



Technology Report 2021

The '20s Roar

BAIN & COMPANY 

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Welcome to the New Technology Economy

Technology-fueled growth across all sectors is poised to accelerate.

By David Crawford



Dear Colleague:

I'm proud to introduce Bain's second annual global Technology Report.

Although Covid-19 remains a global threat, we're in a period of extraordinary economic growth. Government stimulus programs and a pent-up desire to "get back to the office" have piqued expectations of growth and innovation. The technology sector has led the way with strong equity values.

Part of that growth story has to do with the extensive and far-reaching penetration of technology in all sectors of the economy. One indication of this is the interest in last year's report from executives not only in the technology industry, but also in retail, consumer products, industrials, financial services, telecommunications, and more. In response, about half of the initial distribution of this year's report will include client executives from outside the technology sector.

This year's report retains last year's organizing principle built around three themes. The first section, value evolution, takes an analytic view of how equity values and profit pools are developing. The second section offers a general manager's view of major competitive battlegrounds in the technology sector. The last section showcases innovation that creates advantages through the operations of the enterprise itself, including talent, culture, process, and infrastructure.

As we look across this year's technology landscape, three broad forces stand out.

1. Technology as an enabler. It's increasingly clear that technology extends beyond being an industry unto itself; it's the primary force of disruption in every industry across the globe. This phenomenon turns up empirically in the fact that the largest equity gainers across most sectors of the global economy are either technology companies or enterprises with a tech-led strategy.

2. The next chapters of cloud computing. Our clients know the extraordinary impact that the cloud-based computing model has had over the last two decades.

Looking ahead, this innovation path remains potent in several ways.

The first trend is the continued success of the hyperscalers—Alphabet, Amazon, Apple, Facebook, and Microsoft in the US, and Alibaba and Tencent in China—even as they attract heightened regulatory scrutiny. How best to regulate these businesses is far from clear.

The second cloud trend grabbing general managers' attention is the growing traction of hybrid and multicloud solutions. Amazon Web Services, Microsoft Azure, and Google Cloud Platform continue to grow as enterprises shift more computing workloads to the public cloud. The next-largest enterprise workloads are more stubbornly located at the edge or on premises, either to provide more control and security, or

It's increasingly clear that technology extends beyond being an industry unto itself; it's the primary force of disruption in every industry across the globe.

lower latency. As a result, enterprises are attracted to the hybrid and multicloud models, and leading vendors are using detailed customer segmentation to navigate the growing complexity and better tailor their offerings.

The third cloud trend is the emergence of cloud-native and multicloud infrastructure. After the extraordinary equity growth of the hyperscalers, some of the fastest-growing value creators in the technology industry are a group of software providers that includes Snowflake, Datadog, Cloudflare, and Twilio. These firms were born in the cloud and have the potential to live successfully across public clouds, offering interoperability to their multicloud customers.

The fourth trend is the growing presence of custom and special-purpose silicon processors. We don't believe this shift signals the end of general-purpose processors, but it has significant implications for silicon developers and manufacturers, cloud service providers, and their customers.

The last cloud phenomenon showcased this year is the rapid innovation in artificial intelligence spearheaded by large cloud service providers, which are democratizing AI and creating opportunities for all businesses to use it as a competitive advantage.

3. Nonmarket influences. Regulator and geopolitical relations are more consequential than ever. After decades of globalization, several major countries are turning the trajectory toward trade barriers and decoupled economies. The technology sector has found itself at the center of this restructuring. It has forced executives into a high-wire balancing act as they navigate the transition to the decoupled future. Likewise, regulators are tightening their scrutiny of large technology leaders. This includes the landmark action taken by Chinese regulators to rein in the country's cloud service providers and other tech firms in recent months.

Regulator and geopolitical relations are more consequential than ever.

In the context of this new world order, enterprises are trying to make their supply chains more resilient. Covid-19 provided a painful reminder of how many single points of failure had been tolerated for too long. The hard lessons of the global semiconductor shortage have made it clear that defending against future supply chain disruptions will require a more holistic and proactive strategy.

Technology cemented itself at the foundation of the global economy over the past decade. Now, the ingredients are in place to create an explosion of tech-fueled innovation and growth unlike anything we've seen before. We at Bain look forward to helping our clients across industries capitalize on the opportunities that lie ahead.



David Crawford

Leader of Bain's Global Technology Practice



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Value Evolution

Tech-tonic Shifts: Technology Is Reshaping the Global Economy

Technology has emerged as the primary disruptor and value creator across all sectors.

By Matthew Crupi, Chris Johnson, and David Crawford

Most of the largest creators of value in recent years, regardless of sector, have one thing in common: technology is critical to their business (see *Figure 1*).

In general, companies and sectors with less tech-enabled innovation had smaller market-value gains from 2015 through 2020.

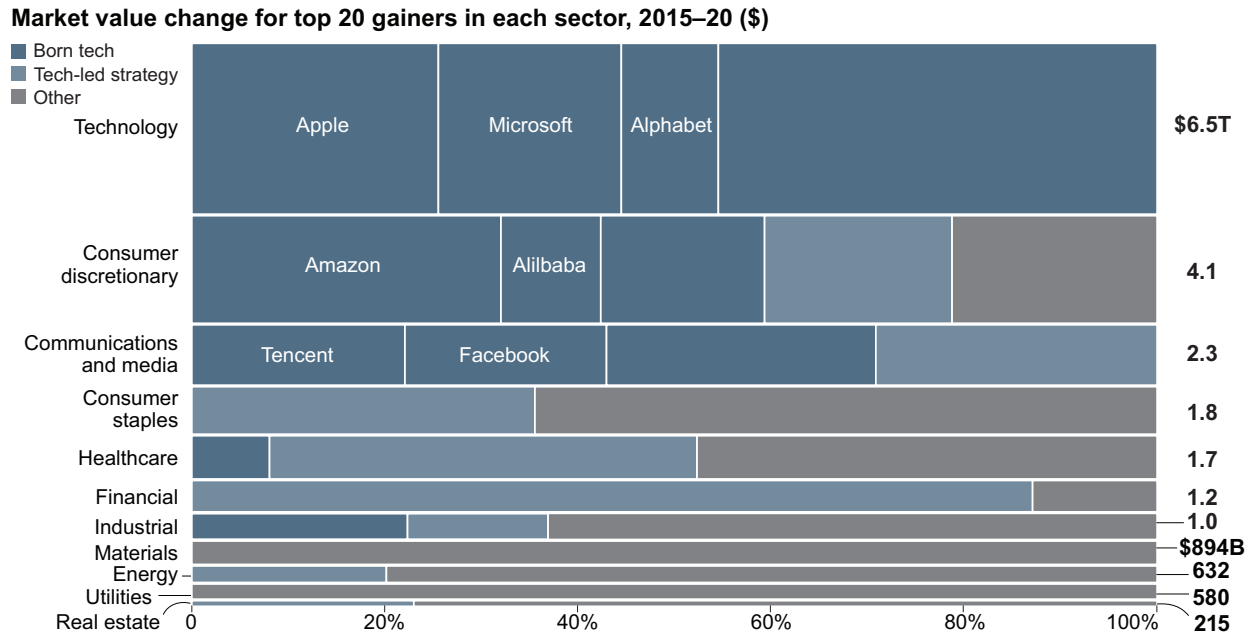
The clear message is that technology isn't just an industry. It has become the primary disruptive force across the entire global economy.

“Born tech” companies deliberately built their businesses upon technology at an early stage because they viewed it as critical to their success, even if their end product isn't a traditional technology product or service. Think Tesla in automobiles, Netflix in media, and Amazon in retail.

But even more-traditional, often “brick-and-mortar,” businesses have recognized the outsized benefits of adopting a tech-led strategy. For example, Disney launched a streaming video service, and Walmart now has a huge online marketplace.

This phenomenon goes beyond legacy companies' digital transformation projects, which often focus on converting analog processes to digital ones. This is about all sectors learning how to wield technology and the tech industry's platform and ecosystem playbook as a needle-moving competitive advantage.

Figure 1: Technology is fueling most of the growth across the economy



Notes: Compares change in market valuation between Dec. 31, 2015, and Dec. 31, 2020; segments without company names aggregate other top 20 gainers in each category
Sources: S&P Capital IQ; Bain analysis

As we explored in last year’s Technology Report, the massive global success of cloud technology and platform business models fueled the technology industry’s value creation over the past decade. These two trends gave rise to the tech giants, the leading cloud tools and service providers that we call “hyperscalers”: Alphabet, Amazon, Apple, Facebook, and Microsoft in the US, and Alibaba and Tencent in China.

Now, cloud technology and platform business models are unlocking significant value for companies across every sector. The winning companies of the next decade will be defined by their ability to take full advantage of these catalysts.

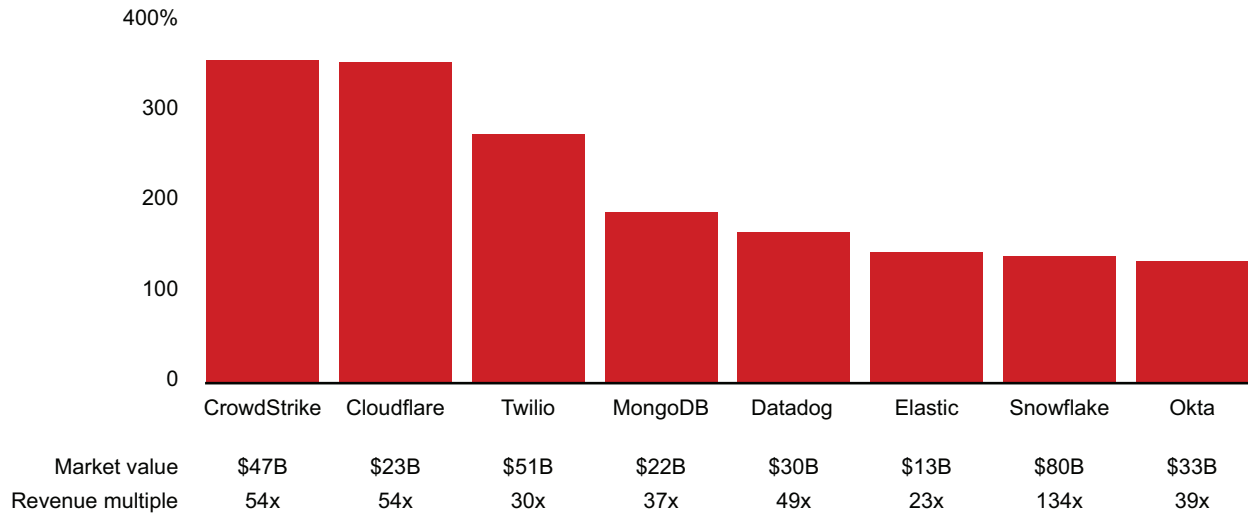
Cloud-native infrastructure software

Within the technology industry, the unprecedented growth of the hyperscalers has overshadowed the rapid rise of another segment that has become a formidable value creator and disruptor in its own right: cloud-native infrastructure software vendors.

The publicly traded companies in this group were collectively worth nearly half a trillion dollars at the end of 2020, with many of the leading ones more than doubling in market value last year (see Figure 2). Plus, there’s a healthy pipeline of earlier-stage competitors reportedly valued at more than \$1 billion each (so-called unicorns).

Figure 2: Market values of top cloud-native infrastructure software vendors are growing rapidly

Market value growth (2019–20)



Notes: Compares change in market valuation between Dec. 31, 2019, and Dec. 31, 2020; growth rate for companies with initial public offerings in 2020 compares change in valuation between IPO date and Dec. 31, 2020; market values as of Dec. 31, 2020; revenue multiple equals market valuation as of Dec. 31, 2020, divided by fiscal 2020 revenue, except for CrowdStrike, which is divided by fiscal 2021 revenue
Sources: S&P Capital IQ; Bain analysis

Cloud-native infrastructure software companies have flourished because they can more easily launch and rapidly scale up new applications by building them on top of the big cloud service providers’ public cloud resources. Rather than making costly up-front capital investments, cloud-native infrastructure software companies can pay for cloud computing resources as they go, based on how much they use. This can free them to focus investments on product development, sales, marketing, and other areas that can grow their businesses.

This model has helped Snowflake become one of the fastest-growing and highest-valued cloud-native infrastructure software vendors. The company developed a platform, running on multiple public clouds, that helps businesses consolidate their disparate data sets so they can more easily analyze and share data, and build data-enabled applications. Snowflake uses the public clouds’ elasticity to flexibly ramp its computing and storage resources up or down independently, based on what customers need. This has delivered cost and performance benefits for both Snowflake and its customers. Furthermore, the standardization and infrastructure management capabilities of each public cloud make it easier for customers to deploy Snowflake’s services using their cloud of choice. Snowflake’s customers in financial services, healthcare, retail, and other sectors are now collectively running hundreds of millions of data queries each day using the company’s products.

Nontech companies and the cloud

As cloud infrastructure and supporting tools get more advanced, they're empowering companies across industries not only to build more efficient and effective IT footprints, but also to use large amounts of data to enhance their business model.

For example, automakers are scaling up vehicle telematics services underpinned by cloud technology. This can improve customers' safety and vehicle experience and lower the total cost of car ownership. General Motors introduced its OnStar telematics system 25 years ago. The company has added a series of cloud-based capabilities to it since the mid-2000s, and GM leaders see OnStar as an important source of future growth. There are now about 20 million Internet-connected GM vehicles worldwide. OnStar, which comes standard in most GM vehicles, transmits telematics data to the cloud for real-time analysis. For consumers, OnStar provides navigation assistance, proactively alerts emergency services when the vehicle has been in an accident, and enables GM's new usage-based insurance offering, which adjusts rates based on driving behavior. Commercial customers can use GM's OnStar Vehicle Insights product to more easily monitor vehicle fleets' performance, location, usage, and other metrics.

Nontech companies and platforms

Platforms are usually associated with the technology sector, but now companies in other industries are shaking up their markets by adopting business models built upon tech platforms. The term "platform" is often used broadly. Here, we use it specifically to indicate a product or service upon which others build their livelihood—one that attracts an ecosystem of partners and customers who collectively deliver value. The power of platforms lies in their network effects, which drive down marginal acquisition costs and fuel compounding increases in value for the platform and its participants.

The power of platforms lies in their network effects, which drive down marginal acquisition costs and fuel compounding increases in value for the platform and its participants.

One example of a traditional business taking advantage of tech platforms is John Deere. The nearly two-century-old tractor manufacturer launched its digital platform MyJohnDeere in 2012. The product combines data generated by sensors installed on the company's farm equipment with third-party data on crop characteristics, soil conditions, yields, weather, and more. The platform's ability to synthesize this information helps farmers manage their fleets by reducing machine downtime and conserving fuel, which reduces costs and increases productivity. The platform's analytical insights

continuously improve as more farmers join and share data. The platform is also a hub for third-party applications that can help farmers make agronomic decisions and better manage their fields. These innovations have deepened John Deere's relationships with customers and strengthened its core equipment business, ultimately helping the company to nearly triple its market capitalization since 2011.

Patterns emerge

In our analysis of companies worldwide adopting cloud technology and platform business models, we've found that the most successful are doing four things differently.

First, they're using data and analytics to gain an edge. By actively managing and drawing insights from large data sets, companies can more rapidly improve their offers based on real-time customer feedback.

Netflix does this well. All that binge-watching of movies and TV shows produces valuable viewer behavior data that guides content development and personalized promotions. Netflix says the vast majority of customers' viewing choices are based on suggestions served up by its data-driven recommendation engine. As customers watch more, Netflix uses that data to shape the content it produces so viewers keep coming back.

By actively managing and drawing insights from large data sets, companies can more rapidly improve their offers based on real-time customer feedback.

Second, winning companies are scaling rapidly while owning fewer assets. Cloud technology and platforms have made this "asset-light" model possible because companies can now achieve scale through "connection" rather than "production," by tapping into capital goods owned by others. As the meme says, Uber became one of the world's largest taxi companies without owning any cars, and Airbnb became one of the largest accommodation providers without owning any real estate.

Third, realizing they don't have to own everything, leading companies are using partnerships to add capabilities faster and cheaper than developing them internally. For example, Swedish financial technology company Klarna, which helps facilitate payments between buyers and sellers online by offering consumers pay-after-delivery and installment-plan options, sought a solution that would allow Klarna users to shop at any merchant, even ones that don't have a direct relationship with the company. Rather than build it in-house, Klarna formed a partnership with Marqeta to provide consumers with virtual, single-use credit cards—which Klarna calls "One-time cards"—that can be used at

checkout like any other payment card. This virtual card allows the consumer to pay with Klarna at the point of sale, without requiring a new technical integration between Klarna and the merchant's registers and terminals. Using Marqeta's card-issuing product, Klarna can fund the card in real time with the exact amount needed to pay for the customer's order. Klarna also used Marqeta's geographic reach to launch in two new countries, the US and Australia, a model Klarna is replicating in other countries. Since launching its partnership with Marqeta in early 2019, Klarna's transaction volume has approximately doubled every quarter.

Lastly, companies are investing in tech talent to help them take full advantage of cloud technologies and platform business models. Just look at Goldman Sachs for a clear view of how executives across sectors are reshaping their businesses with technology. The US-based financial services firm now has more software developers (10,000) than most technology companies. Coders make up about 25% of its workforce.

The question on the table in every boardroom, regardless of industry, is not whether technology can make a difference for the business. It's how, and to what extent? Companies that embrace technology as a fundamental, differentiating capability have a shot at unleashing more growth than ever.



Value Evolution

Regulate with Care: The Case for Big Tech M&A

Most M&A spending by large tech firms benefits consumers and doesn't hamper competition.

By David Crawford and Michael Schallehn

Regulatory scrutiny of “big tech” companies is growing worldwide. Platform business models have helped make the most prominent tech firms—the hyperscaler cloud tools and service providers—strong leaders in their respective markets and among the most valuable companies in the world.

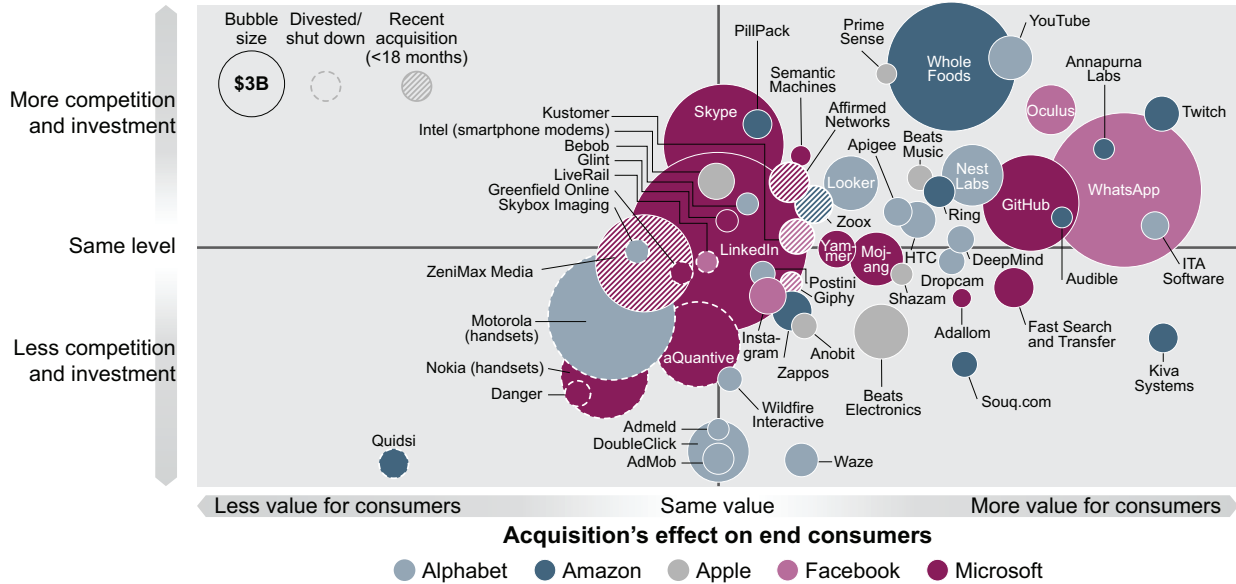
Given the size, complexity, and profitability of these businesses, scrutiny of their behavior is understandable. That said, when it comes to mergers and acquisitions, much of the recent attention has focused more on the *fear of potential* abuse of market power rather than a fact-based review of M&A track records.

When the facts are reviewed, most big tech M&A spending actually benefits consumers and doesn't hamper competition. That's according to Bain's analysis of all \$300 million-plus acquisitions, totaling more than \$150 billion, from 2005 to 2020 by the five US hyperscalers: Alphabet, Amazon, Apple, Facebook, and Microsoft (see *Figure 1*). We recognize, of course, that's a provocative conclusion in the current climate. Here's how we reached it. We conducted a series of double-blinded case studies based on data analysis, which assessed the effect of each acquisition on end consumers (did it drive down prices, increase access to innovative products or services, or improve the products or services themselves?); and market dynamics (did the level of competition increase, did the deal put pressure on incumbents to innovate, or did it result in more external investment?). (See additional details about the methodology at the end of this chapter.)

Excluding deals from the past 18 months and the LinkedIn acquisition, which our analysis determined had a neutral effect on consumers and competition, we found that 72% of US hyperscaler M&A

Figure 1: To date, most US hyperscaler M&A spending has benefited consumers or enriched market dynamics

Market dynamics after acquisition



Notes: Includes all outright acquisitions over \$300 million (2005–2020) by Amazon, Apple, Facebook, Alphabet, and Microsoft; value and impact assessed holistically from before acquisition to the present; for companies later divested, analysis assessed only the period when the hyperscaler owned the asset; HTC was a partial acquisition of smartphone assets
 Sources: Bain analysis; company websites; company financial reports; news articles; press releases; blog posts; equity analyst reports; industry reports

spending since 2005 created value for consumers. Competitive intensity and investment pace also increased after the majority of those deals. The share of hyperscaler M&A spending that benefited consumers rises to 89% when the Google and Microsoft acquisitions of Motorola’s and Nokia’s handset businesses, which were falling behind competitors and arguably no longer viable on their own, are removed from the mix.

The clear takeaway is that, while there are valid reasons to monitor technology M&A, policymakers should proceed with care to avoid stifling the innovation and consumer benefits these deals consistently bring.

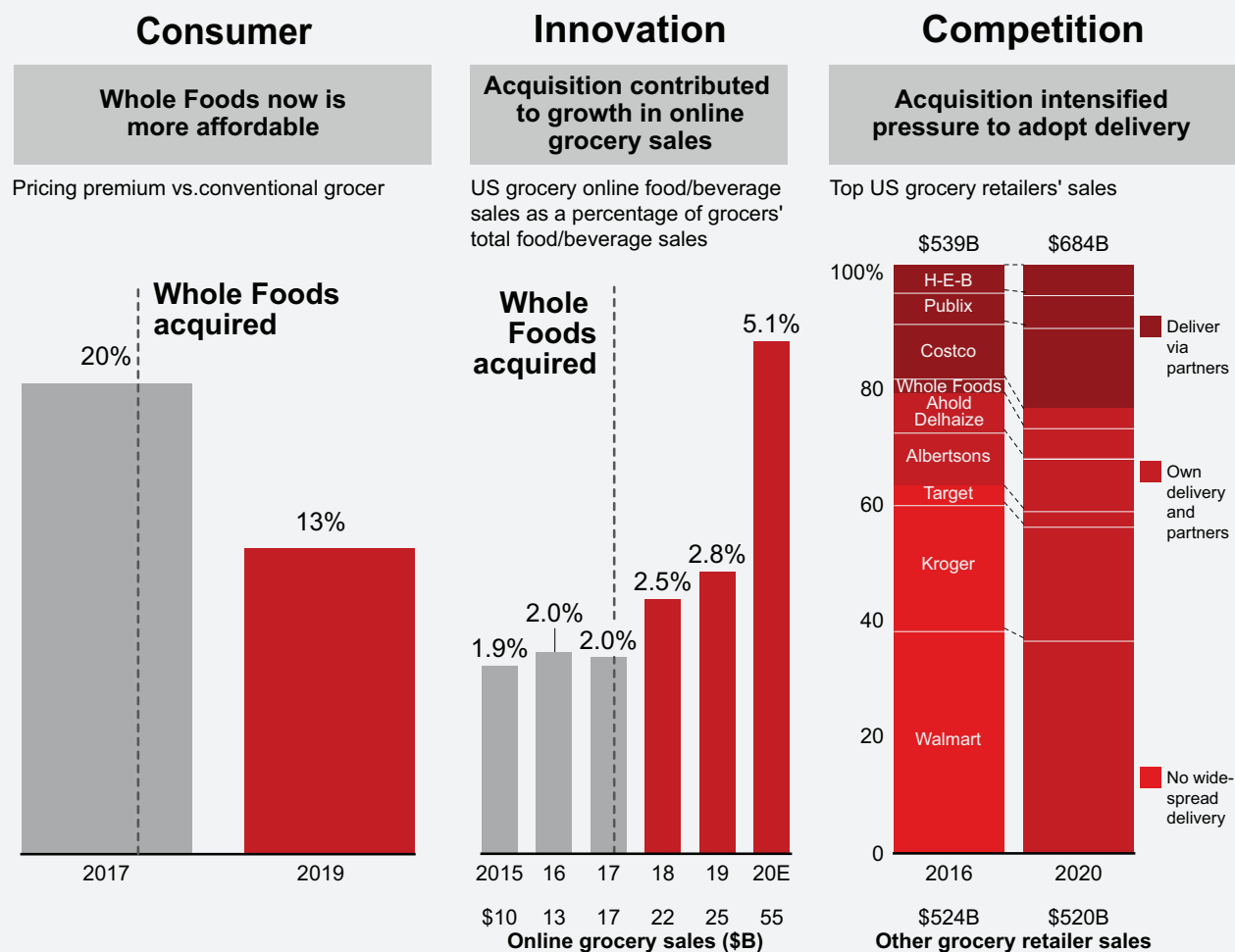
The clear takeaway is that, while there are valid reasons to monitor technology M&A, policymakers should proceed with care to avoid stifling the innovation and consumer benefits these deals consistently bring.

Consumers enjoy the ride: Reducing prices

Most big tech acquisitions end up benefiting consumers in at least one of three ways, according to our research.

Scaling up disruptive, low-cost ideas often results in lower prices for end customers. Amazon used its efficient supply chain and buying power to shrink Whole Foods' price premium vs. conventional grocers, making healthy, fresh food more affordable for consumers (see Figure 2).

