GARTNER FUTURE DIRECTIONS

Gartner®

THIS DECK IS BROUGHT TO YOU BY GARTNER FUTURES LAB.

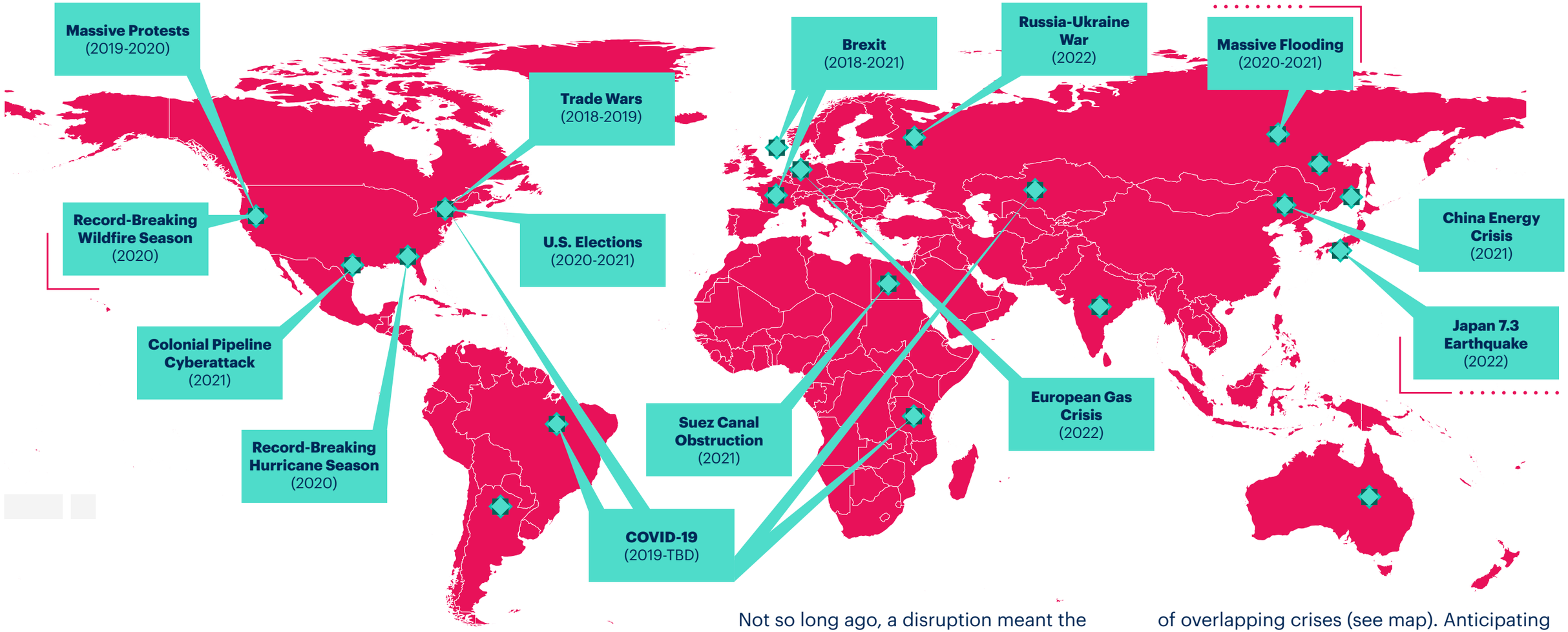
Gartner Futures Lab

The mission of Gartner Futures Lab is to challenge conventional wisdom and to explore plausible "what if" futures to help you reconsider implications for the present.

CONTENTS

INTRODUCTION

The only long-term prediction that currently makes sense is that there really is no predictability. CIOs should assume continued disruption at a higher or equal frequency and scale. CIOs should therefore introduce chaos engineering, redefine what agility means and build a futurist function.



THE AGE OF DISRUPTION

Not so long ago, a disruption meant the sudden emergence of a business rival that upended an industry, usually through digital innovation. Those jolts were scary enough, but lately external shocks have hit even harder, altering many sectors at once. They've hit bigger, surging across the whole world.

CIOs and business leaders tell us they've been unprepared for the knock-on effects of overlapping crises (see map). Anticipating the next political shifts, social upheaval, superstorm, inflation or invasion — and their combined cumulative effect — has been impossible. Executives say they've been going through the motions with obsolete strategies and budgeting exercises.

This report presents an overview of 19 disruptions that might materialize sometime between now and 2033. It includes a Toolkit to help you identify disruptions through the lenses of technology, economics, politics, society, trust and ethics, regulations, and the environment.

You'll find entries that will seem gradual until they reach a turning point, and some that will seem fanciful until they are real. You'll find disruptions that could set your company back and disruptions that could pave the way for huge breakthroughs.

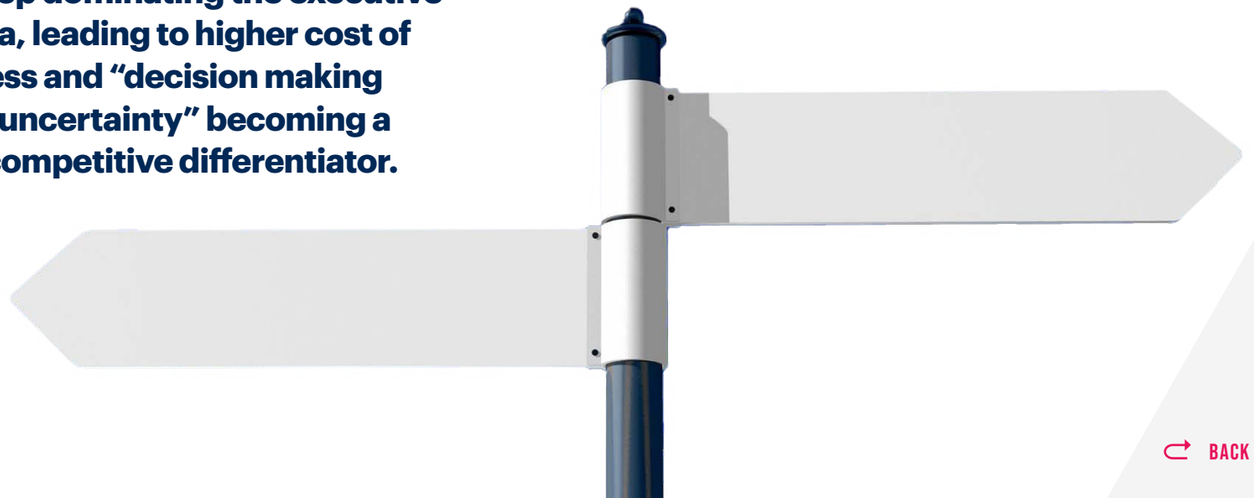
What they have in common: outsized impact if and when they occur.

We have to assume disruption will continue, and at a frequency and scale equal to or greater than what we have witnessed. This assumption is safer than expecting smooth sailing.

Through 2033, sudden disruptions will keep dominating the executive agenda, leading to higher cost of business and "decision making under uncertainty" becoming a main competitive differentiator.

We want you to ride the storm with confidence, so we will also introduce three disruptive ways to surf disruption:

- ✓ Implement chaos engineering to cultivate organizational resilience
- ✓ Redefine agility
- ✓ Build a futurist capability



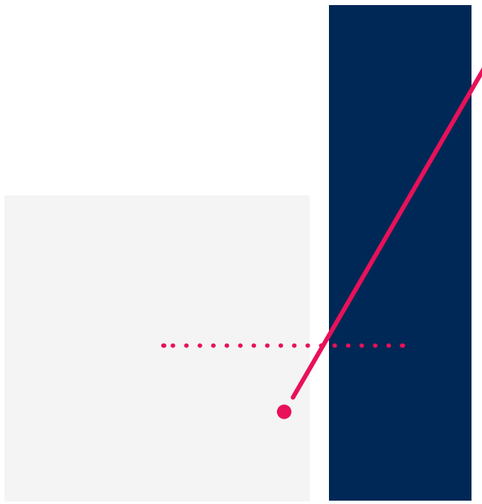
WHAT COULD POSSIBLY GO WRONG?... OR RIGHT?

These disruptions are not predictions. They are examples of things that may or may not happen, which could prompt you to shift gear, improvise and respond.

In September 2022, NASA crashed a spacecraft into an asteroid as an experiment to change its course. The experiment would help prepare for the unlikely event an asteroid would be heading for planet Earth. There are currently no indications this will happen in any particular time frame, but the impact would be so severe that this experiment's success is crucial to survival. **What other disruptions are worth considering?**[1]

TECHNOLOGICAL
POLITICAL
ECONOMIC
SOCIAL/CULTURAL
TRUST/ETHICS
REGULATORY/LEGAL
ENVIRONMENTAL

Category	Disruption	Opinion
Technological	The First DAO to Enter Most Admired Brand List	SETBACK / BREAKTHROUGH
	First Permanent Lab-Grown Organ Transplant	SETBACK / BREAKTHROUGH
	Global Hyperspeed Travel for People Is Possible	SETBACK / BREAKTHROUGH
Political	Dual International Order Takes Hold	SETBACK / BREAKTHROUGH
	Northern African Economic Union Established	SETBACK / BREAKTHROUGH



TECHNOLOGICAL
POLITICAL
ECONOMIC
SOCIAL/CULTURAL
TRUST/ETHICS
REGULATORY/LEGAL
ENVIRONMENTAL

TAPESTRY	Disruption	Opinion
Economic	First Industrialized Nuclear Reactor Commercially Available	SETBACK / BREAKTHROUGH
	Cost of Space Travel: Less Than $10 per Kilogram	SETBACK / BREAKTHROUGH
	Major Coastal City Loses Half Its Population	SETBACK
Social/Cultural	Overcome the 125-Year-Age-Limit Ceiling	SETBACK / BREAKTHROUGH
	The First Country Becomes Calorie Self-Sufficient	SETBACK / BREAKTHROUGH
	A G20 Country Taxes Nonchildrearing	SETBACK
Trust/Ethics	First S&P 100 Company to Fully Disclose Pay	SETBACK / BREAKTHROUGH
	First Brain-Computer Interfaces Commercially Available	SETBACK / BREAKTHROUGH
Regulatory/Legal	AI Gains Personhood in a Legal System	SETBACK / BREAKTHROUGH
	EU Introduces Blanked Right-to-Repair Law	SETBACK / BREAKTHROUGH
	First G20 Country to Introduce UBI	SETBACK / BREAKTHROUGH
Environmental	Geomagnetic Storm Disables Majority of Satellites	SETBACK
	Space Junk Runaway Collisions Start	SETBACK
	Desalinated Water Becomes as Accessible as Bottled Water	SETBACK / BREAKTHROUGH

THREE DISRUPTIVE WAYS TO DEAL WITH DISRUPTION

1. IMPLEMENT CHAOS ENGINEERING TO CULTIVATE ORGANIZATIONAL RESILIENCE
2. REDEFINE AGILITY
3. BUILD A FUTURIST CAPABILITY

Disruptions demand revisiting the way you see and approach the world, the way you work and the way you organize. You can even turn that capability into a competitive advantage.

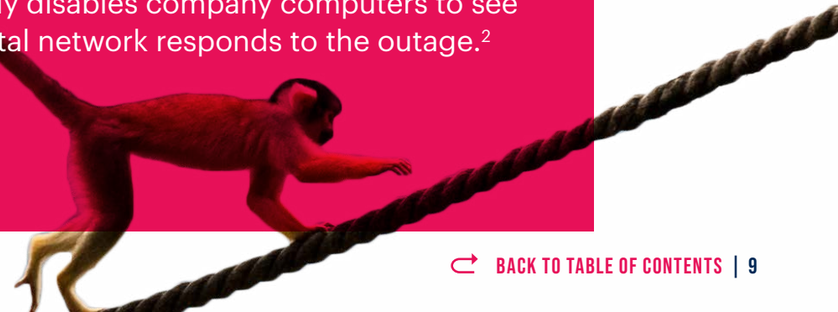
1 IMPLEMENT CHAOS ENGINEERING TO CULTIVATE ORGANIZATIONAL RESILIENCE

Creating resilience is the most popular enterprise response to uncertainty. Resilience doesn't come from guarding against disruption — the aim should be to absorb it, experience it and evolve from it. Sometimes, resilience comes from a counterintuitive perspective, in this case, creating chaos.

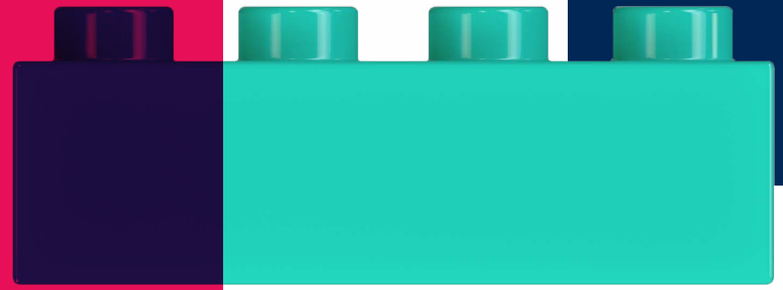
This concept, known as chaos engineering, extends to many industries. Airport security staff, for instance, need a high level of concentration when they watch monitors that display X-rays of luggage. Because prohibited materials rarely show up, it is easy to lose focus. This is why the software has functionality built-in to digitally introduce forbidden objects into the X-ray pictures on the screen. Security staff know they are required to spot these, and it will happen a few times during their shift. Counterintuitively, corrupting the process results in higher levels of safety.

Leaders should make chaos engineering a habit. Your scenario planning should include at least a few outlandish storylines to see how your strategic initiatives would respond to it. In business processes, regularly feed outlier cases that do not fit the standard. The goal is to see whether these cases are ignored, rejected or met with creativity, and periodically give people tasks outside their comfort zone.

Netflix built a tool called Chaos Monkey that intentionally disables company computers to see how the total network responds to the outage.[2]



In one research study, participants were shown a LEGO structure of a bridge that was uneven because of a different number of blocks used on either side. Their assignment was to make the structure even. Eighty percent chose to add a block; only 20% opted for removing a block. When faced with a problem, people tend to select solutions that involve adding new elements rather than taking away existing components.[3]



Go beyond annual rehearsals. Embrace chaos by simulating positive and negative uncertainties before they happen. This means your organization can exploit uncertainties for opportunities missed by your rivals, rather than being held hostage to them when they occur.

2 REDEFINE AGILITY

To adapt quickly to disruption, agility must go way beyond conventional methodologies such as scrums, DevOps, etc.

However, it takes time to build systems, processes or strategies that are agile, and keeping your options open is simply more expensive. Higher costs tie up more capital in your organization, decreasing liquidity. And liquidity is one of the highest forms of agility an organization can have.

Try these tips for crafting a culture of simple agility.

