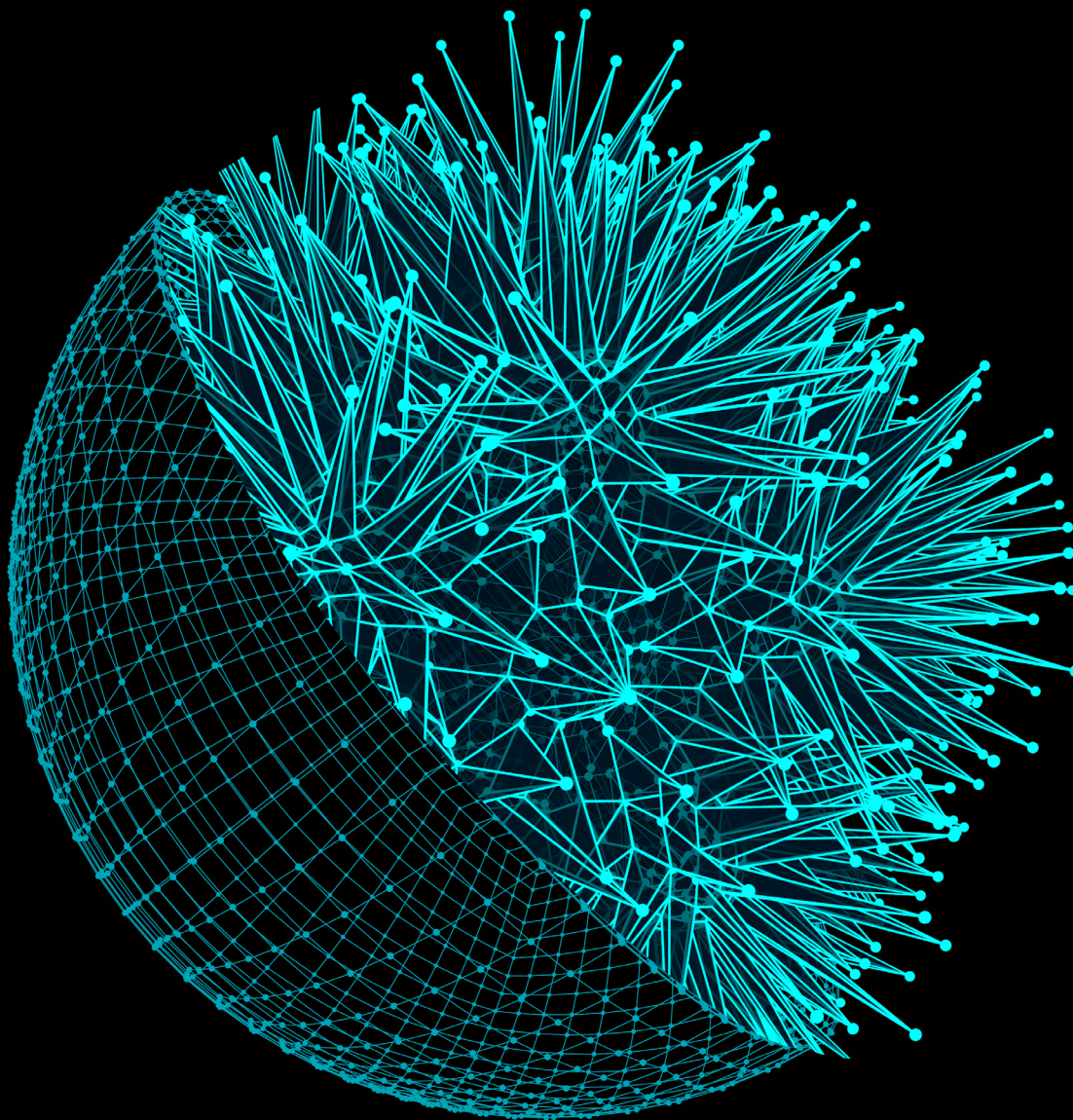


**Deloitte.**



**Digital opportunities for chemical  
enterprises: Creating lasting value**

# Introduction

The chemical industry is going digital. Many new, exciting capabilities are already in place, while many are under way. These changes could represent a more radical transformation than the industry expects. Backed by new digital capabilities, chemical companies are now better equipped to develop and produce more effective and efficient solutions. Advanced computing has also opened new growth avenues.

Aided and enabled by digital technologies, the chemical industry is poised to create more sustainable products with a lower environmental impact. The chemical industry will likely be at the heart of making cities more effective and efficient, meeting increasing global demand for energy and food, and developing new technologies that will be central to the next generation of consumer and transportation products. It has the potential to achieve all this while running with even greater efficiency to produce the volume and quality of products that have long been necessary to support ongoing economic growth and social progress.

## Time is ripe for chemical enterprises to disrupt rather than be disrupted.

Digital technologies are starting to play a prominent role in the chemical industry, but can they do more? Whether as a catalyst for disruption or a potential source of future revenue streams, a properly designed and deployed digital strategy may represent one of the biggest-ever opportunities for the chemical industry, especially when it is driven by a clear business strategy. Finding the proper strategy is key, especially given the new business models that the advent of digital technologies will bring to the industry. The diversity of options available means “finding” the proper strategy is most effectively done by adopting an “agile” culture.

Chemical companies can become more agile, innovative, responsive, and efficient by adopting digital technologies. The adoption will likely create a more intimate relationship among chemical companies, their customers, and end markets. Nonetheless, this does not take away the distinctiveness of a given chemical company depending on its business configuration, proximity to end markets, capabilities, and outside influences.

The key questions for a chemical company's management to ask are whether it is optimally positioned and configured to take full advantage of the digital opportunity and how far it can go by tapping into the adjacent, emerging ecosystems. In deciding where to play and how to win, there are a host of other questions to ask, such as:

- Where on the value chain and ecosystem do digital offerings allow the chemical enterprise to participate?
- How might digital initiatives change existing customer relationships and help build new ones?
- Where can digital capability strengthen and extend the company's value proposition to customers?
- What key technologies, offerings, and profit models will increase the enterprise's differentiation advantage?
- Which new capabilities (data science, marketing, consumer awareness/engagement, multidisciplinary science, etc.) are needed to support lasting value creation?

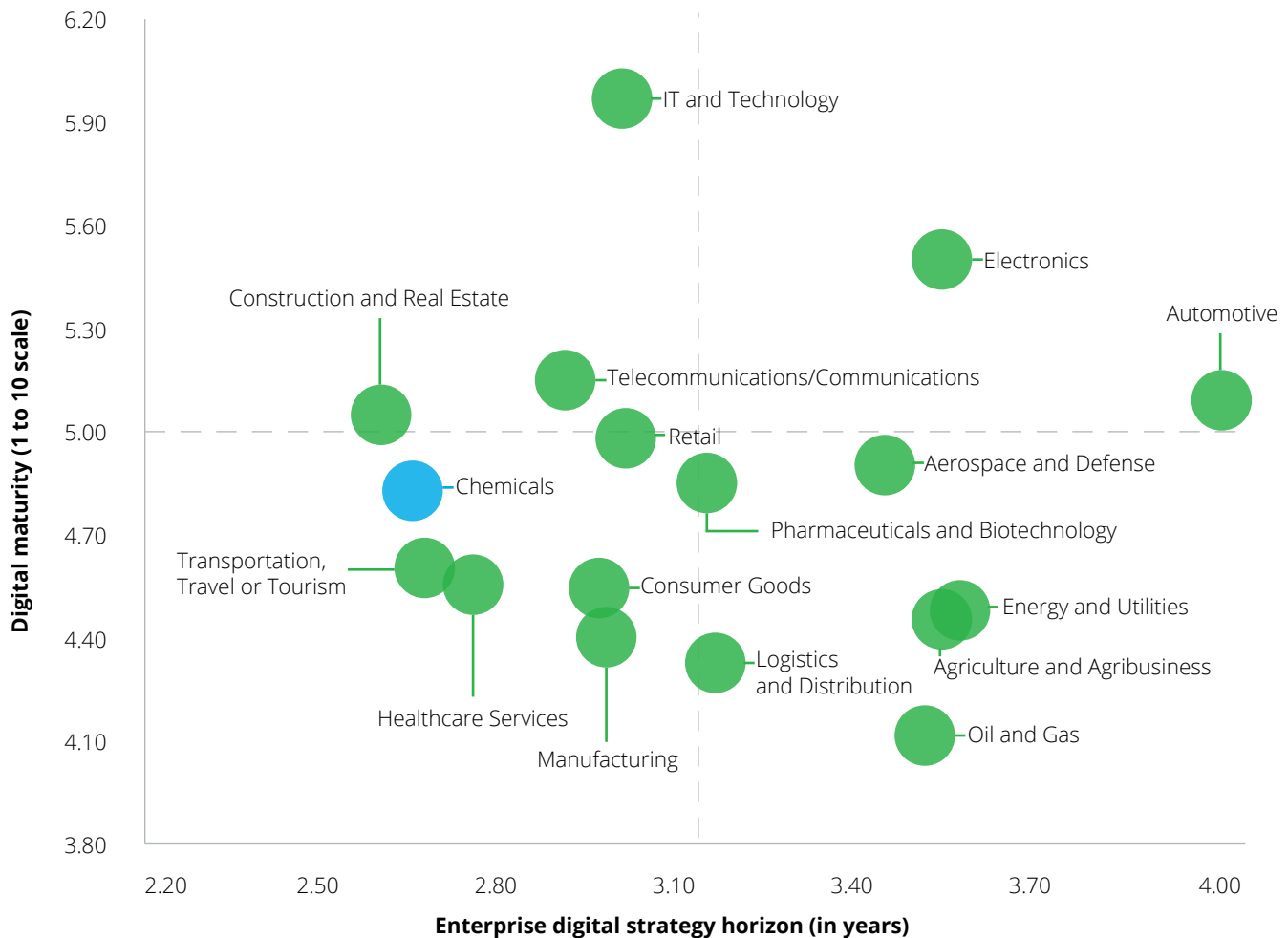
Until recently, the chemical industry was challenged by the slow pace of digital adoption and the pressing need for total innovation. Despite increasing digital maturity, the chemical industry lags other industries in digital strategy (see figure 1).<sup>1</sup> A focus on short-term gains means that long-term goals have been neglected, including investing in transformational innovation and the adoption of new business, profit, and collaboration models to generate sustained revenue growth.

