Successful developer programs include numerous elements that complement each other to achieve market objectives. (See Figure 4.) As they develop their programs, organizations will analyze and consider many features, such as program fees, API access fees, and developer or app certification in their go-to-market strategies. They will gauge success by analyzing measures such as the number of engaged developers (internal or external), the quality and quantity of third-party applications, the volume of API calls, end-customer engagement, and monetization of the service. Measures also extend to internal activities. "Another measure [for the API program] that we're using is how many new APIs we are releasing as a cadence around our progress in opening up more of the network," shares Jacob Feinstein, executive director of new technology at AT&T.

Addressing API adoption challenges

While the RESTful API programming model and integration architecture are fairly well established and scalable to accommodate large enterprise services, most enterprise IT organizations have little experience with them. Moreover, APIs span a wide range of past and present technologies, as detailed in the article, "Consumerization of APIs," on page 34. Going forward, enterprises need to evolve approaches for consuming and offering RESTful APIs that address several challenges.

Challenges in consuming APIs:

- ***Diverse API technologies—*** Although an enterprise may prefer RESTful APIs, API architectures, protocols, and interfaces may vary across publishers of APIs. This diversity complicates the development of enterprise and mobile applications that serve or utilize services from multiple providers.

- ***Reliance on provider capabilities—***The quality of interfaces may be inconsistent, and they may have poor definitions regarding contracts and service schemas. Variations in quality of service and independent API versioning schedules across APIs can cause disruptions.

Table 1: Mitigation approach to the key challenges in consuming and providing RESTful APIs

Diverse API technologies: Reduce the complexity of using multiple services developed with varying technologies from providers.	• Loosely couple or hide the underlying API technologies of providers through an enterprise service interface or gateway to create a consistent service architecture, transport mechanism, and data encapsulation method as is the case with RESTful APIs.
Reliance on provider capabilities: Mitigate the impact of provider changes to service functionality and availability to applications.	• Expose the service to enterprise applications through generic internal contracts. • Divide API functionality into multiple granular services to reduce reliance on a single service. • Allow the orchestration layer to manage exceptions and maintain consistent error messaging.
Asset vulnerability: Reduce the risk of exposing internal assets while still taking advantage of third-party RESTful APIs.	• Encrypt messages sent to RESTful APIs and data that will be stored outside enterprise boundaries. • Centralize API keys and control access to allow API use by only authorized devices. • Encrypt traffic between client applications and the enterprise to secure the transmission of data.
Performance delivery: Accommodate the additional hops for RESTful API use while maintaining performance.	• Cache responses to reduce the time required for clients to complete round-trip vendor API requests. • Use enterprise resources for heavy processing and API mashups. • Preprocess API responses prior to client delivery to reduce the payload and processing required by the client.

"The real opportunity for CIOs is to develop the strategy for how the enterprise participates in the digital indirect channel."

—Sam Ramji, Apigee

Challenges in offering APIs:

- ***Asset vulnerability—***API adoption introduces enterprise assets to new vulnerabilities. Interaction with third-party providers exposes applications to message manipulation and injection attacks from external sources.
- ***Performance delivery—***The use of third-party functionality introduces additional hops and can increase the length of round-trip requests. Restricted capacity and processing performance limit devices' ability to efficiently develop, consume, and utilize large service messages.

As providers and consumers gain experience with RESTful APIs, some best practices for addressing these challenges are emerging. Table 1 organizes some of these methods.

Upgrading the IT organization for the digital ecosystem

Moving into the new digital ecosystem is an organizational challenge for the CIO. First, if the enterprise IT group (and outside service providers) historically has been optimized around the design, deployment, and operation of core systems, it is unlikely the organization has many of the new skills needed.

Second, the traditional structure of formal, separate organizations for development, infrastructure, security, and so forth are unlikely to enable the flexible invention that is the pulse of the digital ecosystem.

Third, the methodologies employed by most IT organizations, including capability maturity models, the IT Infrastructure Library (ITIL), and the methodologies that come with large

systems, such as ERP, are inconsistent with the fast development cycles needed to pioneer the new capabilities.