Do Less

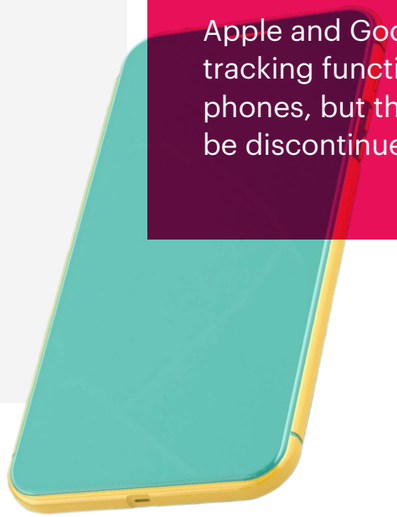
Focus on minimum viable strategies, processes, systems or anything else that requires development or engineering. The less there is to change, the easier it becomes to move fast.

Remove rules, requirements and other forms of complexity. A word of caution here — removing complexity must be based on a clear understanding of strategy: Specifically, which business processes should be considered commodities and which are differentiators. All things being equal, simplifying commodities is a "no regrets" move. Differentiators should be considered more carefully. We should not mortgage the future business by simplifying elements to fit current context and assumptions.

Don't Build for Eternity

Strategies usually have a life span of perhaps one, three or five years. Some organizations have a strategy that is 20 or 50 years out. However, systems or processes are usually built without an end date in mind. Make sure that everything you design has a certain

Apple and Google jointly developed COVID-19-tracking functionality for iPhones and Android phones, but they were temporary measures to be discontinued after the pandemic would end.[4]



rhythm of expiry. For some designs this may be a few years, for others just a few months or even single use — but each one should be disposable. Anything that is easy and cost-effective to replace is also agile.

Find Your Unbalance

Managers in organizations tend to favor stability over change. Adopt some or all of the following practices:

- Use zero-based planning and budgeting mechanisms that do not build on plans of previous periods, but start with a clean slate. Fund new plans based on the value they bring even if that means exceeding the allocated functional budget to grab an important opportunity. Shift resources or find a way to generate the staff time and money required.
- Reward the speed with which people can set new targets when a disruption takes place, instead of sticking to old targets because they didn't expire yet.
- Create a culture in which reorganizations are not seen as a threat, but simply as a local and tactical optimum. Make reassignments of people easy and make it an expectation. Facilitate internal mobility, not just with internal job platforms, but by establishing formal rotation programs for all, or some, key roles. Reward managers whose team members find and move to internal opportunities each year — as well as for their ability to attract internal talent.

3 BUILD A FUTURIST CAPABILITY

Where there is some stability, we can forecast and predict and move forward with a level of uncertainty. That's the easy part. But in times of turbulence and disruption, forecasts and predictions become impossible. Cause-and-effect analysis leads in too many directions. In these situations, it pays to have a futurist capability by introducing "continuous foresight" to the organization.

A futurist doesn't stick to analyzing trends. A futurist helps the organization manage uncertainty.

Some organizations create a small team as part of the strategy function. But a futurist capability can also be a "mindset," something exercised as an executive team.

The futurist must adopt five mindsets:

- **Observers spend time mostly on what's out there.** They discuss current and future trends and help determine how that translates back to the organization.
- **Responders are reactive.** As soon as a disruption occurs, they develop plans to address them and get tactical.
- **Explorers are curious.** They consider what might be likely to happen and the implications of those scenarios. They are proactive and prepared.
- **Architects work inside-out,** designing the organization for the best possible future and building toward it with a clear sense of purpose.
- **Luminaries imagine multiple, alternate futures — some of them improbable.** Luminaries tell us what might happen, and then look backward to fill in the blanks with steps to make that happen, including disruptions and trends to watch for.

With a futurist capability, the goal is to future-fit your organization. How well are your strategic initiatives geared toward multiple future scenarios? How quickly can you pivot, if a disruption requires it? How resilient are you in absorbing change?

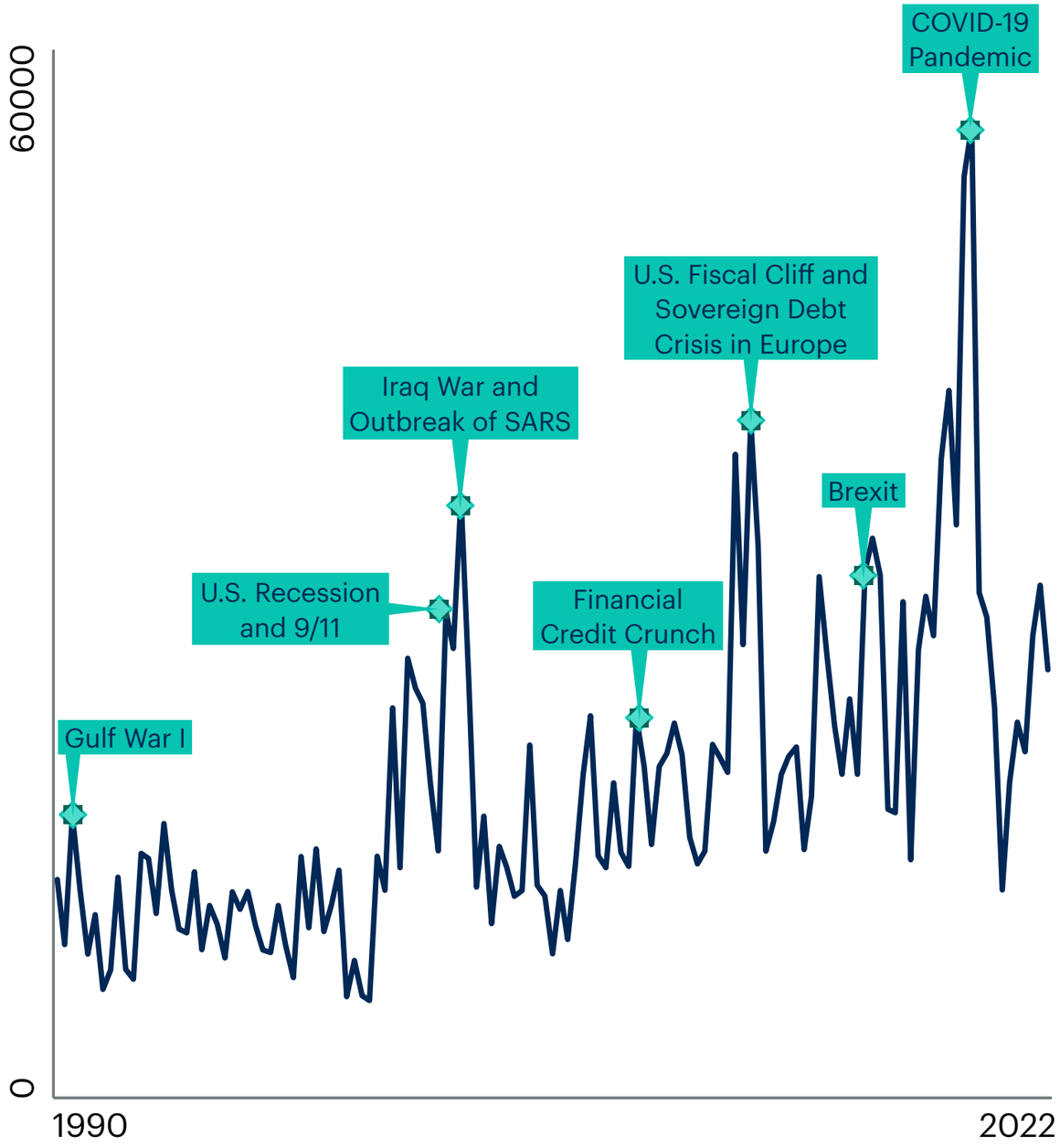
But more important, having a futurist capability helps you to take charge and be a disruptor yourself, and **change the world.**

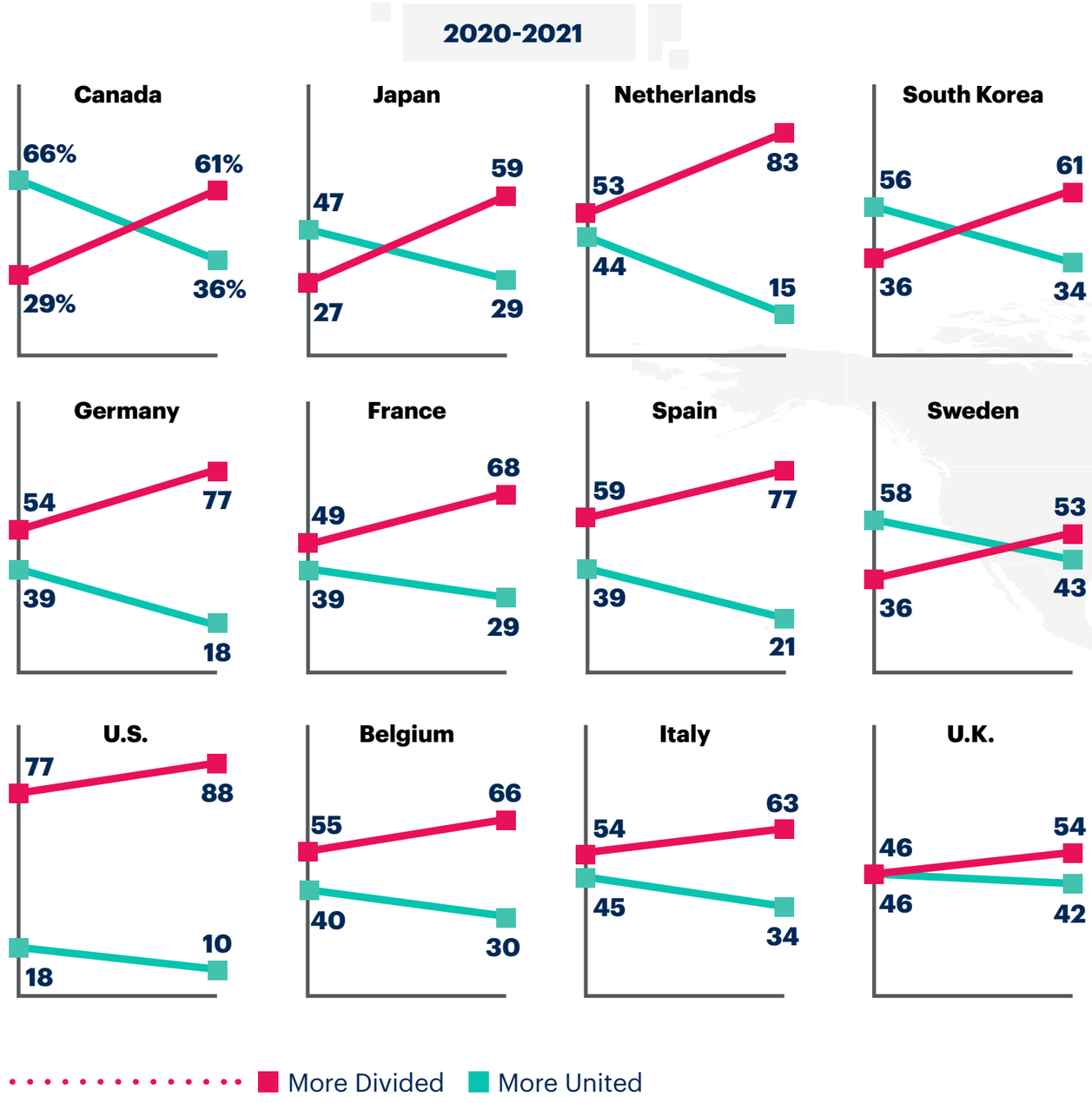
WORLD UNCERTAINTY INDEX

EVEN UNCERTAINTY IS UNCERTAIN

While uncertainty is experienced to different extents around the world, and often followed by periods of stability, the extent (i.e., the peaks) of uncertainty increases with every decade.

The World Uncertainty Index (WUI) is computed by counting the percentage of the word “uncertain” (or its variant) in the Economist Intelligence Unit (EIU) country reports. The WUI is then rescaled by multiplying by one million. A higher number means higher uncertainty and vice versa.





Most people believe their society is now more divided than before the pandemic, according to a Pew Research Center survey in **17 advanced economies.** While a median of 34% of people feel more united, about six in 10 report that **national divisions have worsened** since the outbreak began. In 12 of 13 countries surveyed in both 2020 and 2021, feelings of division have increased significantly, in some cases by more than 30%.[6]

FEELINGS OF DIVISION HAVE INCREASED SIGNIFICANTLY

-30%+

THE ENVIRONMENT IS BECOMING MORE EXTREME

The global mean temperature for 2021 (based on data from January through September) was **1.08 ± 0.13°C above the 1850-1900 average.**

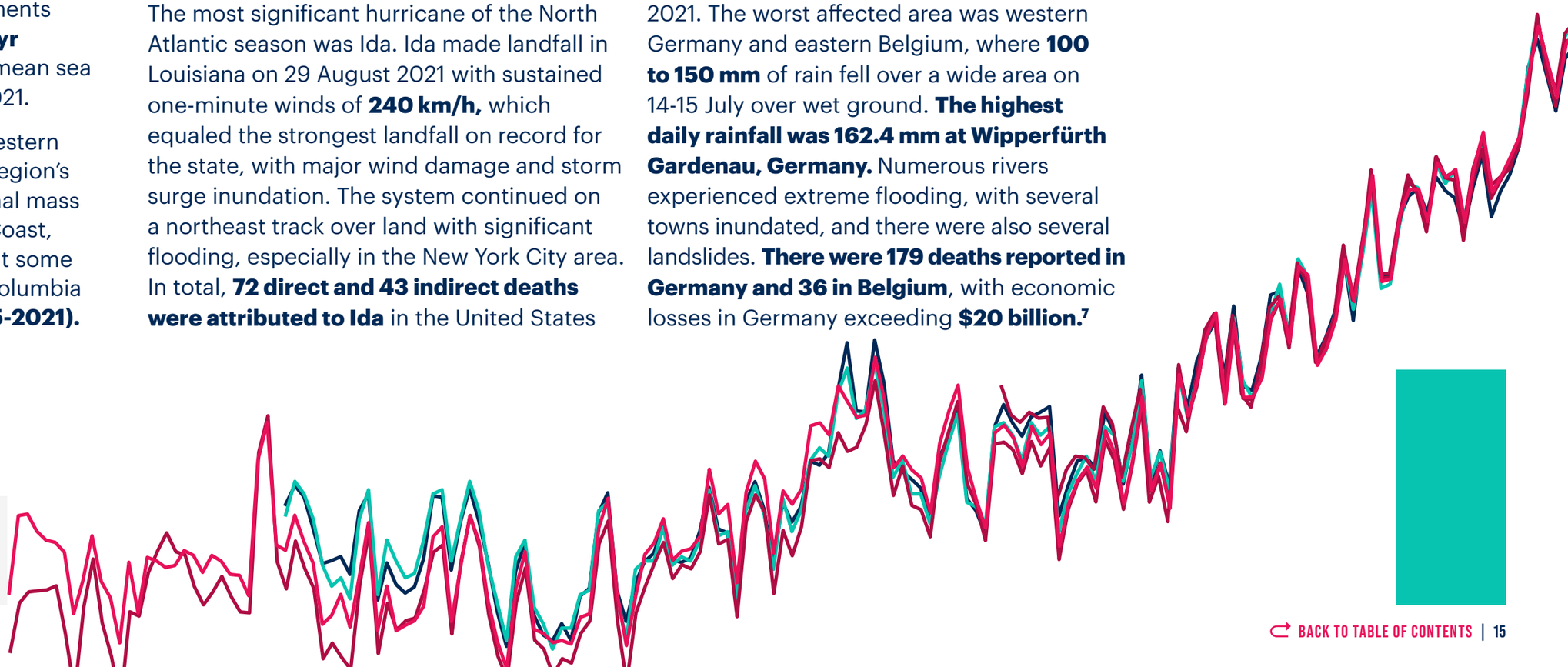
The rate of global sea level rise has increased since satellite altimeter measurements began in 1993, reaching **4.4 mm/yr between 2013 and 2021.** Global mean sea levels reached a record high in 2021.

