A Glimse into the Digital Future

This is why strong digital skills in your boardroom becomes even more important during the next decade(s)

Thomas Kovsted
CEO IBM Denmark

How has IBM transformed in its 110+ year history?

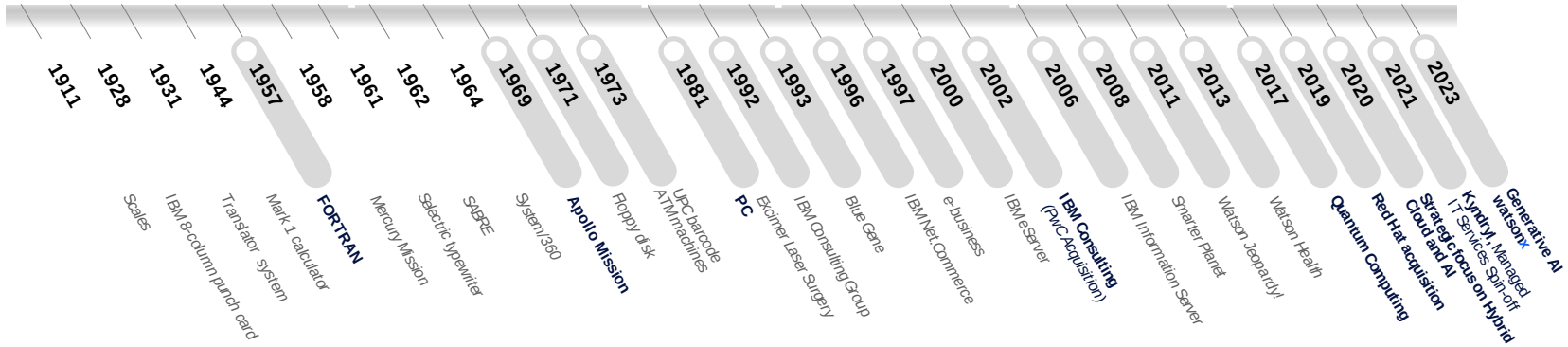
IBM has continued to evolve, transforming over decades, refocusing and integrating the latest technologies into our thinking and offerings, to provide greater value for our clients.

Our firsthand experience positions us well to lead clients in their transformation journeys and reduce risk by leveraging lessons learned from our own internal transformation.

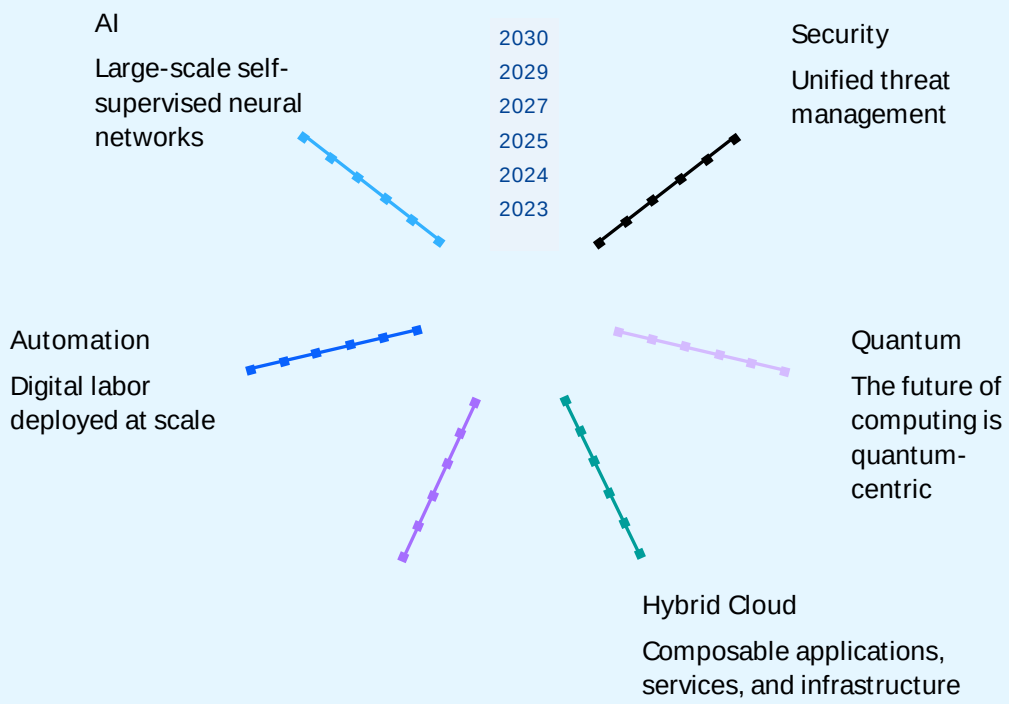
Throughout our history, we have transformed from a hardware-centric to a technology services-oriented company.

For the past 110+ years, IBM has continuously refocused– powering the evolution of business and society

If you roll back 100 years and look at the history of IBM, the one thing that is more remarkable than what we've done, is that we keep reinventing ourselves.



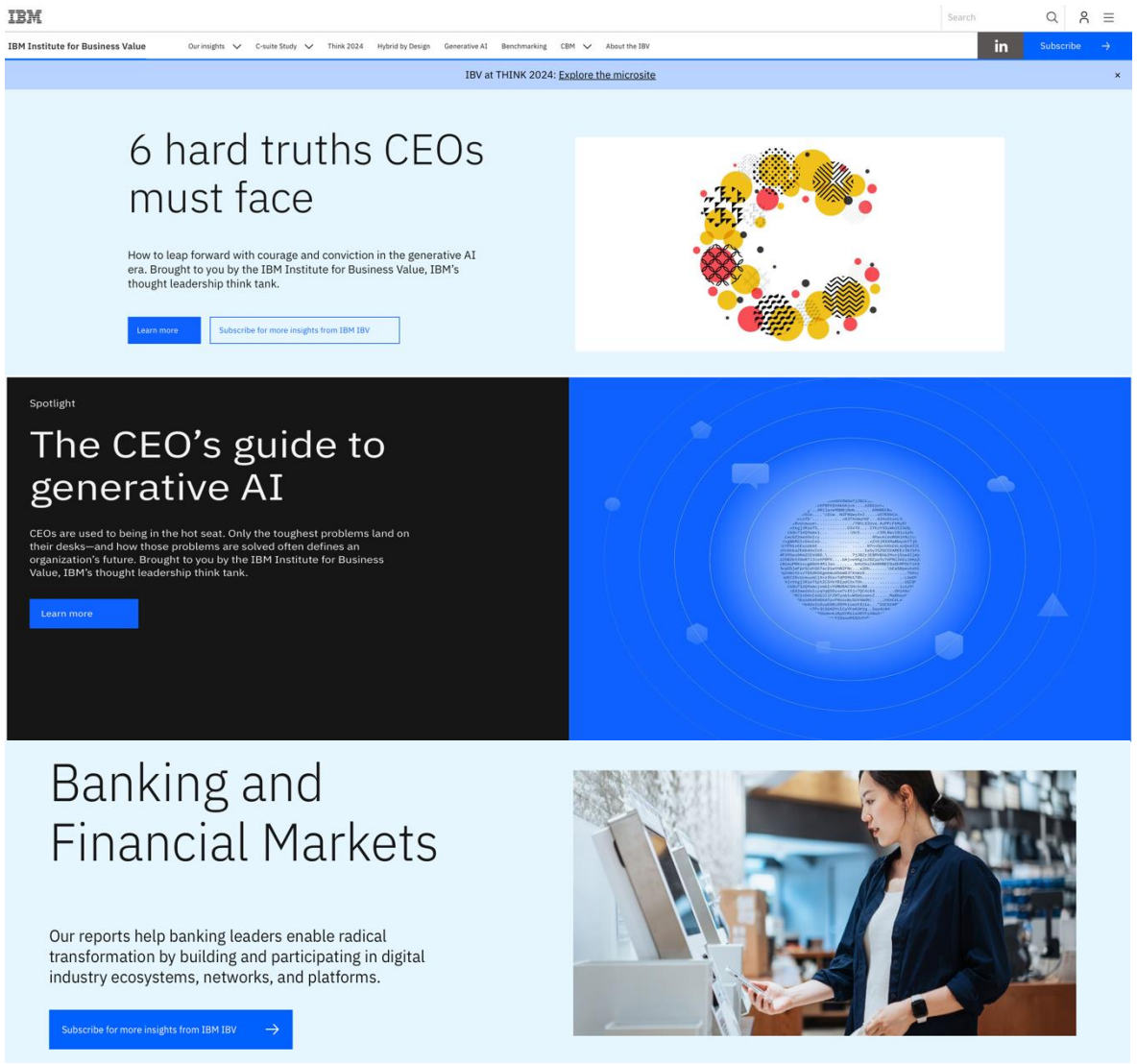
IBM Research & Technology Atlas



We are writing the next chapter in computing with six long-term technology roadmaps that will bring a new era of performance and efficiency to information technology and business.