Recognizing such impediments, CIOs can use the digital ecosystem opportunity to perform a current state assessment of their organization's capabilities. This exercise will allow them to establish the future state organization design, skill sets, and methodologies for development and deployment. If IT wants to perform the role of a software company, much more emphasis must be placed on platform architecture, on technical openness, and on marketing, sales, packaging, and support than is normally the case.

The IT organization must assess its skills and tools in light of the new context. Many IT organizations have not updated their skills, especially in the economic downturn. One major constraint can be the lack of understanding about RESTful API capabilities. The CIO's team needs RESTful API literacy. "RESTful API ignorance is a risk that no CIO wants to be accused of a couple of years from now," says Musser.

Many job descriptions still feature experience with decades-old technology. Many IT organizations have outsourced custom development—perhaps all development—and have no insight into the details of the job skills contracted for. A move to open IT would be an opportunity to offer attractive career growth to staff who have the skills the organization needs to participate in a digital ecosystem.

The CIO needs to focus on building a web-, mobile-, and cloud-competent IT organization. To achieve such an organization, CIOs are separating web development and deployment teams from those that develop and deploy the core, placing them under leadership separate from the applications development organization. Some digital ecosystem CIOs are establishing incubator groups, centers of excellence for SMAC and/or RESTful development that sometimes are located off the main campus. These groups focus on building up a competency in a given area and acting as evangelists for the methods, tools, and so forth that will be used in the future. In addition, the members of these centers might begin to plan, execute, and gain experience building the future state architecture that has been laid out by the CIO. The great news is that many in the IT organization today are anxious to upgrade their skills, and they would welcome the opportunity to learn new skills and technologies. Additionally, the digital ecosystem job opportunities are what attract the people who have the skills needed for the evolving IT group.

Conclusion

Many CIOs are concerned about the chaos that could be caused by the accelerating disruptions associated with SMAC trends. For some, however, it's a blessing in disguise. These CIOs are learning to proactively engage with SMAC by adopting a digital operating model, powered by RESTful APIs and supported by API management platforms. In the process, they also open up new business opportunities for their enterprises in permeable digital ecosystems.

As SMAC trends accelerate, PwC expects that most enterprises will increasingly incorporate features of information (bits), even if they are still in a physical business (atoms) such as retail, distribution, manufacturing, and healthcare. To successfully navigate this transition, enterprise IT organizations must adopt many core competencies of software companies; in particular, they must create platforms the way that software companies do. Just as software companies build successful platforms, enterprise IT will build and manage APIs in a manner that opens up IT for the co-creation of new services internally and externally.

An open platform does not call for a frontier mind-set, where fragmented API generation replaces a carefully managed applications portfolio that CIOs strive to maintain. CIO leadership must keep a balance in this evolution and manage IT assets in new ways. The advice to CIOs is to approach the evolution in four dimensions: business need or purpose, an enterprise architecture for a digital operating model, developer community management, and gaps in organizational capabilities.

First, recognize the hidden potential created by unlocking the enterprise's information assets, and identify specifically which data would be exposed for what business purpose.

Second, devise the new architecture inspired by RESTful APIs and platform thinking. RESTful APIs are pull-centric, not the traditional push model. The new architecture hardens the core while thoughtfully exposing the valuable assets captured by the core—information—via RESTful API connections.

Third, approach the digital ecosystem opportunities by targeting an audience of developers who can create new business value based, in part, by extending your capabilities. You can start with existing mobile projects that can benefit most from APIs, and let the momentum build from there toward a platform and API program.

Fourth, use the digital ecosystem opportunity to upgrade your organizational structure and skills in the context of the inexorable shift toward a new operating model. Apply new leadership approaches to recruit and manage these new skills. Let the organization learn and develop around early trials. Partnering with outside experts is a valuable way to prime these internal capabilities.

Creating a platform

Laura Merling and John Musser of Alcatel-Lucent share how enterprises can use APIs to create platforms from existing assets to unlock new value.