The 2021 summer heat wave in western North America took a toll on the region's mountain glaciers, with exceptional mass losses in the Cascade, southern Coast, and Rocky Mountains. Mass loss at some glaciers in southwestern British Columbia was the **greatest on record (1965-2021).**

Death Valley, California reached **54.4°C** on 9 July 2021, equaling a similar 2020 value as the **highest recorded in the world since at least the 1930s.**

The most significant hurricane of the North Atlantic season was Ida. Ida made landfall in Louisiana on 29 August 2021 with sustained one-minute winds of **240 km/h,** which equaled the strongest landfall on record for the state, with major wind damage and storm surge inundation. The system continued on a northeast track over land with significant flooding, especially in the New York City area. In total, **72 direct and 43 indirect deaths were attributed to Ida** in the United States and Venezuela, with economic losses in the United States estimated at **$63.8 billion.**

Western Europe experienced some of its most severe flooding on record in mid-July 2021. The worst affected area was western Germany and eastern Belgium, where **100 to 150 mm** of rain fell over a wide area on 14-15 July over wet ground. **The highest daily rainfall was 162.4 mm at Wipperfürth Gardenau, Germany.** Numerous rivers experienced extreme flooding, with several towns inundated, and there were also several landslides. **There were 179 deaths reported in Germany and 36 in Belgium**, with economic losses in Germany exceeding **$20 billion.**[7]



THE DIFFERENCE BETWEEN TRENDS AND DISRUPTIONS

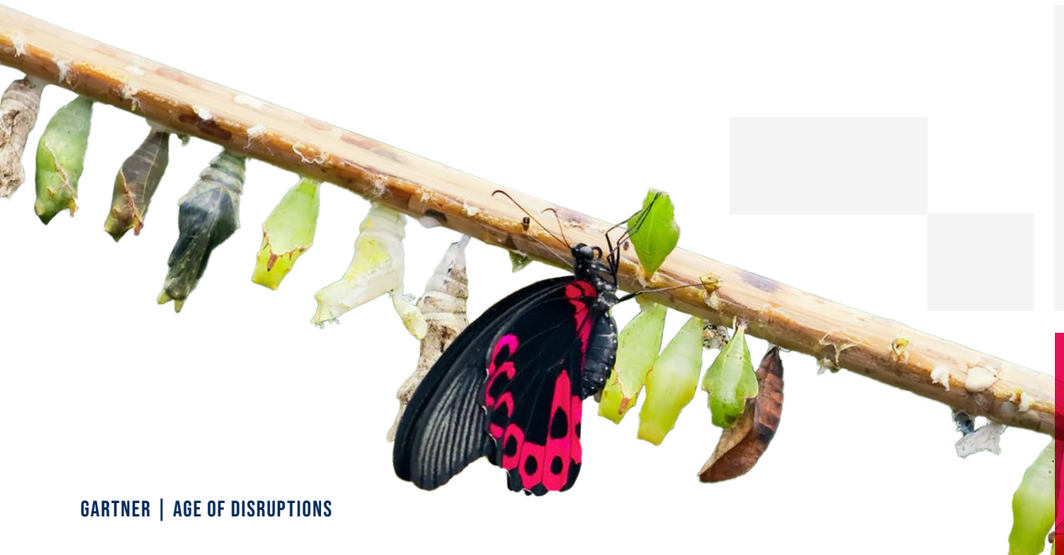
DISRUPTIONS

This research focuses on plausible **disruptions** that may occur ...

NOT

TRENDS

... not **trends** that we would predict.



For this research, many obvious disruptions are missing, such as quantum computing, the metaverse or advances in language models. This is intentional. We chose to highlight a set of disruptions that for many would be less obvious to consider.

DISRUPTIONS

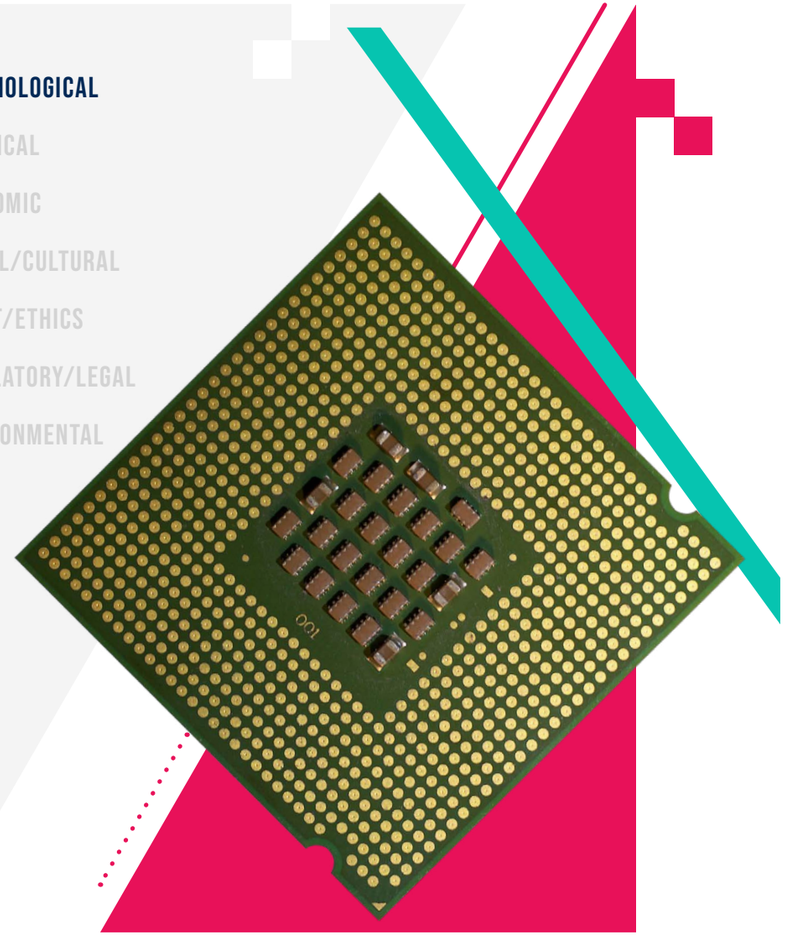
Gartner Futures Lab

The following 19 disruptions come from a series of workshops with the input of hundreds of Gartner experts, across all of its practices, from IT to HR, from marketing to supply chain. The sessions generated a lot of energy and insight, and as a bonus, they were fun.

The final selection was performed by the core project team, largely consisting of members of the Gartner Senior Content Leadership Board. We used our TPESTRE framework (we pronounce it “tapestry”) to structure the workshops and analysis.

Tapestry consists of the following perspectives: technological, political, economic, social/cultural, trust/ethics, regulatory/legal and environmental.

TECHNOLOGICAL
POLITICAL
ECONOMIC
SOCIAL/CULTURAL
TRUST/ETHICS
REGULATORY/LEGAL
ENVIRONMENTAL



SETBACK **BREAKTHROUGH**

SCOPE

Individual Organization — Society as a Whole

LEVEL OF UNCERTAINTY

Completely Unknown — Fully Known

LEVEL OF DEPARTURE FROM STATUS QUO

Partial — Full

THE FIRST DAO TO ENTER MOST ADMIRED BRAND LIST

DAVID PIDSLEY & FRANK BUYTENDIJK

Gartner Futures Lab

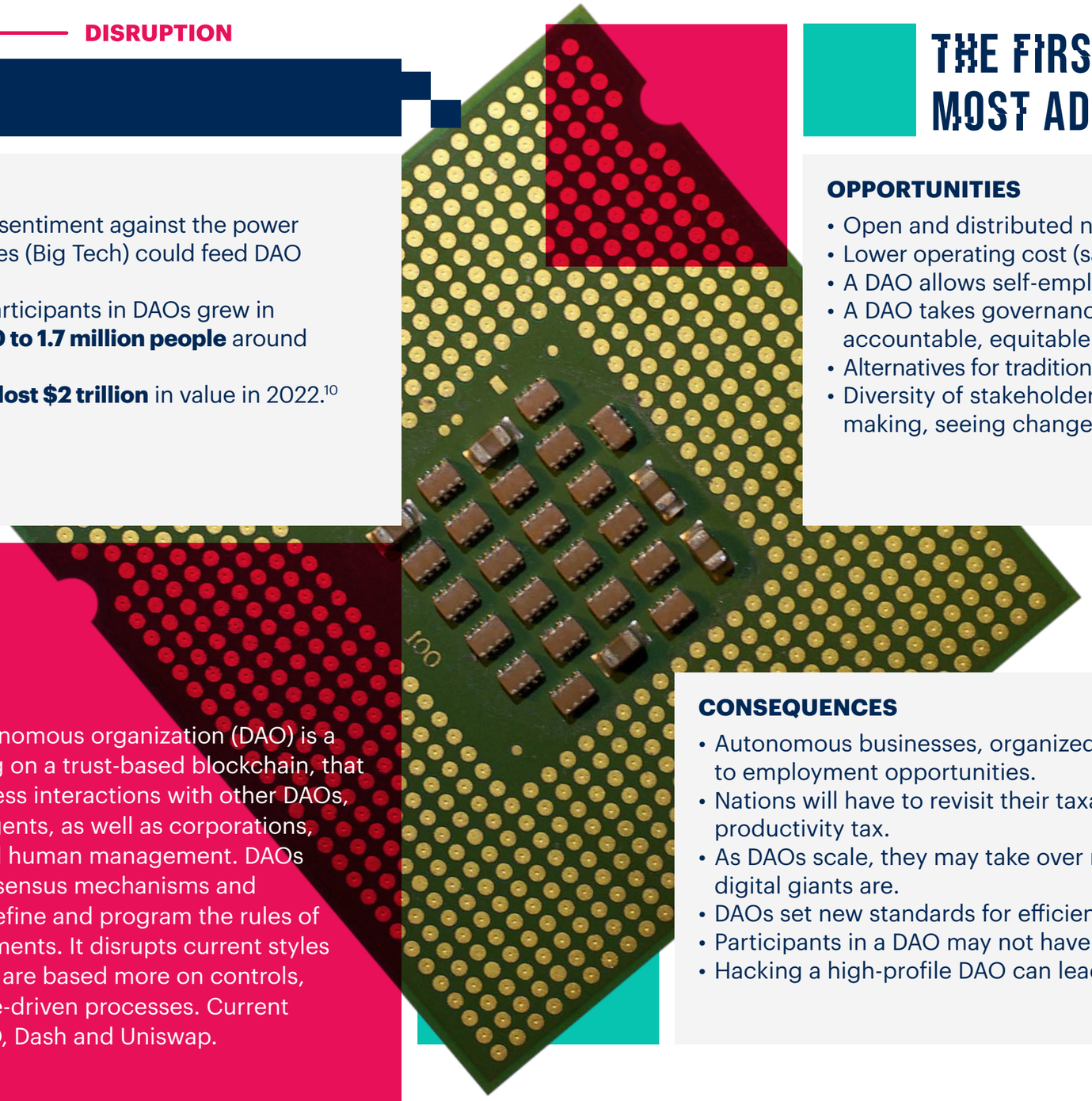
THE FIRST DAO TO ENTER MOST ADMIRED BRAND LIST

DATA POINTS

- Current negative sentiment against the power of large enterprises (Big Tech) could feed DAO momentum.[8]
- The number of participants in DAOs grew in 2021 from **13,000 to 1.7 million people** around the world.[9]
- But … crypto has **lost $2 trillion** in value in 2022.[10]

OPPORTUNITIES

- Open and distributed nature of DAO enables trust.
- Lower operating cost (salaries) and high growth potential (scale).
- A DAO allows self-employed people to organize and unite.
- A DAO takes governance to the next level by introducing an accountable, equitable and transparent incentive mechanism.
- Alternatives for traditional corporate structures that are under fire.
- Diversity of stakeholders may lead to more inclusive decision making, seeing change earlier.



DEFINITION

A decentralized autonomous organization (DAO) is a digital entity, running on a trust-based blockchain, that can engage in business interactions with other DAOs, digital and human agents, as well as corporations, without conventional human management. DAOs rely on software consensus mechanisms and smart contracts to define and program the rules of commercial engagements. It disrupts current styles of organizations that are based more on controls, hierarchy and people-driven processes. Current DAOs include BitDAO, Dash and Uniswap.

CONSEQUENCES

- Autonomous businesses, organized as DAOs, may be detrimental to employment opportunities.
- Nations will have to revisit their taxation practices, introducing a productivity tax.
- As DAOs scale, they may take over markets quicker than the current digital giants are.
- DAOs set new standards for efficiency and speed for every business.
- Participants in a DAO may not have the best intentions when they vote.
- Hacking a high-profile DAO can lead to its immediate downfall.

TECHNOLOGICAL
POLITICAL
ECONOMIC
SOCIAL/CULTURAL
TRUST/ETHICS
REGULATORY/LEGAL
ENVIRONMENTAL

SETBACK

BREAKTHROUGH

SCOPE

Individual Organization ← → Society as a Whole

LEVEL OF UNCERTAINTY

Completely Unknown ← → Fully Known

LEVEL OF DEPARTURE FROM STATUS QUO

Partial ← → Full

FIRST PERMANENT LAB-GROWN ORGAN TRANSPLANT

RITESH PRASAD & SANCHAY TYAGI

Gartner Futures Lab

FIRST PERMANENT LAB-GROWN ORGAN TRANSPLANT

DATA POINTS

- University of Washington scientists devised a new tissue-engineering process that could one day form the basis of lab-grown organs.[11]
- Organoids, lab-grown miniorgans produced in vitro, have already arrived and are making an impact.[12]

OPPORTUNITIES

- Life expectancy will increase substantially for patients with the help of healthy organs.
- Organ transplant processes are also expected to be less complex, leading to time and cost-efficiencies.
- Young people suffering from organ failures will have higher survival rates, thus potentially increasing the working age population and helping economic growth.
- Governments should reconsider retirement ages, creating additional opportunities to grow the workforce.

DEFINITION

More than 100,000 people are on the waiting list for an organ transplant in the U.S. alone.[13] Around 22.6 million patients require neurosurgical interventions annually around the world.[14]

Artificial, lab-grown human organs can be the answer to helping them. With thousands of labs globally making progress, it's not a matter of if we will see a breakthrough in this area but when. Availability of lab-grown organs will lead to increased human life span, lower mortality rates and radical changes in the age demographics of the population.

