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Thematic Intelligence
Healthcare

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Augmented Reality in Healthcare

Contents

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Executive Summary

AR will support process improvement in healthcare

GlobalData forecasts that the global augmented reality (AR) market will be worth $100 billion by 2030. Artificial intelligence (AI) and data analytics are 'must-have' technologies for healthcare companies. While AR is not expected to be a key priority, it will provide value to companies who invest in it astutely. Rather than enable entirely new processes, companies should use AR to improve existing processes. Broadly, AR is useful in processes that are limited by poor information flow—when there is too much information, or when communicating information is practically or intellectually difficult. AR can remove this barrier by delivering the information more intuitively and comprehensibly in these processes. AR has uses in healthcare professional training, R&D, manufacturing, and sales and marketing.

The lack of use cases is preventing widespread use of AR

In general, AR adoption in the healthcare industry—which includes pharmaceutical companies, medical device companies, and healthcare providers—has been inhibited by a lack of both understanding and use cases. Compared to AR, these sectors are more familiar with the applications of virtual reality (VR). AR has the most promise and use cases in supporting healthcare providers, particularly in surgical assistance and professional training. For pharma and medical device companies, AR has been mainly used in niche applications within manufacturing, sales, and marketing.

Digital advancements are driving the healthcare industry

The COVID-19 pandemic pushed the healthcare industry to rapid digitalization. Now, increased use of the telehealth industry, telepresence systems, remote diagnostics, predictive AI, and wearable technology is changing how healthcare is delivered and improving patient outcomes. Emerging technologies such as AR and VR are becoming increasingly routine for professional training, surgical assistance, and treatment of psychological and neurological disorders. In the pharma and medical devices industries, AR, VR, and AI are rapidly accelerating drug discovery and manufacturing and generating supply chain efficiencies. New digital opportunities will look to build upon disruptive technologies. However, affordability is a limiting factor to widespread adoption.

Leaders and challengers

AR Devices

- **Leaders:** Boston Scientific, Stryker, Thermo Fisher Scientific.
- **Challengers:** Augmedics, SentiAR, AccuVein.

AR Platforms

- **Leaders:** GE HealthCare, Philips, Zimmer Biomet.
- **Challengers:** Aira, Atheer, Brain Power.

AR Apps

- **Leaders:** Nihon Kohden, Medtronic.
- **Challengers:** Complete Anatomy, Know My Beat, Proximie.

Inside

Related reports

- Thematic Intelligence: Augmented Reality
- Thematic Intelligence: The Metaverse
- Thematic Intelligence: Artificial Intelligence – Executive Briefing (Second Edition)
- Thematic Intelligence: The Metaverse in Healthcare

Report type

- **Single theme**
- Multi-theme
- Sector scorecard

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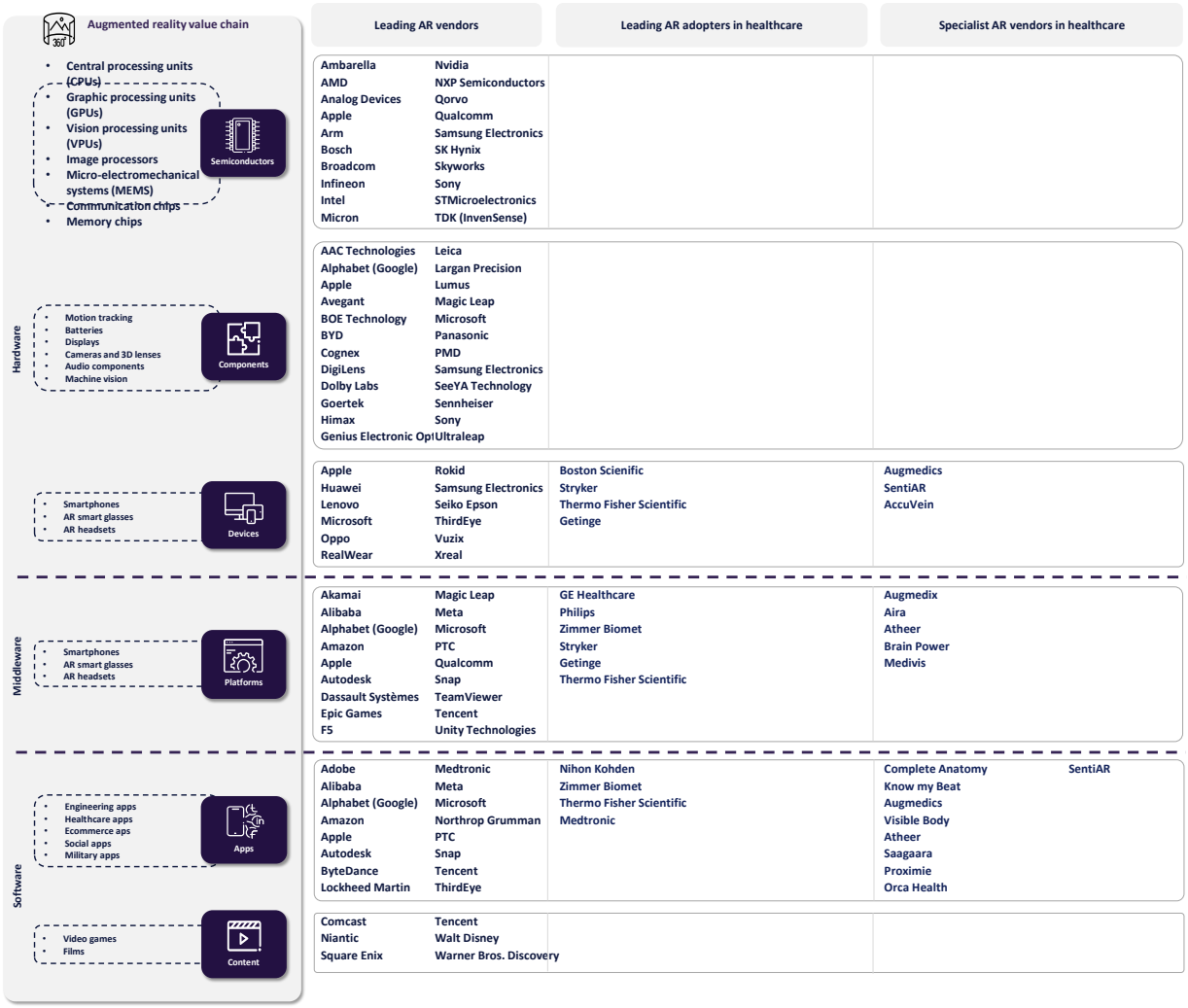
Players

This table shows which companies are most active in each part of the AR value chain. Healthcare companies are not active in the semiconductors market as it is a hardware component with a limited number of known specialist producers (including Qualcomm, Apple, Intel, and Nvidia). Instead, healthcare company activity is concentrated downstream, providing value primarily at the platform level. Some companies have developed their own devices too (including Boston Scientific and Stryker).

Key players in augmented reality



Source: GlobalData

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Healthcare Challenges

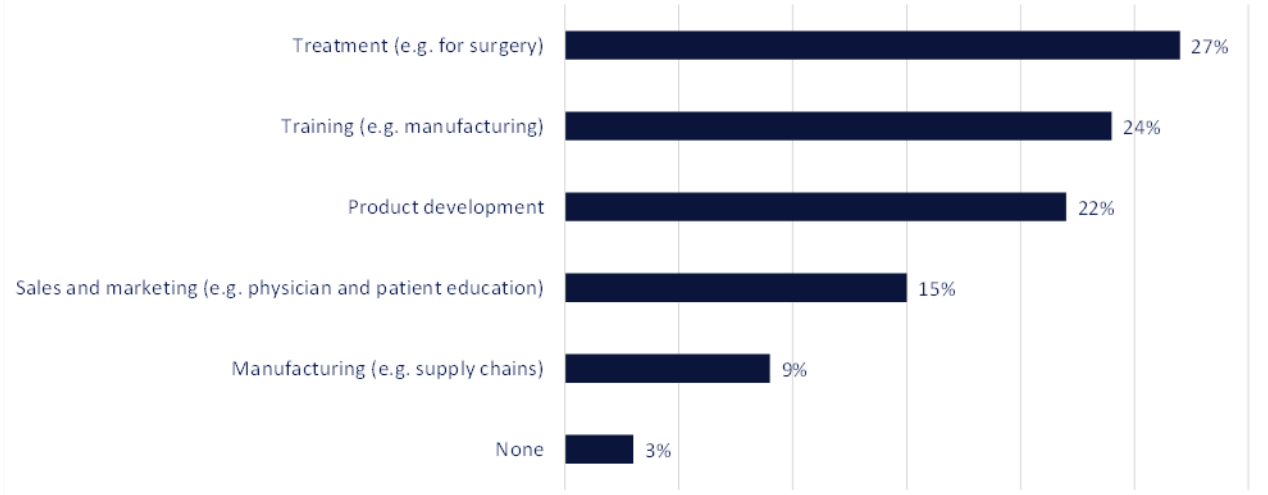
The healthcare industry is often risk-averse compared to other sectors when adopting new technologies. However, the COVID-19 pandemic accelerated the sector's digital transformation. Shifting consumer preferences mean that virtual health and remote care are a preference for many. AR is already being adopted in areas of healthcare such as R&D, training, and medical education.

Digital transformation in healthcare delivers multiple benefits, including improving patient and clinical outcomes, reducing barriers to care and treatment, improving operational efficiencies, and reducing costs.

Between January 29 and February 28, 2024, visitors to GlobalData's Medical Device Network website were surveyed about their thoughts on what aspects of the medical device sector had the most potential with AR. Only 3% of respondents felt that AR had no potential, with treatment (27%), training (24%), and product development (22%) felt to be the aspects with the most potential.

Aspects of the medical devices sector where AR has the most potential

Only 3% of respondents felt that AR had no potential in the medical devices sector



Q. Which aspects of the medical devices industry have the most potential for augmented reality adoption? (N = 214)
Source: GlobalData's Medical Device Network between Jan 29, 2024, and Feb 28, 2024.

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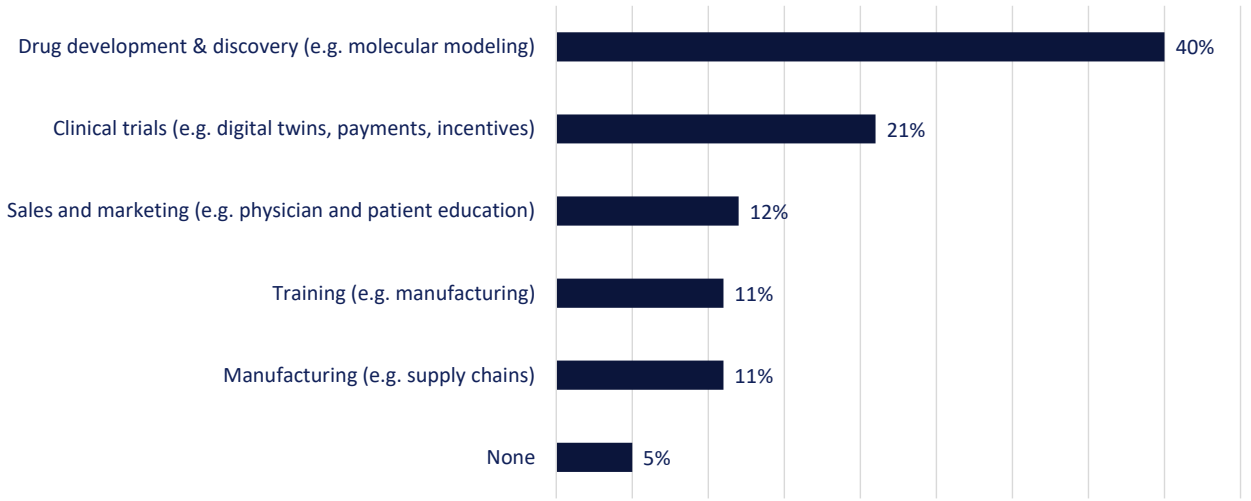
Between January 29 and February 26, 2024, visitors to GlobalData's Pharmaceutical Technology and Clinical Trials Arena websites were surveyed about their thoughts on what aspects of the pharma sector had the most potential with AR. Only 5% of respondents felt that AR had no potential, while drug development and discovery (40%) was felt to be the aspect with the most potential.

Aspects of the pharma sector where AR has the most potential

Only 5% of respondents felt AR has no potential in the pharma sector



Q. Which aspects of the pharma industry have the most potential for augmented reality adoption? (N = 209)
Source: GlobalData's Pharmaceutical Technology and Clinical Trials Arena between Jan 29, 2024, and Feb 26, 2024.

The table below highlights the key challenges currently facing the healthcare sector.

Challenge	What's happening?
Visualization of processes	Traditionally, medical staff, medical students, and drug developers are given in-depth explanations of biological processes, for example, the renal system. Visualization of these processes is key as they are very complex, while also being central tools for diagnosis, outlining treatments, and tracking patient health. With the expansion of diverse treatment possibilities, visualization is important to support important decision-making. There is a need to improve biological visualization, for example, enhancing cardiac coronary system visualization will enable better strategizing of interventional cardiac procedures and, in consequence, pose less risk for the patients.
Training medical professionals	Training medical professionals is a costly and lengthy process. The healthcare system is constantly advancing, adopting new technologies and techniques, and adding new material to curriculums. Pandemic restrictions fueled the rapid transition to online learning, which has remained integral to medical training. Compounding this, training medical students and surgeons using 2D static images, cadaver dissections, and diagrams is challenging. Also, surgical processes require multiple learning sequences, which require sufficient practice to minimize errors. Additionally, access to practical training is sometimes unaffordable in poorer countries.

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Challenge	What's happening?
Improving access to care	Inequitable access to healthcare remains a worldwide problem. Barriers to access, including geographical, cultural, and socio-economic issues or reduced mental and physical health are among many factors that may limit access to healthcare services. Lack of treatment will have significant negative health outcomes in the long term.
Improving patient engagement	Doctors must explain medical procedures to patients before they happen. However, patients often receive a vague and hurried explanation of their procedures. This can contribute to a lack of understanding, which can diminish patient confidence. Patients may resort to using other sources of information (such as the internet), which may exacerbate feelings of confusion, unease, and potential misinformation.
Safety and precision	Particularly in the event of invasive procedures, safety measures are of utmost importance. However, due to difficulties caused by individual human differences (e.g., differences in vein location), it can often be difficult for healthcare personnel to always get invasive procedures right at the first attempt on a new patient.
Source: GlobalData	

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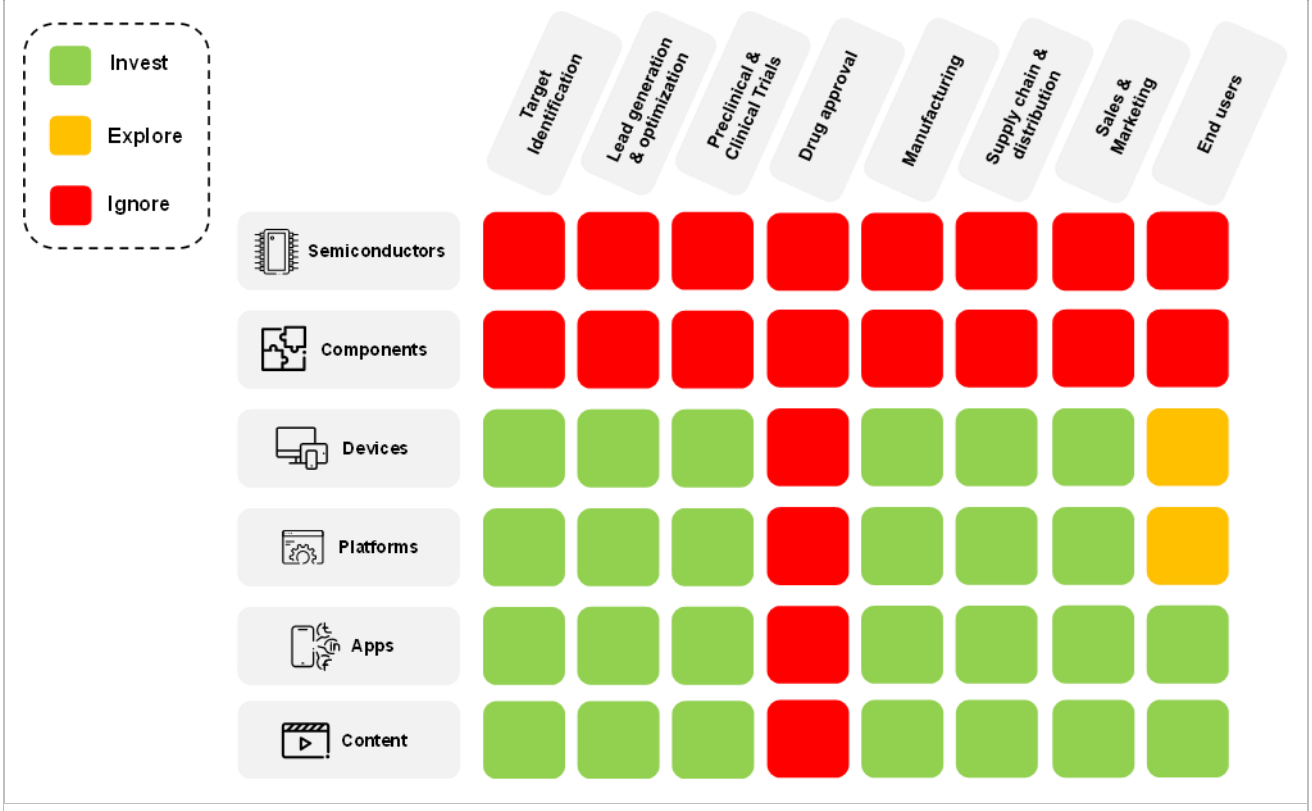
The Impact of Augmented Reality on Healthcare

Pharma

The matrix below details the areas in augmented reality where pharma companies should focus their time and resources. GlobalData suggests they invest in technologies shaded in green, explore the prospect of investing in technologies shaded in yellow, and ignore areas shaded in red.

Thematic impact assessment for pharma

Augmented reality in pharma



Source: GlobalData

Pharma companies should invest in AR for drug discovery, accelerating processes, and amplifying pharma knowledge. 3D modeling of molecules facilitates the identity of new molecules to create novel drugs. With AR drug discovery, researchers can visualize new molecules together, making collaborative work easier.

Pharma companies should also explore AR tools for efficient working in manufacturing, supply chain management, and distribution. AR can help workers navigate facilities, follow steps, record work, and train new and existing employees.

Pharma companies should further examine AR for clinical trials, as AR provides immersive experiences to recreate the trial environment to give potential candidates a better comprehension of the trial while improving patient recruitment. In addition, during the trial, AR can gather data about candidate symptoms, progress, and treatment adherence. An AR headset can make sure the candidates follow the trial procedures correctly as it can display guidance for how to take medication and warnings for side effects.

Pharma companies should put funding into AR for sales and marketing. They can create immersive and interactive experiences for potential consumers to explore the product. In addition, for end users, patients in a shop can interact with the product to find out more information when wearing smart glasses or having an app.

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Medical devices

The matrix below details the areas in AR where medical device companies should focus their time and resources. GlobalData suggests they invest in technologies shaded in green, explore the prospects of investing in technologies shaded in yellow, and ignore areas shaded in red.

Thematic impact assessment for medical devices

Augmented reality in medical devices

Source: GlobalData

The investments of medical device companies in AR should not be dissimilar to that of pharma companies. However, in terms of product development and R&D, medical device companies can benefit from investment in AR-related technologies. Using AR to render virtual prototypes into a physical environment for users is valuable in medical device product development, manufacturing, and market access. Products can be tested before they are completed, increasing the efficiency of new product development.

