# The Future of IT
## What’s next in computing

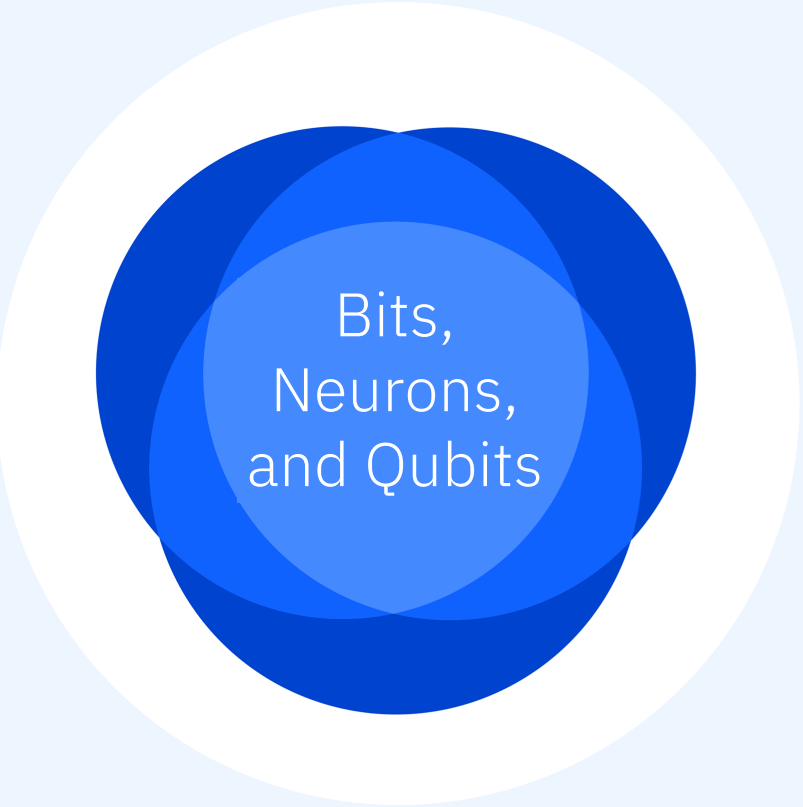
Namik Hrle

IBM Fellow and Vice President
Director IBM Germany Software Development
International member of ANUBiH



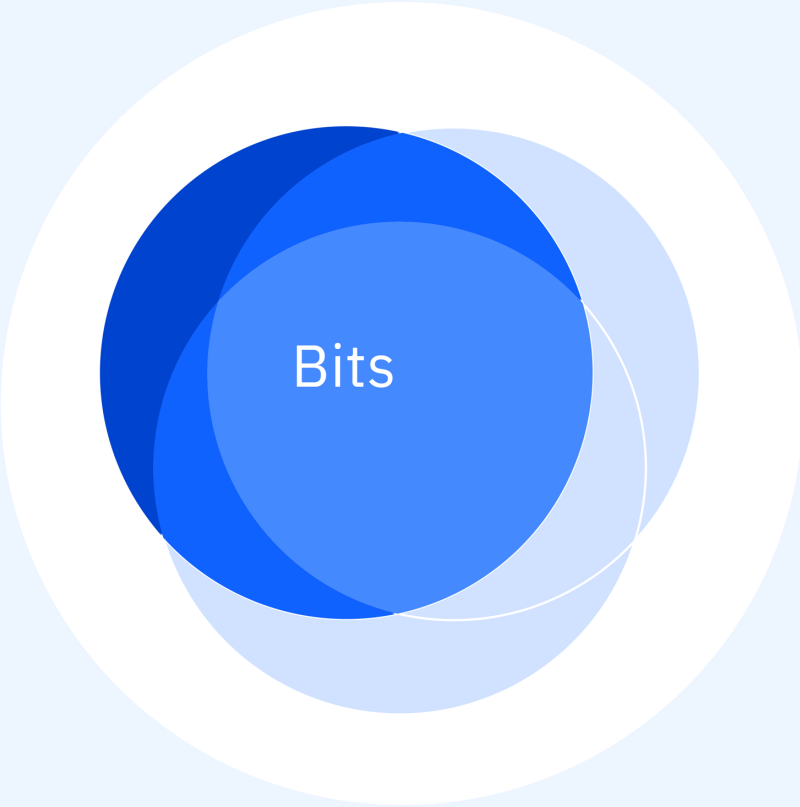
Sarajevo, 16-04-2025

Advances in computing are enabling ever more sophisticated data representations and calculations to support scientific innovations.




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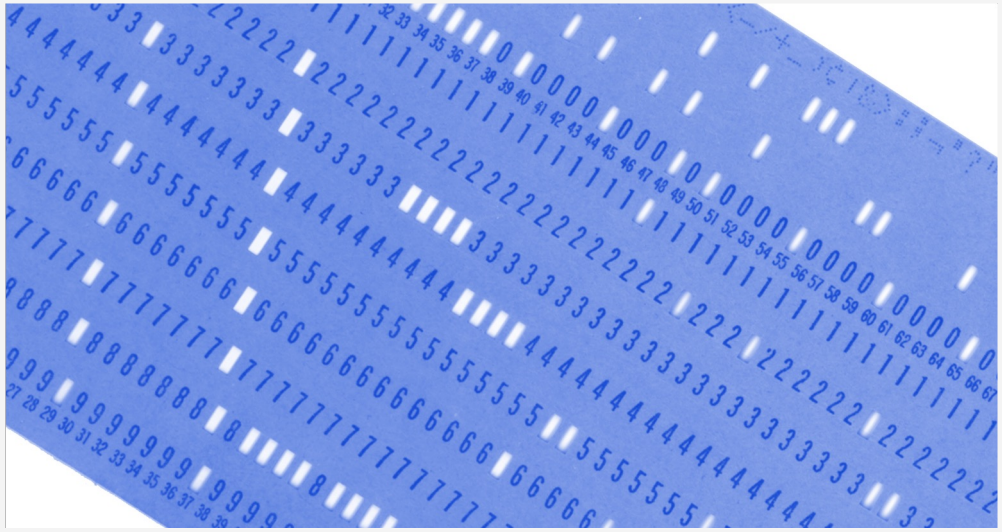
# Bits,
# the semiconductor platform

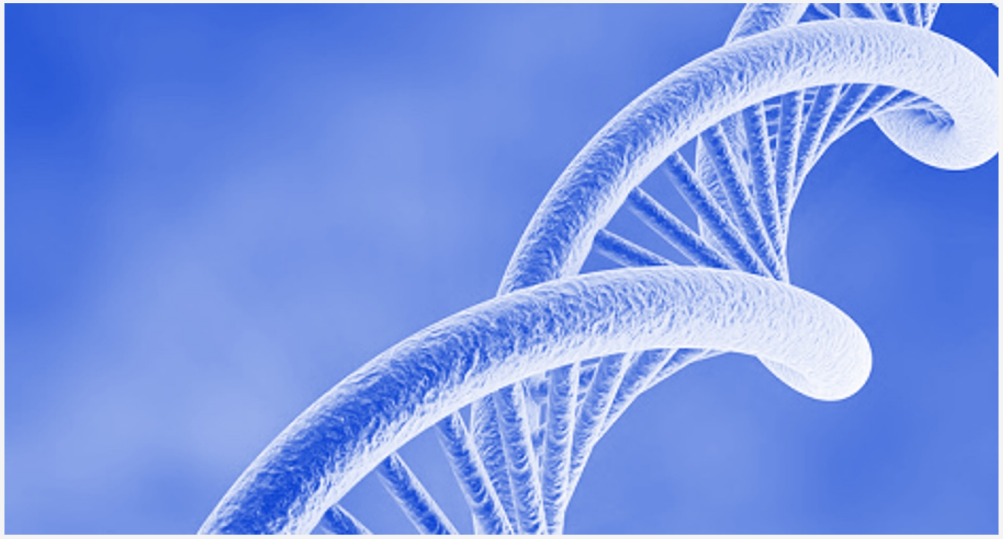



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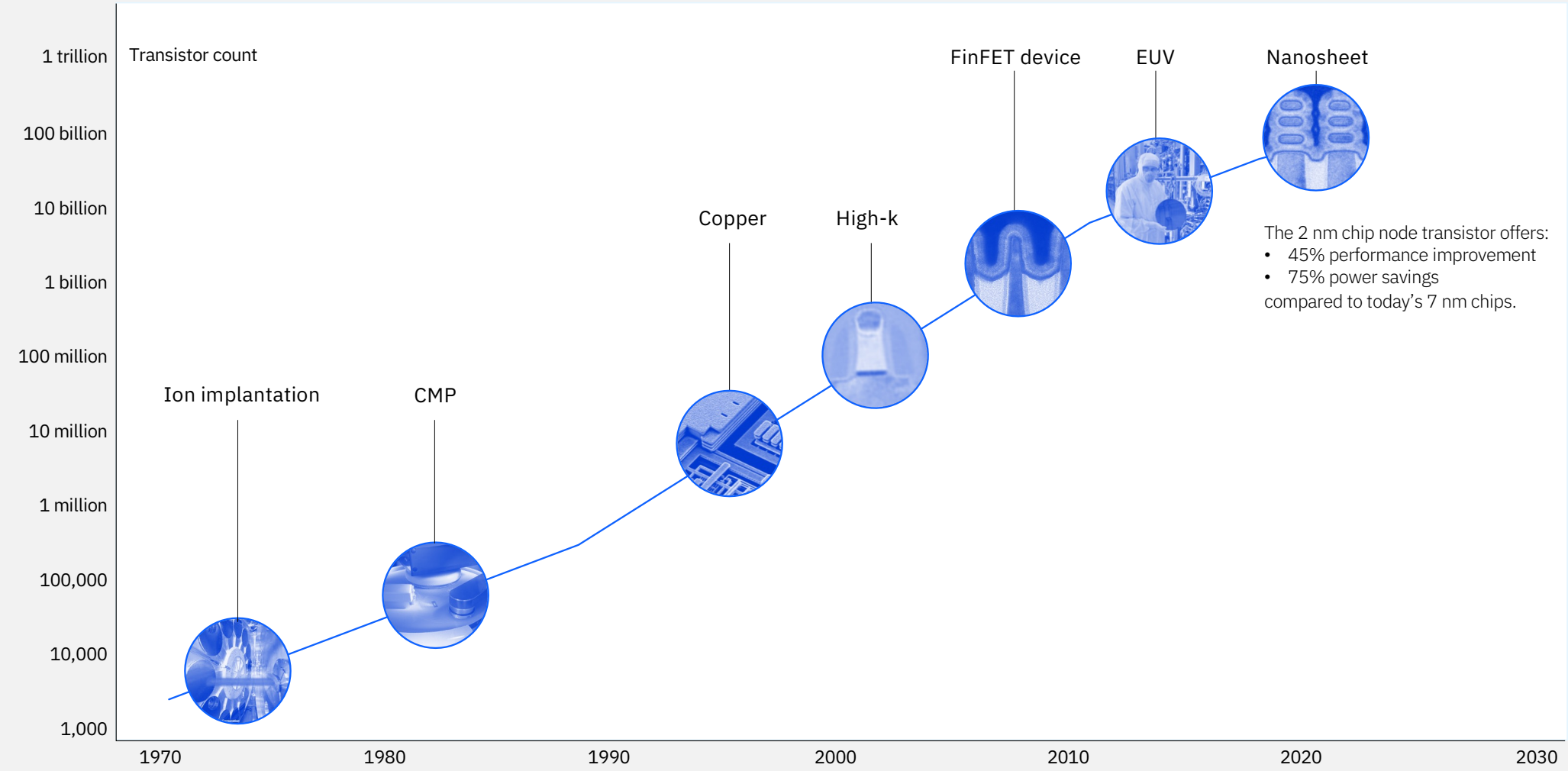
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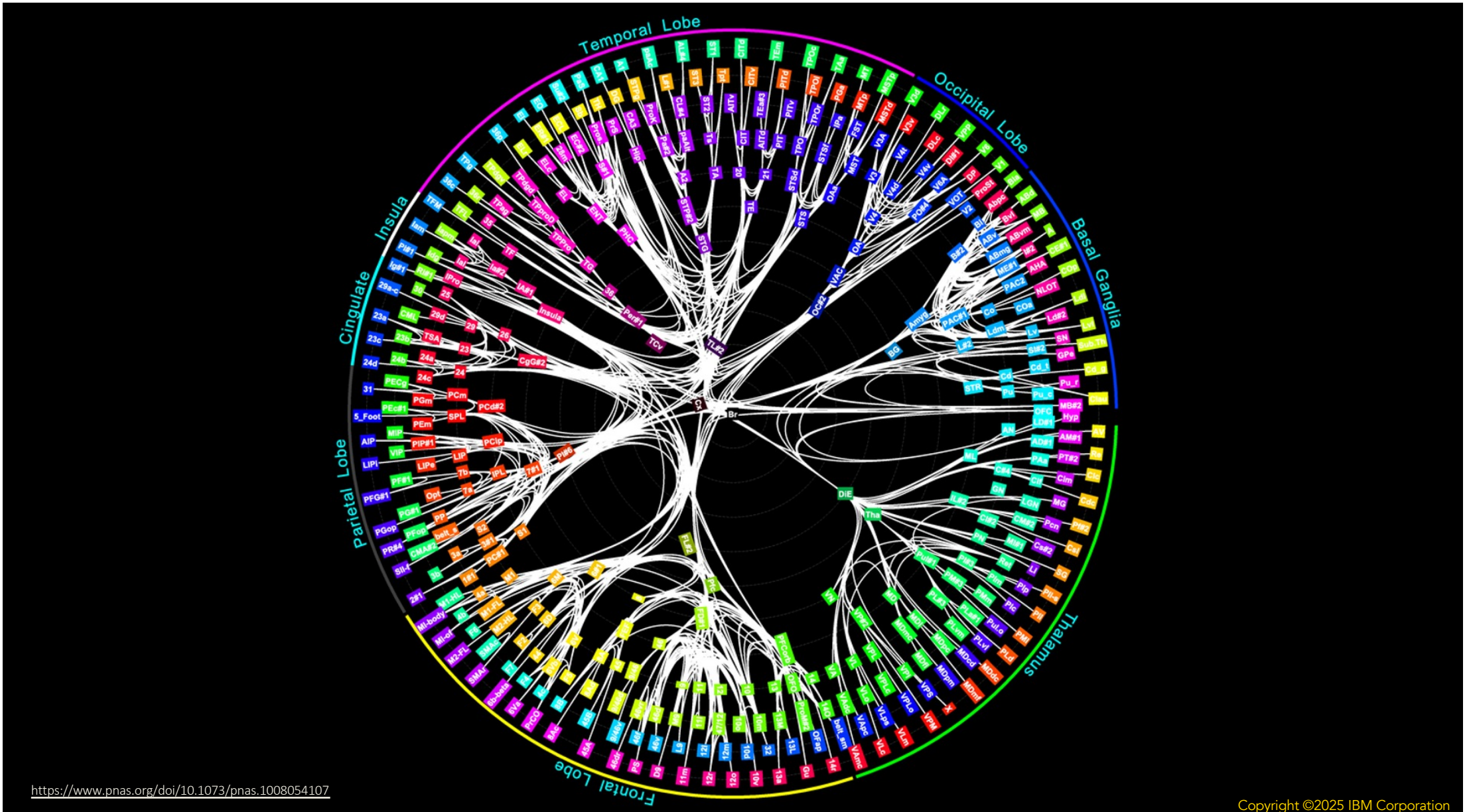