CONSEQUENCES

- Countries will have varying reasons to impose regulations.
- Lower mortality rates will lead to an increase of the average age of the population. This will put more pressure on resources.
- Governments will have to deal with the pressure of providing care for people with longer life expectancies when the aging population already suffers from a lack of caregivers and resources.

TECHNOLOGICAL
POLITICAL
ECONOMIC
SOCIAL/CULTURAL
TRUST/ETHICS
REGULATORY/LEGAL
ENVIRONMENTAL

SETBACK

BREAKTHROUGH

SCOPE

Individual Organization — Society as a Whole

LEVEL OF UNCERTAINTY

Completely Unknown — Fully Known

LEVEL OF DEPARTURE FROM STATUS QUO

Partial — Full

GLOBAL HYPERSPEED TRAVEL FOR PEOPLE IS POSSIBLE

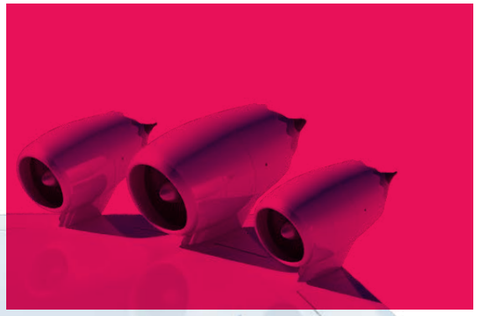
JOHN-DAVID LOVELOCK & MALCOLM MURRAY

Gartner Futures Lab

GLOBAL HYPERSPEED TRAVEL FOR PEOPLE IS POSSIBLE

DATA POINTS

- 2022: Canada's hyperloop dream gets a $550 million capital injection.[15]
- 2021: U.S. Air Force issues a $100 million contract to SpaceX to study the feasibility of Starship rockets capable of transporting 100 million metric tons of cargo to any place in under 90 minutes.[16]
- 2022: A startup raises $100 million to develop a hypersonic plane that would carry passengers at Mach 5.[17]
- 2022: Stratolaunch reveals its first hypersonic design for high-altitude flights.[18]



OPPORTUNITIES

- When prices come down, global hyperspeed travel will allow the average consumer to travel much farther and much faster.
- The distinction between local and global will be further blurred, leading to a globalization of marketing and advertising budgets, and markets.
- Coupled with automation of low-skilled physical work, this disruption could lead to large opportunities for companies involved in upgrading infrastructure globally.
- Even if these flights are currently planned to be very fuel-efficient, their potential volume would pose a challenge for sustainability goals, which would cause opportunities for innovation in new fuel types.

DEFINITION

This disruption pictures a scenario where hypersonic air travel and hyperloops become commercially available to the mass market, giving people the ability to go anywhere in the world in half the time it currently takes.

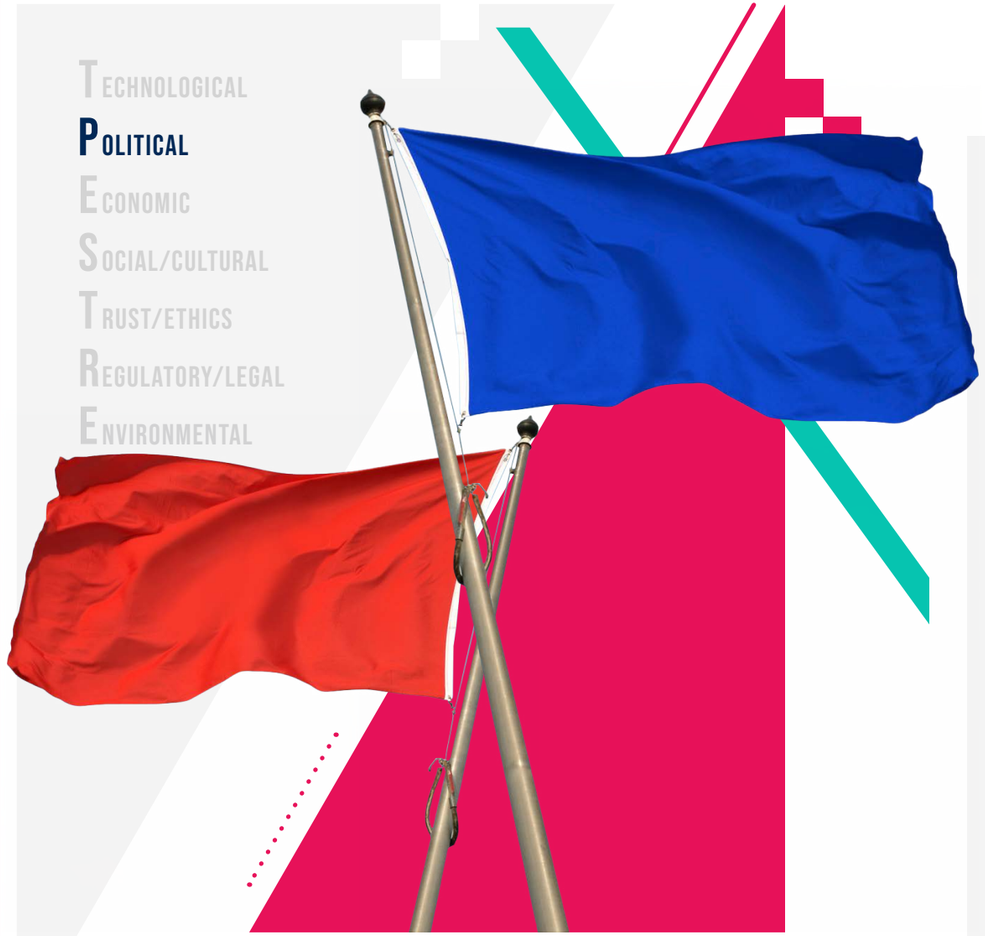
This physical connectivity would disrupt the global talent market for on-site work in the same way digital connectivity transformed the market for knowledge work.

GARTNER | AGE OF DISRUPTIONS

CONSEQUENCES

- As distance would cease to be an obstacle, this kind of ubiquitous global mobility would have widespread consequences for all industries that rely on privileged local access as part of the value proposition and are able to extract rent due to a lack of competition.
- On the talent side, as highly skilled talent for physical skills would now also be able to work globally, akin to today's "digital nomads," this would mean global demand, but also global supply.
- It also applies on the customer side, where customers can tap into a global pool of highly skilled talent for physical local work, potentially drastically impacting profit margins.

T ECHNOLOGICAL
P OLITICAL
E CONOMIC
S OCIAL/CULTURAL
T RUST/ETHICS
R EGULATORY/LEGAL
E NVIRONMENTAL



SETBACK BREAKTHROUGH

SCOPE

Individual Organization — Society as a Whole

LEVEL OF UNCERTAINTY

Completely Unknown — Fully Known

LEVEL OF DEPARTURE FROM STATUS QUO

Partial — Full

DUAL INTERNATIONAL ORDER TAKES HOLD

BRADFORD GROSSMAN & MALCOLM MURRAY

Gartner Futures Lab

DUAL INTERNATIONAL ORDER TAKES HOLD

DATA POINTS

- China and the U.S. have been building strategic technological self-reliance (e.g., with the CHIPS act) and strategically preventing related exports.
- The Shanghai Cooperation Organization (SCO) currently covers 40% of the world's population, and more countries, such as Iran, are joining. This disruption becomes more likely if the SCO continues to gain members as well as influence. Similarly, the BRICS alliance is also growing, with countries such as Algeria seeking to join.[19]

OPPORTUNITIES

- Given the heavy competition between the two blocs, there would be opportunities for unprecedented amounts of capital funding in strategically important areas, similar to the Apollo program (3% of GDP for 10 years). Areas of investment could include AI, semiconductors, biotechnology and nanotechnology.
- Within the blocs, there would be increased integration, not just geopolitically, but also economically and culturally. That could result in free movement of people and capital, with resulting large economic opportunities.

DEFINITION

This disruption creates a world where we are fully split down the middle with all major countries having joined one of two main geopolitical and economic blocs. The two blocs would be of fairly equal strength and influence. Each country has to make a choice which side to be on, a choice that fully determines their economic and political systems, and prevents access to the other bloc. The two blocs would have opposing political philosophies, and the result would be a fully dual international order. The two blocs would not be engaged in armed conflict, but rather a "Cold War 2" of simmering tension.

CONSEQUENCES

- In a dual international order, the big consequences would be duplication and siloing. Companies would only be able to operate within one of the blocs, drastically reducing their potential market size.
- However, within each bloc, there would be more stability and the potential for companies to expand between countries.
- Given the lack of interoperability and communication between the two blocs, key infrastructure such as the internet would likely be branched off and duplicated. Similarly, all or most regulation would bifurcate.

DISRUPTION

TECHNOLOGICAL
POLITICAL
ECONOMIC
SOCIAL/CULTURAL
TRUST/ETHICS
REGULATORY/LEGAL
ENVIRONMENTAL

SETBACK **BREAKTHROUGH**

SCOPE

Individual Organization — Society as a Whole

LEVEL OF UNCERTAINTY

Completely Unknown — Fully Known

LEVEL OF DEPARTURE FROM STATUS QUO

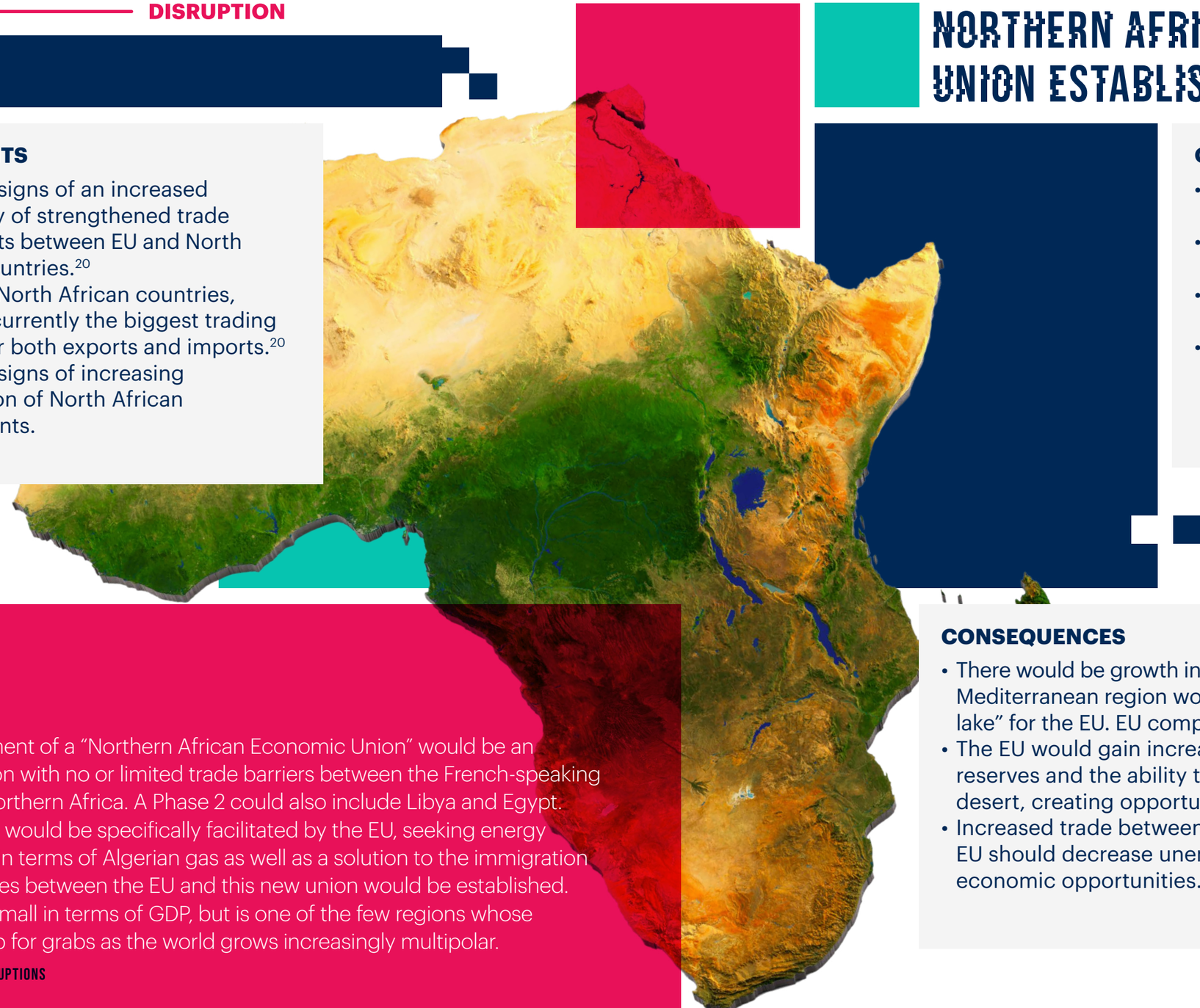
Partial — Full

NORTHERN AFRICAN ECONOMIC UNION ESTABLISHED

KORAY KOSE & MALCOLM MURRAY

Gartner Futures Lab

NORTHERN AFRICAN ECONOMIC UNION ESTABLISHED



DATA POINTS

- There are signs of an increased probability of strengthened trade agreements between EU and North African countries.[20]
- For some North African countries, the EU is currently the biggest trading partner for both exports and imports.[20]
- There are signs of increasing stabilization of North African governments.

OPPORTUNITIES

- Increased trade and freedom of movement between countries.
- Pan North African enterprises will emerge.
- Expansion of EU energy companies to North Africa through "friendshoring."
- More job opportunities for North African residents. This would decrease emigration.

DEFINITION

The establishment of a "Northern African Economic Union" would be an economic union with no or limited trade barriers between the French-speaking countries of Northern Africa. A Phase 2 could also include Libya and Egypt. This disruption would be specifically facilitated by the EU, seeking energy diversification in terms of Algerian gas as well as a solution to the immigration crisis. Strong ties between the EU and this new union would be established. This region is small in terms of GDP, but is one of the few regions whose allegiance is up for grabs as the world grows increasingly multipolar.

CONSEQUENCES

- There would be growth in the power and influence of the EU, as the Mediterranean region would become something akin to "an inland lake" for the EU. EU companies would have access to new markets.
- The EU would gain increased energy security, with access to gas reserves and the ability to build vast solar projects in the Saharan desert, creating opportunities for renewable energy companies.
- Increased trade between the North African countries and the EU should decrease unemployment in the region and create economic opportunities.

