

GP.Bullhound



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Technology Predictions 2024



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The view

FROM GP BULLHOUND

Now in its 17th year, GP Bullhound's Technology Predictions report maintains its reputation for industry-leading accuracy, with nearly 90% of our predictions realised. Leveraging our experience with cutting-edge software and global market insights, we are excited to unveil our predictions for 2024, continuing our legacy of identifying transformative trends in the technology sector.



Per Roman
MANAGING PARTNER, GP BULLHOUND



Alec Dafferner
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THE STATE OF THE MARKET

As we transition from 2023 to 2024, the profound impact of artificial intelligence on technology and its promising future is undeniable. In a climate of economic uncertainty, AI is the cornerstone of our forecasts for the coming year. Key trends include the organisation of legacy data, the commoditisation of large language models, and the ongoing semiconductor shortage, driven by increasing demand for AI-optimised hardware.

These developments are opening up new avenues, such as the revitalisation of space exploration. As we navigate this complex yet exhilarating landscape, we proudly present our predictions for 2024, offering insights into the upcoming opportunities and challenges that await us all.

OUR 2024 PREDICTIONS

Following a turbulent year, 2024 heralds a renewed optimism regarding technology's potential. Artificial Intelligence continues to play an increasingly pivotal role, with businesses reevaluating their entire offerings to leverage its power. But creators are fighting back on AI, bringing a renewed focus on the value of human-created content. Technology is launching into space more than figuratively, with the private sector spearheading a new Space Race, leveraging commercial opportunities in orbit. The world's most valuable but unrefined resource, data, continues to fuel everything we do online, as businesses turn to gen-AI to harness its potential. Here's what's in store for 2024.

1: Large Language Models become smaller, disrupting the AI market

- Large models demand greater resources, with higher expenses and slower response times
- Smaller models yield better results in some cases, breaking down competitive barriers

3: Private sector to spearhead space revitalisation

- Satellites orbiting Earth to increase from c.8,000 today to >100,000 in 10 years⁽³⁾
- Private sector companies are leading the way as the space industry expands

5: AR/VR & AI fuel a surge in immersive education investments

- US edtech companies raised \$5.2bn in 2022⁽⁴⁾, driven by demand for AI-powered learning
- Enterprises leveraging AR/VR to train and upskill employees in unprecedented ways

7: AML and payment protections come centre-stage

- AML market, driven by digital transactions, growing at CAGR of 15.9% 2023-2030⁽⁵⁾
- Regulatory compliance grows as illicit wallets send c.20% of funds⁽⁶⁾ through DeFi

9: AI race escalates semiconductor shortage

- AI-driven applications multiplying, adding strain on semis supply that caters to them
- Large cloud providers in a race to invest in GPUs or risk falling behind

2: Bits to billions: legacy data spurs acquisition boom

- 90% of company data is unstructured⁽¹⁾, but it's no longer useless thanks to gen-AI
- New generation AI uses as little as 1/10 of the data⁽²⁾ of traditional architectures

4: The rise of authenticity as creators challenge AI

- 2024 will be a battleground between AI-generated and human content
- Tools that obstruct AI from training off human-created content will surge

6. Apple's expanded subscription service with ad-free search engine

- An Apple search engine is the missing piece in its internet strategy
- Search engine to rival Google is underway despite the latter's bid for iOS default

8: AI is reshaping media with personalised content and acquisitions

- AI forces businesses to rethink entire offerings to remain competitive
- AI resilient in market downturn with \$23bn in funding in 2023 in US alone⁽⁷⁾

10: Acceleration of carbon accounting as new regulations loom

- Only 10% of companies comprehensively measured emission footprint in 2022⁽⁸⁾
- Greentech companies race to create more automated carbon accounting software

Sources: (1) IDC White Paper: "Untapped Value: What Every Executive Needs to Know About Unstructured Data", (2) BCG: "The Key to Digital Transformation", (3) United Nations Office for Outer Space Affairs, (4) Reach Capital, (5) Grand View Research, (6) Investopedia, (7) Pitchbook, (8) BCG

Recap of GP Bullhound's 2023 PREDICTIONS

As the curtains close on 2023, a transformative year full of triumphs and trials, there is much to contemplate. On the one hand, Natural Language Processing (NLP) significantly influenced business strategies, enabling real-time analytics and taking consumer engagement to an unprecedented level. On the other hand, we witnessed a seismic shift in cybersecurity, as enterprises increasingly adopted a zero-trust architecture to strengthen their defences. And if there was a consistent theme underlying all these changes, it was the critical role of semiconductors, which powered everything from smartphones to autonomous vehicles and high-speed data centres. As we reflect on the past year, we look into the lessons learned from 2023.

NATURAL LANGUAGE
PROCESSING A WATERSHED
FOR BUSINESS STRATEGIES

YES

The technology has validated the prediction and exceeded expectations in its application. One of the most compelling reasons this prediction proved accurate is the exponential development of NLP technologies. NLPs have advanced to the point of understanding context and nuance. This has led to more intelligent interactions between machines and humans. Companies have quickly adopted these capabilities – more than half of Fortune 500 companies use NLP for sentiment analysis, thereby transforming their marketing strategies⁽¹⁾.

INTERACTIVITY AND CHANNEL
SELECTION ARE AD STREAM
GAME-CHANGERS

YES
-
NO

The delayed Google cookie policy has a two-fold impact on the ad industry's shift towards interactivity and channel selection. While it gives advertisers time to adapt to a cookieless environment, it may slow the uptake of data-driven ad formats. However, data from IAB shows that 60% and 70% of CTV advertisers plan to up investment in interactive and addressable ads, respectively, in 2024. This indicates continued faith in these formats. Alternative targeting methods, like contextual and cohort-based targeting, remain viable in a cookieless world, suggesting that the delay won't significantly hinder the growth of interactive and addressable advertising.

TIKTOK THE NEXT KING OF
SOCIAL MEDIA ADVERTISING

YES

In 2023, TikTok solidified its role as a leading platform in social media advertising, hitting two billion global downloads and seeing a 75% YoY increase in ad revenue⁽²⁾. CB Insights predicts its ad revenue will reach \$15bn this year, and eMarketer ranks it as the third-largest ad platform in the US. Moreover, according to Sprout Social, 89% of marketers plan to use TikTok for advertising in 2023. Adweek identifies it as the most effective platform for reaching Gen Z.

ENERGY-SAVING APPS
AND NEXT-GEN BATTERIES
POWERING THE TECH RACE

YES

Energy-saving apps are gaining traction as they enable smarter energy consumption, with the home energy management systems market estimated to reach \$6.2bn by 2025⁽³⁾. These advancements serve environmental goals and fuel tech innovation, leading to more efficient devices and systems. Progress in IoT and AI are enhancing the capabilities of these apps. The Journal of Cleaner Production noted that integrating IoT devices with energy-saving apps could lead to a 15-18% reduction in household energy consumption.

Sources: (1) Deloitte, (2) CB Insights (3) MarketsandMarkets

**TIPPING POINT OF
CYBERSECURITY AND
BROKEN CIRCLES OF TRUST****YES**

Market data supports the idea of cybersecurity as a secular growth area. Gartner projected a 12% year-over-year growth in worldwide spending on cybersecurity to \$150.4bn in 2023. Major providers have been quick to adapt. Companies like Cisco and Palo Alto Networks have aggressively consolidated, acquiring smaller firms to provide full end-to-end solutions. Cisco's acquisition of Duo Security for \$2.35bn and Palo Alto Networks' purchase of CloudGenix for \$420m are cases in point.

**TALENT MANAGEMENT
BUILDING THE FUTURE OF
THE WORKPLACE****YES**

Companies increasingly adopted remote work options, leading to a 40% uptick in cloud-based talent management software usage⁽⁴⁾. These advanced systems filled skills gaps through continual learning and improved employee retention by 15%⁽⁵⁾. Furthermore, data analytics became central to HR decisions, accelerating time-to-hire by 25%⁽⁶⁾. Overall, the modernised approach to talent management has become indispensable for companies striving for efficiency, productivity, and employee satisfaction.

**SOFTWARE DRIVING
SUSTAINABILITY****YES**

Investment in software startups focused on ESG and sustainability is skyrocketing, with \$90bn invested in H1 2023, according to PitchBook. This will outpace the \$180bn record set in 2022. CB Insights corroborates this trend, reporting \$25bn in climate tech investments, led by software firms. An Accenture study revealed that 75% of organisations use software for environmental goals and 60% for social and governance improvement. The World Economic Forum projects the global market for sustainability software to hit \$1tn by 2025.

ROBOTICS NO LONGER SCI-FI**NO**

The expectations for robots with advanced cognitive abilities to become mainstream and significantly replace skilled labour in 2023 have fallen short. Key barriers include limited cognitive capabilities in existing robots, preventing them from taking over tasks requiring complex decision-making and adaptability. Cost remains a significant factor, too, with the average deployment at c.\$100k, making it inaccessible for many businesses⁽⁷⁾. Regulatory hurdles in the US and the EU have also slowed down the rate of adoption in healthcare and transportation.

**E-COMMERCE, BUT MAKE
IT SOCIAL****NO**

Despite high expectations that social e-commerce would revolutionise the market in 2023, the trend failed to achieve mainstream acceptance this year. Livestream shopping events showed lower-than-anticipated adoption rates, and, while pilot projects suggested high ROIs, sales increases for most brands have been modest in 2023. With consumers wary of data breaches involving social commerce platforms, this branch of e-commerce will have to overcome some challenges and focus more on security before widespread adoption in the future.

SEMIS RULE THE WORLD**YES**

Despite initial expectations of a downturn in semiconductor capital equipment spending, investment exceeded market forecasts. The US and China ramped up domestic production to reduce dependency on foreign suppliers, intensifying competition. The EU's initiative to capture 20% of the global semiconductor manufacturing market by 2030⁽⁸⁾ also contributed to heightened spend. Breakthroughs in AI, IoT and 5G further accelerated demand, exacerbating existing shortages. The global semiconductor market grew by 12% YoY, reaching a valuation of \$600bn in 2023⁽⁹⁾.

01

Large Language Models become smaller, disrupting the AI market

An AI model's parameter count denotes how much complexity and nuance an AI model can capture. Ever since Google's seminal paper "Attention is all you need" from 2017 where they introduced the transformer architecture for AI models, which gave rise to the Large Language Models (LLMs) like ChatGPT, the parameter count has essentially been the measure of how good the model is, with bigger being better. But large parameters do not come without their trade-offs and their increasing number does not always equal better performance.

COMPANIES TO WATCH

A D E P T

 Doctrine

ANTHROP\IC

 ElevenLabs

 cohere

 Hugging Face

 DEFINED.AI

 d-Matrix

 OpenAI

Renaiss

 Replicate

 replit

 MISTRAL AI

 runway

stability.ai

 XL

■ IN AI, BIGGER IS BETTER...UNTIL IT IS NOT

OpenAI's GPT models have steadily increased their parameters, where the GPT-1 had 117 million parameters, and the most recent GPT-4 around 1.8tn parameters. With every generation, the parameter count has increased and with it, the performance has improved. But an ever-increasing parameter count does not come without its associated compromises. A side-effect of increasingly large models is they get computationally more resource-intensive to train and use, with higher costs and energy usage, more training time required, and slower query response times. The propensity of the most prominent AI startups like OpenAI and Anthropic to partner with hyperscale cloud providers (Microsoft and Amazon, respectively), is likely partly due to help offset the skyrocketing infrastructure and cost requirements of training and hosting these increasingly large models.