Figure 2: Amazon's Whole Foods acquisition accelerated other grocers' e-commerce plans, while reducing Whole Foods' pricing premium



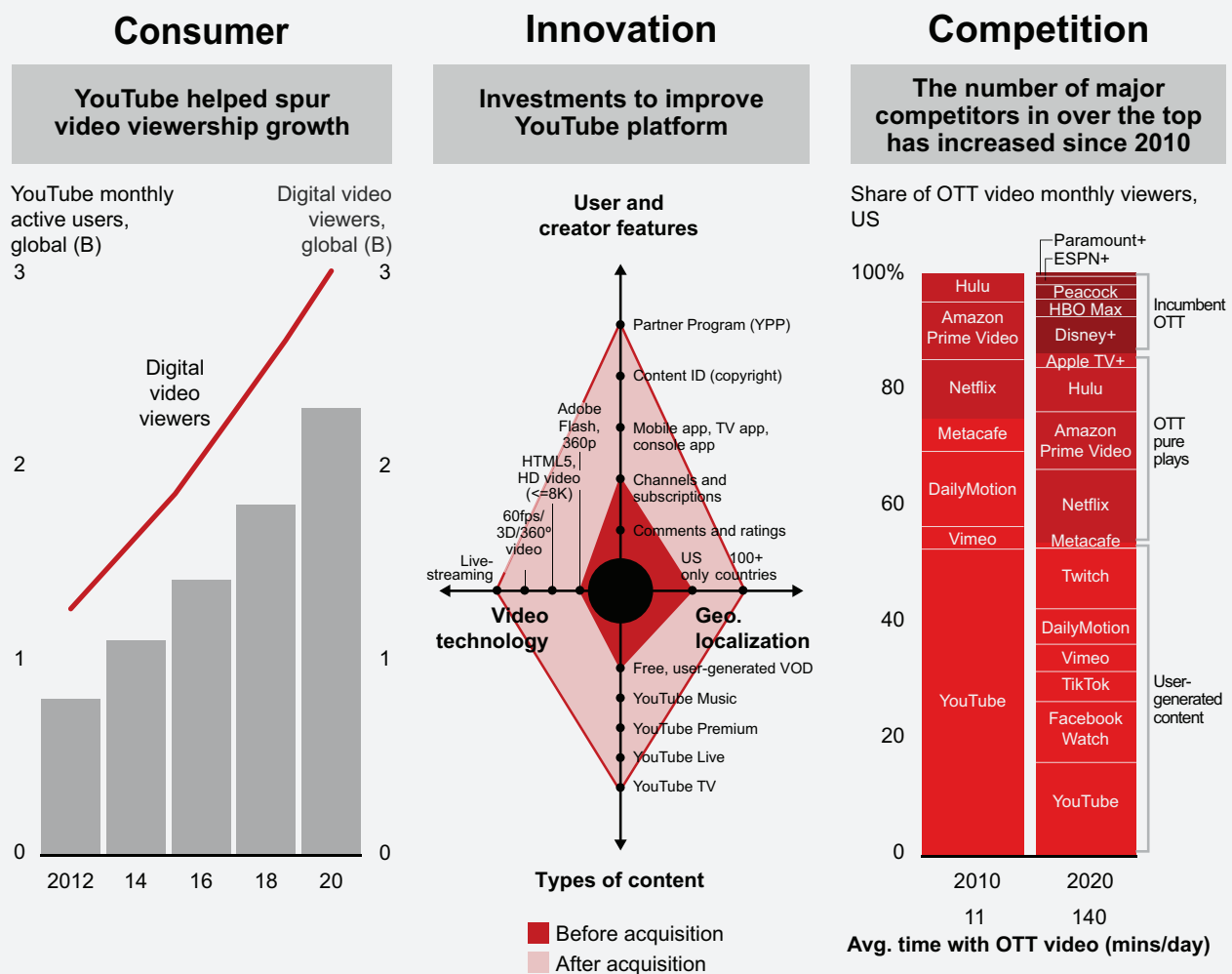
Notes: US online grocery sales includes pickup and delivery; grocery sales excludes health and beauty products and other offerings; other grocery retailers make up 43%–50% of the US grocery market and include regional companies and major drugstores; Kroger and Walmart were testing delivery in select markets in 2016
Sources: Morgan Stanley; UBS; Forrester; company financial reports; Bain analysis; news articles

Consumers enjoy the ride: Increasing access to innovation

Big tech companies' scale can also allow more people to access innovative concepts. Google catapulted YouTube onto an immense growth path that essentially created today's digital video streaming market. Since its 2006 acquisition, streaming video has grown hand-in-hand with YouTube, expanding from about 800 million monthly active users of YouTube in 2012 to around 2.3 billion in 2020 (see Figure 3).

Amazon has also increased access to innovation through its dealmaking. The Whole Foods acquisition contributed to the growth of US grocers' online food and beverage sales, which increased from 2% to 2.5% of US grocers' total food and beverage sales the year after the deal. And Amazon's acquisition of warehouse robotics company Kiva Systems reduced fulfillment times from an hour-plus to 15 minutes, shortening the time from click to delivery for consumers.

Figure 3: Google's YouTube acquisition helped increase online video viewership worldwide



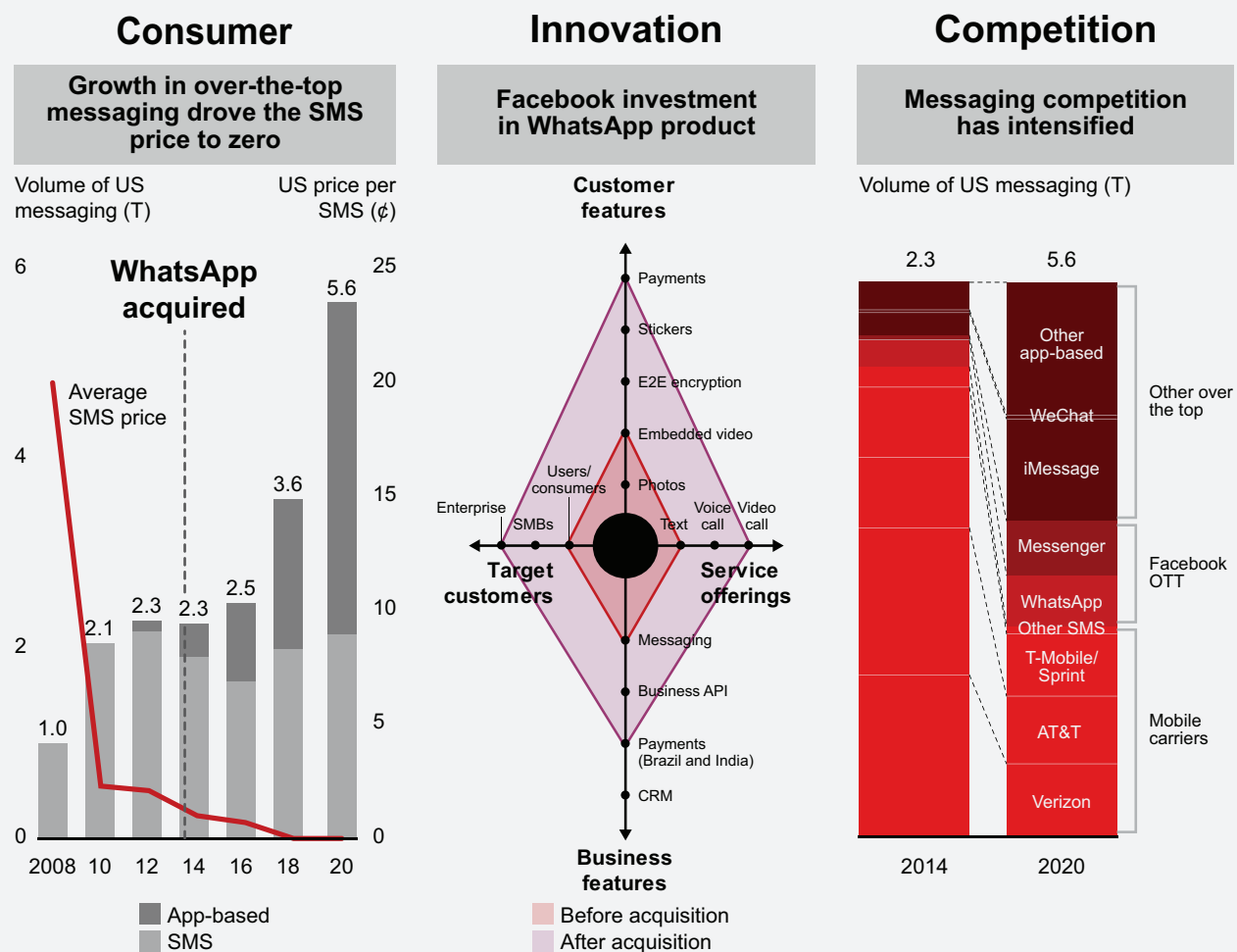
Note: VOD is video on demand
Sources: eMarketer; Zenith; SimilarWeb; company websites; news articles; Bain analysis

Consumers enjoy the ride: Improving products

A third benefit is that tech acquirers frequently accelerate purchased companies' pace of innovation by providing resources and the breathing room to keep experimenting. Facebook's WhatsApp acquisition freed the messaging service to focus on the consumer experience and relieved the pressure to become profitable before it was ready. Under the wing of its parent company, WhatsApp rapidly expanded the app and launched features such as end-to-end encryption, payments, and B2B services (see Figure 4).

There are many examples of this. Amazon expanded Ring beyond connected doorbells and helped live-streaming service Twitch add new genres and partnerships. Google integrated Waze's GPS navigation capabilities with music-streaming services and voice assistants. Facebook expanded virtual reality (VR) company Oculus's offerings to include wireless VR. Microsoft improved the functionality of GitHub's software development platform by adding features such as Codespaces, improving the site for developers.

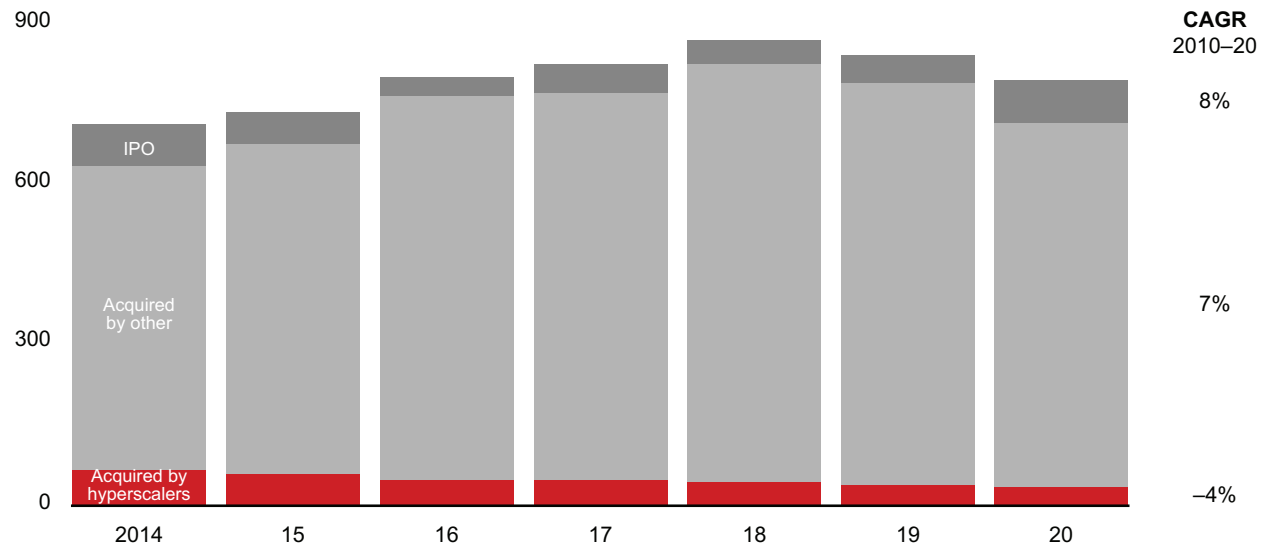
Figure 4: After Facebook acquired WhatsApp, messaging prices continued to fall, the number of credible competitors increased, and WhatsApp expanded its offerings



Notes: SMS includes peer-to-peer (P2P) and application to peer (A2P); Facebook Messenger mobile messaging count estimated based on total volume; SMS count per telco is based on relative market share of subscribers and mobile connections
Sources: Omdia; WhatsApp; CTIA; S&P Global Markets; Facebook financial reports; GSMA Intelligence; Bain analysis

Figure 5: Acquisitions by US hyperscalers represent a modest portion of total tech start-up exits

Number of technology start-up exits by IPOs and acquisitions



Note: Hyperscalers are Alphabet, Amazon, Apple, Facebook, and Microsoft
Sources: Crunchbase; Bain analysis

Competition is alive and well

The common narrative is hyperscalers are acquiring disruptive competitors. But their M&A activity is only a small piece of the overall landscape, representing just 5% of total tech start-up exits last year (see Figure 5).

What’s more, their dealmaking actually contributes to vibrant markets. Of the M&A spending that benefited consumers, 82% also saw more competition afterward, according to our analysis. This plays out in four ways.

Increasing the number of credible competitors

The competition between telcos and app-based messaging companies, including Facebook, Apple’s iMessage, and WeChat, has only grown fiercer since Facebook bought WhatsApp in 2014. Since the deal, the number of credible competitors has gone up, as app-based messaging companies’ share of US messaging volume grew to more than half of all messages sent last year. A judge’s dismissal of the US Federal Trade Commission’s lawsuit against Facebook in June signaled that tech companies continue to compete in broadly defined markets, though the FTC later filed an amended lawsuit to renew its case against Facebook.

In video streaming, YouTube helped fuel the proliferation of “over the top” (OTT) video providers such as Hulu, Slings, and Disney+. Now, YouTube competes for advertising dollars both with other OTT providers and traditional television companies.

Pressuring incumbents to innovate

Amazon’s 2013 expansion into grocery delivery with Amazon Fresh added pressure on US grocery retailers to begin offering online ordering and delivery services, and that pressure only intensified after Amazon acquired Whole Foods. Now, every major US grocery retailer offers online ordering and delivery services, either managed in-house or via partnerships. This was true even before the Covid-19 pandemic.

In video games, Facebook’s purchase of Oculus helped push other companies to build products with virtual- and augmented-reality experiences.

Spurring competition between hyperscalers

Acquisitions have also fueled competition among the hyperscalers (see Figure 6). Facebook, Amazon, and Apple now challenge Google’s YouTube for video views. Apple Music, buoyed by its Beats acquisition, competes with YouTube Music and Amazon Prime Music for paid subscribers. Display ads

Figure 6: Acquisitions have increased competition between hyperscalers

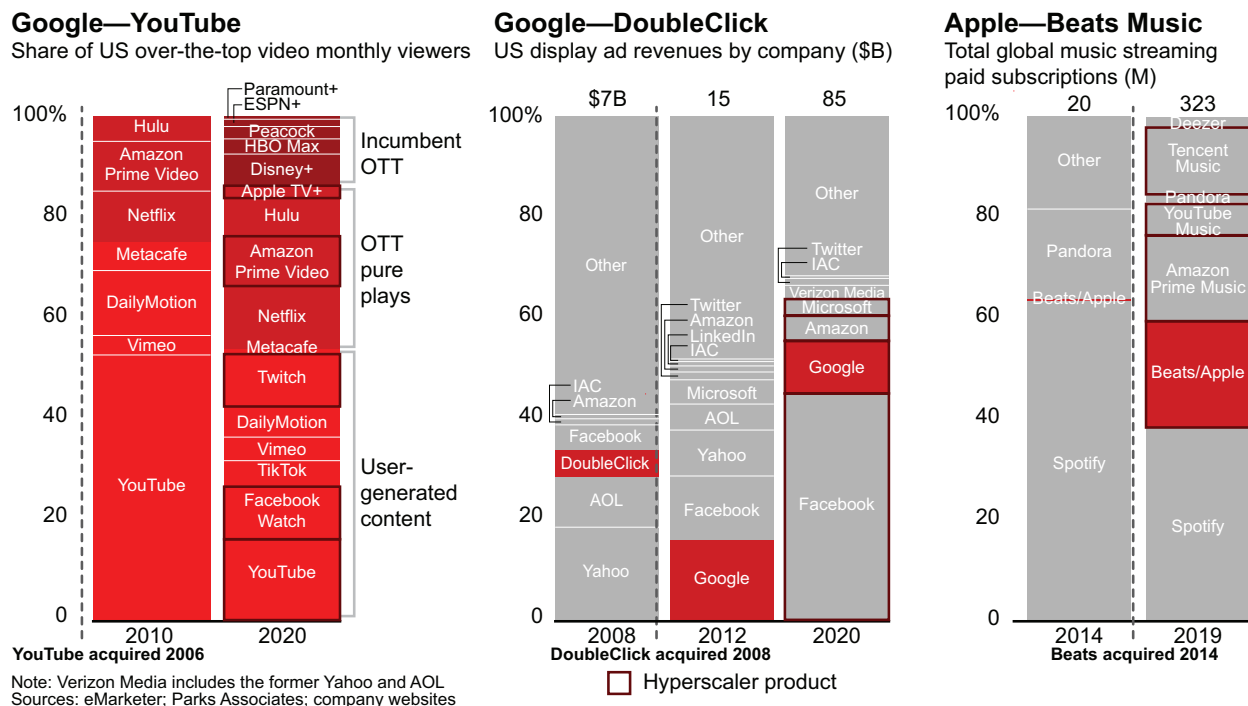
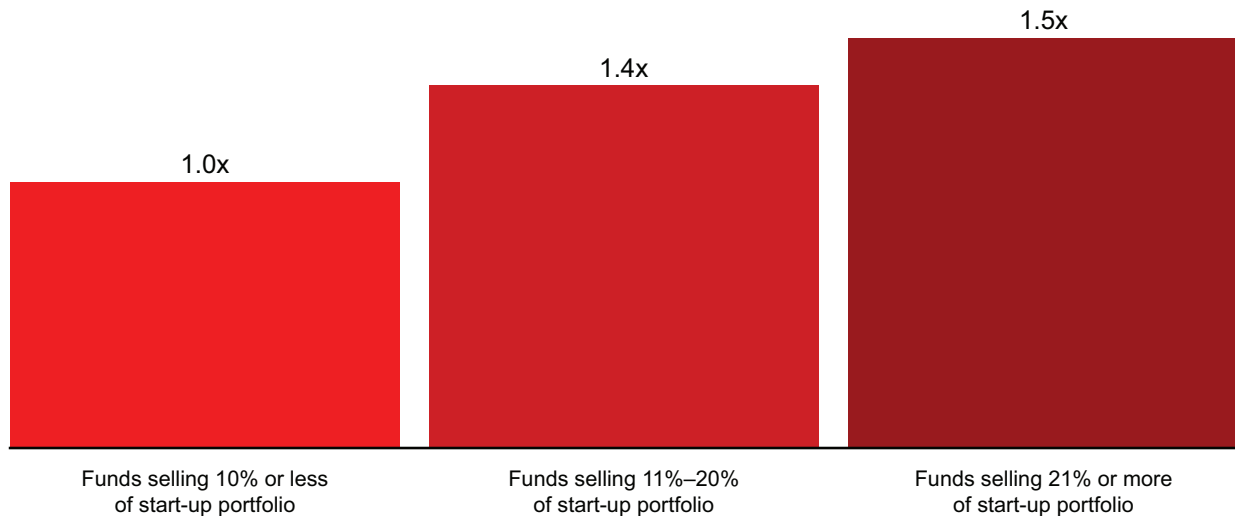


Figure 7: Selling portfolio companies allows venture investors to make more deals**Venture investment rate, by level of portfolio selling (2010–20)**

Notes: Includes investors that made both 2010 and 2020 investments; includes investments by independent venture capital firms and corporate venture funds; excludes private equity investments
Sources: Crunchbase; Bain Startup Investment Cruncher analysis

are a fierce battleground among Facebook, Google, Amazon, and Microsoft, even after Google's DoubleClick acquisition.

Fueling venture capital investments

Acquisitions power a virtuous cycle in start-up investments by providing viable exits that allow investors to pour money into the next wave of deals. Over the past decade, independent venture capital firms and corporate venture funds that sold 11% to 20% of their start-up portfolio invested in 40% more deals than funds that sold 10% or less of their portfolio (see *Figure 7*). The gap is even wider for firms that sold 21% or more of their portfolio.

When is more regulatory scrutiny justified?

Of course, not every hyperscaler M&A deal benefits consumers and competition.

In the vast majority of these cases where consumer value and competition were harmed, the acquired company was ultimately shut down after a decline in market share and/or profitability, thereby reducing competition.

Amazon's price cuts on diapers pushed Quidsi to sell its business, including the popular Diapers.com. After purchasing Quidsi, Amazon raised prices and shut down the business.

The purchases of Motorola's and Nokia's handset businesses were both ill-fated acquisitions by Google and Microsoft, respectively, that may no longer have been viable standalone companies given their decline in market share and innovation even before the acquisitions. Similarly, Microsoft wrote off its aQuantive purchase after a failed attempt to shift the core business from display to search ads, and Facebook shuttered LiveRail due to the low quality of ad inventory and what turned out to be a more promising alternative product developed internally (Audience Network).

For the remaining deals that reduced competition, the acquirer bought a target that was also a market-share leader in the same sector. For example, Google's acquisition of DoubleClick in 2008 allowed the No. 1 competitor in digital ads to purchase the No. 5 competitor. By 2012, their combined share of US digital ad revenue was more than four times the size of their next-largest competitor. But our analysis determined this group of deals had a neutral effect on consumers, and it represents only 3% of total acquisition value in our analysis.

A common refrain in tech is that companies with the most data win. But there's a concern that if companies consolidate data, they might use it in combination with algorithms to steer users toward inferior products that are more profitable.

What about data?

A common refrain in tech is that companies with the most data win. But there's a concern that if companies consolidate data, they might use it in combination with algorithms to steer users toward inferior products that are more profitable. While this can result from consolidating market power after acquisitions, our analysis found this rarely happens in hyperscaler acquisitions.

Facebook's acquisition of Instagram is often mentioned as an example of data consolidation's potentially negative effects. However, Instagram only had 30 million users and no ad business at the time of acquisition. Under Facebook, Instagram expanded from a simple photo-editing app to include messaging, social stories, live broadcasts, and shopping. While Facebook has been good at increasing the size of Instagram's data sets and effectively monetizing them, there's good evidence that it was the parent company's investment in the user experience and advertising engine that allowed Instagram to grow to more than 1.7 billion monthly active users, according to a UBS report.

It's healthy in any market-based society to have a vigorous debate over the benefits of scale to both consumers and competition. That can and should continue. Hopefully, this set of insights provides another useful perspective for both acquirers and regulators as they work to ensure these deals continue to create—not destroy—value.

Additional details on methodology: *Our analysis defined enriched market dynamics in a given sector based on whether, between the acquisition date and 2020, the level of competition increased (e.g., app-based messaging companies capturing market share from telecom companies), incumbent companies increased their adoption of new innovations (e.g., adding online grocery delivery), or there were more external investments in the sector (e.g., increased venture capital investing). We defined an increase in end-customer value based on whether, between the acquisition date and 2020, there was increased access to a product or service; reduced price of a product or service; accelerated innovation of a product or service; or limited data sharing with third parties.*



Value Evolution

Why Venture Capitalists Are Doubling Down on Technology

Increasing competition, rising deal prices, and a diverse start-up landscape are compelling corporate investors to pinpoint their differentiators.

By Michael Schallehn and Chris Johnson

Technology is reshaping the economy, and it starts with venture capital.

Technology was a driving force behind the boom in venture investments over the past decade. From 2010 through 2020, tech start-ups made up a majority of venture funding across all deals by independent venture capital (VC) firms and corporate venture capitalists, according to Bain analysis using our Startup Investment Cruncher database (see *Figure 1*).

Although the total value of venture investments in tech declined 13% from 2018 through 2020 amid an overall venture funding pullback—the first decline since 2012—tech venture investments came roaring back during the Covid-19 pandemic. We've seen a clear trend toward technology companies capturing a growing share of venture funding recently. The total value of venture investments in technology in the first quarter of 2021 nearly doubled from the same period in 2020, more than twice the growth rate of other sectors. Tech start-ups accounted for nearly 70% of total venture investments in the first quarter of this year.

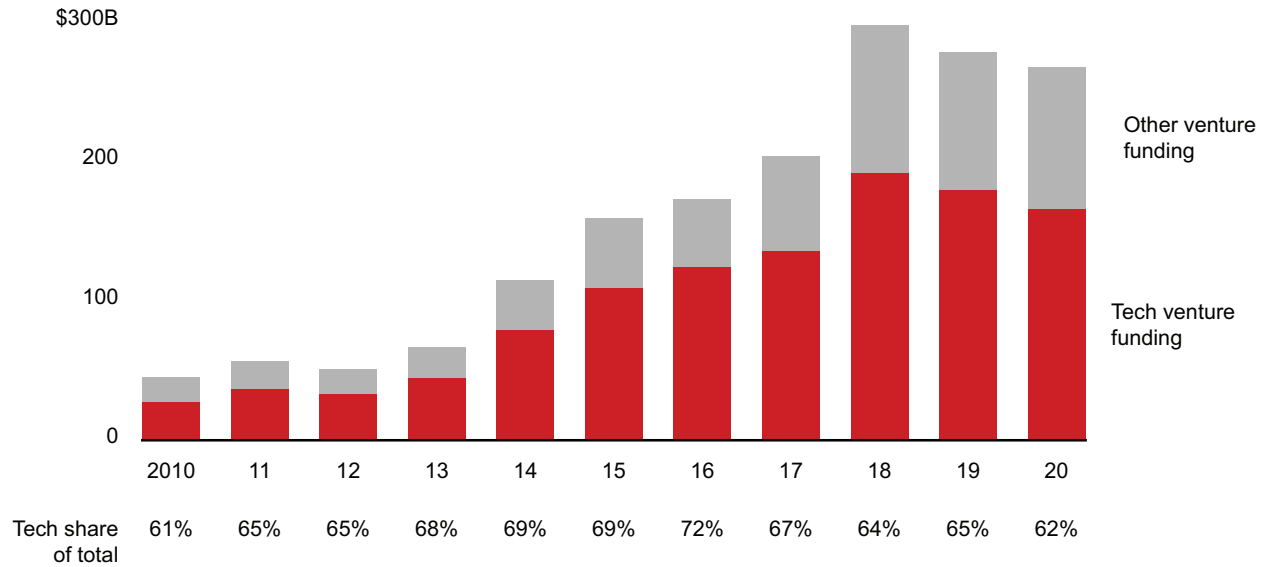
The pandemic fueled this growth by accelerating the shift toward later-stage deals that had been underway for several years. The total value of tech deals in the Series C stage or later ballooned 165% year-over-year in the first quarter of 2021 (see *Figure 2*).

