CBINSIGHTS

Game Changers 2022

9 technologies that could **change the world**

Contents

"What we need to do is **always lean into the future,** when the world changes around you and **when it changes against you.**"

— Jeff Bezos, Amazon founder

Executive summary

Our Game Changers 2022 report highlights 9 emerging technologies that have the potential to change the world over the next 10 to 20 years.

Some, like brain-computer interfaces and cell coding, could lead to breakthroughs in how we treat disease.

Personal data ownership and decentralized commerce aim to put power back in the hands of consumers and sellers, while AI auditors and passwordless authentication protect against cyberattacks, data breaches, and hidden biases.

Other technologies stand to redefine chip design (neuromorphic computing), scientific measurement (commercial quantum sensors), and electronics (lab-grown diamonds).

Read on to explore each of these technologies — and the startups building them.

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Game Changers 2022

Tech that could **change the world**

Commercial quantum sensors

Hyper-sensitive systems that can detect the slightest change in an environment

AI auditors

Platforms that vet AI models to protect against risks like cyberattacks and hidden biases

Brain-computer interfaces

A safer and scalable approach to the much-hyped tech to control devices using the mind

Lab-grown diamonds

A powerful alternative to materials like silicon for use in semiconductors, medical devices, and more

Personal data ownership

Using blockchain to allow consumers to own, protect, and monetize their data

Cell coding

A software-defined approach to biology that reprograms cells to treat diseases

Neuromorphic computing

Using computer systems designed like the human brain to power complex computations

Decentralized commerce

Cutting out e-commerce intermediaries to reduce transaction costs and empower sellers

Passwordless authentication

Frictionless log-ins that reduce the risk of phishing and data breaches at scale

Commercial quantum sensors

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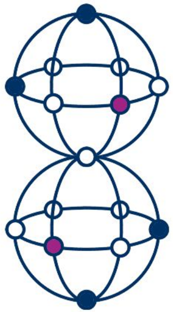
Pushing the limits of sensing to the edge of reality

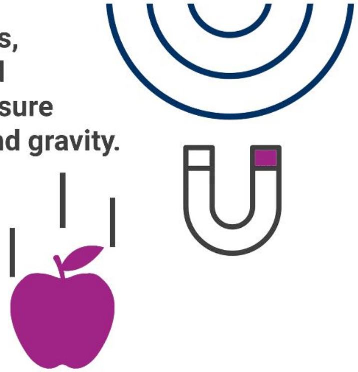
Quantum sensors can detect even the slightest change in the environment. These devices are being built for a wide array of applications — including underground mapping and medical imaging — and can be smaller, cheaper, and thousands of times more precise than conventional rivals.



Quantum systems — built around fragile mechanisms like entanglement, superposition, and more — are easily spooked by the environment around them.

The way in which these systems react to external stimulus can leave behind a tell-tale signal.

By carefully tapping into these quantum properties, researchers want to build devices to precisely measure forces like magnetism and gravity.



Quantum sensing startups are working across a wide range of industries

Headquarters: Singapore

Total funding & stage: $1.9M, seed

Description: Atomionics is working on a quantum gravimeter for applications like navigation and underground mapping.

Headquarters: Ulm, Germany

Total funding & stage: $4M, seed

Description: NVision is applying quantum tech to medical imaging, with a focus on making MRI scans much more sensitive.

Headquarters: Muttenz, Switzerland

Total funding & stage: $7.4M, Series A

Description: Qnami is developing a quantum microscope for high-precision measurements of the magnetic properties of materials.

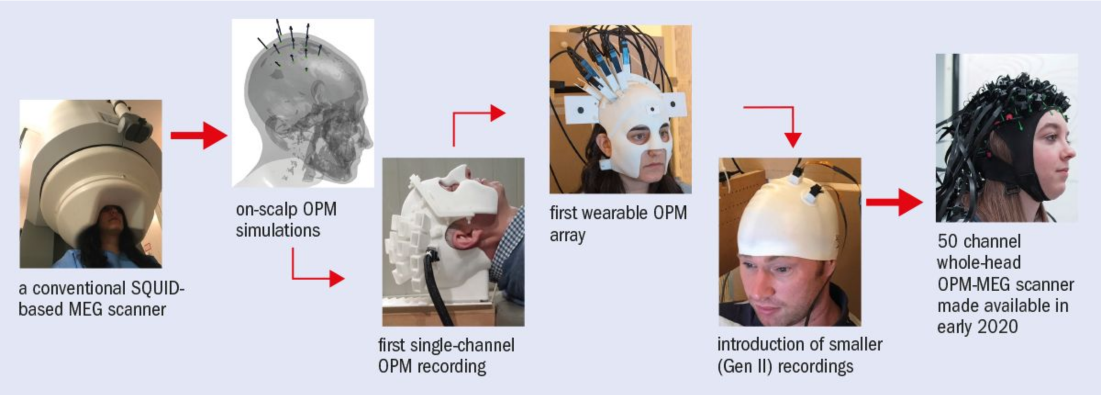
Quantum sensors will have far-reaching commercial implications

Tapping into quantum properties could lead to dramatic advances in medical imaging, navigation, underground mapping, material discovery, and much more.

"What excites us the most is that we can build a completely new positioning system without the need for any satellites or external signals."

