McKinsey & Company

The top trends in tech—executive summary download

The top trends in tech: Introduction

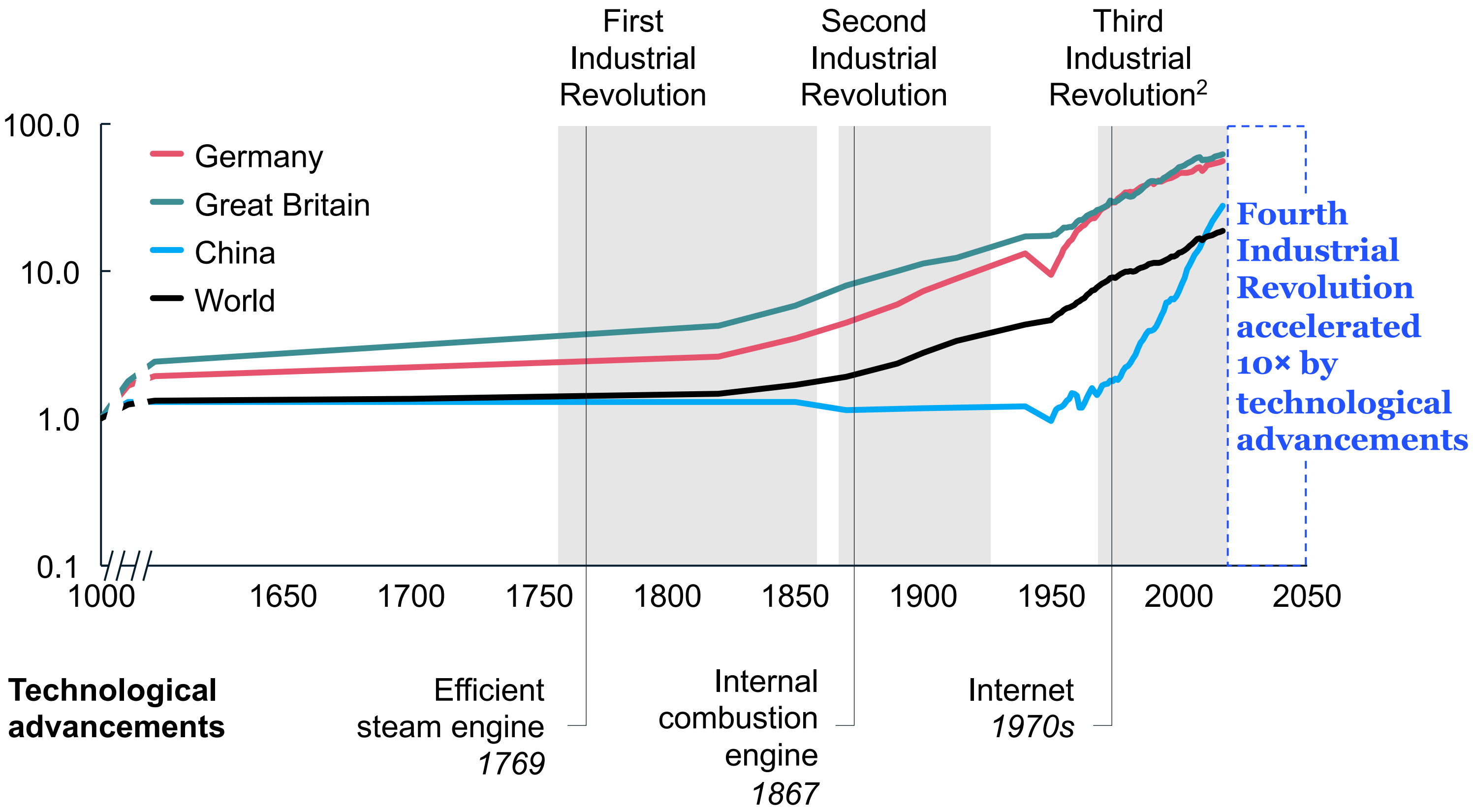
In the next decade, we'll experience more progress than in the past 100 years combined, as technology reshapes health and materials sciences, energy, transportation, and a wide range of other industries and domains. The implications for corporations are broad. In the following charts—and in the related interactive—we bring to bear a unique methodology for sorting out the technology trends that matter most for companies and executives.

Unifying and underlying all these trends is the combinatorial effect of massively faster computation, which is propelling new convergences between technologies, startling breakthroughs in health and materials sciences, astonishing new product and service functionalities, and an irresistible foundation for the reinvention of companies, markets, industries, and sectors.

Will your organization make the most of these trends to pursue new heights of rapid innovation, improved performance, and significant achievement? Start by looking through the executive-summary charts that follow—and don't forget to explore the more detailed research you'll find in our related interactive, "The top trends in tech."