Interview conducted by Vinod Baya, Bo Parker, and Christopher Isaac

Laura Merling

Laura Merling is senior vice president of the application enablement business unit at Alcatel-Lucent. She leads strategy and execution for Alcatel-Lucent's company-wide push to transform the network into a software platform. Merling's most recent experience has been as a strategist in transforming companies to API and cloud-driven businesses. Her more than 20-year career spans leadership roles in executive management, business development, and product management in the software and corporate IT sectors.

John Musser

John Musser is the founder of ProgrammableWeb, the online resource for mashups, APIs, and the web as platform. He is a Seattle-based technology consultant, writer, and teacher. During his 20-year career in software development, he has shipped five award-winning software products in three industries, working with companies that include Electronic Arts, Credit Suisse, MTV, and Bell Labs.

PwC: Laura, can you talk about your organization and the efforts that you are leading at Alcatel-Lucent?

LM: Sure. I lead the application enablement organization. The function of this organization is to drive the adoption of the network as a platform. If you could turn the network into a Facebook-like platform, how would you do that? This goal has a couple of dimensions: the API [application programming interface] dimension and the cloud dimension.

My group does all the software and technology development to expose capabilities of the network as APIs. The capabilities could range from the ability to select what cell you run on, to functionality to route calls or access information such as call history. We also provide mechanisms to manage the use of these APIs; we put controls and rate limits on these APIs, normalize the data, establish business rules—including related business models—on the data or service, and analyze the data related to the API itself. We are also tightly integrated with our cloud offering, CloudBand, to provide API management as an embedded service. CloudBand combines dynamic network availability with cross-cloud access.

PwC: Why is creating and offering APIs to others important now?

LM: In many ways, APIs are the building blocks of the digital economy. They make existing capabilities fungible, so that it is possible to use them in new ways, quickly and easily, thereby

"To fully capitalize on existing assets, other businesses must shift to platform-oriented business models that allow others to extend their capabilities in innovative ways by enabling new applications."

—Laura Merling

spurring innovation and new value creation. All carriers have extremely valuable assets that are effectively locked up in their own networks. Such assets include network capabilities, data about QoS [quality of service], subscriber profile information, and call control. These assets can be used to make existing services better or build completely new offerings, to drive incremental revenues, and to enhance a third party or an enterprise brand.

Leading telecom service providers are aggressively using these assets to build deep, broad value chains across previously unconnected market segments. For instance, Facebook recently announced a relationship with AT&T, Softbank, Mobile Corp., Telefonica, and others to provide in-application purchases using carrier payment services. We already have customers around the globe who have demanded that in the next two years, all of our products should have web-based services or RESTful [representational state transfer] APIs in and out of them. That request is not just for our software solutions but for the hardware solutions as well.

PwC: John, you have tracked the growth of APIs for years. APIs have been a part of computing as long as people have been connecting one piece of software with another. Why the new interest now?
JM: There are a couple of primary differentiators with APIs now. First, they are available and accessible over the public Internet. One of the previous methods, SOA [service-oriented architecture], generally was behind-the-firewall web services within a corporation—or sometimes across partners, but classic SOA is interdepartmental and within a single enterprise. The phenomena growing for the last few years is really about APIs being open and accessible to all over the public Internet as the Twitter, Facebook, or Google Maps APIs are.

Another differentiator is that an API is not an SDK [software development kit], which typically is at either an operating system level or a platform level, such as an ERP [enterprise resource planning] system or database. SDKs used a very traditional behind-the-firewall programmer interface into a layer of the software. The difference now is that the layer of software is a website. Typically over HTTP, you access a web service endpoint that belongs to another company. This is a lot easier to do.

RESTful interfaces create a level of simplicity that didn't exist previously, and simplicity always speeds things up, making integrations cost-effective. One of the challenges with SOA was that it was over-engineered for the complex case, which was only about 20 percent of the use cases. Owing to the complexity, it cannot adapt easily to 80 percent of the simpler cases. APIs today, using RESTful interfaces, make it possible to easily serve 80 percent of the most common use cases. At the same time, the goals of modularity, reuse, ease of integration, and flexibility apply to both approaches.