In the *2016 Global Digital Chemistry Survey*, more than 7 in 10 chemical executives responded that internal digital initiatives were a way to improve organizational effectiveness and efficiency and enhance the customer experience. Nonetheless, only a few looked to digital as a tool to create new business or profit models.<sup>2</sup> In addition, only one-third of respondents said that digital initiatives offered the best opportunity to create new, high-growth product and service offerings.

In another recent survey, supply chain executives identified the top three goals of the digital supply network (DSN) as generating new business development opportunities, reducing operating costs, and improving pricing/margin. Yet the survey revealed that only 26 percent of chemical companies are currently implementing digital transformation initiatives across their supply networks.<sup>3</sup>

These insights show that the digital opportunity remains largely unexplored. The use of digital initiatives in other industries has resulted in a dramatic increase in business benefits, ranging from greater customer engagement to optimized supply networks. These success stories tend to make it more urgent for chemical enterprises to fully incorporate digital initiatives into their own strategies.

**Figure 1. Comparison of digital maturity and strategy horizon by industry**



Source: Deloitte Development LLC analysis of MIT Sloan Management Review and Deloitte University Press, *Achieving digital maturity: Adapting your company to a changing world*, July 13, 2017, <https://www2.deloitte.com/insights/us/en/focus/digital-maturity/digital-mindset-mit-smr-report.html>.

# Making the case for digital investments in the chemical industry

Is the success of digital initiatives in other industries the only reason chemical companies should follow suit? Not at all.

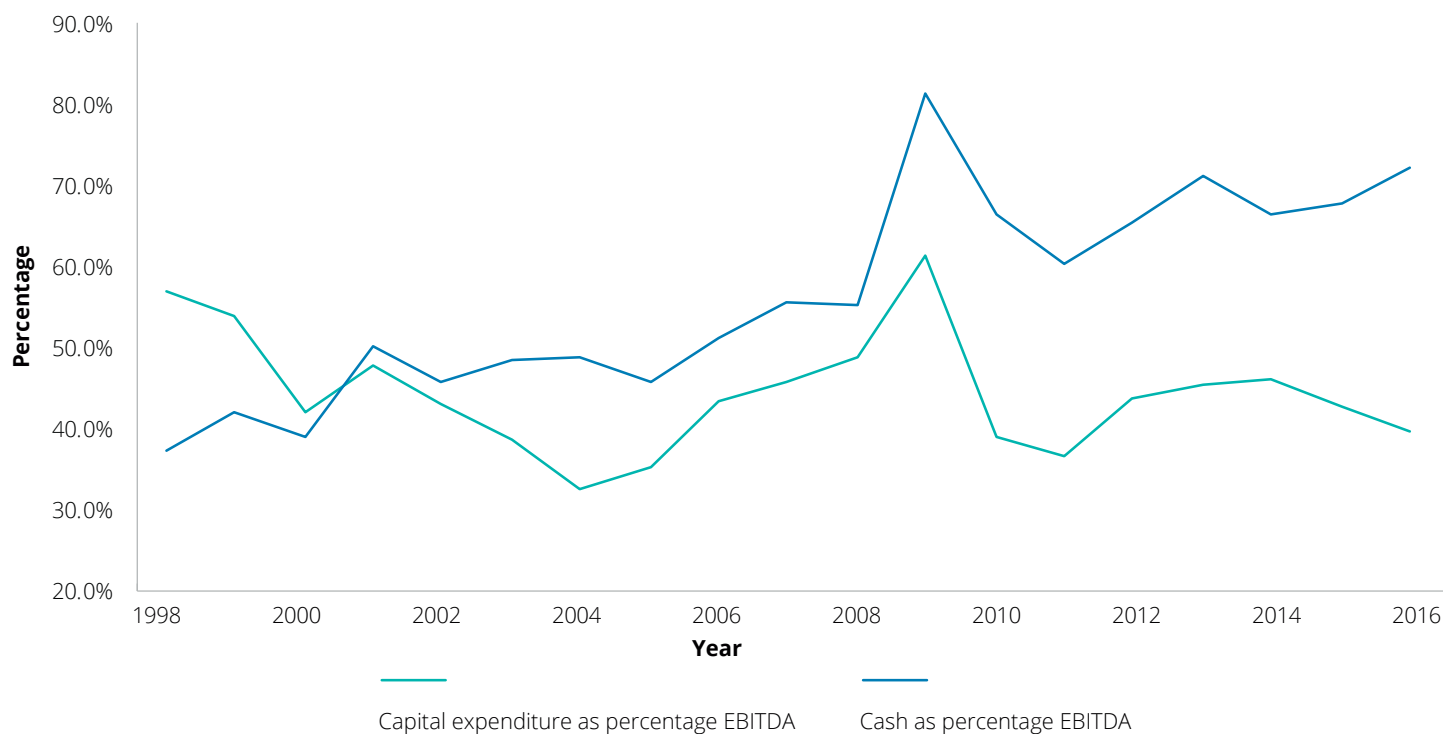
Historically, the chemical industry has improved performance by making investments and acquiring assets with growth opportunities. This is reflected in an improvement in the cash-to-capital expenditure ratio to 3.3 (see figure 2). The question is how to use this advantageous position to create value. Traditionally, the answer is either by adding new capacity, acquiring new companies, or innovating. Each brings its own challenges.

Investing in new capacity has been a sound medium- to long-term strategy in the face of geopolitical, economic, and other risks.

Mergers and acquisitions (M&A) have limitations. There has been significant M&A activity over the past few years, boosting chemical companies' valuations.<sup>4</sup> So, it is sometimes difficult for chemical companies to identify acquisition targets that align with their portfolios and growth aspirations at justifiable valuations. Additionally, large and complex M&A transactions often require a significant amount of management's time and focus to properly integrate acquisitions and achieve the value of the deal. It can be argued that such management time and effort may be better focused on other organic initiatives to grow shareholder value.

What about investing more in research and development (R&D)? While R&D offers intrinsic long-term value, R&D investments compete with short-term operational investments required to survive during times of uncertainty in the industry or economy. The gap between the short-term and long-term value generation may be bridged by better aligning R&D with other functions, leading to improved efficiency and effectiveness.

**Figure 2. Trends in capital expenditure and cash (as a percentage of profit margins) for chemical companies (1998 to 2015)**



Note: EBITDA is earnings before interest, taxes, depreciation, and amortization.

Source: Deloitte Development LLC, *The chemical multiverse 4.0: Promising future of the strong, decisive, and persistent chemical company*, June 2017, <https://www2.deloitte.com/global/en/pages/consumer-industrial-products/articles/gx-chemical-industry-trends.html>.

# Evaluating the strategic segmentation of the chemical industry

Digital initiatives present a significant opportunity to chemical manufacturers across sectors. On a small scale, digital technologies have been a unique catalyst to rally a company's value creation. Some companies are beginning to make large digital investments in response to changing environmental regulations, the rapid introduction of novel technologies, and the shift in consumer preferences and needs.