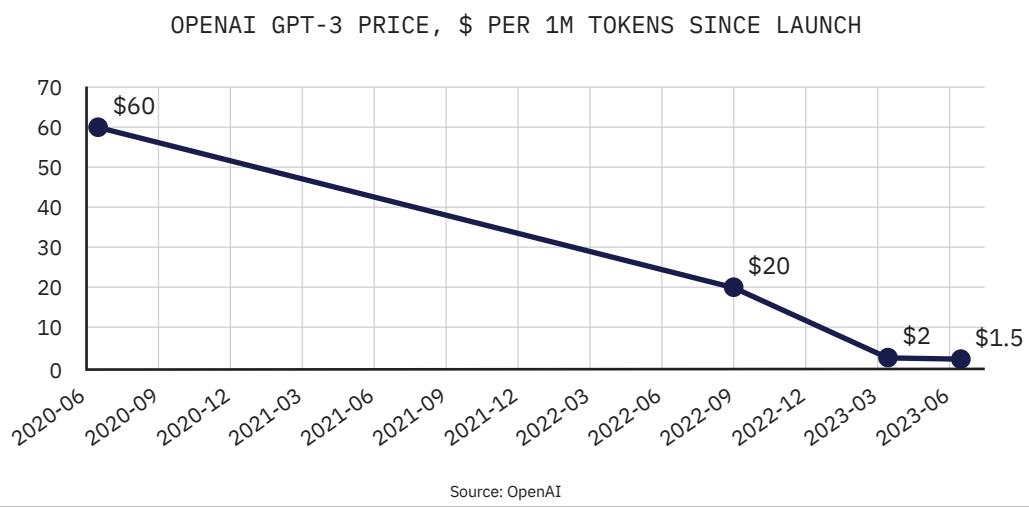
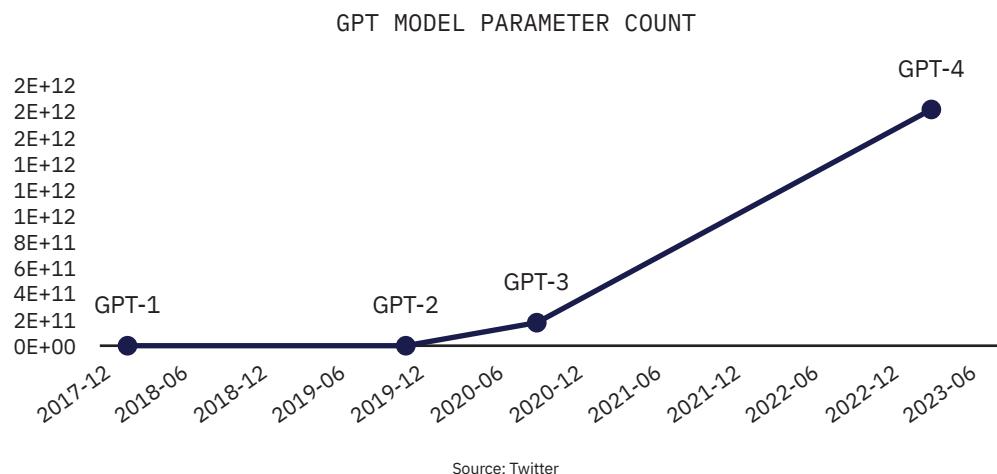
Increased parameters do not necessarily translate to improved performance either. When AI is applied to more focused use cases, a smaller, more targeted model can yield better results than a larger one. For example, Replit's comparatively tiny 3 billion parameter model focused on coding can outperform significantly larger models like ChatGPT. Another example is Apple's iOS 17 update – iPhones run a tiny transformer model on-device for improved keyboard autocorrect and word prediction.

Most importantly, with the highest-performing AI models being closed-source and coming from financially-motivated commercial entities, there is a counter-movement in the open-source community to develop its own smaller and more optimised AI models and make them as performant as the commercial ones. Surprisingly, Meta is one of the key players driving this movement with its open-source LLaMA models, the most recent being close to as performant as OpenAI's models but being 30x cheaper to run due to its smaller size. More recently, the European startup Mistral, which raised a \$113m seed round in June 2023, released a 7 billion parameter model in September that was more performant than Meta's 13 billion model, meaning an additional 2x improvement. These open-source strides are likely because Meta, Mistral and others believe that commoditising AI is the only way to break down the competitive barriers that OpenAI, Google, and Anthropic otherwise set up. To counter this movement, OpenAI has continuously lowered the prices of its models, with the latest version of the GPT-3 API for developers costing 97.5% less than it did at launch in 2020. However, it is unclear how much of that price decrease comes from model optimisation versus offsetting the costs of staying competitive.

THE COMMODITISATION OF AI

All this considered, we predict that GPT-5, once released, will turn this trend and be smaller than its predecessor. There will likely still be a push from the research community to experiment with larger models, but from a practical and commercial standpoint, the next state-of-the-art model will be smaller, not bigger.

In addition, this overarching trend will result in AI models becoming increasingly commoditised, where more companies can run better AI models for cheaper. It is expected more companies will adopt AI features into their products, which in turn will make it increasingly difficult to market and sell AI features for a premium, seeing that it will become increasingly easy for competitors to provide the same offering at continuously lower prices until all excess earnings from AI features are competed away. When it comes to pure-play AI model providers like OpenAI and Anthropic, this commoditisation means it will likely become increasingly difficult for them to compete if all they do is provide access to an AI model through an API or chat interface. As such, we are already seeing these companies expanding their offering beyond the models by integrating closer with their customers, products and data, and providing extensions and supplemental features to their chat platforms.



Note: Tokens = Pieces of words, where 1,000 tokens is c.750 words

02

Bits to billions: legacy data spurs acquisition boom

Ever since British Mathematician Clive Humby declared that “data is the new oil” in 2006, we have become aware that data is a precious asset. However, just like oil, it needs to be refined for us to be able to tap that value. Almost two decades later, the bleak reality is that over 2/3 of all enterprise data goes unused and 90% is unstructured, meaning it has been in a largely unorganised and unsearchable format, rendering it useless. Until now.

COMPANIES TO WATCH

**DIDOMI****ecovadis****glean****hackerone****Klarna****Natural Cycles****RavenPack****RepRisk****RevenueCat****Revolut****ScienceIO****Source****STRATIO****TRUVETA****Typeform****VERACIO****VIVINO****Watershed****WI-LOOP****ZIP**

■ THE NEW OIL THAT NEVER WAS

While most organisations have struggled to unlock a more significant portion of the value within their data, tech companies like Alphabet (Google), Meta (Facebook), and Amazon have realised most of that value. Through their scale and natively digital products, these companies have captured tremendous amounts of structured data of their users and customers, which they have used to target advertisements and optimise outcomes. On the other hand, most other companies have had difficulties realising the value of data, with 70% of companies' digital transformations falling short of their objectives.

■ AI TO THE RESCUE

The advent of a new generation of machine learning techniques and AI models has changed this dynamic almost overnight. All of this unstructured data is no longer useless, as new AI models can use it by training themselves on large volumes of data and generalising knowledge from it. These new AI models are also vastly more performant when applied to specialised sectors like medicine and law, as they can leverage a foundation of general knowledge and then be fine-tuned for their industry using domain-specific data. This method can reduce the data requirement to 1/10 of what it was before, allowing smaller data sets that previously seemed worthless to become incredibly valuable instantly.

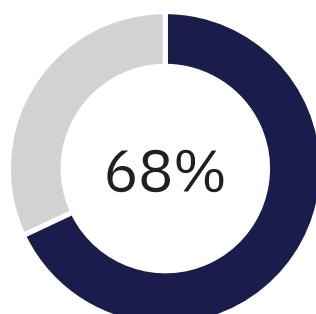
The fact that we now use less structured data and do so from significantly smaller volumes makes organisations look inward to see if it might sit on data they can realise value from. Surprisingly often, many organisations do, and when used to train AI models, they can vastly improve their operational efficiency. For example:

- EcoVadis, which creates sustainability ratings for the largest organisations in the world, is now realising the value of its data from the 100,000+ companies it has rated to date and has started exploring training an AI model on the data to help automate manual parts of this rating process.
- HackerOne uses its global network of ethical hackers to identify and close security vulnerabilities for the world's largest enterprises. HackerOne spends significant time translating intricate vulnerability assessments from its hackers to actionable reports its customers can understand and address. Having done this for over 10 years, HackerOne is now evaluating the prospect of training a private AI model on the data from past reports to help automate the process.

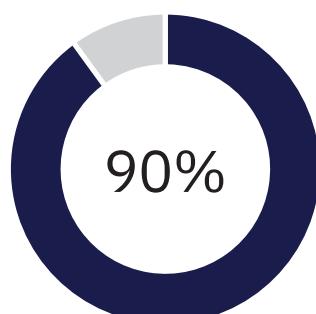
■ HARNESSING THE GOLDMINE

We predict that this newfound value in organisational data through AI will lead to a wave of acquisitions in 2024 of companies primarily to gain access to their data. These companies will have been doing the same repetitive tasks over and over for years, and like with EcoVadis and HackerOne, they can now use that data to train AI models to help automate the processes.

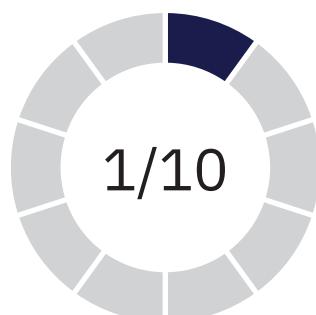
An early example of this is from emission measurement and reporting company Watershed's acquisition of VitalMetrics in early 2023 to get access to its environmental data collected over almost 20 years of consulting and greenhouse gas accounting management. Another one is mining technology company Veracio's acquisition of Minalyze in September 2023 to get access to its geological data and visualisation software. However, we predict these are only the first of many such acquisitions to come.



Until today, more than $\frac{2}{3}$ of company data has gone unused (68%)



90% of company data is unstructured



With the new generation of AI model architectures, we can achieve the same performance as with traditional architectures, but by using as little as 1/10 of the data

03

Private sector to spearhead space revitalisation

After decades of reduced focus following the Moon landing and the Cold War-era space race, we have found ourselves amid a new space competition. This time, however, it is not driven by governments, the US or the Soviet Union. This time, it is a race from the private sector trying to leverage space to build commercial opportunities by using it as a new path to extend and improve the infrastructure for us on Earth.

COMPANIES TO WATCH



■ THE SPACE RACE FOR EARTH

To illustrate, we have seen only over the last few years:

- SpaceX, OneWeb, Amazon, and others deploy thousands of satellites into orbit to provide broadband internet access to remote and conflict-stricken areas.
- Planet Labs, Maxar, BlackSky, GHGSat and others use satellites to collect high-resolution imagery of Earth to aid in disaster response, provide intelligence, and monitor climate change.
- Axiom Space, Voyager Space, Blue Origin, and others use the microgravity environment of space to conduct lab research and experiments that are impossible on Earth.

Even Apple's iPhone nowadays connects with satellite technology for its Emergency SOS and Roadside Assistance features when a cellular connection is unavailable. Even if we do not notice it, space is becoming an increasingly large part of our daily lives and society on Earth at large.

■ THE EMERGING ECOSYSTEM FOR SPACE

Just like Earth needs railways, container ships, and air traffic control, the expansion of the space industry is creating an emerging ecosystem of supporting infrastructure, products, and services.

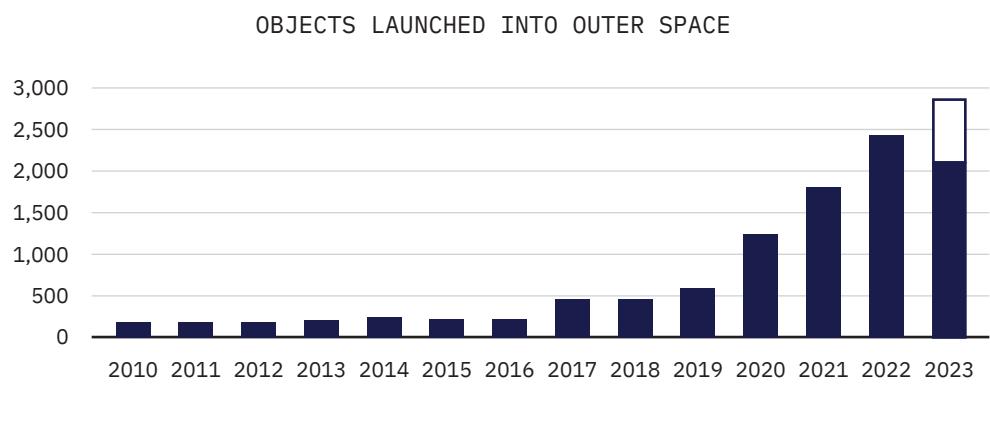
LeoLabs, for example, uses ground-based radars all around the globe to map and monitor all objects in space. With this data, LeoLabs provides a software solution to satellite operators for avoiding collisions with space debris and other satellites. This helps solve an increasingly vital problem for the industry as space is getting congested, with the United Nations expecting the number of satellites orbiting Earth to increase from approximately 8,000 today to over 100,000 in the coming decade, with 90% of satellites orbiting Earth at the same approximate altitude-low-earth orbit (LEO).