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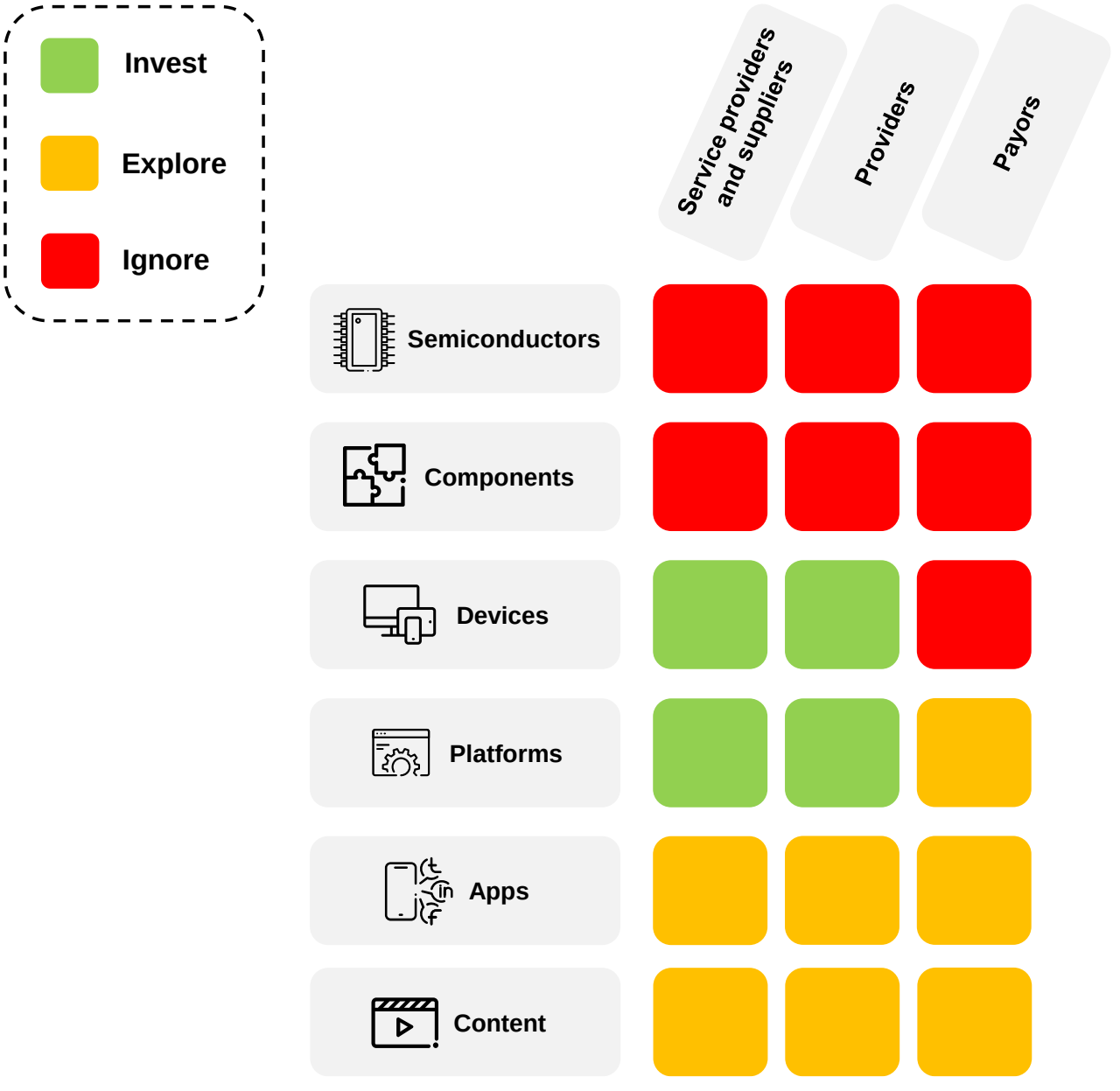
Healthcare providers, payors, service providers, and suppliers

The matrix below details the areas in AR where healthcare providers, payors, service providers, and suppliers should focus their time and resources. GlobalData suggests they invest in technologies shaded in green, explore the prospect of investing in technologies shaded in yellow, and ignore areas shaded in red.

Thematic impact assessment for healthcare providers, payors, service providers, and suppliers
Augmented reality in healthcare



Source: GlobalData

Service providers and suppliers can continue to explore the use of AR for the wider adoption of novel therapies in healthcare centers. For example, better availability of AR headsets can assist in safety and precision during surgery.

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For payors, investment should be limited to speculative exploration of healthcare AR experiences. AR could increase patient access to healthcare through expanded telemedicine services such as mixed reality rehabilitation, physical therapy, and patient monitoring. These would also help to break down current isolation barriers for seniors and people with disabilities. AR would enable improved patient support and access to immersive therapies and a broader range of medical professionals. Better treatment adherence would consequently reduce negative health outcomes for patients.

Investments in user interfaces may be fruitful for those who can afford them. However, access and affordability of devices are issues that need to be addressed.

How AR helps tackle the challenge of visualizing processes

The area where AR may have the greatest impact on healthcare is visualizing processes, particularly when companies introduce new complex therapies or launch new products for patients or buyers like hospitals. These innovations typically involve unique biological delivery mechanisms that would benefit from AR's visual capabilities when introducing them. AR empowers leading healthcare companies to build improved experiences that help healthcare personnel gauge new concepts, arouse excitement about a new therapy or device, and instill greater confidence in the early commercialization process. In 2019, Qiagen, a medical equipment company, used AR to display their QiagenSymphony model, an instrument designed for assays in molecule diagnosis and/or molecular biological applications, in Moscow. This was well received by potential customers and colleagues. The use of AR to display their products solved the issues associated with transporting expensive and heavy equipment. Buyers must visualize the dimensions and working of a product, features that are not available with just 2D photos.

The use of AR for process visualization further opens the door to accurate condition diagnosis and efficient treatment planning. Medical professionals could analyze 3D images of magnetic resonance imaging (MRI) and computerized tomography (CT) scans with AR. Traditionally, doctors need to analyze and compare multiple 2D images, which is time-consuming and labor-intensive. Particularly in the case of multiple scans—for example, to follow tumor growth—AR would be instrumental. The routine use of AR for CT and MRI scans is still in its infancy, with the cost of headsets and smart glasses being an added hindrance in the short term. However, it does show promise; a study was performed in 2020 by the Auckland University of Technology to look at AR's impact on CT diagnosis. It was concluded that AR-enhanced diagnosis also reduces time and cost.

AR's impact on the visualization of processes also has the potential to further drug development. Scientists at Sygnature Discovery are working on the VisMol system, which through the Microsoft HoloLens will enable them to visualize computer-generated molecular models in the world around them. VR headsets are already being used for molecule visualization, however, with AR, colleagues could interact with each other and collaborate on drug discovery.

How AR helps tackle the challenge of training medical professionals

Medical schools are beginning to incorporate AR into learning models to provide students with immersive and hands-on learning opportunities. It will not replace traditional medical schools; however, AR allows medical students to watch and partake in simulated surgeries and procedures. This can allow medical students to practice procedures safely at high volumes with minimal risk.

AR is also digital meaning that it opens the door to collaboration; students can see through AR glasses what their colleague is doing, while not necessarily being in the same location. This is of particular use when medical students are learning how to examine patients. The world's first virtual ward round for medical students was conducted in early 2020 by Imperial College London. A class of 350 medical students watched a consultant examine a patient. The doctor was equipped with Microsoft's HoloLens glasses to examine patients as trainees viewed remotely. With AR, a larger number of medical students can gain insight into one examination. HoloLens allows clinicians to pin virtual pictures, including X-ray scans, medical history, and radiographs, to display and circle details they wish to highlight.

Apps are an instrumental tool to produce in-depth, interactive, and immersive learning opportunities for medical students. A lot of medical apps exist already like Nerve Whiz, which helps students learn the anatomy of nerve roots, plexuses, and peripheral nerves. AR can bring significant improvements to the experience of medical learning apps. The human anatomy is 3D and is complex and therefore understanding it through 2D images is inherently limiting. AR can be

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used to create a realistic 3D exploration of complex systems and organs. AR is also useful when studying complex diseases that have an array of underlying mechanisms. Indeed, Complete Anatomy is an example of a successful AR app that teaches human anatomy, it is already being used by 200 of the world's top universities.

How AR helps tackle the challenge of accessibility to care

AR represents an opportunity to further develop remote patient care, making it easier for people to gain care at home. Indeed, virtual healthcare assistants can be developed with AR. For example, a patient in rehabilitation could benefit from 3D walkthroughs of the steps and techniques they must use, instead of having to travel to a clinic. Remote monitoring devices could routinely check patient symptoms and alert staff of any care needs, with sensors and AR glasses. AR in telemedicine is still in its infancy, however, due to issues with infrastructure, cost, connectivity, and familiarity.

In addition to telemedicine, AR could help in emergency systems. If Emergency Medical Technicians (EMTs) arrive first at the scene of a medical emergency or are in a rural location, being equipped with AR devices would be beneficial. AR devices could enable the EMT to have real-time contact with vital information and expertise to exercise life-saving procedures. This is particularly relevant as emergency systems do not always have doctors on board an ambulance. In addition, nurses and EMTs are restricted in their authorization of what procedures they can perform. With an AR system, nurses or EMTs, equipped with a built-in camera, could consult experts to guide them through first aid.

Directions in real time can be the difference between life and death even before an ambulance comes to the scene. AR devices could enable bystanders to gain valuable instructions so they can perform some first aid steps correctly. The implementation of AR devices in places such as nursing homes and hospitals has the potential to reduce the workload for staff, as personnel can get help from remote experts. This is of particular importance with aging populations, as there will be more issues with staff shortages, so AR could help relieve pressure on healthcare systems.

How AR helps tackle the challenge of improving patient engagement

AR can also be used to educate patients. AR could provide a new depth when teaching patients about healthcare procedures they may be undergoing by utilizing AR's ability to see the real world through a layer of digital content. Through visualization, patients are likely to have a stronger sense of familiarity with procedures. Doctors can use 3D imaging to show disease or injury states to patients and demonstrate different treatment options. Also, by conducting AR simulations of chronic conditions like rheumatoid arthritis and migraines, physicians can better identify potential areas of treatment or therapy. Patients who are involved in this way will feel more comfortable and confident, leading to better adherence and health outcomes. Better understanding improves patients' compliance with treatment and the quality of delivery, which in turn can reduce the overall burden on the healthcare system. Immersive experiences could also be useful for caregivers, teaching them how to care for a family member at home.

AR enables patients to be in more control of their health and conditions. Know My Beat is an app that uses AR technology to educate people with atrial fibrillation so that they are more aware of their condition and can get medical attention when necessary. The app works by displaying a virtual 3D hand, meaning the user knows whether they have put their fingers in the right location to take their pulse correctly.

How AR helps tackle the challenge of safety and precision

AR can also improve the safety and precision of medical procedures. AR's real-time imaging and 3D visualization during surgery is a notable use case in healthcare. Practitioners have been limited to 2D images portrayed on flat-panel monitors during surgery, meaning they must glance away from the patient during procedures. This can cause interferences in the hand-eye coordination of the surgeon and, in turn, affect surgery outcomes. As a result, AR has proven vital in complex operations such as spinal surgery. Augmedics's Xvision Spine System enables surgeons to 'see' the patient's anatomy, which is otherwise not visible with the naked eye, as with an X-ray. This means that surgeons can navigate instruments and implants better during spine operations. Indeed, it has already treated more than 3,000 patients and has been adopted by surgeons in 21 US states. However, complete successful integration of AR into surgery means a lot of investment and training as it involves high-precision tools and data analytics.

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Training for surgery with AR could vastly improve success rates and reduce errors in real life, as they can practice surgeries in realistic environments numerous times with different scenarios. Research is still needed to see if it correlates with higher clinical outcomes, however.

Case Studies

In the following section, we present selected case studies highlighting the use of augmented reality within healthcare.

MediView's AR solution offers visual assistance during surgery

MediView is a US-based med-tech company that partners with GE Healthcare and Microsoft to offer AR solutions tackling long-established challenges in medical imaging during surgery. MediView's XR90 system comprises the Microsoft HoloLens 2 AR headset, a medical imaging device, and the company's own proprietary platform. The XR90 augmented reality-based system assists in visualization and navigation during minimally intrusive surgeries, like biopsies or cancerous tumor excision.

MediView's AR system for minimally intrusive surgeries

Source: Newsroom, Cleveland Clinic

Traditionally, practitioners have been limited to 2D images portrayed on flat-panel monitors during surgery, meaning they must glance away from the patient during procedures. This can cause interferences in the hand-eye coordination of the surgeon and can, in turn, affect surgery outcomes. However, with the introduction of MediView's XR90 system, a surgeon can see the patient's holographic ultrasound in 3D directly on the patient during surgery.

MediView's XR90 offers 3D "X-ray vision", which includes a display of the complete internal anatomy beneath the skin, with bones, tissues, organs, and vasculature. This 3D display of the patient's anatomy is automatically projected onto them and is based on the patient's computerized tomography (CT) scans combined with live ultrasounds. The XR90 also includes a holographic light ray that traces and displays the route of the surgeon's instrument. The device opens the door for clinicians in different and remote locations to work together to provide surgical advice in real-time as they share the visuals of the operation.

In July 2023, MediView obtained FDA clearance for its XR90 augmented reality-based surgical visualization and navigation system. November 2023 saw the XR90's first successful clinical case. Dr. Bradley Pua performed a mediastinal lymph node biopsy. He found a tumor that was not easily spotted with just an ultrasound and the holographic anatomy of the XR90 system enabled him to identify the targeted location and plan exactly how he was going to perform the procedure.

AccuVein offers AR displays of veins for precise IV therapy

Intravenous (IV) therapy is the most frequent invasive treatment in the world. It is also accepted as a routine and fundamental procedure for medical staff to perform, despite the technical difficulties in accessing veins. The procedure requires involvement from trained medical staff and the use of specialist medical devices, but complications are commonplace. A substantial proportion of the population also has a fear of needles.

To assist with IV therapy, AccuVein superimposes an AR display of the patient's veins and arteries onto their skin. AccuVein displays veins, valves, and bifurcations that cannot be seen with the naked eye, which enables practitioners to place the needle or catheter in a more informed and precise way. With this device, the clinician can see the center line of the vein—and from further away than is normally possible. AccuVein claims that it elevates the patient's experience,

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decreases escalation calls, improves first-time successes, and maintains catheters in place for the time needed for therapy.

AccuVein's product works with interventional radiology (IR), which recognizes the hemoglobin in veins. Light is reflected from the target area into the photodetector in the device, this acts as the contrast. The laser then gets more intense to penetrate further into the skin. The photodetector takes up various images of veins from different depths. The images of the veins are then computed by algorithms and layered by depth, resulting in one complete image. Another wavelength is then projected from a second laser onto the target location to show the complete image of the veins.

An AR display of veins for IV therapy

Source: AccuVein

AccuVein can assist especially in difficult patient cases. For example, in September 2022, 37% of patients at four French hemophilia treatment centers had developmental venous anomaly (DVA), a congenital variant that made their veins difficult to locate for IV therapy. With AccuVein, however, the ability to locate veins among patients with difficult venous access improved (92.3% of DVA patients were classified as difficult to locate veins while 76% were when combined with the use of AccuVein).

SentiAR announces second FDA clearance for its CommandEP hub

SentiAR's CommandEP, which is delivered using the Microsoft HoloLens hardware, enables an immersive command hub for practitioners during cardiac ablation therapy, a procedure that uses small burns or freezes to break up electrical signals that cause irregular heartbeats. The CommandEP displays a 3D hologram of an individual's electro-anatomic data in real-time. This solution has the potential to offer crucial insight to aid physician diagnosis and catheter navigation.

An AR-enabled 3D interactive map for cardiac ablation therapy

Source: SentiAR

CommandEP uses real-time data coming from the catheters and a 3D electro-anatomical and electrical map that is unique to the patient. This generates a 3D holographic interface that offers clinicians a 360-degree interactive representation of an individual's unique anatomy that enables them to perform cardiac ablation therapy more accurately.

The CommandEP system comprises a headset (Microsoft's HoloLens) that is specifically designed to be put on by the clinician for hands-free manipulation of the patient's data, in combination with real-time cardiac anatomy and catheter locations in the heart.

In October 2023, SentiAR's CommandEP received its second FDA clearance after Massachusetts General Hospital had a positive clinical experience with the system. They described that being able to see the anatomy in 3D with contact force (technology designed to quantify the contact of the catheter tip with heart tissue) enabled them to spot the targets and navigate more effectively.

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Augmented Reality Timeline

The first head-mounted display (HMD) system, The Sword of Damocles, was invented in 1968 by computer scientists Ivan Sutherland and Bob Sproull. The term 'augmented reality' was initially coined by Thomas P. Caudell in the 1990s. By the end of that decade, NASA was using AR for field navigation.

The development of contemporary AR was boosted by the arrival of Microsoft Kinect (in 2010) and Google Glass (2013), but *Pokémon Go* (2016) brought AR to the attention of the general public. Apple's introduction of the ARKit software development kit (SDK), followed by Facebook's release of the Camera Effects (now Spark AR) platform in 2017, marked the emergence of mobile AR. Google's ARCore (a competitor to ARKit) arrived in 2018. The Magic Leap One headset went on sale in the same year, with Microsoft launching its HoloLens 2 headset in 2019. Adoption of AR increased in 2020, as virtual try-on solutions in online shopping became popular with consumers, and enterprises shifted to remote collaborations amid the pandemic. In 2023, Apple introduced its premium-priced Vision Pro AR headset, while Google stopped selling the Glass Enterprise Edition 2 due to a lack of demand.

The use of AR will increase in the coming years, fueled by the emergence of new use cases, greater availability of 5G networks, and new hardware.

The major milestones in the journey of the AR theme are set out in the timeline below.

The augmented reality story

How did this theme get here, and where is it going?

1968	The first HMD, The Sword of Damocles, was created.
1975	Myron Krueger established an artificial reality lab called the Videoplace.
1990	Former Boeing researcher Thomas P. Caudell coined the term 'augmented reality.'
1992	The US Air Force's Research Lab developed a fully immersive AR system.
1998	NASA's X-38 spacecraft used AR in practical field navigation.
2000	The outdoor mobile AR game *ARQuake* was created.
2008	BMW ran AR-based print advertisements.
2010	Microsoft introduced the Kinect motion-sensing input device.
2013	Google started selling a prototype of Google Glass.
2015	Microsoft announced its HoloLens headset, which went on sale the following year.
2016	Niantic and Nintendo launched *Pokémon Go*, which brought AR to the attention of the general public.
2017	Apple introduced the ARKit SDK for iOS devices.
2017	Facebook launched the Camera Effects platform, which was later renamed Spark AR.
2018	Google introduced the ARCore SDK for Android devices.
2019	Microsoft introduced the HoloLens 2 headset.
2020	AR gained popularity in ecommerce, social media, and advertising.
2023	Apple launched the Vision Pro headset, available to buy from 2024.
2023	Google stopped selling Glass Enterprise Edition 2 smart glasses.
2023	Snap claimed that 250 million people engaged with AR daily.
2024	Meta (formerly Facebook) will introduce its first AR smart glasses for internal use. Shipments will begin in 2027.
2024	Google, Qualcomm, and Samsung Electronics will jointly launch an AR headset.
2024	AR, powered by generative AI tools, will bring novel immersive experiences to social media and advertising.
2027	The use of AR applications in enterprises will increase, supported by 5G networks.
2030	AR will be a $100 billion market, according to GlobalData forecasts.

Source: GlobalData

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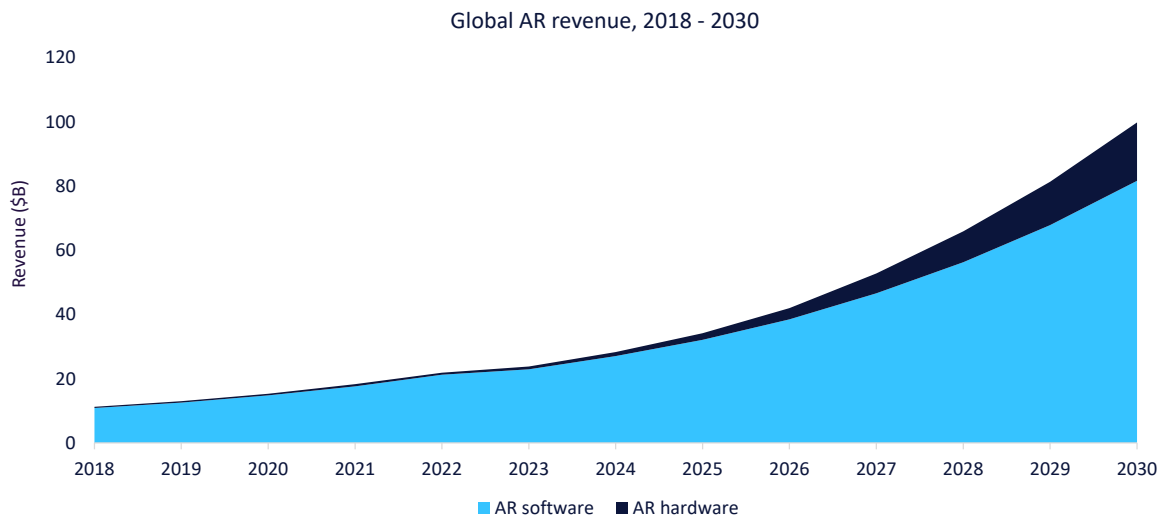
Market Size and Growth Forecasts

Worth nearly $22 billion in 2022, the global AR market will reach $100 billion by 2030, growing at a compound annual growth rate (CAGR) of 21% over the eight years, according to GlobalData forecasts. It is worth noting that the AR hardware estimate includes the sale of AR smart glasses and AR headsets and excludes smartphones. However, AR software that runs on smartphones, such as games, is included in the AR software estimate.