https://www.ibm.com/roadmaps/

IBM Institute of Business Value



https://www.ibm.com/thought-leadership/institute-business-value/en-us

AGENDA

1. Explosion of Digital Data
2. The Future of AI
3. Entering the Quantum Decade

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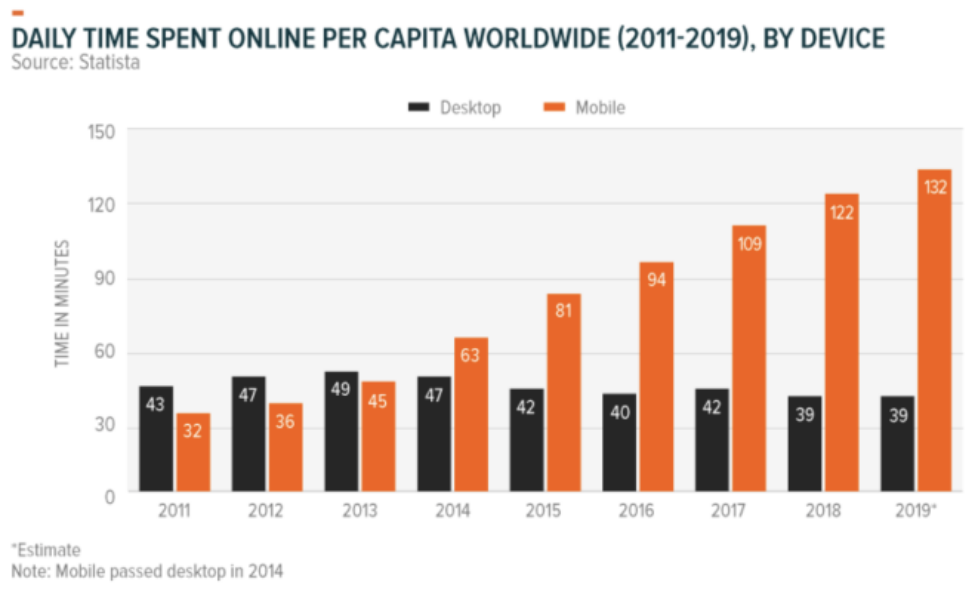
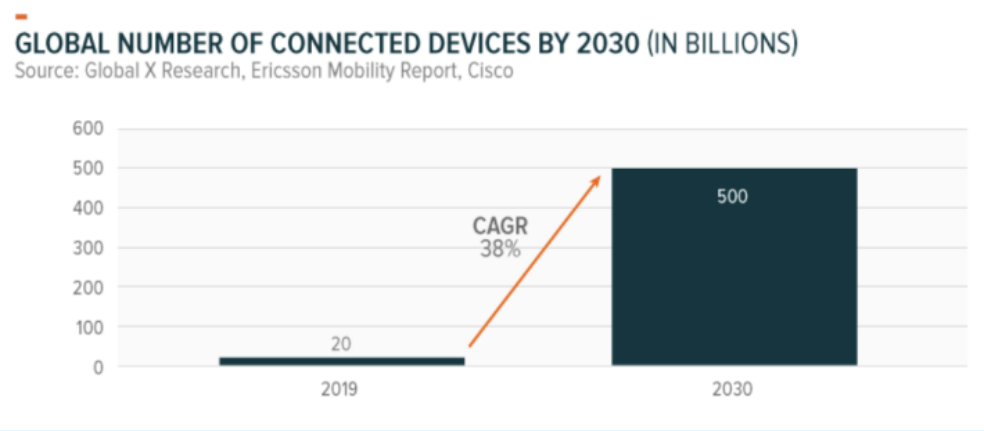
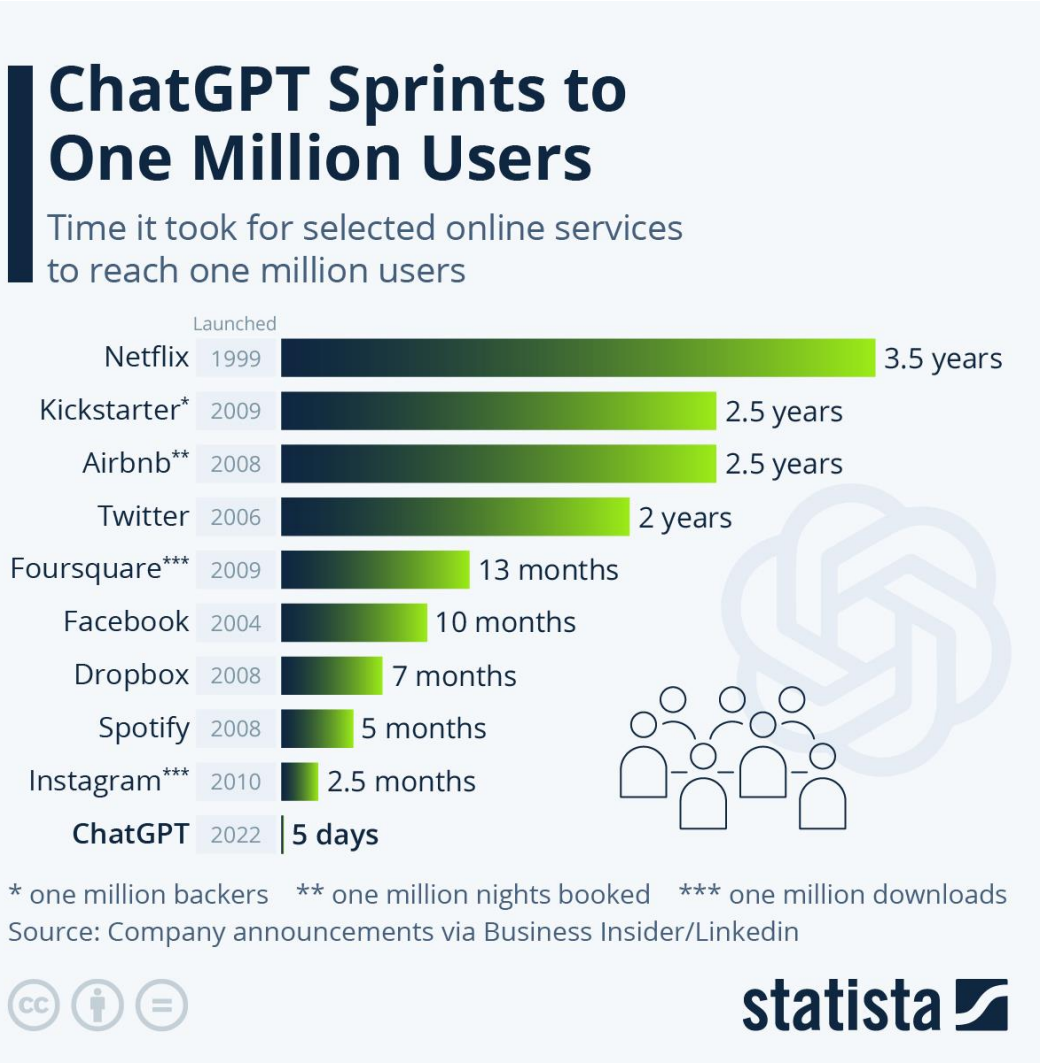
1. Explosion of Digital Data
2. The Future is an AI Economy
3. Entering the Quantum Decade

Todays Digital Reality

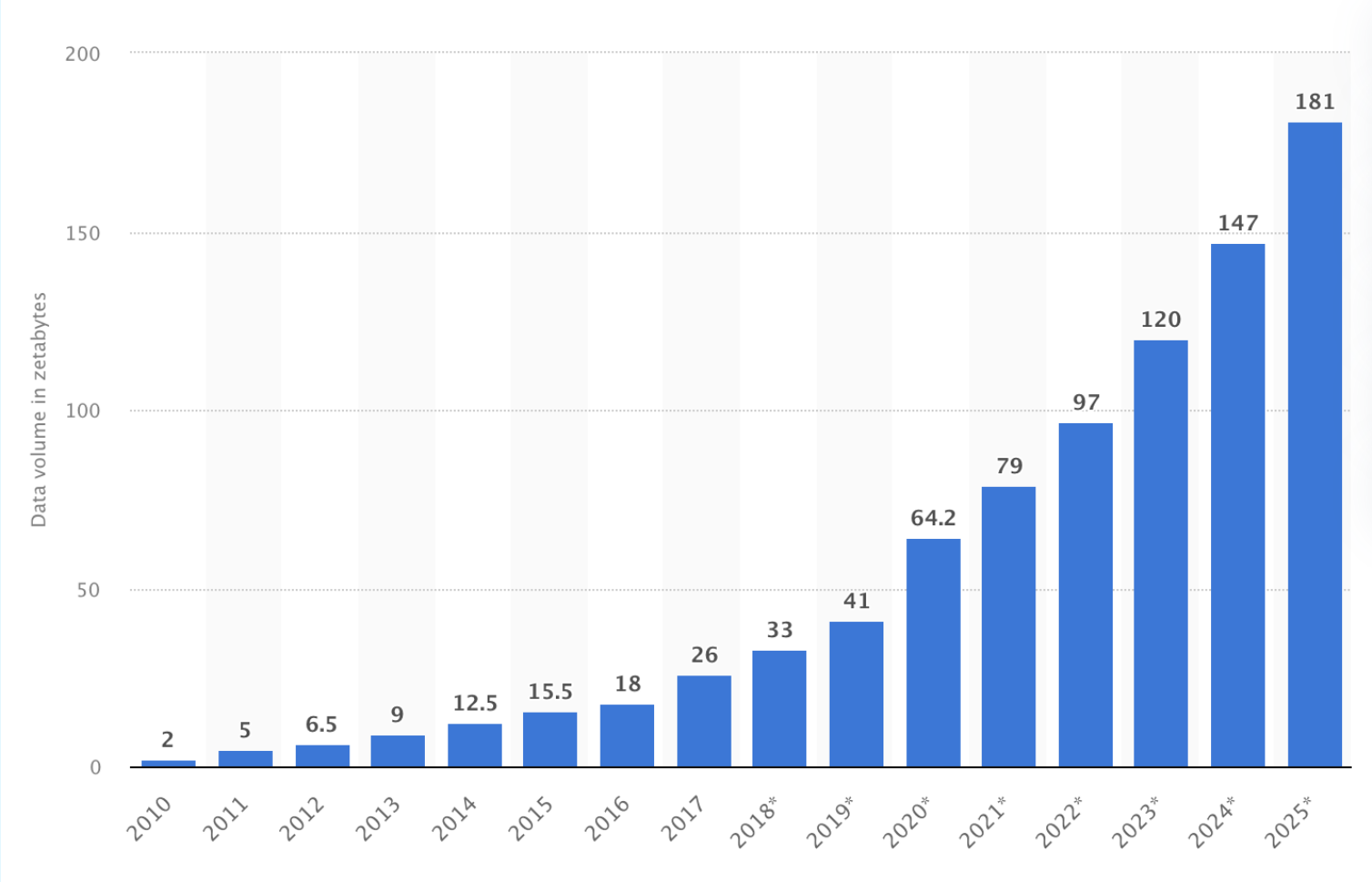






The World's Data Volume/The Data Explosion

- *"We expect the data universe to reach 660 zettabytes by 2030 – equivalent to 610 iPhones (128GB) per person".*
- *By 2025 50% of the worlds data is created at the edge*
- *"By 2050 we will have 50.000-500.000 Zettabytes, which is 1,000 - 10.000 times bigger than in 2020".*
- If you store 100 Zettabytes on a stack of CD-ROMs = 509,1 times the mean distance from the Earth to the moon.



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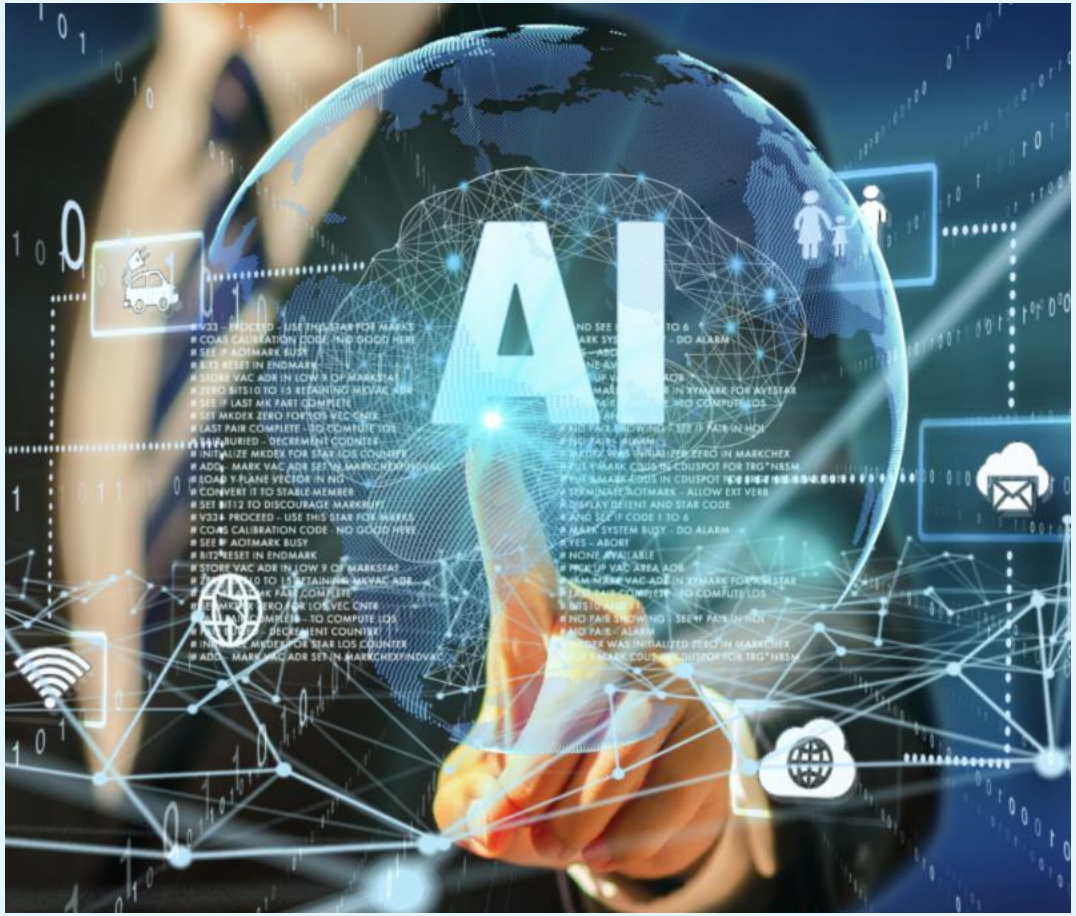


Think 2030

1. 1 trillion transistors on a single chip
2. AI models with trillions of parameters
3. Quantum systems represent 2^100

The future is already here - it’s just not evenly distributed

William Gibson

A Transformational Point in Aerospace History?