PwC: Is this largely a change about how you deliver the service or does it influence the business models in the industry?
LM: I see this as a disruptive change. You can view APIs as a toolkit to co-create value, so they have an impact on how value is distributed in an industry ecosystem. All providers need new ways of thinking about their businesses. Now it is possible to see network capabilities digitized and modularized, and therefore open to access and manipulation by programming code. The network becomes a platform for development. It becomes capable of serving exponentially more use cases. In emerging markets where greenfield LTE [Long Term Evolution] infrastructure is being installed, we see providers wanting their entire network to be API enabled out the door for a nationwide broadband network and differentiated value to the ecosystem.

PwC: Are these messages relevant to industries other than telecom providers?
LM: Absolutely. Broadly speaking, all major enterprises have underutilized assets; that is, the existing business models are not tapping into the full inherent value. For telecom service providers, networks are such assets that can create a lot more value if the providers open them up with APIs.

> *"[Internal and external] developers expect to use their time efficiently. The easier it is for them to tap into your assets, the more they focus on creating value-added capability and bringing it to market quickly."*
>
> —Laura Merling

Similarly, to fully capitalize on existing assets, other businesses must shift to platform-oriented business models that allow others to extend their capabilities in innovative ways by enabling new applications. This cannot be possible if tapping into the capabilities is expensive, time-consuming, or complex.

PwC: What should enterprises know about using APIs?
LM: One common misconception I see in how enterprises define ecosystems is targeting the long tail developers only. However, platforms that have used APIs successfully, such as Twitter or Facebook, have a small number of API users in the ecosystem that drive the bulk of their traffic. Twitter actually acquired the four top companies that were driving all its traffic. Businesses need to also look for B2B2C [business-to-business-to-consumer] opportunities that are real and can scale quickly.

JM: Indeed, the long tail of developers is an option but not a requirement. The requirement is that your audience for APIs could be anything from your own department by transforming your prior SOA efforts to something more systematic, cost-effective, and flexible. You don't need to bend over backward just to have an API; you need to think about that strategically. One of my favorite examples is eBay. Back in 1999 or 2000, eBay opened what really was the first API in this class of APIs. Of all the things eBay could have an API for, what do you think it did first? Most people think eBay had an API to search the auction marketplace. Not so. The company's first API was to add listings to the marketplace, because that was what was strategic. The winner in the auction universe would be the provider with the biggest marketplace, so to eBay, success meant the ability to grow that catalog as quickly as possible.

PwC: What should organizations know to start on this journey?
LM: Organizations need to establish a vision of the ecosystem that they will create or be a part of and what role they would play. This vision is dependent on the existing business model and the assets that organizations can tap to create new value. They also should look for opportunities where they can digitize existing processes, because those processes create the opportunities to expose APIs. Also, any organization that succeeds with an API has a vibrant developer ecosystem. There are many best practices on how to attract and foster a developer ecosystem, and organizations need to learn and adopt some of the best practices. It is important to understand that a developer isn't always the guy in the garage building the next Angry Birds.

We have done studies and learned a great deal about what makes a developer ecosystem—one that spans casual hobbyists to professionals in other large firms—tick. APIs have been with us for a long time, but in the past they always took a lot of time to use and make work. Now, thanks to emerging practices with RESTful interfaces, developers expect to use their time efficiently. The easier it is for them to tap into your assets, the more they focus on creating value-added capability and bringing it to market quickly.

PwC: Are there any guidelines for where CIOs can focus first?
JM: One easy way is to look at your existing portfolio: what's on the plate now, and how can any of those high-priority projects that are either in development or about to get under way benefit from an API? In today's marketplace, anything to do with mobile is a natural candidate. Who doesn't have a mobile strategy right now? Nobody. CIOs should take anything to do with mobile and make sure it is integrated with a platform strategy, because they're such a perfect and natural fit.

Also, CIOs should understand that using APIs is an architectural choice and not a technology choice. Organizations can build a platform using whatever their core technologies are. If they are a Java or Microsoft shop or something else, there's no need to change the core. The concepts are neutral regarding language and implementation platform. Organizations can use whatever stack the enterprise prefers and may have a mix of them as well.

