



**"At odd and unpredictable times,
we cling in fright to the past."**

ISAAC ASIMOV
Science fiction writer



EMBRACING THE UNKNOWN

MAKING SENSE OF A BRAVE NEW WORLD



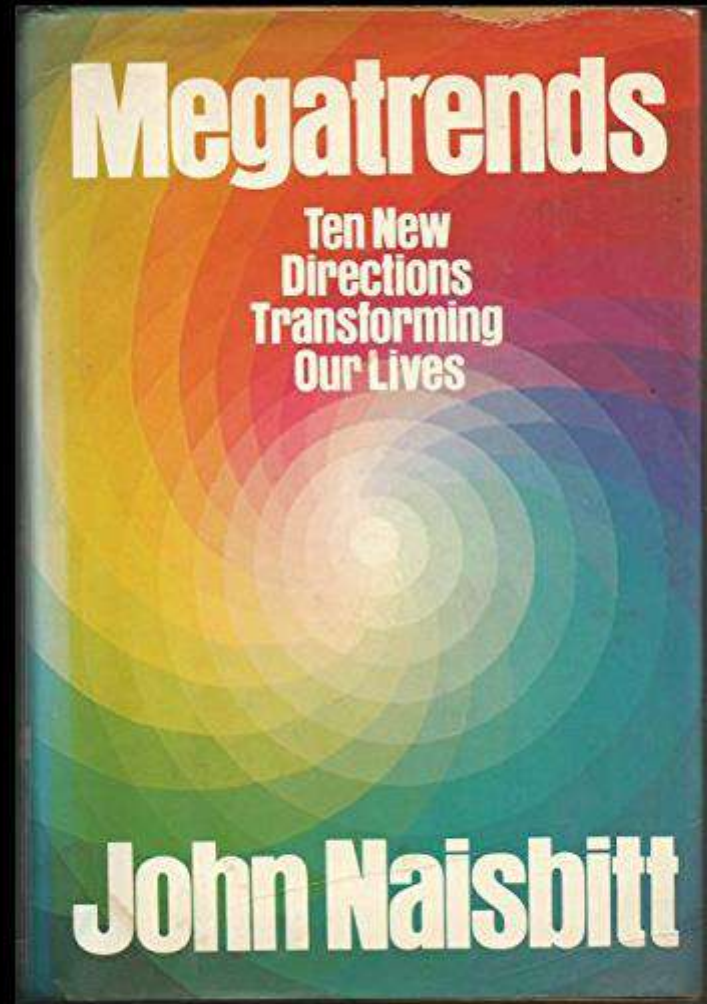
Trendspotting for the decades ahead

Using

Known Knowns to understand

Known Unknowns and be prepared for

Unknown Unknowns



"The Beatles have no future in show business"

A Deca Records executive told the band's manager, Brian Epstein, in 1962

"There's no chance that the iPhone is going to get any significant market share."

Steve Ballmer in 2007

Trend
Compendium

2050

Six megatrends
that will shape the world



June 2023

The Roland Berger Trend Compendium 2050 focuses on stable, long-term developments ...

- > The **Roland Berger Trend Compendium 2050** is a global trend study compiled by **Roland Berger Institute (RBI)**, the think tank of Roland Berger. Our Trend Compendium 2050 describes the **most important megatrends** shaping the world between **now and 2050**
- > Our **trend views are based on expert sources and assessments**. Estimates reflect the normal case, i.e. a stable development of the global economy in the long term
- > To incorporate today's uncertainties into strategic planning, we recommend **combining the megatrends of the Roland Berger Trend Compendium 2050** with the **Roland Berger scenario planning approach**



2050

The graphic features the year '2050' in a large, bold, blue font. Below the text, there are several stylized, upward-pointing arrows in a light green color, suggesting growth and progress. The arrows are of varying heights and are positioned behind the text, creating a sense of depth and movement.

Is it worth dealing with megatrends when globally impactful events such as the COVID-19 pandemic or the war in Ukraine are taking place?

Of course! The coronavirus pandemic and the war in Ukraine have far-reaching consequences and deeply affected people, economies and politics but neither event has derailed the megatrends analyzed herein; such is the inherent nature of megatrends: climate change, societal aging, or technological innovations do not lose their momentum, their direction or their importance. To cope with such challenges and to master resulting opportunities, our awareness and our understanding of megatrends is vital – not least to develop sustainable answers

... and covers six megatrends that shape the future development of our world until 2050

1

People & Society



Population
—
Migration
—
Education & Labor
—
Values

2

Politics & Governance



Global Risks
—
Geopolitics
—
Future of Democracy

3

Environment & Resources



Climate Change & Pollution
—
Biodiversity
—
Resources & Raw Materials

4

Economics & Business



Global Trade & Value Chains
—
Power Shifts
—
Energy Transformation
—
Debt Challenge

5

Technology & Innovation



Value of Technology
—
Frontier Technologies
—
Humans & Machines

6

Health & Care



Global Health Challenges
—
Healthcare of the Future
—
Caregiving



Megatrend 5

Technology & Innovation



Technology investment and innovation capabilities remain key – AI promises vast future potential but raises concerns for human values

Subtrends of megatrend "Technology & Innovation"