Investors have flocked toward surer bets to hedge risk and ride out the storm. But we expect this preference for later-stage rounds to continue after the pandemic. Venture-backed companies are

Technology Report 2021

Figure 1: Tech companies consistently receive the majority of venture funding

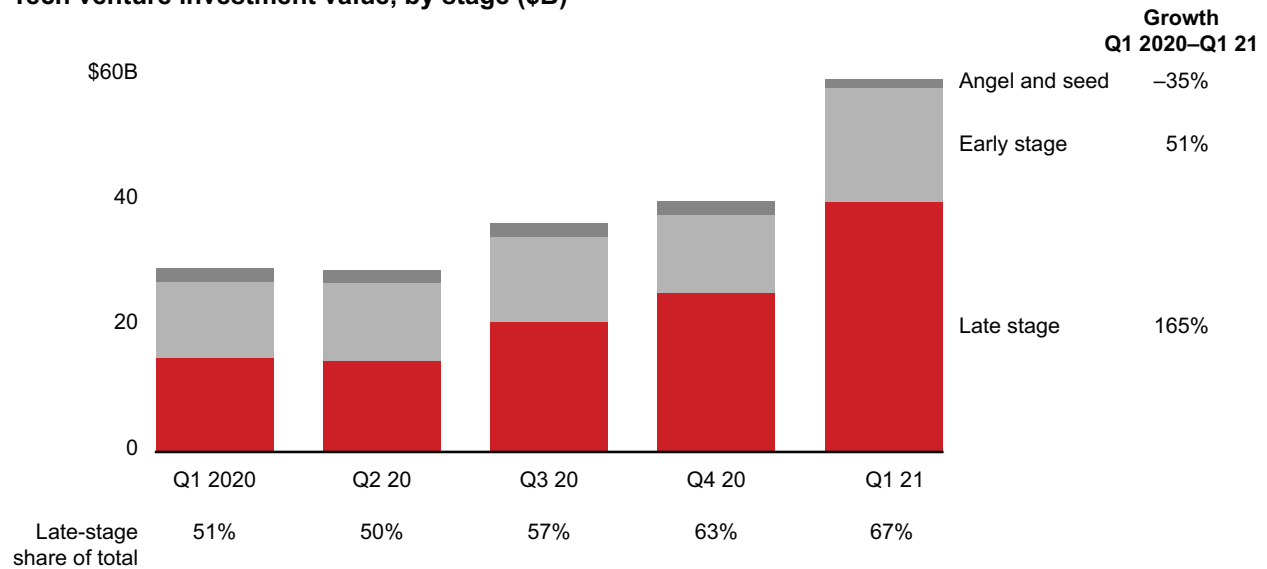
Global investment value (\$B)



Notes: Includes investments by independent venture capital firms and corporate venture capital funds; excludes private equity investments
Sources: Crunchbase; Bain Startup Investment Cruncher analysis

Figure 2: Late-stage deals make up a growing share of tech venture investments

Tech venture investment value, by stage (\$B)



Notes: Angel and seed includes pre-Series A deals; early stage includes Series A and B; late stage includes all Series C and later venture capital rounds; includes investments by independent venture capital firms and corporate venture capital funds; excludes private equity investments and venture capital deals with undisclosed series
Sources: Crunchbase; Bain Startup Investment Cruncher analysis

choosing to stay private longer, which allows them to continue investing in revenue growth by avoiding capital market pressure to focus on profitability. We also see this with moonshot innovations, such as self-driving car companies, which require expensive, long-lasting development cycles. The result is growing competition for late-stage deals, which is creating opportunities for larger-sized funds and blurring the lines between traditional venture capital and private equity.

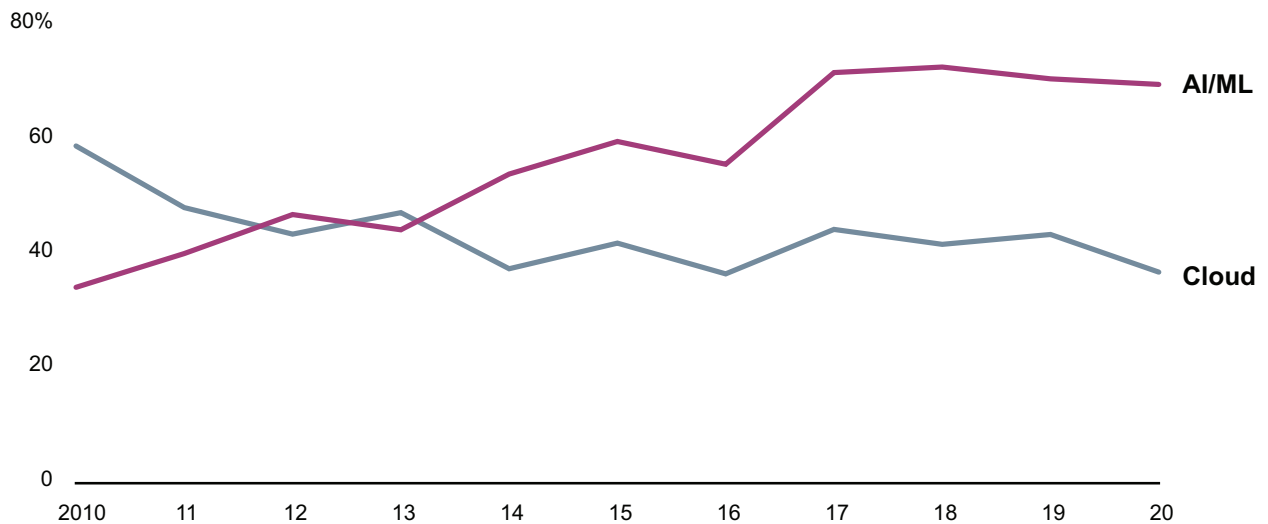
Where are venture investors focusing their technology bets? The two segments generating the most interest right now are artificial intelligence (AI) and cloud technology, which together grew more than twice as fast as venture investments in all other sectors over the past decade and now make up more than a third of total tech venture investment value.

Venture investors' divergent approaches to investing in these two critical sectors symbolize the way they've evolved (see Figure 3). In AI and machine learning (ML), most venture investors now prefer to bet on start-ups developing products customized to specific industries. This signals that investors and entrepreneurs have moved beyond the starry-eyed stage of pursuing a generalized AI algorithm to solve broad problems, and now they're taking a more stepwise innovation path with clearer pay-back opportunities.

The story is different in the cloud. Over the past decade, investors have increasingly placed bets on start-ups with a "horizontal," or cross-industry, focus. During that time, venture investments have

Figure 3: Venture investors prefer industry-specific start-ups in AI and ML, and cross-industry start-ups in the cloud

Industry-specific percentage of investment value



Notes: Includes investments by independent venture capital firms and corporate venture capital funds; excludes private equity investments; AI is artificial intelligence; ML is machine learning
Sources: Crunchbase; Bain Startup Investment Cruncher analysis

grown nearly 30% across both horizontal software-as-a-service (SaaS) applications (business intelligence, enterprise resource planning, productivity tools), and horizontal technologies that enable cloud solutions (data transfer, container frameworks, security, cloud orchestration products).

Venture investors' horizontal inclination is no surprise in either cloud segment. Enterprises across industries are adopting SaaS tools to modernize operations and gain an edge. That trend has only picked up momentum during the pandemic. More than 20% of enterprises have increased their use of horizontal SaaS tools, according to a 2021 Bain IT spending survey of nearly 200 CIOs in North America and Europe. And the increased investments in horizontal cloud enablers reflects the pursuit of a seamless, multicloud infrastructure layer to bring about the hybrid cloud future desired by CIOs. The ability to seamlessly allocate workloads across different computing environments is becoming more urgent as many enterprises boost their spending on edge computing and the Internet of Things.

Looking more closely at AI/ML, the vast majority of venture investments are concentrated in two countries: the US and China (*see Figure 4*). Given the dramatic decrease in foreign direct investment between these two nations in recent years, we may be witnessing the formation of two competing ecosystems around this strategically important technology. Several patterns have emerged in this race.

The two sectors receiving the most AI/ML venture funding, transportation and healthcare, are fragmented, each with more than a dozen well-funded contenders in the US and China. In transportation, this results from long development cycles for autonomous driving, and different dynamics for robo-taxis and long-haul trucking create room for regional champions. In healthcare, venture investors anticipate winners in segments ranging from drug discovery to AI-supported diagnostics and imaging.

The fact that social media platforms ByteDance and Kuaishou are the two biggest venture capital bets on Chinese AI/ML companies over the past decade is likely a by-product of the earlier ascendancy of US social media companies. Investors look to precedents like Facebook and understand the network effects and outsized returns that can result from achieving massive scale.

Three ways corporate investors can win

What does all this mean for mature corporations attempting to use the venture-funded start-up ecosystem to build their business?

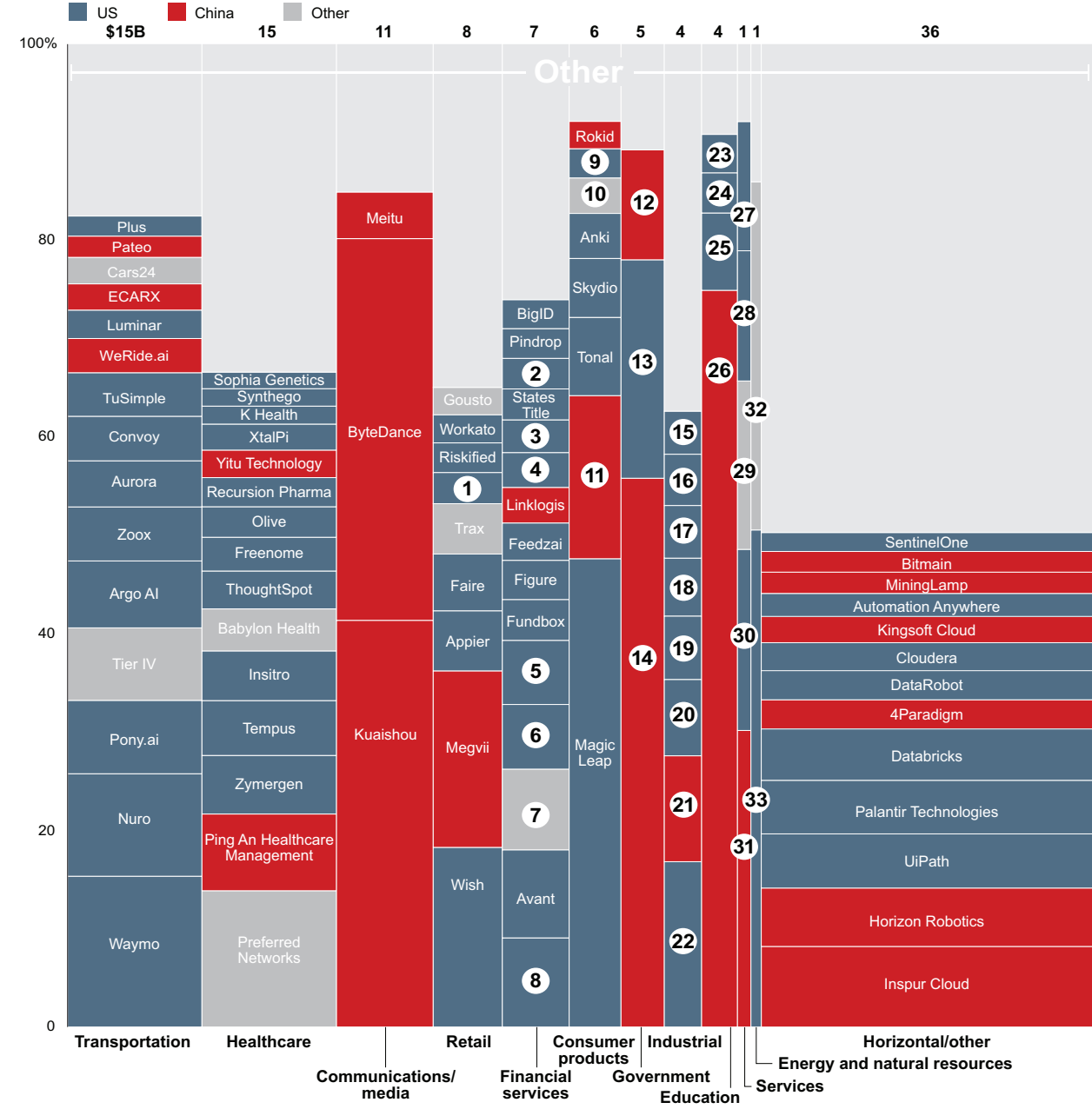
There's no shortage of opportunities to invest, but increasing competition and rising deal prices increase the odds of missteps. In addition, the many fragmented sectors in AI/ML and subsegments of horizontally focused cloud technologies makes it even more critical for investors to understand the diverse landscape of start-ups and technologies. We've identified a few opportunities for corporate investors to differentiate themselves in this environment.

Become a customer or partner. Leading corporate venture capitalists (VCs) don't just invest in start-ups—they often buy their products or services, or form strategic partnerships with them. This is one area where corporate investors can gain an edge against traditional VC firms, which don't

Technology Report 2021

Figure 4: Most AI venture investments are concentrated in the US and China

Artificial intelligence/machine learning venture investments (2010–Q1 2021)



1	Standard Cognition	8	Tradeshift	15	Bright Machines	22	Relativity Space	29	Element AI
2	MoneyLion	9	Bowery Farming	16	C3 AI	23	Knewton	30	Clari
3	Metromile	10	Lightricks	17	Uptake Technologies	24	Udacity	31	Zhubajie
4	Branch International	11	UBTech Robotics	18	Anduril Industries	25	WalkMe	32	Infarm
5	HighRadius	12	Terminus Technologies	19	Berkshire Grey	26	Zuoyebang	33	Farmers Business Network
6	Lemonade	13	Dataminr	20	CloudMinds	27	Disco		
7	OakNorth	14	SenseTime	21	Geek+	28	Harness		

Notes: Totals may not add up due to rounding; includes notable companies and companies with greater than or equal to \$100 million funds raised in 2010 to Q1 2021; includes investments by independent venture capital firms and corporate venture capital funds; excludes private equity investments; Sophia Genetics is coheadquartered in the US and Switzerland
Sources: CrunchBase; Bain Startup Investment Cruncher analysis; company websites; news articles; n=307

always have a clear use for their portfolio companies' products. By becoming a customer or partner of the start-up first, the mature firm can lay the groundwork for a future investment by testing the earlier-stage company's technology and getting to know its team.

Be clear about your parenting advantage. The best corporate VCs not only have a clear deal thesis that fits the business's overall growth strategy. The deal thesis should also entice start-up founders by articulating the benefits of an investment from a corporate VC, such as access to the larger firm's go-to-market capabilities and technical talent. This can give corporate VCs a leg up over pure financial investors.

There's no shortage of opportunities to invest, but increasing competition and rising deal prices increase the odds of missteps.

Build a targeted portfolio. Corporate VC leaders may want to believe they can make rifle-shot investments that dramatically outperform the industry standard, but this approach often backfires. Many larger corporate investors make the mistake of betting on a start-up without thoroughly screening a healthy number of investment candidates. Effective venture capital firms typically screen at least 20 start-ups before making the first investment in a target field. With every new meeting, they go back and revise their investment thesis based on what they've learned. Then, they make multiple investments, selecting the companies that best fit their strategy.

There's no getting around the fact that venture investing can be difficult for large corporations because they don't have the same risk tolerance as independent VC firms. Leading corporate VCs have found a way to comfortably act more like traditional VCs, but it may require modifications both to their organizational payment structure (to better attract and retain venture investor talent) and to the company's governance guard rails around tolerance for failed start-up investments. The stakes have never been higher for corporate VCs to get that balance right.



Value Evolution

SaaS Is Spurring the Next Cycle of Software Superperformance

The shift to cloud-based subscription models is creating even more value in a thriving sector.

By James Dixon, David Lipman, and Christopher Perry

Over the past decade, software has created tremendous value for investors and businesses, thanks largely to its transformative effect on the economy, its role in developing new cloud-based business models, and its ability to increase efficiency in operations. But while software's success in the marketplace has lifted the valuations of software companies, our analysis suggests that some firms may still be undervalued.

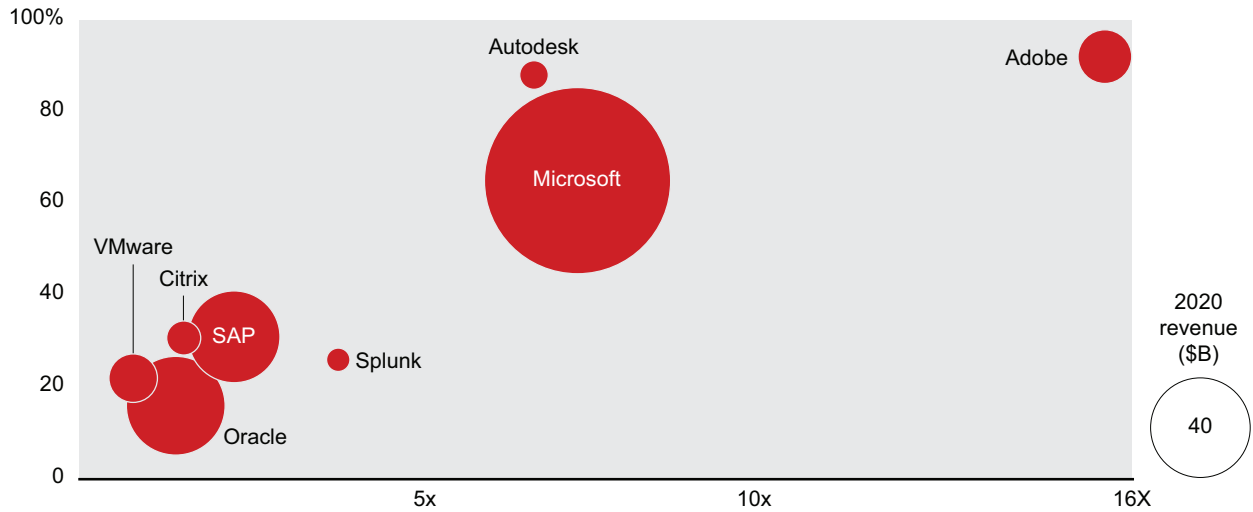
In more mature software companies, we see oversized returns for companies that are moving to software-as-a-service subscription models (see *Figure 1*). The SaaS model allows companies to focus on new ways to create value, and since many companies are early on their journey, more gains may lie ahead.

Many of these software firms may still be relatively undervalued by private equity investors. Analysis of technology deals over the past decade shows that while hurdle rates for software investments are about the same for riskier industries (a target internal rate of return of 21% to 22%), software investments have been more likely to overperform and less likely to lose money (see *Figures 2 and 3*).

If investors identify these trends and believe that they'll continue, we're likely to see some willingness to accept a lower return for a lower-risk asset. Because current pricing and future returns move in opposite directions, lower hurdle rates could push valuations even higher, benefiting current owners.

Figure 1: Software companies that increase their share of revenue from subscription models have stronger growth in share price

Percentage of SaaS/subscription revenue

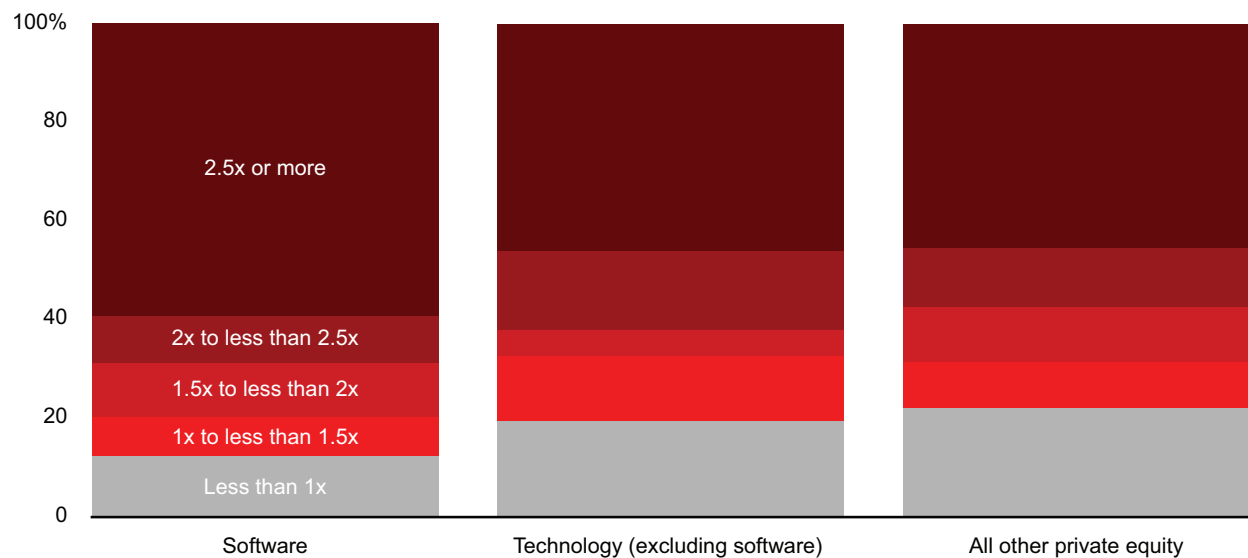


Total shareholder return January 2011 to December 2020 (share price increases plus dividends)

Notes: SaaS is software as a service; Microsoft estimate includes only the parts of its business that are candidates for SaaS (excludes personal computing or enterprise services revenue); Splunk data begins April 20, 2012; Oracle figures based on application subscription revenue
 Sources: S&P Capital IQ; earnings calls transcripts; Griffin Securities; William Blair & Co.; Cowen & Co.; industry participant interviews; Google; Bain analysis

Figure 2: Software and other technology deals have been more likely to overperform and less likely to underperform than most investments in other sectors

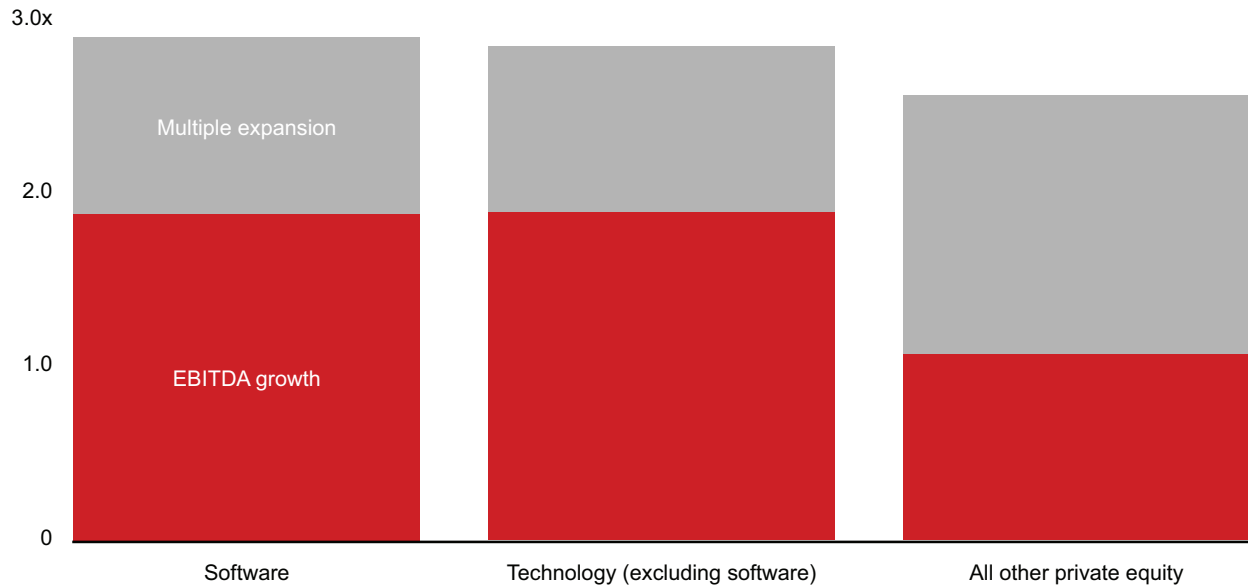
Share of deals, by multiple of capital invested (2010–21)



Source: DealEdge, a partnership product of CEPRES and Bain & Company

Figure 3: Although the expansion of multiples has been significant, revenue and margin growth continue to drive returns on software and other technology deals

Multiple of capital invested, by cause of value creation (2010–21)



Source: DealEdge, a partnership product of CEPRES and Bain & Company

Sticky after all

While there were some worries that the transition to the service subscription model would reduce software's traditional stickiness, those concerns may have been overwrought. When done well, the service model creates a stronger relationship between software vendors and customers, generating new sales opportunities.

Customers like the ability to try before buying and avoiding large, up-front license fees. Other meaningful benefits include:

- faster deployment and less time to real value creation;
- always running the most up-to-date and secure version; and
- the ability to offload more IT tasks to a remote vendor.

Vendors like that they can scale deployment and manage upgrades more consistently, reducing the cost of maintaining old versions. Even greater value comes from getting a better view of how customers use their service, which helps shorten the development time for new features. Rolling out these new features quickly can help companies earn price increases.

Four ways to drive value

Many enterprise software firms already enjoy profit levels that few companies in other industries could aspire to. As more customer companies move to the cloud model and launch their own SaaS products, there's room to create much more value. But, as many executives know, success under this model requires changes in mindset and operations, a switch from selling licenses to encouraging consumption of services. Real transformation runs through four critical areas of change—and moving assertively could deliver a competitive edge.

- **Embrace the cloud operating model.** Selling and delivering continuous cloud services and metering the business require fundamental changes, including new processes, people, and systems. Metrics will also change. Rather than emphasizing license sales, a service model relies on metrics such as annual recurring revenue and consumption levels. Intuit moved assertively to make the shift almost a decade ago, deciding to expand its cloud delivery model when it identified competitors that were trying to disrupt the financial software market. At a time when most of Intuit's revenue came from software like QuickBooks, sold in stores, Intuit doubled down on cloud services, data security, and delivering a consistent user experience on a range of platforms, laying the groundwork for its current business model based on SaaS versions of TurboTax and QuickBooks.
- **Transform Ops to DevOps.** While development teams have followed Agile principles for some time, the cloud and SaaS model requires teams to take responsibility for operations; they become DevOps. Engineers are now service providers, no longer just code writers. This service orientation also translates into the fundamental architecture of the products. They move to service-oriented architectures (SOA), which enable much faster cycle times and continuous release of smaller features and functions, which all make them more responsive to customers' needs. Adobe's embrace of DevOps extends to its customers through tools in the Adobe Cloud suite. Customers won't have to think about DevOps as a discrete methodology, but will see it as the normal process for writing and deploying code within Adobe's cloud environment.
- **Boost consumption through investments in customer success.** The shift to a service model calls for reimagining the customer life cycle from discovery through sales, renewal, and expansion. Customer success teams become strategically important for increasing satisfaction, retention, upselling, and subscription renewals. These teams work closely with customers to make sure they get the most out of the product and all its capabilities. Customer success teams track customer value and relationships, using tools like the Net Promoter ScoreSM or customer satisfaction score to gauge loyalty and prevent churn. Cisco's decision to elevate its top customer service executive to senior management, and its hiring of Maria Martinez from Salesforce to fill that role, demonstrated its commitment to putting customer experience and customer success at the center of its service strategy.