Advancing technology has always spurred economic development, and now it’s accelerating even faster.

Changes in GDP per capita brought about by technological investments, 1000–2000 AD, by country, indexed[1]



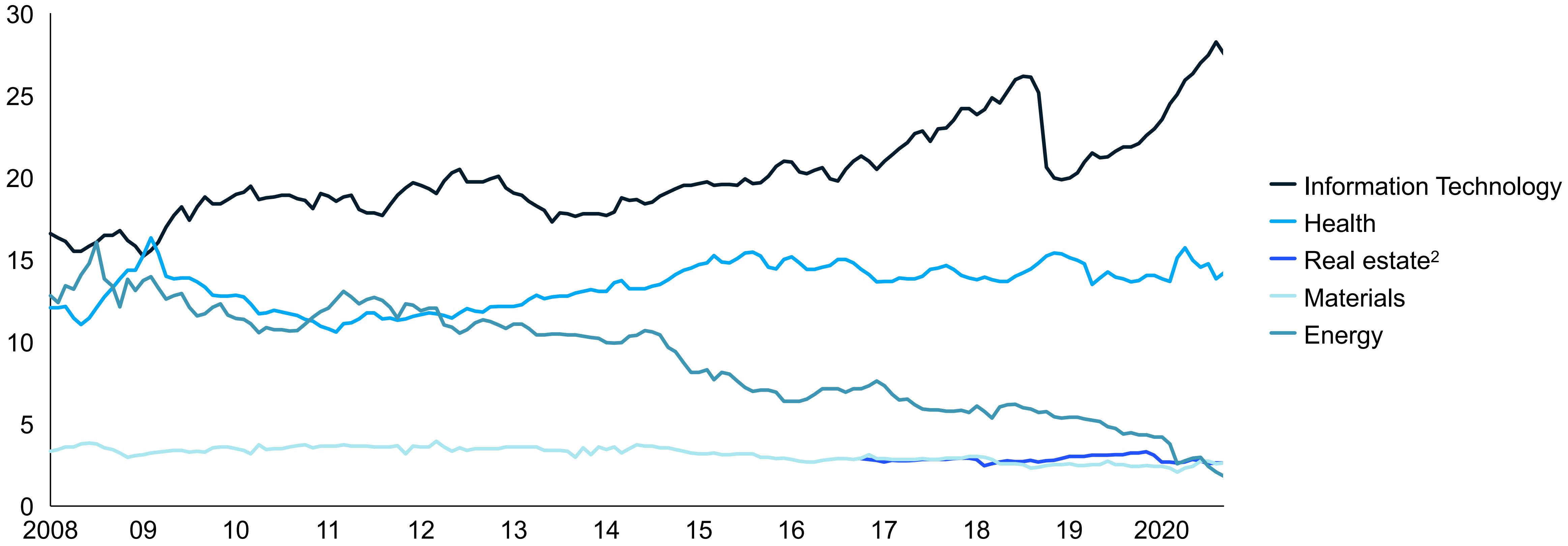
“In the next decade, we will experience more progress than in the past 100 years.”

–Peter Diamandis,
Cofounder of Singularity University

1. Estimated global GDP per capita in USD, adjusted to GDP in 1000 AD = 1; not exhaustive; 2. Includes Industry 4.0 (debate exists as to whether Industry 4.0 is seen as the Fourth Industrial Revolution or simply as the second phase of the Third Industrial Revolution).
Source: Angus Maddison, “Statistics on World Population, GDP & Per Capita GDP, 1-2008 AD,” Maddison Project Database; UBS Asset Management; OECD

High technology-company valuations help fuel rapid growth in tech.

Change in market valuation, 2008–20, by industry,[1] %



1. Top two and bottom three S&P 500 sectors by member weighting; as of end 2020. 2. The real estate sector joined the S&P500 in September, 2016.
Source: Bloomberg; S&P

We prioritized more than 40 individual technologies by technical maturity, industry impact, and momentum.

■ Focus technologies ○ Prioritization dimensions ↑ High momentum → Medium momentum ↓ Low momentum

Technical maturity

Industry applicability	Fundamental research	Market-entry stage	Industry adoption
Cross-cutting technologies	↑ Quantum hardware ↑ Knowledge graphs	↑ Augmented analytics ↑ Quantum computing → Deep learning ↓ Computer vision ↓ Speech technology and NLP[1]	↑ Zero-trust security/cybersecurity ↓ Cloud computing ↓ Supervised classical machine learning
Multiple industries or horizontals	→ Explainable AI ↓ Neuromorphic hardware	↑ 5G/connectivity ↑ Reinforcement learning* → Digital twins → Blockchain ↓ Robots/cobots[2]/RPA[3] ↓ Autonomous things ↓ Software 2.0/engineering analytics ↓ RPA	↑ Edge computing ↑ Hyperscale data centers ↑ Vertical SaaS[4] apps → 3-D/4-D printing → Industrial IoT[5] ↓ Synthetic data ↓ Open Process Automation systems ↓ VR, AR, MR[6]
Niche	↑ Biomachines → Biomolecules/-omics → Nanomaterials	↑ Cyberphysical systems ↑ Generative methods → Battery/battery storage ↓ Smart spaces ↓ Carbon-neutral energy generation	→ Smart distribution/metering