–

Sahil Tapiawala, CEO, Atomonics



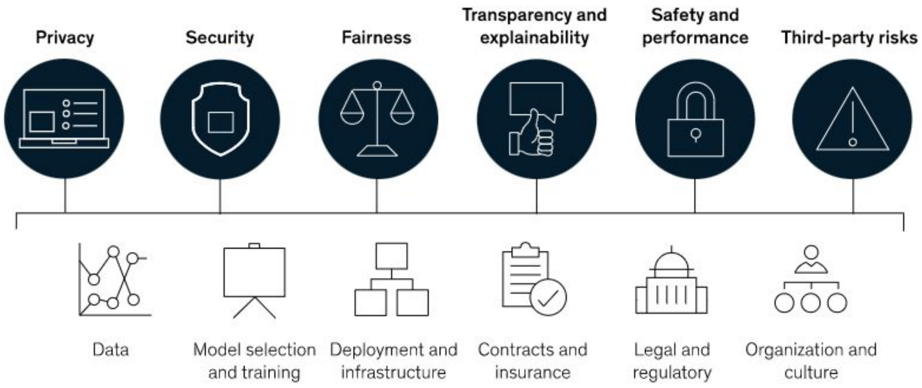
Quantum sensors are enabling MEG scanners — used for measuring brain activity — to become smaller, more accurate, and cheaper.

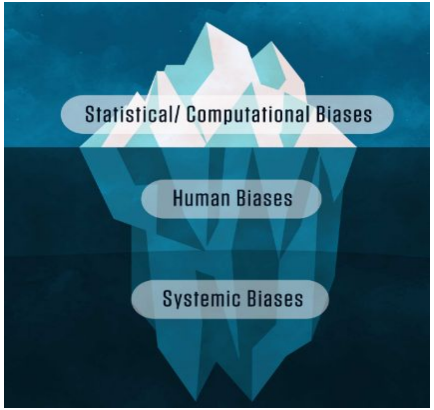
AI auditors

Creating safer, more accurate AI models

AI systems, especially those powered by machine learning (ML), are vulnerable to bias and data poisoning (an attack that tampers with a model's training data). With more than 55% of global companies using AI, these threats can have massive consequences across sectors. To mitigate these risks, startups are integrating software into AI systems to audit and amend problems in the data.

Potential areas where AI could pose risks





AI bias stems from preferences or exclusions in training data, as well as how data is obtained, how algorithms are designed, and how outputs are interpreted.

 Source: McKinsey & Company, NIST

The startups de-risking artificial intelligence

Headquarters: Montreal, Canada

Total funding & stage: N/A

Description: Snitch AI helps companies monitor and troubleshoot their ML models. It has worked with universities and research institutes like IVADO and Polytechnique Montreal to validate its tools.

KOSA AI
Your Responsible AI Guide

Headquarters: Amsterdam, Netherlands

Total funding & stage: Undisclosed, seed

Description: Kosa AI's platform works to reduce AI bias from model design to deployment. Use cases range from point-of-care diagnostics to HR functions to fraud detection.

THE TRUSTED AI COMPANY

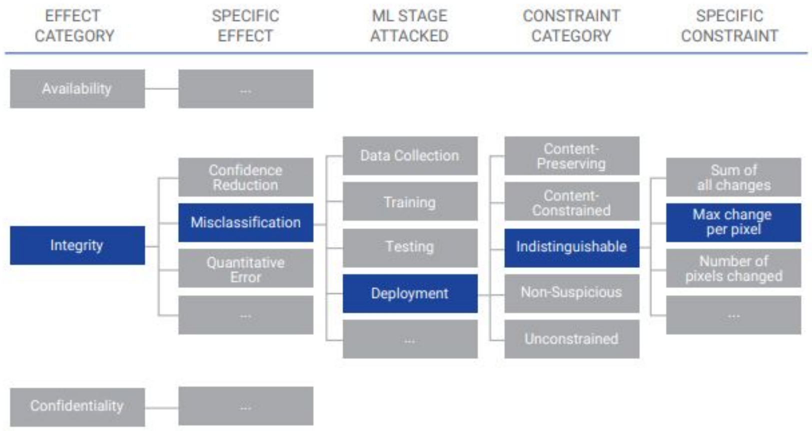
Headquarters: Austin, TX

Total funding & stage: $41M, Series B

Description: CognitiveScale's platform helps detect and score AI risks across 6 dimensions: performance, data quality, robustness, explainability, fairness, and compliance. It can audit existing black-box models.

Mitigating AI's risk to society

The opaque and scalable nature of AI presents risks — from hidden biases to creating openings for cyberattacks — that can have an outsized impact on businesses and society.



Attack options for a hacker targeting a machine learning system. The blue path outlines an attack on an image classification model.

"You have to have awareness of potential biases and how to reduce them, because the reduction of bias…means better business outcomes."