- **Pivot go-to-market to the cloud and digital.** Leaders redesign their marketing and selling for SaaS and cloud models, emphasizing marketing directly to customers, generating demand through digital channels, and elevating specialist cloud sellers to become core reps. They package and price to generate “land and expand” purchases, and bundle offers to include customer care and success. Leaders establish rate cards and a mutually agreed-upon minimum usage of services by each customer. This not only gives the business a stable revenue floor, but can facilitate up-selling and cross-selling through methods such as offering incentives for product upgrades. VMware’s Cloud Universal product suite offers customers the ability to deploy flexibly across private, public, or local cloud, to accelerate hybrid cloud adoption. VMware also reimagined the organization and compensation structures for its sales teams, to adapt to the shift from bookings and license sales to a reward system based on consumption.

Buyers and sellers

As the software sector continues to grow rapidly, here are some of the major implications for various stakeholders to keep in mind as they try to tap into that growth.

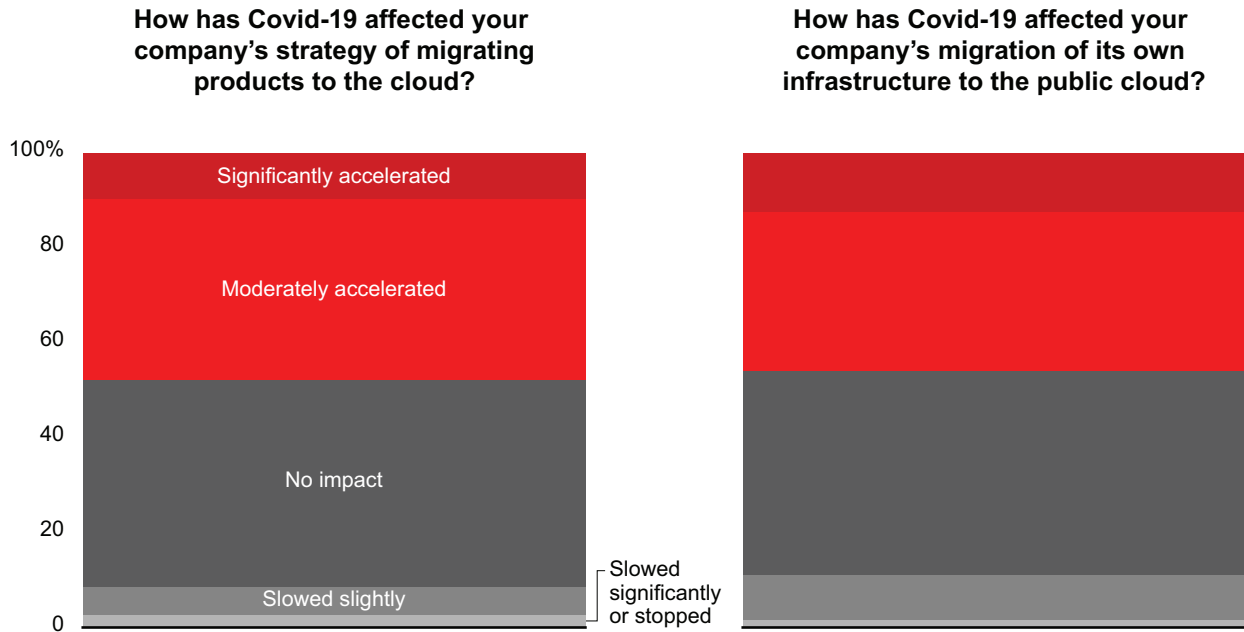
Software companies. While almost every software company is already on a journey to a consumption-based cloud model, most could move faster. Those that adapt too slowly to the SaaS model may have difficulty attracting new customers, who may opt for vendors that offer the delivery and subscription models they prefer.

Hardware technology companies. Makers of PCs, servers, peripherals, networking equipment, and semiconductors recognize the strategic opportunity and are investing in software and SaaS capabilities to differentiate their core products and build new business lines for future growth. Logitech, best known as a provider of peripheral devices, is experimenting with a service that helps gamers improve their skills. Its Playmaster portal assesses players’ game performance in *Counter Strike: Global Offensive*, and then offers a course of training exercises based on the findings.

Enterprise customers. As software continues “eating the world,” even nontechnology businesses are at some stage of digital transformation. Most are under intensifying pressure to reimagine the customer experience and gain a competitive advantage. Just as with software companies, some will be able to deepen their customer relationships with subscription and consumption-based models, in some cases by adapting existing services. For many buyers, the Covid-19 pandemic accelerated their migration to SaaS applications and cloud infrastructure (see *Figure 4*).

Private equity. Most investors know that enterprise software companies have delivered superior returns in recent years, and they can review their exposure, weighing the risks and rewards compared with other industries. Historically, software has been undervalued, and so lower hurdle rates may be

Figure 4: Covid-19 has accelerated the shift to the cloud



Source: Bain Covid-19 B2B IT Software Survey, April 26, 2021 (US n=96, EU n=92)

deserved. Investors should not, however, make unfocused bets on the overall trend. As competition for strong assets increases, private equity investors must focus even more on investing in businesses where they have real advantage. Once they own a business, PE investors should be active owners, helping their portfolio grow rapidly, moving to SaaS models, and making use of best practices in selling and product development. More-passive investors are evolving or getting competed out of the market.



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Competitive Battlegrounds

Bringing Order to Chaos in the Hybrid Cloud

How can companies tame the complexity of merging their on-premise and multicloud computing environments?

By Mark Brinda and Bill Radzevych

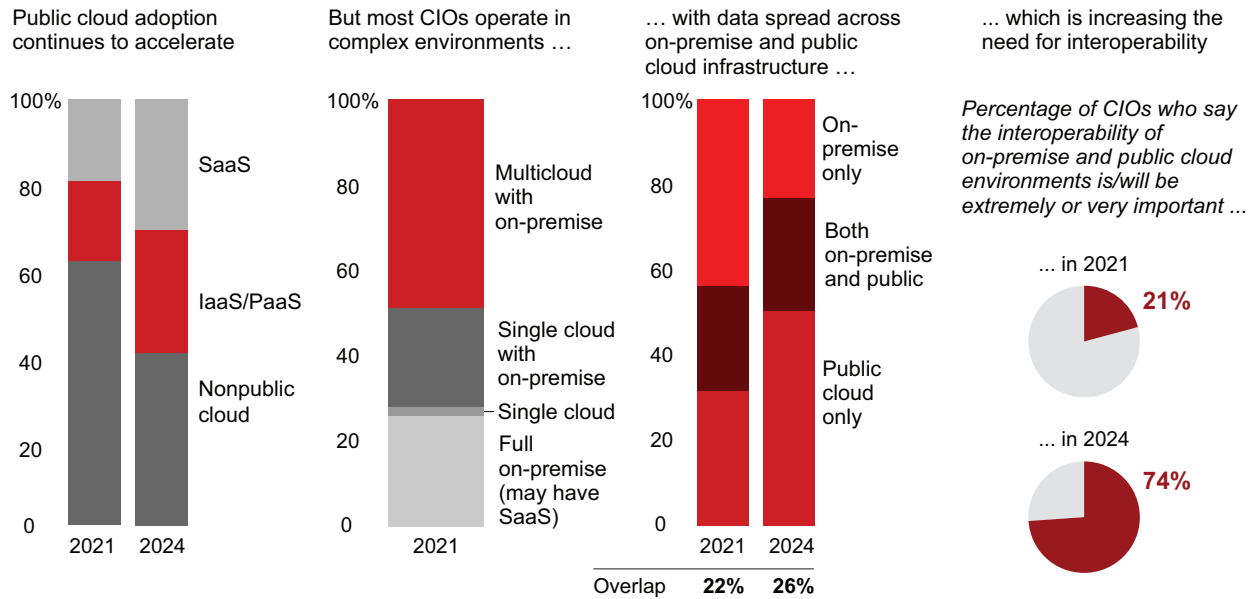
The case for the hybrid cloud has never been stronger, because enterprise computing environments are more complex than ever. As technology vendors try to capitalize on the hybrid cloud opportunity, they're finding that one way to bring order to the chaos is to better understand the emerging customer archetypes in this fast-evolving, strategically important sector.

Despite the accelerating shift to the public cloud, data will continue to be spread across on-premise and public cloud infrastructure for the next few years, and demand for interoperability is skyrocketing (see *Figure 1*). The bottom line is most companies need some sort of hybrid solution.

Part of the challenge is that the lack of a standard hybrid cloud-adoption model has led some companies down misguided paths. We believe that two dimensions can help outline the emerging models: the complexity of the company's on-premise and public cloud environments, and the level of interoperability across these two environments. For example, how many public clouds is the company using, and what percentage of its computing resources is running on public cloud servers? Do the two environments operate in silos, or are they managed through a single pane of (virtual) glass?

Leading hybrid cloud technology vendors are starting to recognize that defining the major customer archetypes and deeply understanding each group's varied challenges, priorities, and likely evolution can enable them to navigate the chaos. And for heritage technology vendors, this is all happening against a backdrop of cloud service providers attacking the on-premise estate with a promise of

Figure 1: The shift to the public cloud is increasing complexity and demand for interoperability



Notes: Average data based on straight line average across data types; SaaS is software as a service; IaaS is infrastructure as a service; PaaS is platform as a service; nonpublic cloud includes on-premise, colocated, managed service provider; level of interoperability defined as self-reported rating on a scale of 1–5, with 1=0% of workloads are/will be interoperable and 5=50% of workloads or higher; environments were considered interoperable if rated 4 (10%–50% workloads interoperable) or 5
 Source: Bain cloud CIO survey 2021 (n=288)

product fulfillment in weeks instead of months. Customer segmentation can help all of these vendors sharpen their focus and tailor their offerings to the priority customers they can serve best, ultimately strengthening the vendor’s position in this vibrant sector.

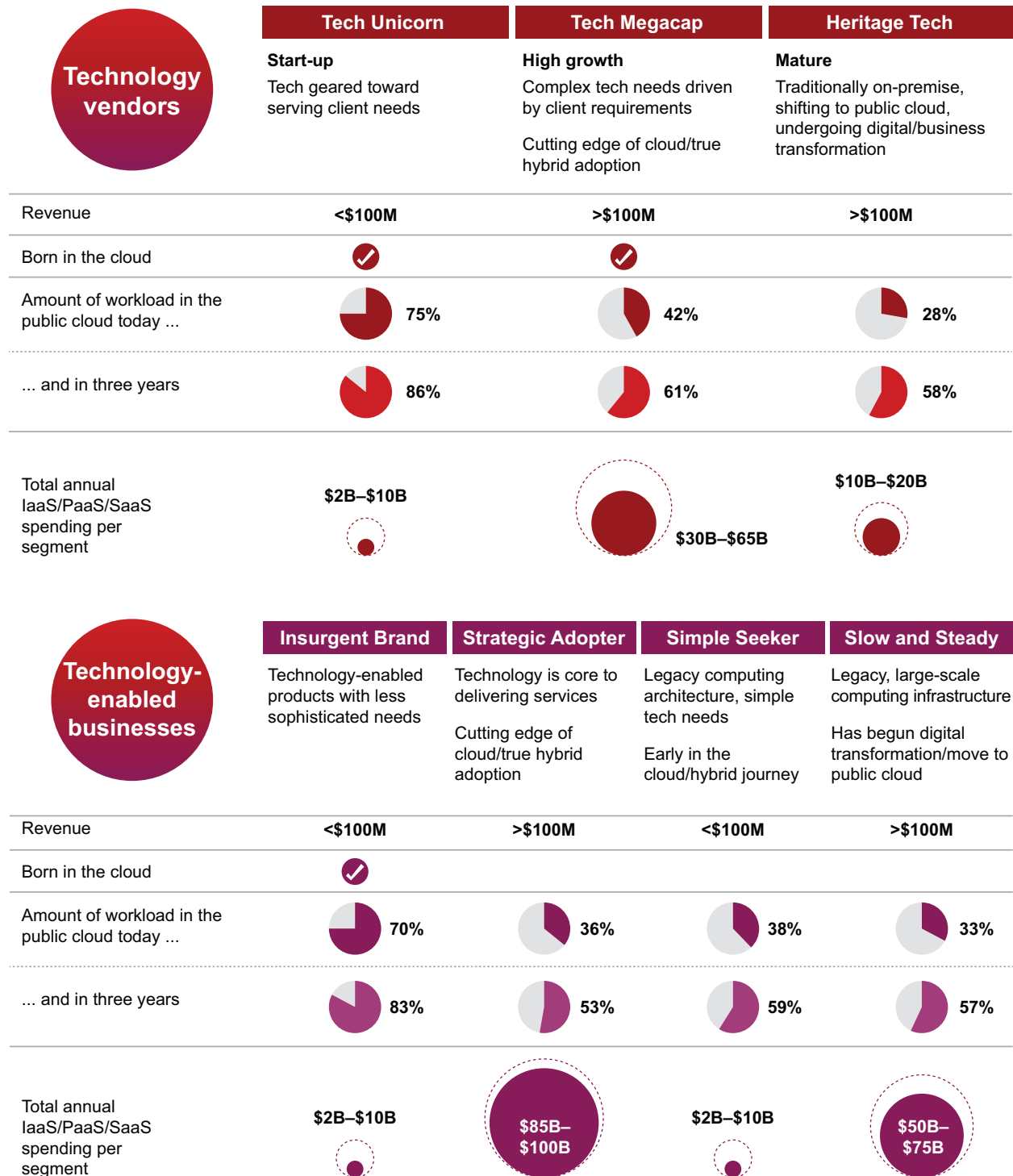
Based on our analysis of the market and experience helping companies develop hybrid cloud strategies, we’ve identified seven main customer archetypes, each with distinct needs (see Figure 2).

What might a customer segmentation project look like on a granular level? Let’s trace two companies’ distinct hybrid journeys in the context of these archetypes.

Strategic Adopters: These large, tech-enabled enterprises typically spend at least 5% of their revenue on turning technology into a competitive advantage. They’ve shifted a meaningful chunk of their computing workloads to the cloud, but now they need to improve interoperability to realize the cloud’s full value and to modernize their remaining complex, legacy applications (see Figure 3).

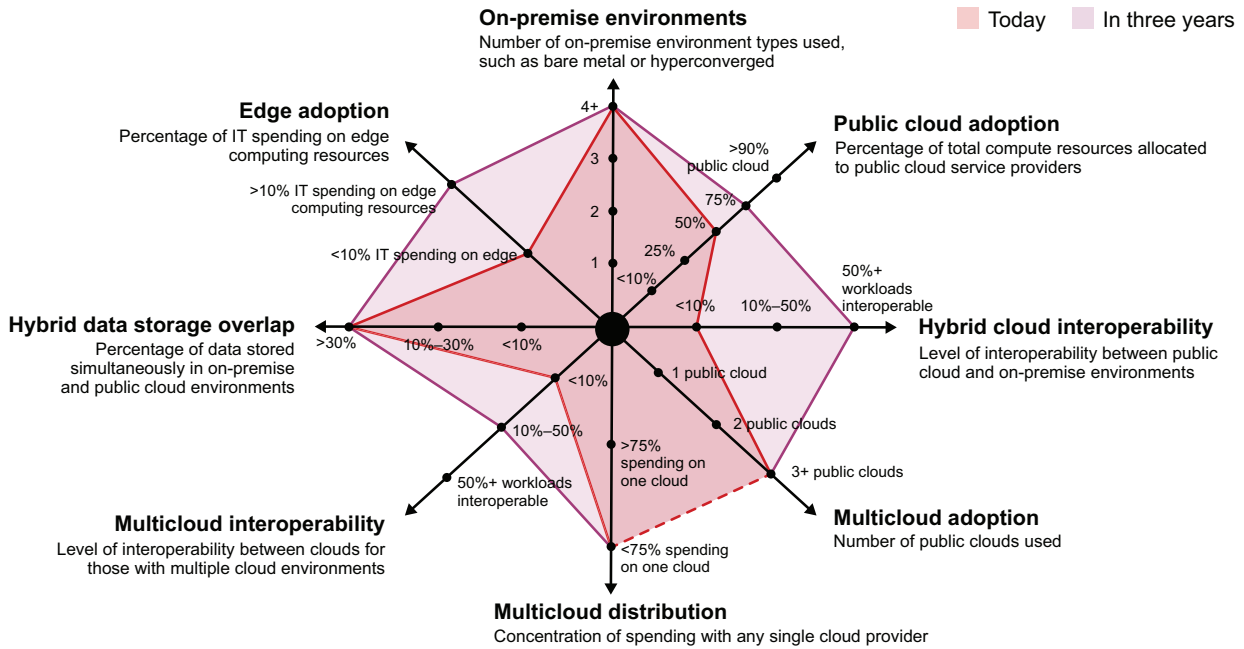
One North American professional services firm has made substantial progress down its hybrid cloud path. About 15 years ago, each of its offices operated IT silos reliant on on-premise servers. This led to inconsistent computing performance and service. Management eventually determined the company was spending too much time and money managing its IT infrastructure. Since launching a hybrid transformation a few years ago, only 20% of its IT workloads and 20% of its data remain in

Figure 2: Seven customer segments have emerged in the hybrid cloud market



Notes: IaaS is infrastructure as a service; PaaS is platform as a service; SaaS is software as a service
Source: Bain cloud CIO survey 2021 (n=288)

Figure 3: Strategic Adopters are investing heavily in public cloud and interoperability



Note: Data on three-year expectations for multicloud adoption and distribution unavailable
Source: Bain cloud CIO survey 2021 (n=288)

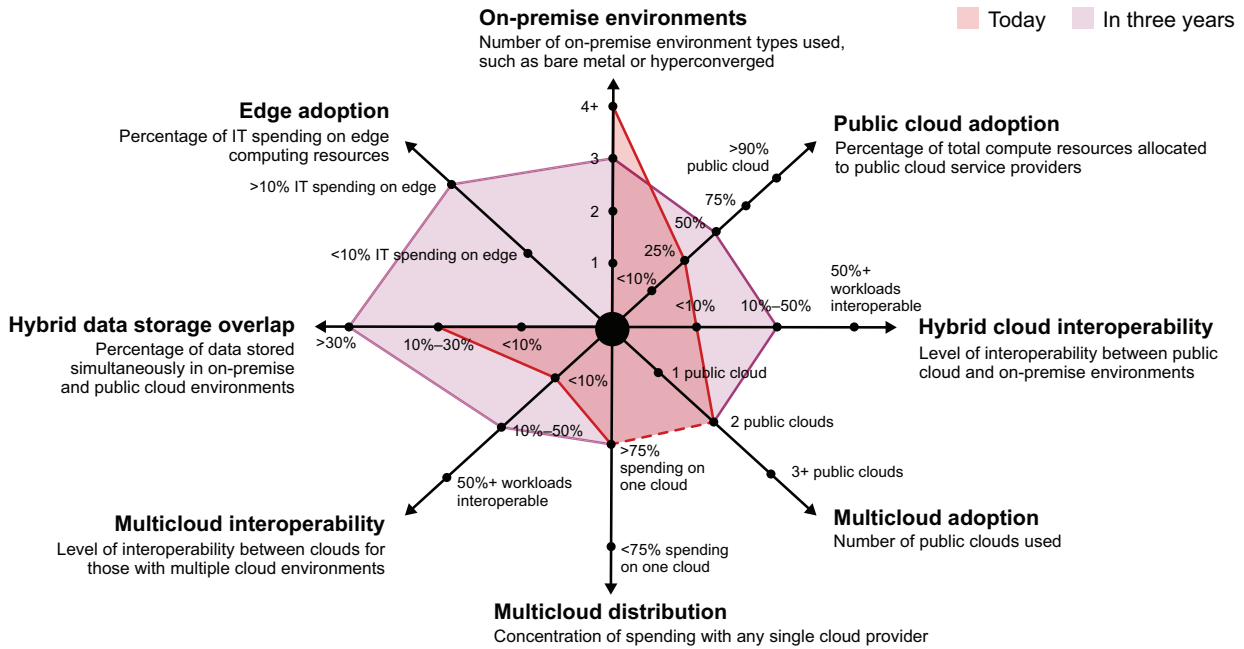
on-premise servers, primarily to improve latency times for key business services. The rest of the workloads run on the public cloud and in a managed services environment, freeing up the company to focus on its core business. To date, the firm has primarily used one public cloud vendor because its leaders believe the benefits of multicloud don't outweigh its added complexity.

For the next phase, the company plans to continue shifting on-premise workloads to the public cloud, while investing more in interoperability. However, this could be the most complicated and slowest phase of its shift to the cloud: The company saved for last the on-premise workloads that will be the most time-consuming and resource-intensive to transition.

Slow and Steady: This other cohort of large, tech-enabled enterprises has substantially different needs. These companies typically have yet to form a clear hybrid strategy. They're also seeking a solution to move basic workloads to the cloud while ensuring bulletproof security, rigorous governance, and compatibility with their large, remaining on-premise footprint (see Figure 4).

Consider a large healthcare company that has multiple clinics across the US. It relies on some software-as-a-service applications. But 60% of its computing workloads are on-premise, and its infrastructure-as-a-service usage and interoperability across environments are both minimal. The healthcare company plans to move more workloads to the public cloud, but its leaders are hesitant because of concerns about the security and privacy of patient data and potential compatibility issues with legacy

Figure 4: Slow and Steady companies are more cautiously adopting cloud computing



Note: Data on three-year expectations for multicloud adoption and distribution unavailable
Source: Bain cloud CIO survey 2021 (n=288)

computing workloads. At the same time, the company is under pressure from customers to use multiple public clouds because they want to tap into the different services each vendor offers, but it's struggling to manage the complexity that comes with a multicloud approach.

What does all this mean for technology vendors?

At a fundamental level, customer segment prioritization has profound implications for hybrid cloud vendors' strategy. The most successful leaders start by making sure everyone across the organization is aligned on the priority customer segment(s). In other words, do the teams across brand marketing, product marketing, product roadmap, go to market, ecosystem strategy, and customer success all serve a common set of buyers in a consistent and optimal way?

A helpful exercise is to contrast the way a buyer in one category—say, a Tech Unicorn—discovers and evaluates a product, with the approach of a buyer on the opposite end of the spectrum, like Slow and Steady.

- **Whom are we targeting with our marketing message?** A Tech Unicorn has probably empowered individuals closer to the IT front line to make more choices, whereas Slow and Steady is more likely to require multiple senior stakeholders—CIO, CTO, CFO, business lead—to agree on a solution.

- **How do they want to buy?** A Tech Unicorn will almost invariably want “pay-by-the-drink” or outcome-based pricing, with minimal up-front expenses. Slow and Steady might prefer to tap the capital budget to make a large, one-time purchase, perhaps via an enterprise license agreement.
- **What ecosystem partnerships do we need?** A Tech Unicorn might evaluate the product through open-source projects, conversations with early-stage start-ups, and availability on marketplaces operated by Amazon Web Services, Microsoft Azure, and Google Cloud. For Slow and Steady, vendors might need to build awareness and capabilities within global IT system integrators; integrate their cloud products with legacy platforms; and tap traditional value-added reseller and distributor channels.

The overarching takeaway is that if different functional leaders within the firm are aiming at different market segments and deploying inconsistent strategies, it’s almost certain to result in an incoherent mess that delights no one. Leading vendors are figuring out how to unite their teams around a cohesive plan that delivers what target customers want.



Competitive Battlegrounds

How Cloud Companies Can Win in Europe

Cloud service providers have to adapt their playbooks to address data security, governance, and regulatory compliance requirements.

By Christopher Schorling, Thibaud Chabrelié, and Alex Martynov

Any successful cloud service provider needs a strong foothold in Europe. But cloud executives are finding that winning in Europe requires a different strategy than other regions—and a strong stomach for uncertainty.

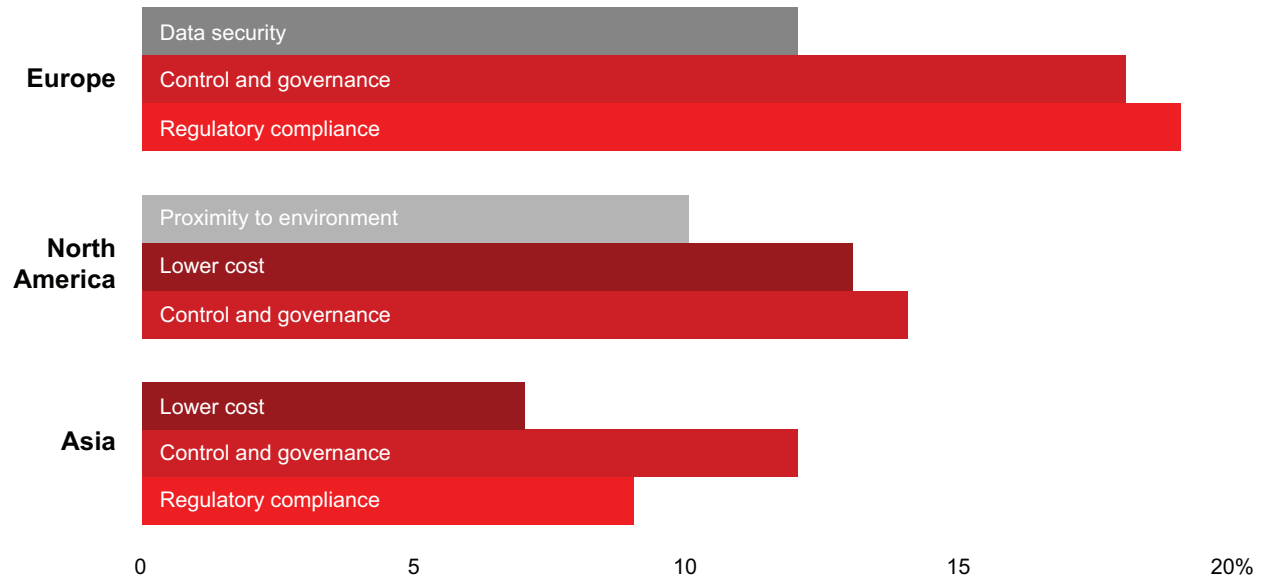
CIOs in Europe control a quarter of global IT spending, and more than a third of them estimate that at least 30% of their computing resources will be allocated to the public cloud within three years. Western Europe's cloud market alone is expected to grow more than 20% annually over the next three years to €44 billion.

But cloud companies can't apply the same playbook in Europe as the rest of the markets they serve. There are more than 20 official languages in Europe, as well as significant differences in per capita GDP, political situations, degrees of technological maturity, and regulatory hurdles at the continental, national, and local levels. As a result, cloud buyers in Europe have significantly different priorities than CIOs in other regions. CIOs in Europe are much more concerned about data security, control and governance, and regulatory compliance than buyers in North America and Asia, according to a Bain survey conducted this year (see *Figure 1*).