Taking drones to the next level?

Expected to be in general use by 2028

Test plane already outperforms skilled test pilots

AI will not replace managers but managers who use AI will replace those who don’t

2024

Adopt multi-modal foundation models in the hybrid enterprise. 5K pre-built & targeted models developed weekly

Build AI governance practice aligning to local & industry regulations.

2025

AI creator vs AI user
Everyone becomes an AI engineer. Release innovation power by democratizing employee access to AI for business.

Agentic AI, moves AI from reactive to proactive with minimal human oversight

AI Scaling
More flexible and energy efficient technology will make AI more affordable and “green”.

2028+

Introducing analog AI chips allow you to address growing data volumes & model complexity within same energy envelope.

Allow AI to be performed where data is born

We will build autonomous AI that can reliably and efficiently learn from its environment and respond to previously unseen situations

https://research.ibm.com/blog/analog-ai-chip-low-power

AI will not replace managers but managers who use AI will replace those who don’t

2030

Build empathic and intrinsically responsible AI agents.

Our AI agents will start to understand and adapt to human personality at both the individual and collective levels, thus enabling more natural and effective interactions. The systems empowered by these AI agents will exhibit the emergence of emotional intelligence.

2030+

Our AI models will be composed of modules with different cognitive abilities:

Perception, memory, emotion, reasoning, and action), enabling them to exhibit behavioural norms for social interactions and mutual theory of mind.

By being able to predict, act, plan, and adapt to new situations and environments, these unified neural architectures will enable a broad variety of use cases requiring effective human-machine collaboration.

AGI

Not an IBM statement

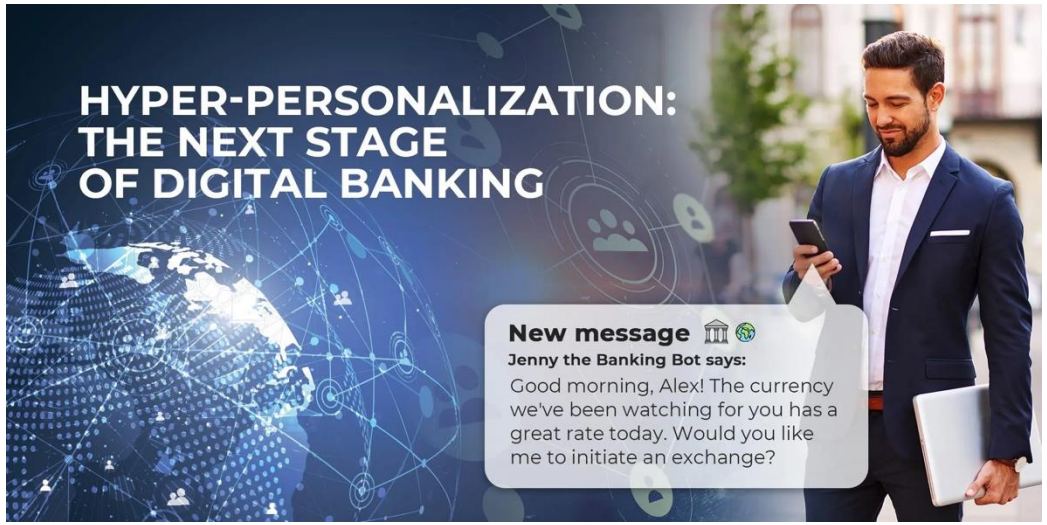
A field of theoretical AI research that attempts to create software with human like intelligence and the ability to self-tech

AGI will create an explosion of intelligence. We will see AGI systems/robots with an IQ of +10.000

We can solve problems we never have been able to solve

The Future of AI: What It Means for CxOs

- **Hyper-Personalization:** AI will enable highly personalized products and services, tailored to individual preferences and behaviours.
- **Automation of Complex Tasks:** AI will automate complex processes beyond simple tasks, from legal work to advanced scientific research.
- **Enhanced Human-Machine Collaboration:** Smarter and more efficient collaboration between humans and machines.
- **New Business Opportunities:** AI will unlock new opportunities and markets, from healthcare to finance, creating new markets and revenue streams.



NEURALINK

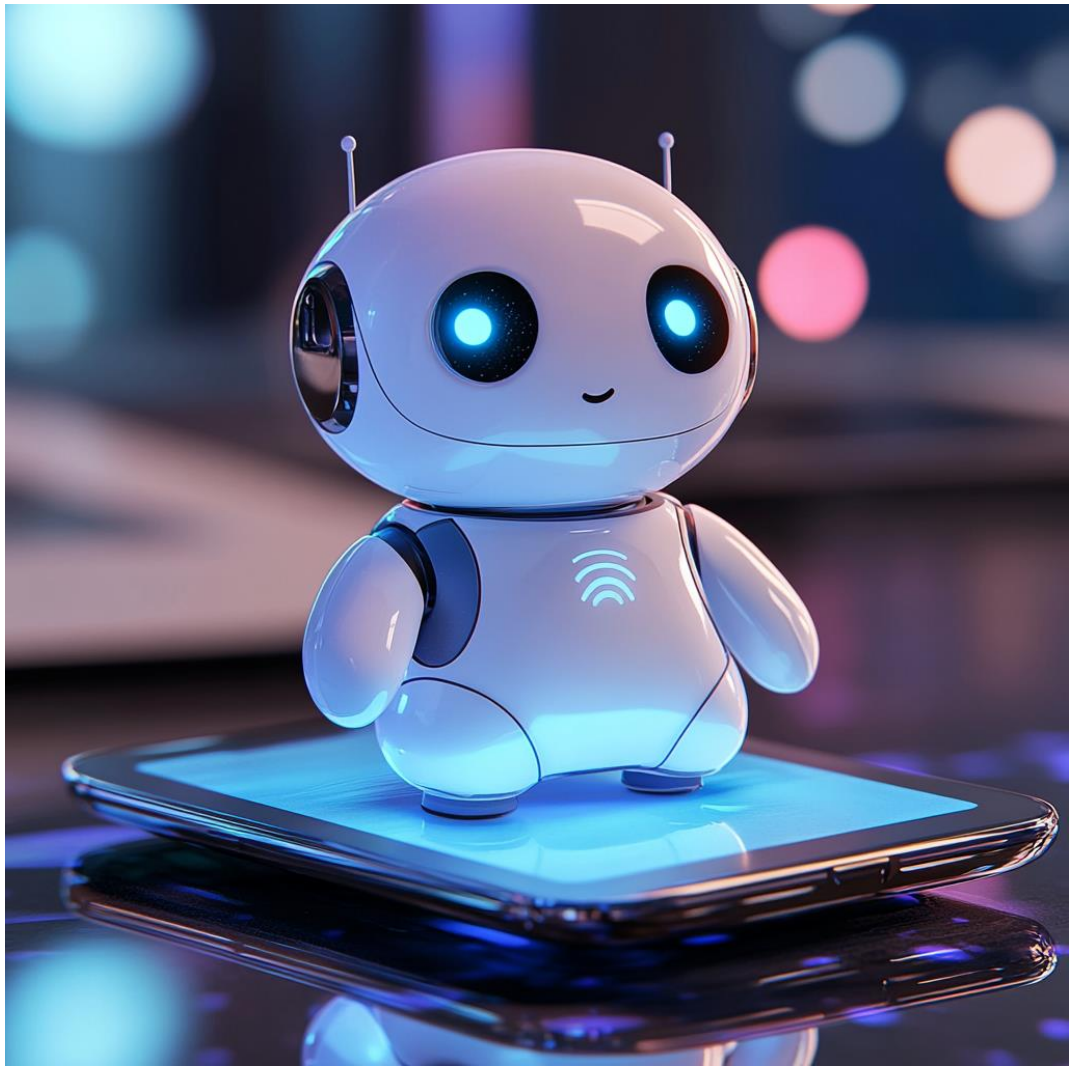
IBM

AI-assistenter over alt…

Glem “Internet-of-things”
Gør klar til “AI-of-things“

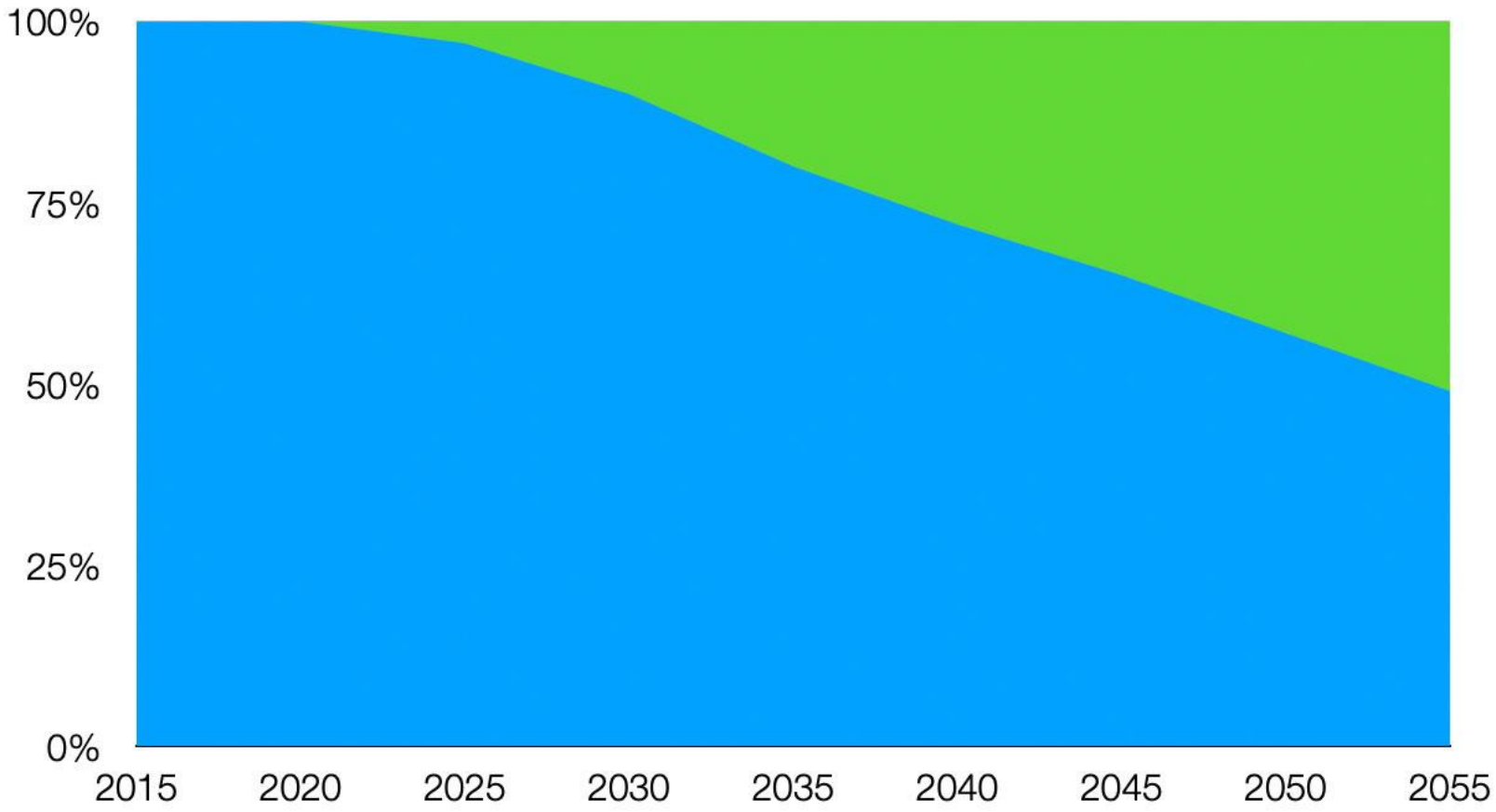
AI-systemer vil være alle steder:

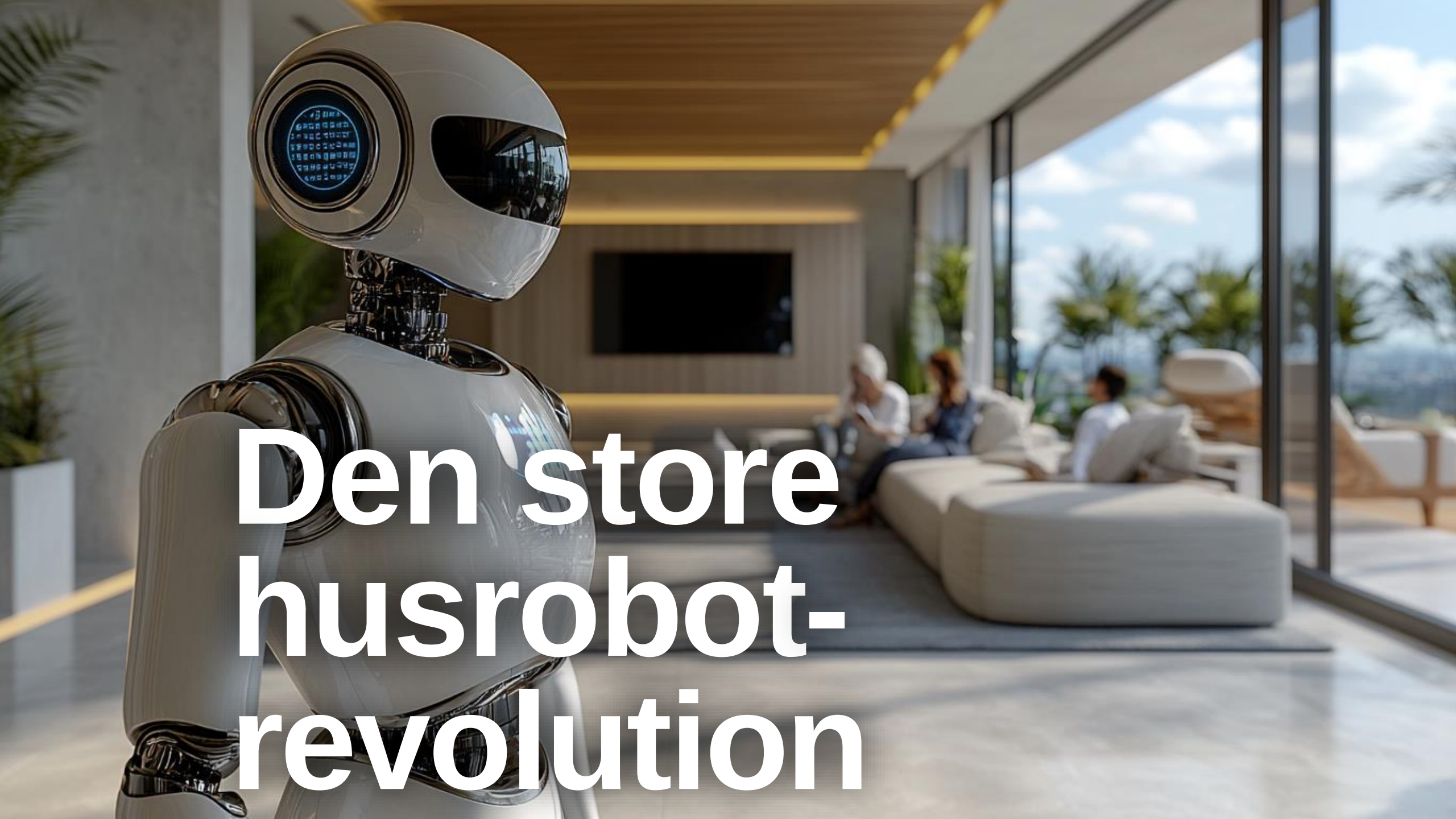
- I vores mobiltelefon
- I vores support funktioner
- Når en telefonsælger ringer
- I form af personlige AI assistent
- I fjernsynet
- I bilen
- osv



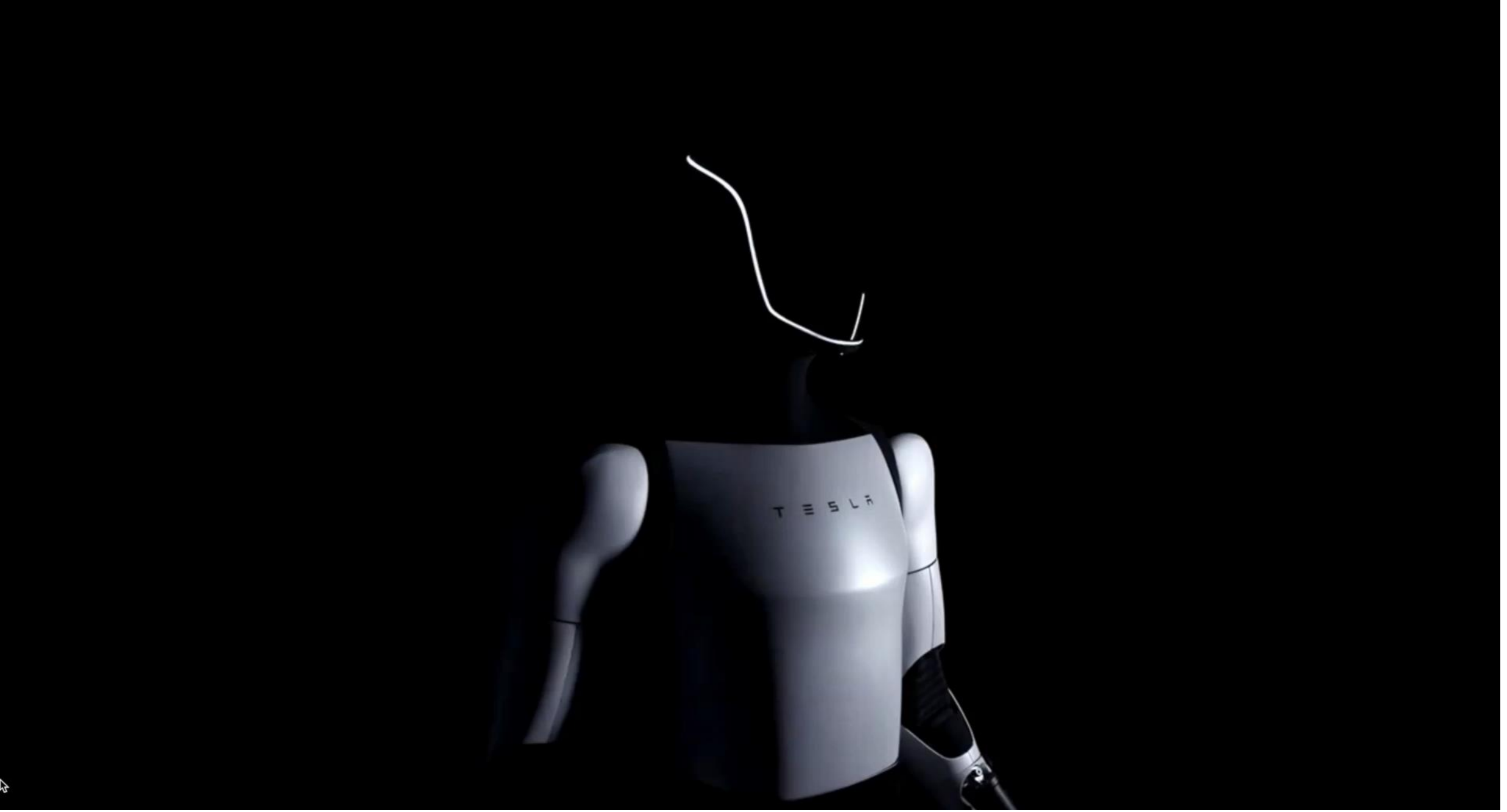
Hvem kommunikerer vi med?