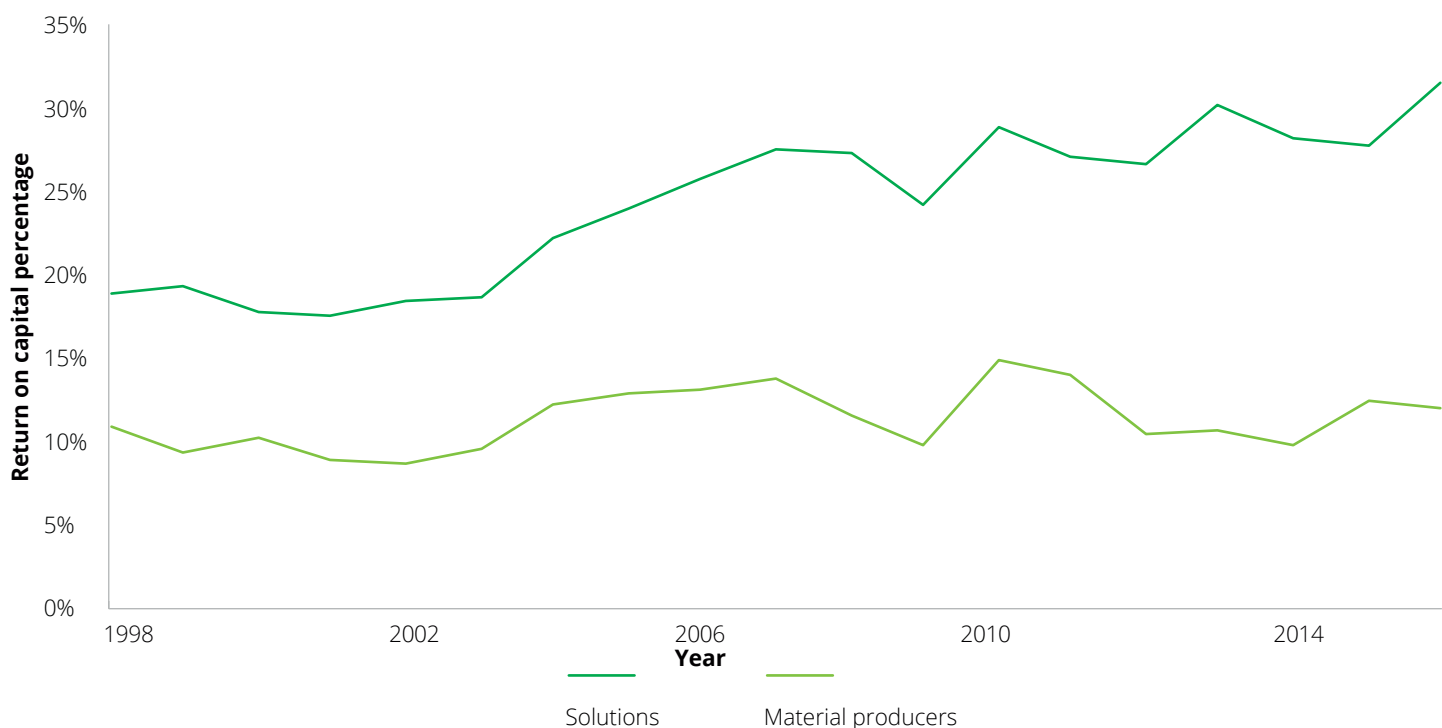
These opportunities are changing the basis for competition in the chemical industry and creating new, strategically distinct segments that differ from the traditional model of producing and selling chemicals.

*The chemical multiverse 4.0* revealed that chemical companies face a choice between two alternatives, namely:<sup>5</sup>

- A “solution” strategy focused mainly on selling outcomes (i.e., value-based packages in which products often come bundled with services or platforms).
- A “material” strategy focused mainly on manufacturing and primarily selling solids and liquids.

Over the past 18 years, the “solution” model has outperformed the “material” model, particularly after the Great Recession (see figures 3a and 3b). During that period, companies delivering solutions were more profitable (based on return-on-capital performance) and more highly valued (based on enterprise-value multiples). When delivering solutions, the priorities and incentives for both producers and customers become aligned through increased cooperation. The results are improved performance, reliability, and safety.

**Figure 3a. Financial performance by strategic choice on key metrics (1998 to 2016)**  
Return on capital (1998 to 2016)

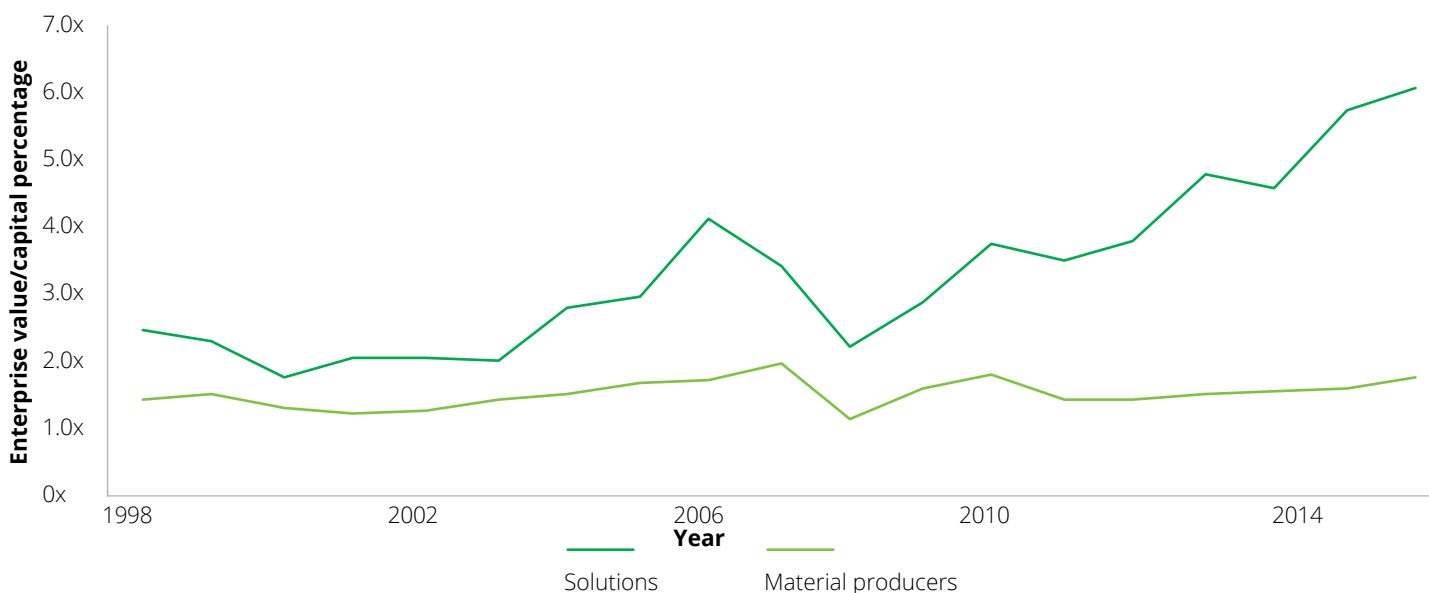


Notes:  
A “Solution” strategy mainly focused on selling outcomes (i.e. value-based packages in which products often come bundled with services or platforms).  
A “Material” strategy mainly focused on manufacturing and selling solids and liquids.

Figure methodology: Capital refers to “Total capital = Net fixed assets + Net working capital,” as used in the Deloitte Development LLP, *The chemical multiverse 4.0*, June 2017. Analysis is based on financial data of 344 global chemical companies extracted from S&P Capital IQ database.

Source: Deloitte Development LLC analysis of financial data of 344 global chemical companies extracted from the S&P Capital IQ database, April 2018.

**Figure 3b. Financial performance by strategic choice on key metrics (1998 to 2016)**  
Enterprise value/capital (1998 to 2016)



Notes:  
 A "Solution" strategy mainly focused on selling outcomes (i.e. value-based packages in which products often come bundled with services or platforms).  
 A "Material" strategy mainly focused on manufacturing and selling solids and liquids.  
 Figure methodology: Capital refers to "Total capital = Net fixed assets + Net working capital," as used in the Deloitte Development LLP, *The chemical multiverse 4.0*, June 2017. Analysis is based on financial data of 344 global chemical companies extracted from S&P Capital IQ database.  
 Source: Deloitte Development LLC analysis of financial data of 344 global chemical companies extracted from the S&P Capital IQ database, April 2018.

A closer look reveals that there are emerging strategic choices as chemical companies opt to become more "end-market intimate" (the y-axis) and "optimize systems and processes using digital" (the x-axis) (see figure 4a).

The transition from delivering products to delivering solutions involves increased end-market familiarity and a transition from a "push" to a "pull" strategy. The push strategy aims to develop and sell products that offer low competitive advantage but can be sold in bulk. The pull strategy aims to respond to market changes with flexible and creative responses. This vertical-axis metric assesses how the combination of digital and physical assets improves the building and maintenance of touch points with customers (i.e., end-market intimacy).

The horizontal axis represents efficiencies realized by reengineering the enterprise by using digital and exponential technologies (with the goal of becoming a digital chemical enterprise [DCE]).<sup>6</sup> With Industry 4.0 as a reference, the DCE approach employs digital and exponential technologies to meet end-market needs, drive competitiveness and efficiency, create more connectedness across

silozed functions, and innovate faster.<sup>7</sup> Using smart, connected factories, processes, and systems is but one intriguing example.<sup>8</sup>

The transition involves shifting approaches for enterprise optimization from one that focuses on transactions to one that emphasizes integrating and optimizing multiple systems and creating new configurations. The traditional approach seeks transactional advantages to optimize costs.<sup>9</sup> The DCE approach seeks configurational advantages to integrate and optimize the systems that drive the business.<sup>10</sup> Therefore, the DCE approach optimizes the organization and allocation of resources and capabilities at the enterprise level.<sup>11</sup>

Along this dimension (i.e., x-axis), innovative physical technologies (such as nanofabrication of distributed, modular microreactors) combine with digital technologies (such as robotics, blockchain, and machine learning) to unlock previously unrealized value. This new configuration enables both traditional asset and asset-light value-creation models—supported by accelerated innovation and low-manufacturing costs—to thrive and prosper.