Moreover, we are seeing vast improvements in the cost of sending payloads into space, with SpaceX inching closer and closer to successfully launching its Starship rocket into orbit.

Compared to its predecessor, Starship can potentially reduce the cost per kilogram to orbit by a monumental 50x, opening up space for even more use cases that previously were not cost-effective. We see companies like Open Cosmos create platforms to share satellite data between organisations to reduce costs, improve quality, and increase the frequency of capture, and we see companies like Leaf Space build ground stations and mission control as a service for spacecraft launches and operations to outsource it from the operators.

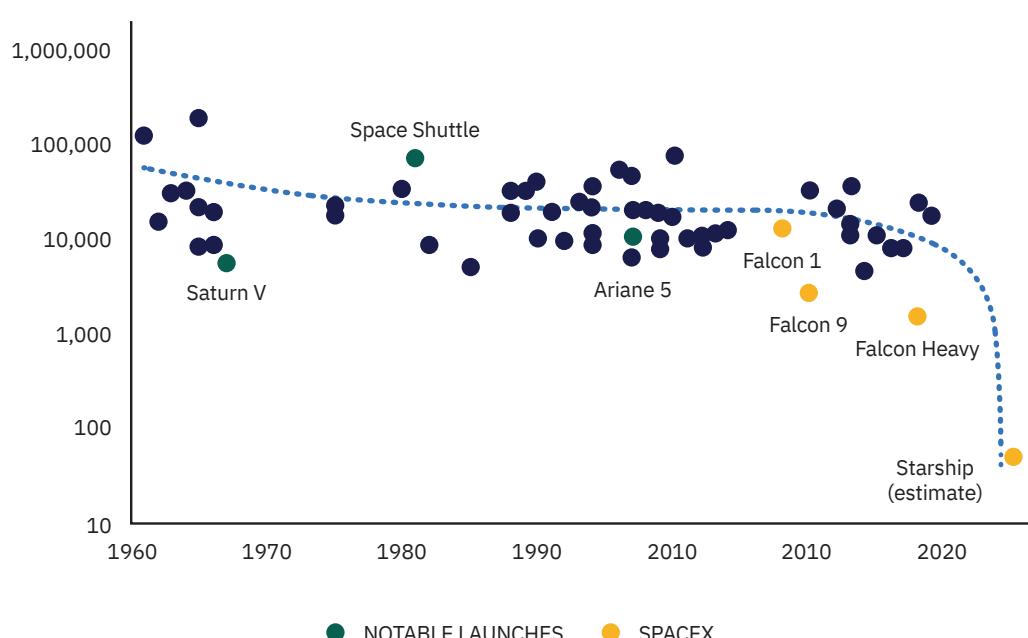
THE OUTSET OF A NEW ERA

All this considered, we are at the outset of a new era for space. The number of satellites launched into space will continue to increase year after year – especially once SpaceX's Starship is operational. The number of companies in the space industry will grow in number and importance. The products and services that utilise satellites will become increasingly capable and commonplace. Even if you do not feel it yet, a new space era is upon us.



Source: United Nations Office for Outer Space Affairs

COST TO LAUNCH ONE KILOGRAM OF PAYLOAD MASS TO LOW-EARTH ORBIT (LEO)
INFLATION-ADJUSTED TO 2021 (\$)



Source: The Aerospace Security Project

Source: All-in Podcast

Note: Objects = satellites, probes, landers, crewed spacecraft and space station flight elements

Expert view

CEO & CO-FOUNDER | LEOLABS

Propelling the dynamic space era



"While stories of scientific space exploration dominate the press, the real story is the revolution that's tightening the links between the space economy and the economy on Earth."

DAN CEPERLEY

HOW WOULD YOU DESCRIBE THE OVERALL MARKET FOR COMMERCIAL SPACE OPERATIONS RIGHT NOW?

It's accelerating. Today's space race drives a revolution in low Earth orbit (LEO). The number of satellites operating in LEO has grown tenfold in less than four years, from around 800 in 2019 to almost 8,000 in 2023. This revolution started with Earth observation satellites. It's since evolved to include logistics and the Internet of Things (IoT). In fact, broadband internet is driving much of the growth, but the battle to dominate the satellite-direct-to-cell phone market is also heating up. We're also seeing the start of satellite-driven global precision automation.

At its core, this space revolution is really a story of next-generation infrastructure and who will build it. From reusable rockets to satellite constellations, cloud computing, and mapping, the winning bets have already been placed, and we're seeing the category kings emerge. While stories of scientific space exploration dominate the press, the real story is this ongoing revolution that's tightening the links between the space economy and the economy here on Earth.

WHAT ARE SOME OF THE INTERESTING THINGS THAT LEOLABS IS DOING IN THIS SPACE TODAY?

First, LeoLabs has automated space traffic safety. We deliver millions of safety alerts daily to satellite operators, which they use for automated route planning to avoid hazards, like using Google Maps on a road trip.

Second, we're powering the clean-up of space. Our services enable active debris removal (ADR) satellites to drive up to pieces of trash. We also give regulators independent assessments of the success of these missions and publish reports on the riskiest pieces of debris to help agencies achieve the highest impact. Finally, we help operators design new satellite constellations so they're safe and sustainable.

Third, we drive transparency. We highlight risky and aggressive behaviours and call them out to prevent conflict in space. Our public messages have been used in the United Nations, by the US Government, and others to highlight dangerous activity. This includes the anti-satellite weapons test conducted by Russia in 2021, which created around 1,600 fragments and threatened astronauts.

WHAT ARE THE KEY CHALLENGES FOR COMMERCIAL PLAYERS IN THE SPACE INDUSTRY?

Satellite operators are scaling up like never before. They're operating thousands of satellites at once, whereas only a few years ago, five satellites were considered a large constellation. That's why large-scale automation is key. They're also navigating increasing concerns and pressures from regulators, such as reducing the disposal time for dead satellites from 25 years to five years. In fact, the US Government issued the first-ever fine for leaving debris in space only a few weeks ago. Measuring and communicating performance and impact is critical for fulfilling regulatory requirements and refining plans for future satellite deployments. In addition, they're operating in and among satellites crucial for national security. The risk of debris-generating events and conflict is, unfortunately, growing.

WHAT ARE SOME OF THE INNOVATIONS AND INTERESTING WORK BEING DONE ACROSS THE COMMERCIAL SPACE OPERATIONS INDUSTRY TODAY?

Satellites are becoming nimbler. They're operating in packs on a routine basis. Historically, only the most advanced national space agencies would design these types of rendezvous and proximity operations (RPOs) — and it was expensive. Now, we're monitoring these activities daily by operators of all sizes.

It's no secret that SpaceX's massive Starship rocket will accelerate the industry. Not only will it carry more satellites to orbit at once, but it'll also enable "big heavy mirrors" for new astronomy missions. Telescopes like JWST took decades to design because they had to be intricately folded to fit into a cramped rocket fairing. Starship's fairing is so large, however, that a telescope mirror can be onboarded without folding. This will lower costs and reduce development schedules.

Another interesting advancement is refuelling. Satellites will essentially be able to drive up to gas stations in space. This is critical for missions to the Moon and deep space missions to Mars. It's also critical for debris removal because the "tow truck" satellites will expend a lot of fuel zipping around LEO. Finally, it'll enable even larger satellite constellations to operate.

WHAT CHANGES/INITIATIVES DID YOU IMPLEMENT OVER THE LAST 12-18 MONTHS TO HELP NAVIGATE MARKET DOWNTURNS?

Lucky for us, the space industry is countercyclical to the downturns in the broader economy. We've seen the space industry grow, and governments continue spending on scientific and national security aims. Hence, we continue to focus on driving sales and converting this market from a cost-plus, big-government-programme mindset to a recurring-revenue SaaS mindset.

From the beginning, we architected our company for global, remote operations and low costs. Our software is built on the cloud, and our radar sites operate remotely. This value was proven during Covid when our radars operated for over two years without maintenance visits.

I'm delighted to say our team delivered that while intelligently managing costs. While we have plans for continued growth of this infrastructure, we're increasing our focus on technical development that is heavily weighted towards AI/ML, analytics, and software.

WHAT DOES SUCCESS LOOK LIKE FOR LEOLABS OVER THE NEXT FIVE YEARS? WHAT IS YOUR VISION FOR THE INDUSTRY AS A WHOLE?

For us, success is tens of thousands of satellites operating safely using our platform. Success is a thriving insurance market built on our unique analytics and expertise. Success is the reduction of orbital debris. Success is the safety of a growing number of astronauts in space. Our vision is to advance the space revolution that's already here as the global leader in space situational awareness.

 "We've seen the space industry grow, and governments continue spending on scientific and national security aims."



04

The rise of authenticity as creators challenge AI

The advance of artificial intelligence and its incorporation into our daily lives is undeniable, but as it progresses with each new update and iteration, one thing becomes more evident: considerations over machine vs. human provenance will come to the forefront. Over the next 12 months, the creative landscape will be a battleground between AI-generated content and human creativity, with a renewed emphasis on the unique value that only human creators can provide.

COMPANIES TO WATCH



artnet

BookVolts



DB



FANVESTOR

GenTwo



HOMA



Numbers

PATREON



royal

STORY

substack

TapNation

TRLab

vidmob



YouTube

■ CREATOR SUPPORT SYSTEMS

As AI continues to infiltrate the creative industries, 2024 will see a surge in decentralised networks designed to ensure provenance for all types of work created by humans, and tools designed to protect and promote human creators. As the lines between human and machine creativity blur, creators will double down on authenticity, community-building, and brand identity. The focus will shift from mere creative output to the values and vision behind the work. Fans will rally behind and invest in what creators stand for, not just what they produce. The creator ecosystem has grown exponentially with the rise in digital media consumption and the emergence of technologies that have reduced barriers to content creation. For example, Amazon releases over 1.4 million self-published books through its Kindle Direct Publishing every year, not counting self-published ebooks with no registered ISBN. As the creator economy becomes mainstream, the time is ripe for human creators to push back on AI.

■ CREATOR PROVENANCE IN THE AGE OF AI

Goldman Sachs Research predicts the creator market to reach \$480bn by 2027, almost doubling from its 2023 figures. Broadly, the creator economy includes both large-scale creators and individuals with smaller personal brands who publish content via digital platforms like YouTube, Instagram, and Substack and independently produce and manage their work. In the growing digital environment, verifying digital content's authenticity, origin, and ownership has become progressively more difficult. With the ascent of AI, guaranteeing the traceability and preservation of data integrity has emerged as a pivotal concern for creators across many industries, including art, music, book publishing and video production.

■ THE SEMINAL MOMENT IN 2024

We predict developments in this space over the next year to be two-fold:

- 1. Fan patronisation of their favourite creators ***
- 2. Growing number of new tools that can protect creator assets from AI and a rising obstruction of AI bots operated by search engines ****

* Music, book publishing and art as investable asset classes have always lacked accessibility and transparency, but the emergence of Web3 introduced unprecedented ways to democratise ownership through tokenisation. Even the poorly performing cryptocurrency market has not stopped the advent of platforms that empower both creators and their fans through shared ownership of the work via tokenised sales. And while the investment potential is an essential driver for fans, the emotional aspect is just as, if not more, important. As fear over emerging generative AI use cases grows, so does fan support for human creators. Another potential scenario is a rising backlash directed at AI-generated content, as people start placing higher value on genuine creativity and be willing to pay a premium for it. As AI struggles with accuracy and flawed reasoning, people will be more willing to pay for trusted human creators, rather than AI-generated information.