–

Yoav Schlesinger,
Architect, Ethical AI Practice at Salesforce

Brain-computer interfaces

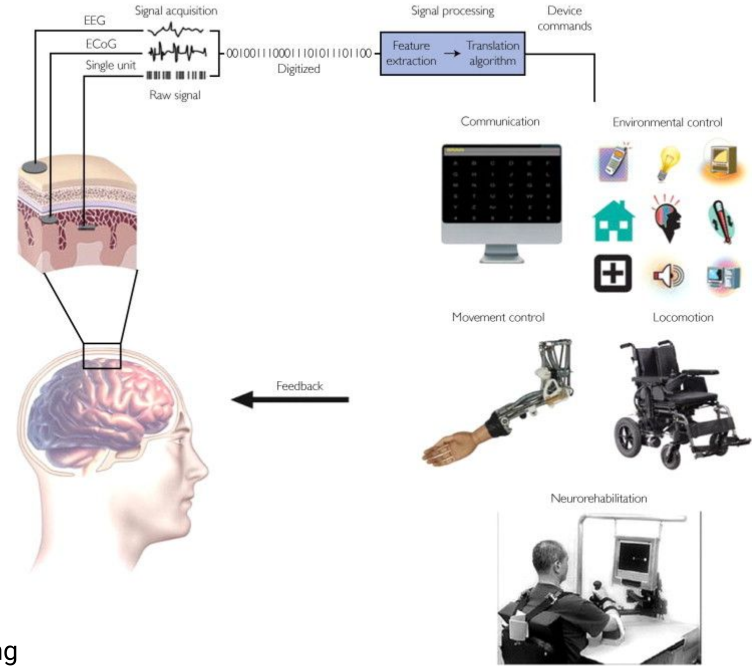
Safely establishing a mind-computer connection

Though brain-computer interfaces have existed for decades, new solutions that are less invasive could accelerate commercialization.

Brain-computer interface (BCI) systems can **detect and quantify brain signals** and **translate them into device commands** to accomplish a user's intent — such as typing out words or moving a robotic arm.

Historically, implanting a BCI has been an invasive, open-brain procedure. However, emerging, **minimally invasive** solutions, such as those from Synchron, may be **less risky** for patients. Further, many surgeons could already have the knowledge to perform the procedure (which is similar to a common stent insertion), making it **more scalable**.

How brain-computer interfaces work



 Source: IEEE Reviews in Biomedical Engineering

Startups developing brain-computer interfaces

NEURALINK

Headquarters: San Francisco, CA

Total funding & stage: $356M, Series C

Description: Co-founded by Elon Musk, Neuralink is developing a brain chip implant that would help study and treat neurological disorders. The company's device has not yet been approved for human trials.

Paradromics

Headquarters: Austin, TX

Total funding & stage: $58M, Series A

Description: Paradromics' implantable device captures thousands of brain signals with the aim of achieving medical outcomes like restored communication and sensation. So far, the company has successfully observed brain activity in sheep.

synchron

Headquarters: Campbell, CA

Total funding & stage: $61M, Series B

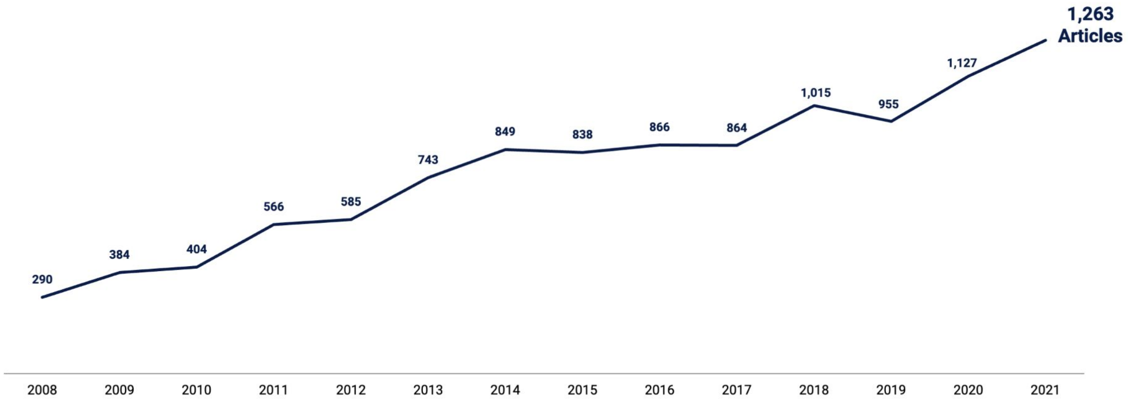
Description: Synchron has developed a permanent, implantable device that can restore function in victims of severe paralysis. The FDA approved the device for human clinical trials in 2021, and Synchron completed its first implant procedure in July 2022.

BCIs offer breakthrough medical benefits

As minimally invasive BCI solutions — intended for long-term use beyond the lab or hospital — take off, the technology could help address a wide variety of medical challenges.

Medical interest in brain-computer interfaces has climbed steadily

Number of medical and science articles on brain-computer interfaces, 2008 – 2021



Source: PubMed

Initial BCI applications have sought to help patients experiencing severe disabilities like paralysis to communicate.

Looking ahead, as **BCI technology advances**, it’s poised to impact a range of medical applications — from more effectively **detecting tumors**, to **improving motor function** for surgeons, to **boosting cognitive performance** as a neurofeedback training tool, to **accelerating rehabilitation** for patients after a stroke.