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# Transistor counts continue to grow




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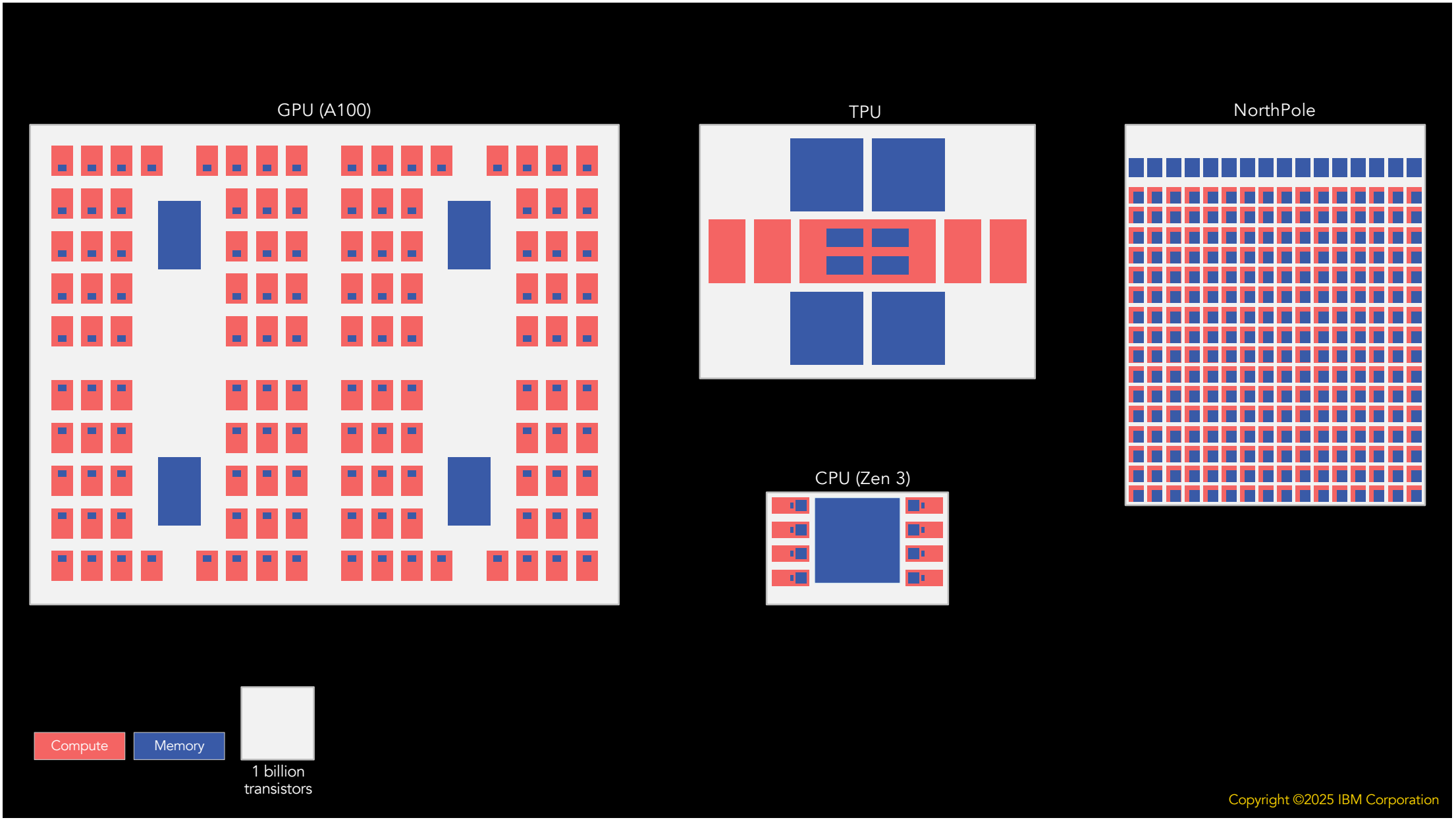



https://www.pnas.org/doi/10.1073/pnas.1008054107

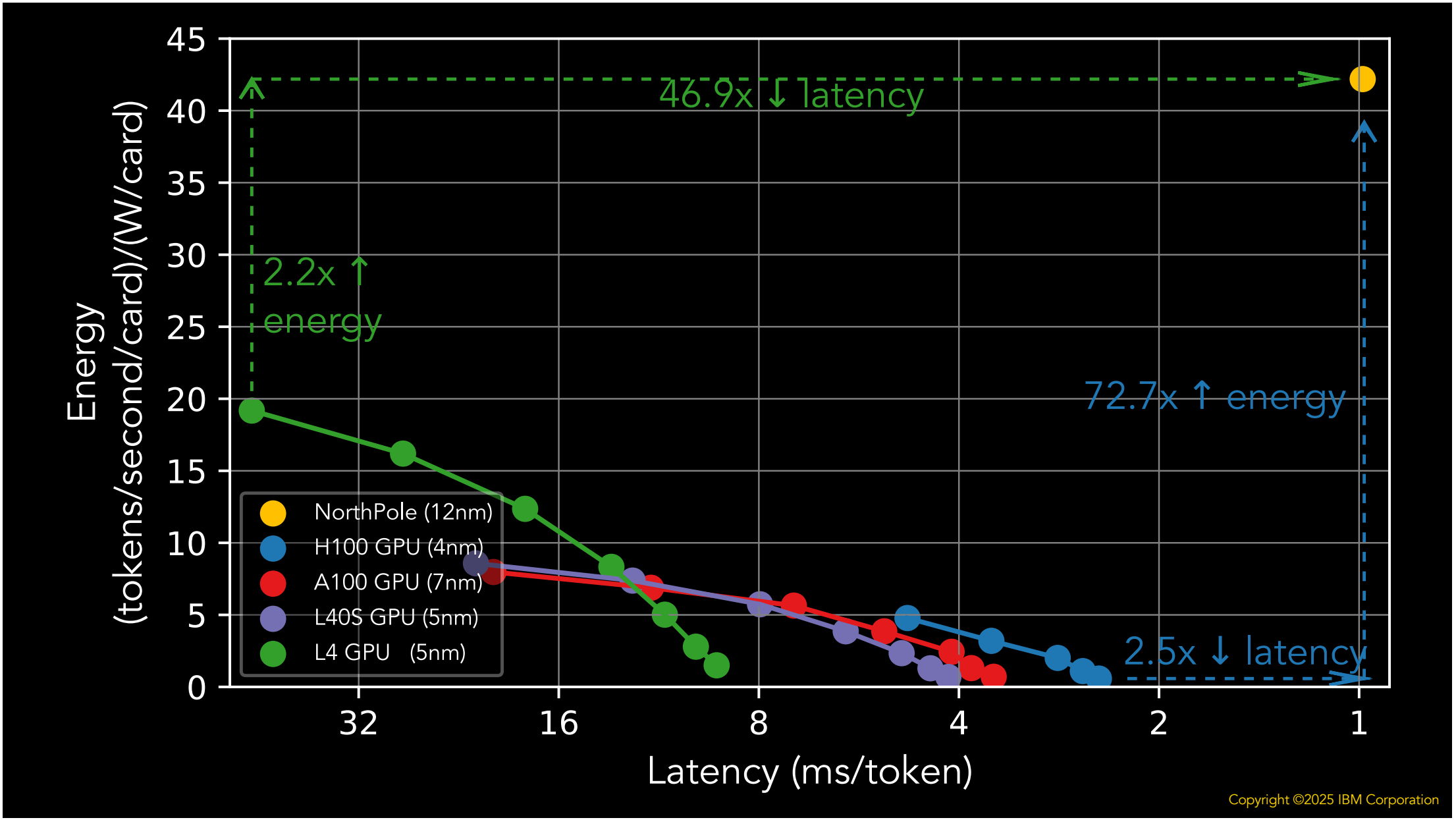
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https://modha.org/wp-content/uploads/2024/09/NorthPole_HPEC_LLM_2024.pdf

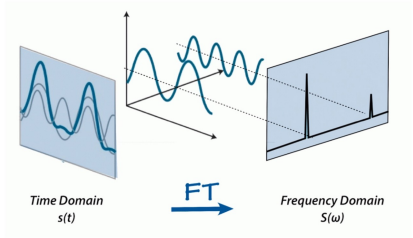



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# Novel data representations are at the heart of major advances in science and technology and created new businesses.




## Spectral representation

Chemical spectrography image processing, seismic processing...

## Original Data

1010
1010

## Relational representation

Transactional and analytical database systems, ...

ORACLE
IBM
SAP
salesforce

RDBMS market
Warehouse market

ERP market
CRM market

## Complex number representation

Electronic devices, electrical motors, quantum computing...

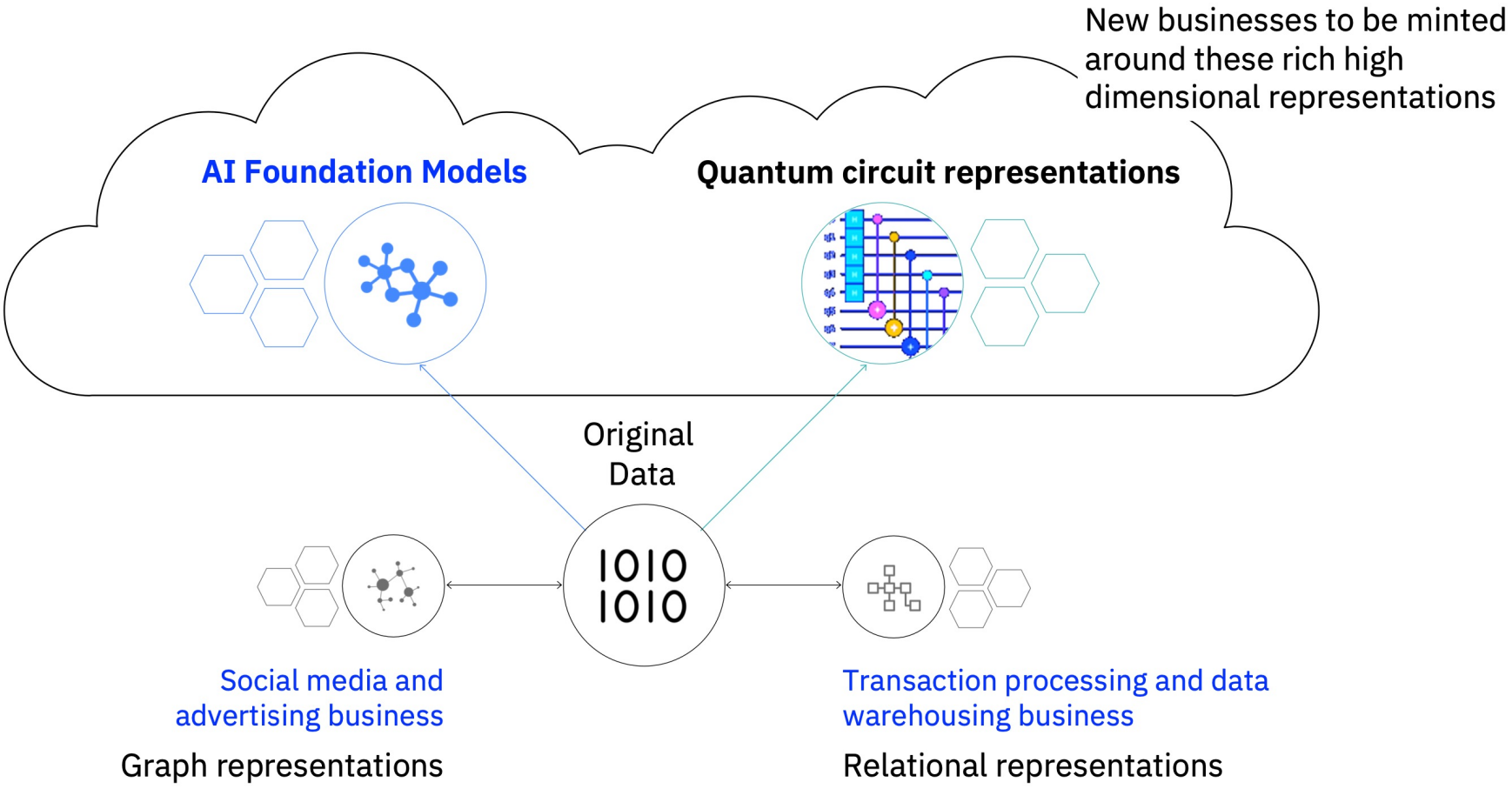
## Graph representation

Network routing, social media...