** The rise of “anti-AI tools” – such as paywall gating, file encryption, or simply opting out of feeding content to chatbots – will be a defining feature, empowering creators to stand out in an increasingly automated world. Greater choice and control over how their content is used for gen-AI purposes has become a recurring pain point for several industries. Google has recently responded to fears by introducing Google-Extended, a new control web publishers can use to manage whether their sites help improve Bard and Vertex AI generative APIs. Incidentally, online publishing platform Medium has declared that it wants to restrict access to OpenAI's GPTBot, an agent that extracts content from web pages to train the company's AI models. However, the more significant development could be the potential formation of a coalition among various platforms to jointly address what many perceive as the exploitation of their content. Other tools, like the University of Chicago's Glaze, which thwarts AI efforts to interpret a piece of art by making subtle pixel-level adjustments that are invisible to the human eye, have already started to emerge in a move to give creators the power to push back on AI.

Next year, more digital media platforms will introduce subscription plans, similar to Substack's, to empower creators to engage and capture more revenue from the most loyal fans. Separately, more creator-focused marketplaces will emerge around royalty sharing, where fans can own a share of the IP of the work produced by their favourite creators, like Royal.io, a marketplace for music royalty rights. Lastly, we expect to see the emergence of solutions that aid in identifying digital content creators and validating information accuracy, assuring the origin of diverse forms of creative content. These solutions will prioritise creators and be geared towards fostering a transparent and secure digital content creation, management, and sharing ecosystem.

↗ >190,000 books were used without author permissions to train gen-AI systems by Meta, Bloomberg, and others, resulting in several ongoing lawsuits in the US in 2023

↗ In just over two weeks between June and July 2023, 5 class actions were filed in the US against gen-AI LLMs, including OpenAI, Microsoft and Alphabet (Google)

↗ An AI-generated image that won first place at the Colorado State Fair annual art competition in 2022 caused a public outcry, sparking concerns over further threats to human artists

05

AR/VR & AI fuel a surge in immersive education investments

Immersive learning technologies have grown in importance as they provide learners with engaging and more effective learning experiences. Immersive environments which utilise Augmented Reality (AR), Virtual Reality (VR) and Mixed Reality (MR), are now being facilitated and delivered through a variety of new methods and scenarios, which historically would have been too cost-prohibitive or resource-intensive to replicate. This rapidly changes education and training, from the classroom to the workplace and, when paired with the rise of generative AI, makes for an interesting future that will have wide-ranging implications for education going forward.

COMPANIES TO WATCH



AVANTIS

BOULEVARD

ENGAGE



FUNDAMENTALVR
FUNDAMENTALVRGERY*

htc

IMMERSION VR

ImmersiveTouch®

inspirit

Kognity

Labster

Lepaya*

Lingokids

Meta

Mursion

nearpod

PIXO

QuiverVision

SHELL GAMES

ScienceVR
Visualize Human Knowledge

SONY

UNIMERSIV

V E A T I V E

VICTORYXR

VRSIM

zSpace

■ A WHOLE NEW WORLD

The education sector has undergone rapid change in the past few years. The tools for remote learning skyrocketed during the pandemic lockdowns and have only grown in the subsequent years. As immersive environments began to expand the limitations set by classroom teaching, the sector continued to evolve, further unlocking enhanced learning. For example, Labster's virtual laboratory allows students to safely engage in over 250 virtual lab simulations and perform diverse experiments. And with augmented reality, schoolchildren can superimpose digital elements onto tangible classroom objects, offering a compelling method of illustrating concepts within the classroom.

Improved learning with AR/VR and AI allows students to acquire knowledge and skills through simulations and interactive activities that engage all the senses – a huge leap from the standardised methods of reading or listening. This has proved not only to boost information retention but also facilitate a deeper understanding of difficult topics and concepts, fostering higher levels of engagement which would otherwise be lost in more conventional teaching methods. For example, students struggling with geometry can utilise AR to see and manipulate 3D geometric shapes. Another example is virtual field trips where students can visualise what the vegetation on Earth looked like during the Mesozoic Era, and see how temperature changes, unlocked via AI, could have impacted the foliage. We expect to see the number of use cases offering more advanced immersive experiences to increase in the coming year as educators realise the gains that learning through AR/VR unlocks.

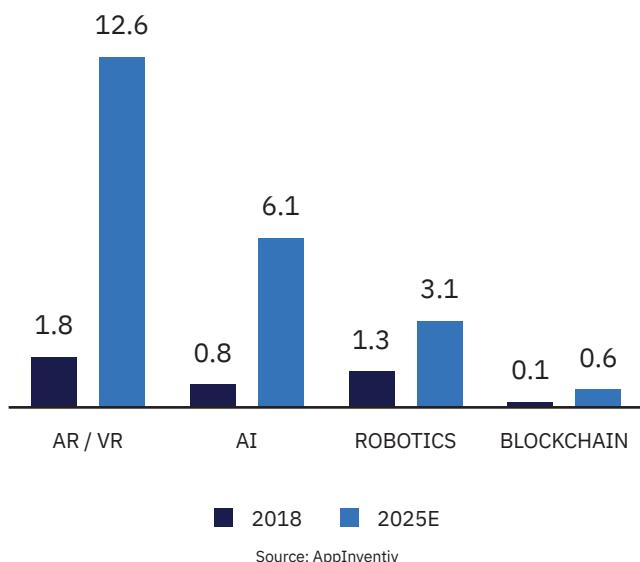
■ IMMERSIVE EXPERIENCES BEYOND THE CLASSROOM

But education is not limited to the classroom. We expect enterprises to utilise AR/VR more in the coming year. Trade workers will be able to experience enhanced training by visualising job challenges and unintended incidents generated through AI to better prepare themselves for real work. For example, companies such as FundamentalVR and Immersive Touch will be critical in the medical field in the coming year as healthcare workers can be trained through immersive solutions. Workplace safety platforms such as PixoVR have grown significantly and should continue expanding as enterprises seek safe, cost-effective training solutions. We expect that AR/VR combined with AI will be mission-critical for healthcare among numerous other sectors for training in 2024.

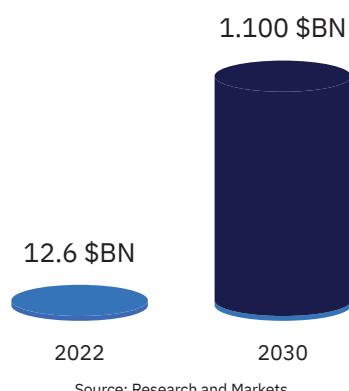
■ NAVIGATING THE TRANSITION

Any new technology brings challenges as people transition to novel learning methods. Organisations should opt for a "think big, start small, and test often" approach to mitigate obstacles to adopting immersive tools in education. While the cost of exploring virtual reality is significant, there has never been more investor interest in the space than now. In the US, education technology companies raised \$5.2bn of investment capital in 2022, driven primarily by a rise in demand for personalised learning powered by AI. As education institutions and other organisations increasingly turn to the metaverse to help integrate innovative teaching and training methods, 2024 will be a transformative year for immersive learning.

GLOBAL EDUCATION TECHNOLOGY EXPENDITURE (\$BN)



GLOBAL MARKET FOR AR IN EDUCATION
MARKET FORECAST TO GROW AT CAGR OF 5.7%



Sources: Immerse UK, Deloitte, Reach Capital

Expert view

CEO & CO-FOUNDER | FUNDAMENTALVR

Immersive simulation for medical and healthcare professions



RICHARD VINCENT

"Immersive VR technology in medical training can potentially revolutionise healthcare, lowering surgical risks and improving patient outcomes."

HOW WOULD YOU DESCRIBE THE OVERALL MARKET FOR IMMERSIVE MEDICAL TRAINING WITHIN A VIRTUAL REALITY ENVIRONMENT TODAY?

The overall market is a dynamic and rapidly evolving landscape with great promise for the future of healthcare, estimated to reach a staggering \$29bn by 2030¹. Over the past century, we have witnessed extraordinary advancements in surgical techniques, transforming how we approach and perform medical procedures. Immersive VR technology in medical training offers several advantages that can potentially revolutionise healthcare. Immersive VR surgical training platforms allow users to hone their precision skills and stay updated on the latest best practices in a truly immersive and hands-on way that lowers surgical risks and improves patient outcomes.

As we look ahead, the intersection of VR and healthcare presents a compelling narrative of innovation and progress, potentially redefining how medical professionals are trained and patients are cared for. The robust market growth projected underscores the transformative power of immersive VR in healthcare. We see customers moving to deeper integration of their systems into virtualised ones, allowing for scale and frictionless skills transfer.

WHAT ARE SOME INTERESTING THINGS THAT FUNDAMENTALVR IS DOING IN THIS SPACE?

We work across a wide range of the medical marketplace, including global leaders in medical devices, robotics and pharmaceuticals to flatten the learning curve through immersive VR allowing for both procedural training and full hands-on skills transfer, through our HapticVR platform. This allows medical device manufacturers to improve access and accelerate product adoption, and as a result scale and achieve their business objectives.

Our partnership with Orbis International is an inspiring demonstration of the real-world impact of FundamentalVR's innovative technology. Orbis, a global nonprofit organisation dedicated to eliminating preventable blindness worldwide, specifically in low- and middle-income countries, joined forces with us to create a manual small incision cataract surgery (MSICS) simulation. This initiative is genuinely exceptional by integrating haptic feedback and cost-effective technology to support Orbis's crucial mission of making eye care accessible and effective.

One of the critical features of our Fundamental Surgery platform is its portability, allowing for the rapid and effective deployment of the simulation system in various locations worldwide. We are deployed to over 35 countries worldwide and have trained thousands of surgeons and support staff, providing real-time and safe rehearsals and detailed real-time assessment and measurement.

WHAT ARE SOME OF THE INNOVATIONS AND INTERESTING WORK BEING DONE ACROSS THE HEALTHTECH INDUSTRY, PARTICULARLY REGARDING VR/IMMERSIVE EXPERIENCES?

In healthcare, we're witnessing a remarkable wave of innovation, driven primarily by integrating virtual reality and immersive experiences.

VR platforms like Fundamental Surgery are revolutionising surgical education. They provide an immersive and risk-free environment for medical professionals to refine their skills, ultimately enhancing surgical competence, patient safety, and outcomes. Moreover, immersive VR platforms enable remote training and collaboration for healthcare professionals, addressing issues of accessibility and educational resources in underserved regions.

The telemedicine landscape is also evolving rapidly, with immersive VR now playing a pivotal role. Patients can engage in immersive consultations with healthcare providers, going beyond traditional video calls to create more interactive and engaging healthcare experiences.

These innovations in healthcare are reshaping the industry, offering new avenues to enhance patient care and refine medical training.

WHAT ARE THE NEW AND NOTEWORTHY THREATS THAT ORGANISATIONS IN THIS SPACE SHOULD BE AWARE OF?

As organisations continue integrating immersive technology into their go-to-market approach to achieve competency at scale, increasingly, these systems are being connected to legacy systems. Therefore, the security and robustness of the platform capacities are vital.

Interoperability is essential moving forward. HCPs cannot support devices with multiple security, data, and UI/UX approaches. The danger for organisations is that the HCPs reject as management logistics become too cumbersome. Therefore, looking for open platforms that allow multi-use devices will aid adoption and reduce potential costs over the longer term.

WHAT CHANGES/INITIATIVES DID YOU IMPLEMENT OVER THE LAST 12-18 MONTHS TO HELP NAVIGATE MARKET DOWNTURNS?

At FundamentalVR, we're proud to be at the forefront of revolutionising surgical training through innovative and immersive approaches.

One of our most exciting recent developments is the launch of our cutting-edge SDK, Fundamental Core. This toolkit simplifies the development of surgical and medical simulations, empowering developers to create, refine, and share medical training scenarios and applications effortlessly. By utilising intuitive building blocks and online tools, we've made it easier than ever to build complex haptic interactions and create truly immersive VR experiences. We're confident that this initiative will drive the market growth for medical VR training, support content creation across various organisations, and the prospect of organisations bringing this in-house.

Further innovations from FVR include the development of virtualised imaging in image-guided therapies to aid with the acquisition of skills transfer in minimally invasive surgery, EP and interventional techniques.

WHERE DO YOU WANT TO TAKE THE BUSINESS? WHAT DOES SUCCESS LOOK LIKE OVER THE NEXT FIVE YEARS?