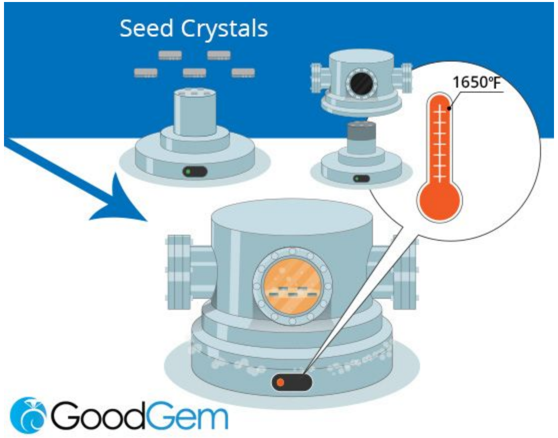
Source: PubMed

Lab-grown diamonds

Producing diamonds at scale

Using a process called chemical vapor deposition (CVD), diamonds are grown in a reactor layer by layer. These can replace materials like silicon, gallium nitride, and fused silica across a vast range of technology applications — from semiconductors and radiation detectors to laser optics and telecom devices — that are otherwise impossible with natural stones.

The CVD process



The direct current CVD reactor at Brigham Young University — one of the largest diamond reactors in the world.

CB INSIGHTS Source: GoodGem, CB Insights

The startups behind lab-grown diamonds

QUANTUM BRILLIANCE

Headquarters: Canberra, Australia

Total funding & stage: $9.7M, seed

Description: Quantum Brilliance develops room-temperature quantum computers by using nitrogen vacancies in single-crystal diamond to generate the qubits (computational units of quantum computers).

APPSILON ENTERPRISE

Headquarters: Istanbul, Turkey

Total funding & stage: $16M, seed

Description: Appsilon is a producer of diamond material for technology applications such as thermal management, optics, quantum computing, high-power electronics, and diamond detectors.

DIAMOND FOUNDRY

Headquarters: San Francisco, CA

Total funding & stage: $300M, Series C

Description: Diamond Foundry produces lab-grown diamonds using proprietary reactor technology. Its diamond bilayers are suitable for technology applications and as material for jewelry brands worldwide.

The diamond age of electronics

Diamond is one of the best materials known to humankind with maximal thermal conductivity and hardness, a high refractive index, and strong electrical insulation. These features support next-gen technologies in semiconductors, optics, renewable energy, medical devices, and more.

Diamond tech has received elevated media attention since 2020

News mentions of diamond technologies

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Improved manufacturing techniques have fueled recent interest in lab-grown diamonds.

"Semiconductor devices with diamond material are available to deliver over one million times more electrical current than silicon or previous attempts using diamond."

–

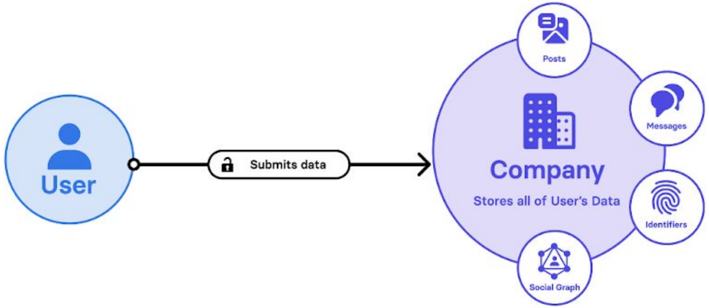
Adam Khan, CEO of AKHAN Semiconductor

Personal data ownership

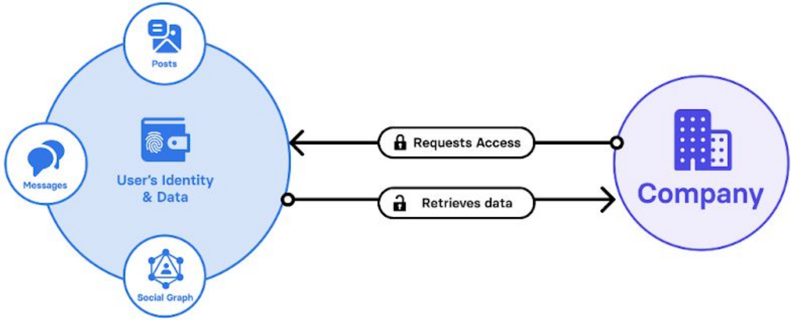
Placing data back in the hands of consumers

Historically, digital platforms have owned consumers' personal data, reaping almost all of the benefits when monetization opportunities arise. Now, a new breed of startups are leveraging blockchain to return data ownership to consumers and create new opportunities for monetization.

Before: Centralized platforms gain full access, control, and ownership over private user data in exchange for services



After: Users own their data and decide how and when to make use of it



 Source: Spruce via Okta Ventures

Startups developing new data-sharing models

Spruce

Headquarters: New York, NY

Total funding & stage: $42M, Series A

Description: Spruce allows users to maintain control of their personal data across the web using sign-in and data storage solutions built using blockchain.