1



Value of Innovation

2



Frontier Technologies

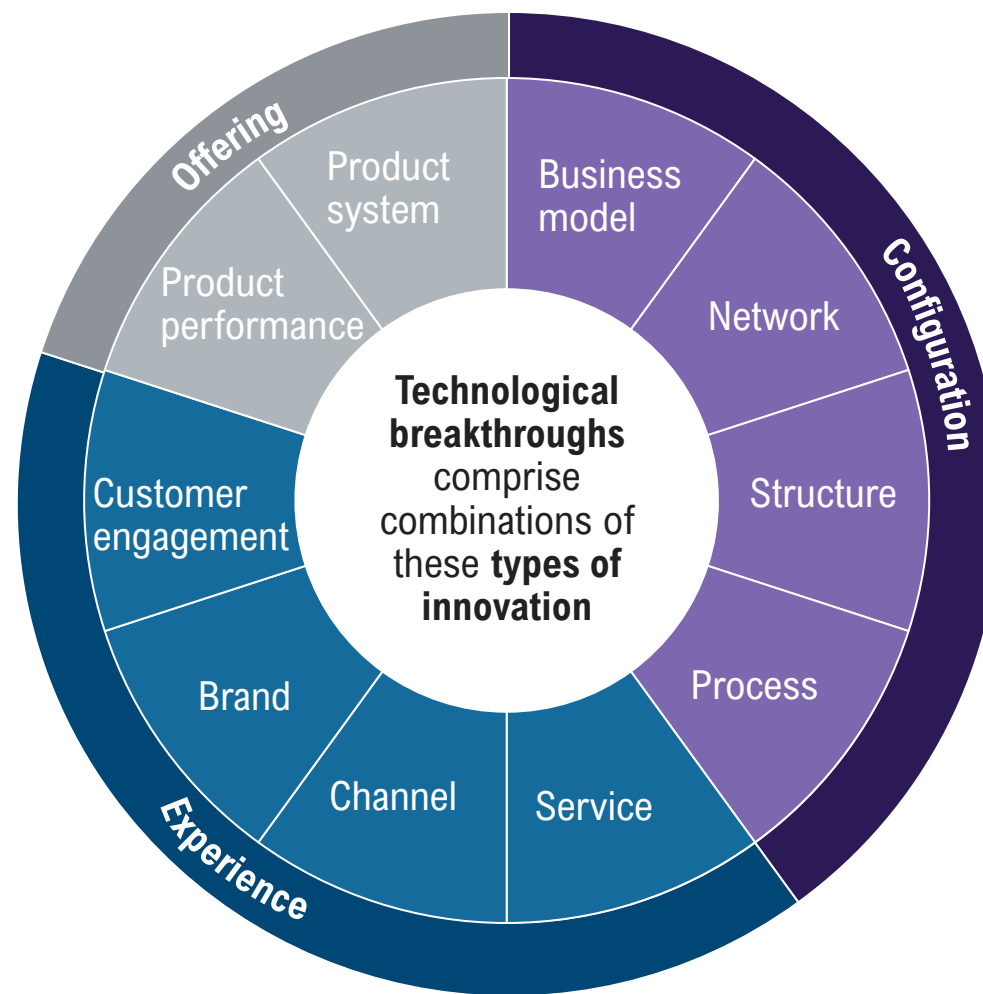
3



Humans & Machines

Innovation combines value adding inventions with successful market penetration and are categorized into different types