Our vision for the next five years involves creating deeper collaborations with industry leaders and healthcare institutions to address pressing healthcare challenges and positively impact healthcare education and patient care.

We are committed to pushing the boundaries of what's possible with immersive technologies in medical training. Our focus is to enhance our existing platforms, expand our applications to serve a broader array of medical specialities and explore new modalities to provide an even more realistic and effective learning experience.



"As organisations continue integrating immersive technology, these systems are connected to legacy systems, so the security and robustness of platform capacities are vital."

FUNDAMENTALVR
FUNDAMENTALSVRGERY*

06

Apple's expanded subscription service with ad-free search engine

In 2024, we predict Apple will leverage its commitment to user privacy and finally enter the search engine market with an ad-free offering bundled with existing subscriptions. This new service will integrate seamlessly with Apple's expanding ecosystem of services like iCloud, Apple Music, Apple Fitness, and Apple TV, enhancing the overall user experience and creating a more comprehensive digital life platform.

COMPANIES TO WATCH



boardreader®

BrandMentions

brave



crunchbase



DuckDuckGo

ekorū

OneSearch

Quantcast

search.co

Startpage

TUNNEL VISION

WolframAlpha

Yandex



YOU!

■ WHY IT MAKES SENSE

The initiative aligns with recent shifts in user behaviour and attitudes toward privacy, as evidenced by Apple's in-house search ads. Analytics firm Branch found that in the first half of 2023, Apple's in-house search ads were responsible for c.50% of iPhone app downloads resulting from ad clicks, up from around 20% in April 2021 before the company rolled out its privacy changes. This trend was further highlighted when Apple introduced its privacy prompt, and only 16% of users agreed to be tracked, reinforcing the demand for more privacy-focused products and services.

■ SEARCH GIANTS HEAD-TO-HEAD

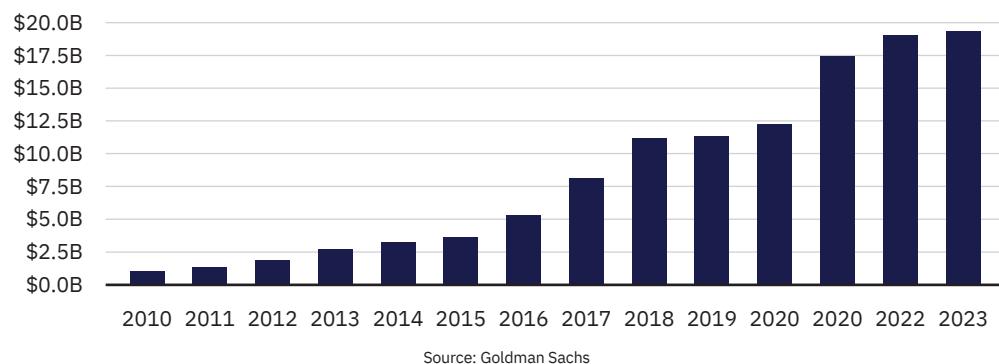
Since 2010, Google has paid Apple an estimated \$120bn to be the default search engine on Safari/iOS. In 2022, Google's payment equalled a third of its net income and increased Apple's by 25%. Moreover, Google's payments to Apple fund more than three-quarters of the latter's R&D expense.

Apple dislikes it when third parties collect its users' data – especially when that data is used to target them. Despite this, the tech giant opts to take Google's cheque instead of offering its own service. Of course, Apple could generate billions from its own search engine. As such, Google's iOS strategy requires the company to give Apple more money than Apple could make directly. The largesse of Google's payments also makes it difficult for another search engine to displace the company on iOS.

■ THE IMPACT ON THE STATUS QUO

Apple's modus operandi has long been to own the core technologies underlying its products. But an entry into the search engine market would unify its tech under one umbrella, disrupt Google's dominant position, and lead to a more competitive and fragmented market, which could benefit consumers through increased innovation and options. 2024 could be a pivotal year that sees Apple capitalising on shifts in consumer behaviour towards privacy and potentially shaking up the search engine market. This move would be consistent with Apple's history of vertical integration and could set new standards for what consumers expect from their digital experiences.

ANNUAL PAYMENTS BY GOOGLE TO APPLE TO BE DEFAULT SEARCH ENGINE ON IOS



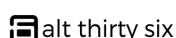
Sources: Branch Analytics, Goldman Sachs Research

07

Anti-money laundering and payment protections come centre-stage

Anti-Money Laundering (AML) and Know Your Customer (KYC) protocols utilise advanced technologies in the cryptocurrency sphere to ensure secure and compliant transactions across decentralised networks. These protocols run on the backend of numerous blockchain platforms and financial exchanges, safeguarding from potential illicit activities by verifying user identities and monitoring transaction patterns. With a growing emphasis on compliance, robust regulatory systems will become even more pivotal in the current financial landscape. Companies enhancing and adopting this technology will gain a significant competitive edge, ensuring both regulatory adherence and user trust in the coming year.

COMPANIES TO WATCH



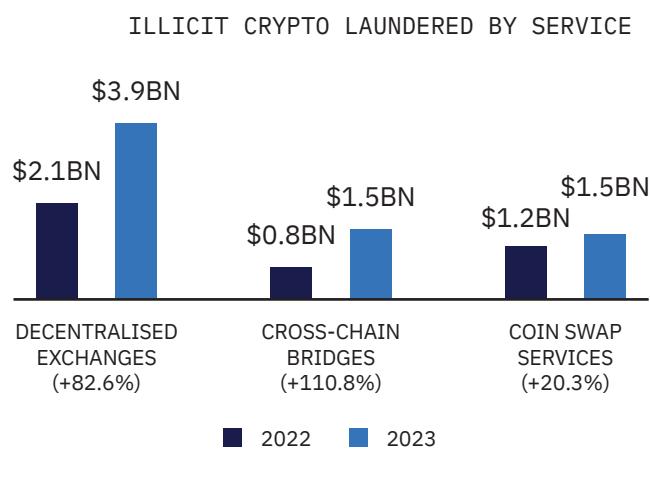
■ MARKET SYNOPSIS

The rise of digital transactions has blurred geographical and jurisdictional boundaries, creating a haven for illicit financial activities. Robust customer identification and verification approaches foster trust, ensure financial stability and promote economic growth. They act as a bulwark against financial crimes, protecting the integrity of financial markets. Money laundering through decentralised finance (DeFi) protocols saw a staggering 1,964% increase, amounting to about \$900m. The global AML market, driven by digital transactions, was valued at \$1.32bn in 2022, with a projected growth rate of 15.9% from 2023 to 2030. However, enforcing these regulations presents hurdles for crypto exchanges and wallets, with traditional processes proving inadequate.

■ THE RISE OF AML SOLUTIONS

The increasing maturity and mainstream acceptance of cryptocurrencies have led to a global push for anti-money laundering regulations. Countries are implementing rules to ensure crypto service providers adopt standards for transaction monitoring and reporting of suspicious activities. The US has been on the frontline with agencies like the Financial Crimes Enforcement Network regularly updating crypto exchange and wallet provider requirements. The Bank Secrecy Act requires crypto businesses to have anti-money laundering programmes. The European Union passed the 5th Anti-Money Laundering Directive, which explicitly includes provisions related to cryptocurrencies. Many other countries, from Singapore to Switzerland, have established regulatory frameworks that mandate or encourage anti-money laundering provisions for crypto enterprises. As the crypto space continues to evolve, striking the right balance between regulation and innovation is crucial.

Regulatory processes that control fraud and financial crimes are pivoting the sector towards enhanced compliance, driven by increased scrutiny towards crypto as an asset class and its growing popularity among institutionals. Initially rooted in traditional banking, AML's embracement in crypto is a testament to the sector's maturity. With the global anti-money laundering solutions market projected to reach \$6bn by 2023, intertwining regulatory protocols with cryptocurrency platforms signifies a growing demand. It aligns the crypto realm with established financial frameworks, fostering broader adoption and investor assurance.



Sources: Grand View Research, Investopedia

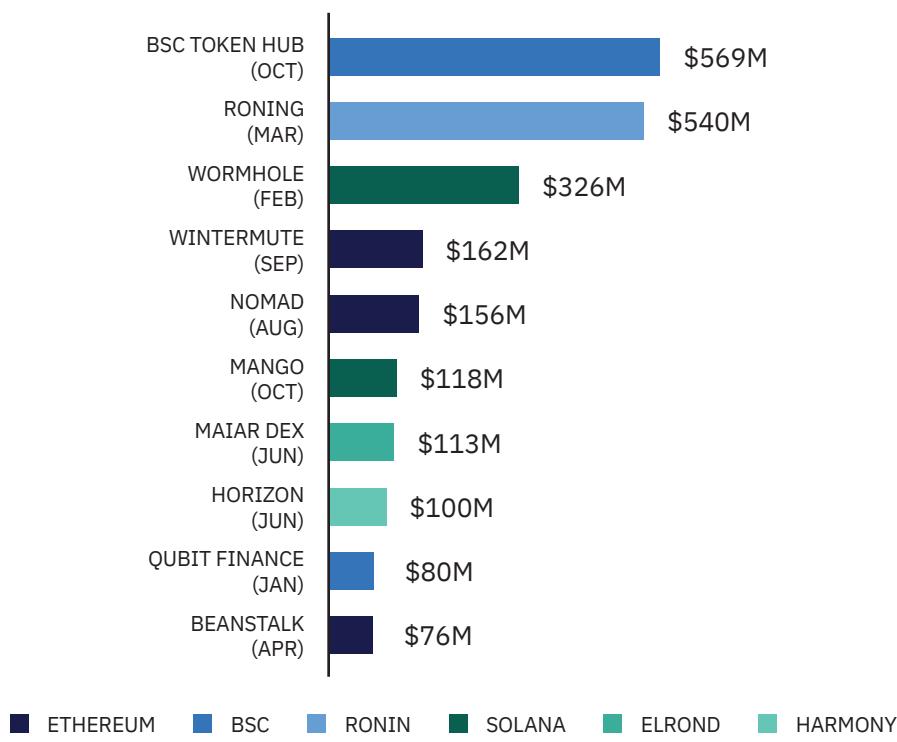
■ AML INITIATIVES IN CRYPTO

Key benefits of the introduction of regulatory frameworks in crypto and the advent of regulatory solutions focused on the sector:

- Market Integrity: AML regulations aim to prevent the use of cryptocurrencies for illegal activities like money laundering, fraud, and the financing of extremist groups. This enhances the overall integrity and reputation of the crypto market.
- Consumer Protection: With stricter procedures, consumers are better protected against fraud, scams, and potential losses in the crypto space.
- Institutional Participation: As the regulatory environment becomes more transparent and robust, traditional financial institutions may feel more confident about entering the crypto market, bringing in more liquidity and expanding the user base.
- Global Interoperability: Standardised regulations can pave the way for better interoperability between jurisdictions. This can make cross-border transactions smoother and may contribute to the broader adoption of cryptocurrencies.

Companies like Chainalysis, CipherTrace, and Elliptic have become prominent in the crypto AML solution space, offering tools and services for transaction monitoring, risk assessment, and compliance reporting. These firms provide cutting-edge solutions to monitor transactions, identify illicit activities, and ensure compliance with evolving regulatory requirements.

TOP 10 DEFI HACKS OF 2022 BY USD AMOUNT STOLEN



08

AI is reshaping media with personalised content and acquisitions

Today, when content consumption behaviours are growing increasingly intricate and evolving more rapidly than ever, media and entertainment businesses find themselves in uncertain, highly competitive markets. In response to these challenges, companies are adapting entire business models to revolve around individual preferences, and leveraging data and consumption patterns to tailor their products. Artificial intelligence presents significant opportunities for companies willing to invest in personalised experiences and 2024 promises to be a turning point in the evolution of media and technology as AI redefines what content we consume and how we do it.