Together, these emerging strategic choices create four distinct strategic segments in the industry (see figures 4a and 4b):

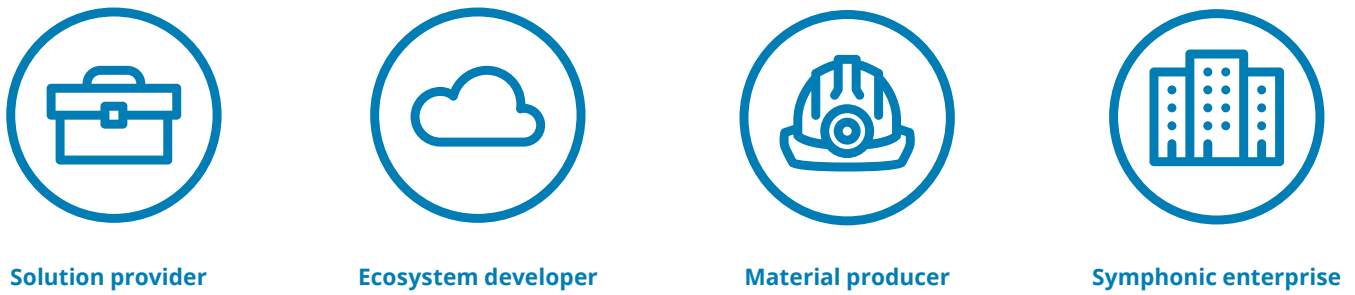
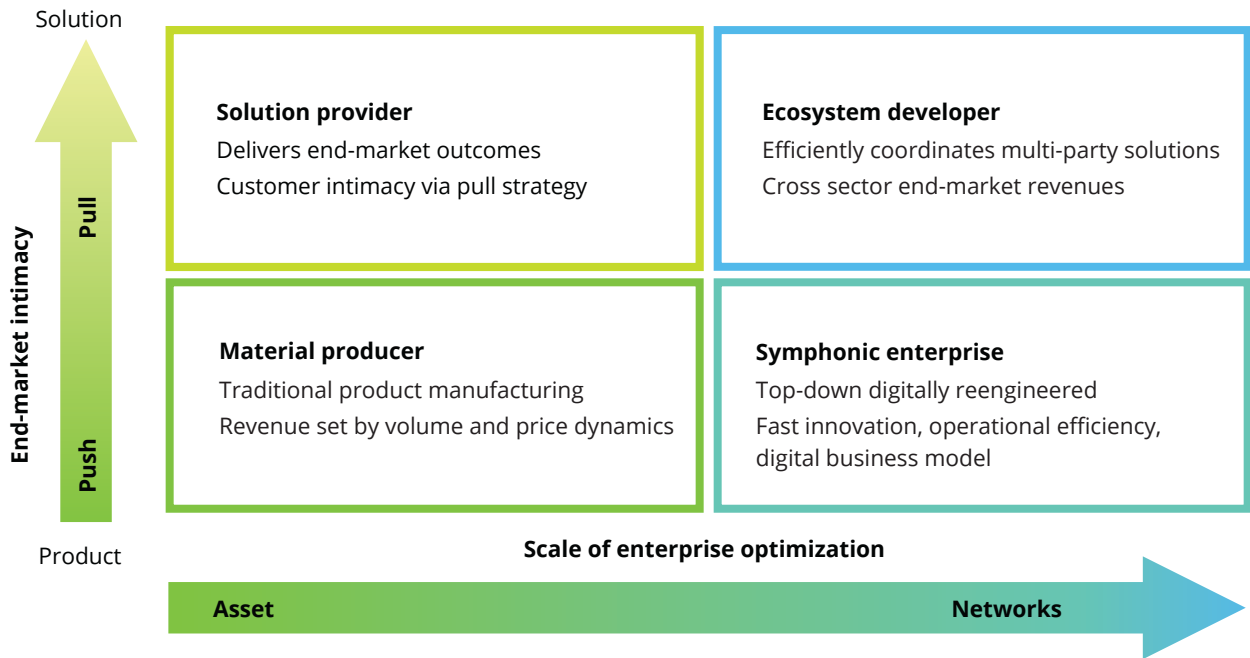


Figure 4a. Strategic segmentation of the chemical industry



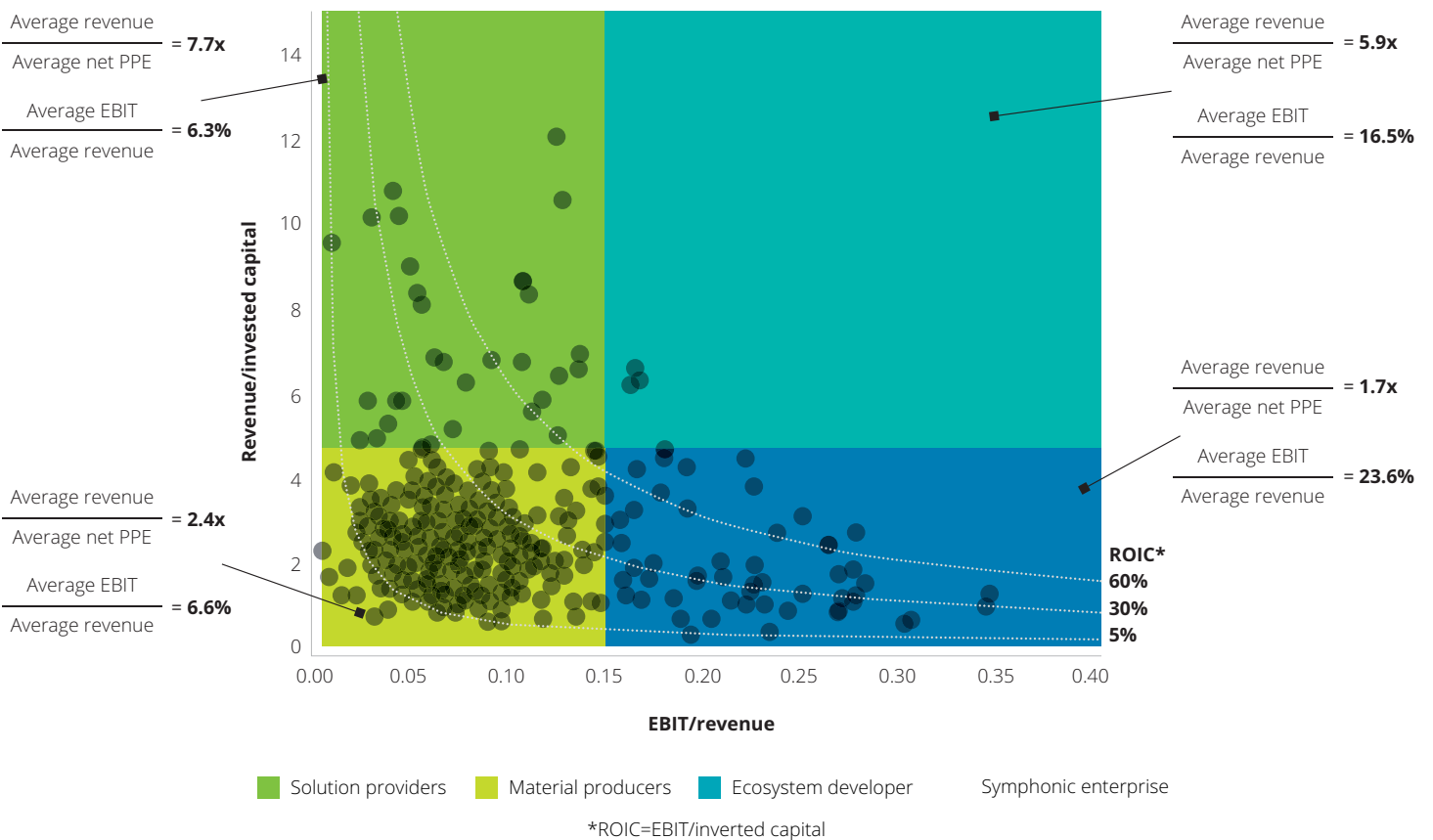
Note: EBIT is earnings before interest and taxes. PPE is property, plant, and equipment.

Source: Deloitte Development LLC, April 2018.

The research included in this report evaluates companies across the chemical industry, based on key metrics of enterprise optimization and end-market intimacy. Enterprise optimization is evaluated on the EBIT-to-revenue ratio that allows a comparison of companies of different sizes pursuing optimizations of different scales throughout the enterprise. End-market intimacy is evaluated on revenue-to-net PPE (property, plant, and equipment) to capture the customer's

willingness to pay for products and services. An analysis of how companies perform against these metrics enables their classification into the strategic dimensions (see figure 4b). Some are clearly placed in a specific strategic segment, while others appear to be in transition from material producer to another segment, typically to ecosystem developer or symphonic enterprise.

Figure 4b. Strategic segmentation of the chemical industry



Note: EBIT is earnings before interest and taxes. PPE is property, plant, and equipment. ROIC is return on invested capital.

Figure methodology: Pulled data from Capital IQ and performed seven-year averages on the metrics (Average on ratios). Used "Invested capital = Total assets - Goodwill - Inventory - Intangible assets ≈ Net PPE, which incorporates the value of all buildings, land, furniture, and other physical capital after depreciation, but disregards capital invested in other assets such as research and development. For simplicity, the strategic segments were classified using fixed thresholds, which were determined by clustering of like performance. Other performance characteristics were considered to test the output classification, such as new patents, types of revenue growth, and quality of business through publicly available information.

Source: Deloitte Development LLC analysis of financial data of 344 global chemical companies extracted from the S&P Capital IQ database, April 2018.



### 1. Material producer

Material producers follow the traditional model where revenues are mainly the product of volume and price.

This material producer dimension is made up of (1) natural owners that have advantages in terms of feedstock, assets, and balance sheet; and (2) differentiated commodities that are involved with a diverse group of assets, products, and markets. Companies in this category represent 90 percent of the chemical industry's total assets and generate about 85 percent of its profits.<sup>12</sup>

Currently, material producers mostly use digital technologies for core functions to improve their competitive positioning with (new) collaboration and operating models that embrace digital and exponential technologies. These may occur on the shop floor or in the front-end product process.<sup>13</sup> In the future, material producers are positioned to collaborate based on the available financial resources, a strong brand, deep knowledge, and trust within the industry that could move them to another strategic segment.