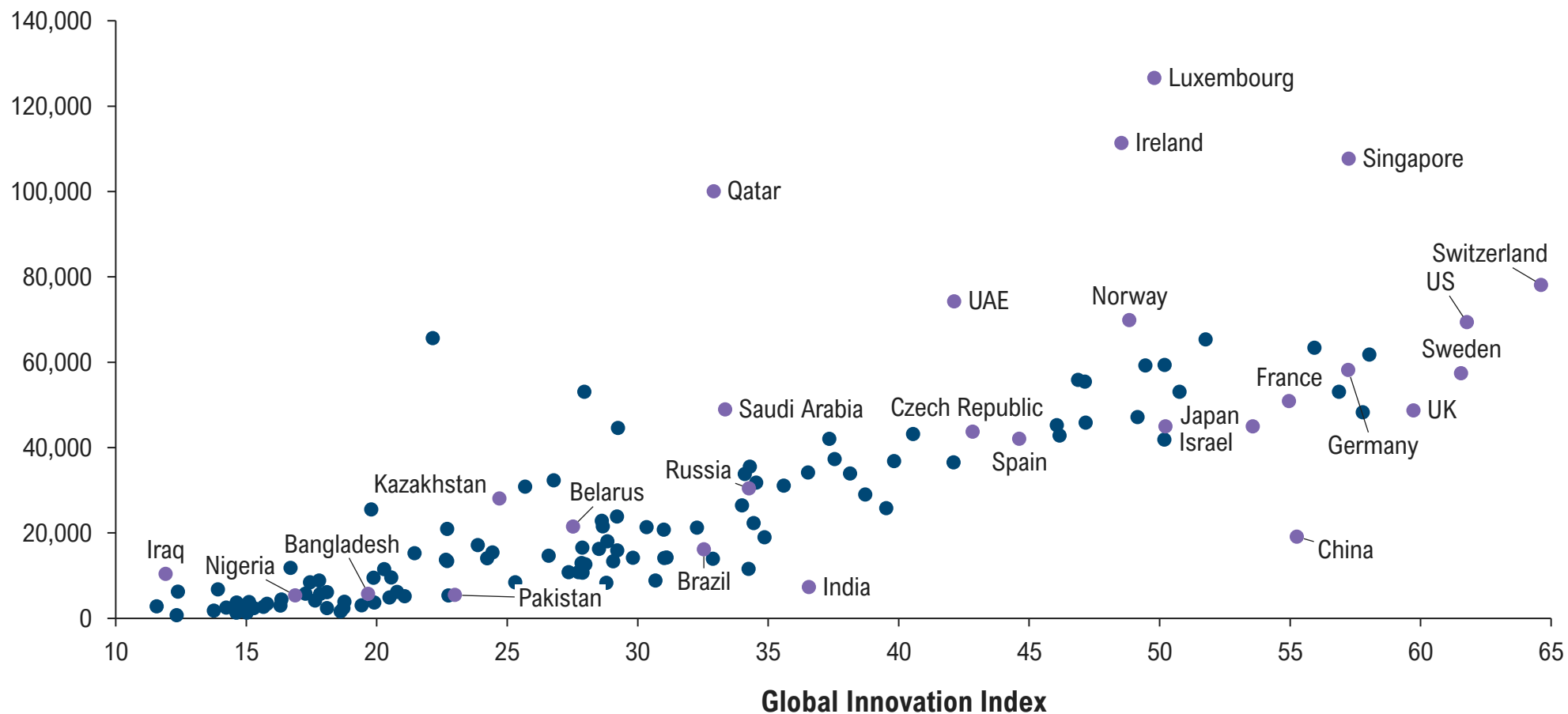
Types of innovation



Technology and innovation drive prosperity – Many developing countries lack abilities and access to catch up with developed countries

WIPO Global Innovation Index (GII) 2022 related to GDP per capita PPP in 2022 [Index, USD]

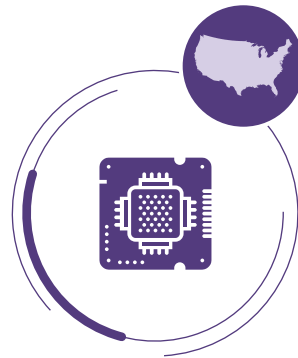
GDP per capita PPP [USD]



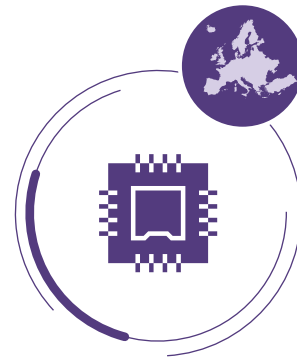
1) See BDI, Fraunhofer ISI, Roland Berger, ZEW: Innovationsindikator 2023
Sources: WIPO; World Bank; Roland Berger

Leading nations and global companies plan to invest heavily in technology – A particular focus concerns chipmakers

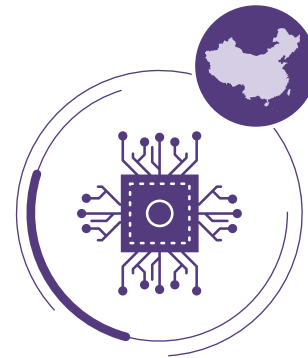
Selected investments in technology



US Chips & Science Act to invest **USD 248 billion** into semiconductors and R&D spending until 2026



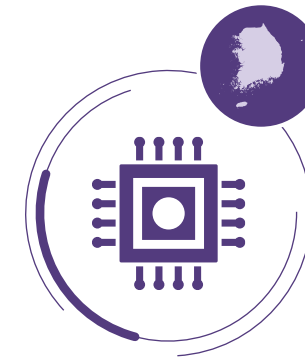
EU Chips Act mobilizes **EUR 43 billion** for research and semiconductor manufacturing by 2030



China is readying a **USD 143 billion** package for its **semiconductor industry** allocated over 5 years



Global IT investments in artificial intelligence to surpass **USD 300 billion** in 2026



Samsung to invest **USD 151 billion** until 2030 in its **chipmaking facilities**



Volkswagen intends to invest **USD 193 billion** in **EV and battery production** until 2028



