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Digital interfaces, in the form of application programming interfaces (APIs), enable cost savings, revenue enhancement and new business models. But little is known about how nontech firms leverage APIs to generate business value. To address this gap, we studied several businesses and collected in-depth data from three large firms in the educational services, distribution and healthcare sectors. Our analysis identified three API value models: the efficiency, focused and transformed value models. Each requires a different combination of people, process and technology investment, and offers a unique value proposition.[1,2]

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Digital Interfaces Are Critical for Digital Innovation

Modern digital interfaces enable one computing device to share data and capabilities with another, creating a host of business value opportunities. Consider, for example, the challenge facing U.S. retail pharmacy chain Walgreens in the early 2010s. Walgreens had a large installed base of photo printing machines in its stores, but few customers brought in storage drives to print things like fridge magnets, photo books and pet calendars. At the same time, smartphone photography was exploding, spurring Walgreens to ask a simple question: how can we engage smartphone users with in-store photo printing?

The response was to develop a photo printing digital interface that created convenience value for customers and encouraged smartphone developers to create apps that linked to Walgreens' photo printing machines. Customers could press a print button within their photo app, select a local Walgreens store, choose a printing service, pay through the photo app and pick up their order in-store at the appointed time. Very quickly, developers created hundreds of apps, significantly increasing photo printing revenue (80% goes to Walgreens, 20% to the app developer) and thus increasing store revenue.[3]

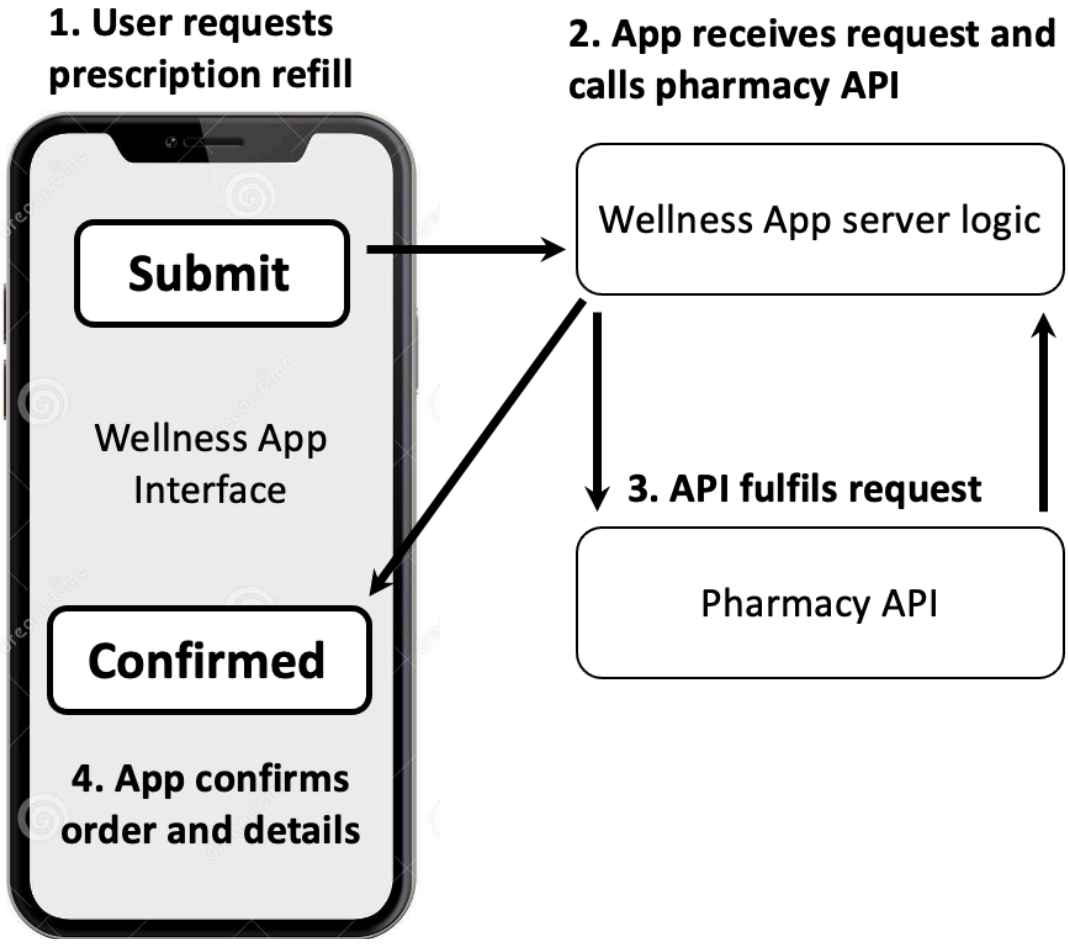
1 Gabriele Piccoli is the accepting senior editor for this article.

2 The authors thank Gabriele Piccoli and the members of the review team for their thoughtful feedback and guidance throughout the review process. We also gratefully acknowledge a grant from the Advanced Practices Council of the Society for Information Management and the support of: Dr. Charles Frazier, Senior Vice President and Chief Medical Information and Innovation Officer, Riverside Health System; Jeff Thomas, Chief Technology Officer, Sentara Healthcare; Shawn Irving, CISO, and Austin Block, Manager, Information Technology at Ferguson Enterprises; and members of the IT leadership team at an educational services provider, referred to anonymously as ESP.

3 Boyd, M. *How Walgreens' API Program Leverages Seasonality And Revenue Sharing*, ProgrammableWeb, December 3, 2015, available at https://www.programmableweb.com/news/how-walgreens-api-program-leverages-seasonality-and-revenue-sharing/native-case-study/2015/12/03.

DOI: 10.17705/2msqe.00046

Figure 1: Illustration of Pharmacy Prescription Digital Interface Use Case



Building on its success with photo printing apps, Walgreens extended the model of exposing capabilities to smartphone users within apps to other digital business contexts. For example, it expanded its prescription fulfillment via third-party mobile health apps. When a customer requests a prescription refill from within a wellness app, the app receives the request and uses the pharmacy interface created by Walgreens to link to a pharmacy. The interface fulfills the request and sends details of the confirmed order to the app on the customer's smartphone (see Figure 1).