ODE

Headquarters: Tempe, AZ

Total funding & stage: N/A

Description: ODE leverages blockchain and AI to deliver a range of personal data solutions, from monetization to secure storage.

invisibly

Headquarters: St. Louis, MO

Total funding & stage: $21M, Series A

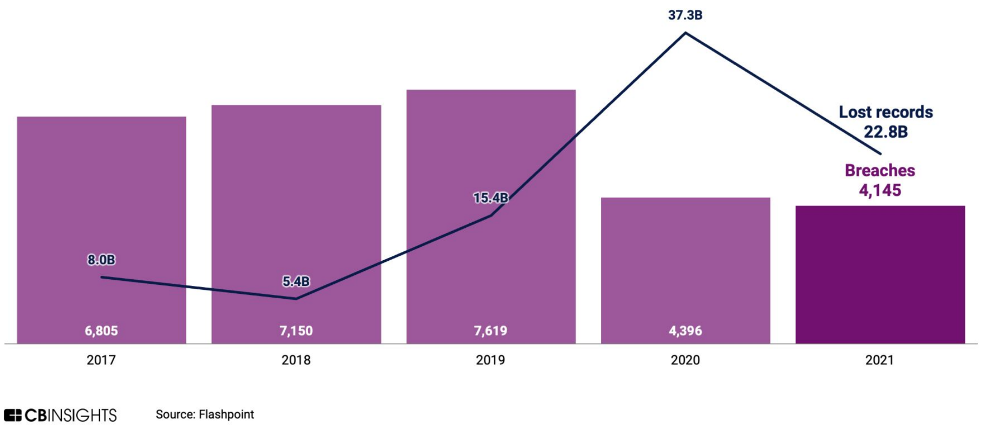
Description: Founded by a co-founder of Block (fka Square), Invisibly allows user to earn points and unlock ad-free content by sharing data.

Preventing corporate mishandling of personal data

The transfer of personal data from individuals to corporations has often left it unprotected and underappreciated, creating conditions for abuse (e.g., data breaches, manipulative advertisements).

Data breaches result in billions of lost records each year

Disclosed data breaches (thousands) and lost records (billions)



86% of US consumers say data privacy is a growing concern

40% of US consumers don't trust companies to use their data ethically

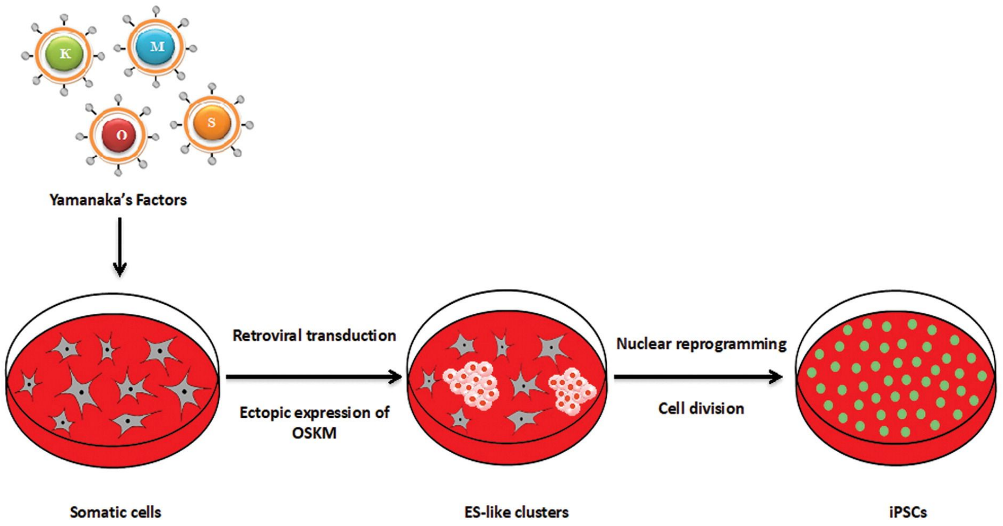
CBINSIGHTS Source: Flashpoint, KPMG

Cell coding

Reprogramming cells with computational biology

Advances in computational biology and bioinformatics are improving the cost and scalability of producing human cells for research and cell therapies. New cell reprogramming technologies are enabling cells to be grown faster and more efficiently than previous methods.

Yamanaka factors reprogram adult cells into iPSCs



Discovered in 2006, Yamanaka protein transcription factors can trigger specific genes in adult cells to turn them into induced pluripotent stem cells (iPSCs).

These stem cells can become any type of cell in the body and open up **new avenues for treatment**. This can happen **much faster** than traditional cell manufacturing techniques, such as mimicking the natural process of embryogenesis.

CBINSIGHTS Source: BioResearch Open Access

The startups working to reprogram cells

bit.bio
THE CELL CODING COMPANY

Headquarters: Cambridge, UK

Total funding & stage: $145M, Series B

Description: Bit Bio applies the principles of computation to biology to code human cells for disease and drug research.

MOGRIFY
Reprogramming Health

Headquarters: Cambridge, UK

Total funding & stage: $38M, Series A

Description: Mogrify develops solutions to address the issues of efficacy, safety, and scalability currently associated with cell therapy development and manufacturing.