5.1
Value of Innovation



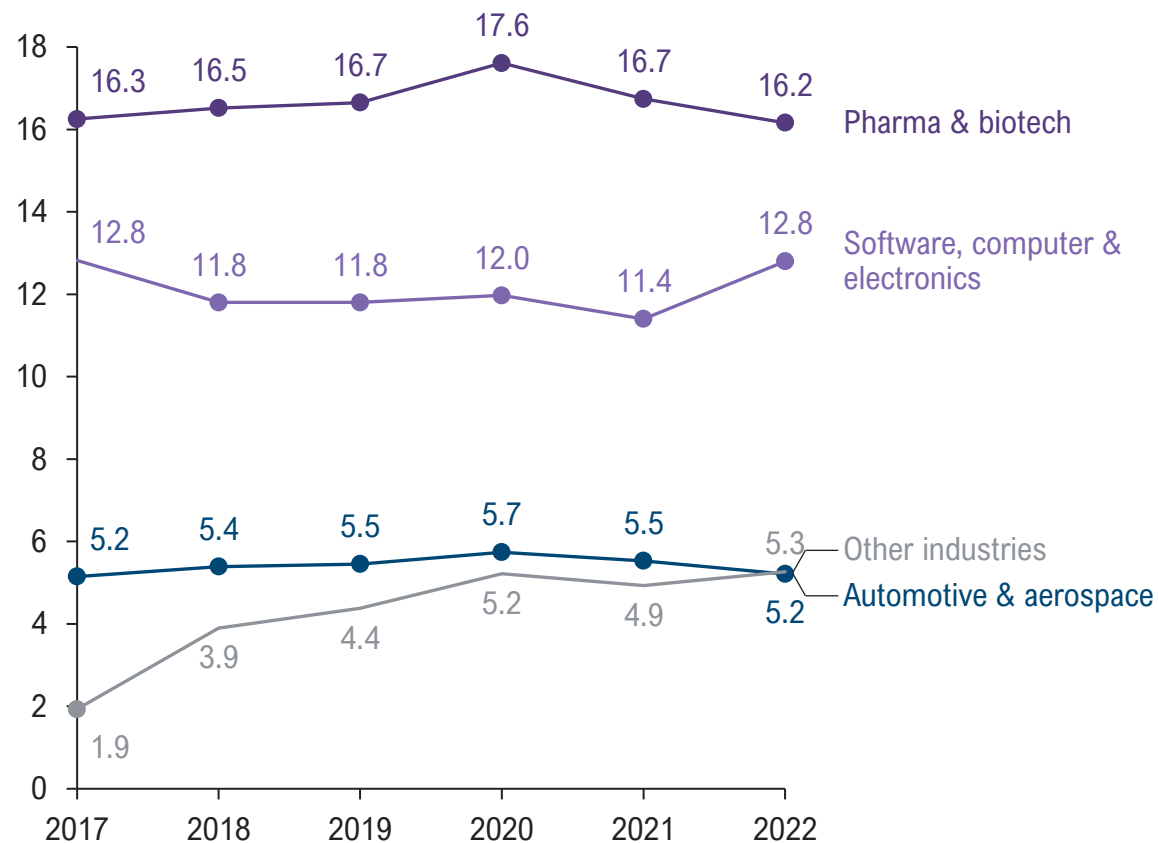
5.2
Frontier Technologies



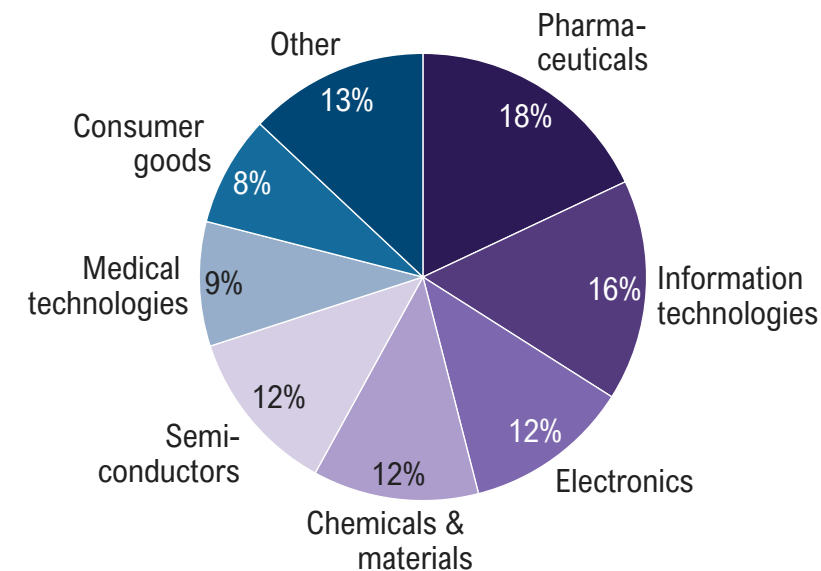
5.3
Humans & Machines

Pharma and Software account for the highest share of R&D expenditure relative to their revenue, thereby leading as most innovative sectors

R&D intensity by economic sector in companies from selected OECD countries^{1,2,3)} [%]



100 most innovative companies, globally, share by industry sector⁴⁾ [%]



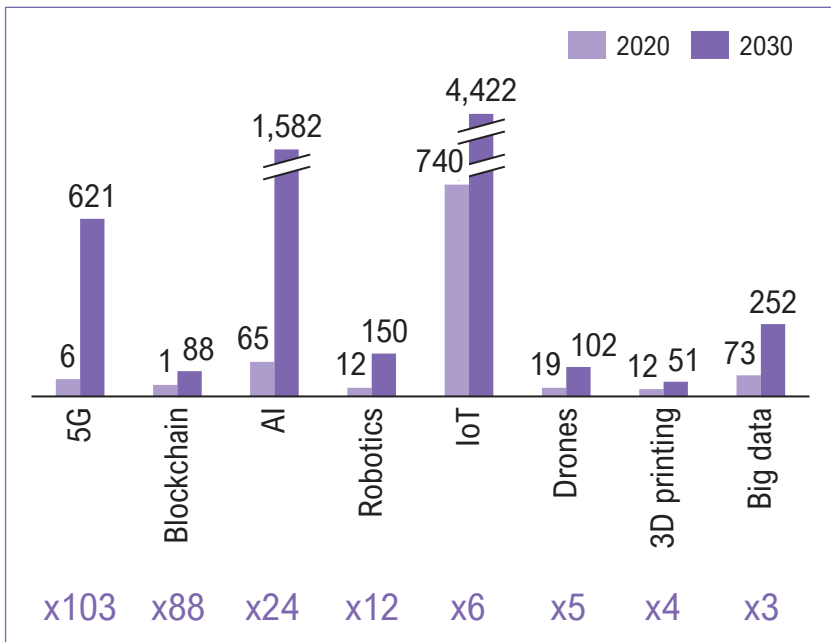
1) Adjusted for OECD inflation 2) The OECD database contains R&D expenditure taken from company reports for a sample of 60 companies across 14 countries, consisting of the 50 top R&D performers in the world featured in the 2020 EU Industrial R&D Investment Scoreboard, plus a selection of 10 other companies known as leaders in their sector 3) Defined as the share of R&D expenditures in the company's revenues 4) The Innovation Momentum Report by Lexis Nexis identifies the top 100 companies according to the size and quality of their patent portfolio