Mulig udvikling I vores daglige kommunikation frem til 2040



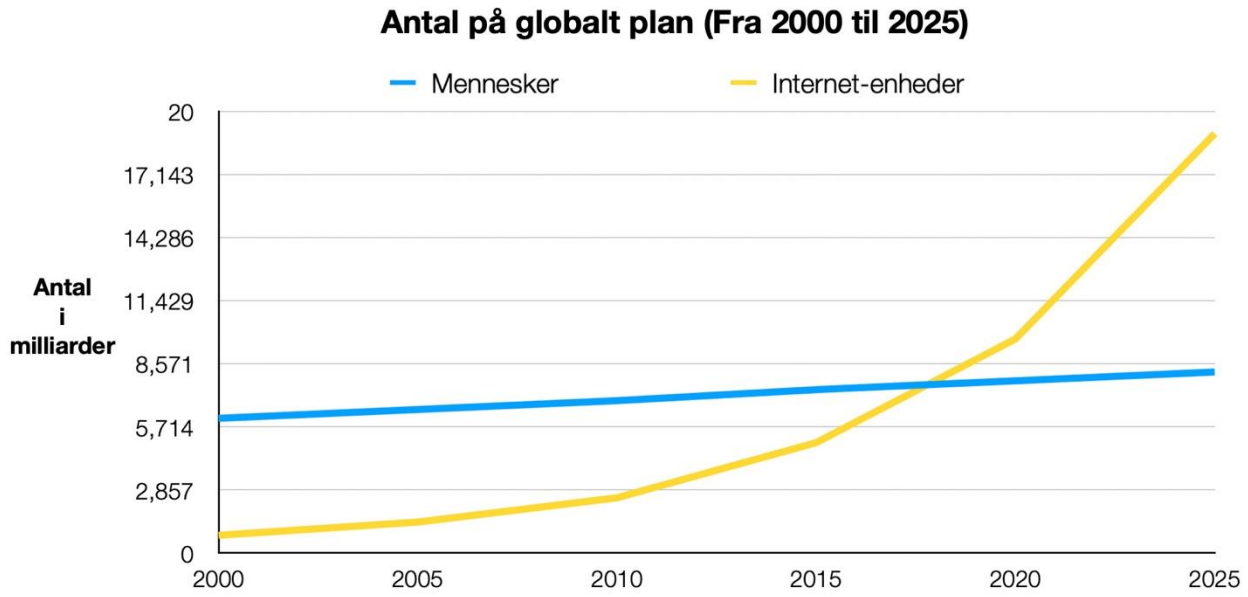


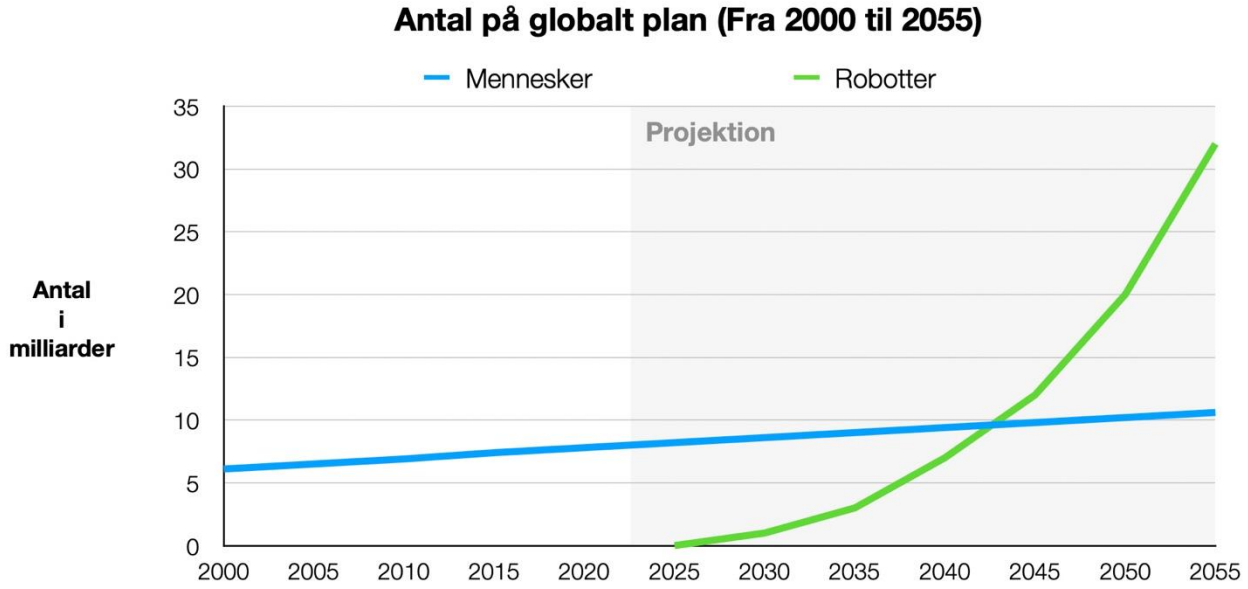
Den store husrobot-revolution


TESLA

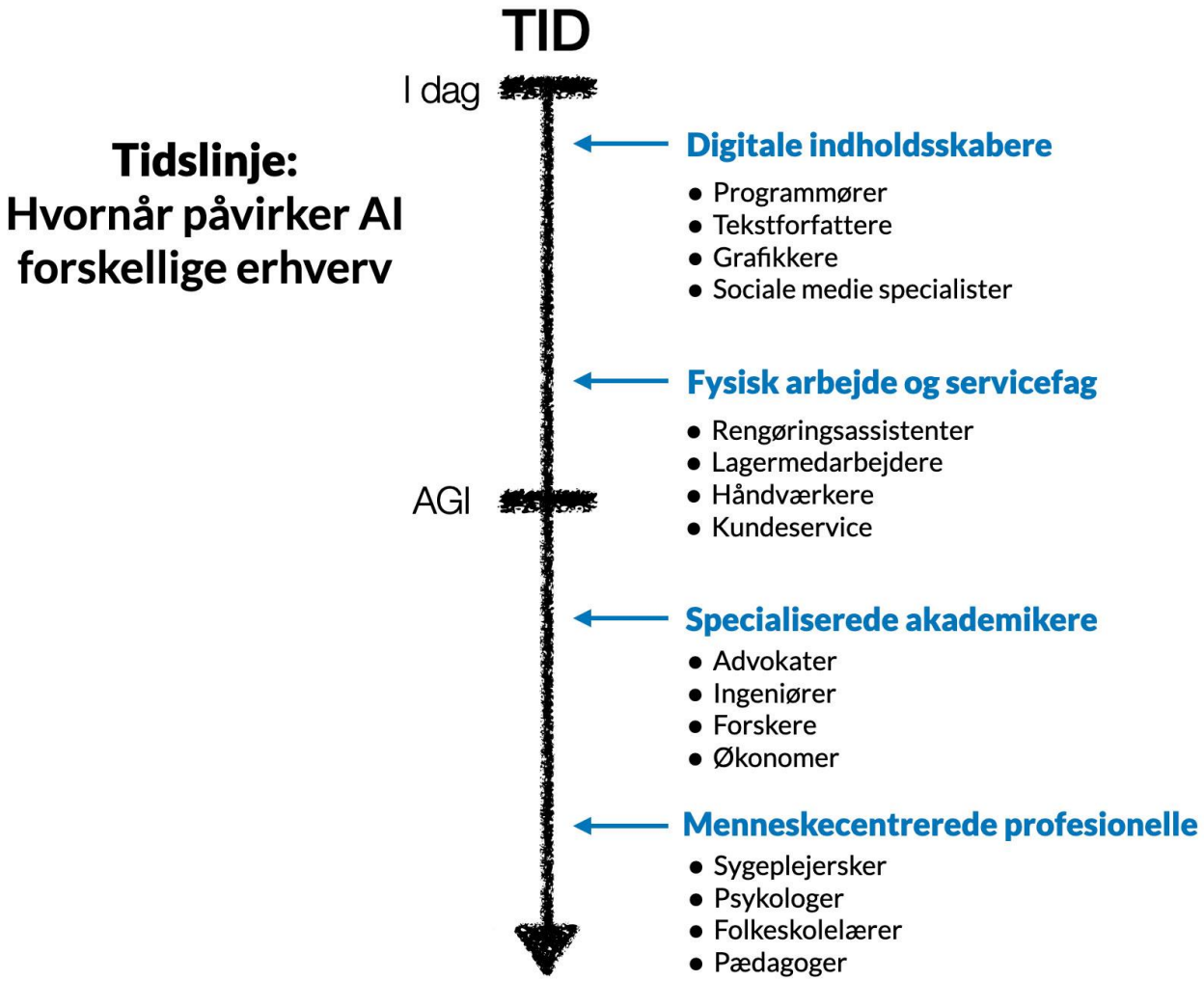
“De teknologiske fremskridt vi gør over de næste 50 år pga AI vil være langt større end alle dem vi har gjort siden menneskehedens begyndelse lagt sammen”

Sam Altman, CEO OpenAI





Hvilke jobs vil AI påvirke?



Det store spørgsmål:

Vil AI gøre os arbejdsløse?

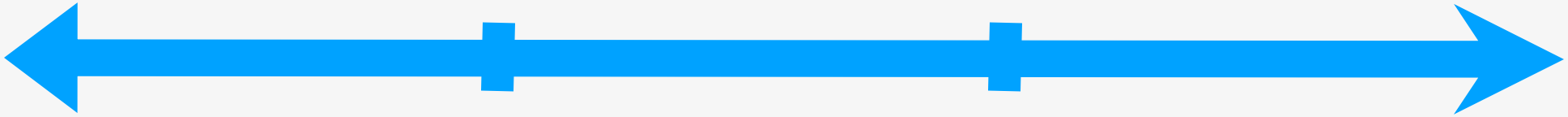
Sandsynligvis

En overgangsproces

- Vi går mod kortere og kortere arbejdsdage.
- Arbejdsløshed er sandsynligvis endestationen.

- Bliver arbejdsløshed snart et mål?
- Vil vi kalde det noget andet end arbejdsløshed?

I dag



Arbejdsuge:
5 dage
af 8 timer

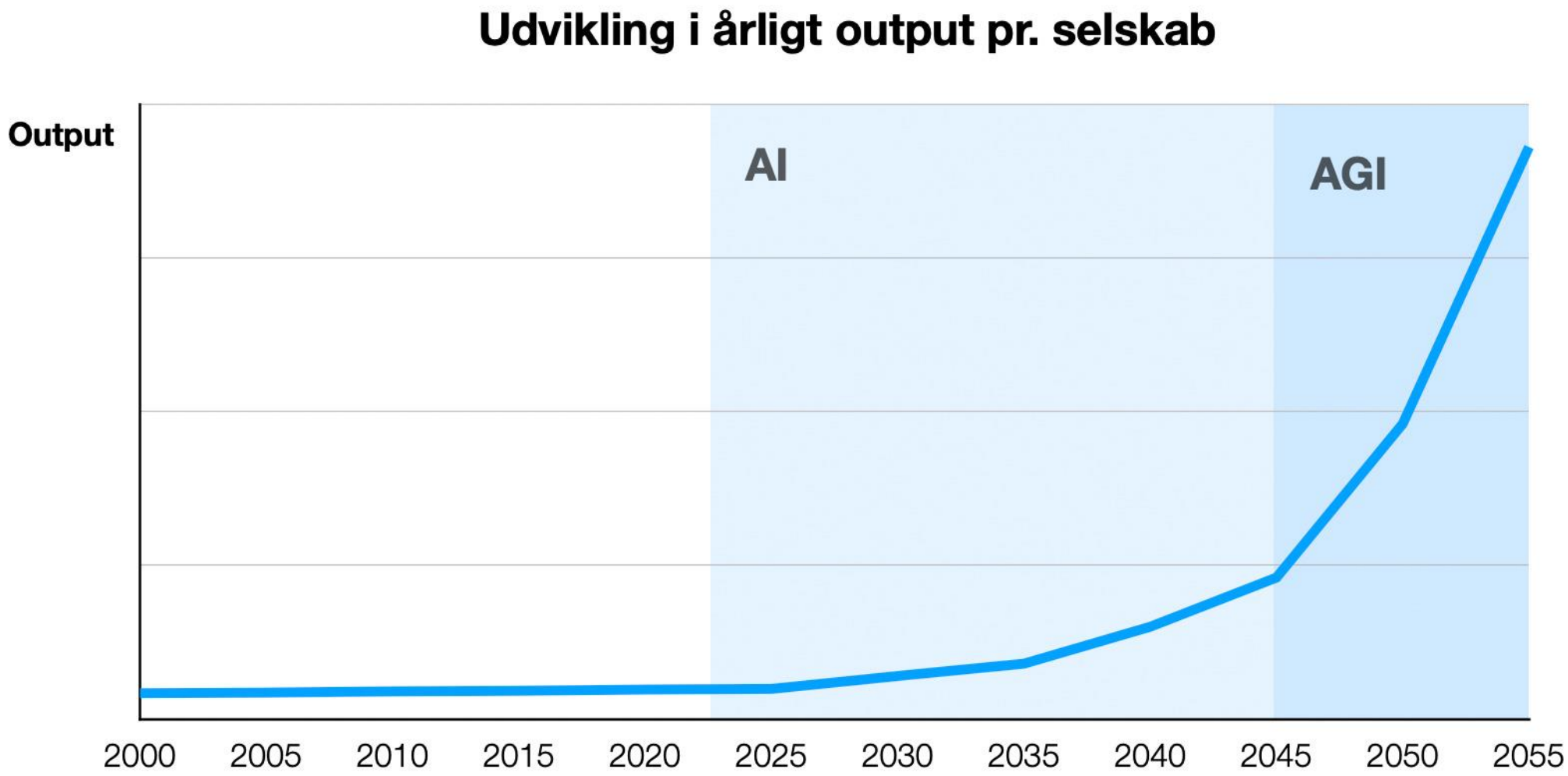
Arbejdsuge:
4 dage
af 6 timer

Arbejdsuge:
2 dage
af 4 timer

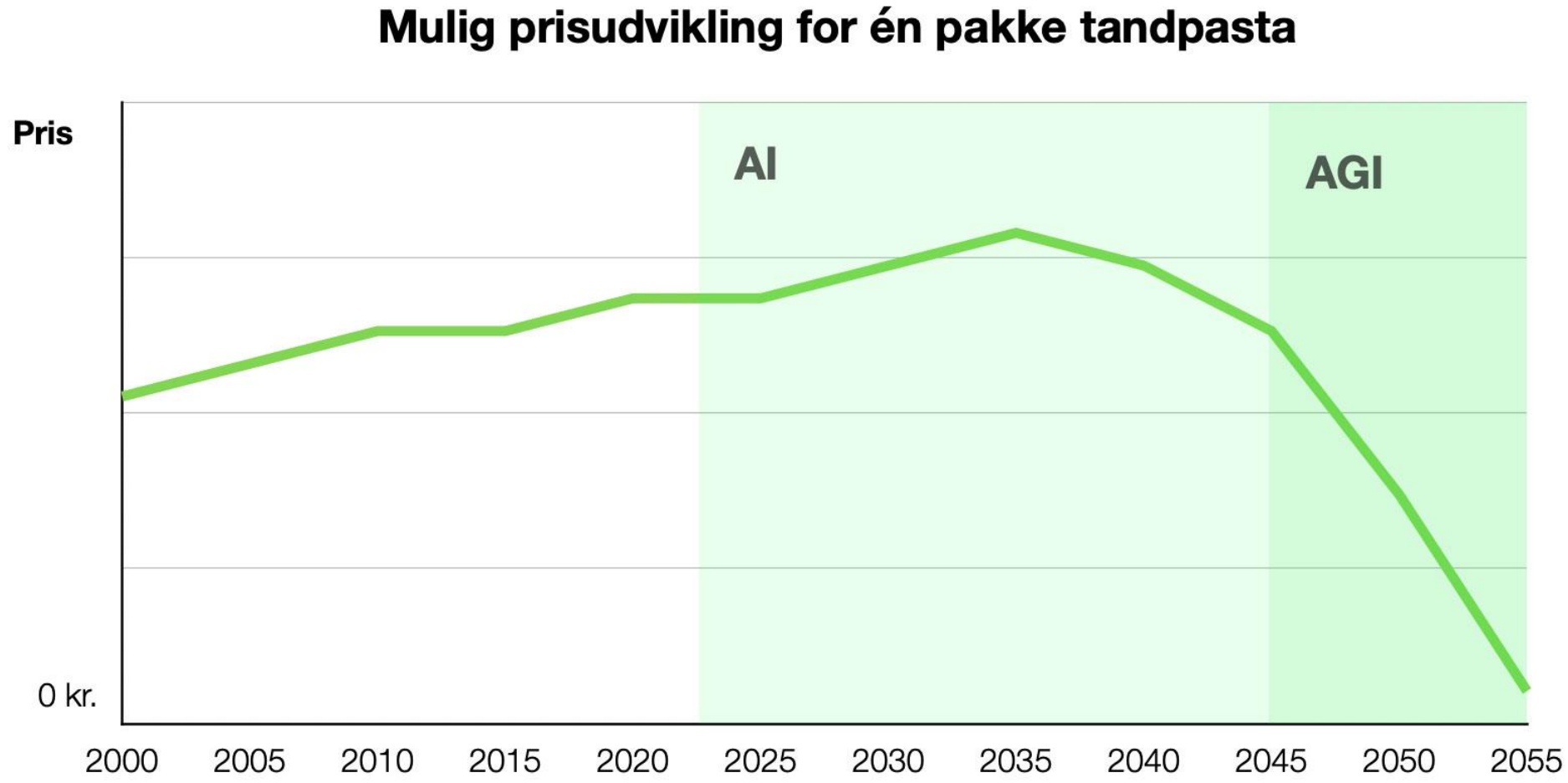
Arbejdsløs!