asgard
THERAPEUTICS

Headquarters: Lund, Sweden

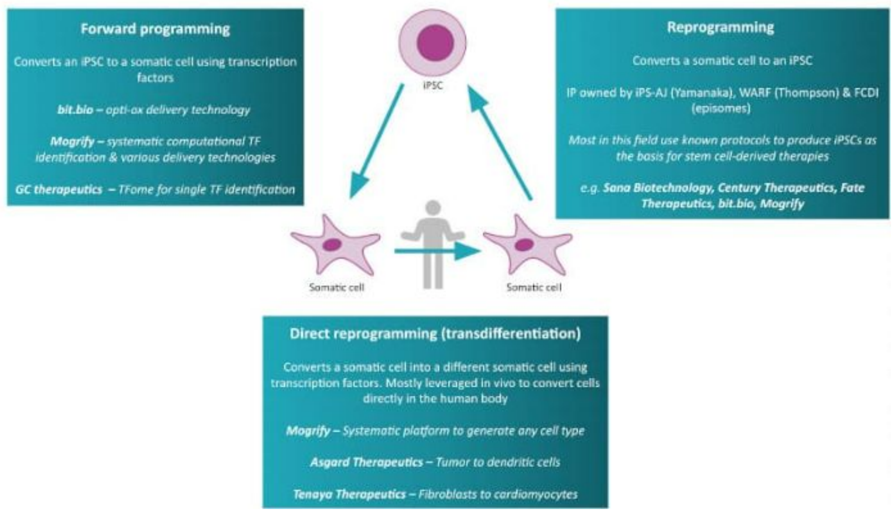
Total funding & stage: $7M, seed

Description: Asgard is a biotechnology company developing a cancer therapy platform for reprogramming a patient's tumor cells.

Cell coding could offer better treatment for more illnesses

Turning adult cells into iPSCs can be a painstaking process, which has prevented the technique from gaining wide traction. To address this, startups are scaling up methods that use computation and automation to shorten the process from months to days — and cut costs along the way.

Emerging cell reprogramming methods using computational biology



What can this tech do?

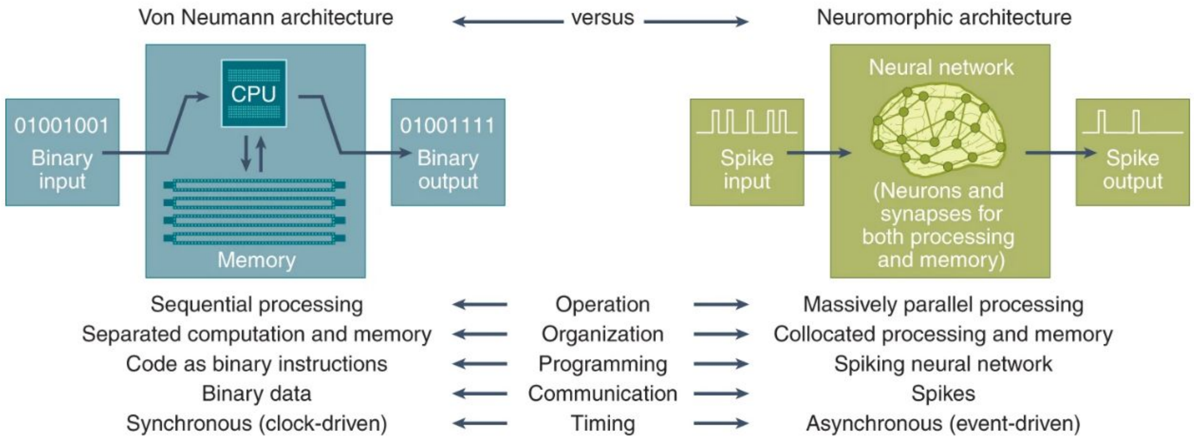
- Eliminate dependency on hard-to-work-with human stem cells
- Decrease cost of cell therapy
- Make treatment more personalized and targeted
- Simplify manufacturing at scale

CBINSIGHTS Source: Labiotech

Neuromorphic computing

Next-gen computing that thinks like a brain

Inspired by the structure and processes of the brain, neuromorphic computers are composed of artificial "neurons" and "synapses" that handle information in a completely different way to the Von Neumann architecture used in most computers today.



Neuromorphic computing, which taps into the flexibility of an analog system, could offer benefits like **massively parallel processing** (where many computations can be performed simultaneously) and **spike-based computation** (where energy is only expended when data is incoming — meaning that just a fraction of the system is being powered at any one time).

These benefits mean that neuromorphic computers could use much **less power** while delivering much **faster processing times**.

CBINSIGHTS Source: Nature

Startups designing new computing architectures

Headquarters: Redwood City, CA

Total funding & stage: $25M, Series A

Description: Rain Neuromorphics is developing a Neuromorphic Processing Unit that features AI inference and training capabilities. The company aims to commercialize the chip by 2025.

Headquarters: Delft, Netherlands

Total funding & stage: $6M, seed

Description: Spun out of the Delft University of Technology, Innatera develops low-power processors for always-on sensor use cases like vital signs monitoring and fall detection. The company unveiled its first chips in 2021.