This frequently forces CIOs in Europe to keep critical workloads on-premise rather than transition them to the cloud. Moreover, the disparities between global and Europe-based cloud service providers

Figure 1: CIOs in Europe have stricter concerns about data security, governance, and regulatory compliance

Top three reasons for keeping data on-premise



Source: 2021 Bain cloud survey (n=EU 204, North America 365, Asia 69)

in regional market share and scale of physical infrastructure will strongly influence their strategies in Europe.

Regulatory compliance has become even more critical to CIOs in Europe as sweeping new regulations have emerged in the past few years, including the General Data Protection Regulation (GDPR) and the proposed Digital Markets Act (DMA) and Digital Services Act (DSA). The Clarifying Lawful Overseas Use of Data Act (CLOUD), passed in the US in 2018, introduced privacy concerns for data hosted by US-based technology companies. In addition, the European Union’s 2020 Court of Justice decision to invalidate the Privacy Shield Framework between the EU and US governments, commonly known as “Schrems II,” has raised further doubts about the legal compliance for services from international cloud companies in EU countries. Such developments create uncertainty for cloud services buyers and sellers. Requirements for regulatory compliance can change quickly, and different stakeholders might come to different conclusions about what’s truly compliant.

Regulatory requirements have a huge bearing on cloud purchase decisions. Our research shows that customers in highly regulated industries often lag cloud adoption in other industries by 10% to 20%. The upshot is that cloud service providers have an opportunity to grow faster if they can figure out how to earn the trust of these more cautious buyers. Healthcare companies, for example, find it tremendously difficult to share patient data across borders—even within the EU—due to GDPR’s strict

requirements for local governments to implement their own rules. Other industries have different cloud needs, not necessarily based on regulations. For utility companies, customization and the costs of migration from legacy computing systems are key criteria, whereas telecom companies care more about scalability and the flexibility to react to customer needs.

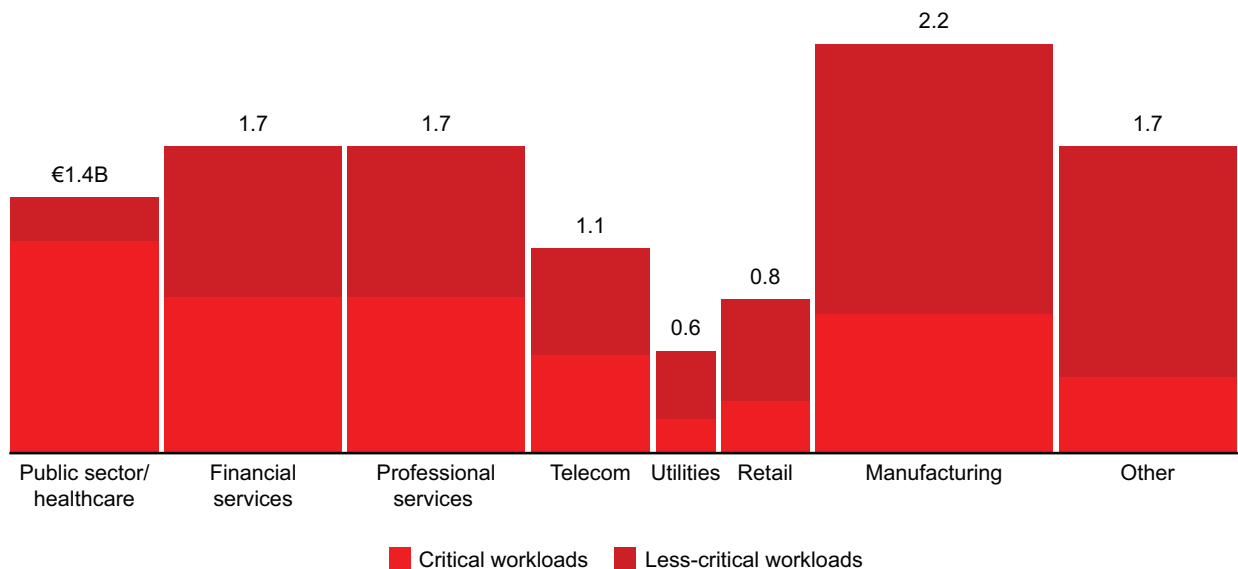
The result is the European cloud market is moving toward offerings tailor-made for specific industries, with rigorous testing to ensure they meet customers' varied requirements. IDC estimates that by 2022, European enterprises will allocate 20% of new cloud services spending to industry-specific cloud solutions.

A Europe-based cloud service provider might have an edge over global hyperscalers in addressing each sector's requirements for housing critical computing workloads, given its decades of experience working within European regulatory frameworks. But the global cloud companies will have a scale advantage in serving customers' less-critical workloads, which make up 60% of Europe's roughly €11 billion infrastructure-as-a-service market (see Figure 2). For CIOs, however, the decision is rarely either/or. Many are adopting a multicloud strategy that gives them the best of both on-premise and cloud infrastructure, while still meeting their needs in data security, compliance, and sovereignty.

So, what's the recipe to win Europe's cloud market?

Figure 2: A range of European industries offer opportunities in cloud services, especially for less-critical workloads

European infrastructure-as-a-service market in 2020, by workload criticality (€B)



Sources: IDC; Bain analysis

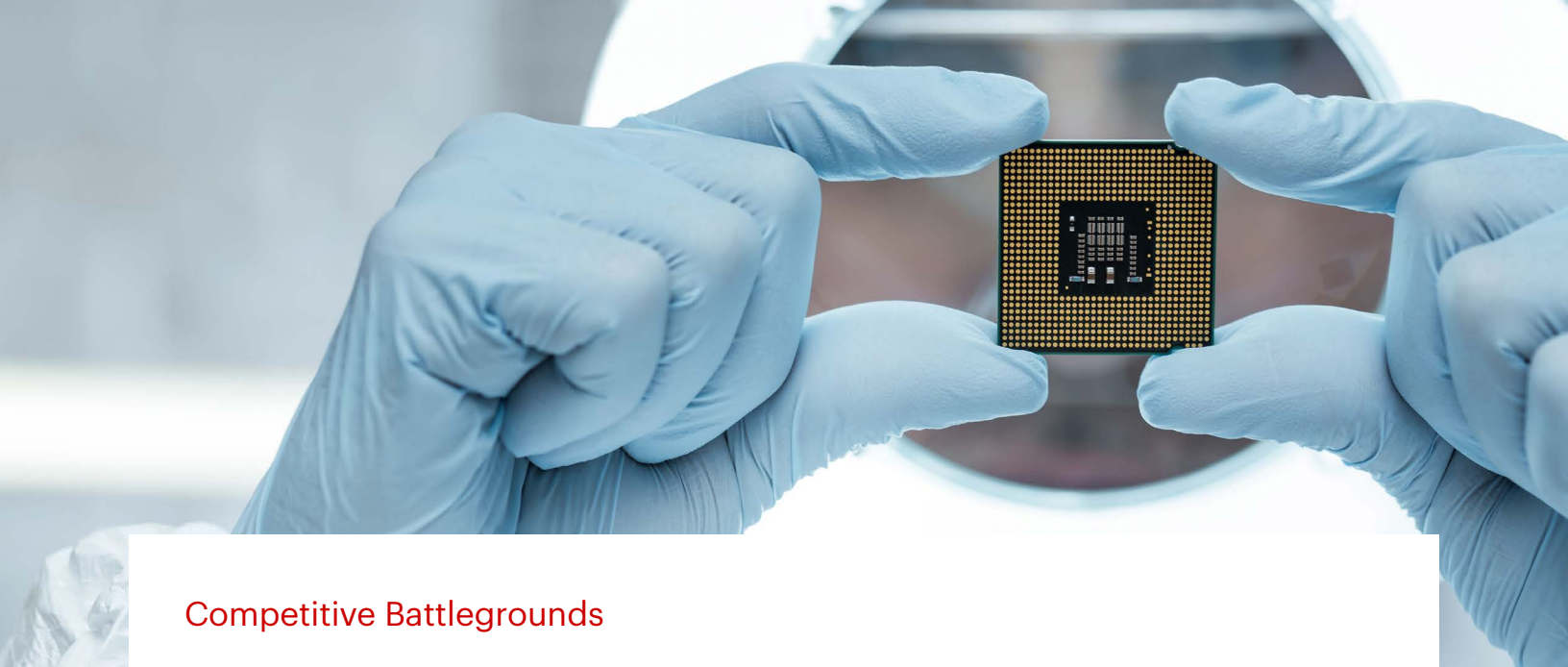
Global hyperscalers have a huge head start. Since they entered the market in the mid-2010s, Amazon Web Services, Google, and Microsoft have been gradually ramping up their data-compliance efforts with new physical data centers and additional guarantees of data sovereignty. Now, this trio controls more than two-thirds of the EU market. These companies can use their physical infrastructure superiority and cost advantages to target multinational or fast-growing European customers whose No. 1 purchasing criterion is scalability. Regulatory compliance and local sales and service structures will likely be mere hygiene investments, while these global players learn how to “be more European.”

Global hyperscalers have a huge head start. Since they entered the market in the mid-2010s, Amazon Web Services, Google, and Microsoft have been gradually ramping up their data-compliance efforts with new physical data centers and additional guarantees of data sovereignty.

Europe-headquartered cloud companies, on the other hand, can build upon differentiators of their own. Many have invested in their customer relationships for decades, keeping their fingers on the pulse of client needs and cloud-migration concerns. French cloud provider OVHcloud, for example, offers a product with IT services firm Atos aimed at serving customers with strong data-security requirements. The product, which houses data in France, earned the SecNumCloud designation from French cybersecurity agency ANSSI, which gives OVHcloud and Atos additional credibility in the market.

In some cases, European cloud companies own physical infrastructure in markets where global hyperscalers simply aren't present, enabling them to offer products with lower latency and better control over customer data. In most parts of Europe, regional cloud providers will want to avoid competing head-to-head with the global hyperscalers. Instead, focusing on segments with special data requirements and staying involved with political initiatives like Gaia-X—a decentralized, EU-compliant cloud framework intended to help European companies compete with global players—can help Europe-based cloud service providers occupy a smaller but profitable market niche.

While a shift in market power between global hyperscalers and local cloud providers is unlikely in the near future, given the fundamental differences in scale, the European cloud market will be large enough to provide sustainable growth paths for all participants.



Competitive Battlegrounds

The Semiconductor Equilibrium Is Shifting

Specialized processors are capturing a growing share of the semiconductor market, but that doesn't spell the end of the general-purpose chip.

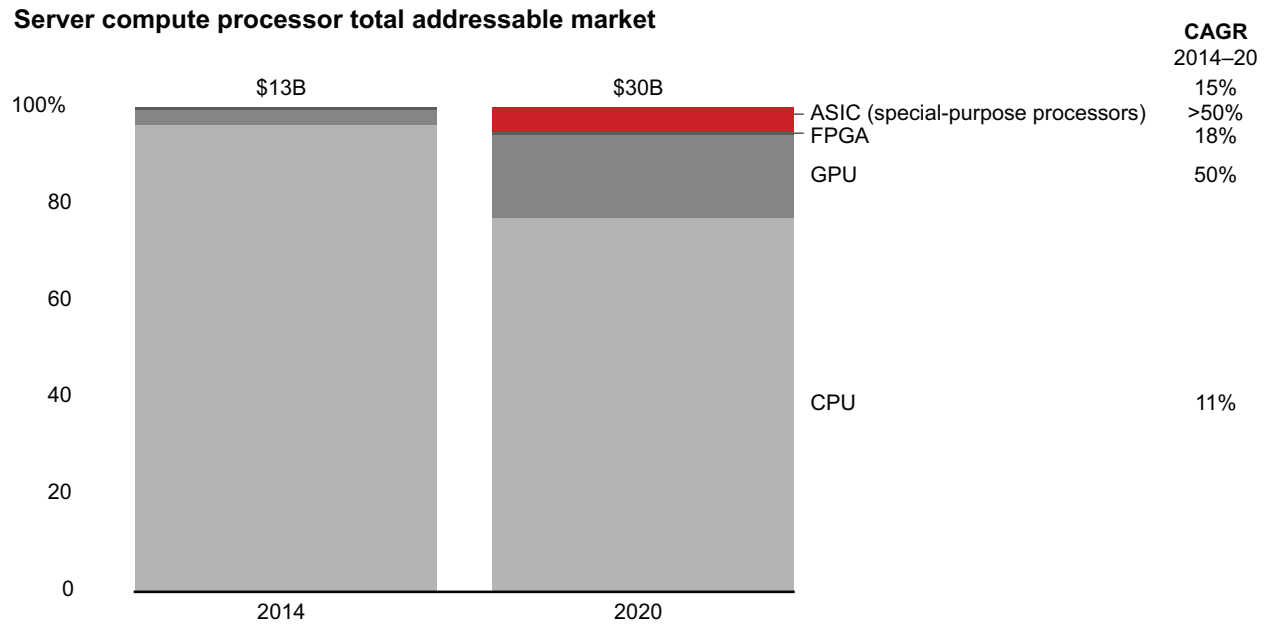
By David Crawford and Jue Wang

While all eyes have been on the shortage of semiconductors this year, a fundamental transformation with even bigger implications for the future of silicon has picked up momentum. Fast-rising demand for specialized processors is shifting the equilibrium between special- and general-purpose silicon that has existed for decades (see *Figure 1*).

Special-purpose chips, known as application-specific integrated circuits (ASICs), have historically occupied an important segment in the market. Each ASIC is designed to perform a limited set of repeatable functions, such as video transcoding or speech processing. Because they don't have to be a Swiss-army knife, end customers know they can substantially outperform general-purpose (GP) processors, such as the industry workhorse, the CPU, for certain functions. However, ASIC customers are also well aware that these specialized chips have expensive up-front design and component costs, such as for masks, and their limited programmability makes them inflexible.

On the other end of the spectrum, GP processors have the benefit of being programmable for a wide range of workloads. Plus, silicon architectural compatibility gives chip buyers peace of mind that software development investments are portable to future generations of GP processors. This compatibility allows software developers to significantly upgrade application performance as the silicon industry makes advances in manufacturing and chip design.

Figure 1: Demand for specialized processors is increasing rapidly



Notes: ASIC is application-specific integrated circuit; FPGA is field programmable gate array; GPU is graphics processing unit; CPU is central processing unit; ASIC percentage is <1% in 2014; FPGA percentages are 0.5% in 2014 and 0.6% in 2020
Sources: IDC; Gartner; analyst reports; Bain analysis

Historically, this general-purpose computing proposition has fueled a roughly \$60 billion compute microprocessor market. Four structural forces have served as catalysts for GP processors’ dominance. First, Moore’s Law has typically allowed GP processors to promise a steady performance-per-watt improvement every two to three years. Second, computing workload diversity in data centers, networks, and devices has persisted, favoring programmable platforms that can flexibly handle a range of workloads. Third, the scale of any individual workload is often insufficient to justify the high fixed costs of designing and manufacturing special-purpose processors. Lastly, GP processors and software tools from GP silicon vendors have reduced software development costs and time to market, enabling developers to bring new services and applications online much more quickly and efficiently.

The shifting semiconductor equilibrium

Today’s computing environments are shifting this equilibrium more toward specialized silicon and blurring the line between special- and general-purpose processors.

As Moore’s Law slows, top semiconductor buyers—the “hyperscaler” cloud service providers (CSPs)—have the intent and scale to control their destiny by designing more custom processors in-house. Workloads are consolidating to a limited number of enormous, global “computers” or “computing clusters” located in buildings of several hundred thousand square feet and often owned by the large CSPs. These warehouse-scale computers can consolidate specific workloads into more homogeneous

server clusters and cloud domains that are focused on a small number of tasks. As such, data center operators are more capable of tailoring computing system and silicon design for this narrow range of tasks, and they can do it more economically than was possible before.

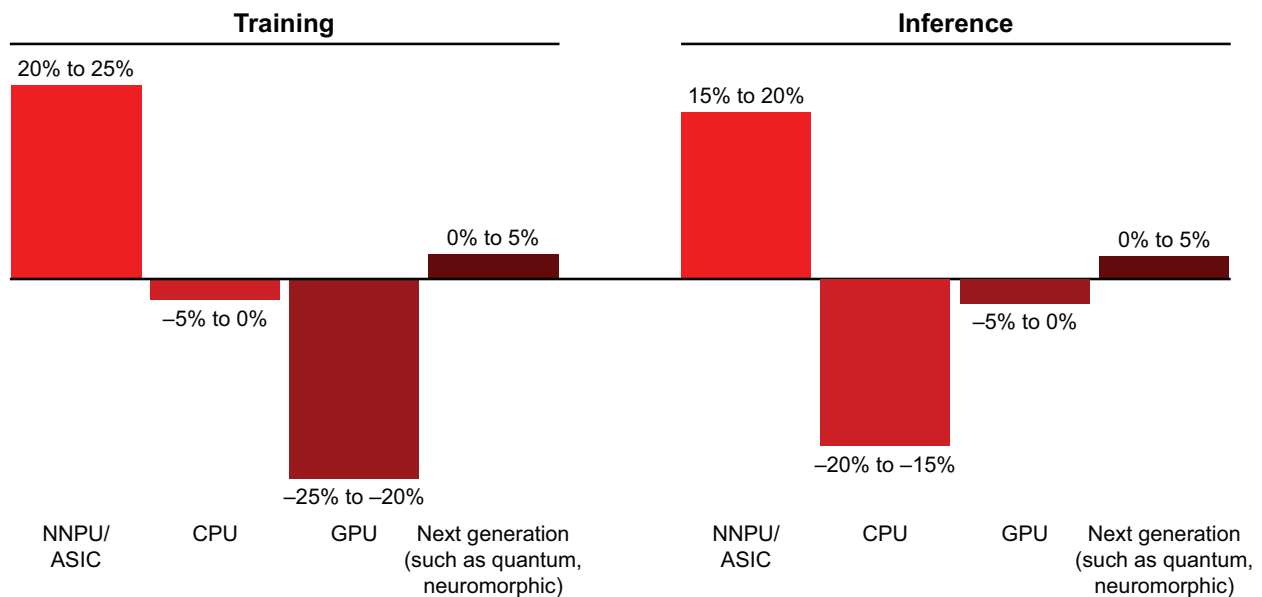
At the same time, the largest semiconductor buyers are increasingly realizing that the proliferation of video, images, speech, and other high-data-volume workloads such as AI training are better suited to chips tuned for the particular processing required (such as vector, matrix, and graph processing). These data workloads aren't served as well by the predominant GP compute platform, CPUs. Engineers are therefore faced with a choice: Use a specialized ASIC chip or a newer type of general-purpose processor, either a graphics processing unit (GPU) or field programmable gate array (FPGA). The ease of developing software using GPUs and FPGAs has improved in recent years, but still lags CPU maturity. Meanwhile, top CSPs have the deep pockets and expertise on staff to develop applications on custom ASICs, and they're planning to do more of this. As one example, look at how dramatically the largest CSPs intend to increase their use of special-purpose chips for internal AI workloads over the next decade (see Figure 2).

How to adapt?

General-purpose silicon vendors might be hearing alarm bells, but there's no need to panic; GP computing has a bright future. That's partly because special-purpose processors are hard to program,

Figure 2: Hyperscaler cloud service providers plan to dramatically increase their use of special-purpose processors

Change in share of hyperscaler CSPs' internal AI compute cycles, by processor type (today to 2025)



Notes: NNPU is neural network processing unit; ASIC is application-specific integrated circuit; GPU is graphics processing unit; CPU is central processing unit
 Source: Bain interviews with hyperscaler CSPs, 2021 (n=20)

and the GP model's flexibility still makes it desirable in most cases. That said, the blurring line between the two calls for GP silicon incumbents to adapt in three areas.

General-purpose silicon vendors might be hearing alarm bells, but there's no need to panic; GP computing has a bright future. That's partly because special-purpose processors are hard to program, and the GP model's flexibility still makes it desirable in most cases.

Product portfolio. Watch for GP silicon providers to develop more processors that can serve diverse scalar, vector, matrix, and graph workloads at various power-performance thresholds. The holy grail may be to offer a family of compatible GP processors to cover the diversity of workloads. This inevitably presents a software challenge as companies try to unify development tools under a common software application programming interface (API) substrate. GP vendors are already adjusting their product portfolios accordingly; see Nvidia's interest in acquiring ARM and Intel's introduction of GPUs as well as its acquisitions of Nervana Systems and Habana Labs for AI processors.

Accelerator blocks. The industry's evolving dynamics are making it necessary to tightly integrate companion accelerator processors and intellectual property (IP) "blocks" with GP processors, in order to offload critical high-volume workloads such as AI and media processing. The industry is in a race; the x86 CPU ecosystem is working to add vector and matrix processing to its chips, while the GPU ecosystem is working to better accommodate scalar processing and general software developers. Ultimately, the trick is hitting the right mix of accelerated special-purpose and GP compute engines, ensuring tight coupling and low latency, and making it easy for programmers to use.

Customer engagement model. GP silicon vendors' largest customers, the hyperscaler CSPs, will increasingly require customization. This involves trimming the unused "kitchen sink" features in GP silicon, calibrating features to large customers' needs, and realigning the organization and resources to enable a higher-touch, nimbler customer engagement model. The industry is moving in this direction, at varying paces. AMD appears to have been prioritizing this with its Semi-Custom business unit.

Meanwhile, all signs point to GP silicon remaining the majority of semiconductor manufacturers' production volumes of leading-edge chips. Winning a fair share of these crucial customers remains at the top of the agenda for foundry executives. Nevertheless, the new silicon equilibrium creates the possibility of enough demand for large-scale production of leading-edge ASICs. A prime example may be cryptocurrency processors, where demand has spiked in recent years. Leading manufacturers

will go after these new special-purpose opportunities, particularly in artificial intelligence (AI) and media processing.

As for hyperscale CSPs, evolving data center economics will require them to take more control of their silicon destiny, in order to differentiate their services and lower their total cost of data center ownership. CSPs recognize, of course, that only they have the necessary insight into the telemetry of their server fleet and most critical computing workloads. Identifying the next growing workloads that aren't well-suited to GP processors, then creating customized system and silicon solutions, will become necessary to stay ahead of the competition. But silicon design requires scale to succeed, so getting into this business introduces critical make-vs.-buy choices.

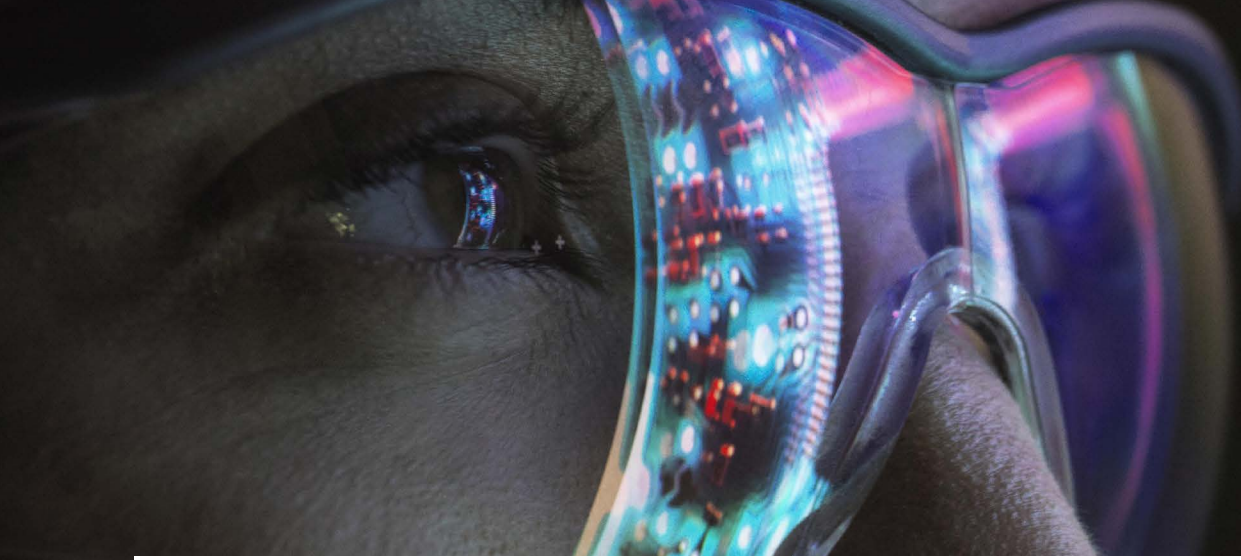
There are a few trends to watch here. First, within GP silicon, GPUs will likely continue to take share from CPUs. An example of this is Nvidia's data center GPU computing business, whose annual revenue has grown by 16 times in the last six years, to \$5 billion in fiscal 2021. Second, there's a strong argument that value-managed relationships will emerge between traditional GP silicon vendors and their CSP customers, which will closely collaborate with the silicon vendors as they increasingly customize their GP processors and add accelerators and other enabling IP, such as memory capabilities. As this introduces the risk of IP leakage for the hyperscalers, many of these value-managed relationships will likely include varying degrees of exclusivity and firewalling—a new behavior for GP silicon vendors. Lastly, for select ultra-high-volume computing workloads, hyperscalers will likely build custom ASICs in order to gain computation efficiency advantages over competing CSPs. We see this already in Google Cloud's tensor processing unit and Amazon's data processing unit investments.

What does all of this mean for the special-purpose end of the market? Specialized silicon vendors have seen a burst of venture funding and the growth of ASIC providers, especially in edge and AI processing.

What does all of this mean for the special-purpose end of the market? Specialized silicon vendors have seen a burst of venture funding and the growth of ASIC providers, especially in edge and AI processing. However, there's an open question about the longevity of small-scale, standalone ASIC vendors. The ones that make it will most likely be acquired by a hyperscaler or GP silicon vendor. We see this in acquisitions such as Intel's Habana deal and Amazon purchasing Annapurna Labs. Don't be surprised to see ASIC vendors pursue more partnerships with their customers, both to learn from them and find a potential exit path.

Meanwhile, the few independent ASIC-design companies with a large-scale business, a proven IP portfolio, and strong foundry relationships are becoming more valuable than ever. Just look at Broadcom's cloud ASIC business, which has an estimated annual revenue run rate exceeding \$1 billion.

Ultimately, general-purpose silicon is here to stay, increasingly blending with special-purpose silicon as it becomes more prevalent in the years to come. That spells opportunity for companies across the semiconductor ecosystem to thrive, as long as they nimbly adapt to find their place in this shifting equilibrium.



Competitive Battlegrounds

Artificial Intelligence: Who Will Lead the Next Era?

The focus on enterprise AI adoption distracts from the real disruption underway, fueled largely by cloud service providers.

By Paul Renno, Jue Wang, and David Crawford

The computing industry has gone through three major transitions over the last half-century: the mainframe era; the shift to PC-server computing; and the rise of cloud, mobile, and the Internet. Now, we're on the cusp of a fourth transition, data-centric computing, which will be powered largely by the increasing pervasiveness of artificial intelligence.