1. Natural-language processing. 2. Collaborative robots. 3. Robotic process automation. 4. Software as a service. 5. Internet of Things. 6. Virtual reality, augmented reality, mixed reality.

We distilled seven cross-industry and three industry-specific trends based on prioritized technologies…

Technology trends and underlying technologies

Industry-agnostic trends

1 Next-level process automation…

Industrial IoT[1]

Robots/cobots[2]/RPA[3]

… and process virtualization

Digital twins

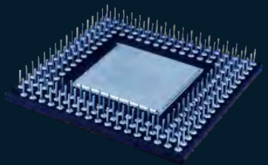
3-D/4-D printing

2 Future of connectivity

5G and IoT connectivity

3 Distributed infrastructure

Cloud and edge computing



4 Next-generation computing

Quantum computing

Neuromorphic chips (ASICs[4])

5 Applied AI

Computer vision, natural-language processing, and speech technology

6 Future of programming

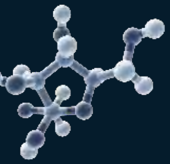
Software 2.0

7 Trust architecture

Zero-trust security

Blockchain

Industry-specific trends



8 Bio Revolution

Biomolecules/"-omics"/ biosystems

Biomachines/biocomputing/augmentation

9 Next-generation materials

Nanomaterials, graphene and 2-D materials, molybdenum disulfide nanoparticles

10 Future of clean technologies

Nuclear fusion

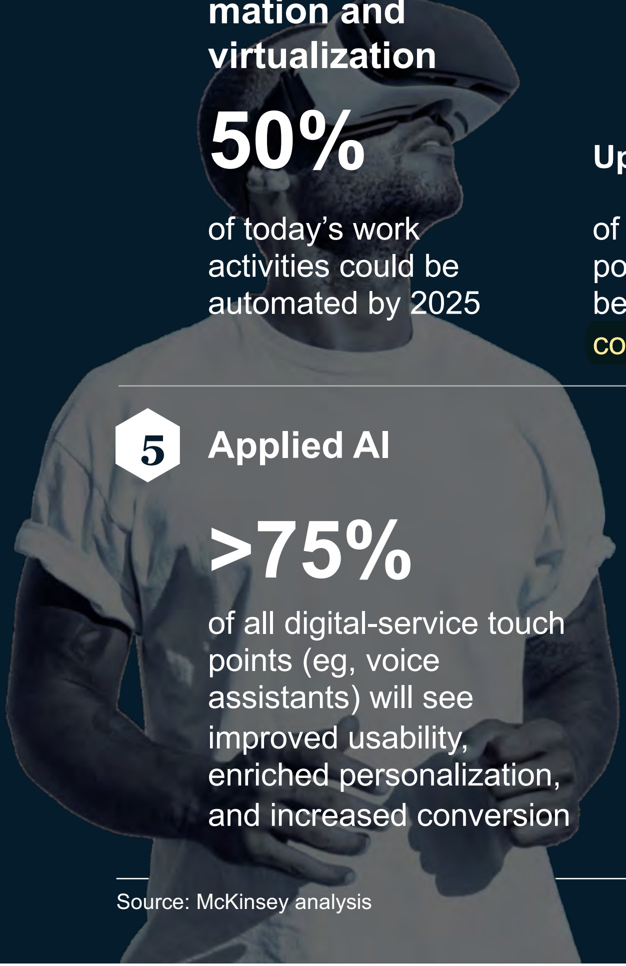
Smart distribution/metering

Battery/battery storage

Carbon-neutral energy generation

1. Internet of things. 2. Collaborative robots. 3. Robotic process automation. 4. Application-specific integrated circuits.

…that could reshape the future of markets and industries in the next few decades.