AR will become a $100 billion market by 2030

It was worth $22 billion in 2022

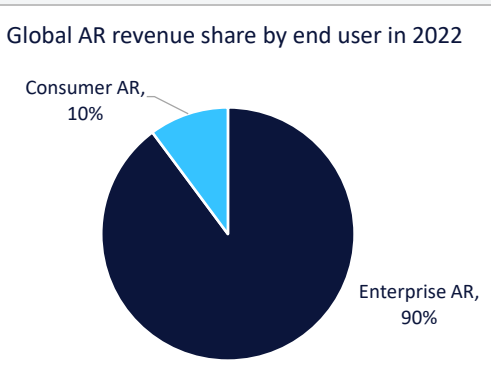


Source: GlobalData

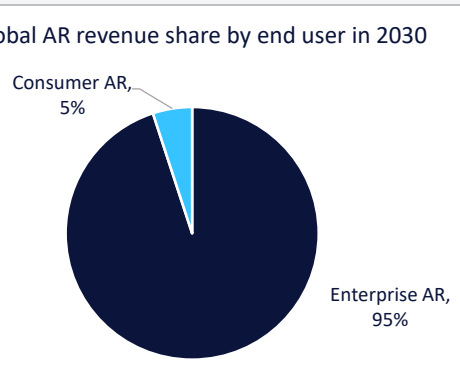
In terms of end users, the enterprise AR segment is dominant and will maintain its lead over the forecast period. It accounted for 90% of total AR revenue in 2022 and will increase this to a 95% share by 2030.

Enterprise AR will continue to be more lucrative than the consumer market by 2030

Enterprise AR held a 90% share of AR revenue in 2022



Enterprise AR's revenue share will grow to 95% by 2030



Source: GlobalData

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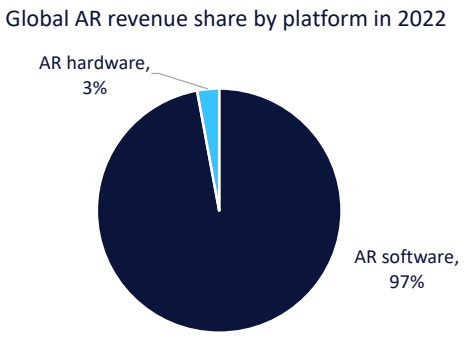
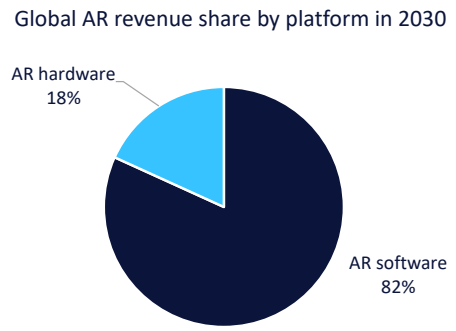
AR software accounted for 97% of the total global AR market in 2022, with the rest coming from the sale of hardware such as smart glasses and headsets. AR software will continue to dominate the market as novel, immersive content and use cases are developed for smartphones, smart glasses, and headsets. However, the launch of new AR smart glasses and AR headset models will increase AR hardware's revenue share to 18% by 2030, up from 3% in 2022.

AR software will dominate the market over the forecast period

AR software made up 97% of the market in 2022



AR hardware will account for 18% of AR revenue in 2030



Source: GlobalData

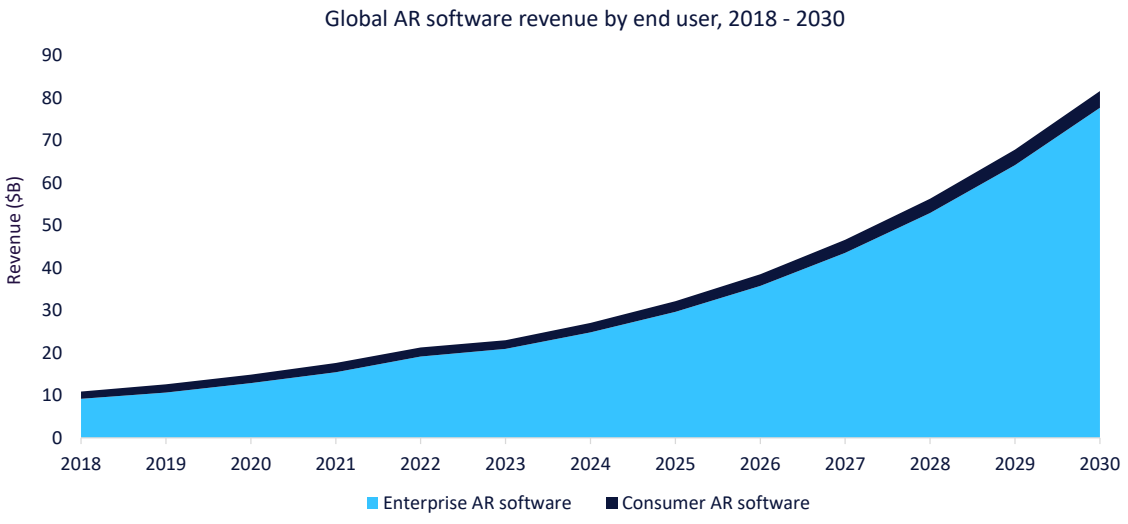
AR software

The AR software market was worth over $21 billion in 2022 and will reach almost $82 billion by 2030, growing at a CAGR of 18% between 2022 and 2030.

Steady investments by enterprises into task-specific solutions (e.g., remote collaboration, training, maintenance, and customer support) will drive the growth of the enterprise AR software market. The benefits, including increased employee productivity and reduced service resolution time, will increase the adoption of AR software. The enterprise AR software market is estimated to expand from $19 billion in 2022 to $78 billion in 2030.

The AR software market will generate $82 billion in revenue by 2030

It was worth more than $21 billion in 2022



Source: GlobalData

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GlobalData estimates the consumer AR software market will be worth about $4 billion in 2030, up from $2 billion in 2022. The main source of revenue is AR games, which accounted for 85% of the global consumer AR software revenue in 2022.

Demand for consumer AR apps based around activities such as shopping, fitness, navigation, and education will help this segment overhaul AR games in the long run. While most consumer apps are anticipated to be free, paid access to premium features and in-app advertisements are key monetization strategies.

The AR software market is becoming fragmented as players like Meta, Apple, Samsung Electronics, and Google bring different operating systems and programming languages to their headsets. As a result, AR content developers are dealing with differing specifications and requirements to enable cross-device applications.

The fragmentation is also visible on smartphones, where different iOS and Android specifications complicate the development process further. Therefore, the need for cross-platform development tools is becoming paramount.

Platforms such as Unity, Snapdragon Spaces, and 8th Wall are becoming increasingly important for developers. These cross-device platforms help AR developers create applications once and deploy them everywhere. GlobalData anticipates the cross-device platforms space will become increasingly competitive as the AR application market gains traction.

AR hardware

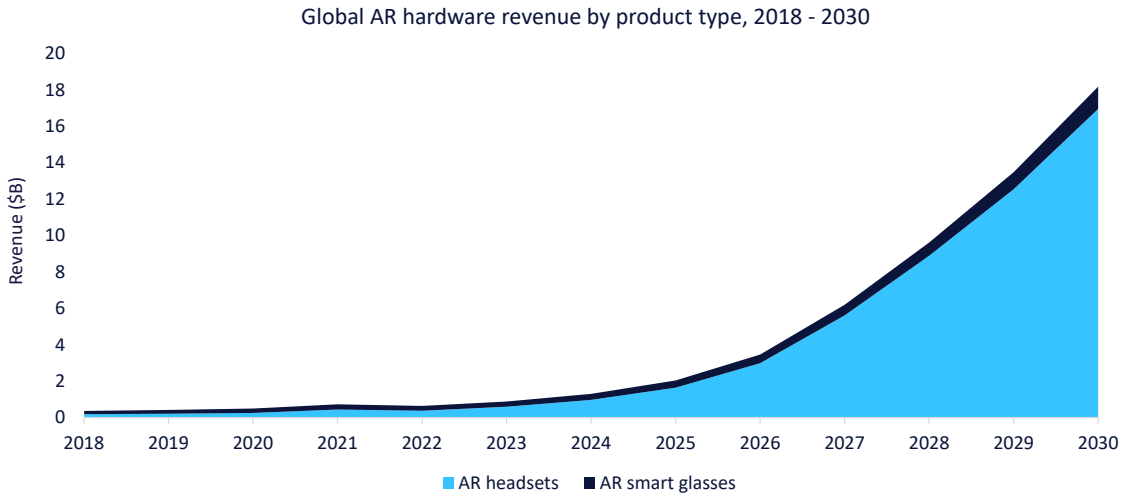
The AR hardware segment generated revenue of $634 million in 2022 and will be worth $18 billion by 2030, representing a CAGR of 52% between 2022 and 2030.

There was little to choose between AR smart glasses and AR headsets when it came to revenues in 2022, but AR headsets will generate far greater revenue, equivalent to over 90% of the AR hardware market, by 2030. This is attributable to the high price of AR headsets, especially those targeted at enterprises, compared to AR smart glasses.

The AR headsets segment will be worth $17 billion by 2030, up from $374 million in 2022. In contrast, the AR smart glasses market will become a billion-dollar opportunity in 2030, expanding from $260 million in 2022.

The AR hardware market will be worth $18 billion by 2030

It was worth $634 million in 2022



Source: GlobalData
Note: AR hardware estimates do not include sales of smartphones

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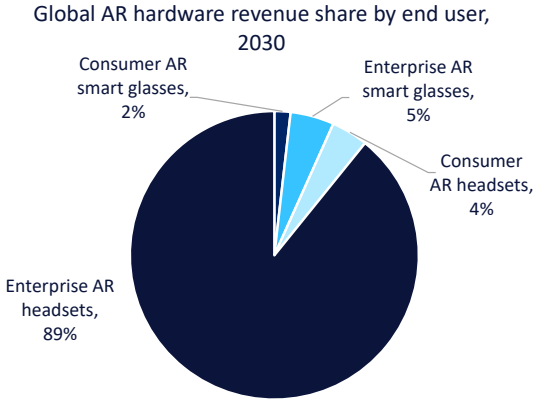
AR is a key technology in the future of work and, as such, will be a focus area for enterprises in the coming years, which will drive demand for AR hardware. The enterprise AR smart glasses market is estimated to generate revenue of $890 million by 2030, while that of enterprise AR headsets will reach $16 billion by 2030.

In contrast, the consumer AR hardware segment will remain small but will grow as affordable devices hit the market. Consumer AR smart glasses sales will increase from $56 million in 2022 to $329 million in 2030. Consumer AR headset revenue will expand from $23 million in 2022 to $745 million by 2030.

Upcoming AR headsets from Samsung Electronics and Google, Sony, and LG Electronics, and AR smart glasses from Apple and Meta, expected to launch between 2024 and 2027, could boost the devices' appeal among consumers and enterprises.

AR headsets will lead the AR hardware market

AR smart glasses will hold less than 10% share in 2030



Source: GlobalData

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Signals

In this section, we use the 145 million signals generated by our thematic engine to predict how the augmented reality theme will develop and who the likely leaders are. These signals are a useful source of competitor intelligence in the AR market.

M&A trends

GlobalData recorded several big AR-related deals between 2020 and 2021, reflecting the high level of interest in the theme at that time. Notable deals included Snap's $500 million acquisition of WaveOptics (in May 2021), Match Group's $1.7 billion acquisition of Hyperconnect (February 2021), and Google's $180 million purchase of North (June 2020). With access to technology the principal rationale, providers of motion tracking, eye tracking, 3D visualization, and collaboration solutions became prime targets during 2020 and 2021. As the metaverse hype subsided in 2022, there was a reduction in AR-related merger and acquisition (M&A) activity. In 2022 and 2023, Apple, Meta, and Snap completed small M&A deals focused on their future AR offerings.

The key M&A deals associated with the AR theme since January 2020 are listed in the table below.

Date announced	Acquirer	Target	Value ($M)	Target company description
Aug 2023	Bowmo	OWNverse	Not disclosed	AR and VR software provider
Jun 2023	Apple	Mira Labs	Not disclosed	Enterprise AR headset manufacturer
Mar 2023	Snap	Th3rd	Not disclosed	3D scanning company
Feb 2023	LBE BidCo	Immotion	25	AR experiences provider for theme parks
Jan 2023	Meta	Gary Sharp Innovations	Not disclosed	Optics provider for AR and VR headsets
Sep 2022	KINS Technology*	CXApp	69	AR-based workplace solutions provider
May 2022	Glimpse Group	Brightline	33	VR and AR technology solutions provider
Mar 2022	Snap	NextMind	Not disclosed	Brain-computer interface provider
Dec 2021	Intema by MTS	VisionLabs	100	AR and facial recognition tool provider
Jun 2021	Graph Blockchain	New World	16	AR-based NFT distributor
May 2021	Snap	WaveOptics	500	AR smart glasses display maker
May 2021	NexTech AR	Threedy.ai	10	AI 3D modeling solutions provider
Apr 2021	Snap	Pixel8Earth	8	3D mapping technology developer
Apr 2021	Dev Clever	Veative Labs	75	AR and VR learning solutions provider
Mar 2021	Snap	Fit Analytics	124	AR garment sizing tool provider
Feb 2021	Match Group	Hyperconnect	1,730	AR solutions provider for social media
Feb 2021	The Gores Group*	Matterport	640	AR and digital twins solution provider
Sep 2020	Surgalign Holdings	Holo Surgical	125	AR-based spine surgery tool provider
Jun 2020	Google	North	180	Consumer AR smart glasses maker

*Part of a special purpose acquisition company (SPAC) deal.
Source: GlobalData

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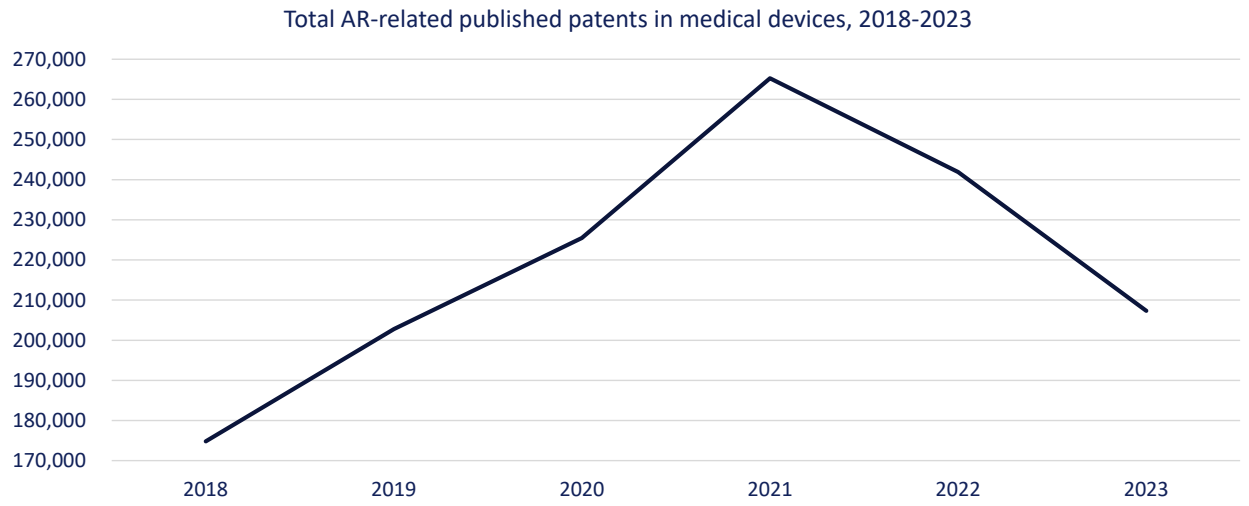
Patent trends

Analysis of patents helps understand companies' investments within a particular theme and identify future leaders. GlobalData's patent analytics shows that the pharma sector filed a negligible amount of AR-related patents. This suggests that AR is not a priority for pharma companies yet. In comparison, medical devices filed the most patents since 2018 because it is the industry that is furthest ahead with the implementation of AR, for example with surgery equipment.

AR-related patents by medical device companies increased from 2018, peaking in 2021

The increased adoption of AR across medical devices is reflected in the volume of patents

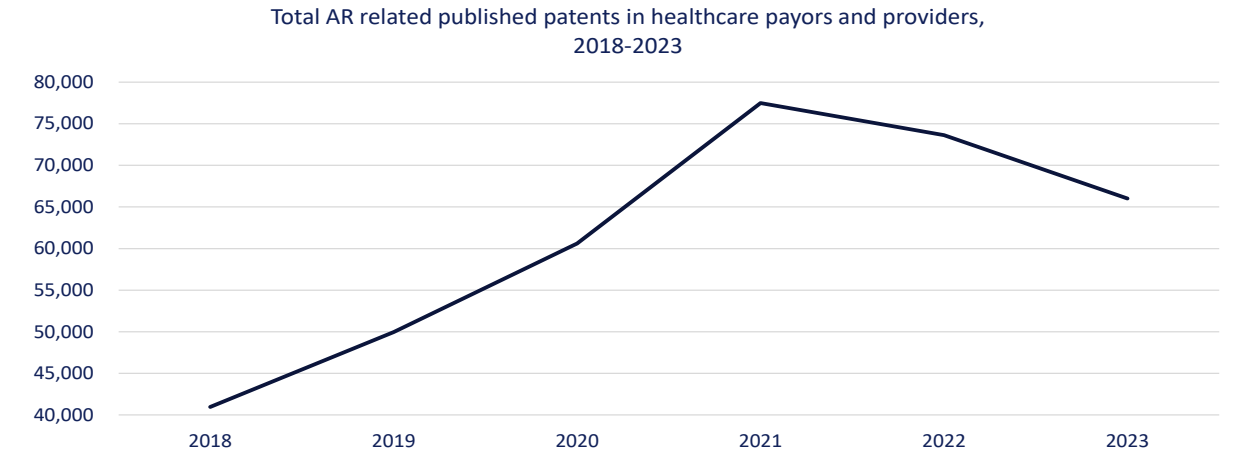


Source: GlobalData

The growth of AR can be seen in both the medical devices and healthcare sectors with a 52% and 89% increase in patents between 2018 and 2021, respectively. The drop from 2021 is likely due to COVID-19, which shifted focus onto remote patient monitoring for social distancing. Similarly, because of inflation, the expense of AR would not be a priority for many companies.

AR-related patents by healthcare payors and providers increased from 2018, peaking in 2021

The increased adoption of AR across healthcare payors and providers is reflected in the volume of patents



Source: GlobalData

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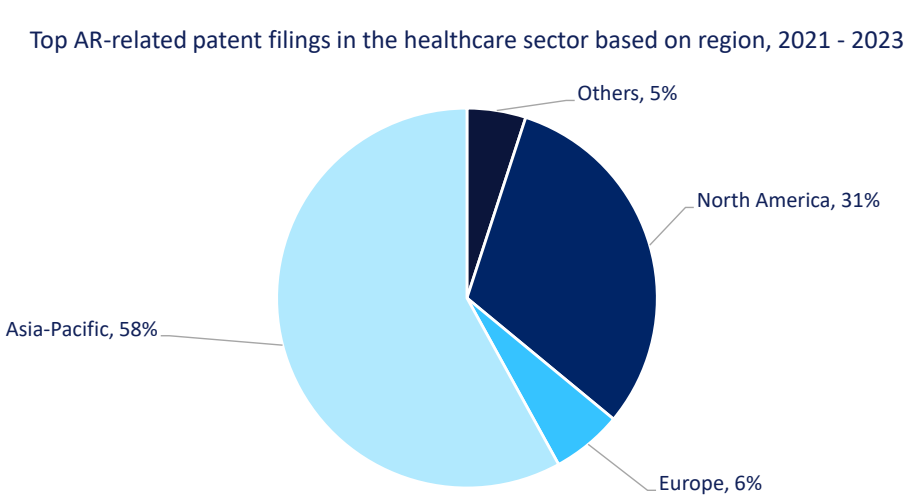
The Asia-Pacific (APAC) region filed the most AR-related patents in the healthcare sector (495,209), followed by North America (263,547). This is likely due to governments that are pursuing the development of extended reality (XR) for economic growth. In Asia, XR is part of Beijing's Made in China 2025 strategy and South Korea's Digital New Deal. Japan also acknowledged that XR will provide new opportunities in industrial and societal sectors. Similarly, in 2022 in North America, XR was listed in the CHIPS and Science Act as a "key technology focus area" designated for government investment.