Spurred by a need to process a dramatic growth of unstructured data and enabled by a drastic reduction in the cost of computing, artificial intelligence (AI) tools are becoming more widely available through cloud platforms and open-source software. It's not hyperbole to say that machines will be able to program machines in the coming years. That will unleash unprecedented efficiency gains for data centers and allow for much broader use of AI technology. Questions about job loss and ethics will remain a feature of the landscape for AI companies, yet it's also increasingly clear AI will continue to improve products and customer experiences through personalization, create new categories of products and jobs, and enable advances in critical areas of society, such as cybersecurity and public safety.

Now, the real question is, who will lead the way in AI?

The reality check

The common narrative is that AI's trajectory over the next several years will be shaped by enterprises in all industries rapidly adopting the technology. In reality, it's clear that large cloud service pro-

viders (CSPs) will continue to fuel the industry as both its leading adopters and innovators, helping other enterprises customize and deploy their own AI-powered products and services.

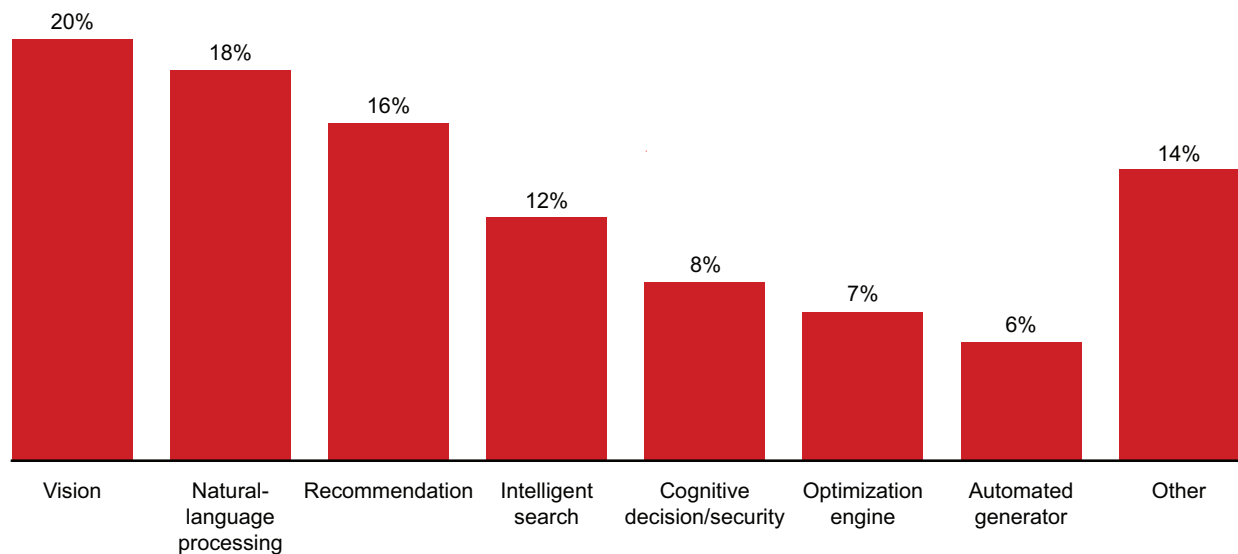
Few companies are qualified to be leaders in raw AI innovation. The CSPs are best positioned because of the significant head start they have in using AI on a large scale. This is true across applications such as natural language processing (think Amazon Alexa), image recognition and processing (Facebook, Google), recommendation systems (Google search, Alibaba e-commerce), vision processing in autonomous driving (Alphabet’s Waymo), and smart cities (Alibaba City Brain, Tencent WeCity).

CSPs’ cloud and digital services have given them access to the enormous amounts of data required to effectively train AI models. The exponential growth in the size and complexity of AI models requires AI practitioners that have the ability to build and operate bespoke, large-scale systems. And the CSP business model benefits from the personalization of services that AI can deliver.

CSPs have the largest fleets of AI servers, and their spending on AI computing architecture is accelerating. More than 15% of leading CSPs’ servers are currently focused on AI computing workloads, and that’s expected to rise to more than 30% by 2025, according to Bain interviews with the companies. By then, the top-four AI workloads—vision, natural language processing, recommendation engines, and intelligent search—will account for around 70% of CSPs’ AI server fleets (see Figure 1).

Figure 1: Vision, conversational AI, recommendation engines, and intelligent search will account for most of hyperscale CSPs’ AI server fleets by 2025

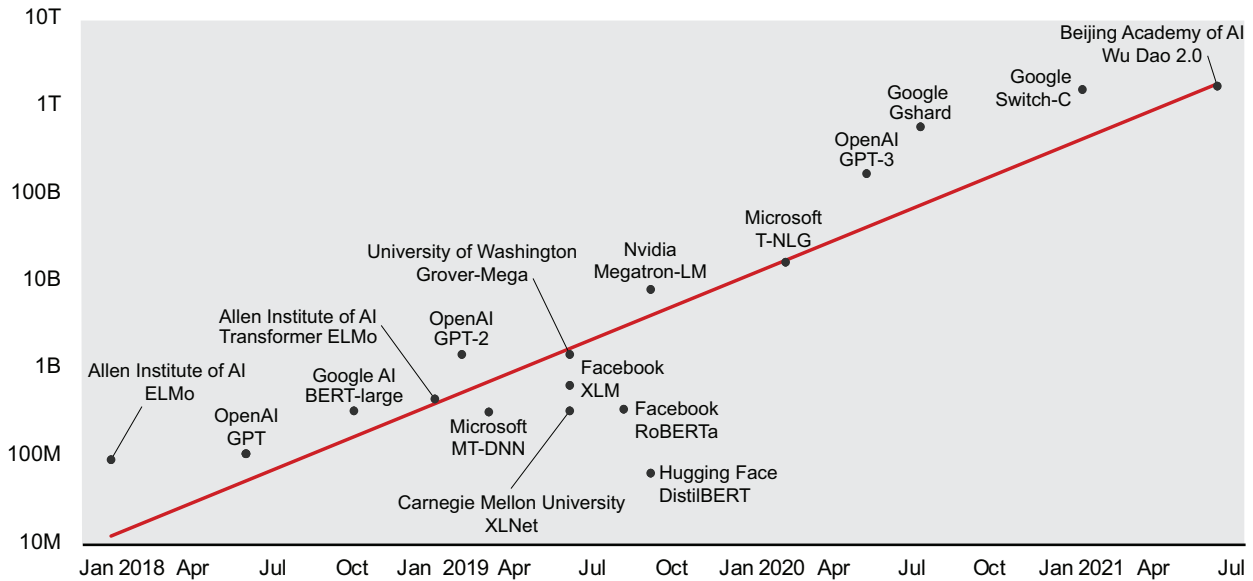
Share of workload for hyperscale CSPs’ AI server fleet (2025)



Note: Values are rounded
 Source: Bain interviews with hyperscale cloud service providers, 2021 (n=20)

Figure 2: The size of deep-learning models is increasing exponentially

Number of parameters in deep learning models (log scale)



Note: Timeline designates when each model was announced
 Sources: Company and developer websites; academic papers; news articles; blog posts; Bain analysis

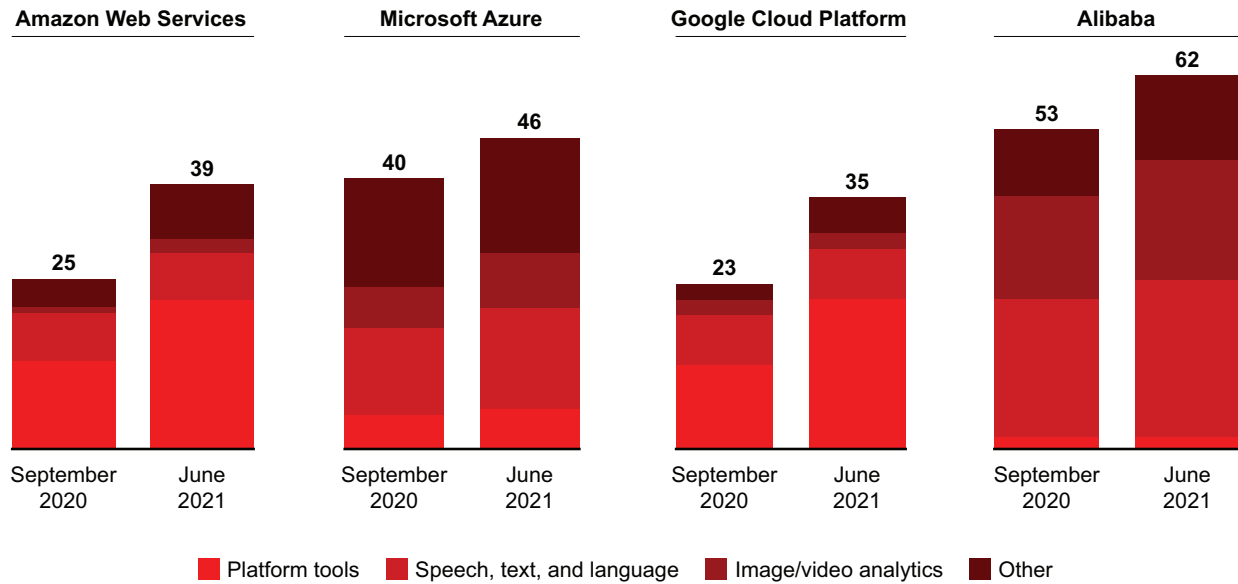
CSPs have also developed some of the most sophisticated commercial AI models. The complexity of deep-learning models is more than doubling every three to four months (see Figure 2). Among the largest ones are Google’s 1.6-trillion parameter Switch Transformer model introduced in January, and OpenAI’s 175 billion-parameter GPT-3 model introduced in May 2020 and commercialized by Microsoft in May of this year.

CSPs created and advanced the leading AI developer frameworks, which are collections of math libraries packaged to support developer training and inference of complex AI neural net models. The vast majority of AI algorithms run on TensorFlow (Google), PyTorch (Facebook), and PaddlePaddle (Baidu), and millions of AI developers worldwide rely heavily on this foundation laid by the CSPs.

Furthermore, CSPs are among the most prolific developers of AI-enabled services. Amazon Web Services, Microsoft Azure, Google Cloud Platform, and Alibaba Cloud expanded their AI platform offerings by about 30% from September 2020 to June 2021 (see Figure 3). Notable advances are being made not only in core AI models and services, but also more sophisticated text-to-speech capabilities and image analysis. CSPs are also introducing tools to simplify the full AI workflow, from data ingestion through model deployment and maintenance. For example, AWS has expanded its SageMaker services to simplify each stage of the AI development life cycle.

Figure 3: Hyperscale CSPs are expanding their AI service offerings

Number of artificial intelligence/machine learning services



Sources: Company websites; Bain analysis

Lastly, much of the AI talent is concentrated within CSPs. The number of AI employees at the top five US hubs (Amazon, Microsoft, Alphabet, Facebook, and IBM) exceeds the size of the AI workforces at the next 45 US companies combined.

All of this points to CSPs likely remaining the primary vehicle through which AI capabilities are turned into products and made widely available. As this democratization of AI accelerates, fewer companies will build their own AI stacks because the time and money required often won't be worth it. Some still will do so for business cases where CSPs' AI tools lack particular features or domain-specific functionality, proprietary and differentiating data sets exist, or when there are privacy and security considerations. But this will increasingly be the exception, not the rule.

Enterprises will be able to build differentiating AI products and services using third-party tools—usually from the CSPs—allowing them to focus on adding value through domain-specific expertise. For example, Intuit engineers are using AWS SageMaker's AI model design and training tools to help incorporate AI into the company's financial software products. This has cut Intuit's typical AI development timeline from six months to less than a week, and in 2020 the company increased its number of AI models in production by 50%, to several hundred. Most importantly, it has helped Intuit save customers time through better self-help software tools and receipt processing, and it has enabled the company to underwrite more loans by improving repayment forecasting.

Choosing a path

So, what does all of this mean for technology providers?

For CSPs, the top priority is staying ahead by continuing to build data sets and maximizing the value of AI in the core business. The race is on to win enterprise AI computing workloads and data sets, which can be fed into the cloud platform to generate new insights that, in turn, help improve AI products.

But CSPs should choose wisely when going after new industries and product adjacencies, balancing near-term return on investment with long-term product differentiation. Success in different industries often requires significant domain expertise and high technical performance. In many cases, forming partnerships with system integrators and third parties will go a long way.

The race is on to win enterprise AI computing workloads and data sets, which can be fed into the cloud platform to generate new insights that, in turn, help improve AI products.

Leading CSPs also recognize it's important to continue putting in the hard work of building trust-worthy relationships and data policies, guiding public understanding and regulations of AI, and developing advanced technology to reduce bias and preserve privacy in AI products. The leaders understand these efforts can pay off not only for the companies themselves, but the AI field as a whole.

Meanwhile, even though technology companies in disrupted industries might not be leaders in raw AI innovation, they can still find innovative ways to apply others' foundational AI tools and services to better serve their own customers. It helps that these companies have some of the winning characteristics of the AI era. These businesses—which include enterprise software firms, system integrators, and technology companies serving manufacturing, retail, healthcare, and other specific sectors—have many customer touchpoints and/or are frequently working with unstructured data.

The emerging leaders in this segment are thinking several steps ahead. While it can't hurt to hire data scientists and chief digital officers, that's no substitute for deeply understanding how AI will transform the value of the company's products to customers. The leaders will develop a customer-led roadmap that prioritizes their desired AI uses and takes advantage of user feedback loops to accelerate product design cycles, enhance products, and improve customer success.

As for the AI computing enablers—semiconductor developers and manufacturers—it's clear now that AI will be the defining computing workload that underpins their success after the cloud and mobile

era. The explosion of AI workloads and the field's dynamics for innovation and democratization led many to declare the death of the general-purpose (GP) processor, such as CPUs. But GP processors actually have a bright future, with targeted adaptations that will likely involve a family of processors better suited to handle the requirements of AI and other critical workloads.

Lastly, many technology hardware vendors have already started the journey of evolving their business model, moving from hardware to software to hyperconverged, integrated "delivery-as-a-service." The proliferation of AI increases the urgency to accelerate this journey.

Companies in this segment are considering turning their traditional hardware products into a vehicle for delivering CSPs' AI software stacks for converged hardware, which could prove powerful in combination with the tech hardware vendors' enterprise expertise and customer reach. Many enterprise customers have the data science and application engineering skills required for their industry's AI uses, but their capabilities aren't as strong in quality of delivery services, server fleet management, and system-level technology operations. At the same time, CSPs, especially in the US, are mostly staying away from being the full AI delivery vehicle for these enterprises because they don't want to get dirt under their fingernails handling all the operations-heavy work of installation, retrofitting, system integration, and maintenance. This could be the sweet spot for the hardware tech vendors, but it would require a swifter shift to a business model based heavily on operational services.

Nevertheless, these vendors will still have opportunities to enhance their existing hardware products with AI-enabled remote monitoring and adaptive improvement capabilities, so they can take an even more active role in helping their customers get the most out of their products.

Ultimately, the AI battleground is still being shaped. But everyone has a viable path to success, from the raw innovation leaders to the many companies building products and services on top. Guided by their company's strengths, the emerging leaders are moving quickly to establish a foothold in this new era.



Competitive Battlegrounds

The US and China Are Decoupling, and Other Countries Are Following

Governments are doubling down on breaking up.

By Anne Hoecker, Karen Harris, and Jue Wang

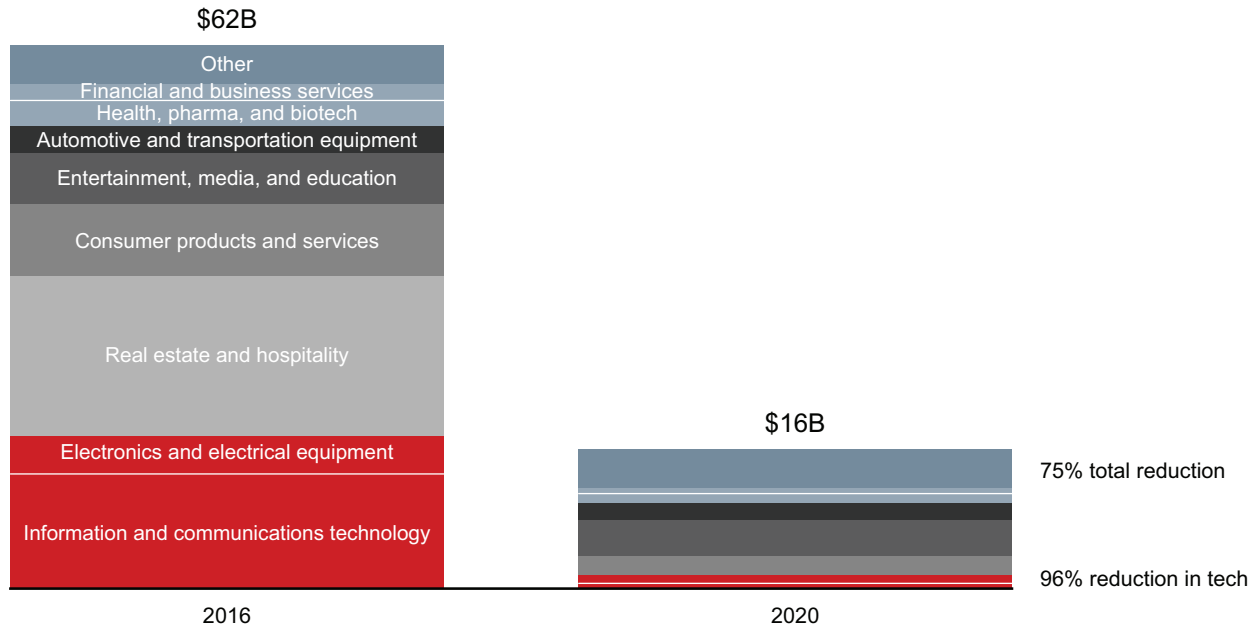
Several major countries are investing more than ever in technology and supply chain independence. And yet the global technology industry will continue to be codependent for the foreseeable future, as many barriers to self-reliance will take years to break down. These two opposing dynamics have forced technology executives into a high-wire balancing act: How can they step toward the decoupled era while simultaneously keeping the other foot stable in today's codependent reality? And how long will they be required to maintain this balancing act?

Decoupling will define the future

The US and China pushed the world in this direction, and the decoupling of their economies and technology ecosystems has been gaining momentum for several years. Consider this: Technology-related foreign direct investment between the two countries dropped by 96% from 2016 to 2020 (see *Figure 1*).

Now, the US and China are upping their bids for technology and supply chain independence with massive domestic investments. In June, the US Senate approved the \$250 billion US Innovation and Competition Act, which would provide \$52 billion for domestic semiconductor research and manufacturing, a 30% funding boost for the National Science Foundation, and \$29 billion to fund a new applied sciences directorate. Meanwhile, China's annual spending on R&D climbed to more than \$350 billion in 2020, and the country is spending \$1.4 trillion over the next few years in infrastructure technologies such as artificial intelligence (AI), semiconductors, and 5G networks. The two nations'

Figure 1: Foreign direct investment between the US and China has declined significantly, especially in technology



Sources: The US-China Investment Hub; Bain analysis

recent moves signal that decoupling will be a defining feature of the technology landscape for years to come, even with one of its most prominent contributors—former US President Donald Trump—no longer in office.

Although the US and China put the world on the decoupling path, other leading countries and regions aren't trying to reverse course; they're embracing it. South Korea announced a \$450 billion investment in May to establish itself as the world's largest chip-manufacturing base by 2030. The European Union in March pledged a \$150 billion investment in "digital sovereignty," with the goal of doubling its share of global semiconductor production to 20% by 2030.

The unprecedented scale and pace of investments in decoupling around the world has technology companies scrambling to update their short- and long-term strategies. But although decoupling appears all but inevitable, multiple chokepoints assure the global technology industry will remain codependent—for now.

Despite significant investments, mainland China has been unable to ramp up domestic semiconductor manufacturing because it lacks key process technology and critical equipment.

Over the past year, as tightening US export controls highlighted these vulnerabilities, China showed signs of shifting to a more friendly approach to multinational corporations. That has led to a surprising

development: Many multinational technology companies have found doing business in China is arguably getting easier, at least for the time being. Additionally, China is trying to alleviate choke-points from multiple angles, from investing in open-source, homegrown alternatives across the technology stack (e.g., RISC-V chip design architecture), to setting a national agenda for next-generation AI standards.

On the other hand, the US relies mostly on Asia for access to leading-edge semiconductor foundries, original equipment and design manufacturers, and component makers. Recent supply chain disruptions, such as the global chip shortage, have only exacerbated these challenges and compounded the desire for self-reliance.

While China's hard-tech chokepoint could require decades to overcome, the US's semiconductor capacity chokepoint could be alleviated in the next decade. But it would take significant investments to construct factories and develop talent. Investments announced by leading chip makers and the US government could help address the problem.

Uncertainties remain

As both the US and China try to secure their domestic technology bases and supply chains, several key uncertainties are clouding the picture for technology executives.

US. America is trying to urge a coalition to present a united front against China. If successful, this could make it easier to limit or block the sale of critical technologies to China.

Europe. Its willingness to join such a coalition isn't yet clear. Will it use its scale to attempt self-reliance, join a US-led alliance against China, or get picked apart by the US and China?

Taiwan. The future direction of Taiwan and its relationship with mainland China has entered the spotlight for technology companies around the world. Can Taiwan walk the tightrope to remain the top global supplier of semiconductors?

China. Technology executives are closely watching China's next steps toward supply chain security. Its effectiveness could hinge on whether its next-generation technology standards and open-source technologies gain traction in the rest of the world.

Worldwide. An important unanswered question surrounding countries' growing domestic technology investments is the level of subsidies for companies headquartered in other countries, particularly those from nations that may be less strategically aligned with the subsidizing country.

How to adapt

The ongoing uncertainty makes it challenging for tech companies to adjust their strategy and feel confident in their choices. Here are several no-regrets moves that executives can make to adapt to the changing environment.

Play the long game. Recognizing that decoupling will take years to play out, technology executives are starting to run scenario-planning exercises projecting the next decade or more. They're preparing for a range of outcomes, hedging their downside risk and exploiting potential upside.

Strengthen government relations. As governments pour vast sums of money into their technology ecosystems, doing business as an international technology company requires an effective public partnership strategy and strong government affairs and global trade teams. Tech executives will find themselves spending more time in Washington, DC; Beijing; and capitals around the world.

Make difficult market choices. Technology executives recognize they need to constantly evolve their thinking on which markets to invest in, given the fragile state of geopolitical and technology ecosystem relationships. Two years ago, many US tech executives were looking at bold moves to maintain access to the Chinese market. Now, the situation on the ground appears to be changing. Ultimately, the answer boils down to where the company can differentiate itself and make itself indispensable for as long as possible.

Support operational linchpins. Technology executives are quickly evolving their long-term supply chain strategy. The key is to evaluate risks to the linchpins across their supply chain and make investments to diversify and get ahead of potential bottlenecks and disruptions.

Plan for talent shortages. These will become more frequent as competing nations try to replicate capabilities and ramp up domestic technology sectors. Companies will need to build new muscles. An important one is the ability to hire from other countries within a network of allied nations. For example, US companies are shifting talent hubs from China to more neutral countries. Companies such as Taiwan Semiconductor Manufacturing Co. are also investing in training programs at their headquarters for new hires based at overseas facilities.

The bottom line is that flourishing in this policy-led era of the technology industry will require executives to be comfortable with constant adaptation. The nimblest ones will step confidently onto stable ground in the decoupled future.



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Operational Advantage

The Tech Talent War Is Global, Cross-Industry, and a Matter of Survival

Companies are winning by finding creative ways to widen their funnel of candidates.

By Jonathan Frick, KC George, and Julie Coffman

With software and technology becoming mission-critical for businesses throughout the economy, CEOs in every industry are recognizing that their ability to compete comes down to one thing: having the right talent.

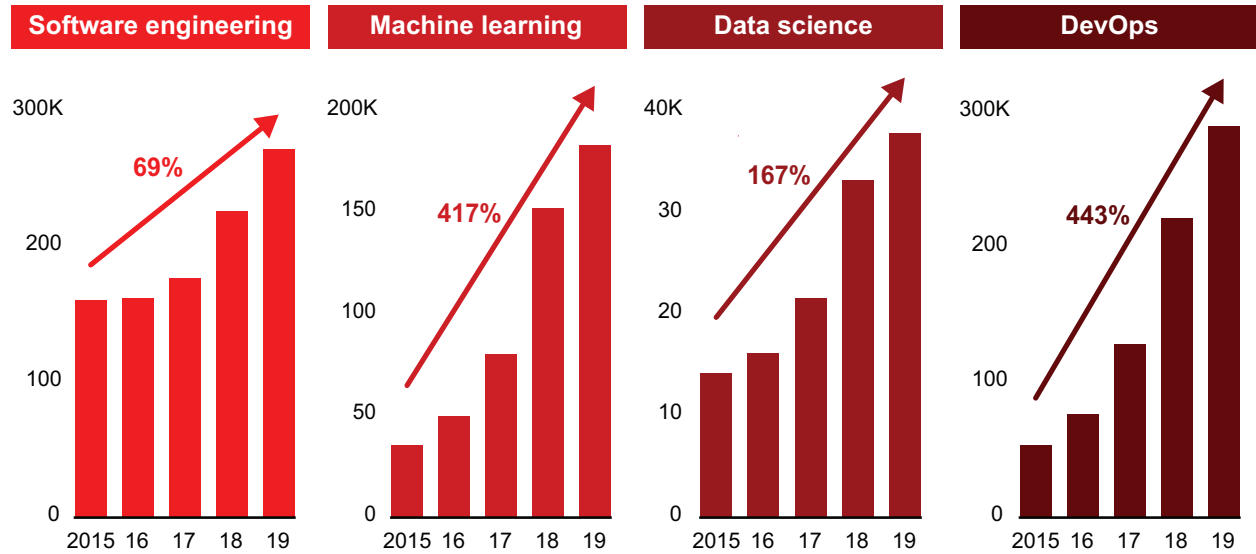
As a result, the war for technology talent is getting fiercer and spreading to new fronts as demand for crucial roles skyrockets. This expanding talent crunch encompasses more than just the well-documented need for data scientists, software engineers, and other technical roles (see *Figure 1*).

There's also rapidly growing demand for the supporting cast that helps bring technology products to market and ensures they thrive; customer success and product managers are among the fastest-growing in this category, according to Burning Glass data on US job postings (see *Figure 2*).