Ads
Search + Ads
Subscription + Ads

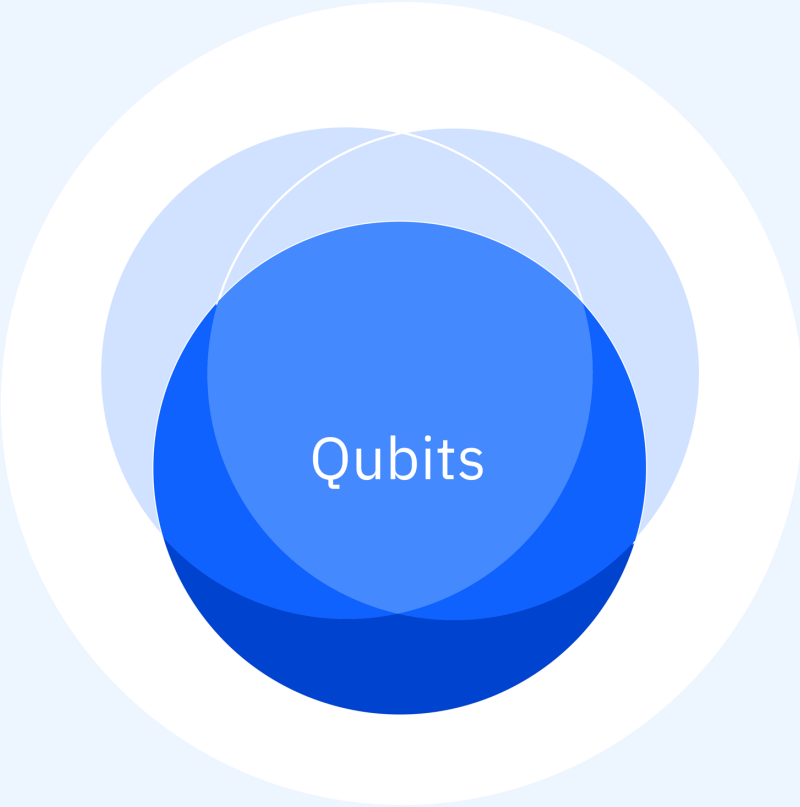
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Advances in technology are enabling the creation of powerful high-dimensional representations around which to build businesses.




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# Qubits, the quantum platform




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# The new wave of computing



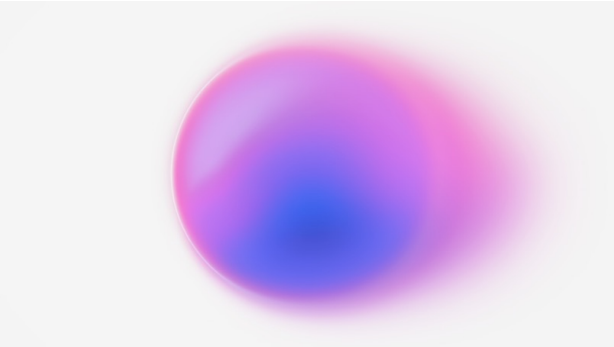


**Classical computer**
Well suited for many problems

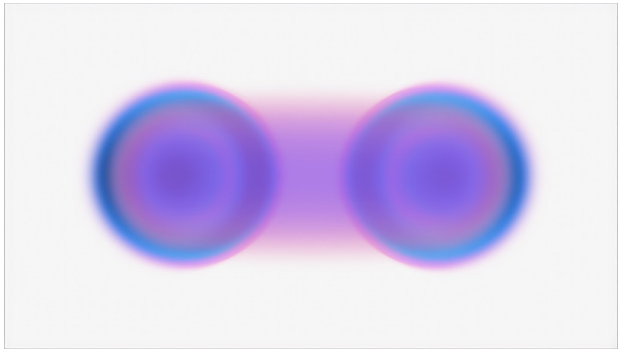
**Quantum computer**
Unlock classically intractable problems

## Uniquely quantum

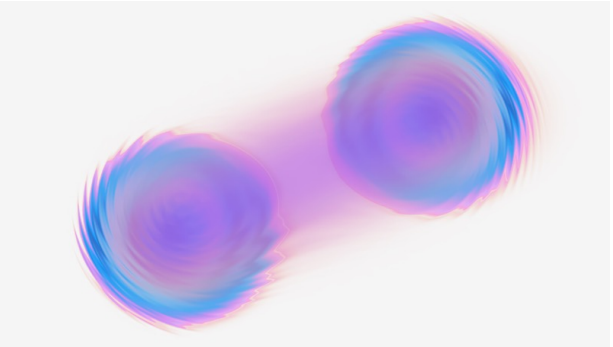
# Some problems are classically intractable and will never be solvable with traditional computers



**Superposition**
A quantum system existing in a complex linear combination of two states until it is measured



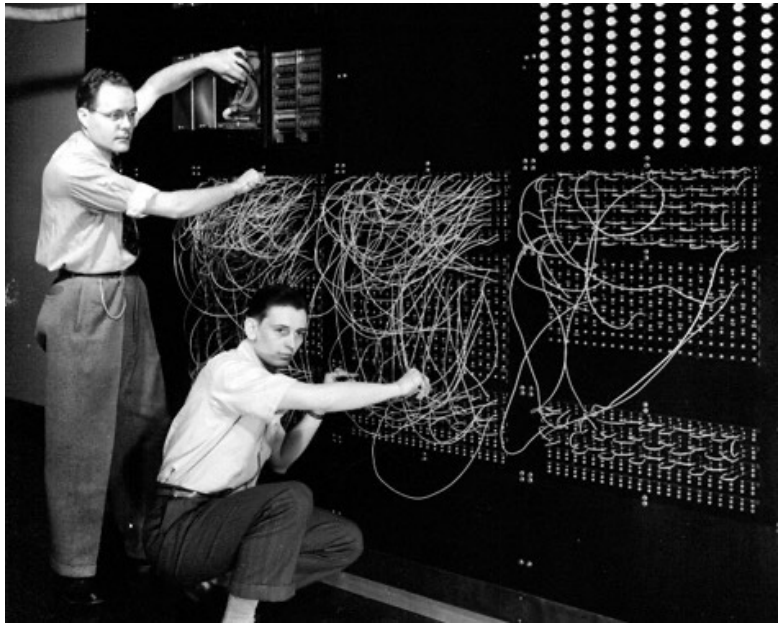
**Entanglement**
Information shared jointly between entangled pairs or groups



**Interference**
Interaction that affects likelihood of solutions

These Quantum concepts can reduce the number of computational steps required for certain algorithms that classical computers can no longer simulate exactly.
But, at a ~100 qubit scale, with sufficient circuit depth and complexity, quantum computers can.

# Classical computers before error correction



Credit: Courtesy of Computer History Museum

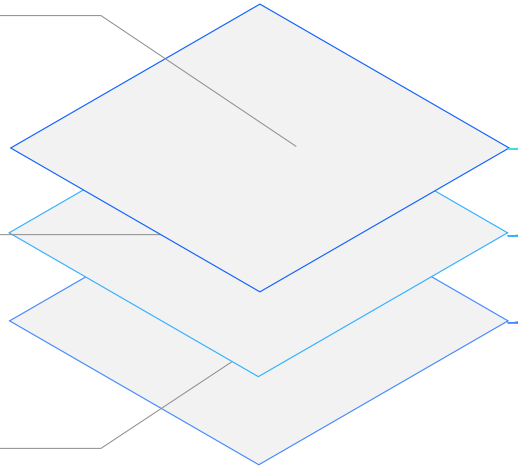
| | |
|---|---|
| 1937 | Atanasoff-Berry computer solves systems of linear equations for astronomy research. |
| 1941 | British Bombe deciphers German Enigma codes. |
| 1944 | IBM Harvard Mark I simulates atomic reactions for Manhattan Project. |
| 1945 | ENIAC calculates artillery firing tables for the US Army. |
| ↳ 1950 | Hamming “error correction” codes are introduced. |

# Quantum computing is expected to have impact across industries

Simulating nature

Mathematics and processing data with complex structure

Search and optimization



**Aerospace & Automotive**
- Customer Experience
- Materials Design
- Structural Design Optimization
- And more

**Financial Services**
- Fraud Detection
- Derivatives/options pricing
- Portfolio optimization
- Risk analysis
- And more

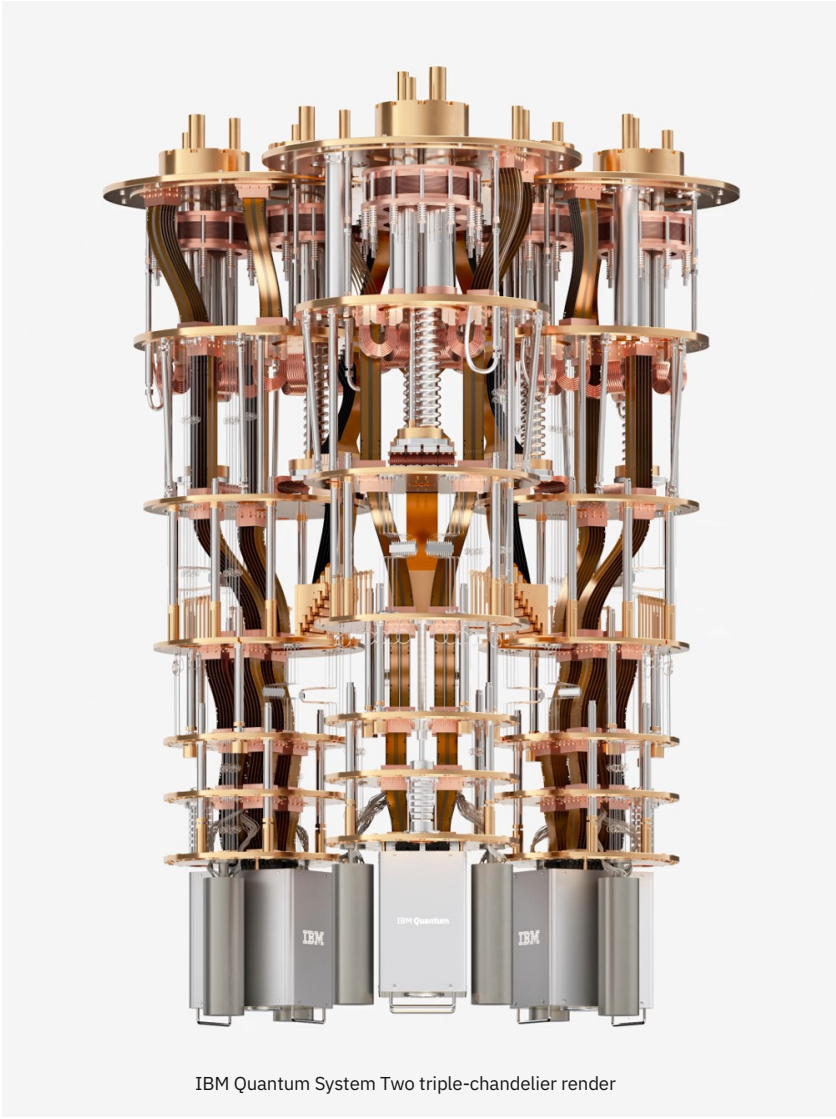
**High Tech**
- Seismic Imaging
- Catalysts
- Supply chain planning
- Manufacturing scheduling
- And more

**Energy, Environment, Utilities**
- Portfolio optimization
- Grid optimization
- Risk Analysis and Options Pricing
- Battery Design
- And more

**Health Care & Life Sciences**
- Disease risk prediction
- Drug discovery and design
- Protein folding predictions
- And more






IBM Quantum System Two triple-chandelier render


IBM
IBM Quantum
System One


IBM
IBM Quantum
System Two

## IBM Quantum capabilities

# Utility-scale quantum fleet enabling utility-scale work

**100+ qubits**
The world's largest fleet of quantum computing systems, all with more than 100 qubits

Advanced processors offering error per layered gate (EPLG) as low as $4x10^{-4}$ and CLOPS (a measure of how quickly our processors run quantum volume circuits in a series) as high as 200K

**Enhanced connectivity**
New coupling technologies to forge more connections between qubits

**Powerful processors**
Tunable couplers between fixed-frequency qubits dramatically reduce noise

See all available system metrics: quantum.ibm.com/services/resources?tab=systems

Learn more about performance metrics: www.ibm.com/quantum/blog/quantum-metric-layer-fidelity