Walgreens' initiatives illustrate four key features of modern digital interfaces, which are also known as web application programming interfaces (APIs):

1. APIs enable data (e.g., current weather in Berlin) and capabilities (e.g., automatically classifying a document) to be shared across computing devices. An API provides a common technical standard for sharing data or invoking capabilities via simple URL-like program calls. Moreover, organizations may generate APIs for others to use (develop, host, manage, etc.), consume APIs that others have generated (connect cloud service to a local system, enhance developer efficiency, etc.), or both.
2. APIs enable two models of initiation: demand pull (e.g., provide mapping features when requested) and event push (e.g., subscribe to the "delay" feed of a cargo container ship for immediate and automatic notification of an event such as a storm).

Table 1: Examples of API Functionality, Business Applications and Business Value

Functionality	Business application	Business value
Enable customer interaction and experience	German rail transportation company uses event streaming APIs employing, for example, sensor data from station platforms to detect the arrival of trains, triggering station loudspeaker announcements.	*API consumer*: low latency, accurate and consistent information to support rail travel. *API producer*: reduced cost, enhanced customer loyalty.
Support business operations	Call center headset maker exposes processed audio data to customers for identifying effective customer service strategies.	*API consumer*: enhanced revenue and reduced costs for call center firm. *API producer*: product differentiation, enhanced revenue, new service development.
Expose back-end data	Banks allow customers to share data subsets with other banking institutions, in compliance with PSD2 regulations. [4]	*API consumer*: service flexibility, enhanced experience. *API producer*: compliance, innovation, service development.

3. APIs are programmatic in that API code can be inserted into one program to call data and capabilities from another.
4. Granular tracking of API-enabled machine-to-machine communication enables various forms of analytics and monetization.

These four features of APIs underpin an array of new business models and growth opportunities. Siemens, for example, is providing smart metering services in the U.K. The U.K. government is aiming to shift energy consumption habits to be more ecofriendly by rolling out more than 50 million smart meters. Along with smart meter manufacturers, Siemens is providing APIs that enable legacy system data to be exposed to connected devices, vendors and energy suppliers. Another example is provided by global shipping giant Maersk, which developed a range of APIs to enhance the efficiency of global supply chain operations, such as tracking, booking and schedule management. Other examples of APIs include exposing industrial data collected via Internet of Things (IoT) business models, and enabling rapidly growing service strategies and service-oriented business models at firms such as Schneider Electric.

4 PSD2 is a European regulation for electronic payment services that seeks to make payments more secure, boost innovation and help banking services adapt to new technologies.

In summary, APIs are now critical for digital innovation, as emphasized in a McKinsey article: "APIs are no longer a matter of technology strategy alone. Today, they are also a key part of any company's business strategy."[5] APIs can enable new functionality, can be applied across a range of industries and can generate value across a range of stakeholders, including consumers and producers of APIs. Examples of the business value that can accrue from APIs are given in Table 1.[6]

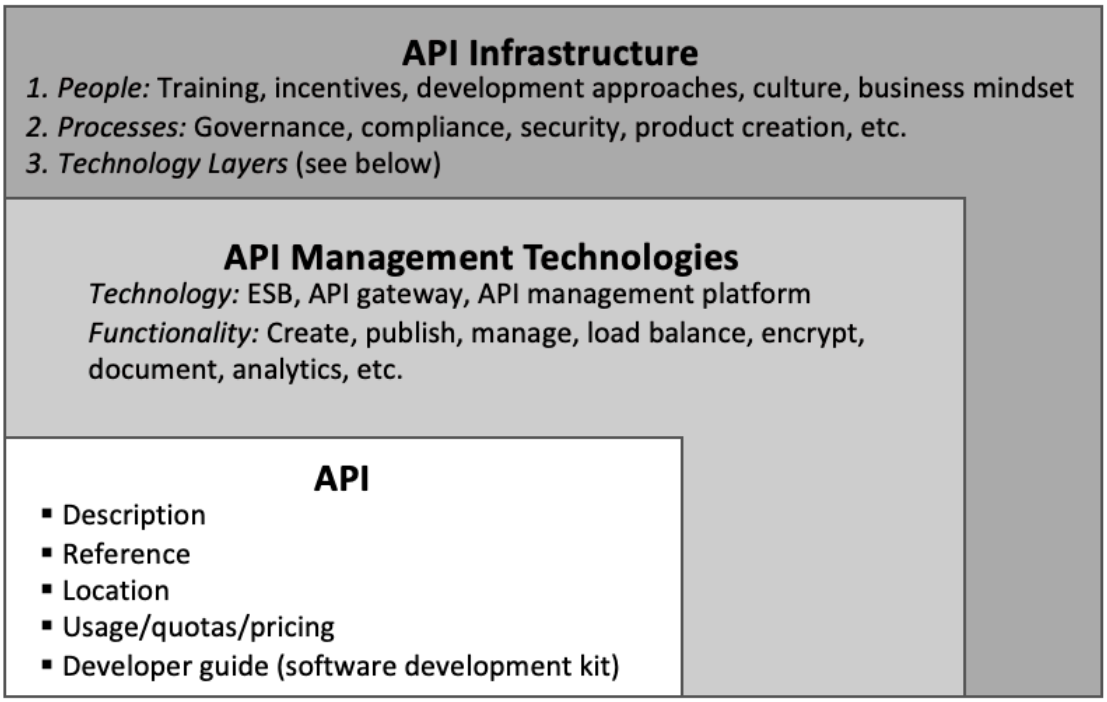
The Need for an API Infrastructure to Drive Business Value

In essence, an API is just a piece of software invoked by one device (go there and get that) to access capabilities or data residing on another (you are authorized and within your limits, here it is) according to usage rules and constraints. But to gain business value from APIs, an organization needs more than just the code. It also needs a system for managing an enterprise API portfolio

5 Iyengar, K., Lau, L., Ramadath, S. and Sohoni, V. *The Seven Make-or-Break API Challenges CIOs Need to Address*, McKinsey Digital, December 19, 2018, available at https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/the-seven-make-or-break-api-challenges-cios-need-to-address.

6 For more information, see Iyer, B. and Subramaniam, M. "The Strategic Value of APIs," *Harvard Business Review* (93:1-2), January 2015..

Figure 2: The Three Components of an API Infrastructure



at scale, including API life cycle management, security, discoverability, analytics, etc., as well as associated people and processes. An organization therefore needs an API infrastructure with three components: people, processes and technologies see (Figure 2).

The people component of an effective API infrastructure encompasses training, design principles, business use incentives, quality assurance, third-party developer support, product mindset, etc.) and the processes component includes governance, strategy, legal, value models, sales and marketing, security, compliance, operations to meet service level agreements, etc. Together with the technologies component (which includes API management technologies and the APIs themselves), the people and processes components enable an organization to maximize the business value from APIs. However, the wide range of API management technologies gives rise to many varieties of API infrastructure across enterprises, depending on their particular uses and goals for APIs.