DISRUPTION

T ECHNOLOGICAL
P OLITICAL
E CONOMIC
S OCIAL/CULTURAL
T RUST/ETHICS
R EGULATORY/LEGAL
E NVIRONMENTAL

SETBACK BREAKTHROUGH

SCOPE

Individual Organization — Society as a Whole

LEVEL OF UNCERTAINTY

Completely Unknown — Fully Known

LEVEL OF DEPARTURE FROM STATUS QUO

Partial — Full

FIRST INDUSTRIALIZED NUCLEAR REACTOR COMMERCIALLY AVAILABLE

SANCHAY TYAGI & JORGE LOPEZ

Gartner Futures Lab

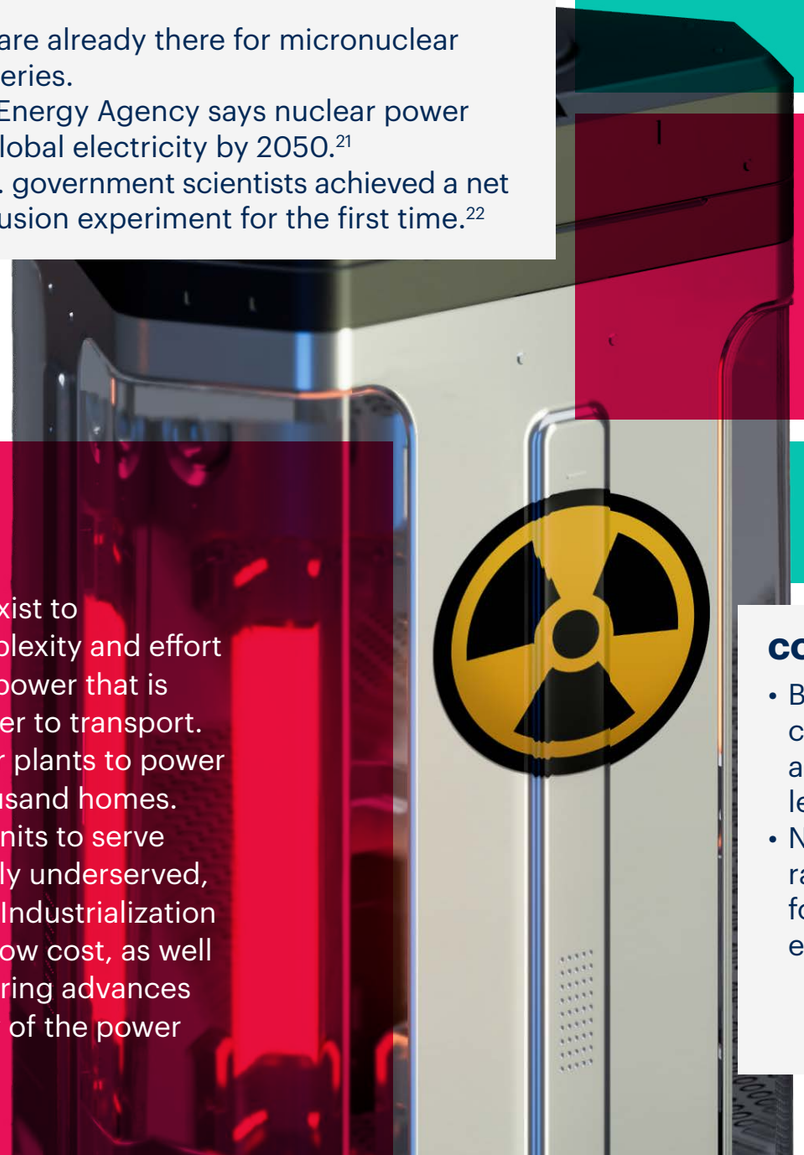
FIRST INDUSTRIALIZED NUCLEAR REACTOR COMMERCIALLY AVAILABLE

DATA POINTS

- The physical possibilities are already there for micronuclear power and advanced batteries.
- The International Atomic Energy Agency says nuclear power could contribute 12% of global electricity by 2050.[21]
- In a big breakthrough, U.S. government scientists achieved a net energy gain in a nuclear fusion experiment for the first time.[22]

OPPORTUNITIES

- All nuclear power designs consume their own nuclear waste to achieve enough power to supply a planet of 10 billion people for 10 billion years.
- Rapid and focused engineering development through the private sector in order to allow greater risk taking in development.
- The current cost of nuclear energy is quite high and industrialization would bring the price down substantially.
- The potential to reduce greenhouse gas emissions substantially, helping organizations with their sustainability strategies.



DEFINITION

Globally, several endeavors exist to dramatically reduce the complexity and effort to build a source for nuclear power that is safer, less expensive and easier to transport. Among these are small power plants to power a neighborhood of a few thousand homes. There could also be smaller units to serve remote areas that are currently underserved, or need more reliable power. Industrialization strategies provide scale and low cost, as well as take advantage of engineering advances to further improve the quality of the power and its safety.

CONSEQUENCES

- Building a nuclear reactor involves many engineering challenges. The process may not yield the desired results right away. The question is whether society is willing to accept that level of risk.
- Nuclear reactors, while effective, also produce a lot of radioactive waste that can be dangerous to human health for thousands of years. Businesses will have to create an effective way to deal with the waste.

T ECHNOLOGICAL
P OLITICAL
E CONOMIC
S OCIAL/CULTURAL
T RUST/ETHICS
R EGULATORY/LEGAL
E NVIRONMENTAL

SETBACK **BREAKTHROUGH**

SCOPE

Individual Organization — Society as a Whole

LEVEL OF UNCERTAINTY

Completely Unknown — Fully Known

LEVEL OF DEPARTURE FROM STATUS QUO

Partial — Full

COST OF SPACE TRAVEL: LESS THAN $10 PER KILOGRAM

JORGE LOPEZ

Gartner Futures Lab

COST OF SPACE TRAVEL: LESS THAN $10 PER KILOGRAM

DATA POINTS

SpaceX leads the world with one rocket launch per week. In a year, that pace will increase to one a day, and continue to grow to more than **three times a day.**

OPPORTUNITIES

- Rocket engine industry grows for the first time in half a century.
- Satellite industry diversifies its services.
- The communications industry will be able to link the 40% of the world currently not connected by satellites.

DEFINITION

The industrialization of space is the application of business and production strategies that relentlessly lower the costs of launching a payload. The current cost per kilo is $1,400. This in turn promotes growth in frequency of launches, satellite deployments, lunar and Mars supply chains, and more.

This is fast-moving and already disrupting the space industry. Executives around the world are making their plans for business growth based on using space to their advantage.

GARTNER | AGE OF DISRUPTIONS

CONSEQUENCES

- The growth in methane production and use for rocket launches which will conflict with carbon-free strategies. This is mostly because methane has 40 times the energy density of today's state-of-the-art batteries, and that energy density is required to launch the very large rockets needed.
- Complete redesign of the Earth's supply chain logistics industry, as rockets prove to be the least expensive way to transport 150 metric tons of material goods and services to and from any point on Earth in less than 90 minutes.

- TECHNOLOGICAL
- POLITICAL
- **ECONOMIC**
- SOCIAL/CULTURAL
- TRUST/ETHICS
- REGULATORY/LEGAL
- ENVIRONMENTAL

SETBACK | BREAKTHROUGH

SCOPE

Individual Organization — Society as a Whole

LEVEL OF UNCERTAINTY

Completely Unknown — Fully Known

LEVEL OF DEPARTURE FROM STATUS QUO

Partial — Full

MAJOR COASTAL CITY LOSES HALF OF ITS POPULATION

HOWARD DODD, AMY ABATANGLE & EMILY ROSE MCRAE

Gartner Futures Lab

MAJOR COASTAL CITY LOSES HALF OF ITS POPULATION

DATA POINTS

- World Bank projects 216 million displacements by 2050 due to climate change.
- The risk of population displacement due to river floods would rise by ~50% for each degree of global warming (currently on track for 2.5 degrees).[23]
- The Internal Displacement Monitoring Centre reported 24 million displacements in 2021 due to disasters.

OPPORTUNITIES

- Lack of residents and commuters causes downtown areas to collapse, but the city takes advantage of this by acquiring valuable real estate at low prices and redeveloping it to attract new migrants.
- Infrastructure investment increases as waterfront land is lost and the city needs new sewage/utilities/transportation.

CONSEQUENCES

- Large investments in corporate real estate are abandoned as remote work or migration to lower-cost areas increases.
- Rapid expansion in habitation of areas surrounding cities as the low-income population moves out of affected areas.
- Increase in volatility/crime/healthcare issues in newly settled areas without infrastructure investment.
- Global “safe zones” emerge – changing risk management postures, but also changing migration/visitation policies.
- Government spending, planning and digital strategy are highly impacted.
- Regional politics are dramatically reshaped.

DEFINITION

Mass migrations of people from today’s highly dense urban cities will be driven by a mix of immediate catastrophic events – Hurricane Katrina (U.S.), an earthquake and tsunami (Japan), as well as slow moving events like the COVID-19 pandemic, and sea-level rise due to climate change. At first, there will be a local migration within a country or region to escape immediate economic or environmental pressure, followed by a broader, more global resettlement to escape core political and economic changes.

GARTNER | AGE OF DISRUPTIONS

TECHNOLOGICAL
POLITICAL
ECONOMIC
SOCIAL/CULTURAL
TRUST/ETHICS
REGULATORY/LEGAL
ENVIRONMENTAL

SETBACK **BREAKTHROUGH**

SCOPE

Individual Organization — Society as a Whole

LEVEL OF UNCERTAINTY

Completely Unknown — Fully Known

LEVEL OF DEPARTURE FROM STATUS QUO

Partial — Full

OVERCOME THE 125-YEAR-AGE-LIMIT CEILING

PETER SKYTTEGAARD & MARTY RESNICK

Gartner Futures Lab

OVERCOME THE 125-YEAR-AGE-LIMIT CEILING

DATA POINTS

- Startup focuses on anti-aging breakthroughs, specifically using epigenomes.[24]
- Researchers were able to block L1 RNA expression and reverse the aging process in cells taken from patients with progeroid syndromes and in mice that are genetically modified to simulate premature aging.[25]
- Humans could live as long as 150 years, new research suggests.[26]

OPPORTUNITIES

- An increased average human life span would open up a new age category for businesses to target; this category has unique opportunities and risks (over 100+), including new types of pension plans.
- New types of employment may emerge for older people.

DEFINITION

The human life span is 125 years at most.[27] Genetic engineering breakthroughs will stop or even reverse the human aging process. People will live longer lives, but also will be able to work and thrive longer, which will change the way we look at the consequences of an "aging population."[28] This would be the opposite of the current aging population trend. Advancements in medicine and sanitation have made increased life spans a regular occurrence for the past two centuries.

CONSEQUENCES

- Younger employees may have to wait longer for more influence in the organization if management stays in roles for longer periods.
- As the approved age of retirement increases, retirement benefits through employers will need to be updated and remain competitive based on employees who live longer.
- There may be an additional financial burden on healthcare. Extending age may come with health problems.

DISRUPTION

T ECHNOLOGICAL
P OLITICAL
E CONOMIC
S OCIAL/CULTURAL
T RUST/ETHICS
R EGULATORY/LEGAL
E NVIRONMENTAL

SETBACK

BREAKTHROUGH

SCOPE

Individual Organization — Society as a Whole

LEVEL OF UNCERTAINTY

Completely Unknown — Fully Known

LEVEL OF DEPARTURE FROM STATUS QUO

Partial — Full

THE FIRST COUNTRY BECOMES CALORIE SELF-SUFFICIENT

MARKUS HOFBAUER & MARTY RESNICK

Gartner Futures Lab

THE FIRST COUNTRY BECOMES CALORIE SELF-SUFFICIENT

DATA POINTS

- Exponential growth of genome sequencing of plants since 2000, due to advances in technology and methodology.
- AI accelerates identification of most valuable gene combinations to fast-track seed modification.[29]
- According to the United Nations, "The world's population is expected to increase by two billion persons in the next 30 years, from 7.7 billion currently to 9.7 billion in 2050 and could peak at nearly 11 billion around 2100."[30]

OPPORTUNITIES

- Superseeds become a new market opportunity for vendors to provide the underlying technologies to keep pace with growing populations, changing diet patterns and the effects of global warming.
- Open-source genetic seed modification approaches accelerate research and experimentation and increase superseed variety. Its global availability provides businesses and agriculture with more opportunities to participate and a lower barrier to entry.

DEFINITION

Genetically modified superseeds have the potential to eliminate hunger because of their higher resistance and higher nutritional value. Seed resilience protects crops against insects, pesticides and climate impacts such as droughts or floods. Superseeds are designed to create crops with higher levels of nutrients, such as protein, minerals and vitamins.

Superseeds that are modified for resilience could also result in significantly increased crop yields.

CONSEQUENCES

- Increased availability of resilient and higher-nutrient crops reduces the risk of wars for water and land, thus causing fewer of the business disruptions and supply chain issues often associated with wars.
- The government and public sectors will be able to direct development aid from nutrition support to other high-priority development areas, such as education, infrastructure support and healthcare.
- There may be consumer concerns about the effects of superseeds, as well as general antipathy for genetically modified food. This could result in a backlash that creates risk for businesses that produce superseeds and the food grown from them.

TECHNOLOGICAL
POLITICAL
ECONOMIC
SOCIAL/CULTURAL
TRUST/ETHICS
REGULATORY/LEGAL
ENVIRONMENTAL

SETBACK BREAKTHROUGH

SCOPE

Individual Organization — Society as a Whole

LEVEL OF UNCERTAINTY

Completely Unknown — Fully Known

LEVEL OF DEPARTURE FROM STATUS QUO

Partial — Full

A G20 COUNTRY TAXES NONCHILDREARING

EMILY ROSE MCRAE

Gartner Futures Lab

A G20 COUNTRY TAXES NONCHILDREARING

DATA POINTS

- For the last 70 years, fertility rates have decreased worldwide, with a total 50% decline.[31]
- Twenty-three nations are expected to see their populations halve by 2100.[32]
- Many countries already offer financial incentives for having children.

OPPORTUNITIES

- National-level messaging about the importance of having and caring for children will begin to dominate discussion. Organizations can leverage the heightened awareness to increase the employee value proposition (EVP) impact of their investments in on-site childcare, childcare stipends, flexible hours and other tools for supporting employees who are parents.
- Organizations can also use this messaging environment to lobby their governments to offer tax credits for their expenditure in supporting employees who are parents.

DEFINITION

Demographic collapse, meaning not having enough population growth to replace the current population, is arguably the greatest threat to political stability for most countries. By 2050, the share of people over 65 becomes the largest group. As countries become increasingly desperate to address demographic imbalances, they will shift from incentivizing having children to disincentivizing not having children and begin to tax people who choose not to have children. Individuals who enable others to have children, such as fertility specialists and childcare providers, will be exempt from the taxes.

CONSEQUENCES

- Additional income to help cash-strapped countries provide services to an aging population, but income alone will not meet the shortfall caused by demographic collapse, meaning businesses may face a higher tax rate as governments try to compensate.
- Penalizing nonchildrearers will increase the birth rate, increasing the extent to which parental leave will affect talent strategies.
- If organizations do not actively cultivate careers for women, more women may leave the workforce or slow their career progression, worsening income and leadership inequities.
- Incentives to raise children force more children into foster care.