## IBM Quantum in numbers

# The IBM Quantum ecosystem is a thriving, rich community driving innovation.

**250+**

**IBM Quantum Network members**
The largest ecosystem

**600K+**

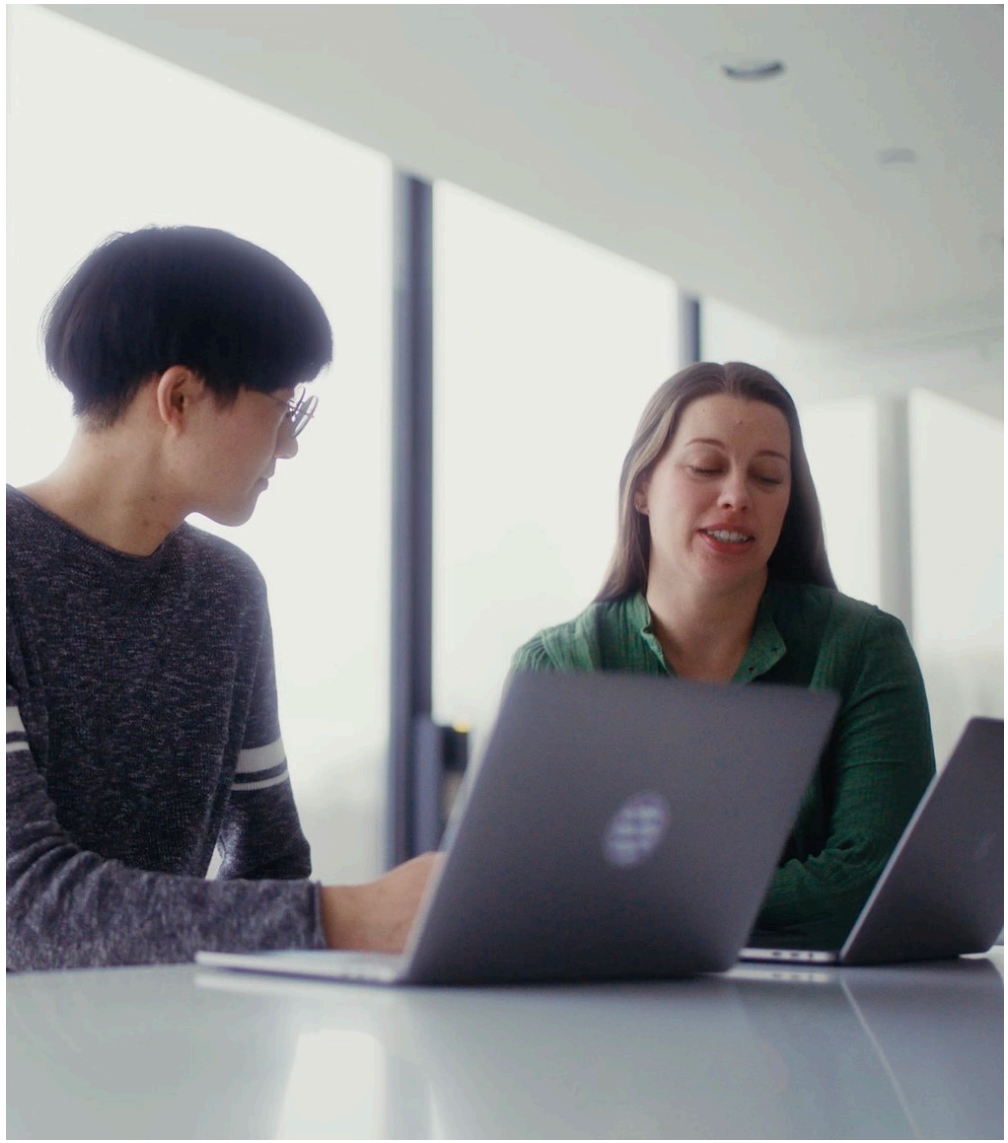
**Users**
The largest user base

**3,000+**

**Papers**
The most innovative ecosystem

**10+**

**Quantum computers**
The largest fleet



# Qiskit SDK v1.x

The most stable open-source quantum SDK and utility-scale tool for building and constructing quantum circuits

74%

of quantum programmers prefer Qiskit SDK

(2024 Unitary Fund survey)

8+

hardware manufacturers support Qiskit-based quantum programs

(Alpine Quantum • Amazon Bracket • Azure Quantum • IBM Quantum • IonQ • IQM • Quantinuum• Rigetti)

Up to

5x

faster with parallelism made possible by new batch execution mode

16x

faster binding and transpiling

(Compared to Qiskit 0.33)

23%

fewer 2Q gates

(Compared to Tket 1.21
Avg. of six 100-qubit algorithms)

55%

decrease in memory usage

(Compared to Qiskit 0.39
Avg. of six 100-qubit algorithms)

# Workforce development and education

For every three quantum technology job openings today, the United States has only one qualified candidate — and by 2025, McKinsey analysts predict, more than half of the country's quantum jobs will go unfilled.

**700+**

Courses created over the last 7 years

**9M+**

Content viewers globally

**1.1K+**

Certified developers

**4K+**

Badges earned

# IBM Quantum offerings

## Access quantum computing

| Open Plan | Pay-as-you-go | Premium Plan | Dedicated Service |
|---|---|---|---|
| | | Subscription required | Subscription required |
| Best for<br>Learning quantum computing and exploring IBM quantum technology. | Best for<br>Performing quantum utility research projects and testing business models with flexible access. | Best for<br>Executing a strategic quantum roadmap and developing quantum algorithms and applications at scale. | Best for<br>Exploring quantum algorithms and applications with high control over your resources and data. |
| ✓ Access to Qiskit® Runtime as a service<br>✓ Access to 100+ qubit utility-scale quantum computers | ✓ Access to Qiskit® Runtime as a service<br>✓ Access to 100+ qubit utility-scale quantum computers<br>✓ IBM Quantum™ technical support | ✓ Access to Qiskit® Runtime as a Service<br>✓ Access to 100+ qubit utility-scale quantum computers<br>✓ IBM Quantum™ technical support<br>✓ IBM Quantum Network membership<br>✓ Optional access to our Quantum Accelerator offering<br>✓ Advanced software features<br>✓ Early access to new features<br><br>Purchased in QAUs<br>1 QAU = up to 1600 Value Units per 28-day period<br>1 Value Unit = 1 minute of usage on <200 qubit system<br>0.5 minutes on 200 to <500 qubit system | ✓ Access to Qiskit® Runtime as a Service<br>✓ Access to 100+ qubit utility-scale quantum computers<br>✓ IBM Quantum™ technical support<br>✓ IBM Quantum Network membership<br>✓ Optional access to our Quantum Accelerator offering<br>✓ Advanced software features<br>✓ Full computer capacity purchased as a service<br>✓ Optional quantum system location on client site |
| **Free**<br>Access to utility scale quantum computers for up to 10 minutes of runtime per month. | Starting at<br>**$96 USD / minute**<br>Pay for what you use. Billed per second of usage via IBM Cloud. | Equivalent to<br>**$48 USD / minute***<br>Reserve the capacity you need for the year with Quantum Allocation Units and use up to 1600 minutes per QAU every 28 day rolling time-window.<br>*Based on list price for 1 QAU (Quantum Allocation Units). | **Price requires quote**<br>Access to an entirely dedicated quantum system that is serviced and maintained by IBM. |

# Neurons, the AI platform



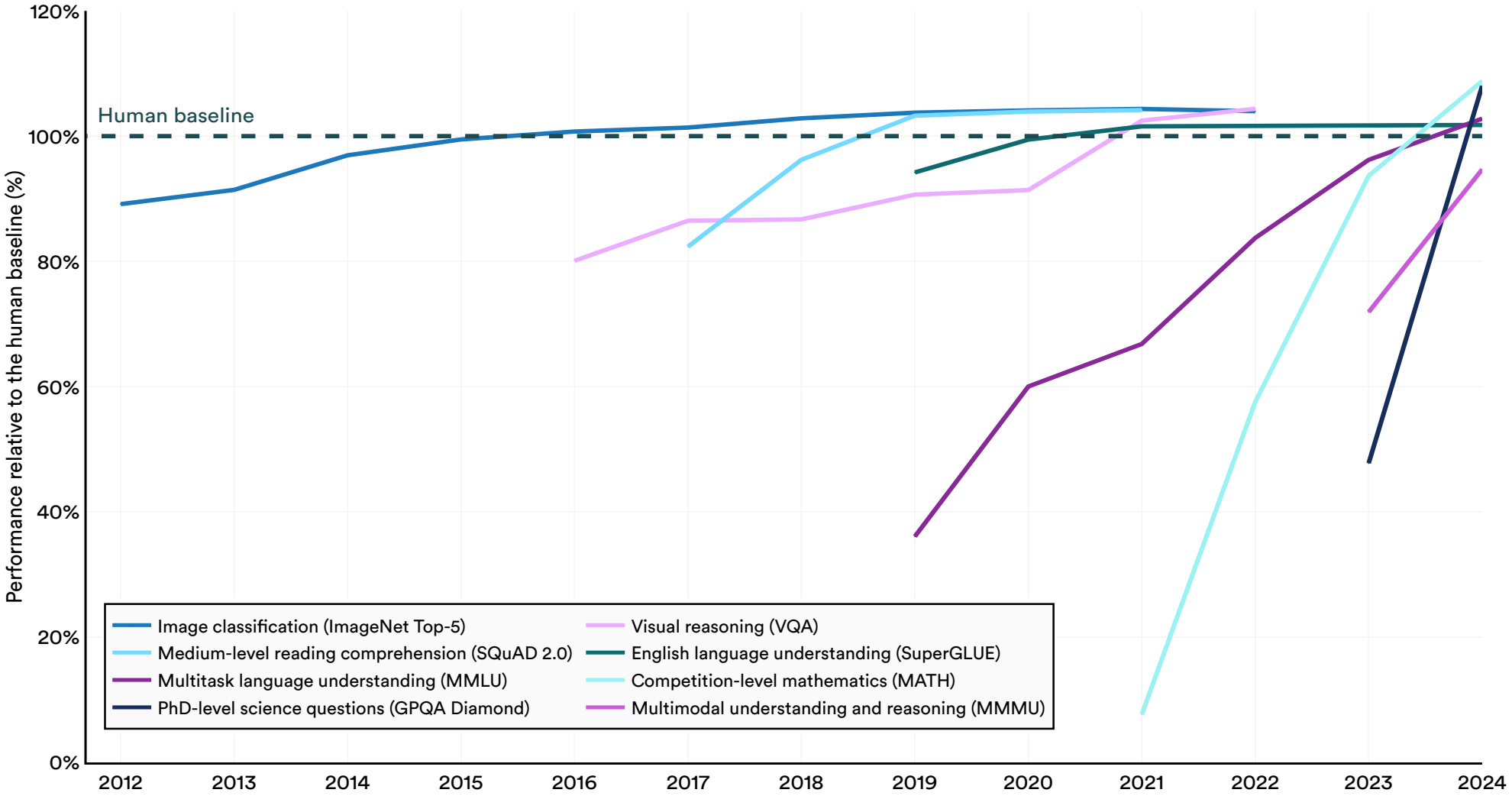

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# AI is not a science fiction: it’s already affecting our lives




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# AI vs. human performance




Source: AI Index 2025, Chart: The AI Index 2025 Annual Report

Reinventing how work gets done

# IBM is actively engaging with enterprise clients across a broad set of business domains

*Client results and analyst studies*

| Customer-facing functions and experiences | HR, Finance, and Supply chain functions | IT development and operations | Core business operations |
|---|---|---|---|
| **Customer service**<br>Empower customers to find solutions with easy, compelling experiences<br>90% customer inquiries handled by an AI assistant[1] | **HR automation**<br>Reduce manual work and automate recruiting, sourcing and nurturing job candidates<br>40% improvement in process productivity[2] | **App modernization, migration**<br>Generate code, tune code generation response in real time<br>60% software development content auto generated by AI[3] | **Threat management**<br>Reduce incident response times from hours to minutes or seconds<br>Contain potential threats 8x faster[4] |
| **Marketing**<br>Increase personalization, improve efficiency across the content supply chain<br>Reduce derivative content creation spend[5] | **Supply chain**<br>Automate source to pay processes, reduce resource needs and improve cycle times<br>Reduce product origin traceability from days to seconds[6] | **IT automation**<br>Reduce automation development, identify deployment issues, avoiding incidents, optimize application demand to supply<br>Reduce mean time to repair (MTTR) by 50%+[7] | **Asset management**<br>Optimize critical asset performance and operations while delivering sustainable outcomes<br>Reduce unplanned downtime by 43%[8] |
| **Content creation**<br>Ex. Enhance digital sports viewing with auto-generated spoken AI commentary<br>Scale live viewing experiences cost effectively[9] | **Planning and analysis**<br>Make smarter decisions, focus on higher value tasks with automated workflows and AI<br>Process planning data up to 80% faster[10] | **AIOps**<br>Assure continuous, cost-effective performance and connectivity across applications<br>Reduce application support tickets by 70%[11] | **Product development**<br>Ex. Expedite drug discovery by inferring structure with AI from simple molecular representations<br>Faster and less expensive drug discovery[12] |
| **Knowledge worker**<br>Enable higher value work, improve decision making, and increase productivity<br>Reduce 90% of text reading and analysis work[13] | **Regulatory compliance**<br>Support compliance based on requirements / risks, proactively respond to regulatory changes<br>Reduce time spent responding to issues[14] | **Data platform engineering**<br>Redesign the approach for data integration using generative AI<br>Reduce data integration time by 30%+[15] | **Environmental intelligence**<br>Provide intelligence to proactively plan and manage impact of severe weather and climate<br>Increase manufacturing output by 25%[16] |

Sources for footnotes: in the handouts

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# Footnotes references

[1]AI-based unified digital messaging amplifies the customer experience, Vodafone case study, Genesys, 2020: https://www.genesys.com/customer-stories/Vodafone

[2]Creating the future of human resources, IBM, October 2022: https://www.ibm.com/case-studies/ibm-human-resources-watson-orchestrate

[3]Generative generated 60% of Ansible Playbook Content in IBM CIO Organization Pilot, IBM, October 2023: https://www.ibm.com/case-studies/ibm-cio-organization-wca

[4]TalkTalk client story, IBM, April 2019: https://www.ibm.com/case-studies/talktalk

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[7]When billions of mission-critical file transfers depend on you, How ExaVault maximizes uptime using Instana, IBM, November 2021: https://www.ibm.com/case-studies/exavault-inc

[8]The Business Value of IBM Maximo, IDC, March 2022: https://www.ibm.com/downloads/cas/7XM93NG9

[9]Acing the US Open digital experience, IBM, October 2023: https://www.ibm.com/case-studies/us-open

[10]The Total Economic Impact™ Of IBM Planning Analytics with Watson, Forrester, December 2021: https://www.ibm.com/downloads/cas/DNPPK7YY

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[13]IBM Watson Discovery product claim: https://www.ibm.com/products/watson-discovery

[14]IBM OpenPages product claim: https://www.ibm.com/products/openpages

[15]Gartner Top 10 Data and Analytics Trends for 2021, Gartner, March 2021: https://www.gartner.com/smarterwithgartner/gartner-top-10-data-and-analytics-trends-for-2021

[16]Environmental intelligence

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# Agentic AI unlocks a new Paradigm for AI Assistants