APAC accounted for 58% of all patent filings

The increased adoption of AR by the region is reflected in patents



Source: GlobalData

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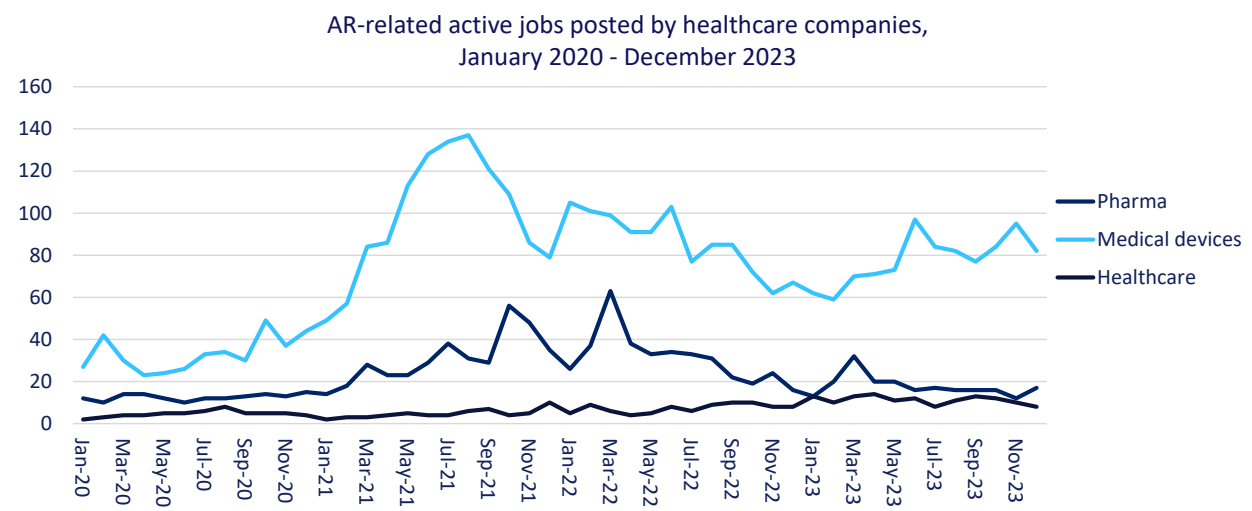
Hiring trends

GlobalData's Job Analytics lets us see who is hiring AR-related talent and at what level. By analyzing the trends in job postings, we can uncover which companies are investing in talent and identify future leaders in each theme.

GlobalData's Job Analytics shows that from 2020 medical device companies have exhibited the most interest in AR-related talent, whereas healthcare payors and providers have the least interest. In both medical devices and pharma, there was a peak of interest in 2021. The decrease in AR-related jobs being posted after 2021 is likely due to COVID-19 and inflation.

AR-related hiring activity peaked in 2021

The medical devices sector has the greatest demand for jobs related to AR



Source: GlobalData

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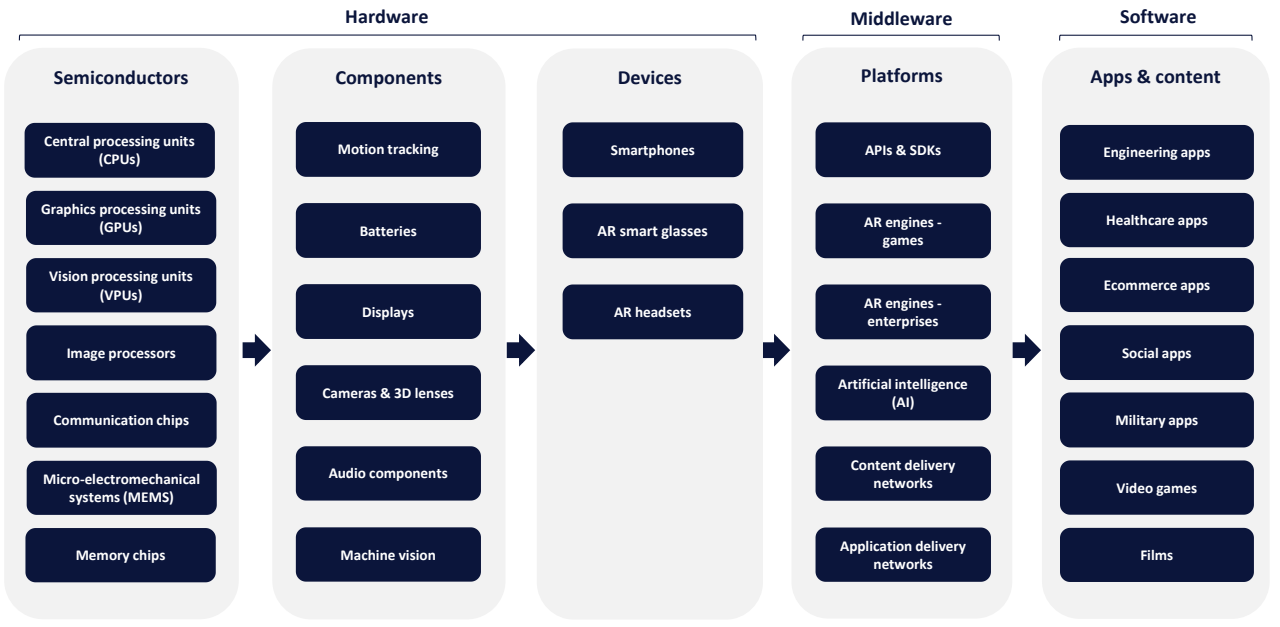
Augmented Reality Value Chain

GlobalData's augmented reality value chain is split into five segments: semiconductors, components, devices, platforms, and applications and content.

The augmented reality value chain
An overview



Source: GlobalData

The following sections look more closely at each segment of the AR value chain.

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Semiconductors

Semiconductors are one of the key battlegrounds in AR today. Until 2018, AR device makers primarily relied on powerful smartphone and PC chips, but Qualcomm's introduction of the XR1 AR and VR-specific chipset changed all that. Subsequently, in 2019, Qualcomm launched the XR2 5G platform, describing it as the "world's first 5G-supported extended reality (XR) platform." Although no new AR-specific silicon has arrived on the market following the launch of the XR2 5G, chipmakers are striving to improve their existing capabilities to suit the evolving requirements of AR, mostly around screen resolution, frame rates, processing speed, and connectivity.

Central processing units

Qualcomm is the leading player in the AR central processing unit (CPU) space, primarily due to its strong position in the smartphone market. Qualcomm's powerful Kryo CPUs are used in several vendors' AR headsets and smart glasses. For example, Microsoft's HoloLens 2 is powered by the Snapdragon 850 system on a chip (SoC).

Apple is also in a strong position thanks to the TSMC-made A-series processors that power its iPhones and iPads and the M-series processors, which power Mac devices. Magic Leap has replaced Nvidia SoCs with AMD SoCs in its Magic Leap 2 headsets. MediaTek, Huawei, Samsung Electronics, Intel, Texas Instruments, and Arm are also working on AR-compatible chipsets. Most of their efforts are focused on efficient battery and power management with longer standby times, improved frame rates, high projection displays, high-fidelity audio, and enhanced haptics.

Graphics processing units

In the graphics processing unit (GPU) space, Nvidia is the leading player, with AMD in second position. Other chipmakers looking to challenge in this market include Intel, which acquired Ineda Systems in 2019 and is banking on its fabrication capabilities to undercut the fabless Nvidia and AMD on price. Qualcomm integrated its Adreno GPUs on its Snapdragon SoCs to strengthen its smartphone portfolio, while Samsung Electronics licensed AMD's Radeon GPU architecture to support its Exynos SoCs and boost the graphics on its smartphones. Arm, with its Mali-series GPUs, is also targeting the smartphone-based AR market, promising high-end graphics support for AR gaming.

The intensifying competition in the GPU space is likely to have a positive impact on AR. GPUs will become faster (in terms of processing speed), sharper (in terms of display quality), and more robust (in terms of load handling), all of which will lead to more effective power management and improved experiences.

Vision processing units

Vision processing units (VPUs)—an emerging microprocessor class designed to accelerate machine vision tasks—are responsible for anchoring virtual objects in the real world in an AR headset. Intel (with the Movidius Myriad X) and Nvidia (with Programmable Vision Accelerators) are strong in this field, while Qualcomm, Samsung Electronics, Cadence, Renesas, Synopsys, and MediaTek also offer VPUs. GlobalData expects robust investment in VPUs over the next three years, driven by the maturity of AR technology and the increasing demand for realistic graphics content.

Image processors

Growth in the image processing field is driven by the demand for real-time and high-quality images. Image signal processors (ISPs) are vital for two AR-related functions: noise reduction (where digital artifacts that can tarnish images are removed) and image sharpening (enhancing the depth and clarity of images). Qualcomm, Sony, Ambarella, and Arm are leaders in this field. They compete against Infineon, STMicroelectronics, NXP Semiconductors, Toshiba, Onsemi, and OmniVision in the AR space.

Communication chips

AR devices rely mostly on Bluetooth, 4G LTE, and Wi-Fi—all integrated on SoCs—while 5G connections are also available. Qualcomm is integrating 5G modems on its Snapdragon SoCs, while Qorvo, Murata, Skyworks, and Qualcomm compete around 5G radio frequency (RF). Qualcomm is an outright leader in this space with its 5G-capable AR-specific XR2 chipset.

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Micro-electromechanical systems (MEMS)

Due to the intensifying miniaturization drive in the semiconductors sector, MEMS manufacturers are seeing rising demand. The emergence of 5G chipsets will only increase the pressure on MEMS vendors to deliver further miniaturization. A significant amount of the storage and processing power will move to the network and server levels, resulting in smaller SoCs. Thus, designers will race to integrate more sensors and expand the operational capabilities of their devices. This should also positively impact user experience, particularly around weight, movement accuracy, and battery life, all of which are essential for AR's success in the consumer market.

STMicroelectronics, TDK (InvenSense), Bosch, NXP Semiconductors, Infineon, and Analog Devices are all strong players in the MEMS field. A significant share of MEMS investment is being directed towards improving inertial measurement units (IMUs), accelerometers, and gyroscopes to address issues such as motion sickness and latency.

Memory chips

Memory-based CPU architecture, which locates faster, denser memory closer to processing units, is a developing investment theme in the critical memory chips sector. The in-memory chips—powered by AI—promise storage-level computation of data, thus allowing faster results. In the race to develop such chips, the leading integrated memory chip makers—Samsung Electronics, SK Hynix, Micron, Western Digital, and Kioxia—face a significant challenge from China's memory chipmaker Yangtze Memory Technologies (an affiliate of Tsinghua Unigroup). However, Yangtze Memory has yet to outpace the aforementioned global leaders in memory chips.

AR value chain – Semiconductors
Leaders and challengers

Semiconductors	Leaders		Challengers	
Central processing units (CPUs)	Apple	Qualcomm	AMD Arm Intel	MediaTek Samsung Electronics Texas Instruments
Graphics processing units (GPUs)	AMD	Nvidia	Arm Intel	Qualcomm Samsung Electronics
Vision processing units (VPUs)	Intel	Nvidia	Cadence MediaTek Qualcomm	Renesas Samsung Electronics Synopsys
Image processors	Ambarella Arm	Qualcomm Sony	Infineon NXP Semiconductors OmniVision	OnSemi STMicroelectronics Toshiba
Communication chips	Arm Broadcom Qorvo	Qualcomm Samsung Electronics Skyworks	Analog Devices Blu Wireless Cirrus Logic	MediaTek Murata Unisoc Technologies
Micro-electromechanical systems (MEMS)	Analog Devices Bosch Infineon	NXP Semiconductors STMicroelectronics TDK (InvenSense)	Goertek Qorvo	Sensata TSMC
Memory chips	Micron Samsung Electronics	SK Hynix Western Digital	Huawei Nanya Tech Yangtze Memory	Intel Kioxia

Source: GlobalData

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Components

Much of the major action in AR components is around 3D sensors, cameras, audio, displays, and batteries. These components come together for positional tracking, motion tracking, gesture recognition, and machine vision. To avoid motion sickness when using AR smart glasses, many of these components are being re-invented with a focus on lowering sensor latency. The aim is to reduce the lag between the user's motion and the corresponding computer-generated response from the device.

Motion tracking

Cameras, light sensors, depth sensors, accelerometers, and gyroscopes are essential components for motion tracking in smartphones, AR smart glasses, and AR headsets. With the simultaneous use of these components, aided by computer vision, AR devices can map the environment and track users' movements in the real world. Sensor suppliers, mapping and tracking companies, and computer vision benefit from the rising demand for motion tracking on AR devices.

Microsoft has the Azure Kinect DK—a standalone hardware kit for sophisticated computer vision and speech models—that features AI sensors, depth sensors, and a spatial microphone array. Google and Apple are working to improve the motion-tracking capabilities of their ARCore and ARKit tools, respectively. Magic Leap and Ultraleap claim that their input-controller devices offer exceptional motion and hand gesture tracking for AR headsets and smart glasses. Augment, Qualcomm (Wikitude), Sixense, and ViewAR are also developing all-in-one tracking solutions targeted at enterprise uses.

Batteries

All-day batteries, coupled with small but powerful snap-on chargers, are a must if AR is to take off. Today's commercially available AR smart glasses offer an average of eight hours of battery life. Still, prolonged use of services like navigation, voice calling, and music streaming will drain batteries more quickly. Similarly, AR headsets also come with limited battery life support. For example, HoloLens 2 and the Magic Leap One headset offer two to three hours of battery life during continuous use. Apple's new Vision Pro headset also promises a similar two-hour battery life; however, it can be attached to an external plug. Smartphones offer better power support, but AR apps will quickly drain batteries.

Device makers continue to rely on lithium-ion batteries, but solid-state batteries' superior energy density, safety, and lifespan could significantly enhance the user experience. Leading battery vendors like Panasonic, Samsung SDI, LG Energy Solution, and BYD constantly aim to improve their battery capabilities.

Displays

The prominence of optical see-through displays will benefit the leading display vendors like DigiLens, Himax, Lumus, and Microvision. Investments in the development of holographic displays are also increasing. Microsoft, Magic Leap, Samsung Electronics, and Apple are among those working to improve their holographic displays. Promising start-ups such as WayRay and VividQ are also developing holographic AR displays for use in automobiles. VividQ claims that its HoloLCD technology can convert normal LCD screens into holographic displays that can incorporate AR for use in smart glasses.

In December 2023, Kopin unveiled the NeuralDisplay, a micro-LED that combines eye-tracking with machine learning to compensate for a user's vision on the fly without additional optics. It measures the light reflected by the user's eyes. The data is subsequently fed into the AI model that learns to compensate for the quirks of each user's vision by adjusting the brightness and contrast of the display. Kopin claims the NeuralDisplay can address issues of nausea, discomfort, and disorientation that are common in AR headsets.

Cameras and 3D lenses

Depth cameras, specifically the time of flight (ToF) variant, are set to become staple features in AR devices. The ability to precisely measure the distance to and volume of an object makes ToF cameras ideal choices for AR device makers. They also support object scanning, indoor navigation, obstacle avoidance, object tracking, and gesture recognition, all of which are essential for effective AR content development. In December 2023, Samsung Electronics introduced the ISOCELL Vizion 63D - a ToF sensor that captures high-resolution 3D images, and the ISOCELL Vizion 931, a global shutter sensor that captures dynamic moments with clarity and precision. The sensors are designed for use in XR devices and robotics.

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Apple, Samsung Electronics, Huawei, and Oppo have already introduced ToF cameras on their smartphones, with Sony as their key supplier. Beyond smartphones, Microsoft's HoloLens features the Azure Kinect DK (also available as a standalone product). Occipital (competent in active stereo cameras) and PMD Technologies (which produces ToF depth cameras) are also notable players in this market, while 3D lens makers like Sony, Carl Zeiss, Leica, and Adlens should benefit from the growing demand for ToF cameras. Smartphone camera and sensor makers such as LG Innotek, Olympus, and OmniVision are also well-positioned in the market as mobile AR gains traction.

Audio component

Audio is a critical element for an immersive AR experience. The audio capabilities of smart glasses like Bose Frames and headsets like Magic Leap One, along with the integration of conversational platforms in AR devices (such as Microsoft's Cortana in the HoloLens 2 and Siri in Apple's Vision Pro headset), demonstrate the importance of sound to AR.

Sennheiser, Panasonic, Goertek, and AAC Technologies are already in this space, while chipmakers such as AMD and Qualcomm offer audio technologies integrated into their SoCs. Improvements in AR content and the growing maturity of devices should present audio companies with new growth opportunities. 3D Sound Labs, USound, and Kinicho are partnering with AR developers to establish a foothold in the market before competition intensifies.

Machine vision

Machine vision systems drive immersive effects and real-time environmental adjustments based on the user's activities. The development of machine vision applications, such as 3D mapping and image processing, is a must for AR to become a viable computing platform in the coming years. Cognex and Sony are strong players in this field, while Seiko Epson, Occipital, Mantis Vision, and Sighthound are some of their closest competitors.

AR value chain – Components
Leaders and challengers

Components	Leaders		Challengers	
Motion tracking	Alphabet (Google)	Microsoft	Augment	ViewAR
	Apple	Sony	Intel	Visometry
	Magic Leap	Ultraleap	Sixense	Qualcomm (Wikitude)
Batteries	BYD	Panasonic	TDK (ATL)	Desay Battery
	LG Energy Solution	Samsung SDI	CBAK Energy Technology	Dynapack
Displays	Avegant	Magic Leap	Dispelix	Microoled
	BOE Technology	Microsoft	Kopin	Saphlux
	DigiLens	SeeYA Technology	LetinAR	Universal Display
	Himax	Sony	LG Display	VividQ
	Lumus	Samsung Electronics	Mojo Vision	WayRay
Cameras and 3D lenses	PMD	Largan Precision	Adlens	LG Innotek
	Genius Electronic Optical	Microsoft	Carl Zeiss	Olympus
	Leica	Samsung Electronics	Fresnel Technologies	OmniVision
	Lens Technology	Sony	Intel	Young Optics
Audio components	AAC Technologies	Panasonic	AMD	Kinicho
	Dolby Labs	Qualcomm	Analog Devices	Mimi (3D Sound Labs)
	Goertek	Sennheiser	Cirrus Logic	USound
Machine vision	Cognex	Sony	Mantis Vision	Seiko Epson
			Occipital	Sighthound

Source: GlobalData

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Devices

AR-enabling hardware comes in various forms, including smartphones, eyewear (AR smart glasses), and AR headsets. For consumer AR applications, smartphones are the most commonly used platform, while enterprises typically prefer AR headsets and AR smart glasses, which offer a broader range of functions.

Smartphones

Smartphones are the primary consumer AR device. The existing smartphone ecosystem, consumer comfort with smartphones, and the improving computing capabilities of these devices are major drivers of mobile AR. The lack of self-contained, affordable, and compelling AR-specific hardware also benefits mobile AR. Apple and Google are the biggest beneficiaries of the growth of mobile AR, given their strong smartphone ecosystems and well-established AR SDKs. The two companies are improving their ARKit and ARCore SDKs to expand AR features on mobile apps, especially maps. Although user awareness of the technology behind the digital overlays during online shopping or commuting remains low, AR is rapidly becoming a standard feature in smartphones and apps.

According to ARtillery Intelligence, much of the AR compatibility in the smartphone landscape happens outside the traditional iOS and Android ecosystems, thanks to social media platforms that support AR. ARtillery Intelligence estimates that in 2023, WebAR can be used on 3.2 billion devices, with Meta's Spark Studio accessible on 3.1 billion devices and Apple's ARKit on 1.4 billion devices. Other platforms with notable positioning and momentum include Snap's Lens Studio, ByteDance's TikTok, and Google Lens (visual search).