Headquarters: Zurich, Switzerland

Total funding & stage: $32M, Series A

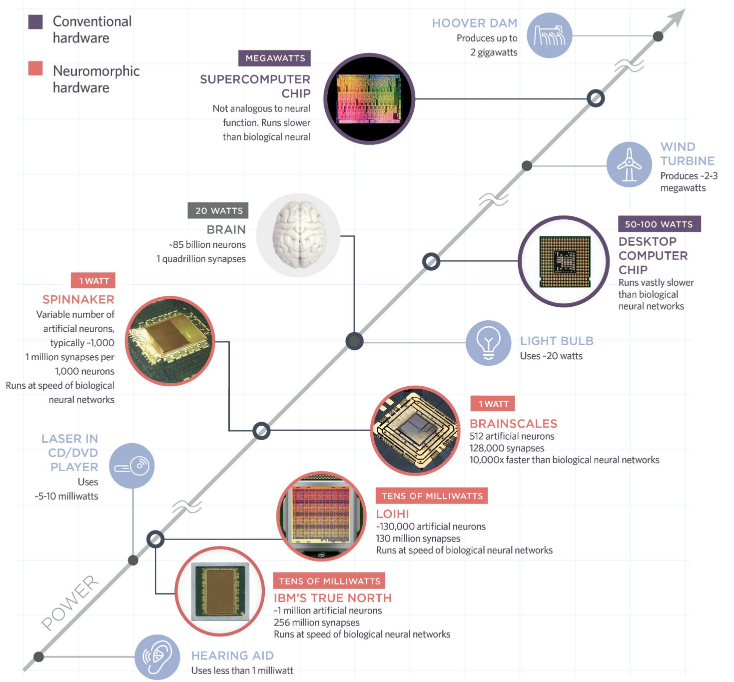
Description: Building on research from the University of Zurich and ETH Zurich, SynSense offers neuromorphic solutions for industries from healthcare to auto. The company is co-developing a chip with event-based sensing company Prophesee.

Powering the future of AI

Neuromorphic hardware processes information differently to conventional computers and can run some types of computations using 1,000x less energy than traditional methods — making it useful for low-power, on-device applications like edge computing or autonomous vehicles.

Meanwhile, the brain-inspired processing methods of neuromorphic computing are naturally well-suited to AI applications that also seek to mimic the brain — allowing for some key AI tasks, like deep learning, to be completed much more efficiently.

Efficiency of neuromorphic vs. conventional hardware



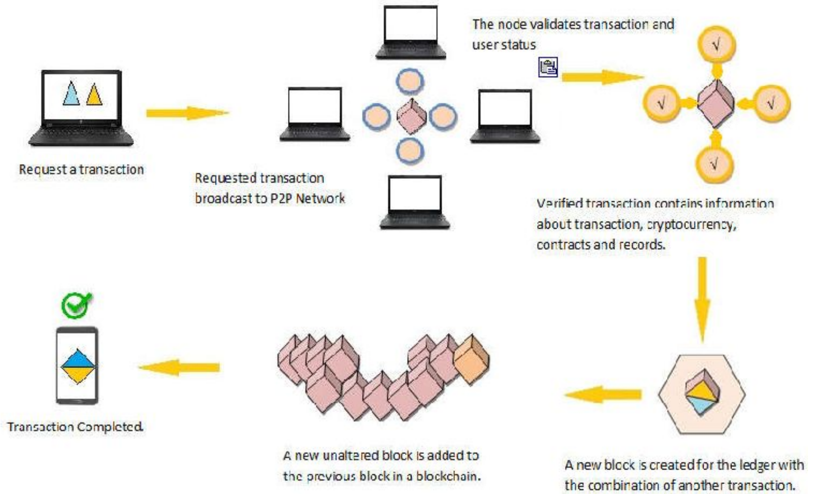
CBINSIGHTS Source: The Scientist

Decentralized commerce

A practical use case of NFTs for brands and retailers

Merchants can tokenize physical products and services as non-fungible tokens (NFTs) — allowing buyers to receive a digital representation that they can then resell or redeem for the physical asset. By transacting on the blockchain, the two parties bypass centralized e-commerce platforms that traditionally take a cut, while preserving transparency and authenticity.

The process of recording a transaction on the blockchain



Using NFTs to represent physical items means sellers can open up new sales channels by plugging into virtual environments like metaverses. In the above, Tommy Hilfiger sells digital versions of physical items in metaverse platform Decentraland using Boson Protocol's decentralized commerce tech.

 Source: International Journal of Management, Technology And Engineering; Boson Protocol

Startups developing decentralized marketplaces

Headquarters: London, UK

Total funding & stage: $10M, undisclosed

Description: Boson Protocol's platform tokenizes real-world assets as NFTs and develops digital marketplaces for physical and virtual goods.

Headquarters: Grand Cayman, Cayman Islands

Total funding & stage: $28M, Series A

Description: Origin helps creators and sellers build digital storefronts to sell NFTs directly to audiences and profit from secondary sales down the line.

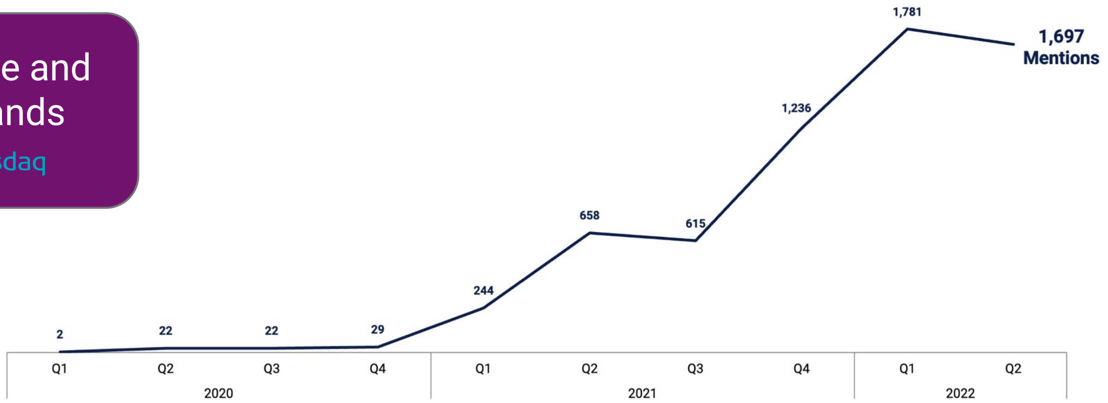
Cutting out the middleman

A decentralized commerce model allows consumers to transact directly with sellers in a transparent, trustworthy environment at a lower cost structure. It balances authentication, visibility, and community to enable reliable and consistent commerce experiences.