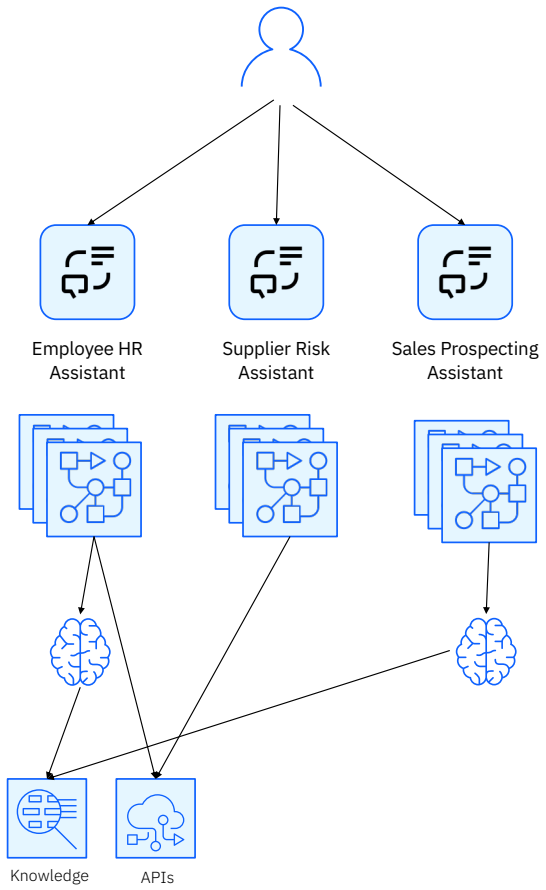
**Assistants with GenAI**

Multiple entry points, fragmented experience

State-machine based control logic determines UX

LLM used for greater flexibility and contextual understanding

Retrieve external knowledge to ground LLM; Connect to external services as action steps




**Assistants with Agents**

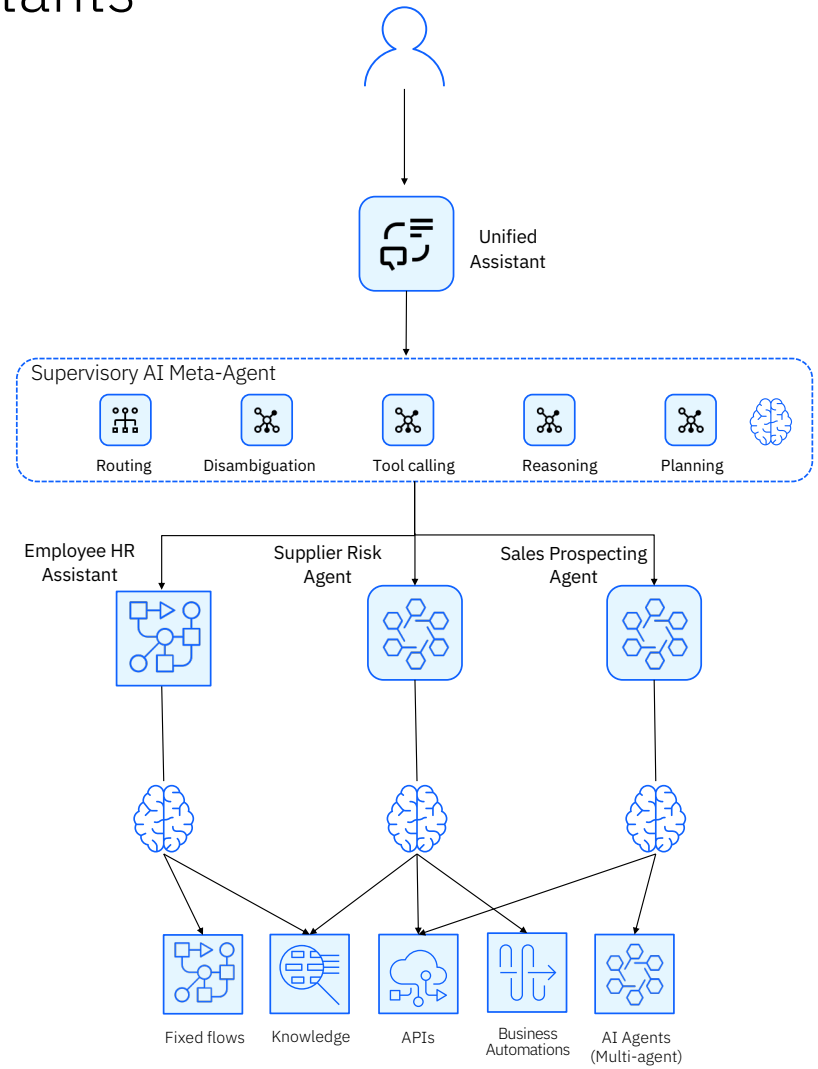
Unified experience

LLM agent facilitates the UX

LLM agents execute actions autonomously and facilitate user interactions

LLM used for multi-turn conversation, tool calling, reasoning

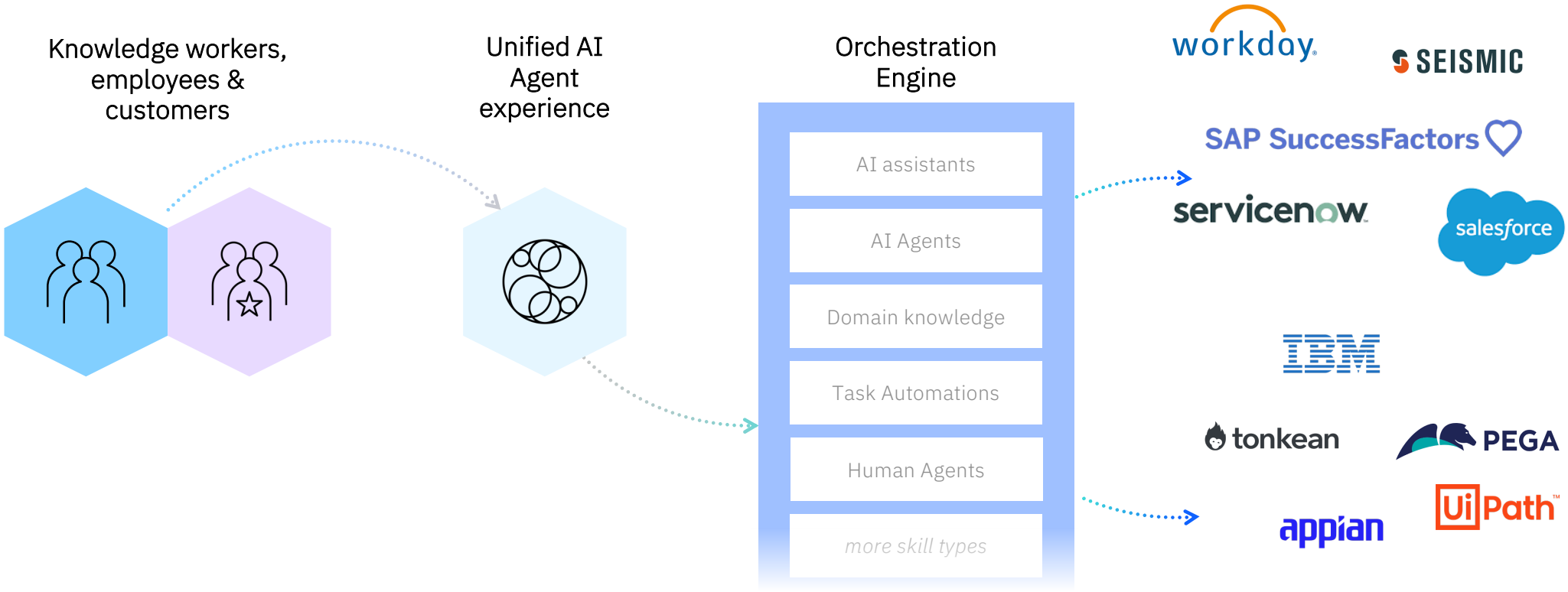
LLM based tool calling enables agent workflows across a wide variety of integrations




watsonx Orchestrate / © 2025 IBM Corporation

# Future of work

## Intelligent orchestration accessible to all users through a conversational experience for enhanced productivity



# IBM’s point of view:
# Core principles to tailor generative AI for enterprise

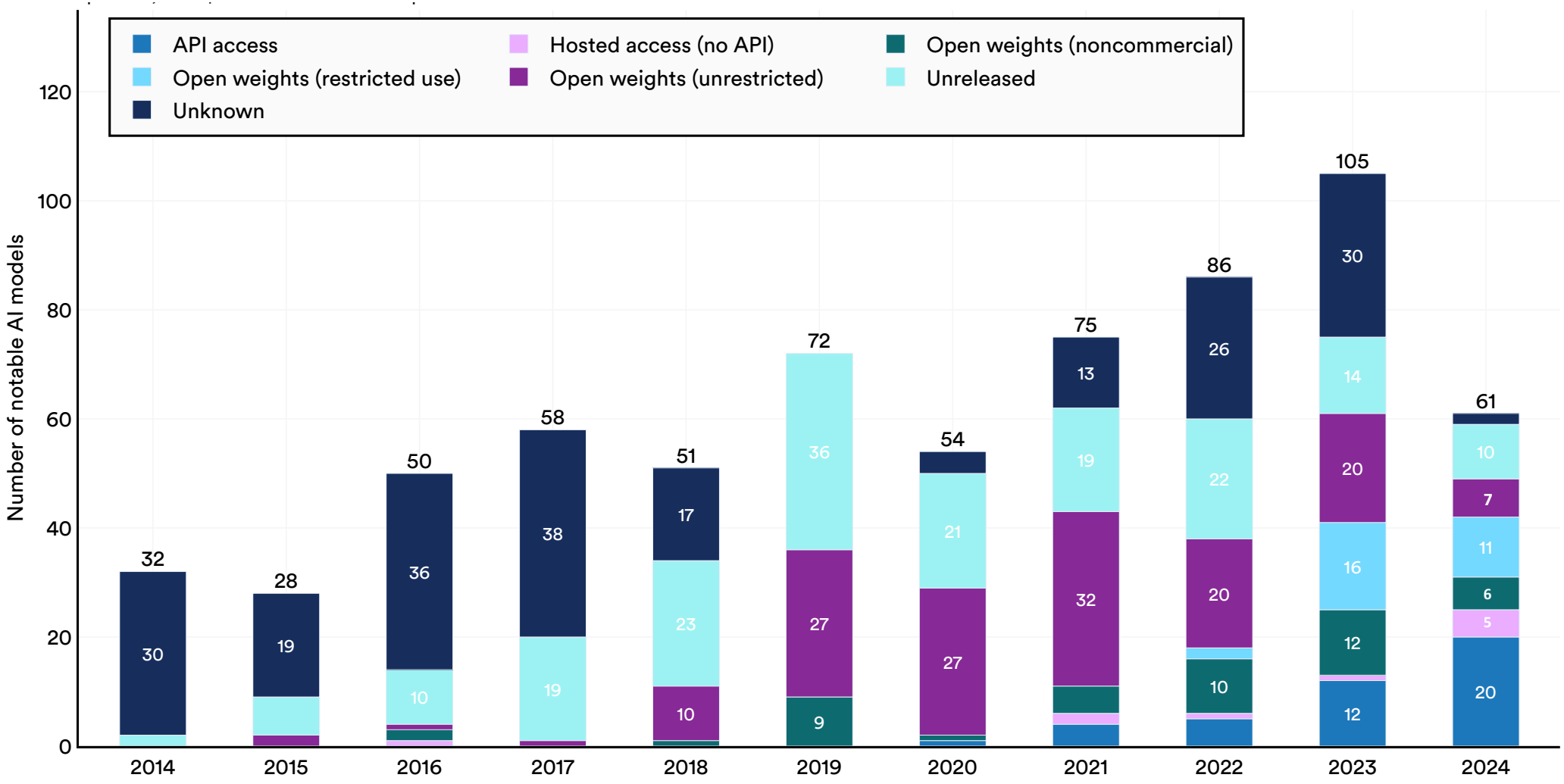
## Open

→ Based on the best AI and cloud technologies available.

→ Giving access to the innovation of the open community and multiple models.

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# Number of notable AI models by access type




Source: Epoch AI, 2025, Chart: [The AI Index 2025 Annual Report]

# IBM’s point of view:
# Core principles to tailor generative AI for enterprise

## Open

→ Based on the best AI and cloud technologies available.

→ Giving access to the innovation of the open community and multiple models.

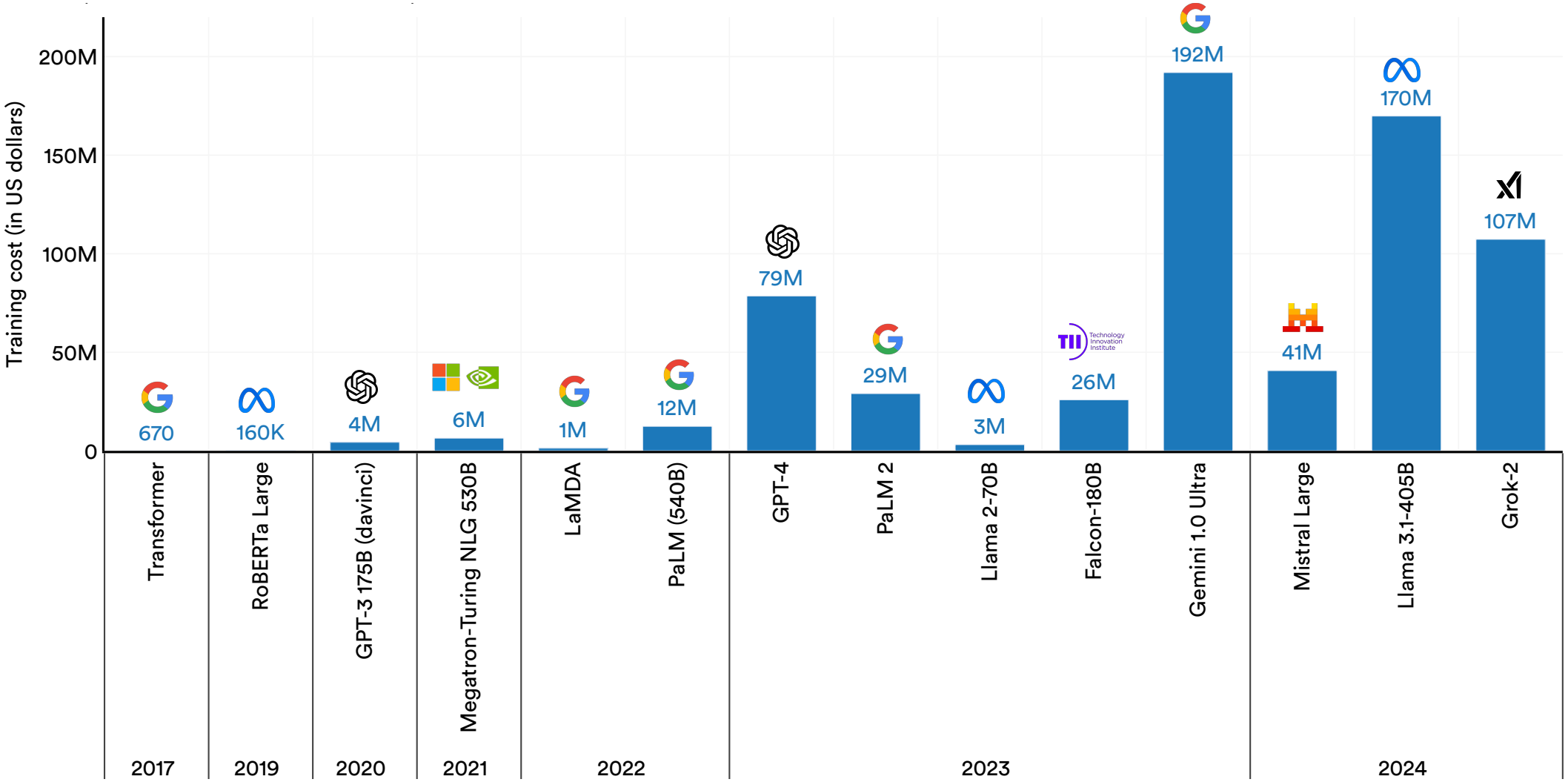
## Targeted

→ Designed for targeted business use cases, that unlock new value.