Effects of technology trends up to 2050

1 Next-level process automation and virtualization

50%

of today's work activities could be automated by 2025

2 Future of connectivity

Up to 80%

of global population could be reached by 5G coverage by 2030

3 Distributed infrastructure

>75%

of enterprise-generated data will be processed by edge or cloud computing by 2025

4 Next-generation computing

>$1 trillion

value potential of quantum-computing use cases at full scale by 2035

5 Applied AI

>75%

of all digital-service touch points (eg, voice assistants) will see improved usability, enriched personalization, and increased conversion

6 Future of programming

~30×

reduction in the working time required for software development and analytics

7 Trust architecture

~10%

of global GDP could be associated with blockchain by 2027

8 Bio Revolution

45×

cost reduction for sequencing the human genome has been achieved in the past 10 years

9 Next-generation materials

10×

growth in number of patents between 2008 and 2018

10 Future of clean technologies

>75%

of global energy will be produced by renewables in 2050

Source: McKinsey analysis

Seven cross-industry technology trends will disrupt company strategy, organization, and operations…

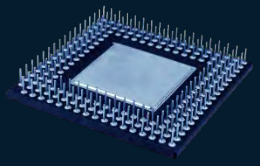
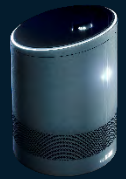
Disruptions across 7 cross-industry trends

Tech-trend clusters			Disruptions
1 **A. Next-level process automation**		Industrial IoT[1] Robots/cobots[2]/ RPA[3]	**Self-learning, reconfigurable robots** will drive automation of physical processes beyond routine activities to include less predictable ones, leading to fewer people working in these activities and a **reconfiguration of the workforce;** policy makers will be challenged to address labor displacement, even as organizations will need to rethink the future of work
B. Process virtualization		Digital twins 3-D/4-D printing	**Advanced simulations and 3-D/4-D printing** will virtualize and dematerialize processes, shortening development cycles as ever-shorter product and service life cycles continue to accelerate, further **pressuring profit pools and speeding strategic and operational practices** that tightly correlate with successful digital efforts
2 **Future of connectivity**		5G and IoT connectivity	With 5G reaching up to 80% of the global population by 2030, enhanced coverage and speed of connections across long and short distances will enable **new services** (eg, remote surgeries), **business models** (eg, connected services), and **next-generation customer experiences** (eg, live VR)
3 **Distributed infrastructure**		Cloud & edge computing	Wide availability of IT infrastructure and services through cloud computing could **shift demand for on-premise IT infrastructure and reduce the need for IT setup and maintenance**, while the democratization of infrastructure will help **shift competitive advantage** away from IT to software development and talent.

1. Internet of things. 2. Collaborative robots. 3. Robotic process automation.

Seven cross-industry technology trends will disrupt company strategy, organization, and operations… (continued)

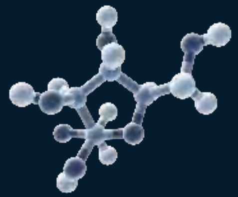
Disruptions across 7 cross-industry trends

Tech-trend clusters			Disruptions
4 **Next-generation computing**		Quantum computing ASICs[4]	**High computational capabilities allow new use cases**, such as molecule-level simulation, reducing the empirical expertise and testing needed for a range of applications and leading to the following: disruption across industries such as materials, chemicals, and pharmaceuticals; highly **personalized product developments**, for instance in medicine; the ability to break the majority of **cryptographic security algorithms**, disrupting today's cybersecurity approaches; and the faster diffusion of **self-driving vehicles**
5 **Applied AI**		Computer vision, natural-language processing, and speech technology	As AI matures and continues to scale, it will enable **new applications** (eg, more rapid development cycles and detailed customer insights), **eliminate labor for repetitive tasks** (eg, filing, document preparation, and indexing), and support the **global reach of highly specialized services and talent** (eg, improved telemedicine and the ability of specialized engineers to work on oil rigs from the safety of land)
6 **Future of programming**		Software 2.0	Software 2.0 creates new ways of writing software and reduces complexity; however, as companies look to **scale their software-development capabilities**, they will need to **master DataOps and MLOps[5] practices** and technology to make the most of the future of programming
7 **Trust architecture**		Zero-trust security Blockchain	Trust architectures help commercial entities and individuals **establish trust and conduct business without need for intermediaries**, even as zero-trust-security measures address growing cyberattacks; countries and regulatory bodies may likely have to **rethink regulatory oversight;** distributed-ledger technologies will reduce cost and enable transformative business models

4. Application-specific integrated circuits.
5. DataOps supports and enables better data analytics; MLOps combines infrastructure, tools, and workflows to provide faster and more reliable machine-learning pipelines.

…and three industry-specific technology trends can help solve humanity's biggest challenges.