PwC: Are there any risks to be aware of?
JM: For CIOs right now, it's more important to be API literate than to be API ignorant. In the future, you're not just going to produce APIs, you're going

to consume them. If you use a single cloud service, just one, your team needs API literacy, period. API ignorance is a risk that no CIO wants to be accused of a couple of years from now.

CIOs are going to need to know how to integrate services in the cloud. They'll need to understand how to deploy using APIs, because there will be some project that they must run on the VPN [virtual private network] version of AWS [Amazon Web Services]. If the CIO's team doesn't understand this market and it's waiting for things to settle down, good luck in your new job because it's not going to be here. Your competitors are going to eat your lunch by being more nimble and agile and not necessarily waiting for things to mature or standards to emerge.

PwC: Where do things stand with respect to the use of APIs internally or externally?
JM: Most of the action today is in external use, but I think it's going to be bigger inside the enterprise. I feel there's a much larger universe of private APIs and their usage than there is of public API usage. The two flavors of private API—for internal companies or for a company's partners—constitute the part of the iceberg that's under the water and the tip of the iceberg represents the public APIs. The real body and meat of the API universe is hidden. This is where a lot of the value is, because you can be more adept and agile and get better ROI [return on investment].

"CIOs should understand that using APIs is an architectural choice and not a technology choice. Organizations can build a platform using whatever their core technologies are."

—John Musser

Users as partners

Brian Katz of Sanofi discusses how consumerization of IT means enterprise IT should treat users as partners.

Interview conducted by Vinod Baya and Galen Gruman

Brian Katz

Brian Katz is a director and head of the mobility industrialization and engineering group at Sanofi. He manages mobile initiatives and enables the organization to make advance-ments in mobile services, such as mobilizing the salesforce, handling BYOD initiatives, and enabling new devices and form factors for business success. He has more than 20 years' experience in managing and implementing IT processes at global multinational corporations.

PwC: Brian, you are an active blogger, and you also lead mobility engineering at Sanofi. A key impact of cloud, mobility, and social technologies on IT is what is being called consumerization of IT [CoIT]. What is the trend and why is it important?

BK: Indeed, there is a lot of talk about consumerization of IT these days. It is often equated to bringing your own device [BYOD], in that no longer are devices (phone or tablet or personal computer) only what is sanctioned by the IT function. Rather, employees can bring the device of their choice and access enterprise services on that device. When I look at the statistics, such as 87 percent of companies are doing BYOD, probably 60 percent to 70 percent of those companies are enabling e-mail on the device. I don't think enabling e-mail on any device is enough to qualify to be doing BYOD. That device needs to access the company's IT ecosystem and the services it represents. Until a company does that, it's not truly doing BYOD.

On the other hand, CoIT is a big deal. A lot of employees today are savvier with IT, as they have grown up with the Internet and associated technologies and services. They want to be able to get their work done and have the capability to build or procure IT services. CoIT brings that dynamic more to the forefront.

"The change necessary is to treat the users as partners. Successful enterprises today are starting to embrace the fact that they have users who can assist in handling many of their own IT issues, because they have already waded through them in the home environment."

PwC: How does that impact IT operations?
BK: The popular opinion of the last 8 to 10 years is that the goal of IT is to enable the business. Yet, there's not a place you can turn where people aren't talking about "IT means no," in that when they take a request to IT, the answer is often "no."

CoIT means it is much harder to say "no" now, because people are going to work their way around it. If IT is nonresponsive, employees today can use their know-how to find better and easier-to-use tools to perform certain aspects of their jobs. If that happens, IT organizations can have a big problem on their hands, because they will have little to no control over these tools and limited visibility into the data used and stored. So IT's challenge becomes how not to say no, and to have a role in enabling new capabilities and services in partnership with the employees.

PwC: What changes should IT make?
BK: Most IT organizations spend way too much time building applications and not focusing on the user. The reason this happens and takes up a lot of IT's time is scope creep on any project. It happens incrementally with people saying IT really should be able to do this one other piece, and then before you're done, you have an application that has 300 features. The reality is that 80 percent of the users only use 30 features; what do you do with the other 270? Does it make sense to design an app with 270 features, where the use case occurs less than 20 percent of the time? Maybe you build another app for when you have that use case or maybe you accommodate that need a different way.