→ Including curated models that can be tuned to proprietary data and company guidelines.

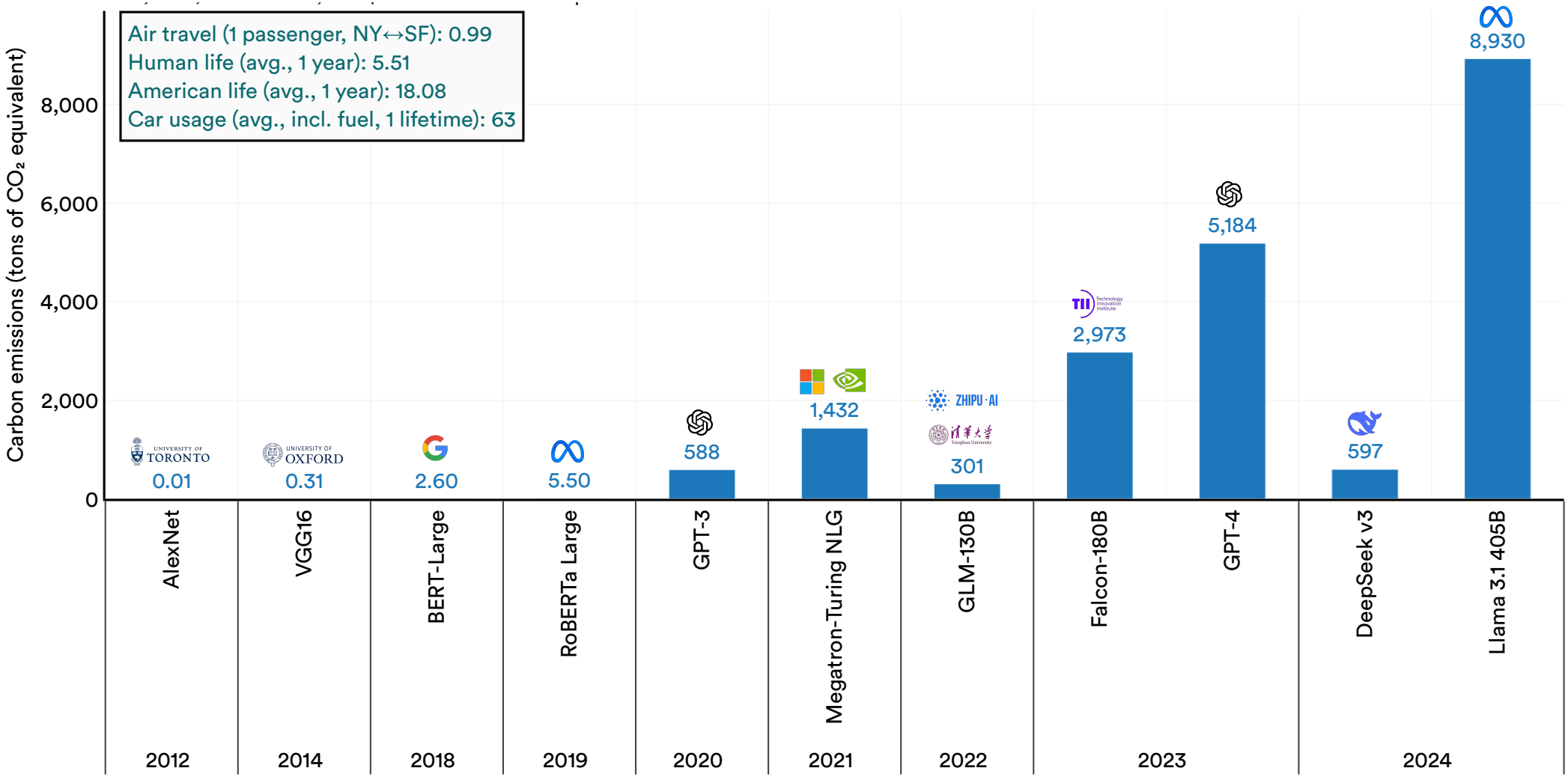
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# Estimated training cost of select AI models




Source: Epoch 2024, Chart: The AI Index 2025 Annual Report

# Estimated carbon emissions from training select AI models




Source: AI Index, 2025; Strubell et al. 2019, Chart: The AI Index 2025 Annual Report

# IBM’s point of view:
# Core principles to tailor generative AI for enterprise

## Open

→ Based on the best AI and cloud technologies available.

→ Giving access to the innovation of the open community and multiple models.

## Targeted

→ Designed for targeted business use cases, that unlock new value.

→ Including curated models that can be tuned to proprietary data and company guidelines.

## Trusted

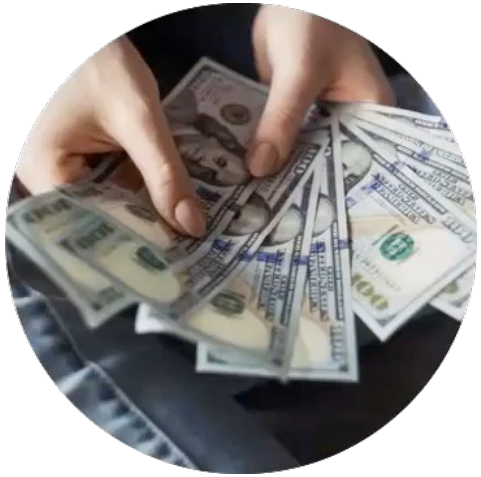
→ Offering security and data protection.

→ Built with governance, transparency, and ethics that support increasing regulatory compliance demands.

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# The need for responsible AI

## AI is powering critical workflows and trust  is essential



loan processing




employment



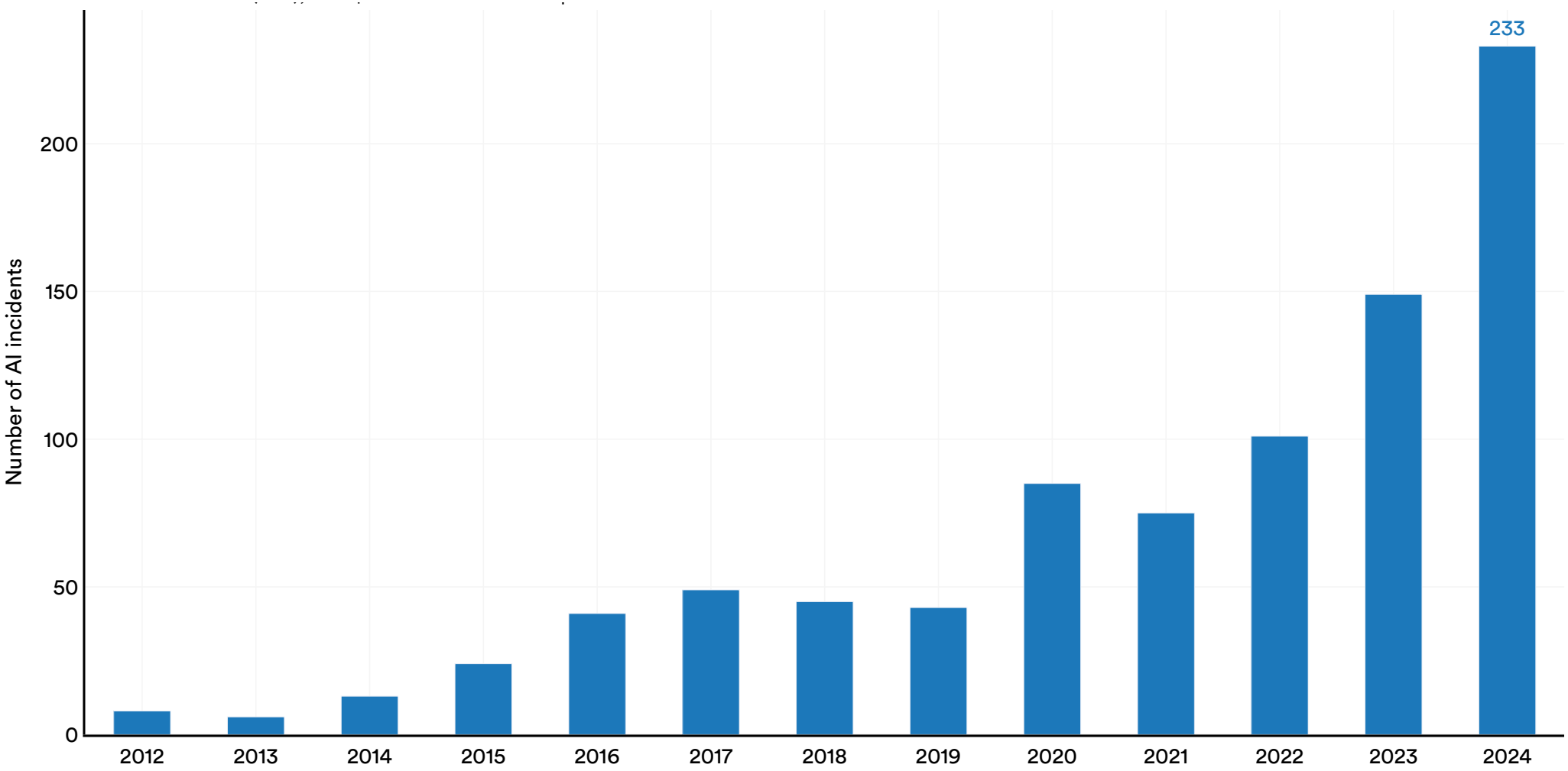
customer management



quality control

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# Number of reported AI incidents




Source: AI Incident Database (AIID) 2024, Chart: The AI Index 2025 Annual Report

# IBM’s point of view
## Four core principles to tailor generative AI for enterprise

### Open

→ Based on the best AI and cloud technologies available.

→ Giving access to the innovation of the open community and multiple models.

### Targeted

→ Designed for targeted business use cases, that unlock new value.

→ Including curated models that can be tuned to proprietary data and company guidelines.

### Trusted

→ Offering security and data protection.

→ Built with governance, transparency, and ethics that support increasing regulatory compliance demands.

### Empowering

→ On a platform to bring your own data and AI models that you tune, train, deploy, and govern.

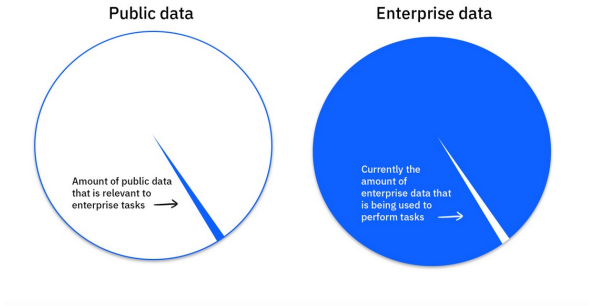
→ Running anywhere, designed for scale and widespread adoption to truly create enterprise value.

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# IBM’s point of view:
# Approach to representing enterprise data with foundational models

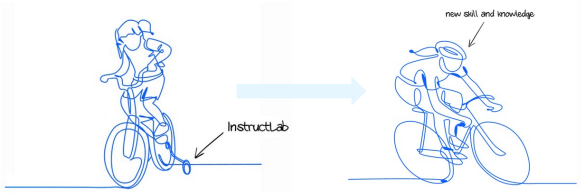
## 1. Select trusted base model

- Choice of execution platforms
- Performance
- Transparency
- Commercial rights
- Indemnification
- For example, new Granite 3.0 models




## 2. Create new representation of your data

- RAG, prompting, fine tuning
- InstructLAB
  - ✓ Most advanced
  - ✓ Makes LLM truly open-source with collaborative model development
  - ✓ Allows LLM to learn as human do, using knowledge and skills
  - ✓ Enables incremental skills teaching.