Disruptions across 3 cross-industry trends

Tech-trend clusters			Disruptions
8 **Bio Revolution**		Biomolecules/"-omics"/ Biosystems Biomachines/biocomputing/ augmentation	"-omics" enable **rapid analysis of genetic materials** and open up possibilities (eg, for rapid vaccine development, personalized medicine, and gene therapy) Using **biological material for computing purposes** can enable a vast expansion of data storage using DNA as the information medium
9 **Next-generation materials**		Nanomaterials, graphene and 2-D materials, and molybdenum disulfide nanoparticles	By changing the economics of a wide range of products and services, next-generation materials may change industry economics and reconfigure companies within them (eg, by allowing for the integration of **sustainable materials and renewable energy sources** into processes), even as innovations in materials science help create **smart materials with programmable properties** that respond to stimuli from external factors
10 **Future of clean technologies**		Nuclear fusion Smart distribution/metering Battery/battery storage Carbon-neutral energy generation	As clean technologies come down the cost curve, they become increasingly disruptive to traditional business models, creating new **business-building** opportunities, **operational-improvement** programs driven by clean technologies, and new **climate-change mandates** that could alter the balance sheet of carbon-intense sectors—all while providing the **green energy** needed to sustain exponential technology growth

The combinatorial effect of technology amplifies and accelerates new business models and innovation…

Mutually reinforcing technology leads to exponential growth.

Outcomes of 3 levels of combinatorial effects on cross-industry tech trends

Infrastructure and architecture

2 Future of connectivity

5G and IoT[1] connectivity

3 Distributed Infrastructure

Cloud and edge computing

7 Trust architecture

Zero-trust security

Blockchain

Enabler

6 Future of programming

Software 2.0 (including MLOps and DataOps)

4 Next-generation computing

Quantum computing

Neuromorphic computing (ASICs[2])

Application

1 Next-level process automation and virtualization

IIoT,[3] Robots/cobots[4]/ RPA,[5] Digital twins, 3-D/4-D printing

5 Applied AI

Computer vision, natural-language processing, and speech technology

New business models and innovation

New **programming modalities** to achieve robust models and build applications faster (eg, MLOps, federated learning)

Novel **architecture paradigms** focusing on orchestration of infrastructure, increasing resilience, flexibility, and speed (e.g., decoupled, microservice-based)

Dedicated hardware delivering **increased computing power**, diffused through new levels of connectivity (eg, edge-based processing or 5G)

1. Internet of things. 2. Application-specific integrated circuits. 3. Industrial Internet of Things. 4. Collaborative robots. 5. Robotic process automation.

…changing the industry landscape by disrupting the status quo and creating new opportunities.

Combination of relevant tech trends will have far-reaching impact across the industry

Example trends and disruptions across industry horizontals

Cross-industry horizontal	Relevant trends	Disruptions
Automation and productivity transformations across value chain	**1** Next-level process automation and virtualization **3** Distributed infrastructure **4** Next-generation computing **5** Applied AI **6** Future of programming	"Grid sharing" technology to create a virtual power plant[1] powered by tens of thousands of EV batteries, where cloud platform manages individual batteries and AI system manages loads across them Use AI to empower credit-card sales team; the sales-advisory tool determines the best product for the customer
Next-generation customer experience	**2** Future of connectivity **5** Applied AI	Novel-risk scoring and claims processing in insurance using blended data from multiple new sources (including computer vision over satellites); chat bots to handle customer acquisition and claims, without humans Seamless customer experience in the "retail store of the future," which gathers and connects data, including RFID,[2] keeping an eagle eye on replenishment and providing data-lake-enabling analytics
Transformation in product/research development	**1** Next-level process automation and virtualization **5** Applied AI	Search potential "biological space" with machine-learning digital simulations of molecular properties; develop novel and sustainable materials
New business models, products, and services	**1** Next-level process automation and virtualization **2** Future of connectivity	New business model in agriculture where underground soil probes monitor temperature and moisture, then relay data back to server every 15 minutes over cellular network; data are used to improve yield, develop fertilization plan,and optimize irrigation

1. A virtual power plant is a cloud-based distributed power plant, in which power from distributed energy resources (eg, solar power from individual households) is stored in batteries and can be distributed in the grid. 2. Radio-frequency identification.

Tech trends affect all sectors, but their impact varies by industry.

Estimated effects of tech trends across select sectors

Major influence · Moderate influence · Limited influence

Tech trend	Healthcare sector: Pharmaceuticals	Healthcare sector: Health	Mobility sector: Transport and logistics	Mobility sector: Automotive	Industry 4.0 sector: Advanced industries	Industry 4.0 sector: Chemicals	Industry 4.0 sector: Electronics	Enabler sector: Information	Enabler sector: Telecommunications
1 Next-level process automation	Moderate	Moderate	Major	Major	Major	Major	Major	Major	Major
9 Next-generation materials	Moderate	Limited	Limited	Moderate	Major	Moderate	Major	Moderate	Moderate
5 Applied AI	Major	Major	Major	Major	Moderate	Moderate	Major	Major	Major
10 Future of clean technologies	Limited	Limited	Limited	Moderate	Moderate	Major	Moderate	Moderate	Moderate
2 Future of connectivity	Major	Moderate	Major	Major	Limited	Limited	Major	Major	Major
8 Bio Revolution	Major	Major	Limited	Limited	Moderate	Limited	Limited	Limited	Limited
4 Next-generation computing	Major	Limited	Moderate	Moderate	Moderate	Major	Major	Major	Major
7 Trust architecture	Major	Major	Moderate	Limited	Moderate	Limited	Moderate	Major	Major
3 Distributed infrastructure	Moderate	Moderate	Moderate	Major	Limited	Limited	Moderate	Major	Major
6 Future of programming	Major	Major	Major	Major	Moderate	Moderate	Moderate	Major	Major