Without expanding the use of digital technologies, material producers may find their operating profits compressed as competing digital strategies are more widely adopted. Material producers may also be bombarded with unexpected developments in adjacent sectors and end-user industries. However, traditional methods and well-established business models mean that material producers generally enjoy lower risks—but also lower profitability.

### 2. Symphonic enterprise

The symphonic enterprise is a digitally reengineered enterprise transformed at all scales to meet end-market needs, innovate faster, and improve operational efficiencies.<sup>14</sup> A symphonic enterprise is one where strategy, technology, and operations work together in harmony across domains and boundaries. Symphonic enterprises have an advantaged position, due to differentiated capabilities, such as digital capabilities, advantaged assets, or access to low-cost feedstock. These companies also enable data-supported business models using new digital technologies that make their models difficult to replicate. Digital and exponential technologies are transforming business configurations by better connecting siloed functions and enabling collaborative innovation. Companies moving toward the symphonic enterprise dimension are more agile and have stronger profitability. Companies such as Albemarle, John Deere, Monsanto, Procter & Gamble (P&G), and SABIC are moving toward becoming more symphonic.

Some material producers appear to be embracing the “symphonic enterprise” strategic choice to improve their performance. BASF appears to be implementing digital transformation along its entire value chain, seeking specific benefits by connecting information found in separate silos. For example, it has built a supercomputer for global chemical research to achieve data-driven innovations to improve products, workspaces, productivity, and competitiveness.<sup>15</sup>

Evonik also appears to be in transition—by 2020, it will invest €100 million to drive a large-scale, coordinated digital strategy within the company and with new external collaborators. These large-scale plans are reflected in the creation of the new chief digital officer role.<sup>16</sup>

### 3. Solution provider

With digital and exponential technologies at the helm, some chemical companies have accelerated and augmented their position as solution providers. Solution providers focus on addressing end-market needs and achieve their goal of gaining customer intimacy at the end-market level.<sup>17</sup> They create new revenue streams through novel uses of materials and by bundling their products with services or platforms of multiple suppliers and customers. Value is added through innovations that not only allow the specialized performance of the material for its intended end use, but also combine products and services (and/or platforms) when required. Solution providers, such as Lockheed Martin, have high profitability with a generally medium risk profile.

### 4. Ecosystem developer

Ecosystem developers collaborate with multiple entities (companies, universities, national labs, etc.) to better serve customers and markets.<sup>18</sup> These entities form an industrial ecosystem where they share and process information at the industry level to solve complex problems and create new opportunities. In an industrial ecosystem, suppliers, manufacturers, distributors, other players, and end consumers share information pertinent to maintaining supply chains and fueling growth from insights obtained through data collection. An industrial ecosystem may use digital technologies to develop solutions that no single company could make individually. Consequently, ecosystem developers gain access to new revenue streams by working in coordination with other entities without having to add many new assets.

The largest of these opportunities lies in emerging end-market needs. By integrating capabilities, new solutions can be developed to address unmet and emerging needs across multiple industries. Ecosystem developers use digital technologies to share data safely, attribute activities financially, and build business cases.

By turning complex unmet needs into attractive opportunities, ecosystem developers create new revenue streams. They do so by combining capabilities from different sources to form and engage ecosystem business models, such as intelligent energy distribution, global plastic reverse supply chain management, farm-to-table integration, clean water, microbiome pharmaceuticals, wellness, and the future of mobility. Focusing on the outcome incentivizes multiple parties to align and achieve the control necessary to maintain a healthy ecosystem. This strategy carries the highest risk among the segments, albeit with corresponding high profitability.

Companies such as Google, Amazon, and IBM appear to aspire to be ecosystem developers. Some of their models are beginning to influence the chemical industry.<sup>19</sup> For example, Ecolab is now providing Internet-of-Things-based services to treat water. This is achieved by combining chemical and digital capabilities.

Eastman is focused on activating ecosystems to bring new innovations to market. It often engages across multiple steps in the value chain, including the end consumers, to create the right demand conditions and alignment. For example, marketing campaigns for microfibers focused on the textiles industry are targeted to brand owners.<sup>20</sup> Eastman's Tritan copolyester is marketed and branded throughout the selling process, including in the promotional taglines on the final product packaging.<sup>21</sup>

Eastman uses digital technologies to optimize its own capabilities and coordinate strategies.<sup>22</sup> It uses digital technologies to automate and streamline production processes to take advantage of unused capacity. It also leverages process data to coordinate supply chain logistical decisions in areas such as procurement.<sup>23</sup>

Siemens has been a long-term partner to the chemical industry and likely aspires to be an ecosystem developer by positioning itself as an Industry 4.0 leader (e.g., using digital twins to both train the workforce and optimize oil and gas energy use) and actively seeking to shape the ecosystem by offering technical services and financial support.<sup>24</sup> Through financing and collaboration, Siemens aims to spur innovation of sustainable digital solutions.<sup>25</sup> These initiatives combine technology, business expertise, and talent to address emerging demands in infrastructure, machinery, and energy-generation solutions.

Another long-term partner of the chemical industry is P&G, which has actively pursued the role of ecosystem developer since 2000 by creating a centralized ecosystem.<sup>26</sup> As a part of its "Connect and Develop" program, P&G uses digital initiatives to transform its relationships with chemical suppliers. It uses high-performance computing (HPC) that models product performance.<sup>27</sup> The HPC technology enables P&G to modify—efficiently and quickly—the formulation of its products at the molecular level by reducing the steps involved in product design and prioritizing convenience.<sup>28</sup> Apart from using supercomputing, P&G also crowdsources ideas from different stakeholders, thus involving and influencing almost the entire ecosystem of consumer packaged goods.<sup>29</sup>

# Looking at end-market intimacy: Assessing the size of the opportunity by strategic segment

Potential competitive advantage in the chemical industry will likely be determined by how companies are positioned to act on the digital opportunity to capture value. The size of this opportunity correlates with the size of the intermediate- and end-markets as products manufactured by the chemical industry are present in 96 percent of all manufactured goods.<sup>30</sup> In 2016, the US chemical industry was worth \$800 billion in global chemical shipments, adding \$377 billion in value to the entire US economy.<sup>31</sup>

The chemical industry and served industries are evolving, and new industrial ecosystems (such as mobility and wellness) are emerging. This will create new opportunities for the chemical companies to develop advanced material solutions and services to serve new needs and to capture more added value to other industries. This could mean more than \$1 trillion per year of additional value.<sup>32</sup>

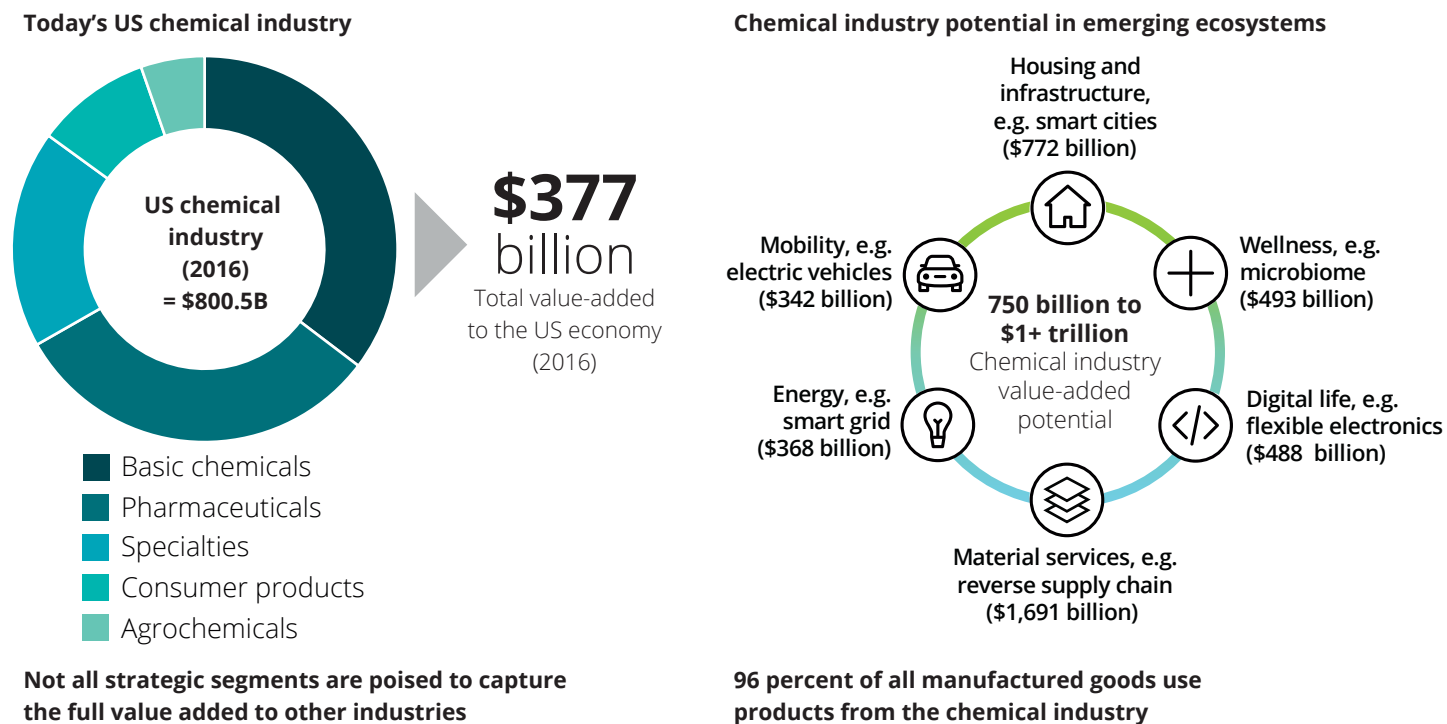
However, not all companies are poised to capture the full value added to other industries. On one hand, material producers will likely be limited to competing in similar business-to-business (B2B) industries providing materials as they do today. Solution providers, on the other hand, will possibly have greater opportunities to capture additional value as a result of delivering on outcomes and being more “in touch” with the end market.<sup>33</sup> Symphonic enterprises also have access to the “new value,” particularly when configured to serve a specific end-market need (using a unique push strategy) and could be poised to become ecosystem developers.