COMPANIES TO WATCH



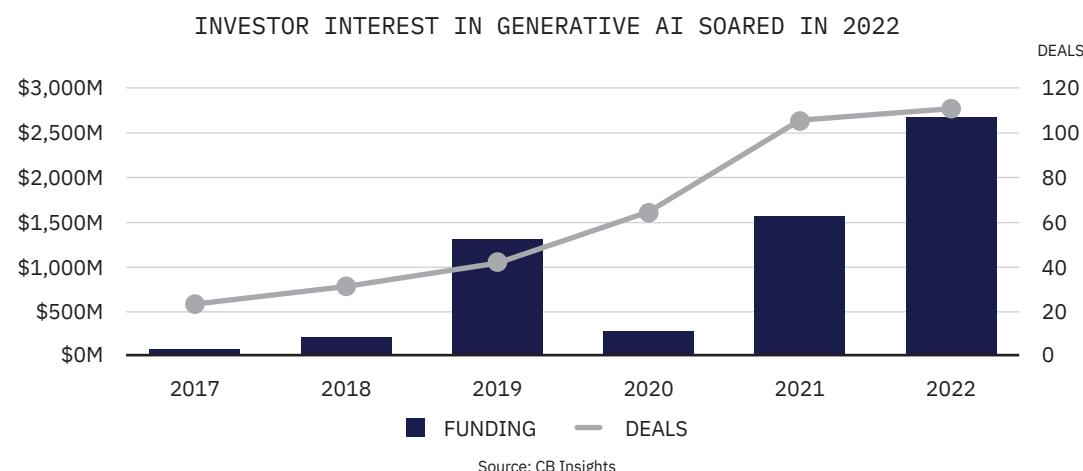
A NEW FRONTIER

In contrast to earlier iterations of artificial intelligence, today's generative AI tools exhibit a distinct potential for creativity. Within a brief period, gen-AI has provided a multitude of creators with newfound capabilities and upheaved industry processes. Ultimately, these tools have the potential to sculpt an entirely unprecedented landscape within media and entertainment. Generative AI startups are emerging at speed as the new frontier in content creation, offering personalised audio and visual experiences, while big media companies are rethinking their entire offerings to revolve around personalised content.

Generative AI is already reshaping industries – in film and TV, it is being trained on actors' movie archives to replicate their voices and mimic their moves, and gestures, creating entire "digital twins". It is also revolutionising video game production by changing approaches to creation and player engagement. With AI, game developers can produce virtual worlds that are not only more authentic but also more immersive and realistic. In contrast, non-player characters (NPCs) can now generate casual dialogue in real-time. This results in more dynamic and realistic gaming experiences which adapt to players' actual actions and conversations.

USE, MISUSE AND THE YEAR AHEAD

Despite AI's seemingly boundless new opportunities, it doesn't come without ethical implications. While gen-AI has the potential to save film studios production time and money, it also raises significant concerns over intellectual property, trust, ownership, and the overall value of the actor. Similarly, as voice cloning has increased in the music industry, so have the concerns over legal rights to reuse an artist's earlier work, and how much "human" input a work of music should have to be copyrightable. But while the balancing act between utilisation and potential exploitation of AI is expected to be complex, VCs have not been deterred. Despite market downturns, AI remained one of the few resilient investment areas in 2023, with funding for AI companies surpassing \$23bn this year in North America alone. Comparatively, non-AI funding reached over \$67bn. As Big Tech companies position themselves to capitalise on AI, we expect high-profile acquisitions to shape the industry in the coming year as well. Before OpenAI's ChatGPT was released at the end of 2022, many companies in media and entertainment still viewed AI as something that gave them a competitive advantage. Today, they're grappling with the realisation that AI is a competitive necessity, and we expect them to make significant acquisitions to integrate generative AI into their platforms in 2024.



Sources: Dataiku, Deloitte Insights, Forbes, Crunchbase, PitchBook

09

AI race escalates semiconductor shortage

Five out of our 10 predictions this year relate to more AI use cases. But crucially, training and using AI models requires a significant amount of semiconductors, most notably GPUs. Those GPUs must be made at the most advanced semiconductor facilities in the world – Nvidia's H100 GPU is made at TSMC's 5nm fab. We expect this supply to accelerate in 2024 as TSMC ramps up more production and, specifically, the supply of more advanced packaging, but not quickly enough, which means GPUs will continue to be in shortage in 2024.

COMPANIES TO WATCH



■ WHERE THERE IS DEMAND...THERE WILL BE SUPPLY?

AI-driven applications are multiplying, and so is the need for semiconductors that cater to them. Companies like Nvidia, AMD, and dedicated AI-chip startups will focus on producing chips optimised for machine learning and AI computations. The push towards edge computing will demand semiconductors that efficiently perform complex calculations on-device rather than in centralised data centres. Further, the need for faster and higher-capacity memory and storage solutions will grow as data generation explodes. Expect High Bandwidth Memory (HBM) to be another area of potential supply tightness. The sector will have to navigate challenges posed by geopolitics and global supply chain dynamics while propelling innovation, so ensuring supply chain resilience and sustainability will be paramount. The overarching narrative will be one of integration, innovation, and indispensable significance in a world that is becoming increasingly digital.

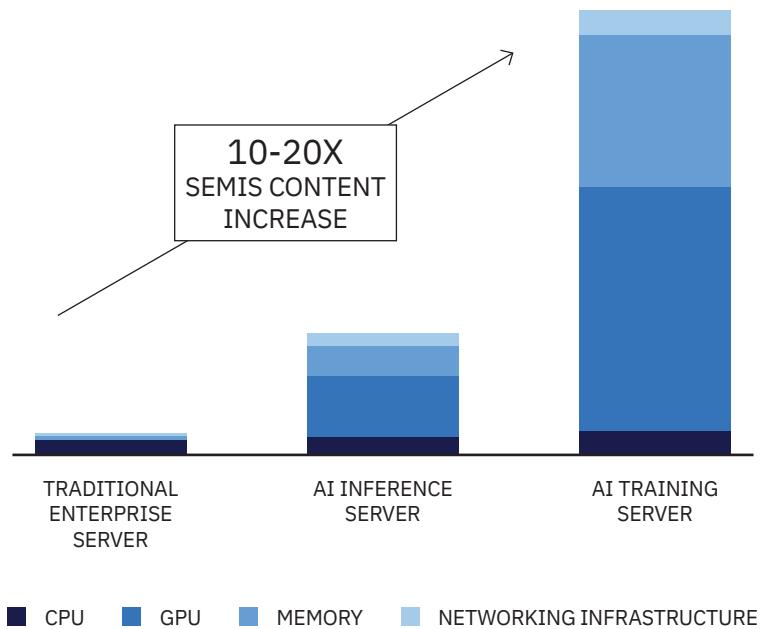
■ HYPERSCALERS WITH INVESTMENT INCENTIVES

Today, most GPUs are bought by large cloud service providers – Amazon, Microsoft, Alphabet, Oracle – which all sell on that capacity and at good margins to businesses wanting to build or access LLMs. For each of them, selling Generative AI capabilities is one way they are trying to attract the next new growth customers to their cloud services. They are all in a race to invest or risk falling behind. We believe hyperscaler capex will amount to ~\$160bn this year, which will increase in 2024. Google, Amazon and Microsoft are all in a position to continue investing, having large cash balances and an ability to sustain high levels of investment over time. This means the strong demand for GPUs will continue to accelerate.

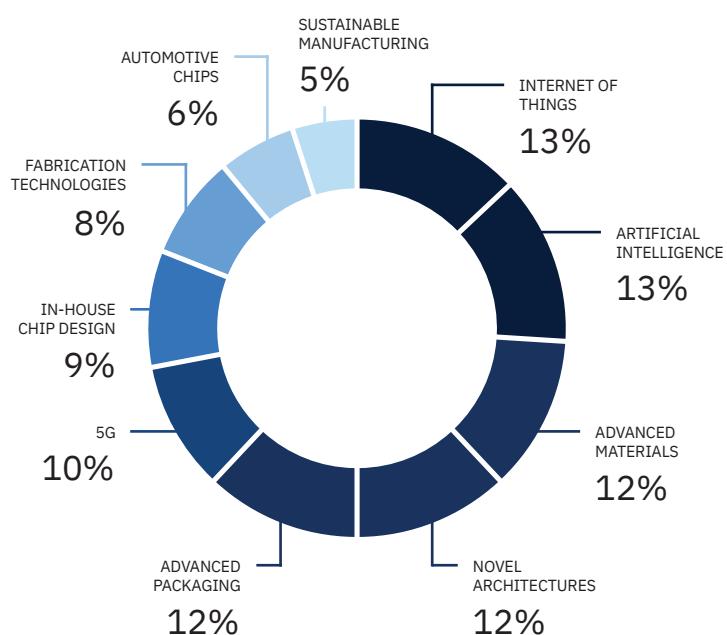
■ NVIDIA LEADS, BUT ROOM FOR MORE WINNERS

There are many reasons why Nvidia, which is the biggest supplier of GPUs, will remain the leader for now. Its long-term competitive moats around CUDA – the parallel computing platform and programming model – and its networking advantages mean that dominance is expected, particularly around training infrastructure. However, we see other competitors emerging. Cloud players are motivated to look for a second source to Nvidia to avoid being tied to one powerful supplier. To the extent that AMD can launch its MI300 GPU alternative to Nvidia by the end of 2023, while Nvidia remains supply-constrained, it would be very positive in establishing itself as a credible alternative to Nvidia in AI workloads. It means AMD could benefit significantly alongside Nvidia in the initial AI infrastructure build-out and, in the longer term, in the AI inference market. The hyperscalers, too, will be motivated to build their own chips, given they have enough utilisation, a sizeable user-installed base, and specific use cases. Google is the most progressed here with its TPU v4. We expect more new chip projects in 2024, though note that the same supply issues will remain as they require production on the most advanced semiconductor manufacturing nodes.

SEMICONDUCTOR CONTENT INCREASE IN THE MOVE TO AI SERVERS



TOP 10 INNOVATION TRENDS AND THEIR IMPACT ON SEMICONDUCTORS



Source: StartUs Insights (August 2023)

Source: GP Bullhound Insights

10

Acceleration of carbon accounting as new regulations loom

In the transition towards a decarbonised economy, it is becoming clear that new expectations are being placed on business leaders. Whether the motivation is to reduce emissions or comply with increasing regulations, accounting and reporting of carbon footprints are becoming commonplace. However, only 10% of companies fully measure their emissions today, and enhanced digital tools are needed for broader adoption. Developments that ease the complexities of data gathering, structuring and processing are crucial and will take carbon accounting to the next level.

COMPANIES TO WATCH



brînk



CarbonCloud



Consequence.



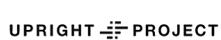
ecovadis



energisme



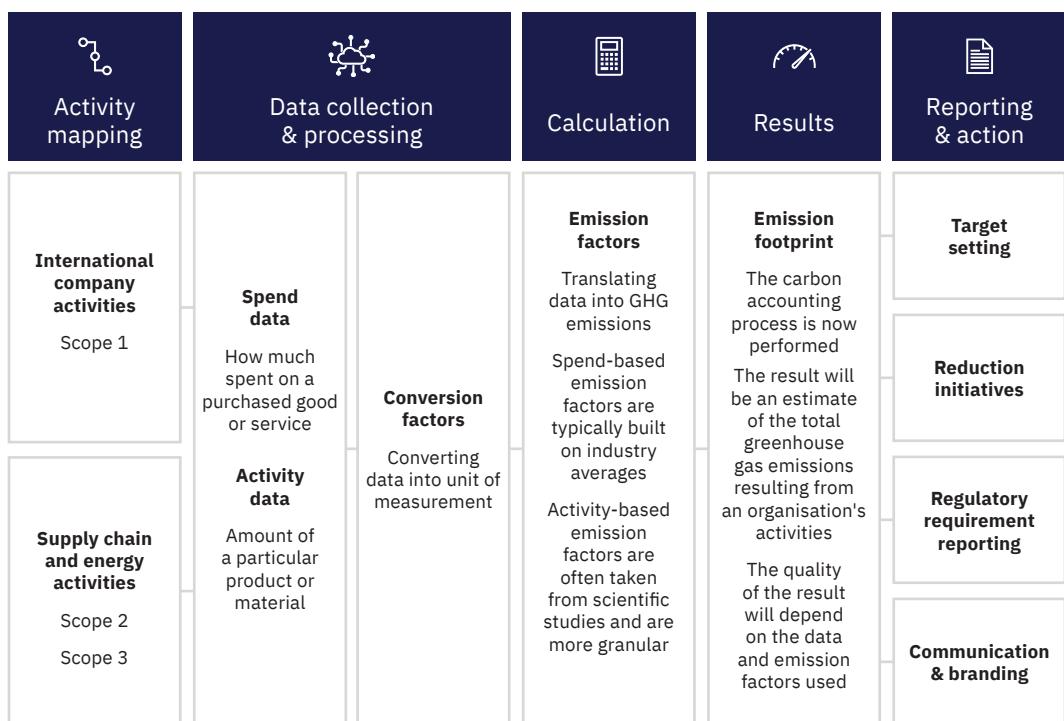
Normative



■ FROM ACTIVITIES TO EMISSIONS: THE CARBON ACCOUNTING PROCESS

Like financial accounting, carbon accounting quantifies the impact of an organisation's activities – though instead of financial impact, it tracks and reports climate impact. Carbon accounting is the systematic methodologies, measurement and monitoring of how much greenhouse gases (GHG) are emitted by a business. The process of carbon accounting can be split into five stages. As the operational applicability and use cases of emission calculations evolve, the process is a dynamic loop rather than a static line.