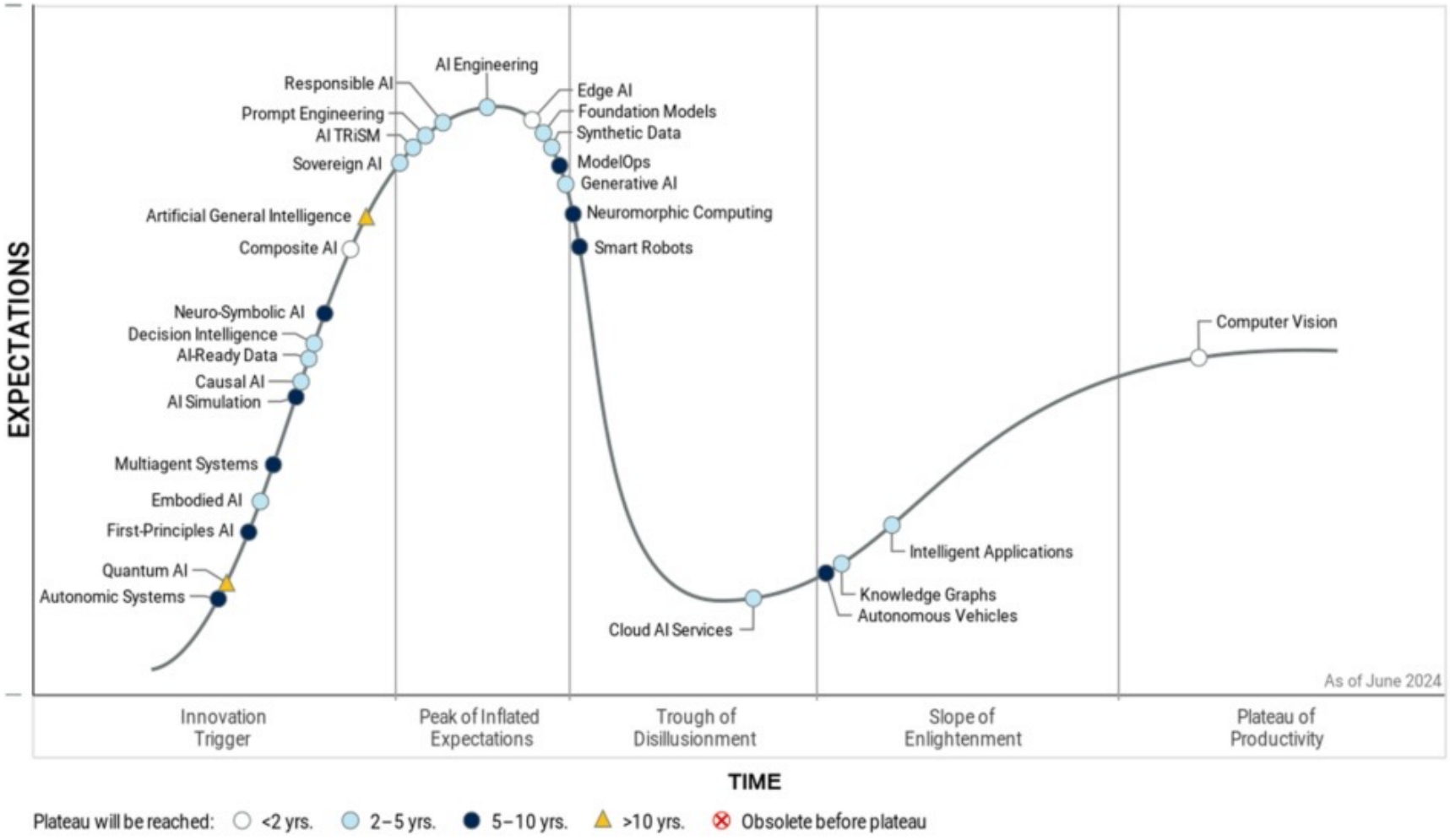



## 3. Deploy, scale and create value with AI

- Choice of execution platforms
- Performance
- Cost
- Sustainability
- Explainability
- Auditing
- Governance

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## Hype Cycle for Artificial Intelligence, 2024

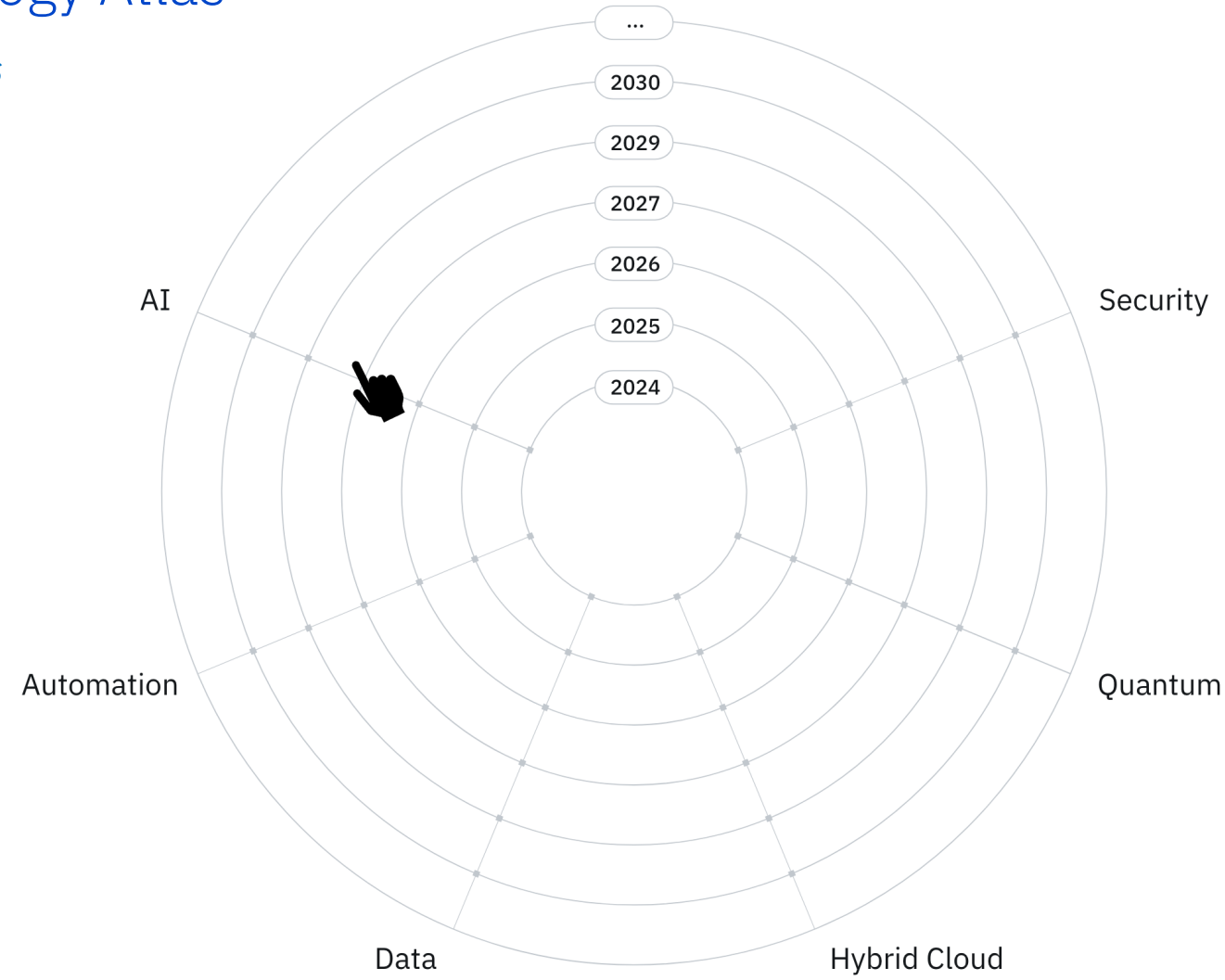



https://www.gartner.com/en/documents/5505695

Gartner

# IBM Technology Atlas

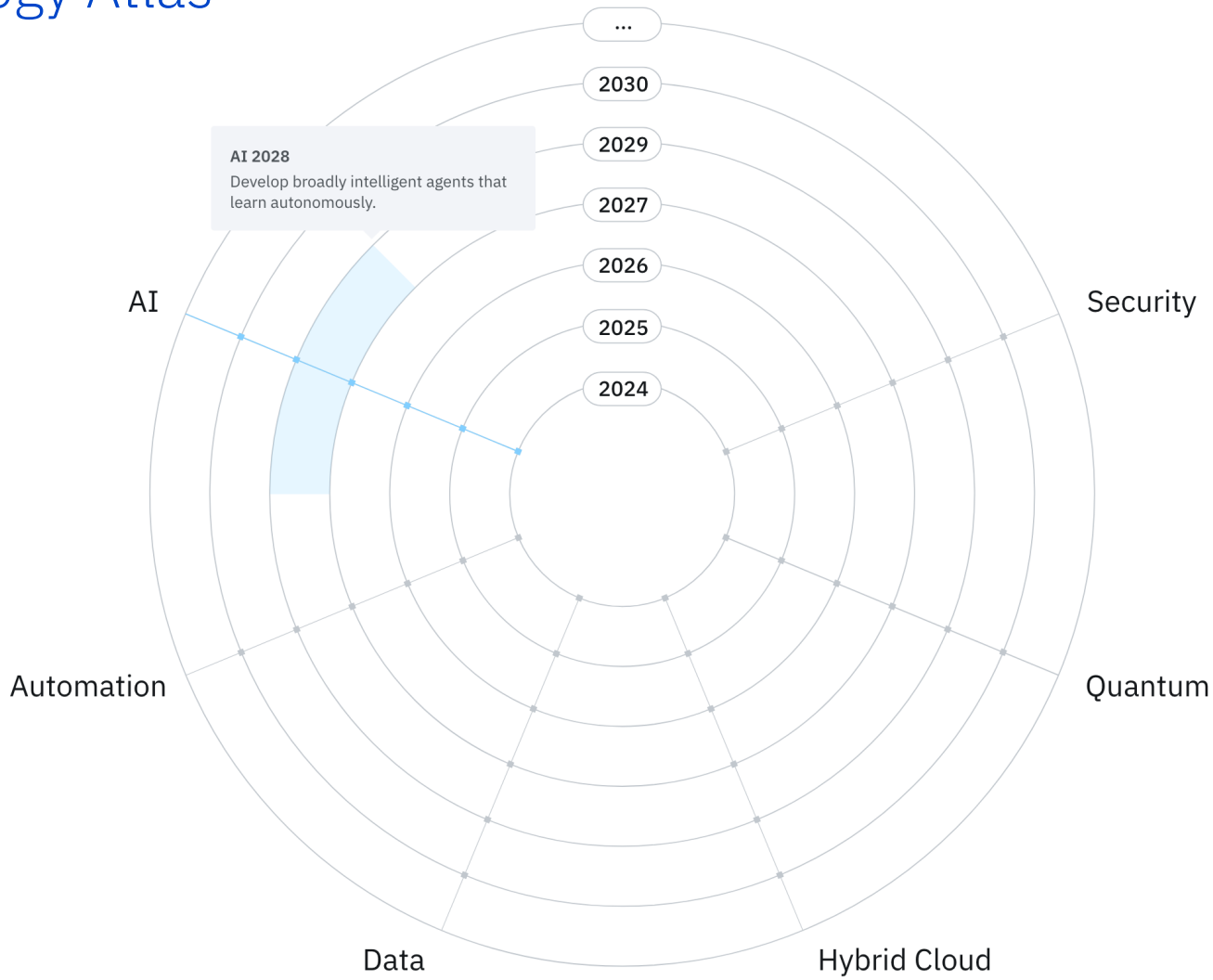
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# AI Roadmap - 2028

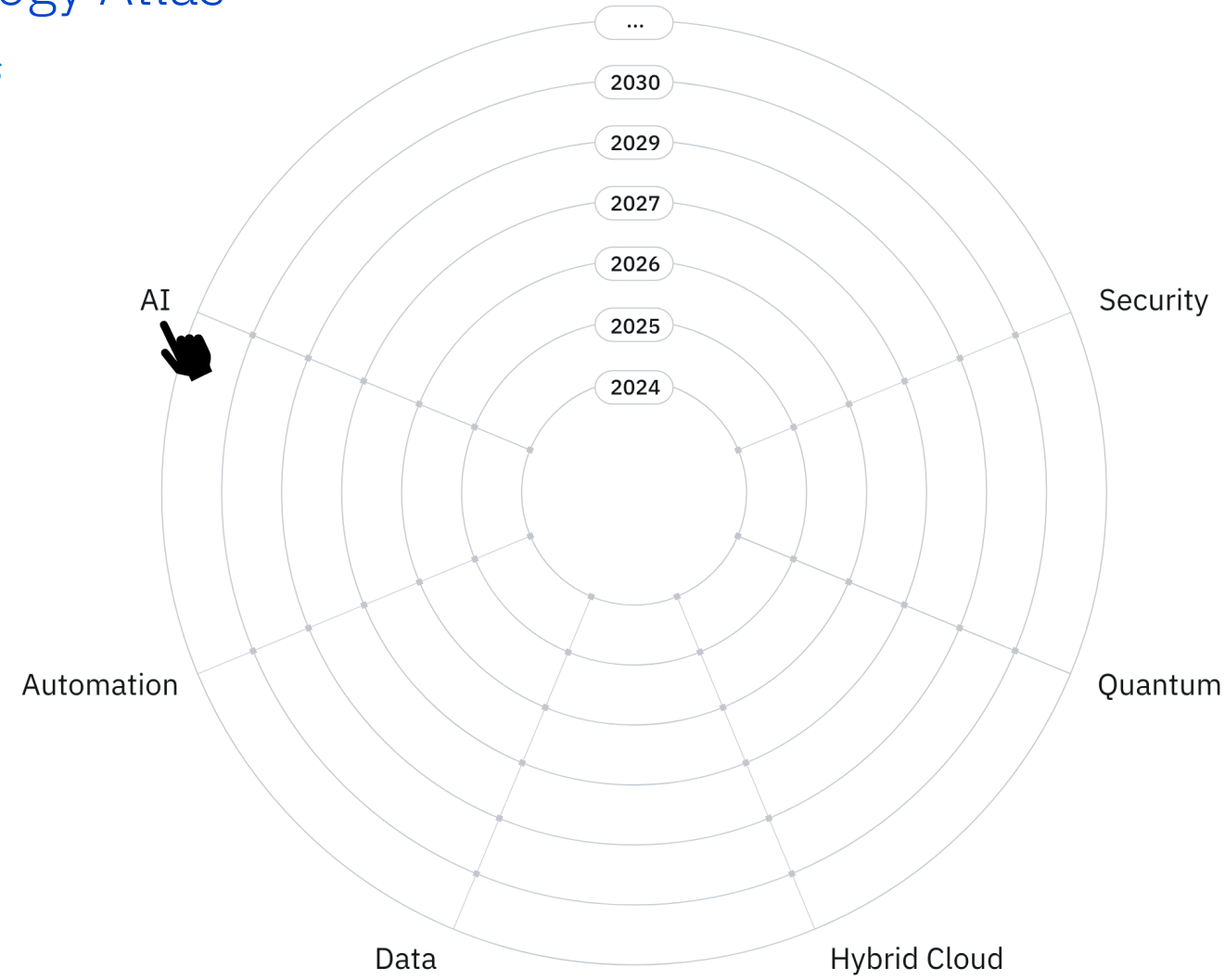
| | |
|---|---|
| Develop broadly intelligent agents that learn autonomously. | We will build autonomous AI that can reliably and efficiently learn from its environment and respond to previously unseen situations through broad generalizations. These AI systems will start exhibiting aspects of cognitive intelligence. |
| Why this matters for our clients and the world | AI will be capable of continually and efficiently learning from multimodal input about how the world works. Those systems will learn to operate effectively even amid uncertainty and develop problem-solving skills. |
| The technologies and innovations that will make this possible | We will build agents augmented with multiple memory systems and multiple neural mechanisms that will interact autonomously with each other. We will develop hybrid neural architectures that will rationalize over constantly evolving information about the world. They will learn to refine their multi-scale world model and develop generalizable skills for complex problem-solving. |
| How these advancements will be delivered to IBM clients and partners | watsonx will support autonomous and broadly intelligent agents with appropriate trust guardrails. |