Sources: OECD SwiFTBeRD; LexisNexis IPS; Roland Berger

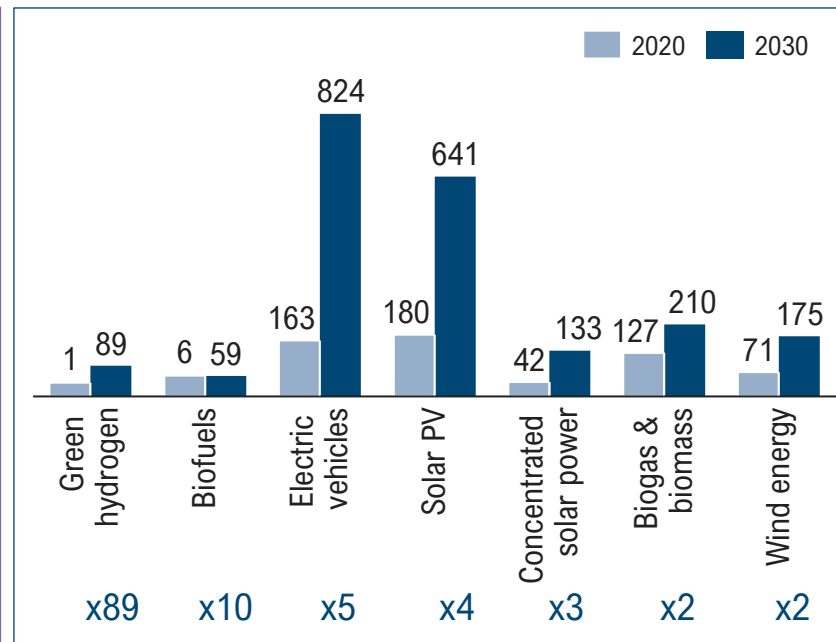
Today's frontier technologies are expected to experience considerable growth, maturing to a market value of USD 9.5 trillion by 2030

Global market size estimates of frontier technologies 2020 and 2030 [USD bn]