VISUALISATION OF THE CARBON ACCOUNTING PROCESS,
FROM ACTIVITY MAPPING TO REPORTING



Source: Normative.io: Carbon accounting explained

■ THE NEWEST ADDITION TO THE BUSINESS-AS-USUAL TOOLBOX

Companies will need reliable, scalable and easy-to-use carbon measurement solutions. A recent study by BCG, which included 1,600 enterprises, revealed that a mere 10% of the companies measured their full emission footprint in 2022. Moreover, 87% expressed a desire to expand their reporting scope – provided they have better digital tools.

Increased awareness around more sustainable business operations, from consumers and regulators, has brought substantial investments into technology-based solutions. In 2022, carbon accounting platforms saw an unprecedented influx of \$970m in funding. Some of the most recognised names in this sector include Greenely, Watershed, Persefon, Sweep, Plan A, Greenly and Normative. Other than the obvious benefits of going from manual processes and spreadsheets to a digital platform, software providers have foremost made carbon accounting more broadly accessible, dynamic and compliant.

While current carbon accounting software providers are paving the way towards new processes, we have only just experienced the first generation of innovators. With a higher degree of standardisation compared to earlier stages, the calculation itself – the conversion of activity data into carbon footprint – has reached a high level of automation in its current state. Further automation in the data collection and ingestion stages will be vital in continuing the broader adoption of carbon accounting.

CURRENT STATE OF CARBON ACCOUNTING AUTOMATION AND AREAS TO IMPROVE

Level of complexity and time spent

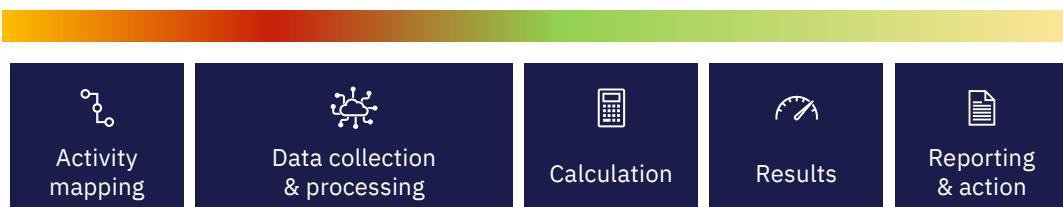
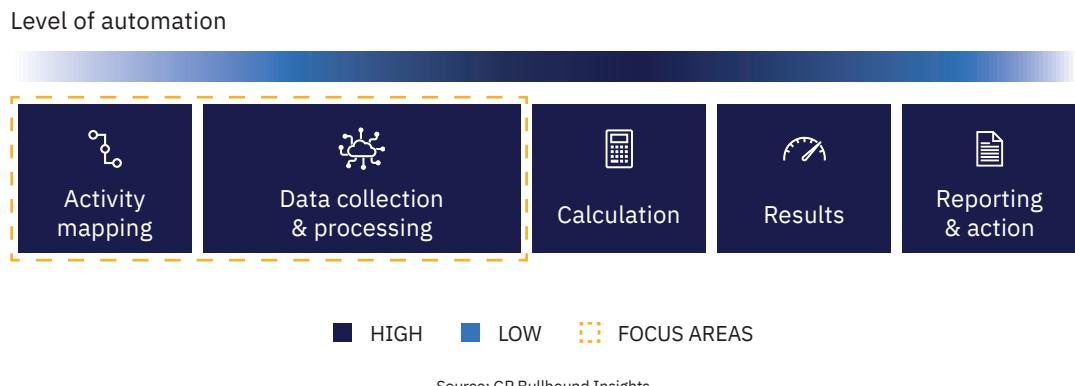


Illustration of the level of complexity and time required in the carbon accounting process

Source: GP Bullhound Insights



■ BUSINESSES PREPARE FOR NEW CARBON REPORTING MANDATES

In the first half of 2023, many organisations were frenzied to adjust their operations in preparation for new regulations. The European Union is gearing up to substantially revise how companies account for their carbon emissions. The Corporate Sustainability Reporting Directive (CSRD) is a pivotal component of this new obligation and was set to reshape reporting practices for approximately 50,000 EU companies. The discussions are also advancing in the US under the Task Force on Climate-related Financial Disclosures (TCFD), jointly increasing regulatory pressure on reporting carbon footprint in the future.

■ INCREASED AUTOMATION IS CRUCIAL

While many carbon solutions aspire to be “plug and play”, there is still much manual work in the data collection stages and beyond. Carbon accounting software users spend 75% of their time mapping business activities and the right data inputs. Regardless of expected regulations, most companies will not dedicate the time and resources currently needed to perform reliable carbon accounting. However, there are various developments existing providers and new entrants can implement to take the industry towards more automated processes. These include improved structuring and cleaning of data with AI, increased reliability and traceability of AI-enabled output and improved API integrations in fragmented sub-categories. Moreover, the ongoing digitalisation of supply chain data will be a crucial systemic shift in the long run, as well as better impact data models and sustainable databases.

The past, present and future

2011

GOOGLE'S ANDROID DISTANCING APPLE'S IOS	✓	MOBILE PAYMENTS SET TO SURGE	✓
Android to distance itself from Apple's iOS platform in terms of market share			
SOCIAL SHOPPING, DATING AND GAMBLING WILL THRIVE ON MOBILE	✗	AR APPLICATIONS TAKEOFF ON LOCATIONBASED SERVICES FOOTPRINT	✗
Services that revolutionised everyday life of millions of users to massively hit the mobile space			
MOBILE AND SMART GRID APPLICATIONS OPEN THE DIGITAL HOME	✓	PRIVACY BECOMES A TOP PRIORITY FOR SOCIAL NETWORK USERS	✗
Home control system suppliers leveraging next-gen devices to help control and manage home equipment			
THIN FILM MAKES A COMEBACK AND VCS TO EXIT TO STRATEGICS	✗	SHORT MESSAGING FORMAT TO GAIN SUPPORT AND MOMENTUM	✓
Massive consolidation driven by the entry of industrial players with their capital and manufacturing might			
GAMING MOVES INTO THE CLOUD	✓	NEW GENERATION OF BUSINESS INTELLIGENCE & DATA ANALYTICS APPS	✓
The interactive entertainment industry to continue to move into the cloud			

2012

RECOMMENDATION ENGINES GET PERSONAL THROUGH SOCIAL MAPPING	✓	HARDWARE AND CONTENT CONVERGENCE WILL ACCELERATE	✓
Set to integrate user-specific preferences and social mapping; recommendations curated just for you			
RUSSIAN INTERNET TO EXPORT NEW SOCIAL MODELS	✓	WINDOWS PLATFORMS PICK UP NEW MOMENTUM	✓
Russian Internet to export new social models; expect activity in this respect			
VOICE RECOGNITION BOUND TO DISAPPOINT - AGAIN	✗	SOCIAL RECRUITING HITS THE MAINSTREAM	✓
Broad market utility and adoption will again fail to materialise due to remaining technical constraints			
SMART WALLET BREAKS THROUGH	✗	A RE-BIRTH OF THE SECOND SCREEN – THE TV	✓
After so many false starts, we expect the smart wallet to finally take hold			
LIGHT-EMITTING DIODE (LED) PRICES WILL COLLAPSE	✓	New feature sets to transform the TV into a fully interactive device; a new era of differentiated TVs	
Prices for LEDs to plummet as competition intensifies to satisfy demand for energy-efficient lights			

Our trends don't just look at the year ahead, they endure – more than a decade ago we were one of the first to predict a surge in mobile payments and digital blockchain technology – both of which have transformed and continue to integrate into our lives with a real impact.



2013

COLLABORATIVE CONSUMPTION BECOMES THE NEW ECONOMY	✓
Economic system built from network technologies for creation of exchange platform for different assets	
THE RISE OF CURATED AND PERSONALISED CONTENT	✗
Content is king holds true, but getting right message to the right person at the right time is a major trend	
CONSOLIDATION TO CONTINUE, LED BY "BIG FOUR"	✓
Major buyers to pursue tech M&A for diversification and revenue growth	
MICROSOFT TO DOMINATE NEXT GAME CONSOLE CYCLE	✗
Microsoft to win fight between Xbox 720 and PS4	
IP ARMS RACE INTENSIFIES IN 2013	✓
After the 1990s web-browser war and the 2000s Internet search war, IP arms race to intensify in 2013	
DISRUPTION OF EDUCATION TO ACCELERATE	✓
Disruption of education system by technology and free online resources to continue to build momentum	
GESTURE AND TOUCH CONTROLS EMERGE AS STANDARDS	✓
The way we interact with computers has moved beyond the computer mouse	
VIDEO CALLING GOES CORPORATE	✗
Although still a novelty today, video calling to grow strongly within the corporate world	
GAMIFICATION – AN EXPLOSION OF INNOVATION	✓
Gamification marketing efforts engage users in game thinking and game mechanics to raise brand loyalty	
WEARABLE TECH – THE HEALTH APP BREAKS THROUGH	✗
Wearable technology applied to health and fitness to make its way into the mainstream	

2014

EYE TRACKING REACHES CONSUMER MASSES	✗
Mass consumer applications of eye-tracking technology to hit the market in 2014	
SMART MACHINES MARKET TAKING-OFF	✗
SmartThings and IoT to penetrate market; innovations, investments and acquisitions to continue	
SOCIAL MESSAGING MARKETS TO CONSOLIDATE	✓
High number of users make these apps attractive to strategic partners searching for growth	
MARKETPLACES TO GO VERTICAL	✓
Vertical marketplaces to be more prominent than horizontal marketplaces on increased investment	
CURVED SMARTPHONES TO FLOP IN 2014	✓
Big players tackle consumer pain of high price points and lack of perceived value of the curved design	
BREAKTHROUGH IN INDOOR LOCATION, COMMUNICATION AND MARKETING	✓
Large retailers leading the way for beacon technology implementation	
SHOPPING GOES 'CLICK & MORTAR'	✓
E-commerce retailers such as Birchbox, Bonobos and Amazon opened retail stores	
THE BATTLE OF 'WHERE' TO UNFOLD	✗
Map applications to proliferate and develop features like lane navigation, restaurant reservation, ETA, etc	
ADVANCED DATA ANALYTICS CLIMBS TO TOP OF CORPORATE AGENDA	✓
Big data and data analytics applications to become attractive to businesses	
CLOUD STORAGE PLATFORMS GO MAINSTREAM	✓
Cloud storage to increase due to time and money saved in IT management and fewer internal resources	