Our research has identified that API infrastructure is the key driver of business value. We therefore set out to answer the following research question: *How do large nontech sector organizations effectively monetize an API infrastructure*? In this article, we describe three models we have identified for API value generation and provide recommendations for business and IT managers as they seek to align the API value opportunity with specific organizational and competitive contexts.[7]

Three Models for API Infrastructure Value Generation

Our analysis of the data collected during the research (our research methodology is described in the Appendix) revealed three models of API infrastructure value generation, which we call the *efficiency value model* (EVM), the *focused value model* (FVM) and the *transformed value model*

7 Chan, Y. and Reich, B. "IT Alignment: What Have We Learned?" *Journal of Information Technology*, (22:4), September 2007, pp. 297-315.

Table 2: Summary of the Three API Infrastructure Value Models

Feature	Description	Example	EVM	FVM	TVM
Consume APIs	Use APIs generated by other firms or other business units	Hospital uses Twilio API to automatically send prescription reminder text messages	✓	✓	✓
Efficiency gains	Enhance time to market or developer productivity	Developer uses Salesforce API to quickly integrate with existing ERP and data warehouse system	✓	✓	✓
API management platform	Adopt technical platform for exposing, security, etc.	Smart lighting company uses Mulesoft to manage its smart bulbs APIs	✓	✓	✓
Generate APIs	Develop APIs for use internally or externally	Global trade company generates APIs to enable its business partners to integrate with its trading portal	✓	✓	✓
API vision	Explicit statement of current/future API program objectives	Distributor creates a vision focused on securely managing capabilities via APIs		✓	✓
Extensive governance	Security, product management, monetization, analytics, etc.	Retailer managers monetize APIs via product managers, as if they were a physical product		✓	✓
Bundling APIs	Analogous to bundling products to provide better customer value	A videoconference provider bundles a set of APIs for call analytics, with a common rate plan		✓	✓
Revenue gains	Monetizing APIs to drive revenue	Customer data platform monetizes a pixel tracing API that enables its customers to monitor email opens		✓	✓
Wide scope of impact	Firm-wide API-enabled changes to structure, processes, etc.	Retailer exposes all internal capabilities as APIs for use by internal units and external organizations			✓
New technology stack	Reformulating applications as microservices exposed via APIs	Financial services firm reformulates systems into microservices, and exposes them as capabilities via APIs			✓

(TVM). These three models are summarized in Table 2, in terms of the API features included in each model. These models do not necessarily represent a complete set, as our data is insufficient to support such a broad inference. However, they represent important clusters along a spectrum of API infrastructure models. As such, they provide rich insights into how firms generate value using APIs, depending on their own particular business conditions.

Below, we describe each of these three models in detail and provide a case example for each. The characteristics of each of the case organizations are summarized in Table 3, together with the API mechanisms deployed, the impacts of the API initiatives and the challenges faced.

Efficiency Value Model

Every large organization uses APIs in some ways. Popular applications include integrating legacy systems with cloud-based systems, such as a customer relationship management system (CRM). Another popular use of APIs is in the development of smartphone apps—for example, invoking the Google Maps API for geolocation and directions. Our analysis suggests that, for many

Table 3: Summary of the Three API Infrastructure Value Cases

	ESP [a]	Ferguson Enterprises	Sentara Healthcare
Industry	Educational services	Building supplies distributor	Healthcare
Value model	Efficiency	Focused	Transformed
Employees, 2020 (FTE)	20,000	27,000	30,000
Description	Evolution from SOA involving APIs for system integration and programming efficiency.	Strong governance and focus on cybersecurity.	Move toward cloud computing and entrepreneurial mindset led to experimentation with digital technologies.
Impacts	System integration efficiency. Application development efficiency. Pockets of user-driven innovation using exposed data.	Efficiency and a platform for innovation, such as new services for business customers.	Bundling APIs to accelerate new revenue sources, API-based services as part of strategic partnerships.
Challenges	Developing and communicating a single API vision. Encouraging generation of APIs and business buy-in, while developing a more extensive API infrastructure.	Scaling up to an enterprise-wide data sharing infrastructure. Creating a strategic mindset among process owners to identify value-added services by leveraging API infrastructure.	Balancing assets and capabilities between internal efficiency and external growth. Implementing analytic capability to exploit data generated from the API infrastructure.

[a]ESP is a pseudonym to retain anonymity of data sources.

firms, the scale and scope of API application is rooted in these types of efficiencies.

Based on our analysis, we define the *efficiency value model* (EVM) as an approach to APIs that is focused on efficiency, in particular in the context of developing apps and integrating and sharing data across systems. EVM characteristics include a modest set of infrastructure features, including APIs that are mostly consumed and not generated, governance and vision focused on meeting data compliance regulations, and modest communications and analytics strategies. We found that firms adopting this API value model may have multiple API management platforms, and may also employ legacy interface management technologies such as enterprise services busses (ESBs)[8] and gateways.

It is difficult to estimate how many firms use the efficiency value model, but data suggest the number is not small. For example, a 2019 survey of 500 firms by IDC[9] indicates that 40% had not yet adopted an API management platform, i.e., they had not yet adopted the more extensive focused value or transformed value models. This data suggests that more than 40% or 50% of large organizations have likely adopted the

8 An ESB provides a standardized approach to connecting systems by providing translation and routing services from a message sent by one system to another—i.e., a service-oriented architecture. ESBs are exposure-centric, typically managed by the IT department, and follow a rigid structure. API management platforms, in contrast, are consumption-centric, and enable enhanced functionality, flexibility and innovation.

9 Thomson, J. and Mironescu, M. *APIs: The Determining Agents Between Success or Failure of Digital Business*, International Data Corporation, August 2019.

efficiency value model, although the precise figure remains unknown.

The two key dimensions of API value generation are systems integration and application development. In this context, many organizations have achieved alignment between their business strategy and the efficiency value model. In other words, their expectations are modest and are met via cloud integrations, consumption of externally generated APIs and limited internally generated APIs. Given this level of API infrastructure, sophisticated analytics are unnecessary, as is a product mindset or a sophisticated communications strategy. These features were observed in the EVM case example, as described below.