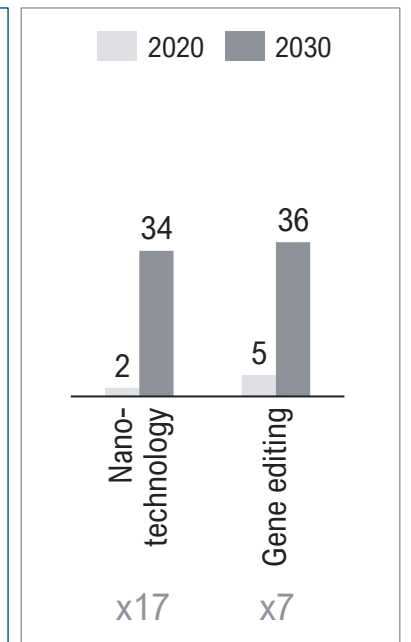
Industry 4.0 frontier technologies



Green & renewable energy frontier technologies

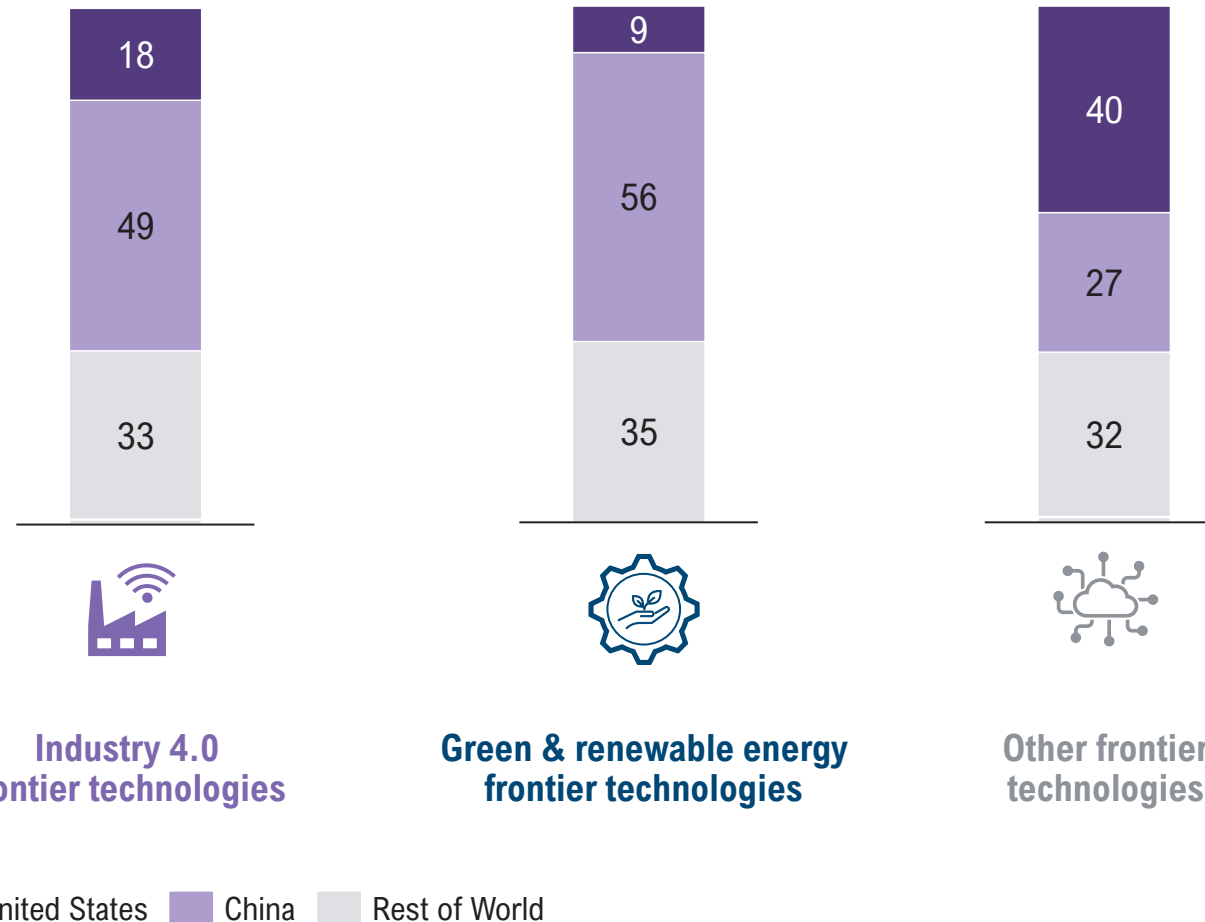


Other frontier technologies












China and the US are dominating the global landscape of frontier technology patents

Global country share of patents, by frontier technology 2000-2021 [%]



However, in terms of research for most of today's critical technologies, China is taking the academic lead

Countries and their position regarding critical fields of technology^{1,2)}

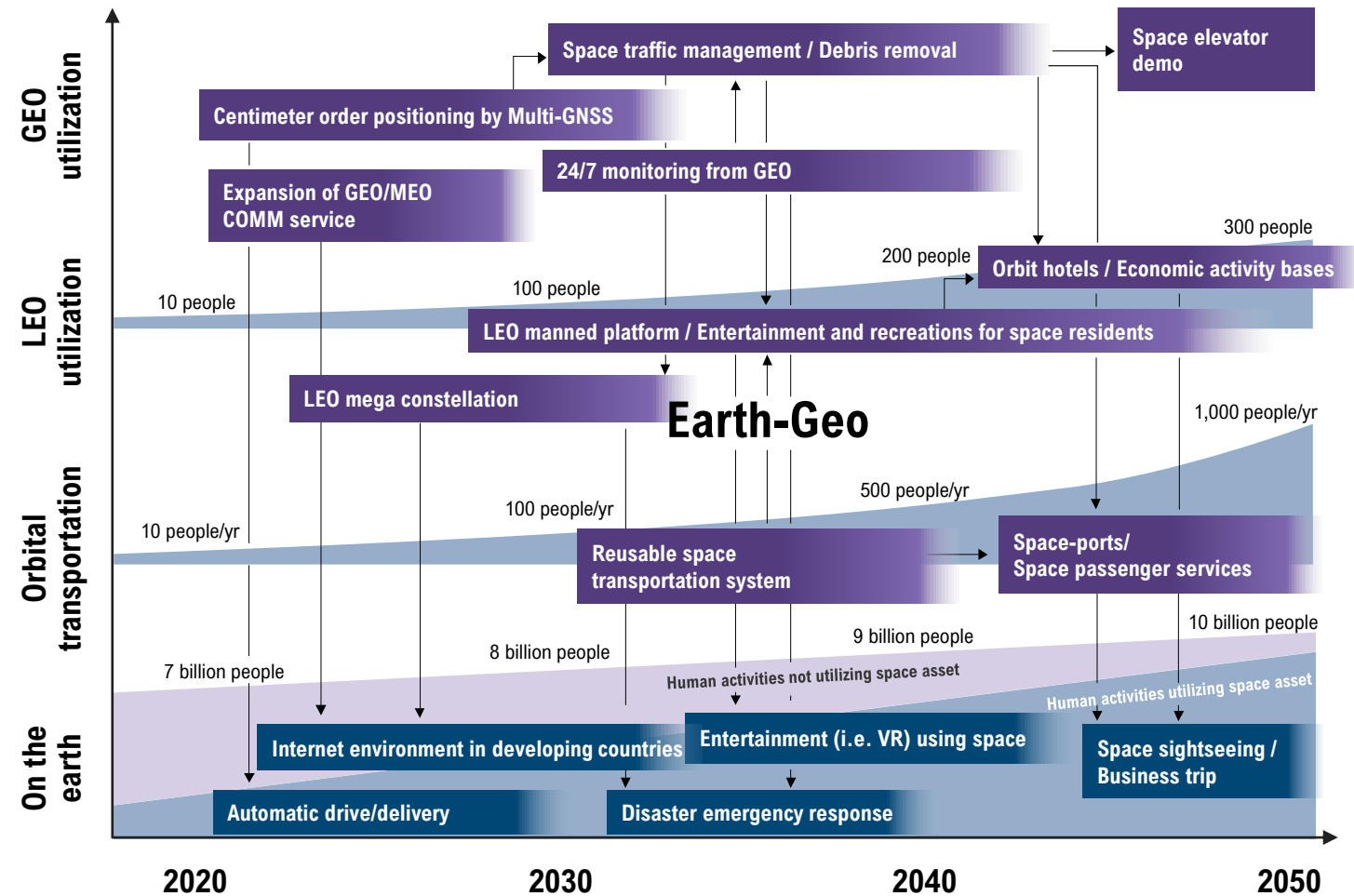
Field of technology	# of subsumed technologies				
		ranks 1 st	ranks 2 nd	ranks 1 st	ranks 2 nd
 Advanced materials & manufacturing	12	12/12	0/12	0/12	9/12
 AI, computing & communications	10	7/10	3/10	3/10	7/10
 Energy & environment	8	8/8	0/8	0/8	6/8
 Quantum	4	3/4	1/4	1/4	3/4
 Biotechnology, gene technology & vaccines	3	2/3	1/3	1/3	2/3
 Sensing, timing & navigation	1	1/1	0/1	0/1	1/1
 Defense, space, robotics & transportation	6	4/6	2/6	2/6	4/6
Total	44	37/44	7/44	7/44	32/44