2015

INTERNET OF THINGS TO MOVE FROM SMART TO INTELLIGENT	✓
IoT to turn intelligent by harnessing insights from actionable data uploaded to the cloud	
MAJOR LANDSCAPE CHANGES IN THE WORLD OF PAYMENTS	✓
Cleaner cryptocurrencies and digital blockchain technology for industries to increase transparency	
END-TO-END SERVICE DISRUPTION GOES BEYOND UBER AND AIRBNB	✓
End-to-end consumer experiences using a fusion of software and labour to penetrate consumption spend	
CONTINUED EMERGENCE OF ONE-STOP SHOPS IN AD-TECH	✓
Consolidation as larger players diversify into digital advertising segments and acquire pure-play ad-tech	
STRONG WAVE OF TECHNOLOGY & PRODUCT EXITS	✓
M&A led by large players targeting consumer experience, electronics, one-stop-shop digital tools	
NEW MEDIA OUTLETS TAKING-OFF	✓
New media brands producing engaging content in various delivery formats to attract mass audiences	
SAAS ADOPTION PERMEATES THROUGHOUT THE ENTERPRISE	✗
Increased adoption of cloud SaaS enterprise applications to increase productivity and efficiency	
3D PRINTING MOVES FROM PROTOTYPING TO END-PRODUCTS	✗
To enter larger, less price-sensitive industries where products are lighter, versatile and durable	
RETURNED FOCUS ON CUSTOMER LONG TERM VALUE IN MOBILE GAMING	✓
Gaming companies target user retention with realistic graphics, culturalisation and community management	
COMPREHENSIVE CYBERSECURITY PROTECTION TO BECOME THE NORM	✓
Big data security options, and multi-factor and biometric authentication to permeate consumer apps	

2016

VIRTUAL REALITY BECOMES REALITY	✓
Virtual reality to revolutionise media, sports, gaming, entertainment, and education	
AUTOMOTIVE INDUSTRY RIPE FOR INNOVATION	✓
New car operating systems to spur growth, dominated by third-party software and technology players	
ALTERNATIVE LENDING CONTINUES TO SHINE IN FINANCIAL TECH SECTOR	✗
From early innovation in Fintech for mobile payments and cryptocurrencies, to alternative lending	
DIGITAL VIDEO BECOMES MORE MEASURED TO KEEP GROWING UP	✓
To be the largest video format; tech/media-focused platforms to adjust to capture video audience	
DRONES TO FLY INTO HEADWINDS OF UNCERTAINTY	✓
Promise of drones undeniable, but drones functioning responsibly at mass scale to remain unproven	
'QUANTIFIED SELF' TRANSITIONS FROM NICHE TO MAINSTREAM	✓
Hardware and software startups to create products and services to track vital health information	
GAMING GIANTS FORTIFY POSITIONS, GOBBLING UP CHALLENGERS	✓
Consolidation to continue and smaller independent developers to build their user base until acquired	
DESKLESS WORKERS AT FOREFRONT IN ENTERPRISE MOBILITY SHIFT	✓
Seismic technology paradigm shifts in recent years, leading to growth in enterprise mobile app companies	
CYBERSECURITY CONTINUES SOUL SEARCHING	✗
Advanced cybersecurity solutions for the enterprise to become ubiquitous and a 'must have'	
TECH UNICORN HUNTING NOW IN SEASON	✓
Some to lose 'mythical' status as growth slows, fundamentals weaken & unrealistic expectations rise	

2017

THE NEXT GENERATION OF AI	✓
AI has made waves since Alpha Go toppled Lee Sedol, 18x world Go Champion; high investment, it's staying	
E-SPORTS TAKES CENTRE STAGE	✓
Rapid growth of e-sports to continue, becoming a billion-dollar industry driven by huge fan base	
THE DAWN OF VR/AR CONTENT	✗
With VR/AR at hype cycle peak and hardware ahead of content, software to drive next platform	
SOCIAL MEDIA TRANSFORMATION	✓
In a flat world of consumer technologies, Western and Asian social media giants to offer similar features	
TECH IPOS SET FOR TAKE OFF	✗
Global uncertainties have hampered performance for IPO markets, but these to rebound in the coming year	
CORDLESS CONTENT ANYWHERE AND EVERYWHERE	✓
Millennials leading change in how media is consumed; cable networks fight the rise of over-the-top services	
FINTECH SHIFTING TECTONIC PLATES	✗
Traditional financial institutions to disrupt themselves to stem the impact of 'banks 2.0'	
DRIVERLESS CARS STILL REQUIRE HUMAN DIRECTION	✓
As cars are more connected, large tech players to enter market	
SAAS SOFTWARE REIGNING SUPREME	✓
Mobile workforce has led to mass adoption of SaaS. Fragmented market to see some consolidation	
YEAR OF THE EUROPEAN DECACORN	✓
European unicorns to continue demonstrating resilience versus Asian and US counterparts	

2018

AN UNSEASY FUTURE FOR POLITICS AND TECH	✓
Tech firms to come under scrutiny for content allowed on their platforms with specific regard for politics	
TRANSLATION TECHNOLOGY TAKES HOLD	✗
Translation technology to enjoy widespread consumer adoption due to advances in machine learning	
MOBILE TRUMPS TV IN CHINA	✓
Mobile phone usage to overtake TV consumption	
OVER AND OUT EMAIL	✗
Information workplace communication tools to overtake email, YoY growth in corp email to cease	
REGULATORS RULE ON BOOM AND BUST OF ICOS	✓
Regulators to look at booming ICO market and create definitive guidelines and regulations for the space	
INTERNATIONAL LABOUR ARBITRAGE FLOURISHES	✓
Companies to abandon traditional tech hubs in favour of smaller and up-and-coming places	
THE UNLIKELY COMBACK OF THE SOFTWARE SUITE	✓
Companies to spend large amounts on IT platforms to aid their digital transformation efforts	
CYBER SECURITY EXPOSURE AND ADOPTION	✓
There will be widespread consumer adoption of digital security in light of hacking in 2017	
INDUSTRY 4.0	✗
Factories to embrace artificial intelligence and robotics, spurring the fourth industrial revolution	
AUGMENTED REALITY ADAPTS FOR EARLY ADOPTION	✓
AR to enjoy a rapid increase in consumer adoption due to improvements in technology	

2019

DIGITAL BANKING CONTINUES TO RISE	
Consumer adoption of digital banking tools as digital transactions continue to increase YoY	
EMPLOYEE ENGAGEMENT GOES HIGH TECH	
HR to embrace AI and data analytics to make capital management more efficient	
ARTIFICIAL INTELLIGENCE IS THE END OF REPETITION, NOT LIFE	
AI to improve working conditions and create more flexible ways of working	
LAST MILE DELIVERY GOING THE DISTANCE	
More retailers to focus on improving last mile delivery solutions to keep pace with vendors like Amazon	
END OF THE BOYS CLUB	
Corporate initiatives for gender balance through improvements in accessibility to female entrants	
APP DISTRIBUTION MOVING AWAY FROM APPLE AND GOOGLE	
Apple and Google to see widespread backlash from developers fed up with their commission fees	
RETAIL TECHNOLOGY GETS SMARTER	
Traditional retail to embrace innovative technologies to usher in the new age of retail	
CONSUMER SUBSCRIPTION SET TO ECLIPSE ADVERTISING	
Subscription models win versus traditional advertising as concerns of data misuse continue to mount	
A BREAK-UP OF AN ADVERTISING DUOPOLY	
Brands to break up large advertising hold of Google and Facebook with own end-to-end services	
CRYPTOCURRENCY WILL GROW UP	
Institutional capital to flow to cryptocurrencies as blockchain activity continues to increase	

2020

THE WAR IN STREAMING FILM AND VIDEO ESCALATING TO A FRENZY	
Consumers using multi-platform for premium content; large incumbents offering bundled premium services	
VERTICALISED AI SOLUTIONS TO SOLVE REAL BUSINESS CHALLENGES	
Until AI models can integrate into existing systems / architecture, purpose-built AI tools to solve needs	
APPLE A13 BIONIC SETS THE PRECEDENT FOR ON-DEVICE AI / ML	
Apple rules computing power and graphical capabilities, but the competitive gap has narrowed	
CORPORATE SOCIAL RESPONSIBILITY TAKES CENTRE STAGE	
Fast growth for CSR software, boosted by increasing awareness and greater adoption of CSR initiatives	
THE EDGE OF TOMORROW	
Importance of running data-intensive processes on devices, with significant business outcomes	
RELATIONAL DATABASES MAKE WAY FOR DATA LAKES	
Data lakes clearly demonstrating supremacy over relational databases and other legacy products	
AI/ML SHOWING QUANTIFIABLE RESULTS IN MARKETING	
Adoption of AI technology to more accurately target consumers and improve ROI is set to continue	
GAMING EMBRACES THE ERA OF SUBSCRIPTION AND STREAMING	
Streaming and subscriptions to become the default way games are consumed and purchased	
5G LANDGRAB: THE RACE FOR COMMERCIAL DEPLOYMENT OF 5G	
5G touches all of the communication ecosystem, and devices and networks are racing to lead	
EVERYTHING AS A SERVICE	
The benefits of an as-a-service model are clear and becoming widely adopted	

2021

EDUCATION IN THE 21ST CENTURY	
Digital learning should continue to surge given the format's clear benefits	
'I WANT IT NOW' E-COMMERCE	
Consumer sentiment proves that the 'I want it now' mindset is going to be a permanent commerce fixture	
CONSUMERS TAKING CONTROL OF PRIVACY	
Products offering privacy controls are a differentiator for tech companies and the new consumer standard	
CASH IS NO LONGER KING	
No longer just for techies, digital wallets and payments are now mainstream	
MARTECH ALL-IN ON CUSTOMER EXPERIENCE	
The convergence of marketing, customer experience and cloud communications is full speed ahead	
NEW PATIENT DOCTOR RELATIONSHIP	
Many are benefitting from tech-enabled healthcare worldwide and we expect continued collaborations	
THE NEXT SOCIAL NETWORK	
The world is connected through a growing number of platforms and devices; more interactions are virtual	
SURVIVAL OF THE FITTEST	
Digital fitness, a new star in the CSS ecosystem, is here to stay as consumers embrace at-home fitness	
THE FUTURE OF WORK	
Employers are rethinking the future of the office with the ever-increasing reliance on collaboration tools	
EPIC'S ULTIMATE BATTLE ROYALE... WITH APPLE	
Apple to continue adapting its app developer approach as more challenge its ecosystem leverage	

2022

THE CREATOR ECONOMY	
The creator economy is now a mainstream industry, growing from \$104bn in 2022 to \$250bn in 2023	
TECHNOLOGY SUPERCHARGING SUPPLY CHAINS	
Businesses and governments globally continue to turn to technology to solve supply chain issues	
THE NEW VIRTUAL PLAYGROUND	
Between Apple's Vision Pro and Meta's Quest 3, the metaverse shows no signs of slowing	
WEARABLES POWERED BY ARTIFICIAL INTELLIGENCE	
From healthcare to IoT, AI integrations continue to prove the growing potential of wearables	
ARTIFICIAL INTELLIGENCE AUTOMATING HEALTHCARE	
Progress is slow as legacy healthcare systems and institutions struggle to integrate and deploy AI	
THE RISE OF DEFI	
2022 institutionalised DeFi as major financial organisations made their first blockchain transactions	
THE ARMS RACE	
As of 2022, ARM technology is the most widely used family of instruction set architectures	
TECH DRIVING DIVERSITY, EQUITY AND INCLUSION	
With more data than ever, HR software continues to power businesses, bridging the gap in DEI initiatives	
THE GLOBAL SEMICONDUCTOR SHORTAGE	
Demand for renewables, EVs and AI-powered computing continues to fuel the global chip shortage	
THE FUTURE OF PAYMENT	
BNPL providers face risk of defaults with consumer credit risks, inflation and higher interest rates	

Methodology

This report is based on the expert insights of GP Bullhound's worldwide team alongside detailed analysis of investment trends across the global technology landscape. It is intended to provide our predictions for the digital economy in 2024.

Each year, we present a transparent assessment of our predictions from the previous report to maintain a high level of scrutiny on our own research. Conceptually predicting tech of the distant future is in many ways simpler than predicting near-term advancements, but our challenge is identifying which technologies will see the greatest progress and market adoption in the coming 12 months.

Historically, we have highlighted significant trends standing the test of time; e.g. our predictions for IOT, wearables and collaboration tech, as well as critical trends in cybersecurity, cloud and edge computing. Many will continue to evolve, eventually forming the foundation for future tech in years to come.

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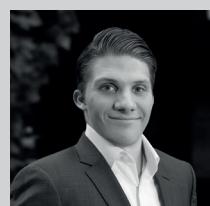
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