Efficiency Value Model Case Example

A large educational services provider based in the U.S. (referred to anonymously as "ESP") employs over 20,000 people and offers a range of services to students. Similar to many large organizations in the early 2000s, ESP began its API journey by adopting a service-oriented architecture (SOA) to address inefficiencies associated with customized and non-reusable connections between an increasing array of applications and data. Specifically, the mechanisms for integrating different systems were costly to develop and maintain, were not reusable, required custom programming and did not adequately address data security requirements. Despite the shift to an SOA, ESP realized that a new initiative was needed to address the remaining inefficiencies resulting especially from rapidly increasing demands for the development of mobile apps.

As a consequence, in the early 2010s, ESP adopted an enterprise service bus and an API management platform, both from an open-source vendor, and quickly published an API directory for API exposure and adapted existing data security requirements to the new API context. Subsequently, in 2016 ESP adopted a new API management platform across the entire organization, together with enhanced governance mechanisms for issue tracking, system architecture, and policy and security issues. ESP is now developing a broader API library to store and expose a small but potentially growing set of internally built APIs across the entire enterprise. ESP also considers enhanced communication across all functional units, as well as continued security upgrades, to be critical to its ongoing API infrastructure development.

Analysis of our interview data and secondary sources suggests that ESP is monetizing its API infrastructure through several areas of tangible and intangible business value generation. First, in terms of efficiency, the API infrastructure has shortened the application development life cycle and thereby reduced not only time-to-delivery but also the backlog of projects and service requests. These efficiency improvements have resulted from reusable APIs removing the need for custom programming (i.e., less reinventing of the wheel). As one development manager at ESP put it:

> *"They were building a mobile app, and trying to pull data from all these different sources … they were spending probably three quarters of their time pulling data and trying to get it into the right format to then consume it for their application … and I wanted to try and flip that number … you should be able to spend three quarters or your time developing the app."*

System integration efficiency has also been improved, as described by an ESP API manager:

> *"[The API directory] reduces the maintenance cost. … At the beginning most data sharing was through database access directly, and we had to manage a lot of remote access control there every time through our system upgrade—that's really painful. … Now through the API directory we have a centralized place to organize resources, and we can reuse those efforts."*

ESP also experienced efficiency gains in the API development life cycle, including logging, monitoring, automated testing and data security. Our research also uncovered pockets of innovation, and associated efficiencies, enabled by the API infrastructure, including empowering students to use data in new ways. As described by an enterprise service manager at ESP, "*It's not infrequent that a student group will say, 'I wish we could do something about how well, or efficiently,*

or poorly the labs are used.' So we can say great, here's a feed [enabled by an API], go nuts."

Second, in terms of data security, the API infrastructure enforces the use of data governance mechanisms. For example, centralized authorization, together with operational logins and logouts, facilitate ease of use while maintaining established security requirements. Our ESP interviewees also mentioned several ancillary benefits of the API infrastructure, including an intuitive interface for browsing, searching and managing APIs; support for change management, auditing and security standards; enabling an effective API access approval workflow; and providing auditing of the mapping of APIs to calling and subscribed applications. For example, an ESP service manager remarked that he could request data as follows: "*Can you give me a list of who's called this API within this particular timeframe, so I can reach back to that application owner, and say, be alert, you need to make a change.*"

In summary, ESP's API journey to date is a good example of the efficiency value model, which involves consuming APIs for efficiency gains. Going forward, as ESP contemplates adopting a cloud-based enterprise-wide system, further development of its API infrastructure will be a critical enabler. In considering how to evolve its API infrastructure, ESP is addressing questions such as: Who will be the API evangelist? What does a unified API vision look like? How do we get everyone on board? And what's the business case?

Focused Value Model

To extend API value beyond efficiencies, some firms have recognized and are leveraging significant API-based opportunities within focused areas of their businesses, such as supply chains or online commerce. These firms view APIs strategically, not just as a means of improving integration or development efficiencies. As a result, they have invested more heavily in an API infrastructure, and are reaping benefits within focused business areas. We call this second API value model the *focused value model* (FVM).

The API infrastructure of the focused value model is characterized by similar technologies used with the efficiency value model, such as APIs, API management platforms and ESBs. Numerous APIs are generated and consumed, typically within a mission-critical aspect of the business. Compared to the efficiency value model, a key differentiator is that the focused value model includes extensive and systematic governance mechanisms, such as deliberate API architectural components designed to ensure predetermined levels of data privacy and reliability, and conformance with the AIC triad[10] for information security.

An FVM API infrastructure also includes people and processes related to the communications strategy, analytics strategy and API vision. The people and process components ensure that key stakeholders (developers, business managers, information security personnel, analysts, etc.) are educated about the motivation and need for API-enabled business models. These components of the API infrastructure foster an ownership mindset based on innovation and possibility rather than on doubt and fear.

All three components of an FVM API infrastructure are interdependent. The technologies and processes components enable business units to easily self-service the use of APIs (through catalog, use cases, etc.). The people component (skill sets, mindsets, incentives, etc.) enables the organization to identify business opportunities and match them with API-enabled solutions. As emphasized by Deloitte, "Deploying and scaling APIs requires capabilities that are different from those typically used in established integration and messaging layers. … Managing APIs deliberately throughout their life cycle can help make them more discoverable [and] serviceable, and more easily monitored."[11]

From a value perspective, the focused value model ensures that objectives are clearly developed and pursued, typically driven by a business unit context such as supply chains, smart products, or e-commerce. Specifically, the value opportunities from this model include: 1) efficiencies, 2) revenue enhancement, and 3)

10 Confidentiality, integrity and availability (the CIA triad) is a security model that guides information security policies within organizations. To avoid confusion with the Central Intelligence Agency, the model is referred to as the AIC triad.

11 Calabro, L., Purpura, C., Vasa, V. and Perinkolam, A. "API Imperative: From IT Concern to Business Mandate," *The Wall Street Journal*, March 27, 2018.

competitive differentiation. Consider, for example, Plantronics, which develops smart headsets enabled by audio processing and trained machine learning algorithms. By exposing the algorithms through APIs, Plantronics achieved competitive differentiation in the marketplace and enhanced its revenue. Successfully adopting the focused value model requires extensive investment in all three components (people, processes and technologies) of the API infrastructure, as illustrated by the case example described below.

Focused Value Model Case Example

Ferguson Enterprises is a large U.S. distributor of industrial and residential supplies. Its internal efficiencies, coupled with excellent customer service within a corporate culture promoting adaptability and flexibility, make it the North American market leader. Ferguson was an early IT innovator. In the 1990s, it developed and deployed an automated tracking system to improve distribution-center and delivery-routing efficiency, increase on-time delivery and reduce freight costs. In addition, Ferguson has used EDI for decades to better connect with its B2B customers, and has employed a transportation management system to optimize routing and reduce costs and vehicle emissions.