That said, the opportunity is even larger when the value added by industrial intermediate- and end-market ecosystems is considered. Digitally enabled disruptions in key industries, such as transportation, computers and electronics, semiconductors, agriculture, and housing and construction, can affect business models across the chemical industry. Empowered by new digital technologies, the emergence of new entrants, increasing bargaining power of existing downstream players, and the evolution of end-product design, companies are now under increasing pressure to reduce the time to market.<sup>34</sup>

Combinations of capabilities, such as high end-market intimacy and high configurational ability, can help a chemical enterprise become an ecosystem developer. This enables the enterprise to have direct access to one or more of the emerging end-market ecosystems, such as mobility, housing and infrastructure, and life sciences, among others. As a result, ecosystem developers will be able to tap into the greatest opportunities ever presented to chemical enterprises, which could exceed \$1 trillion per year (see figure 5).



Figure 5. Potential intermediate and end-market opportunities



Note: Only key dependent industries are shown in the figure.

Source: American Chemistry Council, 2017 *The Business of Chemistry*, Copyright 2017.

Note: Value added potential is based on 2016 figures.

Source: Deloitte Development LLC analysis of data from Statista, April 2018.

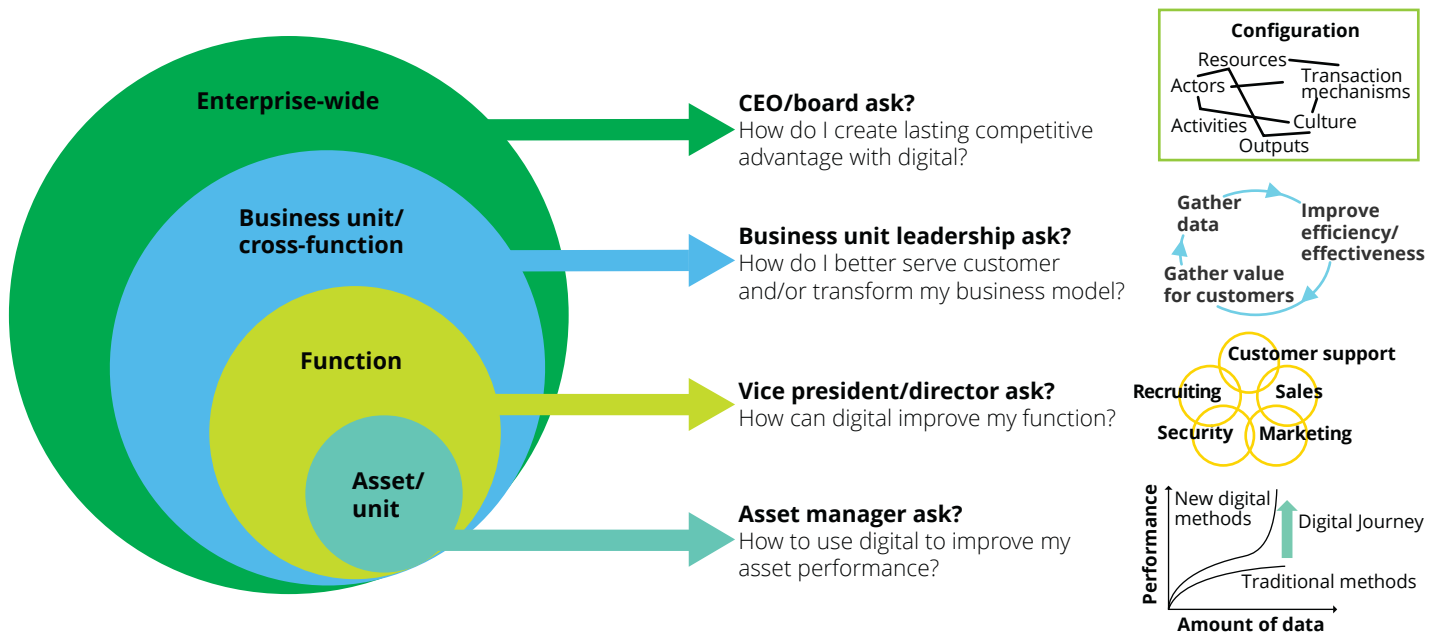
The following sections discuss how to dissect the digital opportunity by first exploring how chemical enterprises can leverage digital in the current industry scenario.

# Enterprise scale optimization: Leveraging digital technologies to exploit the opportunity

Digital technologies can be applied in various scenarios ranging from small-scale, asset-based to large-scale, enterprise-wide. How digital technologies are used at different scales in an enterprise determines whether they will enable transactional or configurational advantages. Transactional advantages arise from optimizing costs. Configurational advantages arise from optimizing the network of business processes by utilizing enterprise-wide information feedback to improve performance and resource allocation. The leading sources for lasting value creation at different enterprise scales are mentioned below (see figure 6).

1. When used at a smaller scale in an organization, namely at levels that require coordination between individual people or assets within a unit, the role of digital is to provide productivity improvements. Improvements are achieved by using novel algorithms on the available data, most notably deep learning, where performance increases with the amount of data available. This can lead to new product and service offerings, innovative customer engagement models, new profit and operating models, and optimized supply networks.<sup>35</sup> Using digital technologies at smaller scales only does not lead to a lasting competitive advantage because competitors can easily imitate these new capabilities.<sup>36</sup>

**Figure 6. Building competitive advantage by using digital capabilities**



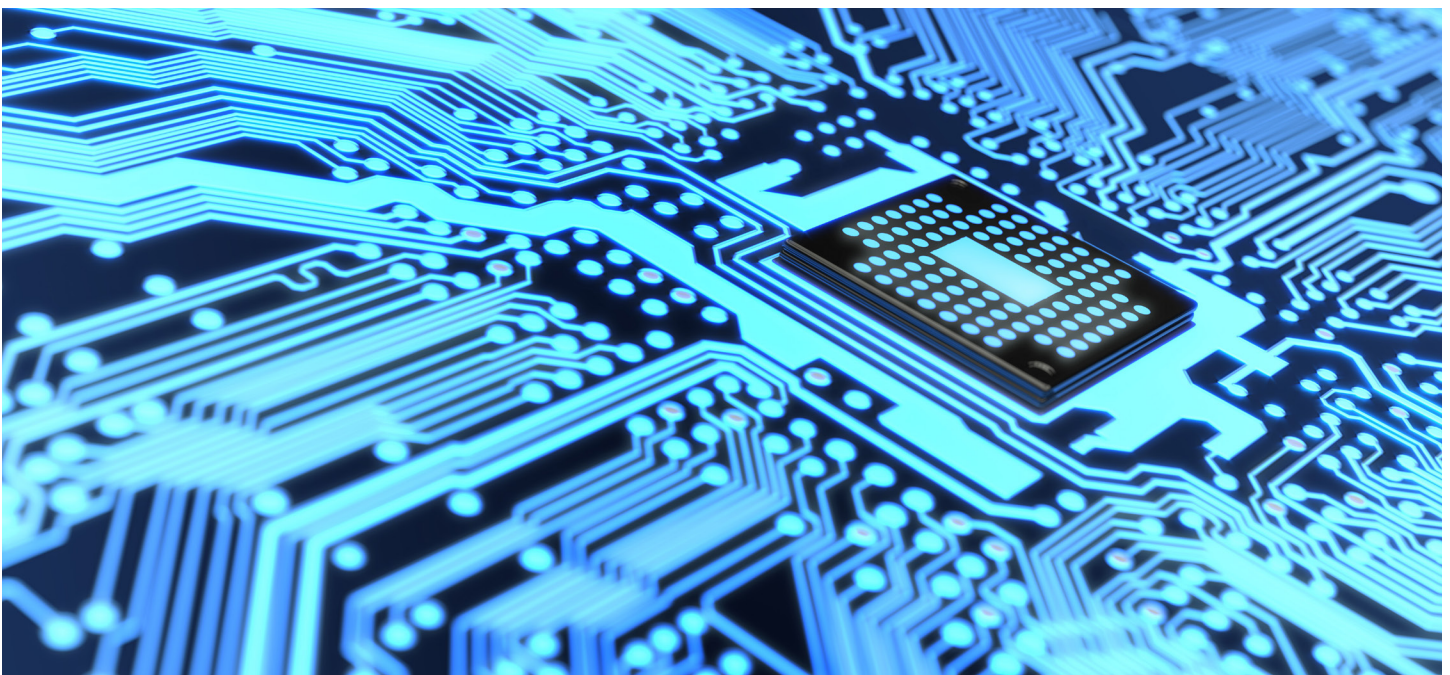
Source: Deloitte Development LLC, April 2018.