1. Based on the average impact across different industries.
Source: Expert interviews; McKinsey analysis

Executives must think through three primary questions as they consider where and when to invest, while getting the timing right.

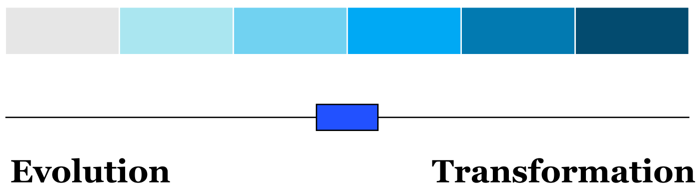
Scale of impact

How important is this trend for a given industry or company?

Will this technology fundamentally disrupt existing value pools?

Which technologies matter most for any given company?

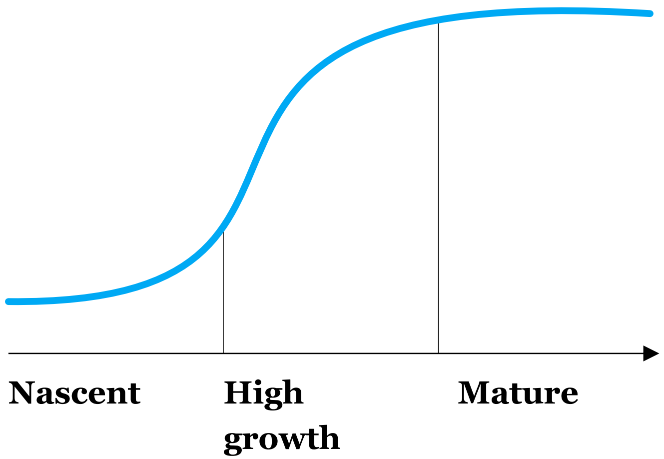
Will implementing these technologies give the company a competitive advantage?



Technical maturity

How fast do you need to react?

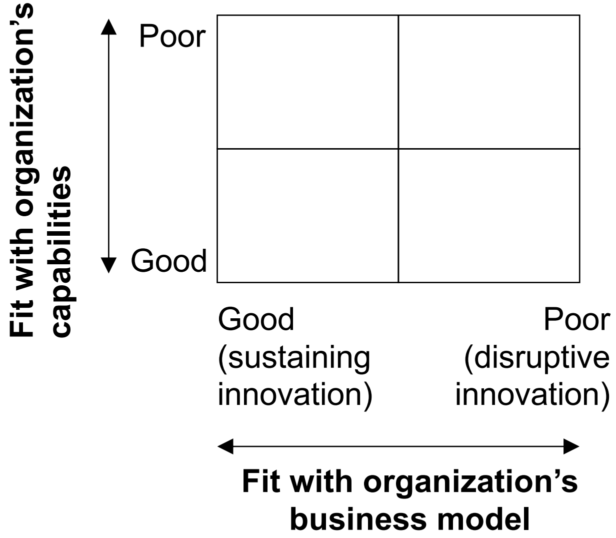
Is it the right time to scale any of the technologies given their stage and speed of maturity?



Fit with the organization

How do you approach the technology implementation?

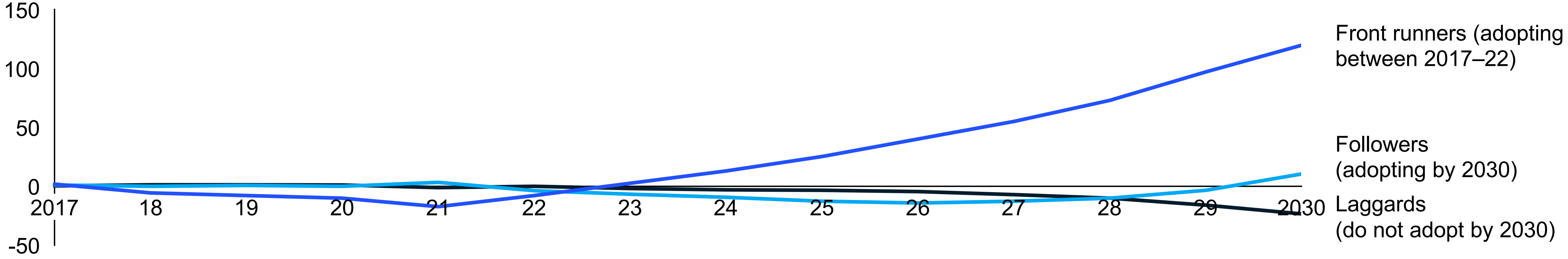
How should you operationalize technologies to capture value?