The change necessary is to treat the users as partners. Successful enterprises today are starting to embrace the fact that they have users who can assist in handling many of their own IT issues, because they have already waded through them in the home environment. This is the vital transformation that IT organizations must go through to continue to help their enterprises be successful. If they keep treating their employees as users, they will end up stuck in their legacy thinking that values process over partnership with their own internal customers. I would say such thinking has led to the exodus of IT talent from many large enterprises that don't see the morale-boosting, efficiency-granting value in CoIT.

PwC: Companies increasingly are becoming digital, and there is the trend to use APIs [application programming interfaces] to share and co-create in a digital ecosystem. How is that impacting IT operations?
BK: If you think about it, information wants to be free, at least within the company. This is new for most companies; most companies lock up their information and don't like to share it. However, when enterprises build APIs to interact with the information repositories, and to read, input, or manipulate the data, they enable new services that can get someone's job done.

In reality, they're building a workflow based upon modular chunks of what the user is doing. Most of the time, users want to do work in small, focused chunks. When companies do work in such a modular way, it's much easier to be more productive in everything else.

PwC: With APIs, in some sense IT opens up its capabilities and allows employees to partner with IT to co-create new functionality. Should IT encourage this?
BK: That is what should happen in the long term. However, today it's a big leap of faith and not everybody is ready to do that yet. For example, I recently visited a very large company that has been transforming IT to make users into partners. A member of the IT team said, "Somebody requested to put an app in our internal app store the other day. They looked at our APIs; they want to try designing something that they could use. They built this great app that a group of other people also thought was a great app, and they're using it based upon capabilities made accessible by APIs."

Non-IT employees created a new app using the APIs. Now IT's role is different. Perhaps IT just puts it in the internal app store and nothing else. Or IT adds security to it, or maybe IT

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looks at it and says, "You know, we could help you make it even better so it scales to all employees." IT may also get new ideas for opening up other APIs that would prompt more co-creation. This is a good partnership.

PwC: To use APIs across the enterprise, do you think IT organizations need to reorganize their assets as platforms with addressable interfaces?
BK: It depends on how they design and architect the platform. If a platform is building APIs to access data and make it available, whether on the premises or in a private or a public cloud, then yes, I agree that a platform is what they need.

On the other hand, they should avoid building a platform that becomes so unwieldy that they cannot make changes to it without much expense or disruption. I've lived through that. If you talk to anybody who did any IT from 1995 to 2005, they will recall platforms that people just kept adding to. They added to the point where, when they need to update a piece, they have 27 other pieces that depend on it, so they can't update because it's locked. The platform is complex and unwieldy.

IT organizations should build the platforms so capabilities are modular and interchangeable, and so modules can be upgraded without disturbing the system. It depends on how they architect a platform. They need to have principles that define how they're going to build their platform to avoid becoming complex and unwieldy.

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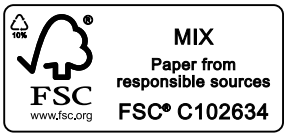

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Subtext

Consumerization of APIs (application programming interfaces)	The combination of trends where software manipulable interfaces (APIs) are becoming open and ubiquitous, as well as the democratization of the ability to create, expose, and consume these interfaces (beyond software and digital native enterprises).
Digital operating model	An operating model that combines the following: instrumentation to digitize operations, modular capabilities in a loosely coupled architecture, and platforms addressable via open interfaces; all coming together to create the ability to scale integrations in a digital ecosystem.
Permeable enterprise	An enterprise that uses a digital operating model to enable co-creation of new value by allowing internal capabilities to reach outside and interact with external capabilities, as well as permitting external innovators to reach into the enterprise to tap into its capabilities.
API management platform	Emerging solutions that package tools, methods, and services that help enterprises create, publish, manage, operate, and analyze APIs, thereby enabling them to pursue a digital operating model and the vision of a permeable enterprise.
SMAC (social, mobile, analytics, and cloud)	An acronym to evoke the disruption and potential from the confluence of the trends of social networking, mobile computing, analytics, cloud computing, and other emerging trends that take advantage of them, such as the Internet of Things.