That said, the number of monthly active users for these platforms is significantly lower than the number of compatible devices. This is primarily due to the current dearth of AR content. However, AR's integration into apps like Google Maps, Instagram, TikTok, and Snapchat will boost awareness and adoption of mobile AR in the coming years.

AR smart glasses

Today's AR smart glasses are primarily targeted at early adopters to build brand recognition and demonstrate the technology's capabilities. Mainstream adoption will only happen when the technology matures and offers valuable use cases. The limited demand for smart glasses is because there are a few things these devices can do better than a smartphone. The lackluster demand has forced some well-funded start-ups like Daqri to exit the market. Google also discontinued its Google Glass Enterprise smart glasses in March 2023. However, big names like Meta and Apple are expected to enter this market over the next couple of years.

Apple is a potential leader in the consumer AR smart glasses market, given its experience designing popular wearables and its ability to build ecosystems around those devices. Meta's full-fledged advanced AR glasses, codenamed Orion, are rumored to be released in 2027 and will initially be targeted at early adopters and enthusiasts as the device will be expensive to build.

Another new entrant in the consumer smart glasses sector is Lenovo, which launched Glasses T1 in September 2022. The glasses can be used for gaming, streaming, and working. In June 2023, ZTE launched its consumer-focused smart glasses, Nubia Neovision Glass, which can be paired with consoles, smartphones, and tablets. TCL is also vying for a share of the market with its Nxtwear S XR glasses, Nxtwear Air, and RayNeo X2 AR glasses.

In the future, smart glasses will gain greater, albeit still limited, consumer acceptance if they offer richer features such as navigation, transcription, translation, and visual search. Smart glasses manufacturers must also address high prices, privacy concerns, and lack of content.

The silver lining for smart glasses manufacturers is that enterprises are using these devices. The use of smart glasses for remote training, patient monitoring, warehouse management, and other functions has enabled enterprises to improve their efficiency and reduce errors. For example, Ricoh Japan deployed Vuzix's M400 smart glasses and TeamViewer software to monitor equipment at service locations and issue instructions to engineers from the office. This reduced service time by two hours per case. Manufacturing companies such as Airbus, GE, and AGCO use smart glasses in their operations. Seiko Epson, Toshiba, Vuzix, ThirdEye, Iristick, and Lenovo are vying for a market share in the enterprise space.

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AR headsets

The AR headset space is currently less crowded than the smart glasses segment. Over the next decade, enterprises will represent a more lucrative customer base for AR headsets than the consumer market. However, large-scale enterprise adoption of AR headsets will be limited in the short term due to their high cost and reports of performance issues.

Microsoft's HoloLens (launched in 2016) and HoloLens 2 (in 2019) failed to prove their usefulness. The company has reportedly shelved plans for HoloLens 3 as it struggles to find buyers. It is also reportedly struggling to meet the technical requirements of its biggest client, the US Army. The departure of the chief architect of HoloLens, Alex Kipman, in June 2022 made the device's future uncertain. This uncertainty was compounded by mass layoffs announced by Microsoft in January 2023 that impacted teams working on HoloLens and mixed reality projects.

Apple announced its Vision Pro headset in June 2023, priced at $3,500. The device will target the architecture, real estate, automotive, and entertainment sectors, while the availability of Disney's huge content library on Vision Pro is a plus for consumers. Apple acquired Mira Labs, a start-up that makes AR headsets for other companies and the US military, in June 2023, suggesting that the Vision Pro's primary focus will be enterprises, at least for the foreseeable future.

Google, in contrast, has reportedly scrapped its AR headset project and partnered with Samsung Electronics and Qualcomm to launch a headset to rival the Vision Pro. Reportedly, Google is developing an Android-based operating system for the headset, while Samsung Electronics is building the hardware and Qualcomm the custom chipset. It is, however, unclear at the time of writing which segment the device will target.

Competition in the consumer AR headsets market is limited. No leading technology company is active in it at the time of writing. However, Jarvish and Eyelights produce consumer AR helmets, mainly targeted at motorbike enthusiasts. Aryzon, on the other hand, offers cardboard-made AR headsets as an affordable way to experience AR.

AR value chain – Devices

Leaders and challengers

Devices	Leaders		Challengers	
Smartphones	Apple	Samsung Electronics	Alphabet (Google)	Lenovo
	Huawei	Vivo	Asus	Nokia
	Oppo	Xiaomi		
AR smart glasses	Lenovo	Seiko Epson	Everysight	TCL
	RealWear	ThirdEye	Iristick	Tilt Five
	Rokid	Vuzix	Mad Gaze	Toshiba
	Realmax	Xreal	Oppo	Xloong
AR headsets	Apple	Microsoft	Argon	Jarvish
			Aryzon	Magic Leap
			Eyelights	Varjo

Source: GlobalData

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Platforms

Building an AR ecosystem—incorporating both hardware and software—is essential for the long-term success of any company in this market. There are four prerequisites for a successful AR ecosystem.

- **Application programming interfaces (APIs) and SDKs**. Owning the software platform on which all the applications and content run is critical. Developers can then create content and applications for the operating system, provided good APIs and SDKs are available. This creates a virtuous network effect whereby platforms with popular APIs and SDKs attract more developers, which leads to more content, which leads to more customers, and higher remuneration for the developers, which attracts more developers. All the leading AR companies—Apple, Google, Microsoft, and others—offer SDKs and APIs to developers. Component suppliers like Nvidia and Qualcomm and services companies like Amazon, Autodesk, and Unity Technologies have also introduced SDKs and APIs to spur AR growth.

  The availability of such a wide array of choices puts developers at risk. Selecting one platform enables them to curb the development cost but offers less visibility while, with multiple platforms, the situation is reversed. Cross-platform SDKs are a way of addressing this issue. Several cross-platform SDKs are available in the AR market, with prominent names including PTC (with Vuforia) and Qualcomm (with Wikitude) and emerging names such as Maxst, Augment, Zapworks, and Visionstar (EasyAR), among others.

- **AR engines – games.** An AR gaming engine helps creators develop games without relying on software engineers to write the code. Apple (with ARKit), Google (ARCore), Unity Technologies, Epic Games (Unreal Engine), Meta (Spark Studio), and Snap (Lens Studio) are leaders in this field, while INDE, AR.js, PTC, and Niantic (8th Wall) are key challengers.

- **AR engines – enterprise.** Enterprise engines provide software that helps corporations quickly and easily build apps for AR systems. Autodesk, TeamViewer (with Upskill), PTC, Microsoft, Unity Technologies, and Dassault Systèmes are strong in this area. Amazon, 3D Systems, Scope AR, Siemens, Cisco, and Bosch, among others, are also jockeying for market share in this space.

- **AI.** AR ecosystems depend on real-time AI to interpret the vast amounts of sensor-based data generated by AR applications. Much of that AI capacity sits in algorithms, with more and more machine learning algorithms being processed in the cloud. GlobalData will look in detail at the AI technology stack later in this section.

- **Application delivery networks (ADNs) and content delivery networks (CDNs).** Distributing apps and content is an important aspect of any successful AR ecosystem. Apple and Google maintain a duopoly in this domain, as most smartphones worldwide run on either iOS or Android, with the Microsoft Store a dominant force at the PC level. Companies such as Vuzix and Seiko Epson maintain online stores for PC-based distribution but are largely dependent on Apple's App Store and the Google Play Store at the smartphone level.

  Third-party developers also market their apps and content through these stores and split the content revenues with the store owners. In the Chinese market, regulatory restrictions on the Play Store have forced developers to use mobile stores offered by Tencent, Huawei, Xiaomi, Alibaba, and Oppo.

  Effective AR experiences also require powerful CDNs, which store cached meta content on edge servers and act as gateways for bi-directional data transfer between the servers and users. Google (with Google Hosted Libraries), Microsoft (with the Azure CDN), Amazon (with the AWS-integrated CloudFront), Akamai, Alibaba, and F5 Networks are strong players in this segment, while Cloudflare, Fastly, StackPath, Verizon, and jsDelivr are potential long-term beneficiaries from the growth in AR.

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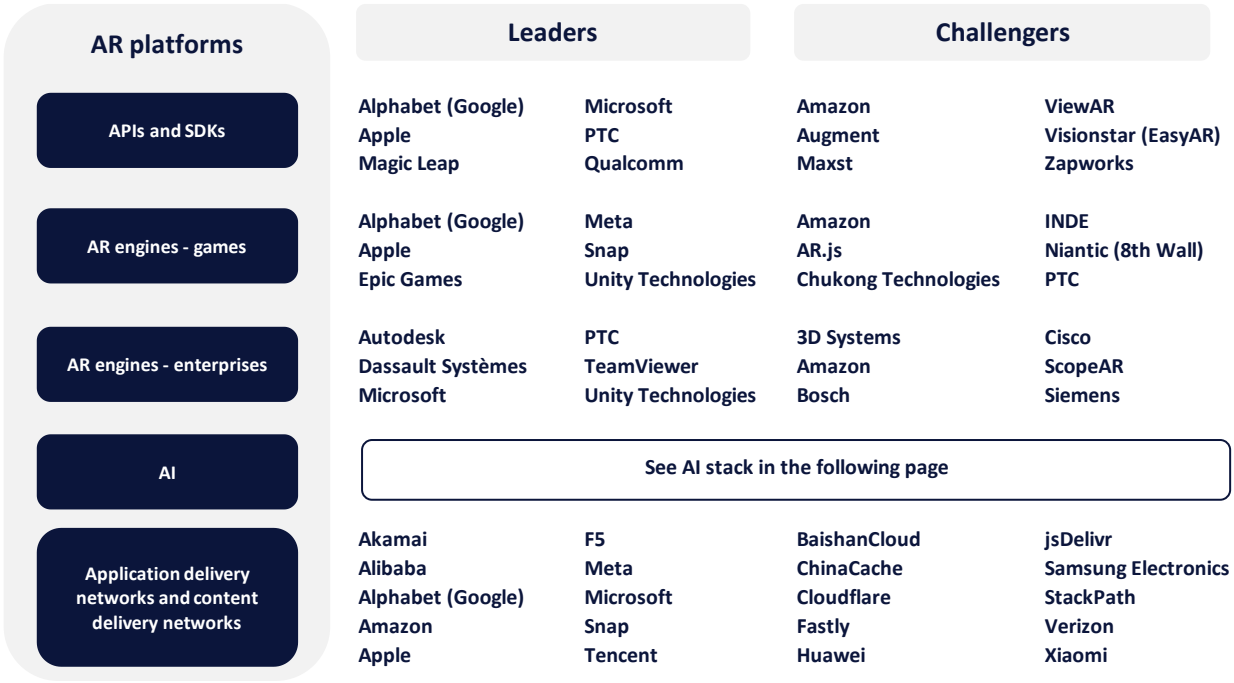
AR value chain – Platforms
Leaders and challengers



Source: GlobalData

Artificial intelligence

AI technologies like machine learning (ML), conversational platforms, and AI chips power most of today's AR devices and apps. AR developers use ML to improve the user experience (UX) by continually analyzing user activities. Apple's CoreML and Google's TensorFlow Lite ML frameworks support ARKit and ARCore, respectively. They allow developers to run ML models to improve object recognition in photos, convert speech to text, and enable gesture recognition. Eye tracking and facial recognition, fast becoming standard functions across all AR devices, use ML to improve UX.

Virtual assistants (e.g., Apple's Siri, Amazon's Alexa, Google's Assistant, and Microsoft's Cortana) enable the hands-free operation of AR devices. This is critical for some use cases, especially in enterprises. At the same time, efforts to develop low-power AI chips for AR devices are also underway.

The graphic below sets out the key players in AI, broadly categorized into foundational AI and advanced AI capabilities. See Artificial Intelligence for a detailed analysis of these categories.

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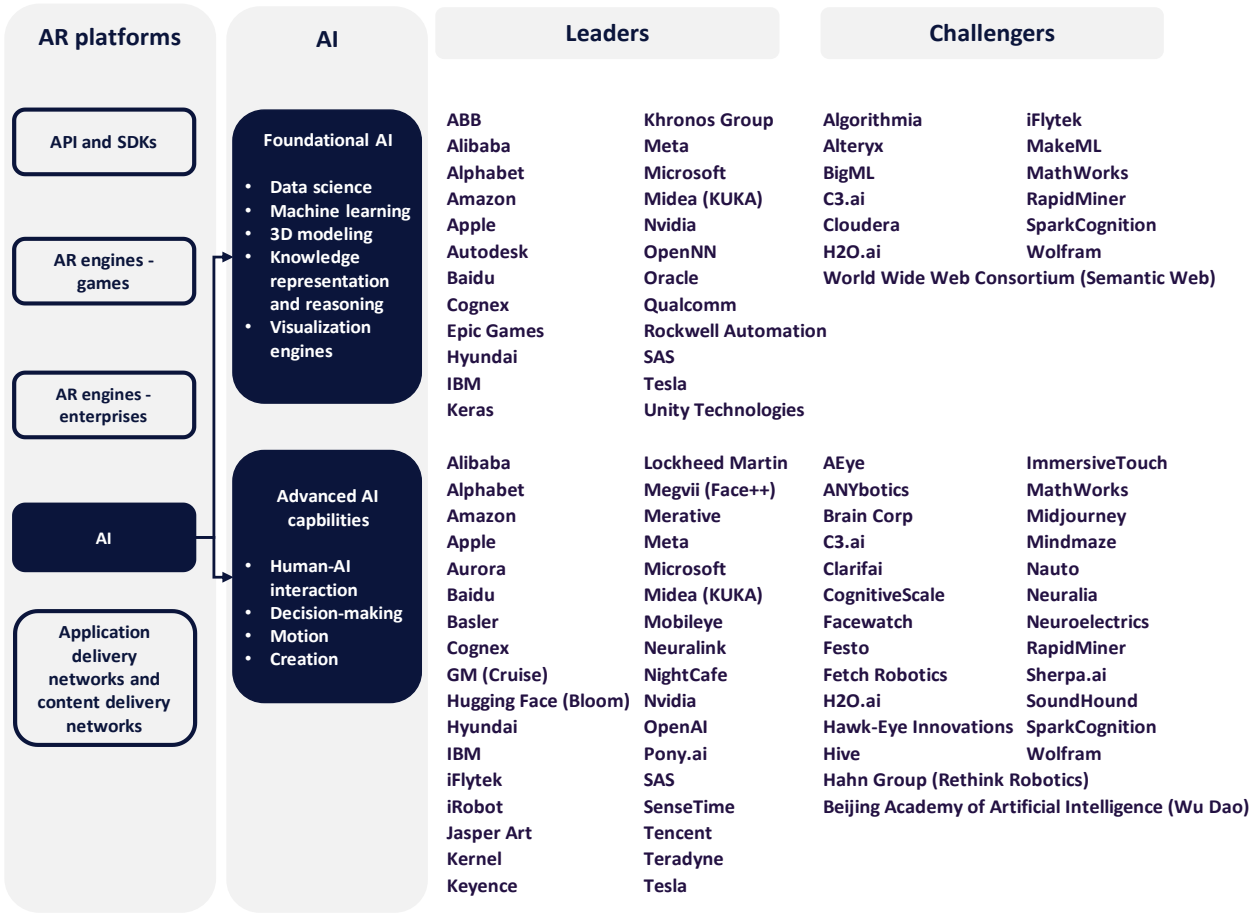
AR value chain – Platforms - AI

Leaders and challengers



Source: GlobalData

The impact of generative AI

Generative AI can support content creation and offer context-aware virtual elements, elevating user engagement. For instance, generative AI-supported AR applications for interior design can craft realistic, virtual furniture in a living room, allowing the user to visualize its appearance. The user inputs a text prompt, and the generative AI platform converts it into a 3D virtual object. Start-up Devar is working on one such generative AI offering for WebAR. The user can then customize the virtual furniture (e.g., in size and design) to fit the space and requirement before purchasing.

Moreover, generative AI can make AR content adaptable in real time. For instance, in gaming, generative AI-supported virtual characters and objects can respond intuitively to the user's environment, making the gaming world feel integrated with reality. Furthermore, AI-created characters can appear in AR to promote a message, brand, or film within a game. In April 2023, Snap introduced AR Lenses powered by generative AI and a 'Cosmic Lens' that turns the user's surroundings into an immersive, animated sci-fi scene.

WebAR platform Geenee AR has partnered with Inworld AI, a generative AI-based platform for developing non-playing characters (NPCs), to allow brands to bring their NPCs to life through AR. For example, an AI-generated brand ambassador can provide in-depth product info and tutorials. This signals the development of new use cases across sectors, promising novel user experiences. However, most initiatives combining generative AI and AR are experimental. Significant commercial opportunities will only emerge when both generative AI and AR have matured.

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Apps and content

Content is a major area of concern for AR companies. Gaming is a fertile ground for AR, but gaming companies struggle to create novel content. Meanwhile, general apps (e.g., maps), ecommerce (e.g., furniture and cosmetic try-ons), and social media (e.g., Snapchat and Instagram filters) are fast becoming growth avenues.

One of these areas will become the prime application for AR over the next few years. Snap, Meta, Tencent, and ByteDance have merged AR and ecommerce into their social media platforms, allowing users to try on products virtually. The ease of viewing products online and the ability to interact with those products give users a novel and immersive shopping experience. A report published by Snap, which analyzed the US market, predicts that 57% of Snapchat users will use AR before buying a product online by 2025.

Enterprises are an increasingly important area of focus for AR companies. Media houses and ecommerce companies have been early adopters of AR, while healthcare, engineering, and military organizations also use the technology. Microsoft, PTC, Deloitte, McKinsey, Accenture, and TeamViewer are investing in AR development platforms to support firms through the AR implementation process. Start-ups such as Re'flekt, Scope AR, and Atheer have also joined the race.

AR value chain – Apps and content
Leaders and challengers

Apps and content	Leaders		Challengers	
General apps	Alphabet (Google)	Microsoft	Adobe	Groove Jones
	Apple	Samsung Electronics	EON Reality	Tencent
			Gravity Jack	Visionstar (EasyAR)
Engineering apps	Adobe	IBM	Augment	JBKnowledge
	Autodesk	Oracle	Intellectsoft	Re'flekt
	Dassault Systèmes	PTC	Schneider Electric (Aveva)	Visionstar (EasyAR)
Healthcare apps	Atheer	Orca Health	Accuvein	Brain Lab
	Augmedics	Proximie	Arspectra	CAE Healthcare
	Medtronic	Vipaar	Apprentice	Medivis
Ecommerce apps	Alibaba	Sephora	De Beers	L'Oréal
	Amazon	Shopify	eBay	Target
	Ikea	Walmart	JD.com	The Home Depot
Social apps	ByteDance	Snap	Cisco	Pinterest
	Meta	Tencent	ImagineAR	TeamViewer
			Microsoft	Zoom
Military apps	Boeing	ThirdEye	BAE Systems	Microsoft
	Lockheed Martin	Northrop Grumman	Elbit Systems	Vuzix
Video games	Bandai Namco	Square Enix	Auxbrain	Nexon
	NetEase	Tencent	Elyland	Nintendo
	Niantic	Ubisoft	Illumix	Resolution Games
Films	Comcast	Netflix	Amazon (MGM)	Sony
	Warner Bros. Discovery	Walt Disney	ViacomCBS	East City Films

Source: GlobalData

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Companies

In this section, GlobalData highlights companies making their mark within the augmented reality theme.

Leading augmented reality adopters in healthcare

The table below lists some healthcare companies currently deploying AR and summarizes their competitive position in this theme.