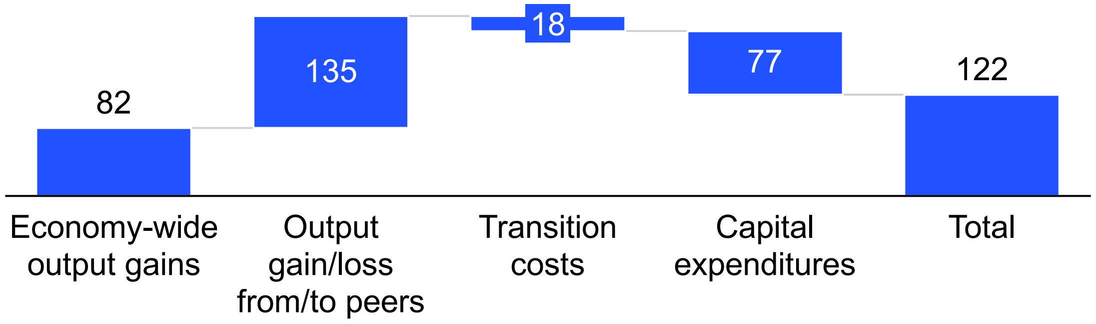
Front runners in tech adoption capture the most benefit.

Economic gains by AI-adoption cohort, front runners, followers, and laggards (simulation)

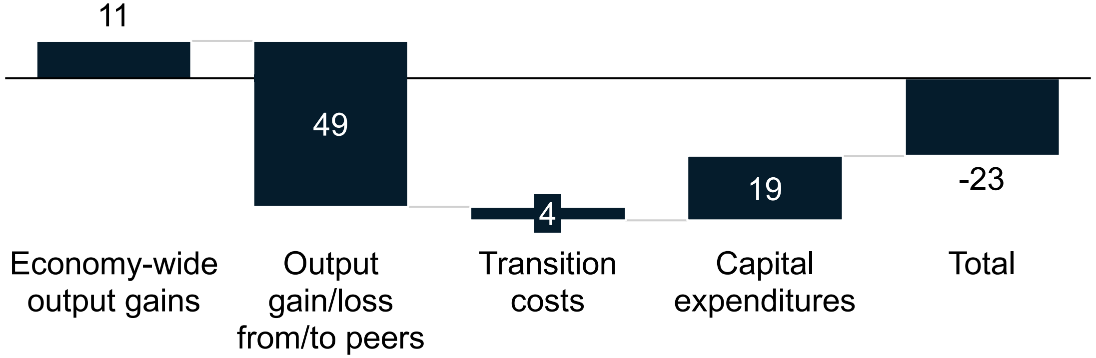
Relative changes in cash flow, Percent change per cohort, cumulative



Front-runner breakdown,
Percent change



Laggard breakdown,
Percent change

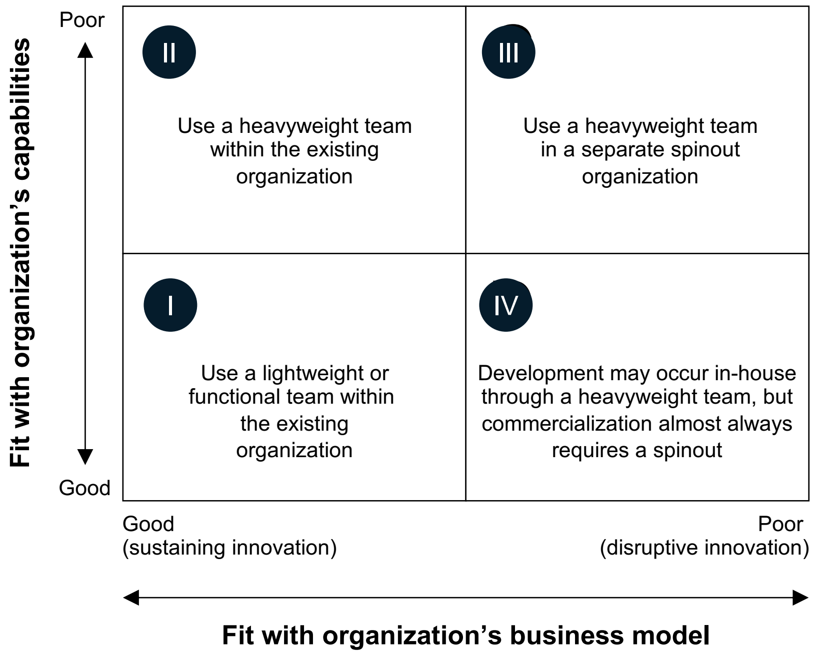


Note: Numbers are simulated figures to provide directional perspectives rather than forecast.
Source: McKinsey Global Institute analysis

As you implement new technologies, pay attention to fit with business model and organizational capabilities…

Taking the current organization into consideration increases the likelihood of success.