1) Database queries identified the relevant set of papers for each technology (2.2 million in total); ranking based on the top 10% most highly cited research publications of the past five years on each of the 44 technologies; 2) Most recent data as of March 2023

Sources: ASPI; Roland Berger

Human activities utilizing space assets will see continuous growth to 2050 – Space activities depend on orbital distances to Earth and commercial appeal

Projected evolution of space activities up to geostationary orbit¹⁾



1) Orbit: refers to the curved path of a celestial object or spacecraft round a star, planet, or moon, especially a periodic elliptical revolution

Sources: Satellite Today; JSASS; Roland Berger

Artificial intelligence is seen as a powerful but also risky frontier technology – Experts expect human-level AI within next 100 years

2022 Expert Survey on Progress on AI

When will unaided machines be able to accomplish every task better and more cheaply than human workers?



90%
of experts

... expect – with a 50% chance – that unaided machines will perform better and more cheaply in every task than human workers within the next 100 years

80%
chance

... that the rate of global technological improvement will dramatically increase in the next 30 years as a result of existing high-level machine intelligence (HLMI)

5%
probability

... that the long-run effects of advanced AI on humanity will be "extremely bad", e.g. human extinction

We asked different AIs on their view of the future of AI – and got some interesting answers

What does the future of AI look like? Please answer in 3 sentences

Open AI

1. The future of AI looks incredibly promising, with continued advancements in machine learning, natural language processing, and computer vision
2. AI will become increasingly integrated into our daily lives, impacting everything from healthcare and transportation to entertainment and education
3. However, there are also concerns about the potential negative impacts of AI, including job displacement, privacy concerns, and bias in algorithms

AskBrian

1. The future of AI is exciting and full of potential
2. It promises to drastically improve the way we live and work by making tasks easier, faster, and more efficient
3. AI will be used in a wide range of applications, from healthcare to transportation, to create smarter and more efficient systems that can automate mundane tasks and allow us to focus on more important and meaningful work

Bard AI

1. The future of AI looks bright, with the potential to revolutionize many industries and aspects of our lives
2. AI is already being used to automate tasks, improve efficiency, and make better decisions
3. It is likely to continue to evolve and become even more powerful in the years to come

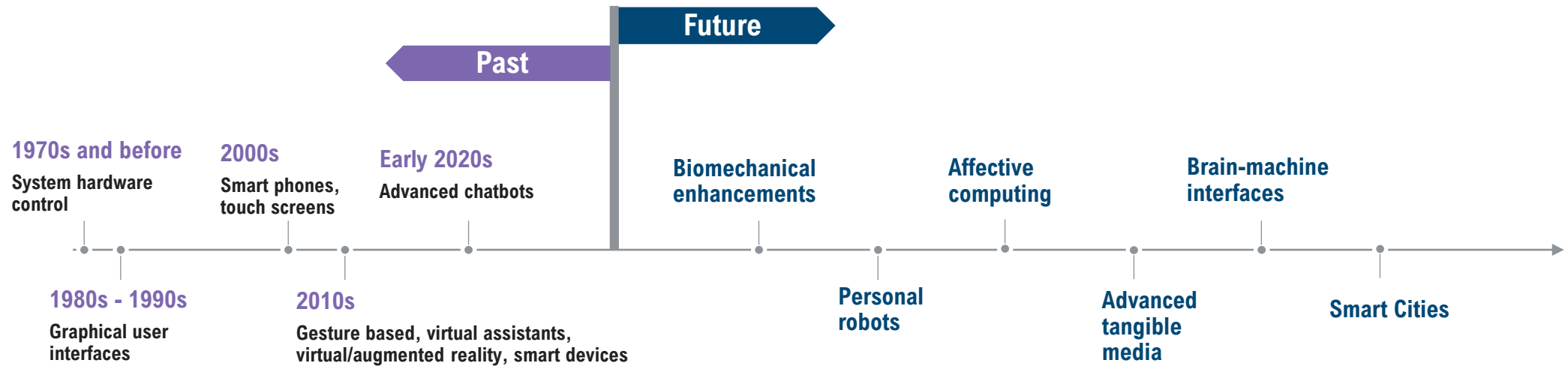


Did you know?

OpenAI's ChatGPT3.5 is one of the fastest adopted technologies, reaching 100 million users within 2 months after launch. By contrast, TikTok took 9 months to reach this milestone

New technologies affect the relationship of humans and machines – Having evolved greatly over past decades, more milestones lie ahead

Development of human-machine interaction



AI particularly touches the human-machine relationship – There is a broad debate about risks and opportunities of AI and how to cope with them ...

Selected expert views on AI

Sundar Pichai
CEO of Alphabet

"[AI is] more profound than fire, electricity or anything we have done in the past."

Bill Gates
Bill and Melinda Gates Foundation

"Just as the world needs its brightest people focused on its biggest problems, we will need to focus the world's best AIs on its biggest problems."

Tim Berners-Lee
Inventor of the World Wide Web

"As long as human beings remain firmly in control of assets in the physical world, it's going to be hard for a hostile AI to do too much damage."