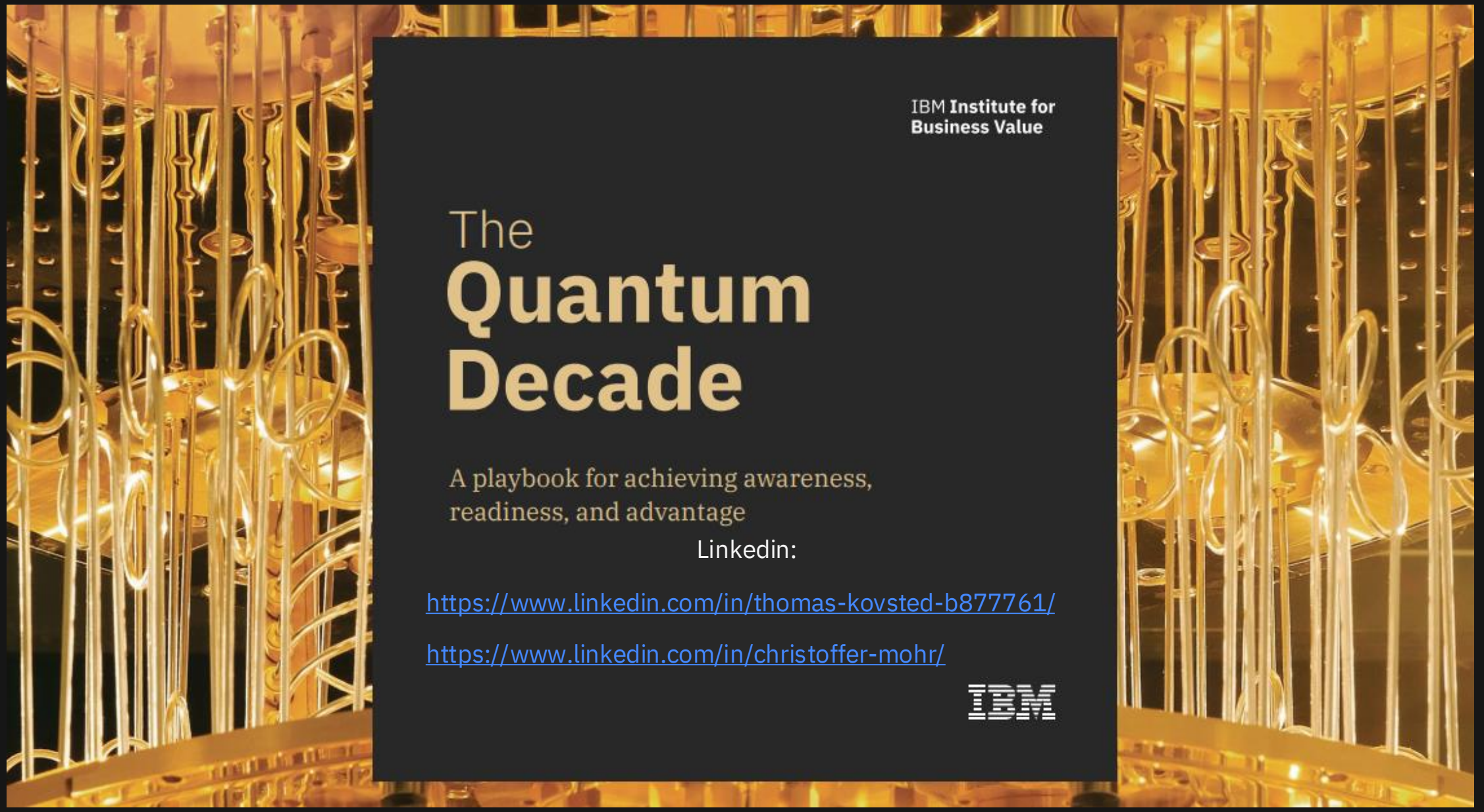
En overflødigheds-økonomi

Arbejdskraft-generator —> Output-generator —> velstandsgenerator



En overflødigheds-økonomi




IBM Institute for Business Value
The
Quantum
Decade
A playbook for achieving awareness, readiness, and advantage
Linkedin:
https://www.linkedin.com/in/thomas-kovsted-b877761/
https://www.linkedin.com/in/christoffer-mohr/
IBM

The limit of bits

For decades we've been simplifying nature into **1**s and **0**s because that was the only way we could manage to create a useful and scalable system of computation.

00100110111001001000100100100110010011100101111
00111110010100100011100010001001010001001001010
01010010101011100100110111001001000100100100110
00100111001011100111111001010010001110001000100
10100010010010101010010101011101110011100101011
1110

One of the world's most powerful supercomputer

Oak Ridge National Laboratory
US Department of Energy

Summit supercomputer specs

200 quadrillion calculations per second

9216 IBM Power 9 processors

27,648 NVIDIA GPUs

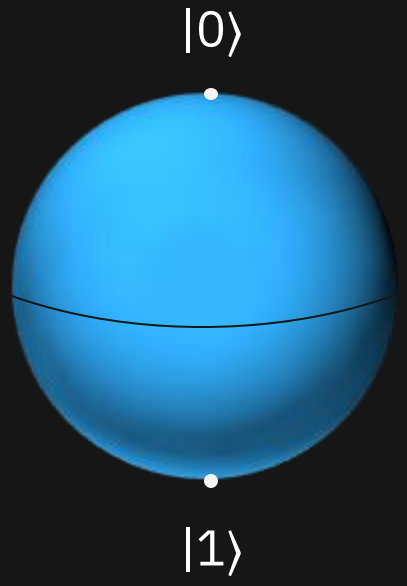
250 PB File System

IBM Red Hat Enterprise Linux (RHEL) v 7.4 Operating System

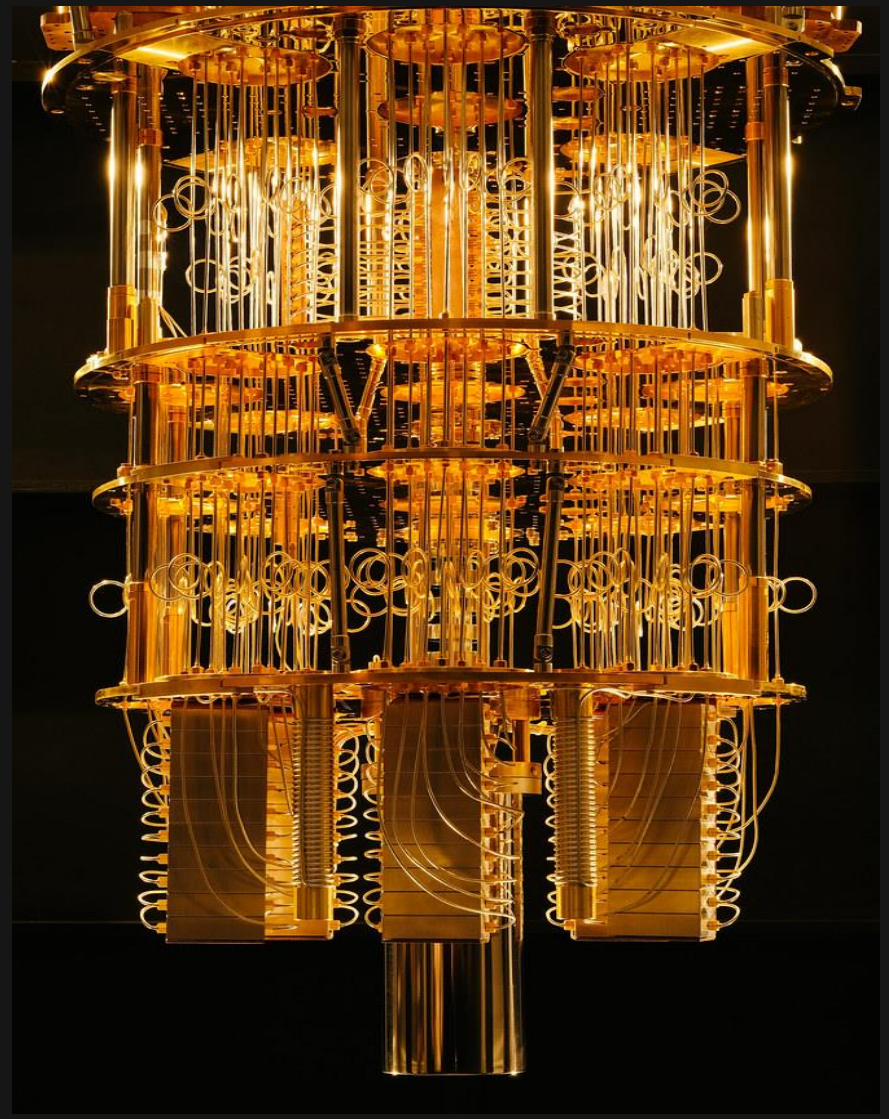
https://www.ibm.com/thought-leadership/summit-supercomputer/

Quantum bits (qubits) and quantum circuits

IBM **Quantum**



A quantum bit or qubit is a controllable quantum object that is the unit of information