T ECHNOLOGICAL
P OLITICAL
E CONOMIC
S OCIAL/CULTURAL
T RUST/ETHICS
R EGULATORY/LEGAL
E NVIRONMENTAL

SETBACK **BREAKTHROUGH**

SCOPE

Individual Organization — Society as a Whole

LEVEL OF UNCERTAINTY

Completely Unknown — Fully Known

LEVEL OF DEPARTURE FROM STATUS QUO

Partial — Full

FIRST S&P 100 COMPANY TO FULLY DISCLOSE PAY

KARTIK DEO & EMILY ROSE MCRAE

Gartner Futures Lab

FIRST S&P 100 COMPANY TO FULLY DISCLOSE PAY

DATA POINTS

- Pay transparency laws exist in 21 states within the U.S. and counting.
- Ninety-eight percent of organizations globally are actively addressing pay equity, with 45% having begun in just the last three years. Most total rewards leaders (72%) say pay equity is a high priority for their organization.[33]
- Sixty-one percent of the surveyed heads of total rewards and compensation said they are concerned about how today's competitive labor market creates pay inequities between new and tenured employees.[33]

OPPORTUNITIES

- To successfully implement pay transparency, organizations will need to be able to articulate the differentiators within pay bands, and conduct audits to ensure that the identified differentiators are being applied correctly.
- Demographic changes and increasing employee reliance on online pay information sources will pose increasing challenges to employee retention. An effective pay transparency strategy can help mitigate these effects.
- Business leaders know that pay inequity leads to a host of negative talent outcomes, reputational risks and the threat of litigation. An increase in pay transparency will create serious challenges for organizations that do not address pay inequity.

DEFINITION

Pay transparency means transparency about the pay range for a role as well as transparency about what characteristics lead to differentiation between current employees or new hires within that range. Laws requiring organizations to disclose the salary range for all open positions are becoming increasingly common. Meanwhile, there will be a pull effect as well. Organizations trying to compete for talent that don't have competitive salaries will embrace pay transparency to retain talent.

CONSEQUENCES

- As companies shift toward pay transparency, there could be a spike in Equal Employment Opportunity Commission (EEOC) and related claims, in the U.S.
- The potential talent and legal costs of pay inequity will force organizations that have not yet meaningfully addressed pay gaps to take action, at great cost.
- Employee confidence in their organization's pay strategy corresponds to an 8.5% increase in intent to stay, a 7.2% increase in employee performance and a 15% increase in employee engagement.[34]

T ECHNOLOGICAL
P OLITICAL
E CONOMIC
S OCIAL/CULTURAL
T RUST/ETHICS
R EGULATORY/LEGAL
E NVIRONMENTAL

SETBACK **BREAKTHROUGH**

SCOPE

Individual Organization ← → Society as a Whole

LEVEL OF UNCERTAINTY

Completely Unknown ← → Fully Known

LEVEL OF DEPARTURE FROM STATUS QUO

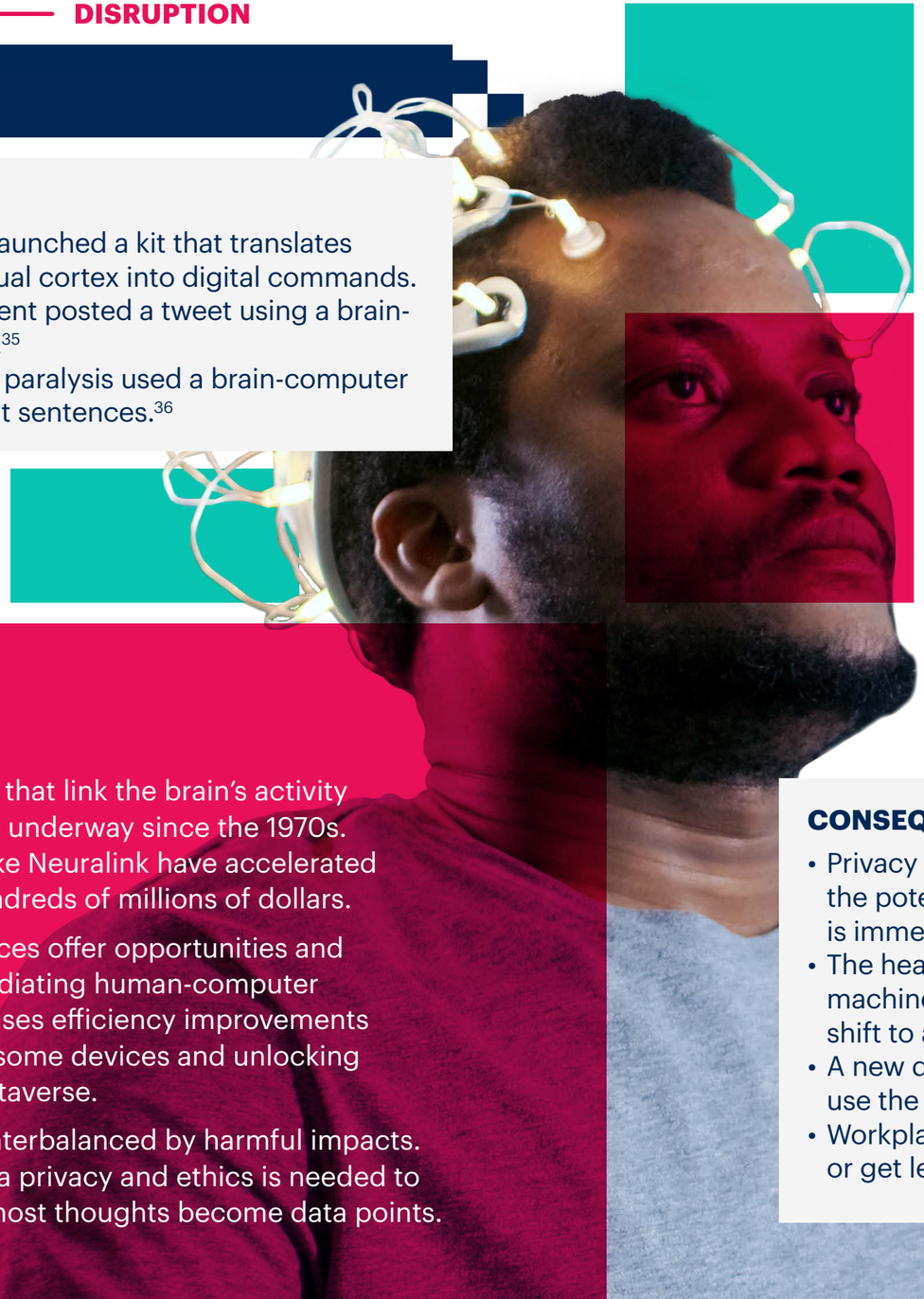
Partial ← → Full

FIRST BRAIN-COMPUTER INTERFACES COMMERCIALLY AVAILABLE

ZACH GINSBURG & EWAN MCINTYRE

Gartner Futures Lab

FIRST BRAIN-COMPUTER INTERFACES COMMERCIALLY AVAILABLE



DATA POINTS

- In 2020, NextMind launched a kit that translates signals from the visual cortex into digital commands.
- In 2021, an ALS patient posted a tweet using a brain-computer interface.[35]
- In 2022, a man with paralysis used a brain-computer interface to spell out sentences.[36]

OPPORTUNITIES

- Technology companies have the opportunity to provide the language and operating system needed to activate a brain-computer interface outside of a lab.
- Opportunities for security data privacy and security technologies are significant. Mainstream adoption requires robust technology, processes and structures.

DEFINITION

Research on interfaces that link the brain's activity to computers has been underway since the 1970s. Recently, companies like Neuralink have accelerated R&D investment by hundreds of millions of dollars.

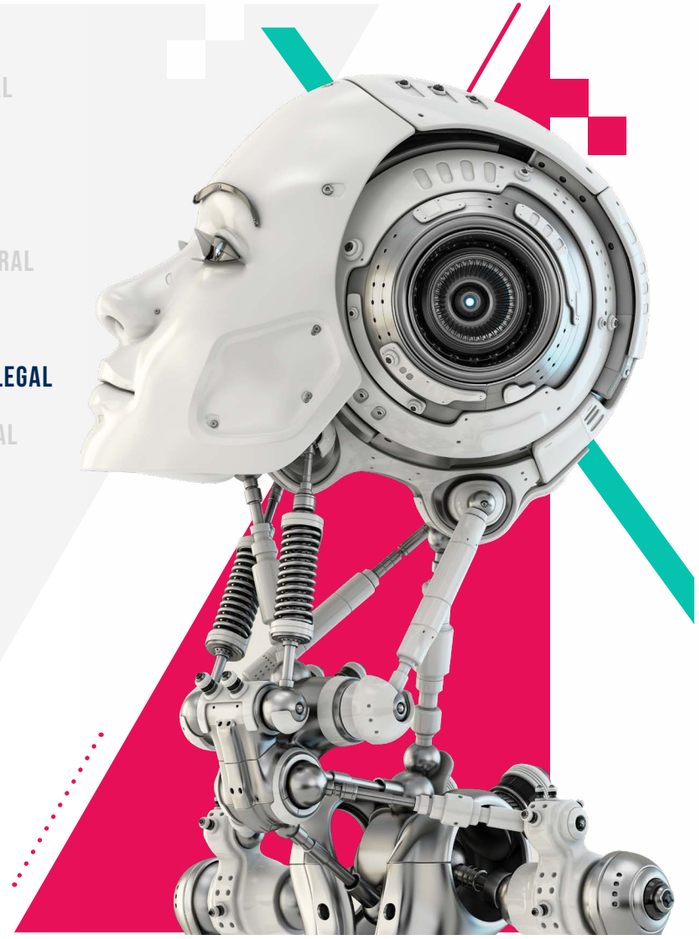
Brain-computer interfaces offer opportunities and challenges. Disintermediating human-computer communications promises efficiency improvements by eliminating cumbersome devices and unlocking the potential of the metaverse.

Opportunities are counterbalanced by harmful impacts. A new paradigm of data privacy and ethics is needed to protect users as innermost thoughts become data points.

CONSEQUENCES

- Privacy and ethical hurdles are considerable. Even with layers of protection in place, the potential for entities to monitor and use thought-generated, highly personal data is immense.
- The health impacts could be manifold. The physical impact of prolonged use of brain-machine interfaces is unknown. The psychological impacts could be even greater, as the shift to always-on hyperconnectivity blur the boundaries between what's real and virtual.
- A new digital socioeconomic divide opens, separating those who can and can't afford to use the technology.
- Workplaces that adopt the interfaces pressure unwilling users to adopt the technology or get left behind.

T ECHNOLOGICAL
P OLITICAL
E CONOMIC
S OCIAL/CULTURAL
T RUST/ETHICS
R EGULATORY/LEGAL
E NVIRONMENTAL



SETBACK

BREAKTHROUGH

SCOPE

Individual Organization — Society as a Whole

LEVEL OF UNCERTAINTY

Completely Unknown — Fully Known

LEVEL OF DEPARTURE FROM STATUS QUO

Partial — Full

AI GAINS PERSONHOOD IN A LEGAL SYSTEM

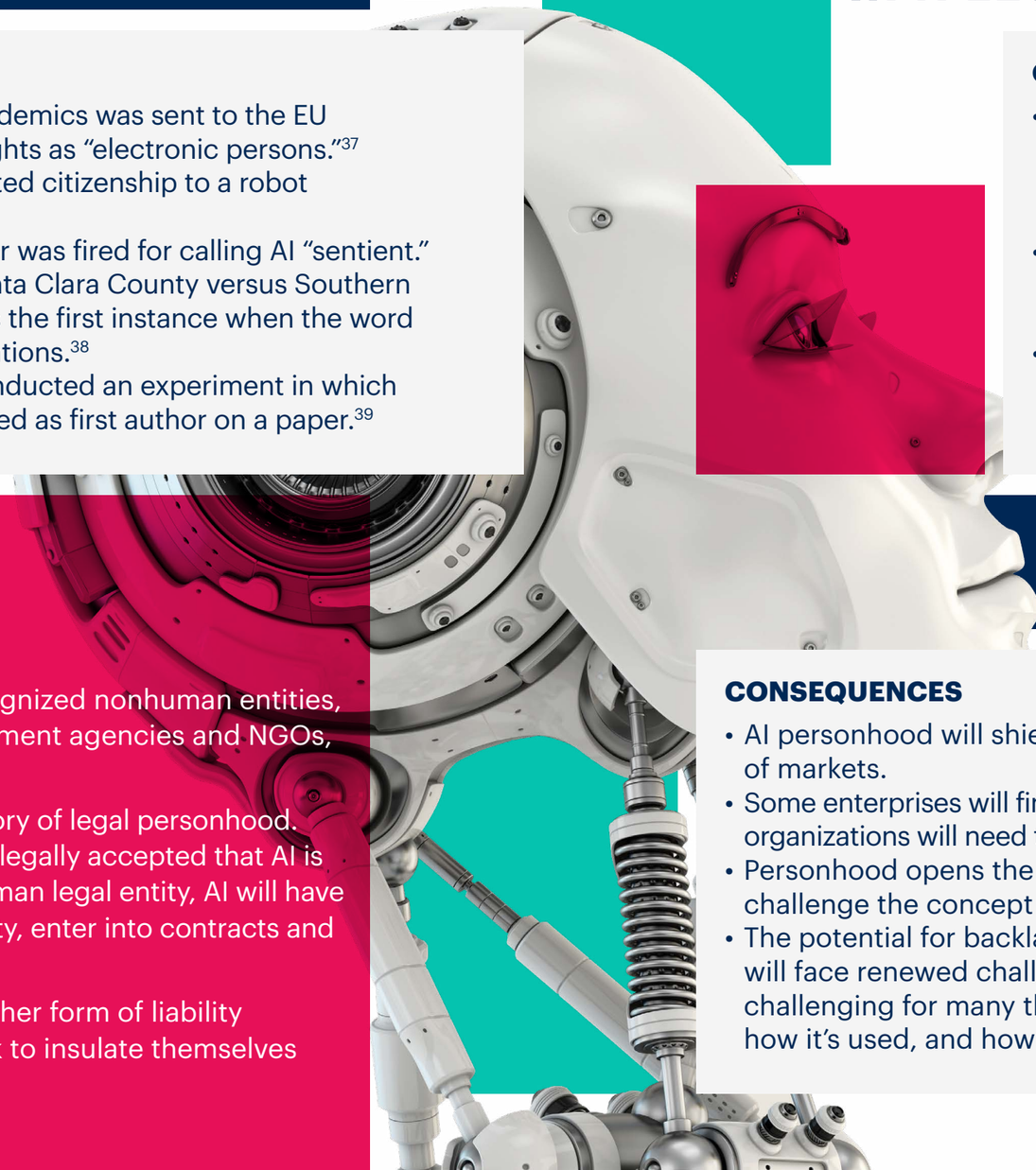
ANDREW FRANK & EWAN MCINTYRE

Gartner Futures Lab

AI GAINS PERSONHOOD IN A LEGAL SYSTEM

DATA POINTS

- A letter signed by 285 academics was sent to the EU arguing against robotic rights as "electronic persons."[37]
- In 2017, Saudi Arabia granted citizenship to a robot named Sophia.
- In 2022, a Google engineer was fired for calling AI "sentient."
- In U.S. law, the case of Santa Clara County versus Southern Pacific Railroad (1886) was the first instance when the word "person" included corporations.[38]
- Academic researchers conducted an experiment in which they tried to get GPT-3 listed as first author on a paper.[39]



OPPORTUNITIES

- Conferring legal personhood on machines could accelerate legal oversight on AI development. The EU's AI Act – the first law on AI from a major regulator – already seeks to deal with unacceptable risks posed by AI development.
- The threat of liability insulation by bad actors may prompt a rethink of the legal structures that have thus far enabled the misuse of legal personhood.
- A shift to legal personhood could raise awareness of the potential risks posed by unrestricted AI development, curbing the most egregious applications.