Although legacy systems such as EDI have served the firm well for many years, new customer imperatives emerged in the early 2010s. Similar to many firms, Ferguson began to accumulate exponentially more data about key processes. Business units increasingly relied on this data, spurring increased requests to combine data sources for use in applications aimed at operational efficiency and customer service improvements. Unfortunately, these requests took too long to implement and the processes needed to carry out the necessary data integrations were inefficient, causing frustration. A senior technology manager recounted a common type of request she received: "*I just need to get product data ... why is it so hard to get product data?*"

The root cause of the inefficiency was a brittle database infrastructure with the services software stack on top of that data. According to Ferguson's API manager, a key motivation for moving toward an API infrastructure was "how brittle a lot of the database infrastructure was with the services stack on top of that data." Every process change required crafted and time-consuming work by IT. As change requests increased, so did the service gap between what was demanded and what could be supplied.

In response, Ferguson developed an API vision for providing capabilities as a service—i.e., abstracting from back-end data platforms to expose a capability, and doing this from a consumption layer in the API infrastructure. As explained by Ferguson's API manager: "*When we started thinking about what APIs mean for us as an organization, it's really that singular view of a capability expressed as a product.*" The focus was on B2B e-commerce, which is critical in the industrial supplies distribution industry. Moreover, a key principle underlying the vision was assigning responsibility for API management to the chief information security officer (CISO). This principle not only ensured rigorous risk management, scalable security and SOX[12] compliance, but also provided the highest levels of assurance to internal and external business partners that API-enablement is safe, accurate and reliable.

Ferguson's API infrastructure journey proceeded in stages, building on earlier middleware and a services-oriented architecture (as was the case with ESP). First, proxy connections were set up to act as a go-between from data requests to back-end data providers. Second, connections and capabilities were bundled into products with versions created, for example, for shipping processes. These products are managed by business product and technical product owners, leveraging associated tools created to promote the development of APIs as products. In the future, Ferguson intends to develop extensive toolsets for automated governance that support self-service innovation at the business unit edge to replace slow and inefficient requests to the IT organization.

In terms of value, Ferguson cited several areas of value generation from its API infrastructure. First was the intangible but significant benefit of risk mitigation provided by maintaining a robust security apparatus around the organization and its data. The API infrastructure enables business units to proceed with innovation with few concerns of data risk, as emphasized by a senior IT manager: "*First and foremost, what's important*

12 SOX is shorthand for the U.S. Sarbanes-Oxley Act of 2002, which addresses fraudulent accounting activity and board of director responsibilities, and specifies criminal penalties.

for us in our platform is to maintain a security apparatus around our organization and our data." Another intangible benefit relates to governance. With increased data flows and exposure of capabilities, the IT organization provides the underlying infrastructure for business units to govern the exposure of data and capabilities. This benefit was highlighted by one of Ferguson's API managers: "*We can sell [the API vision to] the business on its ability to pinpoint what it wants to do.*"

Tangible value accrues via increased revenues and operational efficiencies associated with Ferguson's B2B e-commerce activities. Exposing internal capabilities (in machine- and human-readable formats) as products enables a virtuous innovation cycle in terms of value streams. Ferguson's senior IT manager put it this way: "*It's that abstraction from platforms to expose a capability ... and you really have to do it from the consumption layer.*" For example, Ferguson provides an online shopping cart as a service that follows a customer across different channels (online, in person, etc.), which enhances the information available to field personnel and increases revenue because it is easier for the customer to make more purchases. In a conventional omnichannel approach, the cart would be associated with a particular e-commerce platform. Reformulating the cart as an API product means that the cart is persistent across all channels, which enables business personnel to rethink how best to meet customers' needs and thus generate business ideas of what is possible. According to a senior Ferguson technology manager, once the business realizes the potential of expressing capabilities in a human- and machine-readable way: "*That's when you really throw gas on the [ideation and new value streams] fire.*"

Overall, self-service access to data stores and the exposure of capabilities enabled by APIs directly address the impetus for Ferguson's API program (faster and more efficient data integrations in the B2B e-commerce space) while also providing a springboard for related innovations. Binding new capabilities with security requirements was described by the VP of IT as follows: "*That singular view at the API layer, that API productization view, is giving the business a single plane for ... exerting control, oversight and governance.*"

Moving forward, Ferguson intends to develop all three components of its API infrastructure. For example, it plans to increase the size of the API management unit so it can better define the product vision for APIs, including assessing market fit and developing a strong user voice for generating user stories with compelling business value. Setting priorities, an API product vision, effective solution development and aligning IT and business strategies all contribute to an emerging API-first mindset.

Transformed Value Model

With the efficiency and focused value models, firms leverage their API infrastructures to drive various forms of business value. However, these models do not fully embrace the API orientation of industry leaders. For example, in 2002, Amazon essentially mandated API use for *all* firm interconnections,[13] which led to internal consolidation of data storage as a service, followed by straightforward *externalization* of this capability. That capability is now Amazon's $10 billion cloud services business.

The notion that all systems should be "built to share" and that all capabilities should be exposed to internal and external customers has also taken hold outside of the tech sector. For example, Siemens has created a center that supports business units in writing their own APIs and services, established a portal to make available services discoverable and share their functionality and interface specifications, and defined new data management approaches that enable reuse and self-service by business units. Siemens' digital mindset spans technology and business units, and enables new levels of service development and customer satisfaction.[14]

Amazon and Siemens go beyond the efficiency and focused value models, and exemplify the third and final value model, the transformed value model (TVM), which is defined by an extensive API infrastructure across all facets of the business. A service orientation and focus

13 Rosoff, M. "Jeff Bezos 'Makes Ordinary Control Freaks Look Like Stoned Hippies,' Says Former Engineer," *Business Insider*, October 12, 2011.

14 Goddard, S. *Unsung Heroes: An Architect's role in the new IT operating model, with Siemens*, Mulesoft Webinar, 2016, available at https://share.vidyard.com/watch/ghC7RyEctGPyJ1qJMeRMda.

on innovation complement the technologies component of the infrastructure. Specifically, most or all data sources across the firm are available and provided as a service, sometimes bundled into higher-level services. This model speeds up service development and creates a "better, faster, cheaper" virtuous cycle. From a technical perspective, firms that adopt the transformed value model have modern technology architectures that enable and exploit API value generation, including breaking monolithic applications into smaller units of microservices, and exposing these microservices through APIs.