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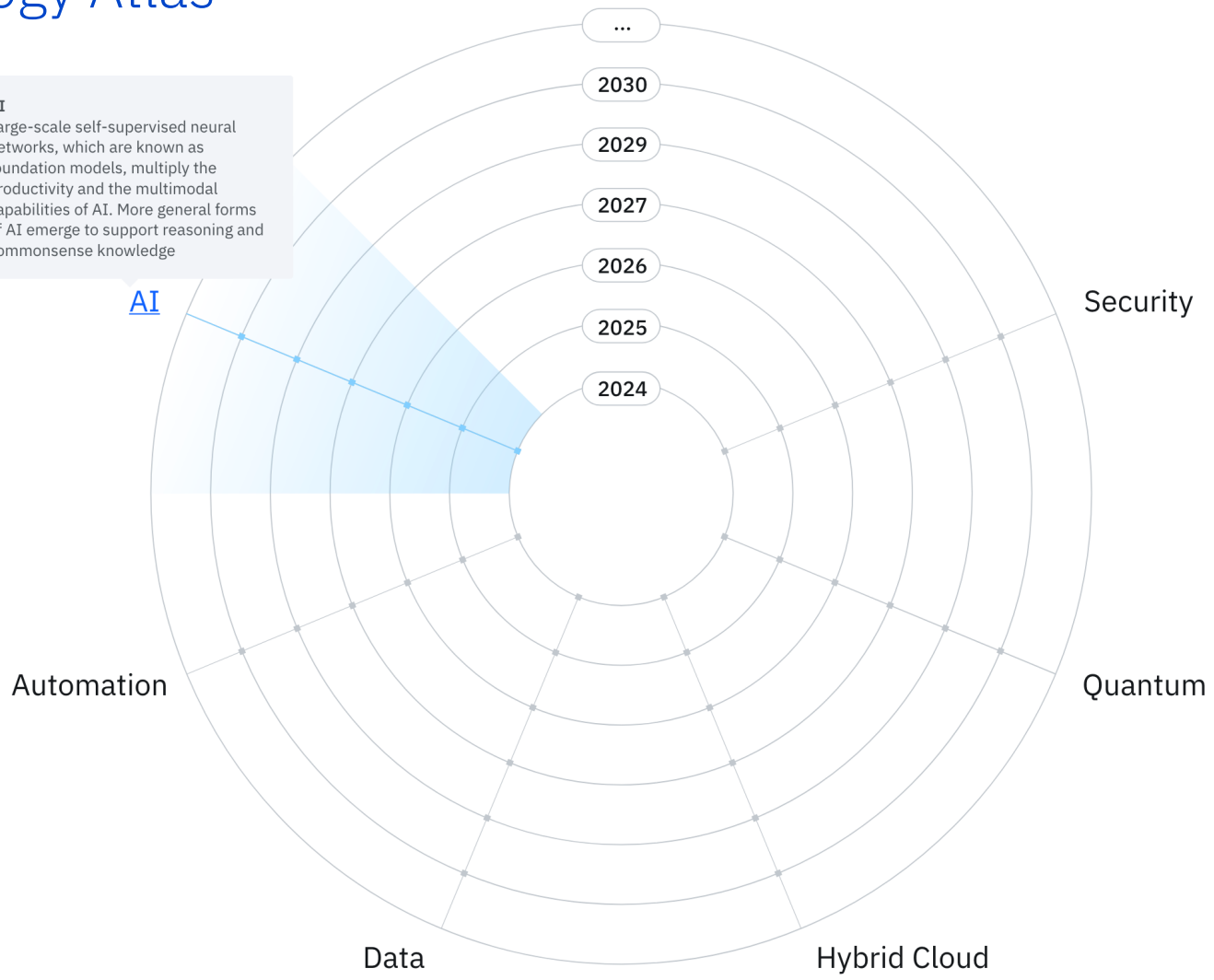
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# AI Roadmap

Large-scale, self-supervised neural networks, which are known as foundation models, multiply the productivity and the multimodal capabilities of AI. More general forms of AI emerge to support reasoning and common-sense knowledge.

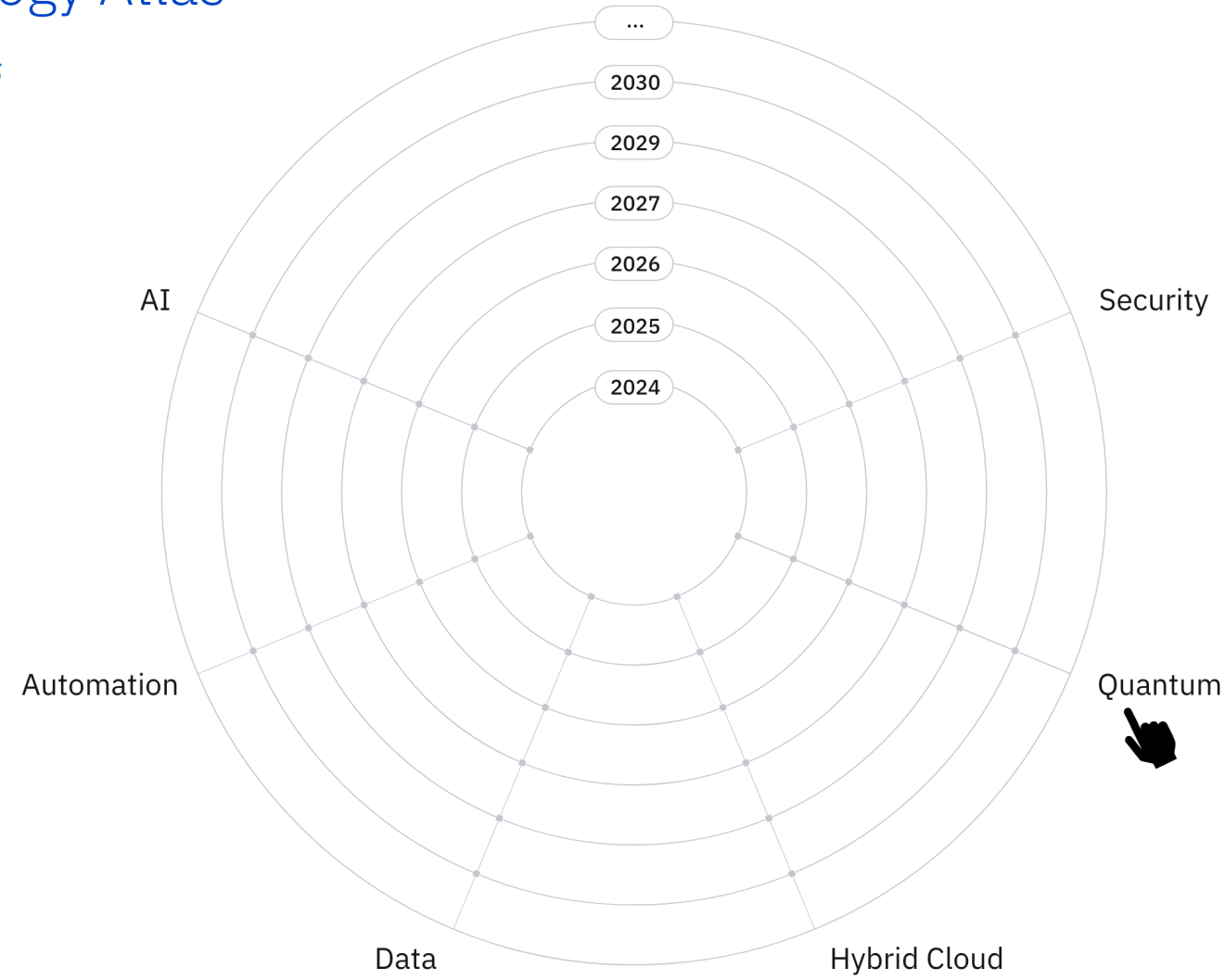
| 2024 | 2025 | 2026 | 2028 | 2030 | 2030+ |
|---|---|---|---|---|---|
| Build modular and multimodal transformers for new enterprise applications. | Alter the scaling of generative AI with neural architectures beyond transformers. | Bring robust, strategic reasoning and commonsense knowledge to AI. | Develop broadly intelligent agents that learn autonomously. | Build empathic and intrinsically responsible AI agents. | Build adaptable and generalist AI for effective human-machine collaboration. |

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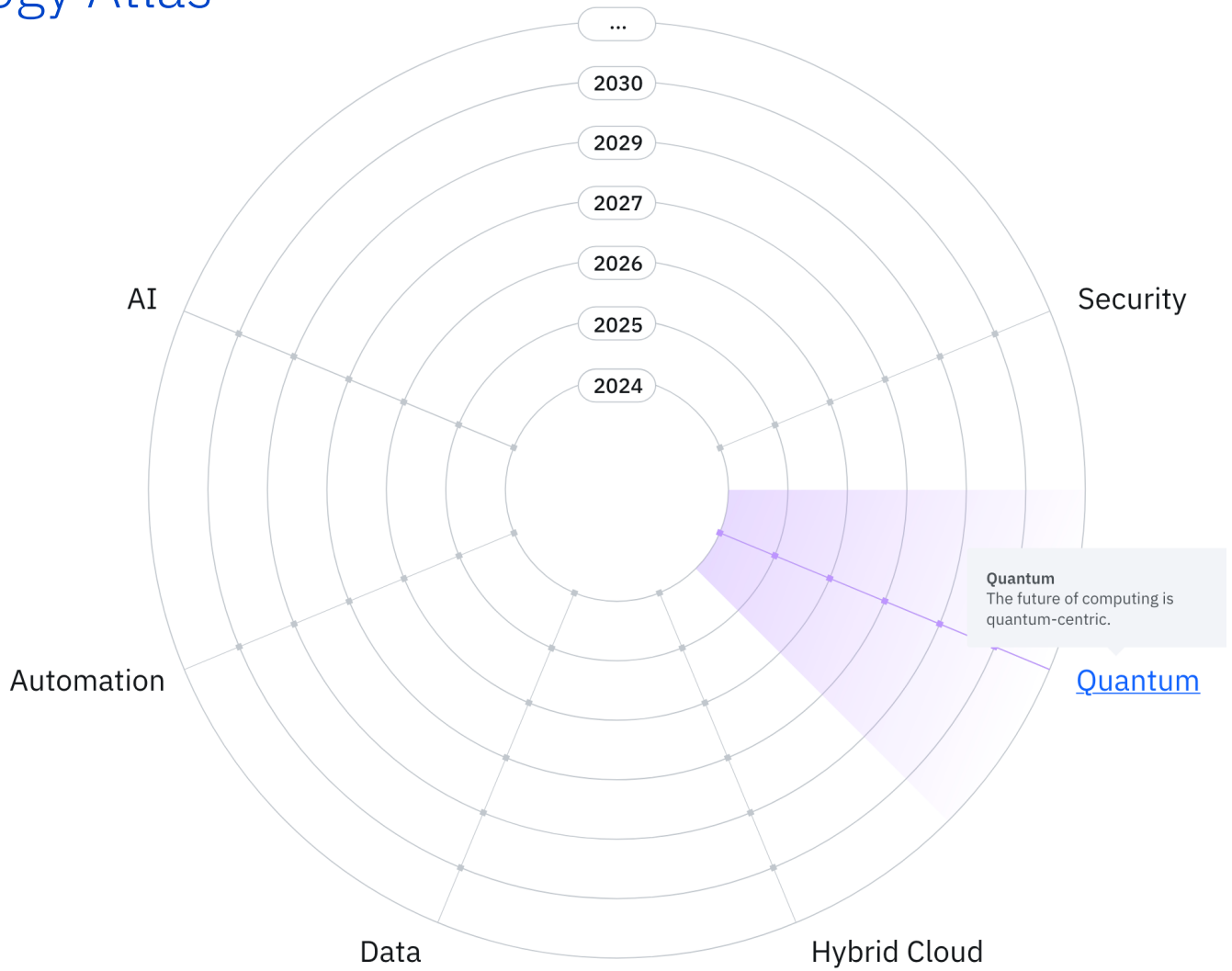
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# Quantum Roadmap

The future of computing is quantum centric.

| 2024 | 2025 | 2026 | 2027 | 2029 | 2033+ |
|---|---|---|---|---|---|
| Expand the utility of quantum computing. | Demonstrate quantum-centric supercomputing | Automate and increase the depth of quantum circuits | Scale quantum computing | Deliver a fully error-corrected system | Deliver quantum-centric supercomputers with 1000’s of logical qubits |

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The AI Index 2025 Annual Report, AI Index Steering Committee, Institute for Human-Centered AI, Stanford University, Stanford, CA, April 2025.