Archetypes of technology implementation



Ecosystems can complement these strategies and help speed up technology adoption

Collaboration with other players reduces risks and increases breadth of technology adoption

Ecosystems help companies access talent and technologies in the market at a faster speed

	I Lightweight or functional team in organization	II Heavyweight team within organization	III Heavyweight team in separate entity	IV Development within organization, commercialization in separate entity
Description	Forming a rollout plan for the entire company with widespread ownership—often with different degrees of customizations, such as road-map and training-program alterations, depending on the nature of the technology	Forming a special unit to execute projects with a powerful team, preferably composed of individuals from both within and outside the existing organization	Establishing, growing, or launching initiatives with a more radical character to the core business within the context of a stand-alone entity; the entity is still feeding of the resources from the mother organization and can be built, acquired, or a joint venture	Creating a centralized way of providing the organization with a specific technology
Ownership	Each business-unit boss	CEO	CEO of the separate unit/company	Chief technology officer/head of IT
Criteria for selection	Having a company-wide effect early in the implementation process Existing culture and processes can handle the change, and the technology is easy to understand Is seen as a hygiene factor in terms of customer requirement Easy to recruit the needed capability	Technological maturity of the organization is generally low, and it belongs to a traditional industry The resistance towards change is relatively high Experimentation and iteration required Scarcity of talent Important to the core business offering	Nature of the technology is disruptive/radically innovative from current products/service offerings Processes required differ from those of the existing operations Cultural requirements differ from those the existing operations Good access to capital	No specific development needed Mid level complexity and maintenance Technology is possible to distribute and control from a central unit Privacy and security regulations might have a severe effect

…while taking into account five primary areas of risk.

5 areas of risk for new technology implementation

Business

Taking primary responsibility for soundness and application of data ethics and maintaining a data-driven culture

Developing appropriate processes and control

Adhering to regulatory and policy requirements

Fostering a culture of data-driven decision making and ethics as an enabler and not as an inhibitor of business-value creation

Society

Safeguarding of societal values from business actions and maintaining internal awareness about societal duty of organization

Engaging actively in societal development and local communities

Proactively waterproofing business actions to be in line with societal norms and promoting inclusion

Openly embracing diversity

Operational risk

Establish robustness of processes and control and mitigate operational risk

Monitoring of processes and controls to operationalize data-ethics codes

Measuring and prioritizing operational risks

Leading enterprise-wide activities to reduce risk through an appropriate data-driven culture (eg, avoid biases)

Compliance

Ensure compliance with a data-driven culture, regulations, and internal policies

Policy design in accordance with regulatory requirements

Information, education, and advice for business on regulatory and policy requirements

Continuous surveys and monitoring of activities and reporting/managing of incidents due to noncompliance

Legal

Proactively advise business lines and rest of organization with legal matters

Expert advice in transactions

External counsel

Advice on general internal-management issues requiring legal expertise, (eg, data-access restrictions)

Source: McKinsey analysis

About the research

This research examines a range of factors to identify the technology trends that matter most to top executives and the companies they lead. For every trend, we calculated a momentum score based on the growth rate the technologies underlying the trends, which we derived from an in-depth analysis of six proxy metrics: patent filings, publications, news mentions, online search trends, private-investment amount, and the number of companies making investments. We then rolled the scores of the underlying technologies into a single composite score for the trend itself. Comparing composite momentum scores will help executives recognize how much disruption a trend is likely to cause and how soon that disruption will have business implications.

The underlying metrics are diverse, the better to account for the varied perspectives each represents. The number of research publications within a field provides a leading indicator of trends as they emerge. Patent filings give a measure of the importance placed on a particular trend by corporations. The quantity of private investment, as well as the number of companies making investments, indicates whether a clear financial interest exists for a specific trend. Finally, search trends and news coverage reveal the level of public interest in a trend. Combining early indicators with measures of public and financial interest creates a holistic view of each trend and provides a good way to rank and compare their potential impact. Using the growth rate as the basis of the momentum score differentiates areas that are merely large from those that are on their way to massive.

Finally, we syndicated our analytical results with external experts on McKinsey’s Technology Council, leading to a unique perspective that combines research analysis with qualitative insights from some of the leading thinkers of our time.