At the same time that the scope of in-demand tech roles is widening, there are also more companies vying for them. It's no longer just tech companies competing against one another; other industries have jumped into the race. In 2019, before the Covid-19 pandemic disrupted hiring for most companies, at least temporarily, more than 40% of software engineer and developer hires were made by nontech companies, up from about a third in 2010, according to analysis of US data using Bain's AuraSM talent platform (see *Figure 3*).

Figure 1: Demand is skyrocketing for technical software skills

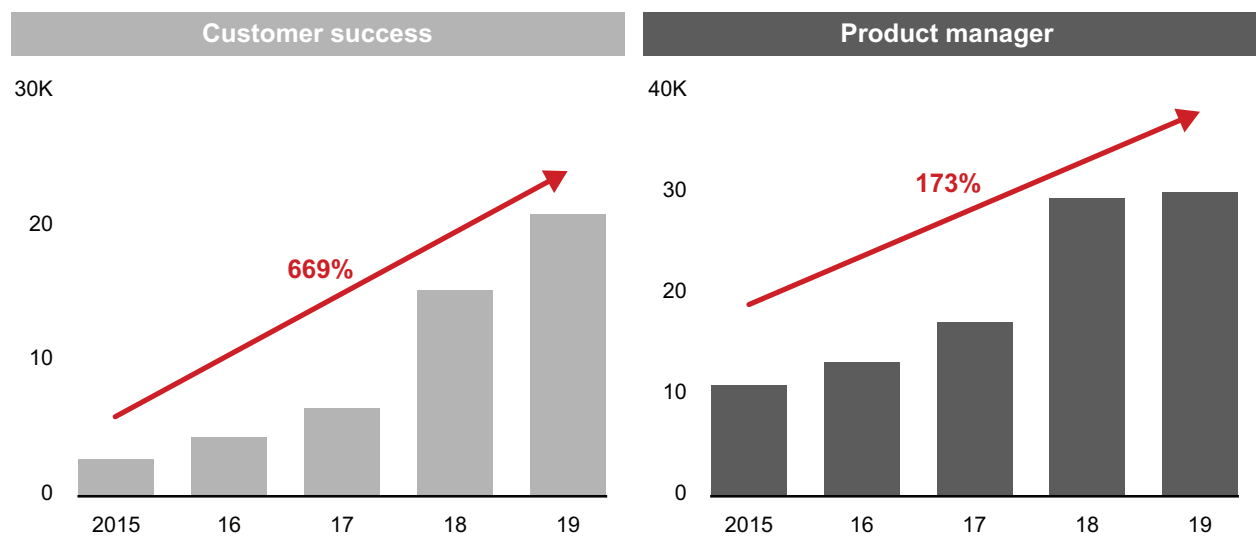
US job postings with demand for a specific skill



Sources: Burning Glass Technologies; Bain analysis

Figure 2: Demand is rapidly growing for nontechnical roles serving technology products

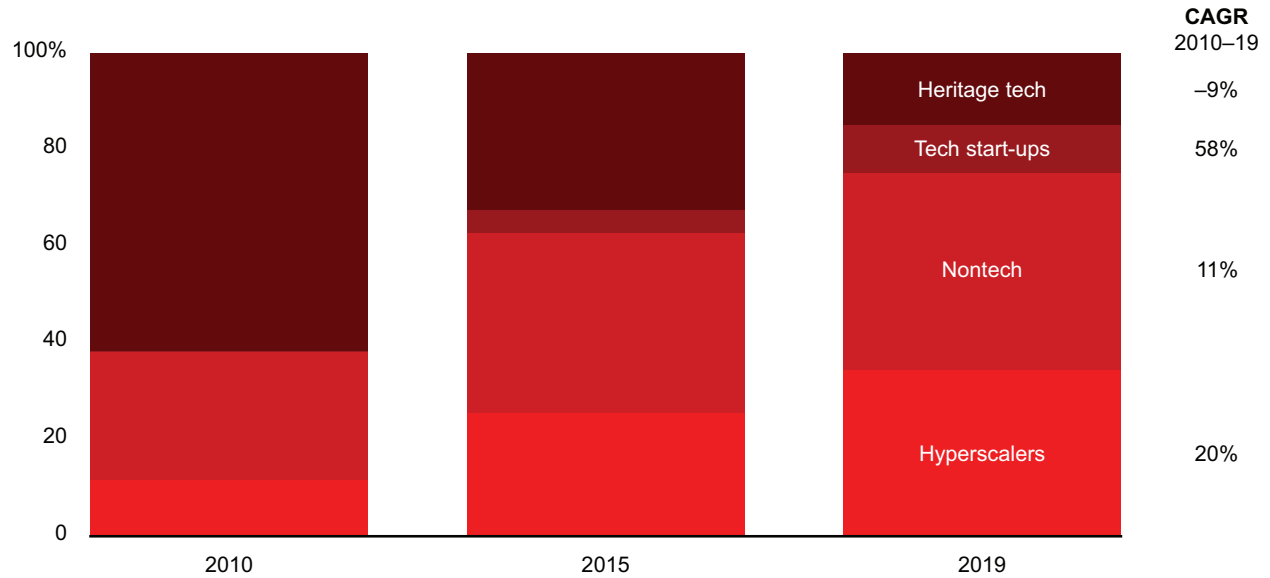
US job postings for specific roles



Note: Product manager includes job postings requesting product manager candidates who have at least one of the following skills: software development, software engineering, systems development life cycle, Atlassian Jira, software-as-a-service, Agile development, Scrum
 Sources: Burning Glass Technologies; Bain analysis

Figure 3: Hyperscalers, tech start-ups, and nontech companies are winning a larger share of tech talent

US software engineer and software developer hires



Notes: Heritage tech includes technology sector companies founded before 2000, excluding the five US hyperscalers: Alphabet, Amazon, Apple, Facebook, and Microsoft; tech start-ups includes technology sector companies founded in or after 2000; nontech includes all nontechnology sector companies
Sources: Bain AuraSM talent platform; Bain analysis

But many companies are struggling to compete for top talent because the largest technology companies—the hyperscalers Alphabet, Amazon, Apple, Facebook, and Microsoft—and tech start-ups are sucking up top-flight candidates at unprecedented rates. Last year, while many companies were furloughing or cutting staff amid the pandemic’s economic fallout, Facebook announced it would hire 10,000 additional product and engineering staff members, and Amazon was reportedly advertising more than 20,000 open tech jobs. And over the past decade, tech start-ups have been increasing the size of their software engineering and developer staffs by nearly 60% each year, the fastest hiring pace among tech and nontech companies, according to our AuraSM analysis.

Now, it’s becoming clear that the competition for tech talent isn’t simply an HR problem. It’s about survival.

Tech companies are more likely to be disrupted than most other industries, and once disrupted, they have more difficulty recovering than most of their peers in other sectors, according to Bain research published last year. There are several factors behind this, but executives attribute it largely to the fact that tech talent is highly mobile and difficult to retain.

The takeaway? Companies that fail to recruit and retain great tech talent are bound to lose their edge, cede ground to competitors, and, in many cases, fade away. Meanwhile, companies that adopt

a winning talent strategy will have a powerful advantage that's just as critical to their success as the competitive moat created by their technology products.

The emerging winners recognize that the key to overcoming the talent crunch is to widen their funnel of candidates by seeking those with a broader set of desired capabilities—not only technical skills—from a much more diverse pool. Then they invest in the company's differentiators to win their target candidates.

Open the aperture beyond technical skills

Mastery of technical skills remains critical, especially for roles where software coding prowess is paramount. But for some tech roles, technical skills are less crucial. Some companies make the mistake of overemphasizing a narrow set of domain-specific skills, such as, "Does this product manager have extensive experience in my niche product category?" Rather, the right question is, "Can this product manager collaborate effectively with all stakeholders and deliver results?" For example, Google broadly defines target candidates as "smart creatives" who are "business-savvy, data-driven, technically knowledgeable power users, with creative energy and bias for hands-on approach."

The most successful companies are focusing on a wider set of capabilities germane to each role, which can open up a larger pool of desirable candidates.

The most successful companies are focusing on a wider set of capabilities germane to each role, which can open up a larger pool of desirable candidates. These companies recognize that if they find a person who possesses the capabilities most predictive of success in the role—for example, collaboration, stress management, and self-confidence, in the case of customer success managers—the new hire can learn the rest on the job through training (formal and informal).

The art of doing this kind of search effectively depends on developing systematic processes to mitigate bias (conscious or unconscious) across the talent-acquisition and management organizations. At Airbnb, beyond giving recruiters and interviewers unconscious-bias training, hiring managers start by thinking through the objective criteria and must-have attributes for a role. Then, they define specific rubrics that align with the desired skills to minimize bias in hiring.

Invest in your differentiators

Leading companies don't just implement measures that candidates now consider table stakes, such as a strong company mission and purpose, competitive pay and benefits packages, and investing in

training and career path opportunities. These firms also create differentiators that help them beat out competitors for the most sought-after talent, including the millennials and members of Generation Z that make up a growing share of the workforce.

Based on our analysis of Glassdoor ratings of tech companies, three key factors are emerging as strong influencers on where the most talented candidates want to work.

Commitment to diversity and inclusion

Recruiting a diverse and inclusive workforce is the right thing to do, and its positive effects on business performance are well-documented. Plus, a strong diversity, equity, and inclusion (DEI) strategy can help companies attract talent because it has become an important factor in recruits' decision making. In a Beqom survey of 1,000 employed adults last year, 48% said they'd consider switching to another company if it had a built-out DEI strategy. But companies really have no choice if they want to overcome the tech talent crunch; ignoring a huge swath of the talent pool isn't an option.

Recruiting a diverse and inclusive workforce is the right thing to do, and its positive effects on business performance are well-documented.

The good news is that opening the recruiting aperture beyond typical sources of recruits helps here, too. Objectively testing for capabilities and skills rather than relying on past experience and credentials has been shown to improve diversity as well. For example, more companies are recognizing that they can find excellent software engineering candidates by scouting recruits with coding boot camp certificates and highly rated coding work samples on GitHub, regardless of whether the candidate has a computer science degree from a prestigious university. That approach opens up more opportunities for underrepresented candidates and widens the company's talent funnel.

Transparent and accountable senior management

At high-performing tech companies, managers are usually visible and willing to engage directly with employees. They also act with speed and decisiveness, and hold themselves accountable for real outcomes. For example, Slack, the business communication and collaboration software maker, created an internal #exec-ama ("ask me anything") chat channel. Employees can ask anything of the executive team, and executives are expected to (and actually do) respond.

Ensuring senior leaders are accountable also has a direct bearing on retaining talent. The best talent, of course, will prefer a firm where they feel their work has real impact. If employees feel leadership is intransigent and unaccountable, they're more likely to leave to build a competing company.

Culture of coaching and development

The path to creating a winning culture can seem opaque, but one clear enabler is high-quality coaching and development of employees. Millennial and Gen Z workers tend to value this kind of investment, but it's also critical to "growing" talented employees who have the right capabilities, but not necessarily the experience. This effort also reinforces inclusion by providing real sponsorship of employees with diverse backgrounds. For example, HubSpot moved from annual performance reviews to social performance management. It allows employees to receive continuous and instantaneous feedback from nearly anyone in the organization, encouraging ongoing skill development.

Earning a reputation for excellence across all these areas won't happen overnight. But the payoff is a high-caliber, diverse workforce hungry to help the company succeed in the new tech-enabled economy.



Operational Advantage

Taming the Wild West of DevOps

In the time it takes to read this article, your DevOps-savvy competitor will have pushed 160 software updates live. Ready to take them on?

By Christian Buecker, Greg Fiore, and Johnny Lee

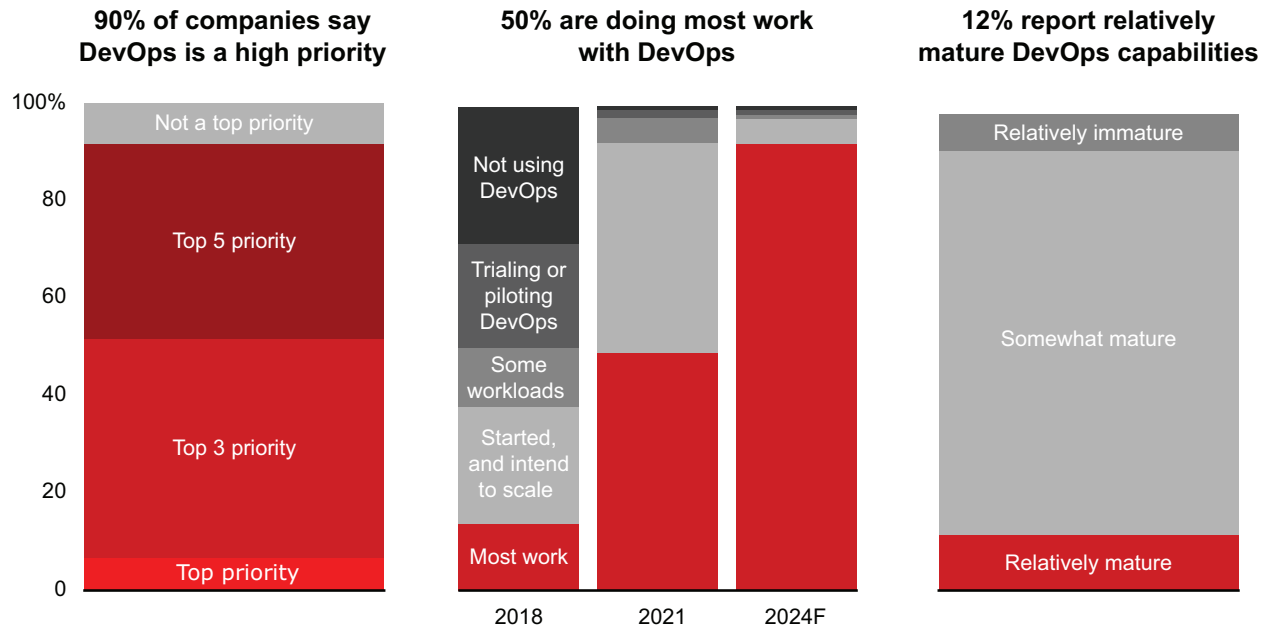
Being great at software development is no longer a capability that's just nice to have; it's becoming a competitive imperative for companies across industries. For most, DevOps is emerging as the best way to develop and deploy software. DevOps speeds up the software cycle by developing and deploying continuously, increasing automation, and giving the development team more accountability for operations. That's why more than 90% of business leaders cite DevOps as a top strategic priority for their business.

It's a powerful tool that helps companies digitalize processes quickly and support critical business operations. DevOps leaders like Amazon and Netflix deploy code thousands of times a day. Spotify uses it to rapidly ship innovations like Spotify Wrapped, its year-end personalized collection based on each user's history, the framework of which was set up in one day.

Difficulty scaling DevOps

But despite prominent successes, many companies are hitting a wall when they try to scale DevOps across their organization. While more than 90% of companies say they've adopted DevOps for at least some cases, only about half have rolled it out broadly, and only 12% describe their DevOps capabilities as mature, with a centrally governed toolchain, full integration, and a high degree of automation (see *Figure 1*).

Figure 1: DevOps is a strategic priority for most companies, but many have yet to use it across the enterprise



Notes: Results exclude “I don’t know”; DevOps maturity was grouped on a scale of 1 to 10 as follows: 1–4=relatively immature, 5–8=somewhat mature, 9–10=relatively mature
Source: Bain 2021 DevOps Pulse Survey (n=120)

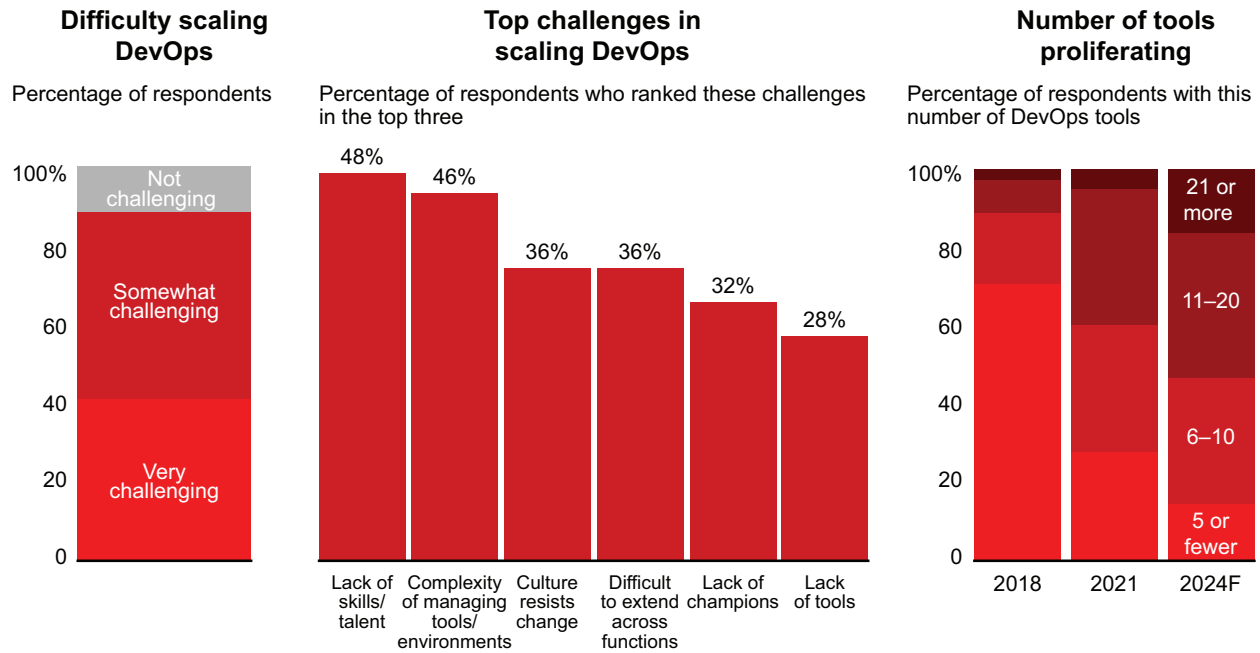
What’s holding them back? Executives see the opportunities, but about 90% of companies say they find it challenging to scale DevOps, mostly due to difficulties finding the right talented people, managing complex systems of tools, and convincing change-resistant cultures (see Figure 2).

Too many companies deal with this complexity by leaving decisions with the DevOps teams, which increases agility, but can also create a “wild west” environment—decentralized, with few standards. Tool vendors exacerbate the problem by selling directly to developers, allowing them to try and buy tools themselves, with little coordination across the company. As recently as 2015, Salesforce’s DevOps had a wild west feel like this, with more than 20 deployment programs, some homegrown, some commercial, and some open source. This model became less manageable as Salesforce grew, so the company created a centralized tool team that helped reduce the number of tools used and actively manages a toolkit that evolves regularly due to frequent acquisitions.

How leaders scale DevOps

Initiatives like those at Salesforce reduce complexity and increase a company’s ability to scale DevOps. We see four common sets of action among companies having more success extending DevOps across the organization. Three of these corral the team around common standards and architectures, while the fourth installs the right mechanisms to persuade change-resistant cultures.

Figure 2: Most companies find it challenging to scale DevOps



Note: Challenge to scale DevOps was grouped on a scale of 1–5 as follows (1–2=not challenging, 3=somewhat challenging, 4–5=very challenging)
 Source: Bain 2021 DevOps Pulse Survey (n=120)

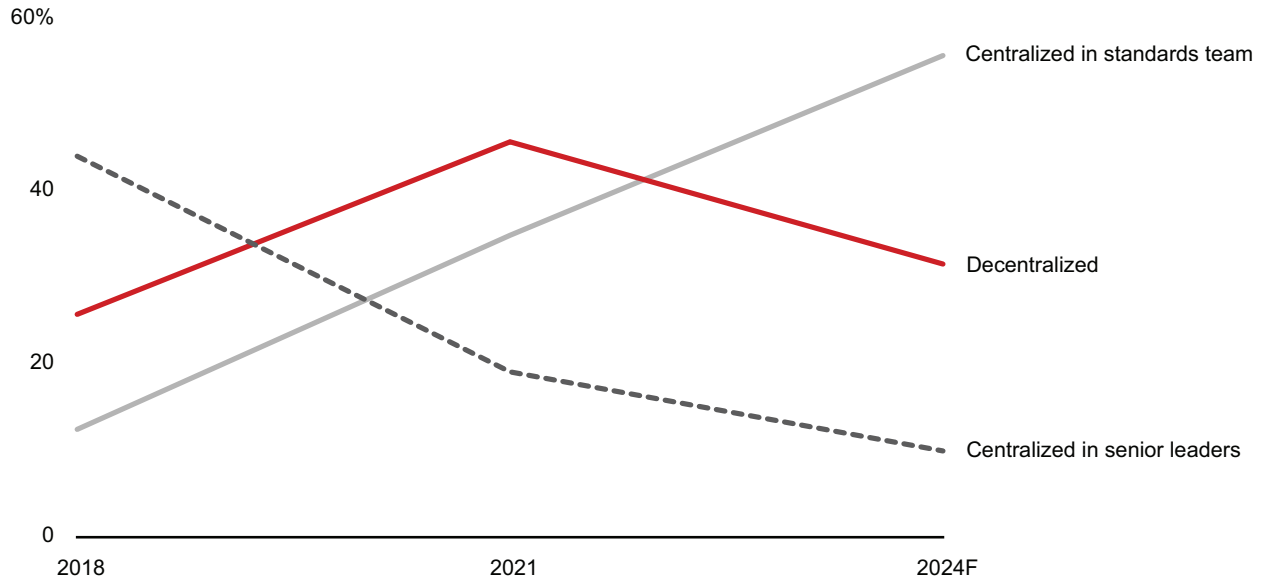
Standardize decision making. Though many companies have left decision making to the DevOps teams, many are now rethinking that strategy (see Figure 3). Standardizing decision making, processes, and tools across teams helps businesses align their development practices with their strategic ambitions—and improves security, compliance, and manageability. Because of this, about 80% of companies say they’d like to recentralize decision making for DevOps (see Figure 4).

Consider the development teams at Airbnb, which used to choose their own tools and vendors independently. This led to poor reliability and frequent crashes with certain software components. The vice president of engineering led an initiative to centralize decisions about tool and vendor selection, aimed at ensuring that each team got the right tool for each task from a curated short list of approved tools, resulting in higher reliability and fewer crashes.

Despite concerns that recentralizing decision making could reduce agility and slow down development, companies using centralized standards teams experience fewer issues of managing tools and environments, which, in turn, can accelerate teams and processes. By contrast, in a fully distributed, heterogenous, wild west model, issues like security, compliance, moving developers across teams, and overall manageability can become huge challenges. Putting in place the right metrics can ensure that teams maintain their agility—a key benefit of DevOps.

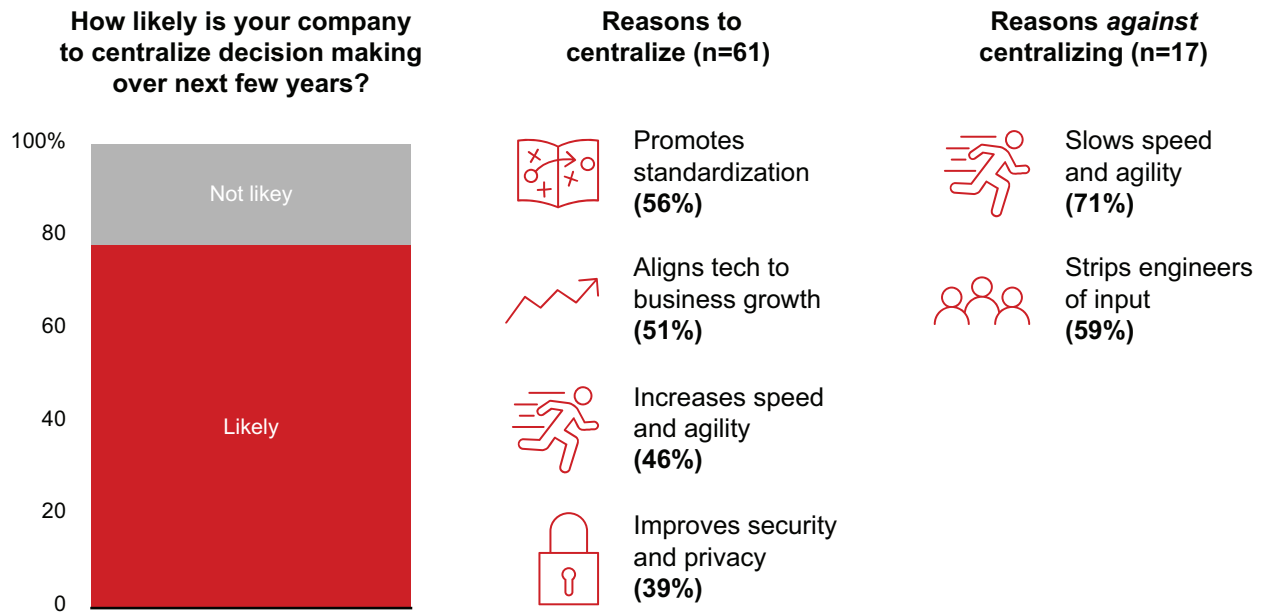
Figure 3: The trend of decentralized decision making may recede over the next few years

Percentage of respondents



Source: Bain 2021 DevOps Pulse Survey (n=120)

Figure 4: Most companies say they plan to centralize decision making



Notes: Includes only respondents with "centralized in senior leaders" or "distributed at team-level"; DevOps decision making n=78; likelihood based on a scale of 1-5, with 1-2=not likely and 3-5=likely
 Source: Bain 2021 DevOps Pulse Survey (n=120)

Invest in tools and automation. Only one in five companies say they have the right tools and automation to scale DevOps. Most will have to invest substantially to fill those gaps, and they should take a strategic approach. About 60% of companies say they plan to consolidate on DevOps platforms over the next three years. For many, that will mean adopting one of the dominant emerging platforms, such as GitLab, Atlassian, or Microsoft's GitHub or Azure DevOps platforms. These are built to serve the DevOps methodology and speed of development and deployment, but they will add cost. For most large companies that need to scale quickly, these investments are probably worth it.

Only one in five companies say they have the right tools and automation to scale DevOps.

Adjacent tools like provisioning platforms (for example, HashiCorp), observability (Datadog), and testing (Postman) are also strategic components of the overall toolchain. Testing in particular remains a major bottleneck on the path to faster release cycles, and the manual testing market is 10 times greater than the automated testing tools (\$30 billion vs. \$3 billion). The testing market is highly fragmented today, but likely to benefit from significant innovation and consolidation over the next few years.

Accelerate adoption of next-gen architectures. Over the next three years, adoption of serverless technologies could rise from 33% to 55% of workloads, and containers adoption from 52% to 75% of workloads. This massive adoption of these next-generation architectures hosted on cloud infrastructure increases scalability and agility. They're better suited to the efforts of DevOps teams, which can own and orchestrate a service, and that should help increase DevOps adoption.