2. At larger scales, companies adopt machine learning and artificial intelligence through the development or acquisition of autonomous enterprise capabilities that perform a large fraction of a traditional function, such as marketing, sales, recruitment, and customer support.<sup>37</sup>
3. A reinforcing competitive advantage can be built by developing a business configuration that attracts new customers based on efficiency and effectiveness improvements, which in turn are generated from data accumulation and analysis. If additional data can be captured from these customers at a rate that competitors cannot match, the end-to-end cycle becomes a source of competitive advantage.
4. To maintain this competitive advantage, companies can use digital technologies at an enterprise-wide scale to develop a digitally assisted strategy. Key considerations are the pace of innovation and its scope for bringing enterprise-wide change. Digital transformation in each of the multiple aspects of the *Ten types of innovation* can be a great catalyst for sustaining differentiation.<sup>38</sup>

Traditional approaches to enterprise optimization use enterprise resource planning (ERP) systems, which are highly centralized and slow to evolve. The ERP systems enable integrated data-sharing and automation of back-office functions (manufacturing, accounting, etc.) and, more recently, front-office functions (customer relationship management, supplier relationship management, etc.). The ERP systems provide value through a modular structure, universal data access, and task automation.

Recently developed digital technologies enable the creation of new transactional and configurational advantages by, for instance, enabling higher-level autonomous functions using cognitive tools. These novel systems enable companies to target value propositions that combine data availability with advanced algorithms.

The implication is that there are entirely new categories of enterprise systems that can be deployed in an agile fashion today. Examples include using a microservices-based architecture that departs from the traditional architecture. To be actionable, novel digital tools, such as predictive maintenance and cognitive sales engines, must provide a path to connect to any existing ERP system during execution. To be robust and rapidly scalable, new systems should be loosely attached to the existing systems so that they can maintain agility, allow fast algorithm evolution, and enable the use of different technology platforms.



# The evolving digital chemical enterprise: Realized opportunities

Chemical enterprises are well aware of the capabilities being enhanced by digital and exponential technologies in their intermediate- and end-market segments. Nonetheless, only a small number of chemical enterprises are acting based on this awareness. For instance, according to *Digital Transformation: Are chemical enterprises ready?*, a report based on the 2016 *Global Digital Chemistry Survey*, only 13 percent of executive respondents from the chemical industry agree that their companies monitor adjacent sectors and indirect competition to forecast asymmetric threats with respect to

the development of digitally enabled ecosystems. Of course, those monitoring capabilities across their end markets and value chains are better placed than their peers to effectively take advantage of the opportunity before it becomes a threat (see figure 7).

In view of these developments, a few chemical companies are implementing the DCE framework by adopting digital and exponential technologies to enhance customer engagement, increase innovation potential, and achieve asset optimization across the value chain.

**Figure 7. Digitally enabled capabilities across the value chain are affecting chemical manufacturers**

## Innovate

### Accelerated learning:

Advanced simulation and optimization capabilities enable rapid learning in R&D and strategy

**BASF** using multifaceted digital strategy to achieve 10x improvements in innovation speed. Techniques range from using supercomputers for complex simulations to developing customer collaborations.

## Make

### Advanced manufacturing:

Redefining the ways system manufacturers operate and offer products and services (e.g., 3D printing, nanotechnology)

Companies like **Hewlett Packard (HP)** are collaborating with **chemical manufacturers (Evonik, Arkema, BASF)** for developing production-ready 3D printing materials for their proprietary Jet Fusion 3D printing technology. In this way, HP and its partners are broadening the overall portfolio of 3D printing materials—plastic, ceramic, and metal.

## Market

### Data-enabled solutions:

Moving profit models from equipment/ product to software/ solution leveraging the full potential of data generated by sensors or apps

As part of Fuse® Connected Services offering, **AGCO** now provides farm optimization services to its customers through its partnership with **Aglytix** and **Farmobile**. This new service provides actionable insights to enable farmers to reduce waste, increase yield, and optimize fleet management.

## Sell

### Online marketplaces:

Addressing given segments by first creating price transparency then introducing value-added services

Third-party online marketplaces like **Molbase.com** (China) or **Kemgo.com** (US) are already disrupting the B2B chemical business which includes petrochemicals, as well as plastics and fertilizers. They also provide supply chain, logistics, and payment services to their suppliers.

## Distribute

### Ubiquitous distributor:

Upgrading positions (under elaboration) via better cost competitiveness and new value-added services to take away from upstream or downstream

**Global Distributor** has already integrated their legacy customer relationship management (CRM) platforms with mobile cloud solutions to have a 360-degree customer insight. Some distributors like **Brenntag** have heavily invested in digital initiatives to boost value-added services and expertise given to chemical manufacturers.

Sources: Deloitte Development LLC analysis of various articles (April 2018) including BASF, "BASF selects HPE to build supercomputer for global chemical research," <https://www.basf.com/en/company/news-and-media/news-releases/2017/03/p-17-152.html>, March 17, 2017; 3ders.org, "BASF accelerates development of 3D printing materials for HP Jet Fusion 3D printer," <http://www.3ders.org/articles/20161102-basf-accelerates-development-of-3d-printing-materials-for-hp-jet-fusion-3d-printer.html>, November 2, 2016; BusinessWire, "AGCO announces development partnerships with Aglytix and Farmobile," <http://www.businesswire.com/news/home/20161206005971/en/AGCO-Announces-Development-Partnerships-Aglytix-Farmobile>, December 6, 2016; Plastics News, "Online material supplier to make first deliveries," <http://www.plasticsnews.com/article/20161019/NEWS/161019842/online-material-supplier-to-make-first-deliveries>, October 2016; Huffington Post, "Univar finds a silver lining in the mobile cloud," [http://www.huffingtonpost.com/chris-oconnor/univar-finds-a-silver-lin\\_b\\_3623767.html](http://www.huffingtonpost.com/chris-oconnor/univar-finds-a-silver-lin_b_3623767.html), September 18, 2013; and ICIS Chemical Business, "Distributors Add Value in Europe," [http://www.terchemicals.com/media/pdfs/news/ICIS%20CB\\_Top%20100%20Distr%202015\\_Jul2015.pdf](http://www.terchemicals.com/media/pdfs/news/ICIS%20CB_Top%20100%20Distr%202015_Jul2015.pdf), July 20–26, 2015.

### How can digital technologies enhance customer experience and engagement?

Digital technologies have a greater role to play than previously thought in driving customer engagement and satisfaction. They can be used to not only unlock new customer insights, but also constantly engage with customers while monitoring their evolving needs.

- **Discerning satisfaction and unmet needs:** Customers are more connected, aware, and alert now than ever before. The evolution of e-commerce and its effect on customers in terms of choice, convenience, and “nearly in-store experience” have had a profound impact on the traditional B2B marketing and sales process. For example, 59 percent of B2B customers do their research online and prefer not to interact with a sales representative.<sup>39</sup> Additionally, 53 percent of B2B customers find online information-gathering superior to interacting with a sales representative.<sup>40</sup>

Unfortunately, few chemical companies have developed digital commerce capabilities. This means that their sales representatives and channel partners often lack insight into what the customer wants. To a significant extent, the adoption of exponential technologies, combined with data science, can help address these evolving needs. For instance, machine learning and predictive analytics can help sense demand and enable mass customization to match offerings to an individual customer’s needs.

- **Engaging in authentic dialogue:** Anecdotal evidence suggests that many companies, including those in the chemical industry, have launched mobile apps to enhance customer service and experience. Mobile apps enable companies to better render services, engage a specific consumer demographic segment (such as Gen Y), and ease the pressure on existing customer service channels. At the same time, investing in popular digital media can help chemical companies strike a chord and maintain an authentic image in the minds of consumers. Companies like DSM regularly monitor their social-media channels and other trends to measure how well their content is generating product interest and awareness among the broader audience.<sup>41</sup> DSM constantly tries to recognize trends, generate consumer insights, and create demand for its products by using different types of social-media ambassadors, such as bloggers, professionals, and influencers.<sup>42</sup>

- **Reaching out to the next generation:** The greatest potential purchasing power belongs to either Gen Y or Gen Z. It is imperative that chemical manufacturers constantly look toward their tastes, preferences, and likes and dislikes, and design products and marketing campaigns accordingly. A rigorous analysis—using advanced analytical techniques—of point-of-sales data can provide chemical manufacturers with valuable end-consumer visibility.

Some chemical companies, including Dow Chemical, are using social media not just to educate and train the next generation, but also to create open communication channels between their scientists and other stakeholders, such as customers, partners (universities), and future employees.<sup>43</sup> The company is also able to connect its corporate values and community involvement with products of interest and at the same time communicate with a wider audience via social media.<sup>44</sup>

### Can digital platforms boost innovation and unlock future growth opportunities?

Digital platforms help chemical enterprises find new sources of growth through product innovation. The discovery of new chemicals and materials can be made easier and faster by using digital and exponential technologies, while crowdsourcing platforms can open new avenues for innovation-led growth.