In terms of value, revenue generation is driven by capabilities as a service, while the "Lego-like" model of underlying service exposure reduces time to market and development costs. In this way, the transformed value model enables "blue ocean strategies."[15] With these strategies, the value-efficiency tradeoff no longer holds: both can be gained simultaneously. Finally, because the transformed value model increases customer satisfaction and partner involvement, firms adopting this model pull the entire industry toward new levels of service, quality and cost containment. In effect, firms adopting this model are not only transforming their internal operations but also entire industries by setting new standards for customer service, quality and efficiency.

Transformed Value Model Case Example

Sentara Healthcare is a U.S. not-for-profit integrated healthcare business based in the mid-Atlantic region. It serves more than 850,000 individuals across 12 hospitals, 10 nursing centers and three assisted living facilities. Sentara also provides health insurance services through its subsidiary Optima Health to 580,000 members, including 35,000 care providers. For more than a century, Sentara has pursued its mission "to improve health every day."

Sentara has a long history of effective adoption of healthcare IT. For example, after a five-year effort, the firm introduced a glycemic management system in 2014 that significantly improved glucose management for inpatients. Another example is Sentara eCare, which was rolled out in 2016. This system provides a unified electronic medical record that incorporates Epic[16] and other modules to support functions such as labor and delivery, emergency department workflow and an online patient portal. Over the years, these and other best-practice technology innovations led to Sentara being named in 2018 as HealthCare's Most Wired by the College of Healthcare Information Management Executives.

Despite Sentara's long and illustrious history of effective digital innovation, many opportunities remained. In 2019, the firm's CEO stated: "*Healthcare is miles behind other customer-centered industries—think retail and banking—when it comes to reaching consumers digitally. We have not delivered on the connectivity most people have come to expect in 2019.*"[17] This call for action resulted in several significant initiatives. For example, in 2020, Sentara developed an enterprise platform providing a unified view of patient data, including those of Optima, using Microsoft Azure. Optima also implemented a telehealth application to improve healthcare, in collaboration with MDLive (which provides 24 x 7 on-call access to doctors). And, as described below, Sentara's use of APIs in recent years has been transformative.

Sentara's API vision is driven by the chief technology officer (CTO), an evangelist who communicates to Sentara business leaders the possibilities for enhanced patient care and administrative services enabled by a robust API infrastructure. Rethinking services, and enabling applications, together with the underlying infrastructure, have transformed operations. Specifically, Sentara has developed an API-enabled patient-centric application model involving clusters of services (scheduling, care, etc.) via combinations of back-end support services. These support services are exposed via APIs for accessing both administrative and clinical data, and via internally developed enterprise APIs or externally accessed APIs (e.g., Zoom for video conferencing and Epic for physician lists). The application model

15 Kim, W. C. and Mauborgne, R. "Blue Ocean Strategy: From Theory to Practice," *California Management Review* (47:3), April 2005, pp. 105-121.

16 Epic is an electronic medical record (EMR) system provided by Epic Systems Corporation.

17 Kern, H. and Heyne, C. "Sentara CEO Howard P. Kern: 3 Core Strengths for Success in 2019," *Becker's Hospital Review*, May 30, 2019.

is enabled by a new technology stack that employs a microservices architecture built on Azure Kubernetes Services and Azure API Management. APIs are deliberately managed via an API management structure. For example, APIs are structured within tiers according to their function, such as presentation, business objects or enterprise systems. This structure facilitates performance optimization and compliance with security protocols.

The overall API vision for both the application model and the underlying technical architecture is rooted in capabilities. According to the CTO, "*The reason you're managing APIs is you're really managing your interaction to new capabilities … it's capabilities as a service.*" Sentara's API vision contrasts with the mindset of less innovative competitors, as emphasized by the CTO: "*People are used to building a platform that does everything and then they live within the constraints of that platform.*" In contrast, the transformed value model adopted by Sentara is able to respond to the need for differentiation and ever-increasing customer expectations, as described by the CTO: "*To provide a distinct customer experience … I can't just buy a platform because then I'm constrained by the innovation of the platform. … With APIs, I now can build innovative experiences [in response to] changes or innovations within the environment. … The APIs are moving very very quickly.*" Sentara's experience suggests that the transformed value model can enable organizations to adapt existing cycles of innovation and stability to better align with rapidly shifting customer expectations.

An example of the value provided by the transformed value model is the digital support provided for a core Optima process: patient management of their healthcare plans. This process involves multiple complexities. Patients have to coordinate with healthcare providers and insurers to determine which services are covered under the insurance plan, to find out what the out-of-pocket expenses will be, to book service appointments, and so forth. To handle these interactions, insurers set up call centers and employed member service representatives to verify the services that are covered, pre-authorize procedures and specify the reimbursable amounts so that patients can calculate their out-of-pocket expenses. All of this is inconvenient for members, costly for insurers and causes delays in patient treatments. In response, Optima automated these processes with APIs that integrated various data sources and made them available on the mobile app that members already use to coordinate with their healthcare providers. Building on this capability, Optima partnered with a noncompeting healthcare services provider to enable mobile healthcare by exposing select capabilities via APIs. Optima's capabilities were combined with those of its partner and wrapped together within a mobile app to serve its partner's customers.

Sentara's transformed value model provides several significant benefits. First, the capabilities-as-a-service (CaaS) model embodied in direct services such as mobile apps delivers higher revenues for Optima. Second, the TVM provides value in terms of adaptability and resilience. During the early stages of the Covid-19 pandemic, Sentara's new API-enabled technology meant it was able to scale its telehealth appointments 100-fold within just one week—few other healthcare providers could match this agility and adaptability. Third, the partnering business models enabled by capabilities exposure via APIs provide value for Sentara through service revenue and differentiation. Fourth, Sentara's transformed value model is changing the nature of industry competition by pulling partners and vendors along its innovation trajectory and is therefore positioning Sentara as an industry leader.

Recommendations for Developing an API Strategy

Our research suggests that firms seeking to leverage value opportunities afforded by APIs should follow a strategic approach in a series of steps. The first step is to conduct an API infrastructure audit to assess which of three API value models described in this article best matches the firm's current API infrastructure. Key indicators that differentiate the three models are the presence of an overall API vision and clear and effective communication of that vision, data governance, the ratio of API generation and API consumption, and the scope of API application across the firm.