Company	Country	Competitive position in the augmented reality theme
GE HealthCare	US	In 2022, GE HealthCare partnered with MediView, a clinical AR med-tech company, to develop the OmnifyXR Interventional Suite System for the integration of medical imaging into mixed-reality solutions. In 2023, MediView obtained FDA clearance for its XR90 AR-based surgical and visualization system. In November 2023, XR90 was successfully used in a clinical case.
Nihon Kohden	Netherlands	In 2018, Nihon Kohden launched Nihon Kohden Dimensions (NKD), an AR app, to accompany the Clinical Excellence Services contributions from Nihon Kohden University (NKU), an online training platform. The app is aimed at healthcare providers for training purposes and is to be offered as an AR training experience for the correct lead placement and detection of cardiac arrhythmia.
Philips	Japan	In 2021, Philips introduced a new product as part of its Azurion image-guided therapy platform. ClarifEye's AR surgical navigation system was launched for minimally invasive spine procedures in a hybrid operating room. This system enables surgeons, through AR, to have a 3D view of the patient's anatomy in real time. The constant tracking of the patient is provided by video tracking and non-invasive markers on the skin. The system also provides visualization of the tip of the ClarifEye Needle as it moves along the planned route in the spine.
Thermo Fisher Scientific	US	In 2019, Thermo Fisher Scientific launched a new employee training center, which uses AR to simulate equipment and floor environments. The objective is to enable trainees to be nearer to running equipment and traditional training. Thermo Fisher Scientific invests in immersive technologies to propel digital transformation in laboratories. They have an app with SampleManager, which enables scientists with a mixed reality headset to have hands-on access to the laboratory information management system while they work. This helps lab training and means there are fewer deviations during lab work.
Zimmer Biomet	US	In 2021, Zimmer Biomet launched the OptiVu mixed reality platform, used with Microsoft HoloLens. This mixed-reality platform consisted of three apps: OptiVu Instrument Assembly (step-by-step guide of instrument assembly), OptiVu Patient Assessments (gathers and stores patient data before and after surgery), and OptiVu Surgical Demo (shares mixed-reality experience with surgeons during a procedure). In 2022, Zimmer Biomet added another addition to its OptiVu mixed reality platform. Zimmer Biomet partnered with Surgical Planning Associates to co-market the HipInsight System, which was the first FDA-cleared mixed reality navigation system for hip replacements. The technology gives surgeons "X-ray vision" using AR, allowing them to see the patient's anatomy in real time. It uses the Microsoft HoloLens 2 to offer 3D holograms of the patient's specific anatomy.

Source: GlobalData

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Leading augmented reality vendors

In this section, GlobalData highlights companies making their mark within the AR theme.

Company	Country	Competitive position in the augmented reality theme
Alibaba	China	Alibaba has been active in AR since 2018 when its Taobao Buy app, accessible via Microsoft's HoloLens, allowed users to browse and interact, using hand gestures, with 3D holograms of a select range of products. In 2019, it partnered with Perfect Corp to bring AR beauty solutions to its shopping apps, Tmall and Taobao. It also acquired Infinity, an AR and computer vision start-up, in 2019 and invested in AR companies like WayRay, Nreal (renamed Xreal in May 2023), and Magic Leap. In 2020, Alibaba's DingTalk messaging app released an AR smart glass in collaboration with Nreal, featuring 3D virtual meeting rooms. In the same year, AutoNavi, a web mapping, navigation, and location-based services provider, integrated AR into its Gaode Map app for vehicle distance monitoring and precision navigation. However, Alibaba's AR-related announcements have dwindled in 2023 due, at least in part, to strict data privacy regulations in China.
Alphabet (parent company of Google)	US	Google will benefit from AR in the long run, thanks largely to its ARCore SDK (also called Google Play Services for AR), which had an installed base of 1.4 billion devices in 2023, up from 633 million in 2020 (according to ARtillery Intelligence). Its AR services also include Chrome AR (its WebAR platform), Cloud Anchors (its AR cloud platform), and Scene Viewer (a tool that allows users to view 3D models of products on websites). In July 2021, Google announced the addition of AR masks and filters to its Meet video calling service. It offers the Google Cloud to AR developers for storing and streaming AR. However, it shuttered production of the Glass Enterprise Edition 2 in March 2023 and has also shelved its AR glasses, codename Iris. It has partnered with Samsung Electronics and Qualcomm to launch an AR headset in 2024, but little more is known at the time of writing. In October 2023, it introduced new AR try-on tools for the Google app and mobile web to make AR widely available.
Amazon	US	Amazon positions itself in the AR market as a service provider rather than a device maker. In 2017, Amazon Web Services (AWS) launched Sumerian, a managed service that helps developers create AR, VR, and 3D apps and games. Subsequently, it integrated Alexa on smart glasses like Vuzix Blade. On the retail side, the AR View feature on Amazon's mobile app lets users visualize how products such as chairs, tables, and sofas would look in their homes. In 2020, it launched the Amazon Augmented Reality app, allowing users to scan QR codes on Amazon packaging for fun AR images. In May 2023, it introduced Amazon Anywhere, allowing customers to buy physical products from within AR video games and virtual worlds. While Amazon's AR capabilities are limited, it works with companies like Snap and Hexa (a 3D visualization platform to make digital twins) for immersive shopping experiences. In 2022, it partnered with Snap to allow Snapchat users to try eyeglasses via AR before buying. Similarly, Hexa enables sellers to create and display 3D images, 360-degree views, virtual try-ons, and AR content directly on Amazon.

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Company	Country	Competitive position in the augmented reality theme
Apple	US	Apple offers AR SDKs, such as the ARKit (launched in 2017), which operates on all iOS devices, and the RealityKit (available on iOS and Mac devices). It also offers AR creation tools such as Reality Composer (a library of AR content for developers) and AR Quick Look (that positions 3D objects in the real world). The RealityKit and AR creation tools work with the ARKit. Apple has added Light Detection and Ranging (LiDAR) sensors to its flagship iPhones and iPads for precise 3D mapping, boosting the simultaneous localization and mapping (SLAM) capabilities of ARKit and helping developers create AR content. ARKit is also integrated with the Safari browser for WebAR. In June 2023, Apple launched the Vision Pro AR headset, priced at $3,500. However, it has encountered editions even before going on sale, with expected production falling to fewer than 400,000 units against initial estimates of around a million units. This is due to manufacturing issues in China, as producing advanced high-definition screens at scale is challenging.
ByteDance	China	ByteDance, the developer of TikTok, is expanding its foothold in the AR market with its AR Effects platform. This is integrated into TikTok, allowing users to add AR filters to their videos. In May 2020, ByteDance launched AR Brand Effect as a service, allowing brands to build interactive ads in TikTok. Subsequently, in June 2020, it launched TikTok for Business to help marketers make AR ads that mirror user content. Brands like Spotify and MAC have launched AR-based ad campaigns on TikTok. In April 2023, TikTok introduced Effect House, a platform that enables users to design and share AR effects and experiences. At the launch, TikTok claimed that over 450 developers had created AR immersive effects across 1.5 billion videos. ByteDance competes with Snap and Meta for a share of the social media-based AR entertainment and ads markets.
Magic Leap	US	Magic Leap's fortunes have revived since 2022, thanks to its enterprise-focused AR headset Magic Leap 2. Initially backed by Google, Qualcomm, and Alibaba, sales of its first headset, Magic Leap One (launched in August 2018), were disappointing. In 2020, Magic Leap faced existential challenges, which led it to reduce its workforce by 50% and shutter its consumer business. Consequently, its valuation declined from $6.4 billion in December 2019 to $450 million in June 2020. In 2022, Saudi Arabia's Public Investment Fund bought a controlling stake in Magic Leap for $450 million. The Magic Leap 2 (launched in September 2022) boasts technical improvements in lightness, wide field of view, and improved display technology compared to its predecessor. Magic Leap tested the device with Cisco, SentiAR, NeuroSync, Heru, Taqtile, PTC, and Brainlab before launch.
Meta (formerly Facebook)	US	Meta's AR drive has been spearheaded by the Spark AR Studio (launched as the Camera Effects Platform in 2017). Spark AR is compatible with 3.1 billion devices in 2023, the highest among all mobile AR platforms, according to ARtillery Intelligence. It offers AR filters on Messenger and Instagram and helps companies develop AR ads and virtual try-ons for consumer products. In 2019, it acquired CTRL-Labs for its electromyography technology that enables impulse-based control of AR smart glasses. In partnership with EssilorLuxottica, Meta has launched two generations of non-AR smart glasses, which have seen mixed reviews from consumers. In November 2023, Meta partnered with MediaTek to develop custom chips for its future AR smart glasses. Reportedly, Meta plans to introduce its first AR smart glasses in 2024 for internal use and to ship it to consumers in 2027.

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Company	Country	Competitive position in the augmented reality theme
Microsoft	US	Microsoft's AR offering is primarily based on its HoloLens headsets. In 2021, the company secured a contract, potentially worth $22 billion over 10 years, to supply 120,000 HoloLens headsets to the US Army. The first batch of headsets was criticized as soldiers became physically ill while using them. The problematic headsets were part of an order of 5,000 devices the Army took delivery of in September 2022. However, in August 2023, the Army tested an improved batch of devices and confirmed no issues with soldiers, earning Microsoft a new contract in September 2023. The devices will undergo testing in 2025 for use in combat. HoloLens 2 struggled to gain traction outside of the US Army due to its high cost and limited use cases. In addition, the departure of the chief architect of HoloLens, Alex Kipman (in June 2022), and layoffs in the HoloLens team (in January 2023) made the device's future uncertain. However, in April 2023, Microsoft equipped the HoloLens 2 with Windows 11 to attract developers. In October 2023, it applied for an AR smart glasses patent, potentially indicating ambitions to fill the gap left by the demise of Google Glass Enterprise Edition 2.
Niantic	US	Founded as an internal start-up within Google, Niantic is the maker of *Pokémon Go.* According to Sensor Tower, the mobile AR game has generated nearly $8 billion in revenue since its launch in 2016. However, Niantic has seen limited success with its other AR games, including *Ingress Prime* and *Harry Potter: Wizards Unite*. Beyond games, Niantic's AR cloud platform Lightship (previously called Real World Platform), provides creators with tools to build AR-based shared experiences. In November 2021, Niantic raised $300 million in funding at a valuation of $9 billion. Subsequently, in March 2022, it acquired 8th Wall, a leader in WebAR technology, to create metaverse experiences.
Qualcomm	US	Qualcomm's AR activities range from chips, developer reference AR headset kits and SDKs, to content development. It launched the XR1 chipset in 2018, claiming to improve battery life, enhance audio and video quality, and reduce power consumption and temperature on AR headsets. It has also partnered with Tobii to explore eye-tracking technologies. In June 2021, it partnered with PhotonicSENS to improve the image quality and enable AR on smartphones using the Snapdragon 888 5G platform. Later, in September 2021, Qualcomm acquired Wikitude to boost its location-based AR capabilities. It also works with 15 telcos to develop and commercialize XR over 5G networks. In 2023, its Snapdragon XR2 Gen 2 and AR1 Gen 1 powered Meta's Quest 3 and Ray-Ban Meta Smart Glasses, respectively. However, it suffered a blow as Meta chose MediaTek to develop custom chips for its future AR smart glasses. Qualcomm has partnered with Google and Samsung Electronics to launch an AR headset in 2024.
Samsung Electronics	South Korea	Samsung Electronics is active in several segments of the AR value chain, ranging from semiconductors to devices and apps. Several Samsung smartphones are compatible with Google's ARCore, making them capable of running AR apps. Its AR Canvas allows users to create semi-persistent AR on Galaxy smartphones. In March 2021, Samsung added a Snapchat Lens feature on its Galaxy A-series smartphones, allowing users to access Snapchat filters from the devices' camera apps. It is working on an AR headset with Google and Qualcomm. The device is likely to launch in 2024. For the headset, Samsung Electronics acquired eMagin, a micro-OLED manufacturer, for $218 million in October 2023.

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Company	Country	Competitive position in the augmented reality theme
Snap	US	Snap is best known for the Snapchat platform. With 406 million daily active users at the end of Q3 2023, Snapchat offers AR features like Lenses (AR filters), 3D Bitmojis (personalized emojis), and Snappables (interactive AR filters) via its Lens Studio. Snap claims that over 3.5 million Snapchat lenses have been created by users, amassing over nine trillion views on Snapchat and in apps powered by the Camera Kit SDK. Snap gives brands the ability to build AR ads and try-on solutions. It has acquired AR shopping firm Vertebrae (in 2021), fashion suggestion app Screenshop (2021), garment sizing firm Fit Analytics (2021), and 3D scanning firm Th3rd (2023) to bolster its capabilities in this market. Its Spectacles-branded smart glasses do not support AR but can capture photos and videos that can be overlaid with AR via the Snapchat app. It acquired WaveOptics (in 2021) and NextMind (2022) for smart glasses display and brain-computer interface expertise, respectively.
Tencent	China	Tencent, which has 1.3 billion monthly active users on WeChat, has been a long-term advocate of AR. The company's involvement in the technology spans from developing WeChat's AR framework (QAR) in 2017 to the launch of the mobile AR game *Let's Hunt Monsters* in 2019. It introduced AR on the WeChat mini-program platform in 2019, allowing users to access AR-based gaming, shopping, virtual try-ons, and real estate inquiries, and brands to incorporate AR ads. it has also funded start-ups like Oben (which develops AI-based 3D AR avatars) and Innovega (AR smart glasses and contact lenses maker). In recent years, China has tightened regulations on tech giants involved in businesses that gather user data. The regulations have restricted Tencent's investments in technologies like AR.
Unity Technologies	US	Unity provides the most widely used AR game development platform. Expert in creating games, interactive experiences, virtual avatars, and simulation platforms, Unity offers 2D and 3D models, templates, SDKs, and AR tools for developers. It supports AR devices and is an integrated platform for Apple's ARKit, Google's ARCore, and Snap's Lens Studio. In 2020, Unity introduced the Mixed and Augmented Reality Studio (MARS), a set of tools for developers to build AR experiences in any physical space without requiring extensive coding. In March 2021, it acquired VisualLive to support AR visualization and collaboration in the architecture, engineering, and construction industry. In January 2022, it acquired Ziva Dynamics to help companies create virtual humans and characters. It has invested in AI to bolster its 3D features and offer flexible tools to creators for developing AR content.
Vuzix	US	Vuzix offers display technologies, smart glasses, AR technology, and products. Its display devices have manufacturing and training applications and are also used as military tactical equipment. Vuzix has a robust lineup of smart glasses, including the M-Series, Vuzix Shield, and the Vuzix Ultralite AR smart glasses. These glasses are used in various industries such as healthcare, construction, security, and retail. Vuzix is a leading promoter of enterprise smart glasses. For example, it supported DHL's Vision Picking program and developed AR smart glasses for Toshiba.

Source: GlobalData

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Specialist augmented reality vendors in healthcare

The table below lists some specialist AR vendors in the healthcare sector and summarizes their competitive position.

Company	Country	Competitive position in the augmented reality theme
AccuVein	US	AccuVein uses AR to display a patient's veins and arteries on their skin. This allows the clinician to place a needle or catheter in a more informed or precise way. With this device, the clinician can see the center line of the vein—and from further away than is normally possible.
Augmedics	US	Augmedics produces an AR surgical navigation device for spinal surgery. Its Xvision Spine System allows surgeons to "see" the patient's anatomy through the skin and tissue to navigate instruments and implants accurately during spinal procedures.
Complete Anatomy	US	Complete Anatomy is an app that uses AR to teach human anatomy to medical students. They provide a realistic 3D exploration of the complex systems and organs. It is being used by 200 of the world's top universities.
Know My Beat	US	Know My Beat is an app that uses AR technology and educates people who have atrial fibrillation so that they are more in the know about their health condition and can get medical attention when necessary. The app works by displaying a virtual 3D hand, meaning the user knows whether they have put their fingers in the right location to take their pulse correctly.
MediView	US	MediView uses AR to offer a 3D display of the patient's holographic directly on the patient during surgery. It assists practitioners in visualization and navigation during minimally intrusive surgeries, like biopsies or cancerous tumor excision. This has been successfully used for a mediastinal lymph node biopsy.
SentiAR	US	SentiAR uses AR to create a holographic visualization of a patient's anatomy designed for clinicians. The 3D image floats over the patient during interventional procedures, allowing physicians to understand exactly what is happening. This has been used successfully for viewing the anatomy of the inner heart surface and in procedures such as treating cardiac arrhythmias in a catheter lab.
Source: GlobalData		

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Sector Scorecards

At GlobalData, we use a scorecard approach to predict tomorrow's leading companies within each sector. Our sector scorecards have three screens: a thematic screen, a valuation screen, and a risk screen.

For a full explanation of our thematic scoring methodology, please refer to the methodology section at the back of this report.

Drug development sector scorecard

Who's who

Who does what in the drug development space?

Drug development
(52 companies)

Company	Ticker	Sector	MKT CAP (US$ M)	Country	Description
AbbVie	ABBV	Pharmaceuticals	320,085	USA	chronic and complex diseases.
Amgen	AMGN	Biotechnology	145,523	USA	from serious diseases.
Astellas Pharma	4503	Pharmaceuticals	19,602	Japan	Discovers, develops, manufactures, and commercializes a wide range of pharmaceuticals.
AstraZeneca	AZN	Pharmaceuticals	205,614	UK	pharmaceuticals and vaccines.
Bayer	BAYN	Pharmaceuticals	27,820	Germany	equipment, and OTC products.
Biocad	Unlisted	Pharmaceuticals	Unlisted	Russia	Biotechnology company that develops, manufactures and distributes generic pharmaceuticals and biosimilars.
Biogen	BIIB	Biotechnology	31,924	USA	neurodegenerative diseases.
Boehringer Sohn	Unlisted	Bio/pharmaceutical	Unlisted	Germany	Manufacturer, marketer and supplier of pharmaceutical products and also medicines for animal health.
Bristol Myers Squibb	BMY	Pharmaceuticals	106,145	USA	medicines to patients with serious diseases.
Cadila	Unlisted	Pharmaceuticals	Unlisted	India	Develops, manufactures and distributes pharmaceutical products, including API and pharmaceutical formulations.
Catalent	CTLT	Pharmaceuticals	10,248	USA	products.
Celltrion	68270	Pharmaceuticals	29,725	Korea	biopharmaceuticals.
Charles River	CRL	Pharmaceuticals	13,377	USA	development.
Cipla	CIPLA	Pharmaceuticals	14,604	India	Pharmaceutical company which manufactures and distributes branded medicines, generics and APIs.
Coherus	CHRS	Pharmaceuticals	242	USA	Biosimilar platform company that develops and commercializes biosimilar drugs.
CSL	CSL	Pharmaceuticals	90,430	Australia	Discovers, develops, manufactures, commercializes, and distributes biopharmaceuticals and related products.
CSPC	1093	Pharmaceuticals	10,000	China	related products.
Daiichi Sankyo	4568	Pharmaceuticals	62,236	Japan	prescription drugs, OTC drugs, vaccines, and others.
Dr. Reddy's	DRREDDY	Pharmaceuticals	12,668	India	Pharmaceutical company that manufactures and markets generic formulations, APIs, biosimilars and proprietary products.
Generium	Unlisted	Pharmaceuticals	Unlisted	Russia	pharmaceutical products, with a focus on orphan diseases.
Gilead Sciences	GILD	Biotechnology	92,449	USA	Biopharmaceutical company focused on the discovery, development and commercialization of medicines.
GSK	GSK	Pharmaceuticals	88,603	UK	healthcare products.
Innovent Biologics	1801	Pharmaceuticals	8,849	China	Biopharmaceutical company that discovers, develops and manufactures innovative and biosimilar monoclonal antibodies.
Intas	Unlisted	Pharmaceuticals	Unlisted	India	range of diseases and disorders.
IQVIA	IQV	Pharmaceuticals	46,148	USA	Provider of information, novel technological solutions and contract research services.
Johnson & Johnson	JNJ	Pharmaceuticals	383,500	USA	Researches, develops, manufactures and sells pharmaceutical products, medical devices and consumer products.
Lilly	LLY	Pharmaceuticals	722,819	USA	Company that discovers, develops and markets human healthcare products.
Lonza	LONN	Pharmaceuticals	41,015	Switzerland	Provides contract manufacturing and development solutions to lifescience industry.
Lupin	LUPIN	Pharmaceuticals	9,085	India	Develops and manufactures generic and branded formulations, biotechnology products and APIs.
Merck	MRK	Pharmaceuticals	75,599	Germany	antibodies and end-to-end systems.
Merck & Co	MRK	Pharmaceuticals	305,209	USA	therapies, vaccines and animal health products.
Novartis	NOVN	Pharmaceuticals	226,590	Switzerland	pharmaceutical products and eye care products.
Novo Nordisk	NOVO B	Pharmaceuticals	466,107	Denmark	Biopharmaceutical company that discovers, develops and manufactures innovative biological medicines.
Otsuka	4768	Pharmaceuticals	8,448	Japan	equipment, functional chemicals, medical devices and OTC products.
Parexel	Unlisted	Pharmaceuticals	Unlisted	USA	for the development and commercialization of new medical therapies.
Perrigo	PRGO	Pharmaceuticals	4,183	Ireland	company, nutritional products, and infant formulas and foods.
Pfizer	PFE	Pharmaceuticals	158,844	USA	Discovers, develops, manufactures and commercializes biopharmaceuticals and generic and branded pharmaceuticals.
Regeneron	REGN	Biotechnology	105,266	USA	Discovers, develops, manufactures, and markets medicines for the treatment of serious medical conditions.
Reliance Industries	RELIANCE	Exploration & Production	234,107	India	Manufacturer of petrochemicals and synthetic fibres, producer of gasoline and other products
Roche	ROG	Medical Supplies	215,882	Switzerland	Biotechnology company that develops drugs and diagnostics to treat major diseases.
Samsung Biologics	207940	Pharmaceuticals	45,430	Korea	biosimilars leader.
Sanofi	SAN	Pharmaceuticals	121,406	France	Company that discovers, develops, manufactures and markets a wide range of medicines and vaccines.
Shanghai Henlius Biotech	2696	Pharmaceuticals	1,044	China	antibody drugs, and antibody-drug conjugates among others.
Sun Pharma	SUNPHARMA	Pharmaceuticals	45,534	India	generic pharmaceuticals.
Takeda	4502	Pharmaceuticals	46,137	Japan	and export of pharmaceutical drugs.
Teva	TEVA	Pharmaceuticals	15,553	Israel	Discovers, develops, manufactures and commercializes generic and specialty medicines.
Thermo Fisher Scientific	TMO	Medical Equipment	223,033	USA	Develop therapeutic and diagnostic medical products for heart and movement conditions
UCB	UCB	Pharmaceuticals	22,625	Belgium	Biopharmaceutical company that discovers and develops novel medicines and solutions to help treat various diseases.
Vertex	VRTX	Biotechnology	105,589	USA	threatening diseases.
Viatris	VTRS	Pharmaceuticals	14,037	USA	and consumer healthcare products.
WuXi AppTec	603259	Pharmaceuticals	20,357	China	manufacturing services for advanced intermediates and APIs.
Zydus Lifesciences	ZYDUSLIFE	Pharmaceuticals	12,176	India	biologics, vaccines and new chemical entities.