DEFINITION

Legal systems have long recognized nonhuman entities, such as corporations, government agencies and NGOs, as "persons."

Machines create a new category of legal personhood. That's not to say that it will be legally accepted that AI is conscious; rather, as a nonhuman legal entity, AI will have the permission to own property, enter into contracts and sue or be sued.

This may be regarded as another form of liability limitation, as enterprises seek to insulate themselves from legal risk.

CONSEQUENCES

- AI personhood will shield people and organizations from liability, risking the integrity of markets.
- Some enterprises will find the advantages of such shields irresistible. Meanwhile, other organizations will need to mobilize resources to expose and contain the threats.
- Personhood opens the door to courts conferring greater rights to AI entities. This could challenge the concept of ownership of technology.
- The potential for backlash is significant. Organizations and governments that use AI will face renewed challenges to explain and justify their use and oversight. This will be challenging for many that have already adopted AI without justification of where and how it's used, and how safeguards and accountability are assured.

TECHNOLOGICAL
POLITICAL
ECONOMIC
SOCIAL/CULTURAL
TRUST/ETHICS
REGULATORY/LEGAL
ENVIRONMENTAL

SETBACK **BREAKTHROUGH**

SCOPE

Individual Organization — Society as a Whole

LEVEL OF UNCERTAINTY

Completely Unknown — Fully Known

LEVEL OF DEPARTURE FROM STATUS QUO

Partial — Full

EU INTRODUCES BLANKET RIGHT-TO-REPAIR LAW

EMILY POTOSKY & EWAN MCINTYRE

Gartner Futures Lab

EU INTRODUCES BLANKET RIGHT-TO-REPAIR LAW

DATA POINTS

- Adoption of the Motor Vehicle Owners' Right to Repair Act, in the U.S.
- The introduction of a fully (and easily) repairable mobile phone from a major manufacturer.
- Planned obsolescence has long been a concern of legislators. Similarly restricting access to parts is a tactic that brands have employed throughout the 20th and 21st centuries. The introduction of connected devices and cars has exacerbated a long-running issue.

DEFINITION

The right-to-repair movement advocates increased consumer ability to use, modify and repair their products outside of official sources. This includes making repair information, parts and tools available; allowing unlocking; and designing devices so they are easy to repair. Apple's launch of its Self Repair Service in 2021 was an important milestone in the right-to-repair journey. While this service is limited, it signals a shift from the upgrade culture that has prevailed over recent decades. If fully realized, the implications of right-to-repair for major brands are significant, especially those currently benefiting from revenue streams associated with servicing and upgrading products.

OPPORTUNITIES

- The EU estimates that between 2009 and 2019 the total weight of electrical and electronic equipment in the EU market increased 49%, with further growth predicted. Right-to-repair reduces the environmental impact by minimizing the resources required to produce electrical and electronic equipment including metals and rare earth elements.
- Right-to-repair redistributes economic benefits, creates jobs in the repair sector and benefits smaller, local businesses. It represents a step toward a circular economy and the EU's Green Deal.
- Brands will focus on product innovation, rather than iteration, as inbuilt obsolescence no longer sustains an upgrade-oriented business model.

CONSEQUENCES

- Reduced earnings may curtail enterprise R&D investment, as brands can no longer rely on steady income streams delivered through upgrades and servicing.
- Product safety is compromised if unqualified technicians are free to repair devices. It is likely that some form of regulation will be required to mitigate the risk.
- Decreased extraction of raw materials may economically harm some developing economies in the near term.
- Reduction in e-waste exports to developing countries, where informal recycling is an important part of the economy.
- Repairing devices (and motor vehicles) requires access to diagnostic data. Opening access to such data may have unintended consequences for data privacy.

TECHNOLOGICAL
POLITICAL
ECONOMIC
SOCIAL/CULTURAL
TRUST/ETHICS
REGULATORY/LEGAL
ENVIRONMENTAL

SETBACK **BREAKTHROUGH**

SCOPE

Individual Organization — Society as a Whole

LEVEL OF UNCERTAINTY

Completely Unknown — Fully Known

LEVEL OF DEPARTURE FROM STATUS QUO

Partial — Full

FIRST G20 COUNTRY TO INTRODUCE UBI

ANNIKA JESSEN & EMILY ROSE MCRAE

Gartner Futures Lab

FIRST G20 COUNTRY TO INTRODUCE UBI

DATA POINTS

- Completed UBI pilots globally, including in the U.S. (California and Massachusetts), Namibia, Uganda, India, Brazil, Finland, Italy and Scotland have shown positive social and economic impacts.
- In about 60% of occupations, at least one-third of the constituent activities could be automated by AI that already exists.[40]

DEFINITION

Universal basic income (UBI) provides people with a stipend that covers basic needs for shelter, food and healthcare. It is not enough for anyone to "get rich" but it is enough such that the financial costs of existing in their societies – paying for basic bills and food – is gone.

As more and more work is automated and digitalized, the productivity of economies rises without a commensurate increase in effort or labor by human workers. Demand for UBI is expected to increase as technology reduces the need for human workers.

While many UBI pilots have focused on low-income or marginalized communities, the pilots that have targeted a random selection of households better reflect how UBI might have an effect when implemented on a broader scale.

OPPORTUNITIES

- UBI pilots tried at the local level will help determine potential impacts before the idea is rolled out on a national level.
- As the cost of automation technology goes down, more and more organizations will need to implement automation to stay competitive. If these investments result in talent cuts, this may increase the pressure for governments to implement UBI.
- With UBI, the existential threat to workers of their roles being eliminated will be greatly reduced. Organizations can implement technology with less concern about the brand and engagement impacts of layoffs.

CONSEQUENCES

- High potential for government budget, spending and taxation increases that cause economic slowdowns or at least raise corporate tax rates.
- People will have potentially more capacity to innovate and start their own businesses without the survival imperative of work. However, that also means that less appealing work will need to be higher paid or otherwise incentivized for people to accept those roles.
- This innovation could also lead to more competitors entering established markets, particularly disrupting the competition and changing traditional delivery, marketing or pricing models.

T ECHNOLOGICAL
P OLITICAL
E CONOMIC
S OCIAL/CULTURAL
T RUST/ETHICS
R EGULATORY/LEGAL
E NVIRONMENTAL

SETBACK BREAKTHROUGH

SCOPE

Individual Organization — Society as a Whole

LEVEL OF UNCERTAINTY

Completely Unknown — Fully Known

LEVEL OF DEPARTURE FROM STATUS QUO

Partial — Full

GEOMAGNETIC STORM DISABLES MAJORITY OF SATELLITES

MARK HORVATH, ROBERTA WITTY & FRANK BUYTENDIJK

Gartner Futures Lab

GEOMAGNETIC STORM DISABLES MAJORITY OF SATELLITES

DATA POINTS

Geomagnetic storms have caused problems for centuries:

- 774, Miyake Event: Large spike of carbon-14 captured in tree rings.
- 1859, Carrington Event: Telegraph lines caught fire, and compasses were rendered useless.[41]
- 1921, Great Railroad Storm: Telegraph exchanges in Sweden and the U.S. burst into flames.[42]
- 1989, Quebec, Canada: Hydro Quebec was knocked offline and transformer fires caused billions in replacement costs.
- 2022: Satellite damage.[43]

OPPORTUNITIES

- IT service providers, including cloud service providers, must provide protection against geomagnetic storms.
- Every organization must include geomagnetic storms as scenarios in business continuity and disaster recovery planning, and practice those plans.
- Affected organizations should prepare for cash-only operations for an indefinite period of time.
- The impact of losing communications because of geomagnetic storms can be lessened by repositioning working satellites.

DEFINITION

Geomagnetic storms are explosions on the sun of radiation (solar flares) or gas (coronal mass ejection). They are unpredictable but typically run on an 11-year cycle. The peak of this current cycle should be in July 2025.[44]

Class C storms are small, and limited radio blackouts are possible. Class M is medium-size, with radio blackouts in the polar regions. Class X storms are large events triggering blackouts around the world.[45] However, all classes can have effects on satellite communication (internet) and can cause the satellites to fall out of orbit. Consequences of a Class X storm can impede critical infrastructure services, such as power, water, food, fuel, communication, emergency services and more. Recovery can be months or years depending on the scale of the impact, as all damaged equipment would need to be replaced, in addition to the secondary damage caused by the storm.

CONSEQUENCES

- Electronic equipment, high-frequency radio communication, mobile phone networks and global navigation satellite systems damaged or deorbited.
- Electricity and technology processing disrupted for weeks or months.
- Communication (cell, landline, satellite, etc.) and weather analysis and reporting capability halted.
- Civilian aviation impacted, resulting in death (planes in the air at the time of the release), as well as business and personal travel.
- Military aviation and operations halted, resulting in national security challenges.
- Life sustaining medical devices damaged, resulting in death.
- Natural disasters, such as earthquakes and volcanoes, can be triggered, causing even more damage.
- Some of these events combined would lead to massive civil unrest.

T ECHNOLOGICAL
P OLITICAL
E CONOMIC
S OCIAL/CULTURAL
T RUST/ETHICS
R EGULATORY/LEGAL
E NVIRONMENTAL

SETBACK

BREAKTHROUGH

SCOPE

Individual Organization — Society as a Whole

LEVEL OF UNCERTAINTY

Completely Unknown — Fully Known

LEVEL OF DEPARTURE FROM STATUS QUO

Partial — Full

SPACE JUNK RUNAWAY COLLISIONS START

ZACH GINSBURG & MALCOLM MURRAY

Gartner Futures Lab

SPACE JUNK RUNAWAY COLLISIONS START

DATA POINTS

- There are currently 2,000 active satellites, 3,000 dead satellites and 34,000 pieces of "space junk" in orbit.[46]
- The rising number of smaller satellites will increase the problem of space junk. Space X plans to launch 7,500 Starlink satellites.[47]
- The International Space Station already had to change course because of space junk, such as in 2022.[48]

OPPORTUNITIES

- Growth of huge P2P mesh networks for internet connectivity.
- There is an opportunity to clean up space for anyone that invents a space vacuum cleaner.
- Companies that have shorter supply chains and rely more on locally sourced materials would benefit.

DEFINITION

A space junk cascade would be a self-sustaining, runaway cycle of debris-generating collisions in low-Earth orbit. Once it starts, it would turn into a chain reaction that would fill low-Earth orbit with enough junk to prevent further space activities. The build-up for this has already started and will continue with the launches of many small satellites. There may also be a geopolitical "space war" if certain nations deliberately destroy satellites to prevent other nations from launching new satellites because of the extra debris.

GARTNER | AGE OF DISRUPTIONS

CONSEQUENCES

- The destruction of satellites would lead to the loss of satellite navigation systems, which would affect military operations, the ability to forecast weather patterns and the ability for global shipping to continue.
- Affect telecom and internet connectivity around the world.
- Space junk collisions will have geopolitical consequences, leading to worldwide conflicts.
- Unless a solution was found, it would severely hamper further space exploration and our ability to develop the space economy.

DISRUPTION

TECHNOLOGICAL
POLITICAL
ECONOMIC
SOCIAL/CULTURAL
TRUST/ETHICS
REGULATORY/LEGAL
ENVIRONMENTAL

SETBACK

BREAKTHROUGH

SCOPE

Individual Organization — Society as a Whole

LEVEL OF UNCERTAINTY

Completely Unknown — Fully Known

LEVEL OF DEPARTURE FROM STATUS QUO

Partial — Full

DESALINATED WATER BECOMES AS ACCESSIBLE AS BOTTLED WATER

ANSHUL MAHESHWARI & SANCHAY TYAGI

Gartner Futures Lab

DESALINATED WATER BECOMES AS ACCESSIBLE AS BOTTLED WATER

DATA POINTS

- From less than 10,000 desalination plants in 2000, the worldwide number for desalination facilities has reached more than 21,000 in over 120 countries.[49]
- The operating costs of desalinated water dropped by around 90%, from approximate unit costs of $10/m³ in the 1960s to less than $1/m³ in 2010. In 2019, the average price range of desalinated water reached between $0.5/m³ and $1.5/m³. [50]

OPPORTUNITIES

- UNESCO states that the global freshwater shortage will reach 500 trillion gallons per year by 2025, which could lead to water wars. Large-scale desalination can supply the needed water.[52]
- Health will improve significantly with people being able to access safe drinking water, especially in arid regions.
- Industries heavily reliant on water (e.g., agribusinesses) will see increased application of desalinated water in their operations. This will allow businesses to reduce the risk of water scarcity.
- Preventing groundwater depletion, by providing a limitless supply of clean water, and emerging as a permanent drought-tolerant source of water.
- Numerous byproduct applications are becoming common, including uses such as electricity generation, irrigation of salt-tolerant species, extraction of metals, etc.

DEFINITION

More than 780 million people still lack access to safe water.[51] With a growing gap between water supply and demand, desalination has become a go-to solution. It involves removing salt from seawater and has become especially popular in the Middle East region, with some nations relying on it to meet up to 90% of their drinking water needs.[48] With advancements in desalination technology and breakthroughs in the energy industry, devices that can perform large-scale desalination economically will become ubiquitous. The price of water generated with desalination will decrease substantially.

CONSEQUENCES

- Desalination plants discharge hypersaline brine, creating unoxygenated dead zones for marine life.[53]
- If the current energy-intensive process continues, it will put more pressure on diminishing fossil fuels. As a result, the cost of energy may go up.
- Even though organizations are developing technologies to reduce the conversion cost for water desalination, poorer countries may not be able to make the required investment.

DISRUPTION COMBINATIONS

Gartner Futures Lab

When disruptions converge, the whole is more than the sum of its parts — one example is the triple squeeze of inflation, supply chain turmoil and labor challenges, which all impose constraints on companies trying to negotiate economic fragility.

What could come next? Assume adoption of hyperloop transit and hypersonic flight technology at the same time as adoption of metaverse technology. Each disruption offers potential. But together they might trigger a mobility divide.

Rich people get to use hypertransport; poor people connect virtually in the metaverse.

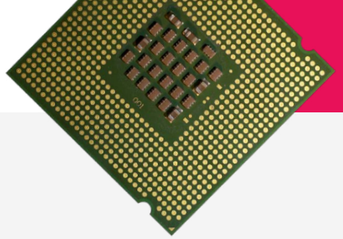
Here is a set of combinations that let you see how interacting disruptions can play out.

SYNERGISTIC

Examples of synergistic combinations, in which the **sum is bigger** than the parts:

Mobile nuclear reactors	+	Cost of space transport decreasing	=	Further decreases in cost (e.g., new types of vessels become possible and cost-efficient).		
Cost of space transport decreasing	+	Hypersonic flight commercially available	=	Space technology being reused for travel between points on Earth.		
Tax on non-childrearing	+	Super-seeds	+	Breaking the 125-year age ceiling	=	Potentially combustible combination where the global population grows significantly.