Exponential growth

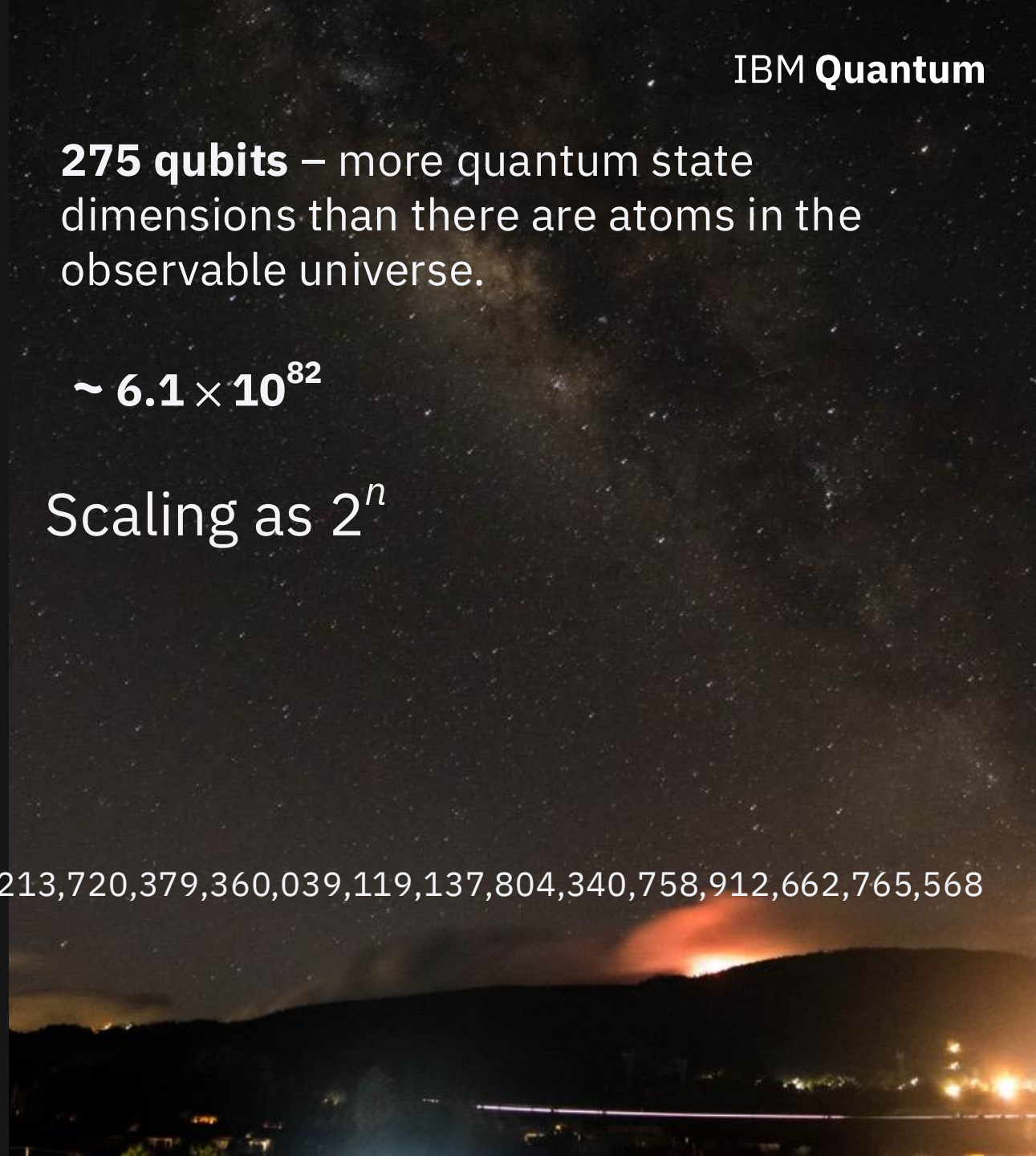
2^{275}

60,708,402,882,054,033,466,233,184,588,234,965,832,575,213,720,379,360,039,119,137,804,340,758,912,662,765,568

275 qubits – more quantum state dimensions than there are atoms in the observable universe.

~ 6.1×10^{82}

Scaling as 2^n



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,137,804,340,758,912,662,765,568

$\sim 6.1 \times 10^{82}$

181 zettabyte = 397.8g DNA = 1.79 humans

6pg per cell * 37 trillion cells/human = 222g/human

1/ (455 exabytes/g/ 181 zeetabytes) = 397.802197802g

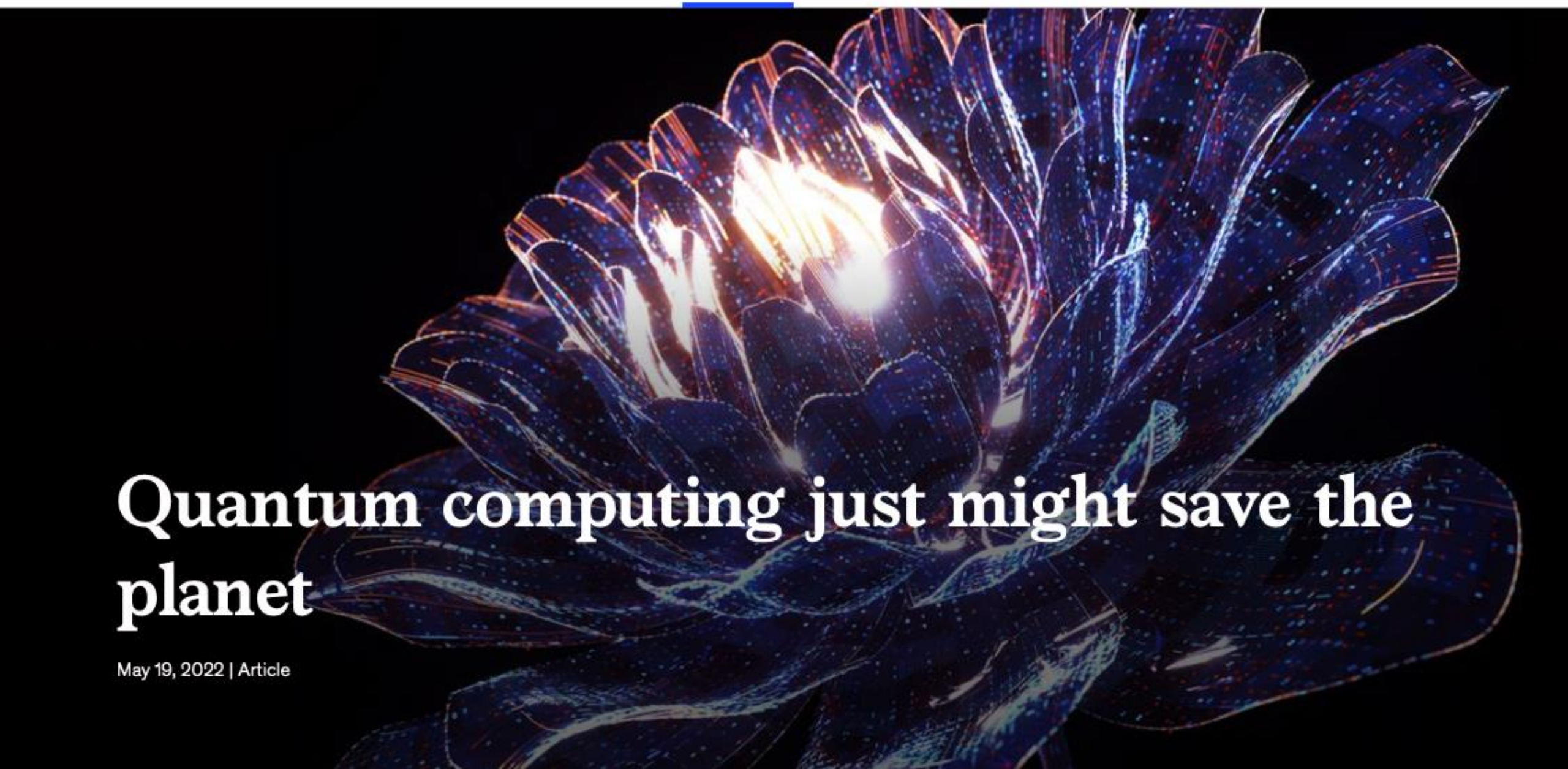
1.7919017919 humans per worlds data volume

Sources:

https://arep.med.harvard.edu/pdf/Church_Science_12.pdf

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4484964/

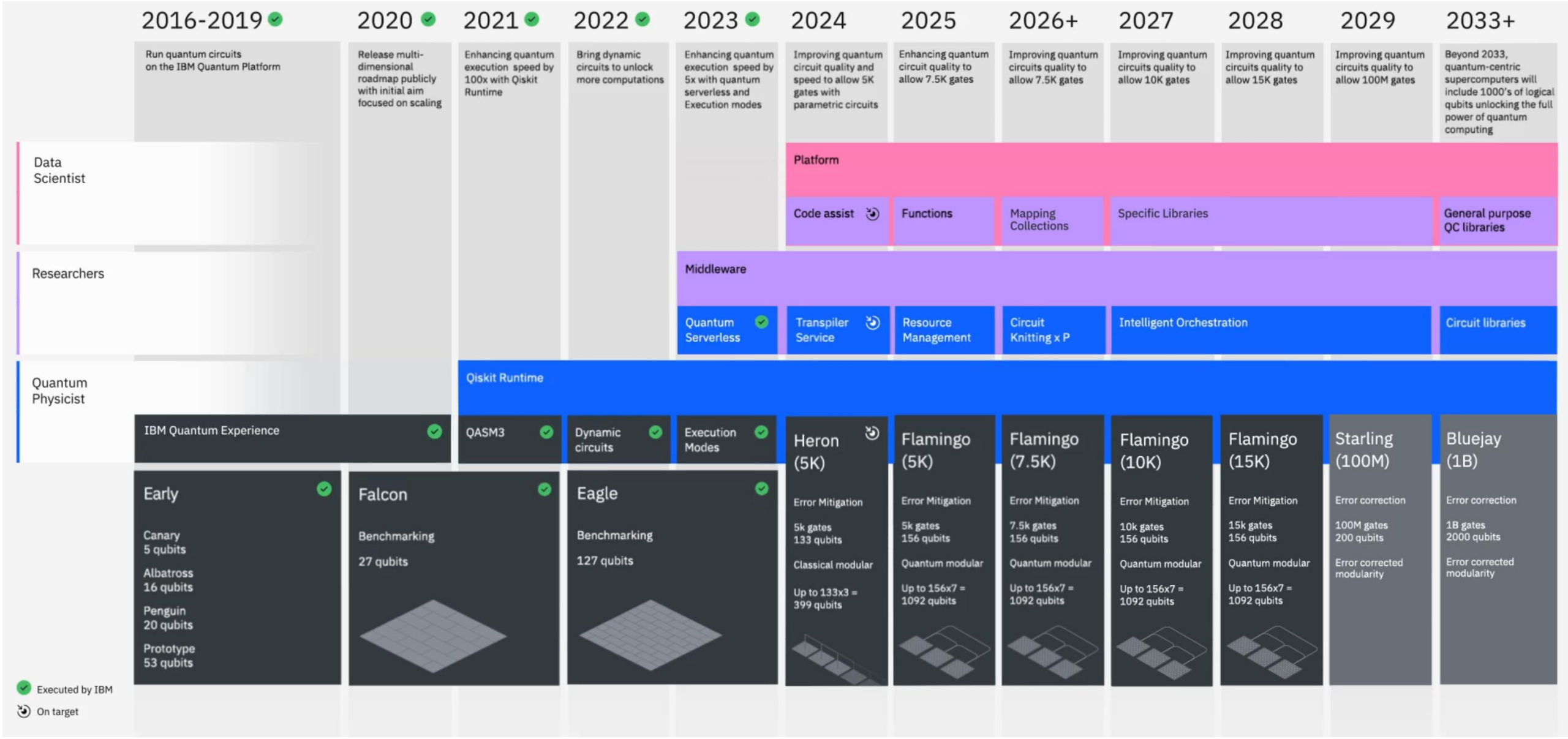
... or 77.26 qubits



Quantum computing just might save the planet

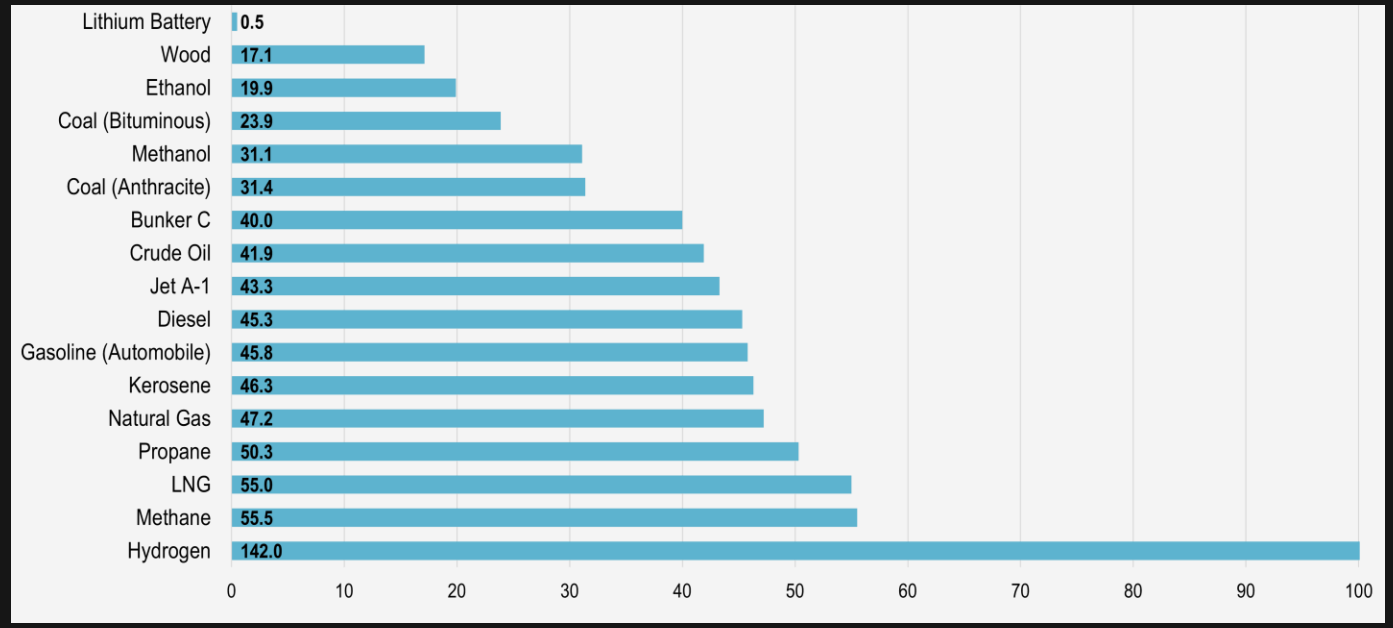
May 19, 2022 | Article

Development Roadmap



Simulating Nature

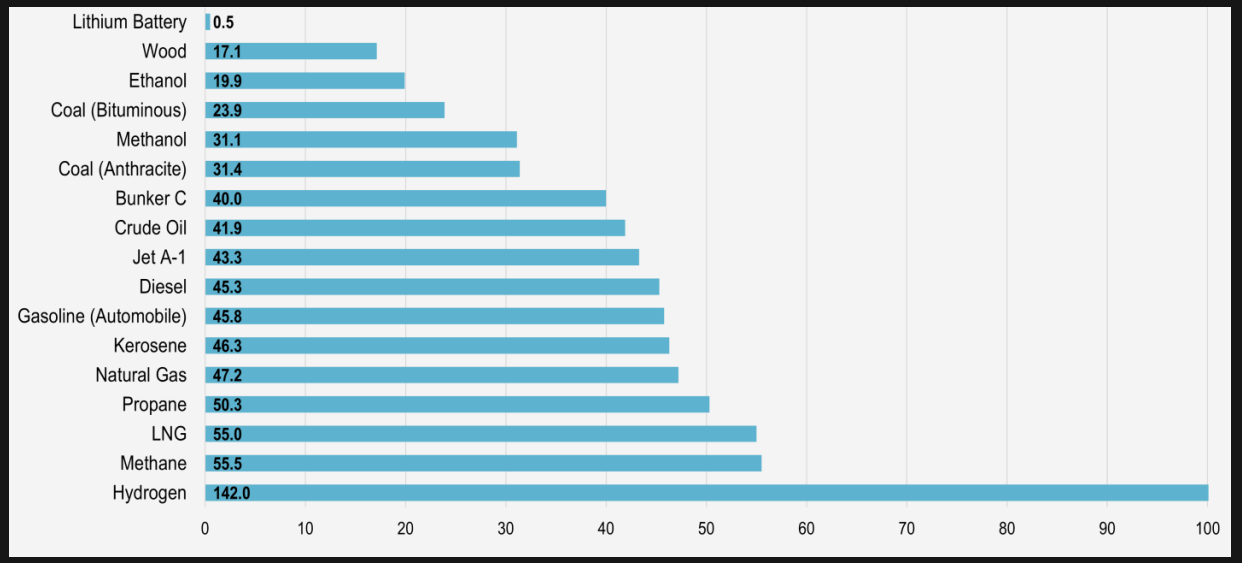
- Simulating a protein: 10^143 number of ways that an unfolded protein could potentially fold. This correspond to 475 qubits.
- Batteries today rely on scarce materials
- They are large, heavy and hard to recycle



Chemical Energy Content of some Fuels in MJ/kg

Simulating Nature

- Batteries today rely on scarce materials
- They are large, heavy and hard to recycle
- Imagine an EV with >35,000 km of range



Chemical Energy Content of some Fuels in MJ/kg

Lithium-Air:

Theoretical max is 11000 Wh/kg

If we could make this, we could have the same capacity @ 6.81 kg

Range = 11000/156 * 500 km = 35256 km of range

Does not require rare metals

A lot more sustainably material sourcing

Transportation & Logistics Optimization

Use Case: Quantum computing has the potential to revolutionize transportation and logistics by optimizing complex routing and scheduling problems. Traditional algorithms often struggle with the "traveling salesman problem," which involves finding the most efficient route between multiple destinations. Quantum computers can process these complex calculations exponentially faster, enabling real-time optimization of logistics networks.

Impact: This can lead to significant cost savings, reduced fuel consumption, and improved delivery times. Enhanced logistics efficiency can benefit industries ranging from retail to manufacturing, ensuring goods are delivered faster and more reliably.

Example: ExxonMobil + IBM are modeling maritime inventory routing on quantum devices. By analyzing different strategies for vehicle and inventory routing they're laying the foundation for constructing practical solutions for their operations.

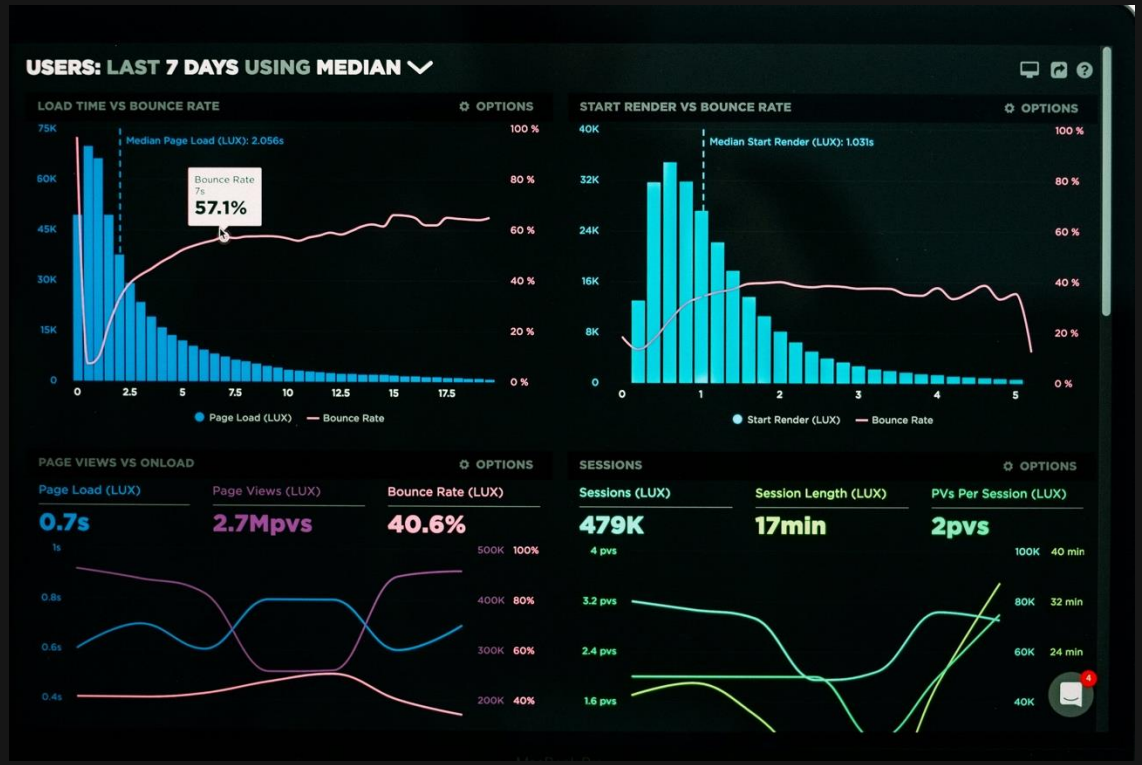
References:
https://www.fastcompany.com/90976690/quantum-routes-how-quantum-computing-is-set-to-revolutionize-navigation-and-optimization-in-logistics

Financial Modeling

Use Case: Quantum computing can significantly improve financial modeling and risk management by processing vast amounts of data more efficiently than classical computers. This includes optimizing investment portfolios, improving asset pricing models, and enhancing fraud detection systems.

Impact: Financial institutions can achieve better returns on investments, reduce risk exposure, and enhance the security of financial transactions, leading to a more stable and efficient financial system.

Example: IBM & JP Morgan are exploring quantum algorithms to optimize trading strategies and manage risk more effectively.



Climate Modeling

Use Case: Quantum computing can enhance climate modeling by processing complex simulations of Earth's climate systems more quickly and accurately. This involves analyzing large datasets related to weather patterns, atmospheric conditions, and ocean currents.

Impact: Improved climate models can lead to better predictions and more effective strategies for mitigating the impacts of climate change, helping to safeguard the environment and human life.

Example: The European Organization for Nuclear Research (CERN) is hosting The Open Quantum Institute, investigating quantum computing's potential to improve climate predictions (addressing UN Sustainability Development Goals 13, climate action, among several other goals).

References:
CERN, https://home.cern/news/news/computing/open-quantum-institute-launches-its-pilot-phase-cern
HPC Wire: https://www.hpcwire.com/off-the-wire/cern-backed-quantum-initiative-aims-to-tackle-global-challenges-through-advanced-computing/

Drug Discovery and Development

Use Case: Quantum computing has the potential to revolutionize the field of drug discovery by enabling the simulation of molecular structures at an unprecedented level of detail. Traditional computers struggle with the complexity of molecular interactions, but quantum computers can handle these complexities much more efficiently.

Impact: This could drastically reduce the time and cost associated with bringing new drugs to market, potentially saving millions of lives and billions of dollars in the pharmaceutical industry.

Example: Researchers at IBM and Moderna are already working on using quantum computing to accelerate the discovery of new mRNA treatments for diseases like Cancer.

References:
https://newsroom.ibm.com/2023-04-20-Moderna-and-IBM-to-Explore-Quantum-Computing-and-Generative-AI-for-mRNA-Science

The Dark Side of Quantum

Exponential speedup for some algorithms

A quantum computer can solve certain problems much faster

2048-bit composite integer

25195908475657893494027183240048398571429282126204032027777137836043662020707595556264018525880784406918290641249515082189298559149176184502808489120072844992687392807287776735971418347270261896375014971824691165077613379859095700097330459748808428401797429100642458691817195118746121515172654632282216869987549182422433637259085141865462043576798423387184774447920739934236584823824281198163815010674810451660377306056201619676256133844143603838390441495263443219011465754445417842402092461651572335077870774981712577246796292638635637328991215483143816789988504044536402352738195137863656439212010397122822120720357

Problem: find prime factors

$= p \times q$

Expected computation time

Most powerful computer today

millions of years

Shor's Quantum Algorithm

some hours

“There is a 1 in 7 chance that fundamental public-key crypto will be broken by quantum by 2026, and a 1 in 2 chance of the same by 2031.”

Dr. Michele Mosca
Institute of Quantum Computing, University of Waterloo