Source: GlobalData

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Thematic screen

Our thematic screen ranks companies based on overall leadership in the 10 themes that matter most to their industry, generating a leading indicator of future performance

Drug development
(52 companies)

Company	MKT CAP (US$ M)	Ticker	Country	Weighting	15% Immuno-Oncology	15% Precision and Personalized Medicine	10% Regenerative Medicine	10% Rare Diseases	15% Biosimilars	10% Genomics	5% Artificial Intelligence	5% Deal Making	10% Supply Chain Management	5% Augmented Reality	100% Thematic Ranking
					Thematic Screen										
Pfizer	156,626	PFE	USA		5	5	4	5	5	5	5	5	5	5	1
Thermo Fisher Scientific	222,736	TMO	USA		4	5	5	5	5	5	4	5	5	5	2
Sanofi	121,031	SAN	France		4	5	4	5	5	5	5	5	5	4	3
Johnson & Johnson	375,348	JNJ	USA		5	5	4	5	5	4	5	4	4	5	4
Novartis	209,917	NOVN	Switzerland		5	5	5	5	3	5	5	5	5	4	5
Catalent	10,094	CTLT	USA		5	5	5	5	5	5	2	4	5	1	6
Amgen	148,423	AMGN	USA		4	5	4	5	5	5	4	5	4	4	7
IQVIA	46,203	IQV	USA		5	5	3	4	5	4	5	4	5	3	8
Roche	207,629	ROG	Switzerland		5	5	4	5	3	5	4	5	4	4	9
AstraZeneca	200,421	AZN	UK		5	5	4	5	2	5	5	5	5	4	10
Lonza	42,794	LONN	Switzerland		5	5	5	4	4	4	3	4	5	2	11
Merck & Co	313,085	MRK	USA		5	5	4	5	3	4	5	5	5	1	12
Bristol Myers Squibb	104,325	BMY	USA		5	5	5	5	2	4	5	5	4	4	13
Parexel	Unlisted	Unlisted	USA		5	5	2	5	5	3	3	5	5	1	14
Gilead Sciences	91,054	GILD	USA		5	5	5	5	2	4	4	4	4	1	15
Takeda	47,022	4502	Japan		4	5	4	5	1	4	5	4	5	4	16
Biogen	31,710	BIIB	USA		4	4	4	4	4	5	3	4	4	2	17
GSK	87,214	GSK	UK		4	4	4	5	1	5	5	5	5	3	18
Astellas Pharma	19,995	4503	Japan		4	4	5	5	1	5	4	5	4	4	19
Charles River	14,041	CRL	USA		3	4	4	4	3	4	4	4	5	5	20
AbbVie	311,376	ABBV	USA		4	5	3	5	3	4	3	4	4	1	21
Merck	74,218	MRK	Germany		4	4	4	4	4	3	5	4	4	1	22
WuXi AppTec	19,904	603259	China		3	4	4	3	4	4	4	4	5	3	23
Lilly	731,874	LLY	USA		4	5	3	5	2	4	4	5	4	1	24
Novo Nordisk	448,409	NOVO B	Denmark		3	4	4	5	2	4	4	5	4	1	25
Daiichi Sankyo	64,191	4568	Japan		3	4	4	5	4	3	4	5	4	1	26
Boehringer Sohn	Unlisted	Unlisted	Germany		4	4	2	4	3	4	4	4	4	4	27
Samsung Biologics	45,613	207940	Korea		4	4	1	4	5	3	3	4	3	4	28
Bayer	28,118	BAYN	Germany		3	4	4	4	2	4	5	5	4	3	29
Vertex	107,381	VRTX	USA		3	4	5	5	1	4	3	5	4	1	30
Regeneron	106,251	REGN	USA		4	4	4	4	1	4	2	4	3	4	31
Cipla	14,091	CIPLA	India		2	4	4	3	5	3	3	3	3	2	32
Innovent Biologics	8,162	1801	China		4	4	3	4	5	2	1	4	1	3	33
Shanghai Henlius Biotech	987	2696	China		4	4	1	4	5	1	2	4	3	3	34
CSL	88,406	CSL	Australia		2	4	2	4	3	4	3	4	3	4	35
Teva	14,931	TEVA	Israel		2	3	1	3	5	2	4	3	5	4	36
Dr. Reddy's	12,262	DRREDDY	India		3	3	3	3	4	3	3	3	4	1	37
Sun Pharma	44,851	SUNPHARMA	India		3	4	1	4	3	3	2	3	4	3	38
Celltrion	30,296	68270	Korea		3	4	1	4	5	1	2	4	3	1	39
Viatris	14,108	VTRS	USA		2	4	1	4	4	2	3	4	4	1	40
Intas	Unlisted	Unlisted	India		3	4	1	4	5	1	1	3	3	1	41
UCB	23,605	UCB	Belgium		2	3	2	4	2	3	4	4	4	3	42
Lupin	8,592	LUPIN	India		2	3	1	3	5	3	3	3	3	2	43
Reliance Industries	236,530	RELIANCE	India		2	3	4	3	4	1	3	2	2	3	44
CSPC	9,875	1093	China		3	3	1	4	3	4	1	2	2	3	45
Zydus Lifesciences	12,039	ZYDUSLIFE	India		2	3	1	3	4	3	1	3	4	1	46
Biocad	Unlisted	Unlisted	Russia		3	3	1	3	4	2	2	3	3	1	47
Otsuka	8,599	4768	Japan		4	3	3	3	1	2	3	2	3	2	48
Coherus	280	CHRS	USA		4	3	1	3	4	1	1	3	2	1	49
Generium	Unlisted	Unlisted	Russia		2	3	1	2	5	3	1	2	2	1	50
Cadila	Unlisted	Unlisted	India		1	3	1	3	3	3	1	2	2	2	51
Perrigo	4,280	PRGO	Ireland		2	1	1	4	1	1	2	4	3	1	52

Source: GlobalData

Thematic leader

Thematic laggard

Key: 1 (red) implies this theme will have a negative impact on earnings over the next 12 months; 3 (amber) implies a neutral impact; and 5 (green) a positive impact. See the methodology section at the back of this report for an explanation of our research methodology.

Source: GlobalData

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Valuation screen

Our valuation screen ranks our universe of companies within a sector based on selected valuation metrics

Drug development

(52 companies)			Weighting	Valuation Screen 25%	20%	15%	20%	20%	100%
Company	MKT CAP (US$ M)	Ticker	Country	EV/EBITDA	EV/Sales	Div yield %	Net Debt (Cash)/ Market Value %	FCF yield %	Valuation Ranking
CSPC	8,880	1093	China	6.0	1.7	3.3	-26.6	7.7	1
Astellas Pharma	19,277	4503	Japan	11.6	1.8	3.5	-9.6	8.3	2
Otsuka	8,394	4768	Japan	14.8	1.1	1.9	-19.7	4.9	3
Bayer	28,395	BAYN	Germany	5.5	1.2	9.2	119.3	9.1	4
Sanofi	121,831	SAN	France	9.6	2.6	4.0	6.1	6.5	5
Bristol Myers Squibb	107,743	BMY	USA	7.1	3.0	4.4	23.6	11.7	6
Viatris	14,643	VTRS	USA	9.1	2.1	3.9	115.3	15.9	7
GSK	90,220	GSK	UK	9.2	2.7	3.2	16.8	6.3	8
Gilead Sciences	91,764	GILD	USA	10.6	4.0	4.2	18.0	8.1	9
Takeda	46,235	4502	Japan	9.0	2.7	4.0	49.7	4.9	10
Perrigo	4,023	PRGO	Ireland	14.3	1.6	3.7	81.1	7.6	11
Roche	219,757	ROG	Switzerland	11.7	3.7	4.1	10.0	2.7	12
Novartis	225,226	NOVN	Switzerland	13.3	5.1	3.2	4.6	5.2	13
Dr. Reddy's	12,712	DRREDDY	India	15.5	4.1	0.5	-5.1	3.8	14
Merck	74,527	MRK	Germany	11.7	3.4	0.4	10.7	3.6	15
WuXi AppTec	21,078	603259	China	14.0	3.8	1.1	-8.1	0.4	16
Johnson & Johnson	382,681	JNJ	USA	17.3	4.6	3.1	0.5	4.8	17
AbbVie	318,972	ABBV	USA	17.0	6.7	3.3	14.5	6.9	18
AstraZeneca	201,942	AZN	UK	16.5	4.9	2.2	10.4	3.3	19
Reliance Industries	241,570	RELIANCE	India	16.0	2.6	0.3	2.8	-1.4	20
Amgen	146,231	AMGN	USA	16.6	7.1	3.1	36.5	5.0	21
Pfizer	151,277	PFE	USA	39.3	3.6	6.1	29.0	3.2	22
UCB	23,334	UCB	Belgium	18.0	4.4	1.2	8.6	2.1	23
Cipla	14,455	CIPLA	India	23.5	5.0	0.3	-5.1	1.7	24
Teva	14,877	TEVA	Israel	20.2	2.0		111.6	5.7	25
Regeneron	106,832	REGN	USA	22.1	7.5		-12.7	3.4	26
Biogen	31,886	BIIB	USA	17.9	3.8		16.1	3.9	27
Charles River	13,878	CRL	USA	15.5	4.0		15.4	2.6	28
Zydus Lifesciences	11,935	ZYDUSLIFE	India	34.0	5.9	0.3	-1.2	1.7	29
Novo Nordisk	459,409	NOVO B	Denmark	28.2	13.6	1.0	-0.1	2.2	30
Vertex	106,046	VRTX	USA	23.7	9.7		-12.6	3.1	31
Sun Pharma	46,506	SUNPHARMA	India	32.7	8.7	0.7	-3.6	0.9	32
Merck & Co	314,023	MRK	USA	60.5	5.7	2.4	8.4	2.9	33
IQVIA	46,934	IQV	USA	19.2	4.0		25.9	3.2	34
Daiichi Sankyo	62,739	4568	Japan	48.2	7.0	0.6	-5.8	0.5	35
Thermo Fisher Scientific	227,895	TMO	USA	24.8	5.9	0.2	11.8	3.0	36
CSL	88,550	CSL	Australia	26.0	7.6	1.2	11.9	1.0	37
Lupin	9,184	LUPIN	India	44.8	4.7	0.2	3.6	0.5	38
Lonza	39,275	LONN	Switzerland	35.5	5.3	0.8	3.3	-0.9	39
Samsung Biologics	42,581	207940	Korea	35.1	15.3		-0.3	1.0	40
Celltrion	29,024	68270	Korea	45.1	17.1	0.3	0.3	-0.8	41
Lilly	741,280	LLY	USA	95.6	22.4	0.5	2.6	-0.4	42
Catalent	10,186	CTLT	USA	57.0	3.5		44.9	-3.2	43
Innovent Biologics	7,980	1801	China	-29.9	11.5		-9.9	-5.7	44
Shanghai Henlius Biotech	951	2696	China	-31.2	3.0		41.4	-5.6	45
Coherus	246	CHRS	USA	-2.0	2.5		114.6	-98.8	46
Biocad	Unlisted	Unlisted	Russia						47
Boehringer Sohn	Unlisted	Unlisted	Germany						48
Cadila	Unlisted	Unlisted	India						49
Generium	Unlisted	Unlisted	Russia						50
Intas	Unlisted	Unlisted	India						51
Parexel	Unlisted	Unlisted	USA						52
Median				15.8	3.9	0.6	4.1	2.8	
Mean				18.5	4.9	1.6	16.3	1.0	

Cheap

Expensive

Source: GlobalData

Key: Green denotes that the company is cheap (15% more attractively priced than the median value for the sector) relative to its global peers; amber denotes it is within 15% of the sector median value; and red denotes that it is expensive relative to its global peers. Private companies are shown at the bottom of these rankings by default because they do not have a publicly listed market price. See the methodology section at the back of this report for an explanation of our research methodology.

Source: GlobalData

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Risk screen

Our risk screen ranks companies within a particular sector based on overall investment risk

Pharma

(52 companies)

Company	MKT CAP (US$ M)	Ticker	Country	Weighting	Risk Screen				
					40%	30%	15%	15%	100%
					Operational Risk	Financial Risk	Industry Risk	Country Risk	Risk Ranking
Vertex	109,530	VRTX	USA		4	4	4	5	1
Regeneron	106,600	REGN	USA		4	4	4	5	2
Seagen	Unlisted	Unlisted	USA		4	4	4	5	3
WuXi AppTec	24,195	603259	China		4	3	4	5	4
Charles River	13,295	CRL	USA		4	3	4	5	5
Roche	215,524	ROG	Switzerland		4	3	4	5	6
CSPC	9,077	1093	China		3	4	3	4	7
Johnson & Johnson	385,017	JNJ	USA		4	3	4	4	8
Jiangsu Hengrui Medicine	38,916	600276	China		3	4	4	4	9
Zhifei Biological	18,153	300122	China		4	3	4	4	10
Lonza	39,068	LONN	Switzerland		4	3	4	4	11
Parexel	Unlisted	Unlisted	USA		3	4	5	5	12
Novo Nordisk	438,917	NOVO B	Denmark		4	4	4	4	13
Biogen	32,128	BIIB	USA		4	3	4	5	14
Daiichi Sankyo	63,582	4568	Japan		3	4	4	5	15
Celltrion	28,860	68270	Korea		3	3	4	5	16
Bristol Myers Squibb	102,970	BMY	USA		4	3	4	5	17
Gilead Sciences	90,007	GILD	USA		4	3	4	5	18
AbbVie	312,754	ABBV	USA		4	2	4	5	19
Novartis	232,886	NOVN	Switzerland		4	3	4	4	20
Lilly	752,796	LLY	USA		4	3	4	5	21
Coherus	253	CHRS	USA		3	3	4	5	22
PPD	Unlisted	Unlisted	USA		3	3	4	5	23
Sanofi	119,188	SAN	France		3	3	4	4	24
Pfizer	146,195	PFE	USA		4	2	4	4	25
Merck & Co	314,175	MRK	USA		4	2	4	4	26
Dr. Reddy's	12,734	DRREDDY	India		3	3	4	4	27
Patheon	Unlisted	Unlisted	Netherlands		3	3	4	5	28
CSL	88,070	CSL	Australia		3	3	4	4	29
Amgen	149,730	AMGN	USA		4	2	4	4	30
Zydus Lifesciences	11,562	ZYDUSLIFE	India		3	3	4	4	31
Sun Pharma	44,954	SUNPHARMA	India		3	3	4	4	32
BASF	45,628	BAS	Germany		3	3	3	4	33
Cipla	14,341	CIPLA	India		3	3	4	3	34
Innovent Biologics	8,643	1801	China		3	2	4	4	35
Catalent	10,293	CTLT	USA		3	2	4	5	36
Reliance Industries	246,221	RELIANCE	India		4	2	3	3	37
GSK	87,135	GSK	UK		3	2	3	4	38
AstraZeneca	197,004	AZN	UK		3	2	4	4	39
Lupin	9,184	LUPIN	India		3	2	4	4	40
Bayer	29,942	BAYN	Germany		3	2	3	4	41
Viatris	14,678	VTRS	USA		3	2	4	5	42
Cadila	Unlisted	Unlisted	India		3	3	4	3	43
Shanghai Henlius Biotech	962	2696	China		3	2	4	4	44
Biocad	Unlisted	Unlisted	Russia		3	3	4	2	45
Teva	15,216	TEVA	Israel		3	2	4	4	46
Takeda	46,067	4502	Japan		3	2	4	5	47
Perrigo	3,555	PRGO	Ireland		3	2	4	5	48
Intas	Unlisted	Unlisted	India		3	3	4	3	49
IQVIA	45,658	IQV	USA		4	2	3	3	50
Samsung Biologics	41,404	207940	Korea		2	2	4	5	51
Generium	Unlisted	Unlisted	Russia		3	3	4	2	52

Key: Green denotes low risk; amber denotes medium risk; red denotes high risk. See the methodology section at the back of this report for an explanation of our research methodology.

Source: GlobalData

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Medical devices sector scorecard

Who's who

Who does what in the medical devices space?