Based on the findings of the audit, the firm can determine the extent to which current and future

business strategy aligns with the identified API value model. For example, while ESP's current strategy aligns with the efficiency value model, a potential shift to a cloud-based enterprise system in tandem with an increased focus on student-centered digital innovation may necessitate a shift to a focused or transformed value model.

If this first step shows there is current or likely future misalignment between the business strategy and current API value model, the firm should then determine which model is the best fit and set out to make the business case for creating a new API infrastructure that incorporates the people, processes and technologies components to support the desired API value model.

To ensure that data privacy will be "baked into" the desired value model, the business case should pay attention to risk exposure. For example, Ferguson's initial business case identified that security of product pricing data was critical to the business and assigned responsibility for the API infrastructure to the information security organization. This sent a clear message to the entire business that security is a primary concern for generating business value from APIs.

If the alignment assessment shows that the business strategy and API value model are currently aligned, the firm should identify future changes that might require it to reconsider whether the value model is still appropriate. For example, ESP has identified that the acquisition of a new cloud-based enterprise system will necessitate enhancements to its API infrastructure. Based on our experience of working with API-enabled firms, and the experiences of the three case organizations described in this article, we provide the following strategic and tactical recommendations for developing an API strategy.

Strategic Recommendations

Following the audit to assess alignment between business strategy and the API value model, we recommend three strategic actions firms can then take to ensure they gain the maximum business benefits from their API infrastructure.

Strategic Recommendation 1: Connect to Internal and External Partners. Firms can take advantage of API capabilities by identifying the chunks of data needed for decision-making and evaluating whether that data resides in disparate systems within the organization or among external partners. Firms should determine the business value that will be created by accessing this data and who will appropriate that value, meaning that there must be a common organization-wide understanding of which data will be accessed and how it will be used. At Ferguson, for example, this meant that the shopping cart as a service needed to be tightly controlled to maintain integrity across platforms, with only certain stakeholders allowed to access data at certain times. In some cases, immediate business value from APIs is appropriated by one partner, as illustrated by an opioid prescription API where a hospital or pharmacy gains tangible business value from accessing a state's prescription database system. The "intangible" value to the state in allowing access is in serving the health and general welfare needs of residents. In commercial situations, the appropriated value may emerge from deeper insights into processes, co-creation of products and services, or improving customer services for partners.

Strategic Recommendation 2: Build a Platform to Connect Others. As more partners exchange data and cross-system activity increases, a network effect emerges in which all partners experience greater value from data sharing. This presents a strategic opportunity for a firm to build a robust platform to host various data subsets that other partners contribute to and use to expand value for their product or service offerings. This wider use of the platform across a large user base can be a source of revenue as well as new services. For example, headset manufacturer Plantronics provided a way for customers to exchange data and then built a platform to offer its clients API-enabled revenue-generating, value-added services such as support call analytics, customer sentiment analysis and overall service quality reports.

Strategic Recommendation 3: Monetize APIs. Providing revenue-generating API-enabled services is an important form of monetizing APIs, as illustrated by Walgreens' photo printing API. However, firms can also strategically monetize the expertise gained from API development and use. For example, Optima monetized the set of APIs relating to connectivity of patient data as

a product by providing the API shell to a joint venture partner. Not only can firms gain revenue by providing an API as a product, but firms can also use know-how gained during its deployment to offer consulting services that can help others integrate the API into their own infrastructures. Over time, as firms gather data and process insights from various deployments of their APIs, they may even consider spinning off their API business to technology services firms.

Tactical Recommendations

In following our three strategic recommendations, firms may encounter several challenges as they delve into the details of their API infrastructures and value models. We provide five tactical recommendations for overcoming these challenges.

Tactical Recommendation 1: Develop and Communicate Robust API Data Governance. We identified several factors that challenge the effectiveness and efficiency of the efficiency value model and hamper the firm's ability to consider moving to a focused or transformed value model. A key challenge is the lack of an overarching strategy for data security and governance that goes beyond the basics, such as requiring users to request and employ keys for API use. Without such a strategy, business users will be uncertain as to whether this new way of sharing data is safe and secure. This in turn may create a barrier to adoption by business partners, regardless of the potential value of API-enabled data sharing. To address this challenge, firms must treat data as both a source of business value and as a source of business risk, and this requires firms to develop and communicate robust API data governance. One way of doing this is assigning responsibility for API management to the CISO, as Ferguson did. Another option for organizations in which data privacy is critical (such as banking or healthcare firms) is to use private networks rather than the public internet to carry API requests and responses, which is what Sentara did.

Tactical Recommendation 2: Educate Business Staff about API Value Generation Opportunities. We observed that business staff members in firms that adopt the efficiency value model are inadequately trained in the value-generation possibilities of APIs. The mindset in these firms is akin to "build an API and they will come." There is a great deal of misinformation and uncertainty in these firms about the role and value potential of an API infrastructure. For example, many business staff members have a myopic view of APIs as just another integration tool. In contrast, firms that have adopted the focused or transformed value models set a clear API vision, communicate it through a well-developed campaign and perceive business users as learning and innovation partners. At Sentara, for example, the CTO is both the technical visionary and the business evangelist. We recommend that firms educate business executives and staff members about the possibilities that APIs provide for efficiency and growth, using, for example, use cases from other firms to secure their buy-in.

Tactical Recommendation 3: Shift from a Project Management to a Product Management Mindset. Many organizations assume that agile teams and mature project management provide a robust structure for building a particular API or bundles of APIs. While project management is appropriate in many contexts, we observed that firms' API infrastructure is more than a project. Our research suggests that a project management mindset may be appropriate for the efficiency value model. However, we found that firms that had successfully adopted the focused or transformed value models treat APIs as products developed and managed over time by incorporating customer feedback, with improvements made in a continuous, virtuous cycle. The people component of the API infrastructure indicates the need to appoint an API product manager and an API architect to shepherd APIs into the business flow, as Sentara did. The processes component indicates the need to track appropriate agile metrics, such as the direct business value of APIs to customers and the developer adoption of APIs.

Tactical Recommendation 4: Appoint an API Evangelist to Set and Communicate the API Vision. Firms adopting the focused or transformed value model appoint an evangelist, typically a senior technical person or an IT services guru with "TED Talk"-like charisma to make a compelling case for API-driven change. API evangelists can help develop an organizational culture and mindset that demands

the availability of data as a self-service capability, so that businesspeople can create "x-as-a-service" options on the fly with built-in security and governance guardrails. Evangelists can also set appropriate structures for controlling APIs—for example, an API library to revise, retire or expand APIs, or a governance mechanism for experimenting with new APIs when business managers propose new opportunities.