Invest in change management. As with any significant transformation, deploying DevOps at scale requires strong change management capabilities: securing executive support, getting teams excited about the merits of DevOps, and ensuring top-to-bottom alignment so that engineering, IT leadership, and frontline teams are collaborating. This can be challenging for many companies; only 23% say they have strong norms in place that empower teams to make decisions and maintain accountability after deployment. Operational metrics can help track success. Mature DevOps organizations use about 40% more indicators to measure success, including deployment frequency, deployment time, lead time, and mean time to recover.

Technology providers selling to DevOps buyers

For vendors, the rise of DevOps means several things. First, they'll need to adjust their sales model to reflect the expanded range of customers. In a DevOps world, developers have more say over which tools get used, so some vendors that once sold primarily to IT leaders will now be communicating directly with the developers who have their hands on the code and products. That means they'll need

to build developer advocacy in the form of communities, strong documentation, code snippets, and easy trials. They can complement those efforts with a more centralized go-to-market plan that includes converting small pockets of advocates into enterprisewide standards.

Second, vendors will need to serve a market that's moving toward standardized platforms, either through end-to-end platform offerings or niche-point solutions that are integrated with existing platforms. While only 10% of companies have standardized around a single DevOps platform today, another 60% say they're likely to do so over the next few years. Vendors will need to meet that demand while also innovating new offerings that work in next-generation environments, including cloud infrastructure and application programming interfaces.

The next steps in the DevOps journey

DevOps continues to expand, and the requirements for running mature DevOps capabilities at scale will continue to evolve and serve as a competitive advantage for those who can achieve it.

On the horizon, we see three vectors for expansion.

- **Evolution to DevSecOps.** As cybersecurity incidences increase in severity and frequency, it's not surprising that three out of four companies plan to incorporate security into their capabilities to develop fully integrated DevSecOps. Less than a quarter of companies do so today, and fewer than 10% report having a mature capability here. Successfully integrating the security considerations, new tools, and interfaces into the DevOps process will be one of the major challenges and trends over the next three to five years.
- **More test automation.** Creative models like Applause (crowd-sourced application testing) are streamlining a slow and manual process. But availability of automated testing tools and penetration of test automation remain low. We expect this to be an area rich with innovation and investment in the future. Companies that are investing to fully automate testing of applications, even legacy ones, will continue to deliver higher-quality products faster.
- **Extension of DevOps principles to data and analytics.** About half of tech leaders say they're looking into new areas like DataOps, MLOps, and PrivacyOps, but with only about 10% to 20% implementation, these new models only scratch the surface.

Decentralized decision making was a smart move for most companies. It allowed DevOps teams to experiment with a wide range of tools and platforms, enabling them to compare while they developed their capabilities. Now, as DevOps matures, its wild west frontier is closing. For those who want to reach the destination of scale DevOps across the enterprise, with all the competitive benefits that entails, the journey is clear: Recentralize decision making, standardize tools and processes, and consolidate DevOps and auxiliary tools on common platforms.



Operational Advantage

How to Grab Tech Buyers at “Hello” and Never Say “Goodbye”

Business-to-business technology vendors are transforming their go-to-market model, teams, and technology to support today’s more digital customer journey.

By Mark Kovac and Dianne Ledingham

The past year highlighted an inconvenient truth about business-to-business sales that many executives have felt in their gut for a while: If a product’s digital presence doesn’t captivate a prospective buyer’s attention before a conversation with a sales representative, good luck making a sale.

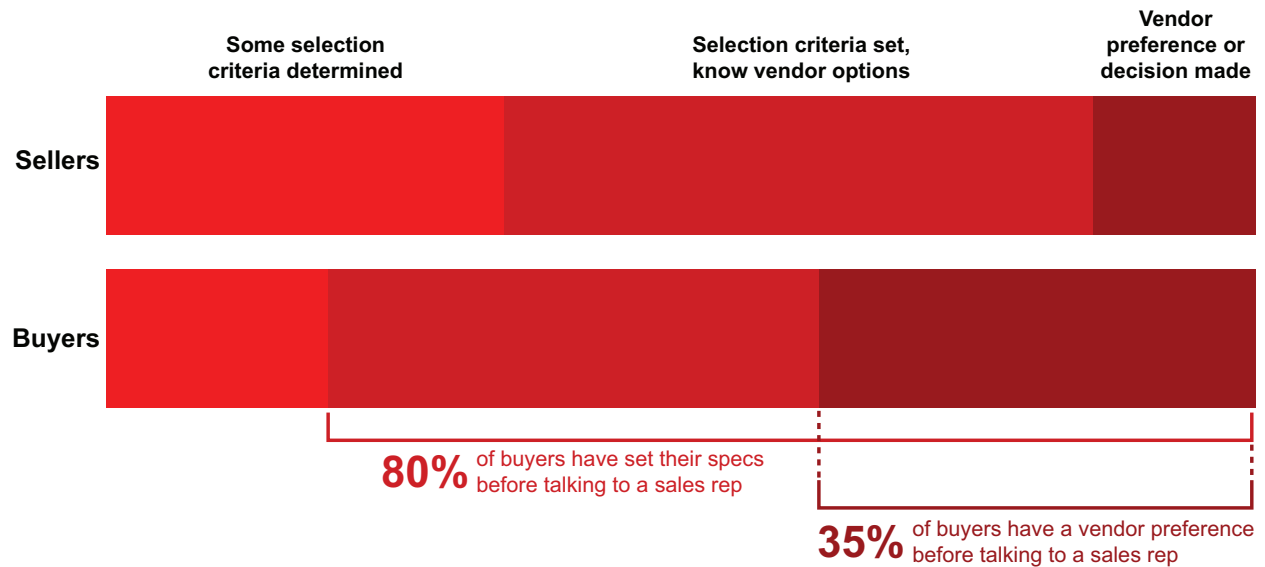
What’s eye-opening is how much the Covid-19 pandemic has empowered buyers to do their digital homework on a product. Uncertain budgets and the lack of face-to-face sales meetings left buyers no choice, and they’ve found the digital discovery process to be effective and enjoyable. Now, vendor consideration depends significantly, and at times *exclusively*, on a product’s digital footprint.

Nevertheless, many sellers continue to underestimate the change. For both simple and complex, high-value purchases, around 35% of buyers already have a vendor preference before engaging with a sales rep, and 80% have solidified their decision criteria and vendor options, according to a survey conducted this year by Bain and Dynata (see *Figure 1*).

But it’s more than that. The salesforce is no longer the focal point of B2B selling. Marketing is playing a much bigger role in serving up offerings and generating demand. Often the product architecture needs to be rethought to enable prospective customers to engage with offerings online. And the growing importance of customer success has added another function that must be woven into the go-to-market model.

Figure 1: Sellers underestimate how often buyers make decisions before engaging with a sales representative

By the time you engage directly with a sales rep, how far along are you in the overall decision process to purchase a product?



Source: Bain-Dynata survey launched January 2021 of B2B buyers (n=171) and B2B sellers (n=78); excludes C-Suite and SVPs or SVP equivalents

The most successful B2B technology providers recognize that changing buyer behavior demands rethinking and realigning their go-to-market model. Furthermore, they understand that the potential blurring of traditional and new go-to-market roles requires synchronizing functions and technology resources to orchestrate and support a constantly evolving—and ever more digital—customer journey.

Leading companies are focusing on three best practices.

1. Creating captivating experiences for buyers to digitally discover offerings

A majority of buyers indicate they prefer to contact a sales rep when they’re ready—not the other way around—at nearly every stage of the buying process and often through digital channels, according to a survey conducted this year by Bain and Google (see Figure 2). Early impressions matter.

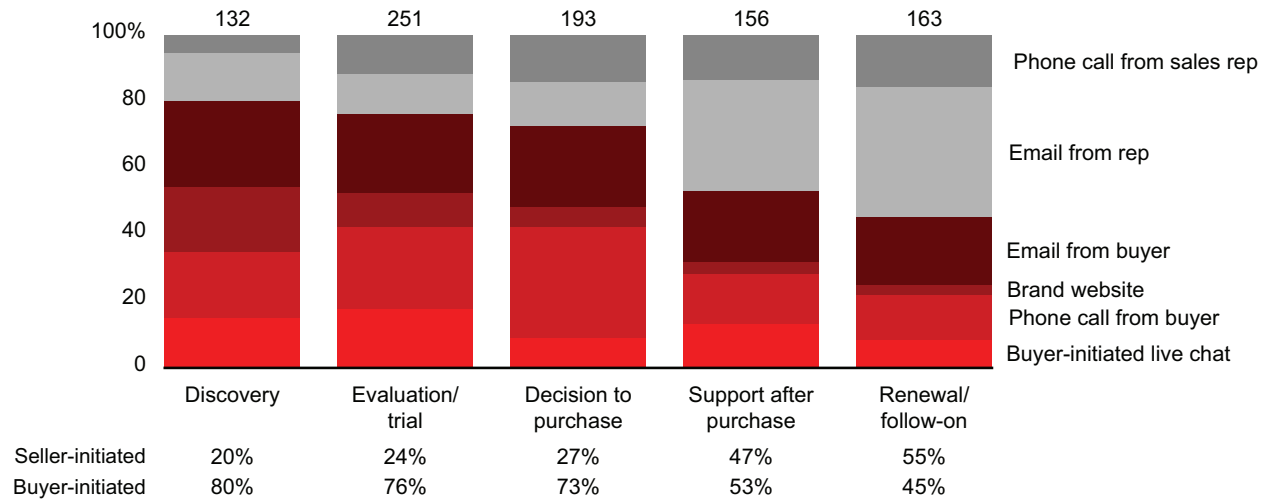
Pouring money into search and basic digital marketing isn’t enough. Leading firms truly engage buyers digitally with a thoughtfully planned product experience that sparks interest and keeps them hooked, while clarifying how the product stands apart.

That requires a collaborative process between product managers and digital marketers to co-design the buyer’s product discovery journey. It’s also crucial to capture and analyze all of the digital exhaust

Figure 2: Buyers prefer to initiate interactions with sales rep before purchases, often through digital channels

What type of direct interaction with a supplier rep is most helpful at each stage in your purchasing process?

Share of buyers, by type of preferred outreach for each stage of customer journey



Note: Values above each bar represent the number of buyer respondents for each stage of the customer journey
 Source: Bain-Google survey May-June 2021 of US B2B buyers (n=304) and sellers (n=101); excludes C-suite and SVP or SVP equivalents

that prospects leave behind. This informs which content—product demonstration videos, customer testimonials, self-assessment surveys, white papers—will best engage a prospective buyer.

One large enterprise software provider has recognized the power of personalized digital discovery. Tailoring messages to buyers’ specific challenges around remote work environments lifted its offerings’ share of impressions in search campaigns by 40%. Adding targeted educational messaging to email content improved click-to-open rates by up to five times.

2. Synchronizing all go-to-market functions

Salesforce productivity now depends upon seamless collaboration across functions to meet customers as they discover, try, transact, use, renew, and expand. Staying in sync across disparate go-to-market functions is now fundamental for delighting customers and growing share of wallet. That includes tight integration between marketing and sales on lead management, and between customer-success and account management after the sale and during the renewal cycle. Unfortunately, most companies’ go-to-market teams are a cacophony rather than a world-class symphony orchestra.

Leading companies are taking a two-pronged approach to synchronization.

First, they’re using sales plays as the “atomic unit” to connect strategy with execution and coordinate all the go-to-market functions. A sales play consists of a prescriptive, coordinated set

of sales and marketing actions orchestrated to create and win a sales opportunity. An example in the technology sector is a competitive takeout play, where an attractive offer is targeted to displace a specific competitor's offering.

Many technology providers say they run sales plays, but few execute them well. According to a recent survey conducted by Bain and Salesforce, winning B2B companies, defined by revenue and market share growth, are 2.7 times more likely to outperform on all the elements of an effective sales play system.

Executing a sales play requires a robust customer and prospect database that quantifies, for each buying unit within a company, the total available spend and share of spend by product category (what we call a MoneyMapSM). This helps prioritize sales plays and ensure marketing campaigns and sales resources are focused on the same plays, with the same messages, targeted toward the same prospective customers.

About 60% of customer relationship management (CRM) deployments fail to meet return on investment (ROI) expectations, and a lack of tight integration with other relevant applications is often a root cause.

This isn't just the domain of sales and marketing. For example, a provider of software-as-a-service pricing solutions for automotive dealers has a team of customer success managers monitoring each customer's usage of its software. The customer success manager's role is not to sell, but rather to help customers get the most value out of the software they've already purchased. The best customer success managers become deeply embedded, trusted advisers to customers, enabling them to provide valuable guidance on where the account team should be unearthing the next sales opportunity with the customer.

Second, they're integrating workflows across the sales and marketing tech stack to support a seamless buying journey. About 60% of customer relationship management (CRM) deployments fail to meet return on investment (ROI) expectations, and a lack of tight integration with other relevant applications is often a root cause.

The winning B2B companies identified in our survey with Salesforce run on average more than 11 marketing and sales technology applications, while laggards run fewer than eight. Orchestrating them properly makes a big difference.

LeanData, a go-to-market solutions company, provides workflow optimization software that uses rules-based logic to help sync applications across its customers' tech stacks, so they can deliver fast, accurate, and personalized outreach to their customers. Here's a typical example. LeanData software makes it easier for users to prioritize, based upon the account status in Salesforce CRM, an inbound lead from Marketo initiated by a customer filling out a web form. It then allows users to quickly pull in contextual data provided by ZoomInfo to enrich the lead, route the lead to the right sales development representative or account executive, and then connect with a sales engagement platform like Outreach to deliver the right message. The prioritized, enriched lead crosses multiple applications in minutes instead of hours or days. This allows sales to contact the customer when their need is top of mind and prevents good leads from getting lost among technology platforms or in the hand off between marketing and sales.

3. Trading off investments across go-to-market functions

In any given year, go-to-market spending represents a technology vendor's largest discretionary investments. However, companies tend to take a myopic view of spending, with each department jostling for its share of the budget. Moreover, it's a real challenge to develop apples-to-apples ROI measures for investments spanning marketing, sales, and customer success. Even within a function, the highest ROI isn't always clear. For example, the effectiveness of virtual selling during Covid-19 is prompting companies to reconsider their mix of virtual vs. traditional field sales capacity.

As a result, chief financial and revenue officers often struggle to decide where to invest their next dollar across go-to-market functions. This argues for more holistic and integrated planning for each function and role supporting key customer journeys. For companies with resources "rusted" in place, it's time to start with a clean sheet.

For companies with resources "rusted" in place, it's time to start with a clean sheet.

Rather than aiming for the perfect theoretical approach, we suggest starting by benchmarking against competitors and identifying the breakthrough practices that address the following questions.

- What are the buyer personas and customer journeys that should guide my investments? Which go-to-market functions are critical to delivering these journeys?
- Should I invest in more sales capacity or spend more on marketing, with an expectation of higher sales productivity?

- How much should I invest in digital marketing? What low-ROI spending can I shift toward building a more captivating digital footprint?
- Which customer segments yield the greatest payoff from investing in customer success?

Macroeconomic disruptions dramatically reshape market positions, and the inventive disruptor can take significant share. With the rapid acceleration of buyers' digital behaviors during Covid-19, is your organization ready to disrupt, or will it be disrupted?



Operational Advantage

Two Lessons the Chip Shortage Taught Us about Supply Chains

Navigating future disruptions calls for a more holistic and proactive strategy involving closer collaboration between suppliers and customers.

By Peter Hanbury and Anne Hoecker

In 2021, if we didn't open an article about the technology supply chain by talking about the semiconductor chip shortage, you'd wonder why.

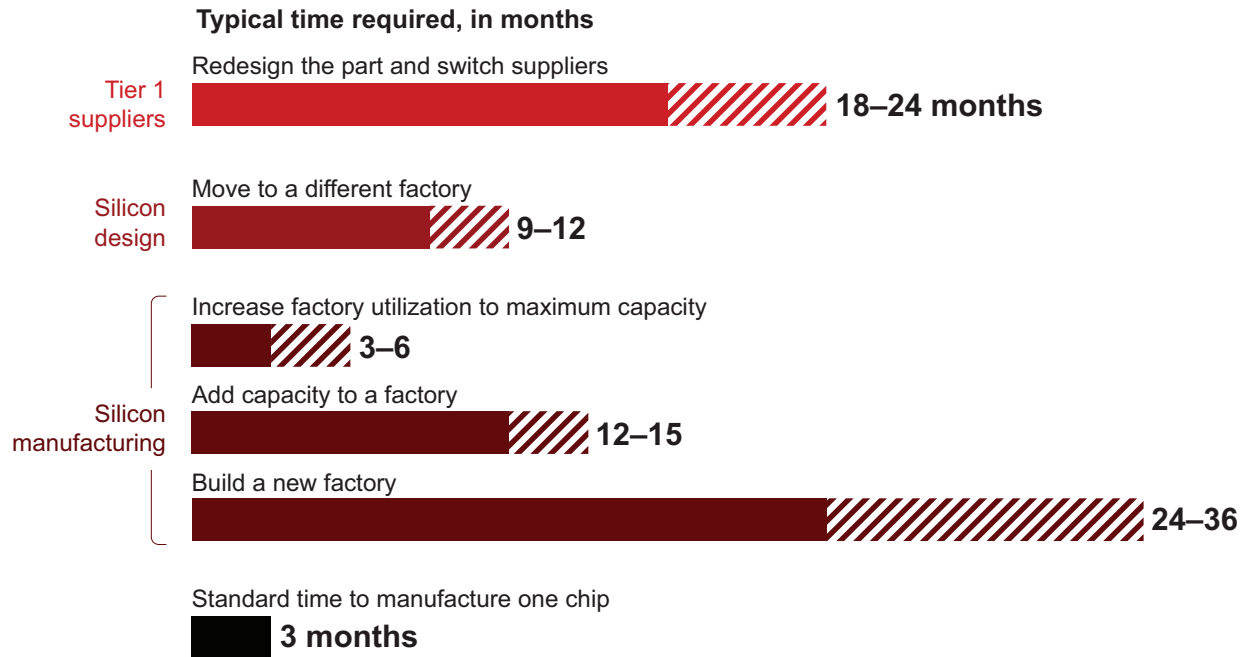
Technology executives are well aware that the shortage has made the already-pressing issue of increasing supply chain resiliency even more painfully acute. Indeed, technology companies have been dealing with increasingly disruptive supply chain shocks for years, so it was only a matter of time before one of this magnitude hit. While the breadth and depth of this shortage's impact on the tech industry and the global economy is unprecedented, the reality is we're going to see more of these disruptive events.

The hard lessons of the chip shortage have made it clear that navigating future disruptions calls for a more holistic and proactive strategy, one that requires closer collaboration between suppliers and their customers than in the past.

Lesson 1: Major supply chain disruptions don't have quick fixes.

Despite massive investment announcements from semiconductor makers and pledges of government support, industry stakeholders have been struggling against a harsh reality: There are limited short-term solutions to the chip shortage (see *Figure 1*). It takes two to three years to build a new semiconductor factory, or fab. Most have been running at full production capacity since the third quarter of

Figure 1: Most solutions to the chip shortage have long lead times



Sources: Bain analysis; industry interviews

2020, and even adding capacity to an existing fab can take more than a year. It’s also incredibly expensive. We estimate that adding just 5% to 10% capacity across existing nodes in the chip supply chain would cost about \$40 billion.

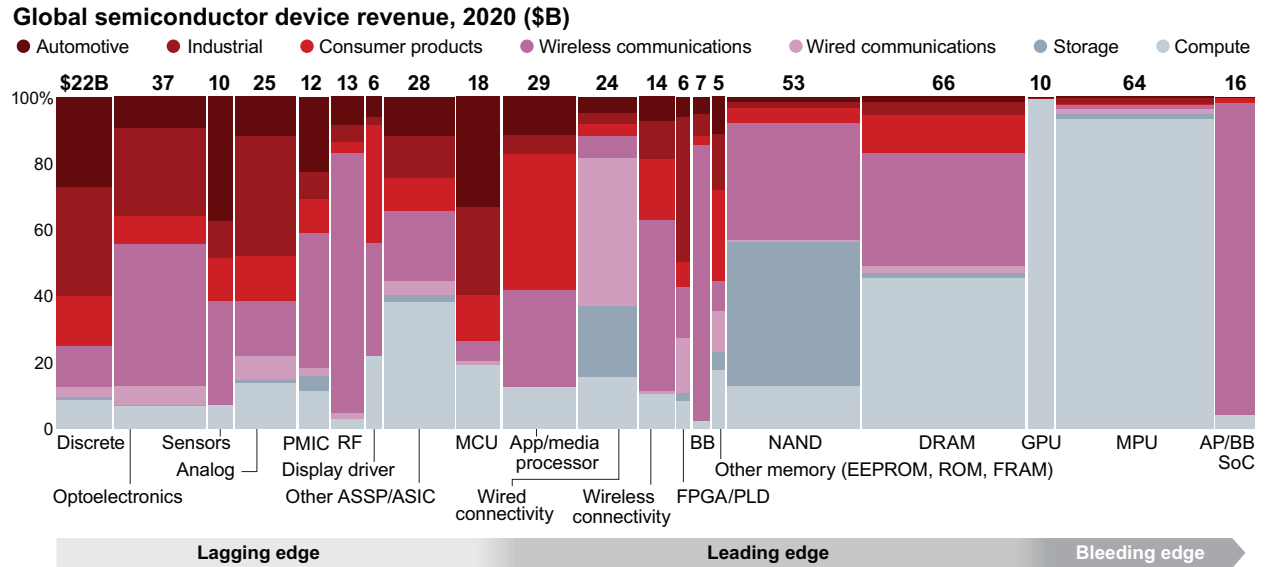
Although some of these dynamics are specific to front-end semiconductor manufacturing, the overarching principle holds for many steps of the tech supply chain. For example, the production of chip components such as substrates and silicon wafers faces similar lead times and disconnects between supply and demand. That’s dialing up the urgency for tech suppliers and their customers to prepare for the next big disruption.

Lesson 2: This is unlikely to be the last tech supply chain disruption that affects multiple industries, as more products across sectors rely on components that share the same manufacturing capacity.

Automotive was the canary in the coal mine. But the impact of the chip shortfall soon spread to other sectors, even hitting blue-chip tech companies such as Apple, Nintendo, and Cisco. The crisis disrupted even the best-prepared companies that had been investing in supply chain resiliency for years.

Why did the shortage spread? Most investments in semiconductor R&D and capital expenditures for new fabs go into the “bleeding-edge” technology needed to produce the advanced chips in smartphones, laptops, and servers. But “lagging-edge” chips have been the major pinch-point in the

Figure 2: Lagging-edge chips play key roles in products across automotive, industrial, consumer products, and other sectors



Notes: Bleeding edge refers to wafers less than 7 nanometers (nm) in size, leading edge is 7–28 nm, lagging edge is 28 nm and larger; PMIC is power management integrated circuits; RF is radio frequency; ASSP is application-specific standard products; ASIC is application-specific integrated circuit; MCU is microcontroller unit; FPGA is field programmable gate array; PLD is programmable logic device; BB is baseband; EEPROM is electrically erasable programmable read-only memory; ROM is read-only memory; FRAM is ferroelectric random-access memory; DRAM is dynamic random-access memory; GPU is graphics processing unit; MPU is microprocessing unit; AP/BB SoC is application processor/baseband system-on-a-chip
Sources: Gartner; Bain analysis

shortage. These chips, though based on technology developed more than a decade ago, play fundamental roles in automotive and industrial goods like cars and washing machines, as well as tech products such as laptops and smartphones (see Figure 2).

However, chip makers have had limited incentive to invest in additional production capacity for these less-advanced chips, which typically sell for a dollar or two apiece, compared with \$100 or more for higher-end semiconductors. Unlike their bleeding-edge cousins, the fabs that produce lagging-edge chips tend to be older and fully depreciated, and have historically been run at full capacity for maximum efficiency. When demand spiked last year, lagging-edge fabs had no excess capacity to give.

Where might the next supply chain disruption hit? It’s possible that other components shared across industries could spark a similar event. For example, tech firms have been the largest consumers of lithium-ion batteries for years, but they’re quickly being overtaken by the automotive sector as it shifts to electric vehicles. In a battery shortage, tech vendors may find themselves the smaller, lower-priority customer losing access to a vital component.

Governments are already bracing for the possibility of a battery shortage. The European Union and India this year announced subsidies for domestic battery production, and the US has also signaled increased support for the sector.

A holistic strategy

As supply chain resilience has risen to the top of the CEO and board agenda, here are the investments leading companies are prioritizing.

1. **Developing a segmented strategy.** Leading companies rank and prioritize components based on the probability of whether and how much they'll be disrupted. Companies assess risk across several areas: lead time to add capacity; concentration of the supply base; geographic concentration (considering weather risk and geopolitical tensions); and multiple industries competing for supplies from the same producers.
2. **Instilling smart resilience.** Companies are embedding more resilience in their supply chains through a custom blend of investments. They run numerous scenarios to pressure-test supply chain resilience and identify the relative return on investments in addressing weaknesses. The most effective strategies emphasize three capabilities:
 - **Adaptability.** Companies are revising their component qualification process to emphasize standardization of hardware where possible. Electric vehicle maker Tesla uses standard semiconductor hardware, but is developing the software running on those chips in-house. That has given the company more flexibility in the components to manufacture its cars.
 - **Redundancy.** For select areas, companies are building a supply buffer by buying up extra product inventory and, where possible, purchasing from multiple vendors.
 - **Real-time feedback.** Leading companies build a real-time market monitoring system with a dynamic heat map of potential supply chain failure points. For example, BMW is working with Amazon Web Services to use machine learning and blockchain technology to improve supply chain visibility.
3. **Deploying a cross-functional operating model.** Efforts to boost supply chain resilience can't be confined to the supply chain team alone. The most effective approaches involve all key stakeholders, including supply chain planning, engineering, procurement, and sales. This can head off supply chain disruptions or shift customer demand toward products with larger inventory. More companies are looping the supply chain team into the product design phase to highlight potential risks and trade-offs. Germany-based automotive parts maker Continental established an advanced buying process increasing the purchasing department's role in the engineering of parts. This streamlined component use and reduced the number of parts in Continental's end products, thereby cutting costs and limiting the company's exposure to supply chain shocks.
4. **Collaborating up and down the supply chain.** Companies increasingly recognize that complex, specialized supply chains, like those involving semiconductors, require strong collaboration between customers and suppliers. What does this look like?

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- More industrywide data sharing and negotiation for manufacturing capacity, both to improve transparency and avoid the bullwhip effect we saw with the chip shortage
- Integrated planning teams to jointly assess the market situation and develop aligned strategies
- Teaming up to appeal for government subsidies to locate manufacturing in home countries or diversify production capacity

The current chip shortage will pass eventually. The companies that act decisively now to build supply chain resilience will be best positioned to weather the next storm, wherever it comes from.

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