Decentralized commerce and what it will mean for brands
June 15, 2022 Nasdaq

Rising interest in NFTs as an element of e-commerce

News mentions of “commerce” and “NFT”



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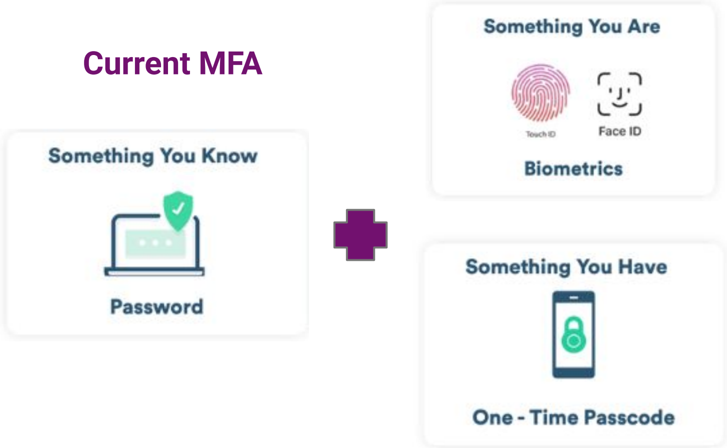
Passwordless authentication

Improving security with invisible MFA

Over 60% of data breaches can be attributed to weak or reused passwords, and the average data breach costs over $4M. Invisible multifactor authentication (MFA) improves upon current MFA with automated, seamless authentication that could spur mass adoption of passwordless identity verification — a vital step toward preventing cyberattacks.



The next generation of MFA skips the password altogether by tying a user's device to their identity. For instance, if logging in on a laptop, a user could simply type in their username and the system will verify their identity invisibly and automatically using a protected key on their smartphone.

CB INSIGHTS Source: Expert Insights, Beyond Identity

The startups replacing passwords

Headquarters: New York, NY

Total funding & stage: $68M, Series C

Description: HYPR offers companies a platform for authenticating employees and consumers with devices instead of passwords.

Headquarters: New York, NY

Total funding & stage: $205M, Series C

Description: Co-founded by Netscape founder Jim Clark, Beyond Identity securely binds users to their devices to enable passwordless verification.

Headquarters: San Francisco, CA

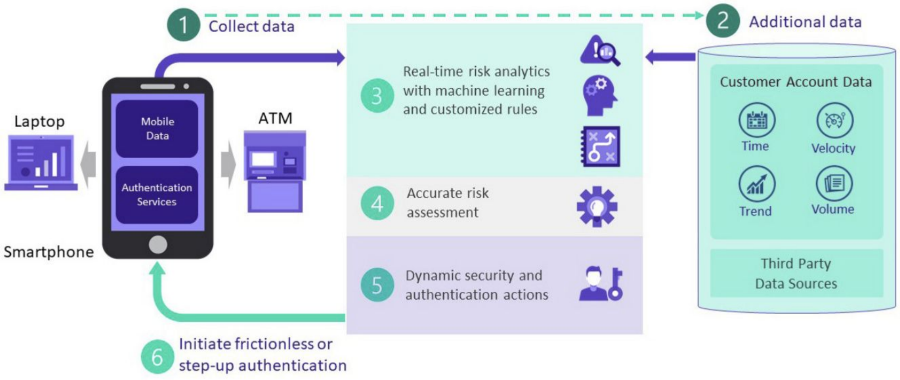
Total funding & stage: $126M, Series B

Description: Stytch provides infrastructure (i.e., APIs) that allows organizations to authenticate users via several passwordless methods (e.g., device, biometrics, etc.).

Creating a more secure digital future

Invisible MFA requires no additional hardware or steps (e.g., tokens or one-time codes), does not store user information, and uses patterned variation that prevents stolen data from being used to impersonate anyone. This takes the security responsibility out of the users' hands and provides a frictionless user experience.

A variety of data sources are used to score and verify identity during authentication



"A closer examination of major breaches reveals a common theme: In every 'major headline' breach, the attack vector has been the common password. The reason is simple: The password is by far the weakest link in cybersecurity today."

–

Michael Chertoff

Former US Secretary of Homeland Security

Appendix

Methodology

How we selected the 9 game-changing tech categories:

We looked at recent moonshot investments and tech developments, focusing on companies trying to address major issues impacting societies and economies.

In addition to looking at where high-profile investors are placing their bets across the tech space, we also used the following CB Insights platform features:

- **News Mentions Tool,** which mines and organizes millions of media articles to quantify media attention.
- **Earnings Transcripts Search Engine & Analytics,** to understand what corporates are saying about company strategy and the future of their respective industries.
- **Company Mosaic Score,** which evaluates startup health, based on our National Science Foundation-backed algorithm.
- **Business Relationships Tool,** which tracks a company's competitors, partners, and more.
- **Market Sizing Tool,** which aggregates market size estimates and provides a visual of market growth.