We found that some firms with mostly internally facing APIs successfully centralized the API evangelist role within the IT organization, as ESP did. On the other hand, we observed that in firms adopting the focused or transformed value model, business units define and budget for APIs for external consumption and partner with the IT organization for the development of the APIs. In some cases, an API committee or council, comprising technical and business leads, may have responsibility for API portfolio management. Regardless of the particular mechanism, we recommend that firms appoint an evangelist to promote APIs and to ensure that resources are available when new business opportunities are identified.

Tactical Recommendation 5: Identify New Partnering Opportunities and Structures. Once firms have successfully created API-enabled value-generating applications, we recommend that they explore opportunities to expand the impact of APIs, for example, by partnering with data keepers or platform owners or by identifying new areas of demand. For example, Home Depot (a U.S. home improvement retailer) extended its platform to include repair and installation services for products that it does not sell. Customers can use a Home Depot app to state the service they need, and service professionals can register with Home Depot. Through APIs, Home Depot can access manufacturers' product information and do-it-yourself instructions and further monetize the platform by cross-selling related products. Such API-enabled platforms can create an ecosystem of buyers and sellers, installers and repair professionals, as well as providers of financial products and warranties.

Concluding Comments

Digital innovation is and will continue to be a key strategic imperative as new technologies and associated features and functionality become available for commercial use. However, the proliferation of digital systems brings both business opportunities and business risks, and successful innovation will require the integration of diverse systems to ensure seamless data flows. Many firms focus on immediate needs, such as developing new service add-ons to existing products. Moreover, consultants and academics provide frameworks and advice for developing digital innovations, such as the application of machine learning for decision support. Nevertheless, in an era in which digital interfaces are core to combining data sources and providing capabilities for modularity, effective innovation is not possible without connecting digital systems—a process that until now has been tedious, error-prone and expensive.

A practical solution for this problem is for firms to develop an appropriate API infrastructure that is aligned with the business strategy and that can support the value-generating opportunities provided by APIs. Our research identified rich cases of firms that have developed robust digital innovations enabled by an appropriate and advanced API infrastructure. In some ways, the importance and role of such an infrastructure is akin to the iceberg metaphor in IT management: it is easy to observe the visible results and attempt to emulate them while being oblivious to the invisible enabling infrastructure and as a result, fail to achieve digital innovation objectives. We strongly believe that, in the current era of technology-enabled change, an integrating and interfacing infrastructure that enables computing devices to expose (demand pull) and subscribe to (event driven) data and capabilities located on other devices is a core strategic capability.

But that is just the start. API pioneers such as Amazon, Siemens, Maersk and Walgreens are setting new standards for "better, faster, cheaper" services and products. Moreover, by selectively opening their API infrastructures to supply chain and business partners within an API ecosystem, they are pulling the entire industry with them. In effect, these firms are redefining customer value and operational efficiency by employing API infrastructures to change the rules of the game. If this dynamic continues, a competitiveness gap will likely emerge and widen, with the laggards being those who have not properly addressed

the immense challenges of developing all the components (people, processes and technologies) of an appropriate API infrastructure. In this article, we provide insights that will enable fast-follower firms to plot a strategic course to continued competitiveness in a rapidly evolving and API-driven era of digital innovation.

Appendix: Research Methodology

We used an exploratory case research methodology[18] because it aligns well with our research topic, which is emergent and not well documented. Data collection and analysis proceeded in four phases.

Phase 1: Background

We explored the organizational context of APIs in use across a range of industries using secondary sources. The goal was to familiarize ourselves with different perspectives on APIs and their business applications and implications. To do so, we gathered, read and synthesized more than 10 vendor and consulting reports including those published by Mulesoft, Apigee, McKinsey and Gartner. In addition to application insights, this background material enabled us to identify firms employing leading API platforms, and then to perform separate database searches on those firms (Walgreens, Maersk, Siemens, Plantronics, etc.) to gather further contextual insights contained in news articles, presentations and publicly available videos. Overall, the background phase helped us to formulate a strategy for collecting and analyzing primary data from targeted nontech firms that span a spectrum of API applications and impacts.

Phase 2: Data Collection

To help answer our research question, we identified three organizations outside of the tech sector with legacy systems implemented over several decades (rather than "born digital" tech firms without such legacy systems) and conducted a set of wide-ranging interviews with each of them. We purposely chose organizations in three different industries (education, distribution and healthcare) because they represent different intensities of API implementation and business value generation, and collected primary data from each firm. Because of Covid-19 restrictions, we conducted and recorded online video interviews (rather than in-person interviews) with senior executives and middle managers over the course of several months. In all, we conducted 10 interviews, resulting in a total of 9 hours 54 minutes of recorded conversation. The interviews included semistructured questions on API infrastructure and API value generation. There were also specific questions about the background of the interviewee's role in the organization; high-level description of API infrastructure including people, processes and technologies; and leveraging API infrastructure for business value.

Phase 3: Data Analysis

We analyzed the collected data using standard guidelines. In line with our research question, which focuses on the monetization of APIs, we tagged the transcribed interviews according to business value dimensions (cost, revenue, intangible, innovation, etc.) and API infrastructure components (people, processes and technologies). Iteratively combining tags into themes revealed a spectrum of investment and return. We then iterated on how to position each of the three case organizations along the risk/return spectrum. Once the organizations were situated, naming schema were proposed and iterated, resulting in the final three: the efficiency value model, focused value model and transformed value model. Finally, in preparation for the final validation phase, each case was further developed to focus on its unique approach to API monetization by iterating back to third-party data so that we could further refine each value model.

Phase 4: Validation

We validated the three API value models in two ways. First, we shared our value model categorization with representatives of each case organization to get their input and feedback. This step yielded nuanced additions but no substantial changes to the models. Second, we presented the refined value model categorization to a group of more than 30 senior technology executives (none of whom were from the case organizations) in a 90-minute workshop and presentation and asked

18 Yin, R. K. *Case Study Research: Design and Methods* (4th ed.), Sage, 2009.

for their feedback and critique. This feedback resulted in slight refinements to the value models but confirmed the robustness of the overall categorization. For example, in one breakout session, executives were easily able to position their organizations in one of the three models and provided specific examples of how they were addressing opportunities and challenges within, for example, the efficiency value model.

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