ANTAGONISTIC



Examples of antagonistic combinations, in which the **sum is smaller** than the parts:

Personhood for AI	+	Brain-computer interfaces	=	Ramifications in terms of liability, ownership, etc., for the connected brain-machine entity if two "persons" are connected.
Dual international order	+	Tax on non-childrearing	=	Continued declining population growth may incite countries to tax nonchildrearing, as well as to close their borders, so they do not lose human capital. This may prevent a free movement of people within the blocs of a dual international order.

DISRUPTION COMBINATIONS

Disruptions should not be analyzed in isolation. Different patterns may emerge if two or more disruptions take place around the same time. These combinations can take different forms: synergistic, antagonistic, acceleratory and deceleratory. Gartner Futures Lab has provided examples of each.

Gartner Futures Lab

DISRUPTION COMBINATIONS

ACCELERATORY

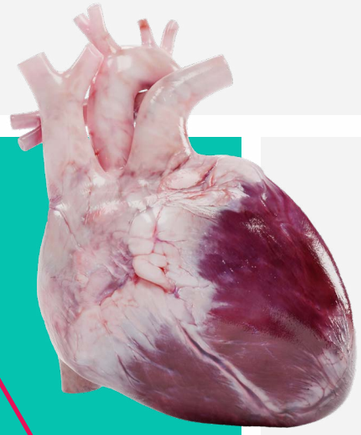
Examples of acceleratory combinations, in which disruptions are **sped up** by the others:

Lab-grown organ transplants	+	Human longevity	=	Solving the scarcity of organ transplants would increase the chances of helping humans pass the current, seemingly unpassable ceiling of a 125-year life span.
Geomagnetic storm	+	Space junk cascade	=	A storm could trigger a larger cascade of space junk.
Pay transparency	+	Global mobility	=	As the market globalizes for physical work, this will put additional pressure on pay transparency demands.

DECELERATORY

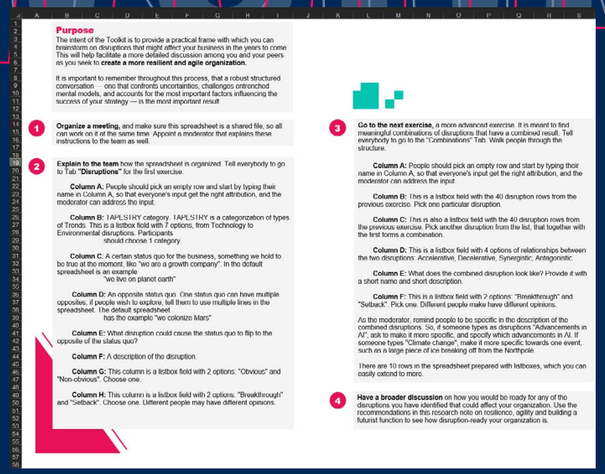
Examples of deceleratory combinations, in which disruptions are **slowed down** by the others:

Large-scale desalination	+	Mass migrations due to climate change	=	With mass migrations being triggered in part by a lack of water, large-scale, cost-efficient desalination could alleviate some of this need.
Space junk cascade	+	Lower cost of space transport	=	Major setback and potential barrier to space transport really taking off.



Gartner Futures Lab

WORKSHOP



Purpose

The intent of the Toolkit is to provide a practical frame with which you can brainstorm on disruptions that might affect your business in the years to come. This will help facilitate a more detailed discussion among you and your peers as you seek to **create a more resilient and agile organization.**

It is important to remember throughout this process, that a robust structured conversation — one that confronts uncertainties, challenges entrenched mental models, and accounts for the most important factors influencing the success of your strategy — is the most important result.

1. **Organize a meeting,** and make sure this spreadsheet is a shared file, so all can work on it at the same time. Appoint a moderator that explains these instructions to the team as well.

2. **Explain to the team** how the spreadsheet is organized. Tell everybody to go to Tab **"Disruptions"** for the first exercise.

   Column A: People should pick an empty row and start by typing their name in Column A, so that everyone's input get the right attribution, and the moderator can address the input.

   Column B: TAPESTRY category. TAPESTRY is a categorization of types of Trends. This is a listbox field with 7 options, from Technology to Environmental disruptions. Participants should choose 1 category

   Column C: A certain status quo for the business, something we hold to be true at the moment, like "we are a growth company". In the default spreadsheet is an example "we live on planet earth"

   Column D: An opposite status quo. One status quo can have multiple opposites, if people wish to explore, tell them to use multiple lines in the spreadsheet. The default spreadsheet has the example "we colonize Mars"

   Column E: What disruption could cause the status quo to flip to the opposite of the status quo?

   Column F: A description of the disruption.

   Column G: This column is a listbox field with 2 options: "Obvious" and "Non-obvious". Choose one.

   Column H: This column is a listbox field with 2 options, "Breakthrough" and "Setback". Choose one. Different people may have different opinions.

3. **Go to the next exercise,** a more advanced exercise. It is meant to find meaningful combinations of disruptions that have a combined result. Tell everybody to go to the "Combinations" Tab. Walk people through the structure:

   Column A: People should pick an empty row and start by typing their name in Column A, so that everyone's input get the right attribution, and the moderator can address the input.

   Column B: This is a listbox field with the 40 disruption rows from the previous exercise. Pick one particular disruption.

   Column C: This is also a listbox field with the 40 disruption rows from the previous exercise. Pick another disruption from the list, that together with the first forms a combination.

   Column D: This is a listbox field with 4 options of relationships between the two disruptions: Accelerative, Decelerative, Synergistic, Antagonistic

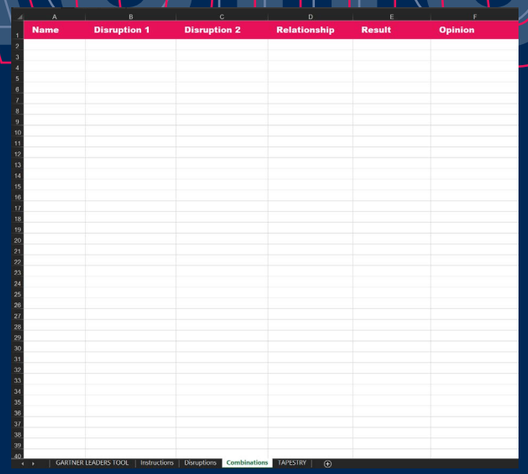
   Column E: What does the combined disruption look like? Provide it with a short name and short description.

   Column F: This is a listbox field with 2 options: "Breakthrough" and "Setback". Pick one. Different people make have different opinions.

   As the moderator, remind people to be specific in the description of the combined disruptions. So, if someone types as disruptions "Advancements in AI", ask to make it more specific, and specify which advancements in AI. If someone types "Climate change", make it more specific towards one event, such as a large piece of ice breaking off from the Northpole

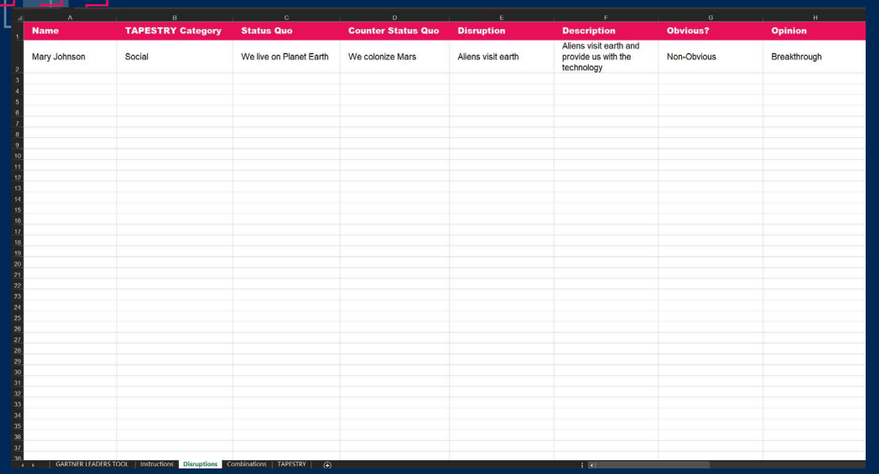
   There are 10 rows in the spreadsheet prepared with listboxes, which you can easily extend to more.

4. **Have a broader discussion** on how you would be ready for any of the disruptions you have identified that could affect your organization. Use the recommendations in this research note on resilience, agility and building a futurist function to see how disruption-ready your organization is.



Name	Disruption 1	Disruption 2	Relationship	Result	Opinion

GARTNER LEADERS TOOL | Instructions | Disruptions | Combinations | TAPESTRY



Name	TAPESTRY Category	Status Quo	Counter Status Quo	Disruption	Description	Obvious?	Opinion
Mary Johnson	Social	We live on Planet Earth	We colonize Mars	Aliens visit earth	Aliens visit earth and provide us with the technology	Non-Obvious	Breakthrough

GARTNER LEADERS TOOL | Instructions | Disruptions | Combinations | TAPESTRY

This Toolkit provides a practical frame you can use to brainstorm disruptions that might affect your business in the years to come. This will facilitate a more detailed discussion among you and your peers as you seek to create a more resilient and agile organization.

A robust, structured conversation – one that confronts uncertainties, challenges entrenched mental models and accounts for the most important factors influencing the success of your strategy – is the most important result.

WORKSHOP

SOURCES

[1] NASA's Dart Mission Hits Asteroid in First-Ever Planetary Defense Test, NASA

[2] Chaos Monkey, GitHub

[3] Our Brain Typically Overlooks This Brilliant Problem-Solving Strategy, Scientific American

[4] Apple and Google Partner on COVID-19 Contact Tracing Technology, Apple

[5] World Uncertainty Index (WUI): Global, World Uncertainty Index

[6] People in Advanced Economies Say Their Society Is More Divided Than Before Pandemic, Pew Research Center

[7] State of the Global Climate 2021, World Meteorological Organization

[8] Survey Highlights Backlash to Increasingly Political Corporate America, ProMarket

[9] Are "Decentralized Autonomous Organizations' the Business Structures of the Future?, World Economic Forum

[10] This "Crypto Winter" Is Unlike Any Downturn in the History of Digital Currencies. Here's Why, CNBC

[11] Researchers Use Lasers and Molecular Tethers to Create Perfectly Patterned Platforms for Tissue Engineering, University of Washington

[12] Human Organoids: Model Systems for Human Biology and Medicine, NLM

[13] Organ Donation Statistics, HRSA

[14] How 3D-Printed Organs Could Save the Lives of Transplant Patients, World Economic Forum

[15] Canada's Hyperloop Dream Gets $550m Capital Injection, PlaceTech

[16] SpaceX Snags $102 Million Contract to Rocket Military Supplies and Humanitarian Aid Around the World: Report, Space.com

[17] A 20-Seat Hypersonic Plane Is Being Built in Atlanta, Freethink

[18] Stratolaunch Reveals Its First Hypersonic Design for High-Altitude Flights, Space.com

[19] Algeria's Application to Join BRICS Shows the Group's Attractiveness, The Global Times

[20] EU Trade Relations With Morocco. Facts, Figures and Latest Developments, The European Commission

[21] IAEA Increases Projections for Nuclear Power Use in 2050, International Atomic Energy Agency (IAEA)

[22] Fusion Energy Breakthrough by U.S. Scientists Boosts Clean Power Hopes, Financial Times

[23] One Degree of Global Warming Causes a ~50% Increase in Population Displacement Risk, PreventionWeb

[24] Startup Says It's Honing in on a Way to Reverse Aging, Futurism

[25] Scientists Successfully Reverse Premature Aging, SciTech Daily

[26] Humans Could Live Up to 150 Years, New Research Suggests, Scientific American

[27] Has The Human Life Span Hit The Ceiling?, National Public Radio (NPR)

[28] Brave New Worlds: Tapestry of Trends 2022, Gartner Futures Lab

[29] Hunger and Undernourishment, Our World in Data

[30] Global Issues: Population, United Nations

[31] What Does the Global Decline of the Fertility Rate Look Like?, World Economic Forum

[32] Fertility Rate: "Jaw-Dropping" Global Crash in Children Being Born, BBC

[33] The 2022 Gartner Pay Equity and Transparency HR Leader Survey

[34] 2022 Gartner Total Rewards Pay Equity and Transparency Employee Survey

[35] Synchron Announces First Direct-Thought Tweet, "Hello World," Using an Implantable Brain Computer Interface, Business Wire

[36] Generalizable Spelling Using a Speech Neuroprosthesis in an Individual With Severe Limb and Vocal Paralysis, Nature Communications

[37] Open Letter To The European Commission Artificial Intelligence and Robotics, Robotics Open Letter Addressed to European Commission

[38] Google Fires Engineer Who Contended Its AI Technology Was Sentient, CNN Business

[39] We Asked GPT-3 to Write an Academic Paper about Itself — Then We Tried to Get It Published, Scientific American

[40] Jobs Lost, Jobs Gained: What the Future of Work Will Mean for Jobs, Skills and Wages, McKinsey & Company

[41] The Carrington Event: History's Greatest Solar Storm, Space.com

[42] The Great Geomagnetic Storm of May 1921, Space Weather Archive

[43] Solar Storms Can Destroy Satellites With Ease — A Space Weather Expert Explains the Science, Space.com

[44] Hello Solar Cycle 25, National Weather Service

[45] What Are Solar Flares?, The European Space Agency

[46] What Is Space Junk And Why Is It a Problem?, National History Museum

[47] FCC Authorizes SpaceX to Begin Deploying up to 7,500 Next-Generation Starlink Satellites, CNBC

[48] The International Space Station Had to Move to Dodge Space Junk, National Public Radio (NPR)

[49] How Technology and Entrepreneurship Can Quench Our Parched World, World Economic Forum

[50] Cost Effective Desalination: Innovation Continues to Lower Desalination Costs, ResearchGate

[51] Low-Income Communities Lack Access to Clean Water. It's Time for Change, World Economic Forum

[52] How 1,500 Nuclear-Powered Water Desalination Plants Could Save the World From Desertification, Forbes

[53] The State of Desalination and Brine Production: A Global Outlook, Elsevier

GARTNER FUTURES LAB

Dan Berman
Frank Buytendijk
Chris Howard
Lizzy Foo Kune
Kelly McCarron
Daryl Plummer
Marty Resnick

CONTRIBUTORS

Amy Abatangle
Dave Aron
Kartik Deo
Howard Dodd
Andrew Frank
Zach Ginsburg
Bradford Grossman
Markus Hofbauer
Mark Horvath
Annika Jessen
Koray Kose
Jorge Lopez
John-David Lovelock
Anshul Maheshwari
Ewan McIntyre
Emily Rose McRae
Malcolm Murray
Judy Pasternak
David Pidsley
Emily Potosky
Ritesh Prasad
Chris Redfearn-Murray
Peter Skyttegaard
Sanchay Tyagi
Roberta Witty

R&A STUDIO

Aaron Bynum
Katelyn Chiedi
Selena Granado-Kral
Steve Hennessey
Paige Howard
Bhagyanshi Pathak
Joab Phillips
Tara Starner-Corrow

GARTNER FUTURE DIRECTIONS

Gartner®