- **Chemicals/materials selection:** Similar to the Human Genome Project, the US government-funded Materials Genome Initiative (MGI) aims to increase the pace of advanced materials discovery, innovation, manufacturing, and commercialization through joint collaboration among US government departments, companies, universities, and national labs.<sup>45</sup> The first and foremost objective of the initiative is to create a single database of every known chemical and material, accessible by any interested chemical manufacturer. This will help reduce the time required to discover and commercialize new materials. Similar repositories can be made possible because of digital developments, such as lower data-storage costs, high-performance computing, and advanced analytics.<sup>46</sup>



- **Processing technologies and performance modeling:**

Once selected, specific chemicals and materials must be tested in different permutations and combinations to get to the specific functional properties required in the final product. Before the advent of supercomputing, this process was time-consuming and expensive. Now, as a part of the MGI, institutions like Rensselaer Polytechnic Institute have included new big-data analytics of materials using supercomputers in their research priorities. They are also advancing materials discovery and analysis with IBM Watson's natural language capabilities.<sup>47</sup> High-performance computing can also be used to reverse engineer materials and chemicals so that chemical manufacturers start with the function they want in the final product and back-calculate, using computer simulations, the chemicals and materials most compatible with the desired properties.<sup>48</sup> Manufacturers can then use advanced prototyping techniques, such as 3D printing, to test the product physically by applying digital tools, such as computer-aided design.<sup>49</sup>

- **Achieving market acuity:** Chemical manufacturers should first understand the market opportunity as a function of end-user-defined performance and economic requirements, and then strategize accordingly.<sup>50</sup> For this, it is important to know the pulse of the customer and the consumer, as determining unmet needs can be a key differentiator. With Industry 4.0 connectivity, monitoring, and analytics, chemical companies can have direct visibility and interaction with their customers' operations and can provide real-time recommendations to optimize those operations and improve the design of their customers' facilities.<sup>51</sup>

At the same time, crowdsourcing platforms, enabled by digital technologies, can not only help gauge consumer sentiment about a new product, but also generate ideas to make it more appealing to the target segment. For example, AkzoNobel, the Dutch multinational chemical giant, pursues open innovation through its online portal, including soliciting partnerships and research ideas from any entity. The company connects with intellectual property owners or partners who want to co-create products, then matches the proposals submitted with its business needs and funds the feasible ideas or projects.<sup>52</sup>

- **Business management:** Support services that require repetitive tasks can be automated through digital technologies. Using an agile methodology, Bayer has created a global digital platform, Data.One Project, to standardize and centralize the reporting and planning processes for countries, functions, and business units. Although each business unit has specific needs, Bayer was able to use state-of-the-art database software and a data visualization platform to deploy dashboards that transformed existing reporting practices. Building on this success, the company is contemplating extending this platform to other areas of business activity beyond finance, such as operations.<sup>53</sup>

#### What can digital technologies do for chemical assets?

The asset-heavy nature of the chemical industry makes it a ripe candidate for digital transformation. By making existing assets intelligent and more efficient and workers safer, chemical manufacturers can devote their resources to other priorities.

- **Production and operations:** Industry 4.0 technologies can make a chemical plant more efficient by anticipating real-time demand and optimizing resource utilization around it. A case in point is that of BASF. The company's demand forecasting is based on a new predictive analytics approach and sophisticated information technology. The predictive models combine company data and economic information that are then matched to the market environment for calculating future product demand. This way, BASF can effectively forecast accurate demand for its product segments and plan for contingencies accordingly at the factory level.<sup>54</sup> At the same time, BASF is using digital technologies to make production safer and more efficient. By feeding live data collected through sensors into special analysis software that also takes historical operations data into consideration, the company can predict maintenance downtimes and coordinate maintenance and production processes.<sup>55</sup>
- **Logistics/supply chain:** Digital and exponential technologies have a greater role to play in logistics planning and supply chain management, especially when it comes to maintaining a company's cost competitiveness. For instance, Dow has launched executive sales and operations planning to forecast its transportation needs months in advance. To monitor its distribution centers and carriers, Dow determines the balance between supply and demand of its products and uses executive logistics demand planning to give monthly logistics forecasts to carriers and third-party logistics providers. Through this planning software, Dow has achieved substantial cost savings and optimized its fleet management by reducing the need for dedicated transportation equipment.<sup>56</sup>




### Pulling it off: Things to ponder before taking the digital plunge

Activities on the digital playground are driven by a clear business strategy, one that is fully integrated with an enterprise's digital strategy to drive growth. The strategy should also consider trends related to digital and exponential technologies and how these affect different customer segments. In short, never start the journey without a good map.

Before taking the full digital plunge, chemical enterprises can ask themselves what best suits their business when it comes to driving value creation. What role will customers, data, and platforms play in extending competitive advantage? How can they improve existing business and operating models?

Chemical enterprises should also consider different combinations of digital levers. A one-size-fits-all approach will not work in today's dynamic environment. A little experimentation with radically different digital designs—with varying emphasis on innovation, differentiation, or capturing more value—can yield unexpected, positive benefits in the long term. In this regard, chemical enterprises can capitalize on digital innovation laboratories to test in smaller geographies before a global rollout, as well as test with key customers by involving them early in the development process. Chemical companies are unique and must also find the solution that works best for them. They can begin with asking the questions that were posed at the beginning of this report: Are they optimally positioned and configured to take full advantage of the digital opportunity? How far can they go by tapping into the adjacent, emerging ecosystems?

The time is right for chemical enterprises to begin their digital journeys in earnest. They need to keep redefining and retesting their strategic choices, leveraging digital technologies to innovate. To count on continued product and service breakthroughs, companies must embed digital technologies in the entire organization as a core capability.<sup>57</sup> This means transforming the entire chemical enterprise with a clear definition of the strategy, the role of digital technologies, as well as the approach to innovation, the incorporation of appropriate organizational and talent models, and the relevant business metrics and individual incentives. In closing, three questions should be considered:

-  What is needed to improve the customer's real experience?
-  What new capabilities are needed to accelerate performance and to best compete in the future?
-  What does the new business model look like with digital capability?

The role of senior leadership in sounding the bugle and inciting a call to action to bring about this digital change cannot be overemphasized.



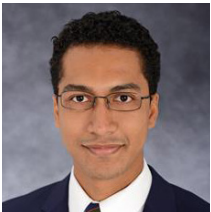
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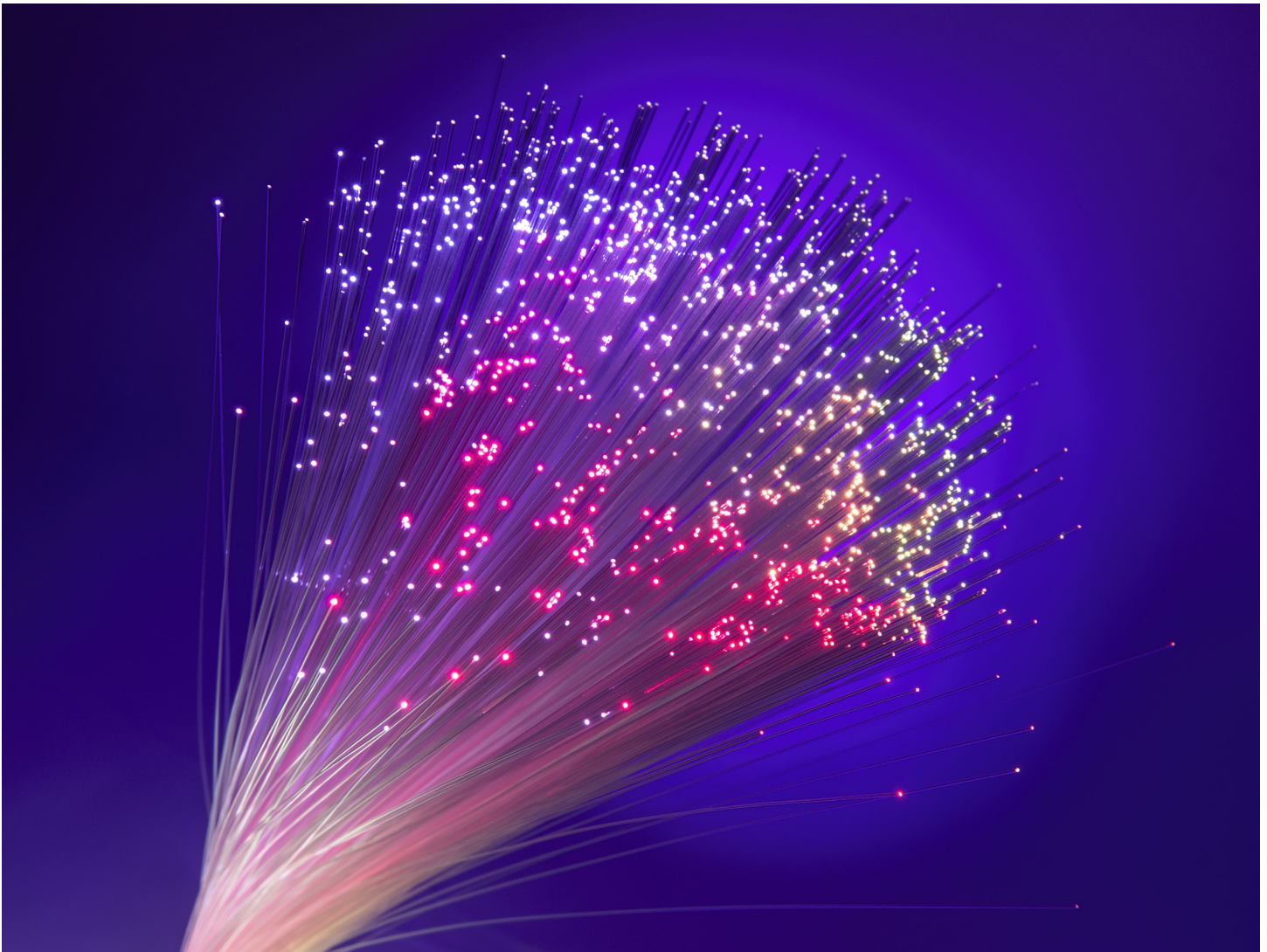
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# End notes

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