Geoffrey Hinton
"Godfather 1 of AI"

"I think we should continue to develop it [AI] because it could do wonderful things. But we should put equal effort into mitigating or preventing the possible bad consequences."

Open Letter 2023
Future of Life Institute

"AI systems with human-competitive intelligence can pose profound risks to society and humanity (...). Advanced AI could represent a profound change in the history of life on Earth and should be planned for and managed with commensurate care and resources."

Several AI experts, Statement on AI Risk
Center for AI Safety

"Mitigating the risk of extinction from AI should be a global priority alongside other societal-scale risks such as pandemics and nuclear war."

Yoshua Bengio
"Godfather 2 of AI"

"If they [the AI systems] are smarter than us, then it's hard for us to stop these systems or to prevent damage."

Stuart Russell
Berkeley University

"The algorithms don't care what opinions you have. They just care that you're susceptible to stuff that they send. But of course, people do care."

Santiago Valderrama
Machine Learning engineer

"AI will not replace you. A person using AI will."

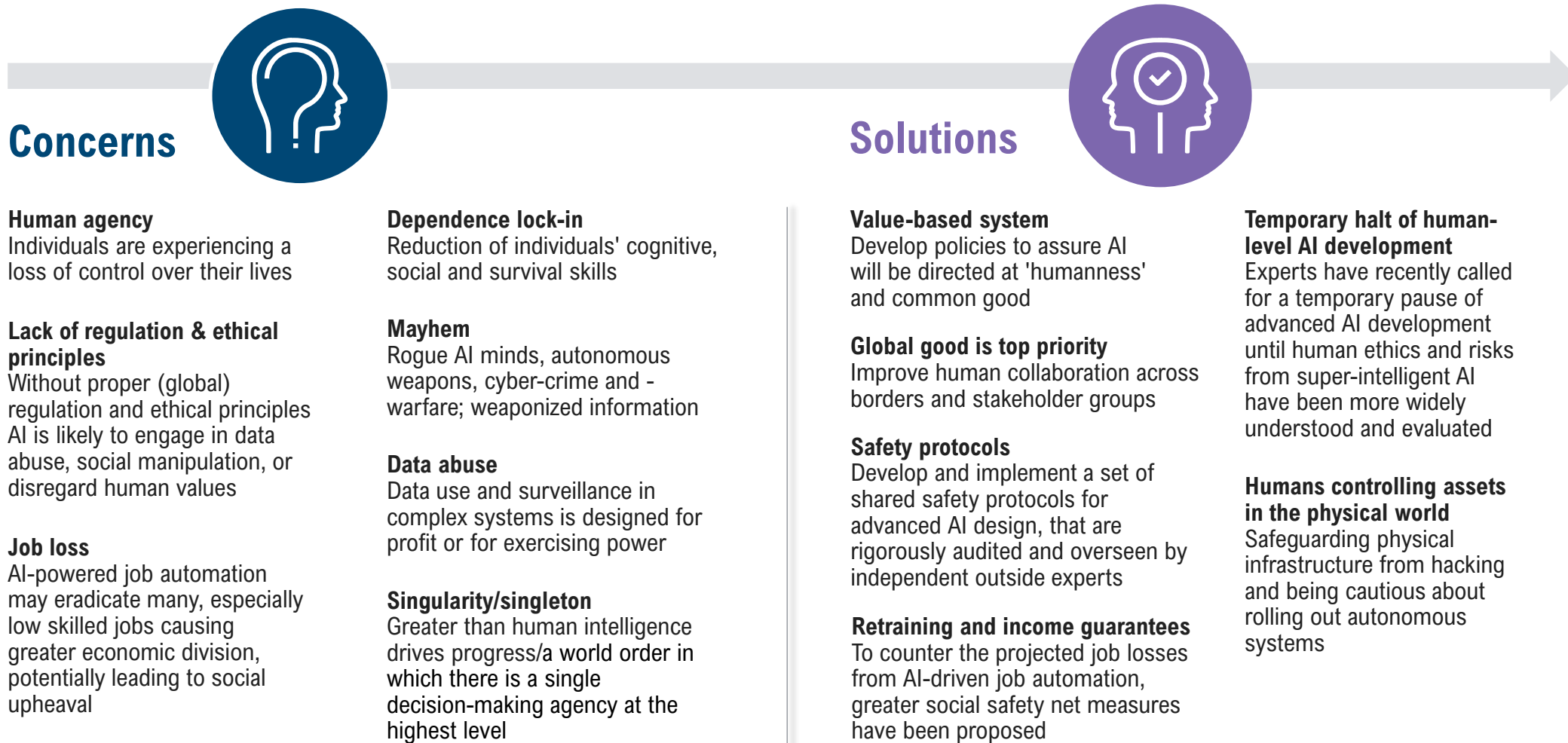
Nick Bostrom
Oxford University

"(...) consider a super intelligent agent that wanted to maximize the number of paperclips in existence (...). It might then want to eliminate humans to prevent us from switching it off. It might also want to use the atoms in our bodies to build more paperclips."



... which can be summed up in a set of concerns and possible solutions

AI and the future of humans – Selected concerns and solutions



- 1 People & Society
- 2 Politics & Governance
- 3 Environment & Resources
- 4 Economics & Business
- 5 **Technology & Innovation**
 - 5.1 Value of Innovation
 - 5.2 Frontier Technologies
 - 5.3 **Humans & Machines**
- 6 Health & Care

Roland
Berger

THINK:ACT