Medical Devices
(34 companies)

Company	Ticker	Sector	MKT CAP (US$ M)	Country	Description
3M	MMM	Medical Equipment	50,539	USA	Technology company that creates electronic devices and products
Abbott	ABT	Medical Equipment	208,292	USA	Designs, manufactures and markets medical products relational to orthopedic and surgical products
Agilent Tech	A	Measurement equipment	41,864	USA	Manufacturer of bioanalytical and measurement systems
Alphabet	GOOGL	Internet ecosystems	1,662,761	USA	Internet ecosystem monetised by advertising, primarily through the Google search engine
Apple	AAPL	Mobile phones	2,703,873	USA	Internet ecosystem monetised by the sale of proprietary hardware (smartphones and computers)
Baxter	BAX	Medical Supplies	21,583	USA	Offers diagnostic services for human infusion, respiratory therapies, ultrasound and echo cardiography
Becton Dickinson	BDX	Medical Equipment	68,080	USA	Manufactures eyecare products
Biotronik	Unlisted	Medical equipment	Unlisted	Germany	Biomedical technology company
Boston Scientific	BSX	Medical Equipment	98,926	USA	Provide medical tech for imaging, lab diagnostics and reading solutions for health care applications
Coloplast	COLO B	Medical Supplies	28,517	Denmark	Provides diagnostic, detection and information systems for veterinary food and water testing applications
Danaher	DHR	Industrial conglomerate	189,504	USA	Manufacturer of medical, professional, commercial and industrial products.
DexCom	DXCM	Medical Supplies	47,149	USA	Develops and markets advanced medical devices such as orthopaedics, endoscopy and wound management
Edwards Lifesciences	EW	Medical Supplies	52,325	USA	Develops, manufactures and markets products for chronic acute medical conditions
Garmin	GRMN	Wearable tech	26,786	Switzerland	Manufacturer of navigation and comms devices - esp. GPS
GE HealthCare	GEHC	MedTech	42,225	USA	Medical technology company spun off from General Electric in 2023
Getinge	GETI B	Medical Equipment	4,987	Sweden	Produces and sells medical products for the treatment of neurological disorders
Illumina	ILMN	MedTech	21,881	USA	Manufacturer of life science equipment used for gene sequencing
Intuitive Surgical	ISRG	Surgical robots	141,138	USA	Manufacturer of surgical robotic systems
Johnson & Johnson	JNJ	Pharmaceuticals	385,017	USA	Researches, develops, manufactures and sells pharmaceutical products, medical devices and consumer products.
Medtronic	MDT	MedTech	112,945	Ireland	Developer of therapeutic and diagnostic medical products
MicroPort	853	Medical equipment	1,739	China	Medical device developer and manufacturer
Nihon Kohden	6849	Medical Equipment	2,433	Japan	Develops, manufactures and sells medical equipment
Omron	6645	Robotic components	7,777	Japan	Manufacturer of electronic components, equipment and systems used for factory automation.
Philips	PHIA	MedTech	18,546	Netherlands	Manufacturer of medical systems and lighting products (sold its TV and consumer businesses in 2013)
Qiagen	QIA	Medical Supplies	9,729	Netherlands	Global provider of sample to insight solutions to transform biological materials into valuable molecular sights
Quest Diagnostics	DGX	Medical Equipment	13,873	USA	Provider of diagnostic information services to patients and physicians
Roche	ROG	Medical Supplies	215,524	Switzerland	Biotechnology company that develops drugs and diagnostics to treat major diseases.
Siemens Healthineers	SHL	Health Care Providers	68,783	Germany	Provider of medical solutions
Smith & Nephew	SN.	Medical Equipment	11,525	UK	Develops, produces and sells personal care products
Stryker	SYK	Surgical robots	135,317	USA	Manufacturer of robotic orthopedic solutions
Teleflex	TFX	Medical Supplies	10,588	USA	Develops, produces and sells dental implants that are implantable in the jaw
Terumo	4543	Medical Equipment	29,751	Japan	Manufactures products for ostomy, incontinence, mastectomy, wound healing and skin care
Thermo Fisher Scientific	TMO	Medical Equipment	221,787	USA	Develop therapeutic and diagnostic medical products for heart and movement conditions
Zimmer Biomet	ZBH	Medical Equipment	25,740	USA	Develop, manufacture and market specialty surgical products including navigation

Source: GlobalData

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Thematic screen

Our thematic screen ranks companies based on overall leadership in the 10 themes that matter most to their industry, generating a leading indicator of future performance

Medical Devices
(34 companies)

Company	MKT CAP (US$ M)	Ticker	Country	Weighting	Artificial Intelligence 20%	Wearable Tech 10%	Cybersecurity 10%	Mobile Health 5%	Remote Patient Monitoring 10%	Internet of Things 15%	ESG 5%	Digital Health 10%	Cloud 10%	Augmented Reality 5%	Thematic Ranking 100%
Medtronic	110,754	MDT	Ireland		5	4	4	5	5	5	4	5	3	5	1
Apple	2,646,275	AAPL	USA		5	4	4	5	5	5	2	4	4	5	2
Johnson & Johnson	375,324	JNJ	USA		5	4	4	4	4	5	4	4	4	5	3
Abbott	193,490	ABT	USA		4	5	3	5	5	5	3	5	4	4	4
GE HealthCare	41,529	GEHC	USA		5	4	3	3	5	4	5	4	5	5	5
Roche	207,629	ROG	Switzerland		4	4	4	4	4	5	5	4	5	4	6
Philips	18,763	PHIA	Netherlands		4	3	4	4	5	4	4	4	5	5	7
Alphabet	1,841,576	GOOGL	USA		5	4	5	5	4	2	3	4	5	4	8
Siemens Healthineers	67,694	SHL	Germany		4	3	3	4	4	5	3	4	5	4	9
DexCom	51,092	DXCM	USA		4	4	3	5	5	5	3	4	4	1	10
Baxter	21,334	BAX	USA		4	4	3	4	5	5	3	3	4	3	11
Boston Scientific	99,117	BSX	USA		4	4	3	4	4	4	3	4	4	5	12
3M	59,691	MMM	USA		5	4	3	4	3	3	5	3	5	4	13
Nihon Kohden	2,426	6849	Japan		5	4	3	2	4	4	3	3	3	5	14
Zimmer Biomet	26,060	ZBH	USA		5	4	1	4	5	3	3	4	3	5	15
Becton Dickinson	69,805	BDX	USA		4	4	3	1	4	4	3	3	5	4	16
Omron	7,824	6645	Japan		4	3	2	4	5	5	3	4	2	4	17
Intuitive Surgical	138,930	ISRG	USA		4	3	3	3	3	4	3	4	5	3	18
Stryker	134,427	SYK	USA		4	4	3	2	3	4	2	4	4	5	19
Thermo Fisher Scientific	222,736	TMO	USA		4	2	3	3	3	4	3	3	4	5	20
Illumina	21,841	ILMN	USA		4	3	3	3	3	3	3	3	5	1	21
Smith & Nephew	11,546	SN.	UK		4	4	3	3	3	2	3	4	2	4	22
Agilent Tech	43,589	A	USA		4	3	3	3	3	3	3	2	3	4	23
Qiagen	9,729	QIA	Netherlands		4	3	2	3	3	3	3	3	4	2	24
Garmin	28,410	GRMN	Switzerland		1	5	2	4	4	4	3	3	4	3	25
Biotronik	Unlisted	Unlisted	Germany		2	4	2	4	4	5	3	4	1	1	26
Quest Diagnostics	14,262	DGX	USA		4	3	1	2	3	3	4	2	3	3	27
Getinge	5,020	GETI B	Sweden		2	2	1	2	2	5	3	3	4	5	28
Danaher	187,966	DHR	USA		2	2	3	3	3	3	3	2	3	3	29
Edwards Lifesciences	55,945	EW	USA		1	3	2	2	2	4	4	2	3	5	30
Teleflex	10,559	TFX	USA		1	3	3	1	3	3	3	3	2	1	31
MicroPort	1,623	853	China		1	3	1	1	2	4	3	3	2	4	32
Coloplast	28,682	COLO B	Denmark		1	3	1	3	3	3	4	2	2	3	33
Terumo	28,545	4543	Japan		1	3	1	1	2	3	3	2	2	3	34

Thematic Screen

Source: GlobalData

Key: 1 (red) implies this theme will have a negative impact on earnings over the next 12 months; 3 (amber) implies a neutral impact; and 5 (green) a positive impact. See the methodology section at the back of this report for an explanation of our research methodology.

Source: GlobalData

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Valuation screen

Our valuation screen ranks our universe of companies within a sector based on selected valuation metrics

Medical Devices
(34 companies)

Company	MKT CAP (US$ M)	Ticker	Country	Weighting	Valuation Screen 25% EV/Sales	20% P/E	15% Net margin %	20% P/Book	20% FCF yield %	100% Valuation Ranking
Baxter	21,583	BAX	USA		2.2	8.1	17.9	2.6	4.8	1
Quest Diagnostics	13,873	DGX	USA		2.0	16.2	9.2	2.2	6.2	2
Johnson & Johnson	385,017	JNJ	USA		4.6	11.0	41.3	5.6	4.7	3
Getinge	4,987	GETI B	Sweden		1.8	21.4	7.6	1.7	3.1	4
Garmin	26,786	GRMN	Switzerland		4.7	20.8	24.7	3.8	4.4	5
Omron	7,777	6645	Japan		1.2	15.8	8.4	1.6	0.7	6
Zimmer Biomet	25,740	ZBH	USA		4.2	25.1	13.8	2.1	3.5	7
Philips	18,546	PHIA	Netherlands		1.2	-36.7	-2.6	1.4	9.5	8
Medtronic	112,945	MDT	Ireland		4.1	30.1	12.0	2.2	4.1	9
Teleflex	10,588	TFX	USA		4.1	29.7	12.0	2.4	4.0	10
Alphabet	1,662,761	GOOGL	USA		5.1	22.5	24.0	5.9	4.2	11
Nihon Kohden	2,433	6849	Japan		1.6	21.3	8.3	2.2	-2.9	12
Roche	215,524	ROG	Switzerland		3.7	16.6	19.6	6.5	2.7	13
GE HealthCare	42,225	GEHC	USA		2.5	26.9	8.0	5.9	4.1	14
Qiagen	9,729	QIA	Netherlands		5.2	28.5	17.4	2.6	3.0	15
Smith & Nephew	11,525	SN.	UK		2.6	43.8	4.7	2.2	1.6	16
Apple	2,703,873	AAPL	USA		7.2	27.9	25.3	43.5	3.7	17
Becton Dickinson	68,080	BDX	USA		4.3	45.9	7.7	2.6	3.1	18
Siemens Healthineers	68,783	SHL	Germany		3.6	42.0	7.0	3.5	2.0	19
Agilent Tech	41,864	A	USA		6.3	33.8	18.1	7.2	3.5	20
Thermo Fisher Scientific	221,787	TMO	USA		5.8	37.0	14.0	4.7	3.1	21
3M	50,539	MMM	USA		1.9	-7.2	-21.4	10.5	10.0	22
Danaher	189,504	DHR	USA		8.5	39.8	19.9	3.5	3.1	23
Abbott	208,292	ABT	USA		5.4	36.4	14.3	5.4	2.4	24
MicroPort	1,739	853	China		3.1	-4.0	-51.9	1.5	-33.3	25
Stryker	135,317	SYK	USA		7.1	42.8	15.4	7.3	2.3	26
Edwards Lifesciences	52,325	EW	USA		8.6	37.3	23.4	7.9	1.2	27
Terumo	29,751	4543	Japan		5.5	50.0	10.9	4.0	1.0	28
Boston Scientific	98,926	BSX	USA		7.5	62.1	11.2	5.1	1.8	29
Coloplast	28,517	COLO B	Denmark		8.8	40.9	19.5	11.3	1.5	30
Illumina	21,881	ILMN	USA		5.0	-18.8	-25.8	3.8	1.3	31
Intuitive Surgical	141,138	ISRG	USA		19.1	78.5	25.2	10.6	0.5	32
DexCom	47,149	DXCM	USA		13.0	87.1	14.9	22.8	1.1	33
Biotronik	Unlisted	Unlisted	Germany							34
Median					**4.4**	**28.2**	**12.9**	**3.8**	**3.0**	
Mean					**5.0**	**27.4**	**10.4**	**6.1**	**1.9**	

Source: GlobalData

Cheap

Expensive

Key: Green denotes that the company is cheap (15% more attractively priced than the median value for the sector) relative to its global peers; amber denotes it is within 15% of the sector median value; and red denotes that it is expensive relative to its global peers. Private companies are shown at the bottom of these rankings by default because they do not have a publicly listed market price. See the methodology section at the back of this report for an explanation of our research methodology.

Source: GlobalData

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Risk screen

Our risk screen ranks companies within a particular sector based on overall investment risk

Medical Devices

(34 companies)

Company	MKT CAP (US$ M)	Ticker	Country	Weighting	Risk Screen 40% Operational Risk	30% Financial Risk	15% Industry Risk	15% Country Risk	100% Risk Ranking
Edwards Lifesciences	52,325	EW	USA		4	4	4	5	1
Intuitive Surgical	141,138	ISRG	USA		4	4	4	4	2
Roche	215,524	ROG	Switzerland		4	3	4	5	3
Johnson & Johnson	385,017	JNJ	USA		4	3	4	4	4
Apple	2,703,873	AAPL	USA		5	3	3	4	5
Quest Diagnostics	13,873	DGX	USA		4	3	3	5	6
Alphabet	1,662,761	GOOGL	USA		4	4	3	4	7
Thermo Fisher Scientific	221,787	TMO	USA		4	3	4	4	8
Abbott	208,292	ABT	USA		4	3	4	4	9
Omron	7,777	6645	Japan		3	4	3	4	10
Siemens Healthineers	68,783	SHL	Germany		4	3	4	3	11
Danaher	189,504	DHR	USA		3	3	4	4	12
Coloplast	28,517	COLO B	Denmark		3	3	4	4	13
Medtronic	112,945	MDT	Ireland		4	3	4	4	14
Nihon Kohden	2,433	6849	Japan		2	4	4	4	15
Terumo	29,751	4543	Japan		3	3	4	4	16
Stryker	135,317	SYK	USA		4	2	4	5	17
3M	50,539	MMM	USA		4	3	3	3	18
Agilent Tech	41,864	A	USA		3	3	4	4	19
Qiagen	9,729	QIA	Netherlands		4	3	4	4	20
DexCom	47,149	DXCM	USA		3	3	4	5	21
Biotronik	Unlisted	Unlisted	Germany		3	3	4	5	22
Philips	18,546	PHIA	Netherlands		3	3	4	4	23
Boston Scientific	98,926	BSX	USA		4	2	4	4	24
Baxter	21,583	BAX	USA		3	3	4	3	25
Illumina	21,881	ILMN	USA		3	3	4	3	26
Becton Dickinson	68,080	BDX	USA		3	2	4	4	27
GE HealthCare	42,225	GEHC	USA		3	2	4	5	28
Getinge	4,987	GETI B	Sweden		3	3	4	3	29
Smith & Nephew	11,525	SN.	UK		3	2	4	4	30
Garmin	26,786	GRMN	Switzerland		3	4	3	3	31
Teleflex	10,588	TFX	USA		3	2	4	3	32
Zimmer Biomet	25,740	ZBH	USA		3	2	4	3	33
MicroPort	1,739	853	China		2	2	4	4	34

Key: Green denotes low risk; amber denotes medium risk; red denotes high risk. See the methodology section at the back of this report for an explanation of our research methodology.

Source: GlobalData

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Glossary

Term	Definition
5G	5G refers to the fifth generation of cellular technology standards that will be based on IMT2020 standards, under development by the 3GPP. The term '5G' does not explicitly refer to any particular technology or standard and is therefore a loose term that can be used and interpreted in multiple different ways, typically for marketing purposes.
Accelerometer	An instrument used to measure the acceleration of a moving or vibrating body.
AI chips	Chips that are designed to perform AI tasks more efficiently, thereby reducing the time taken to, for example, process the large data sets associated with machine learning. They are often referred to as AI accelerators and come in a variety of forms, including graphics processing units (GPUs), field programmable gate arrays (FPGAs), and application-specific integrated circuits (ASICs).
Algorithm	A finite sequence of well-defined instructions implemented by a computer to solve a class of problems or to perform a computation.
Anamorphosis	An optical illusion to distort an image so it only appears in its natural form under certain conditions, such as when viewed from an angle or reflected in a curved mirror.
Application programming interface (API)	A set of defined methods of communication between programs so that information can be exchanged without the need to access the core of either program.
Application-specific integrated circuits (ASICs)	Silicon chips designed to do a single specific task.
AR Cloud	A persistent 3D digital copy of the real world.
Artificial intelligence (AI)	Refers to software-based systems that use data inputs to make decisions on their own.
Augmented reality (AR)	Technology that allows the user to see the real world overlaid with a layer of digital content such as sensor-based data, location-based data, sound, video, or graphics.
Battery	A container consisting of one or more electrochemical cells in which chemical energy is converted into electricity. Batteries are used as a source of power.
Central processing unit (CPU)	The unit which performs most of the processing inside a computer. It carries out all the logical and arithmetical operations.
Collaboration tools	Software tools that aim to boost productivity by helping teams work together more efficiently. They incorporate services like instant messaging, file sharing, and video conferencing.
Computer vision	One of the key AI technologies, this category includes all technology that attempts to capture and interpret images or videos in a meaningful or useful way. There are four main categories of computer vision, namely image recognition, object recognition, video recognition, and machine vision.

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Term	Definition
Content delivery network (CDN)	A geographically distributed network of servers that store cached meta content on edge servers and act as gateways for bi-directional data transfer between the servers and users, enabling faster access to high-quality data.
Conversational platforms	Tools that employ a variety of technologies—including speech recognition, natural language processing (NLP), contextual awareness, and machine learning—to enable human-like interaction with computer systems.
Data privacy	The way in which customers' information is handled and shared by a company based on its importance, individual's consent, or regulatory obligations.
Deep learning	A field of machine learning that is built using artificial neural networks that model the way neurons in the human brain talk to each other.
Digital twins	Software representations of assets and processes that are used to understand, predict, and optimize performance to achieve improved business outcomes. Digital twins typically consist of three components: a data model, a set of analytics or algorithms, and knowledge.
Ecommerce	The buying and selling of goods and services over an electronic network (typically the internet).
Extended reality (XR)	An umbrella term incorporating augmented reality (AR), virtual reality (VR), mixed reality (MR), and everything in between.
Eye tracking	A sensor-driven deep learning technology that enables the development of a human-to-machine interface by measuring the user’s point of gaze (POG) and eye movement.
Facial recognition	A software capable of identifying or verifying a person by comparing and analyzing patterns based on the person's facial contours.
Field of view (FOV)	The observable area a person can see through their eyes or via an optical device.
Field programmable gate array (FPGA)	Chips that can be configured by the user. They contain a large pool of logic gates that can be ordered and combined in an almost infinite number of designs. FPGAs can be programmed to run a specific algorithm for a particular task and then reprogrammed for another purpose once the task is complete.
Foveated rendering	A graphics-rendering technique that uses an eye tracker to reduce the rendering workload by reducing the quality of the image seen in the user's peripheral vision.
Frame rate	Frame rate—measured in frames per second—refers to the frequency at which a GPU renders successive images on a device’s display.
Future of work	Refers to the changes impacting employment resulting from the increased use of technology.
Game publisher	Publishers publish video games that have either been developed internally or externally by a third-party video game developer. Traditionally (as with book publishers), video game publishers are responsible for their product's manufacturing and marketing, including market research and all aspects of advertising.

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Term	Definition
General Data Protection Regulation (GDPR)	A regulation that came into force across the EU in May 2018, giving consumers certain rights and protections over the data that organizations hold on them, including the right to data portability.
Graphics processing unit (GPU)	A programmable logic chip specialized for display functions. Modern GPUs can manipulate computer graphics and provide image processing very efficiently. They are also able to take large data sets and perform the same operation repeatedly and at high speed, which has made them fundamental to the development of AI technologies.
Group of Seven (G7)	An intergovernmental, political, and economic forum, comprised of seven of the world's advanced economies, including Canada, France, Germany, Italy, Japan, the UK, and the US. The European Union (EU) is technically the eighth member of the group, holding all the privileges and obligations of membership but without the right to host or chair a summit.
Gyroscope	A device used for measuring or maintaining orientation and angular velocity.
Haptics	Technology that stimulates the senses of touch and motion, to reproduce sensations that would be felt by a user interacting directly with a physical object.
Head-mounted display (HMD)	A type of computer display device or monitor that is worn on the head or is built in as part of a helmet.
Latency	The time it takes a data packet to transit from point A to point B.
Light Detection and Ranging (LiDAR)	A remote sensing method that uses light in the form of a pulsed laser to measure ranges (variable distances) to the Earth. These light pulses—combined with other data recorded by the airborne system — generate precise, three-dimensional information about the shape of the Earth and its surface characteristics.
Light-emitting diode (LED)	A semiconductor light source that emits light when electric current flows through it.
Lithium-ion battery	A type of rechargeable battery, commonly used in laptops, smartphones, electric vehicles (EVs), and energy storage packs.
Machine learning	An application of AI that gives computer systems the ability to learn and improve from data without being explicitly programmed.
Machine vision	Machine vision (MV) applies computer vision to industrial and manufacturing functions. The technology is a combination of software and hardware that provide operational control to devices to execute functions such as capturing and processing images and measuring various characteristics required for decision-making.
Marker-based AR	A type of AR technology that utilizes smartphone cameras to recognize visual markers (such as an image or a QR code) to initiate three-dimensional animated content on the screen.
Marker-less AR	A type of AR technology that utilizes a smartphone camera, GPS, compass, gyroscope, and accelerometer to deliver pre-developed, relevant virtual content on the screen, based on simultaneous localization and mapping (SLAM) algorithms.

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Term	Definition
Metaverse	The metaverse is a virtual world where users share experiences and interact in real time within simulated scenarios.
Micro-electromechanical systems (MEMS)	Miniaturized mechanical and electro-mechanical elements (typically devices and structures) that are made using the techniques of microfabrication.
Microphone	A device that captures audio by converting sound waves into an electrical signal.
Microprocessor	An integrated circuit that incorporates all the functions of a central processing unit.
Mixed reality (MR)	A hybrid technology that enables the user to see and interact with virtual objects integrated into the real world.
Motion tracking	The process of measuring the movement of an object in 2D or 3D space.
Natural language processing (NLP)	A field of AI concerned with enabling computers to analyze, understand, and derive meaning from human language (both text and speech).
Neural networks (NNs)	Inspired by the structure of the brain, NNs are one of the main tools used in machine learning. An artificial neural network has anywhere from dozens to millions of artificial neurons - called units - arranged in a series of layers. The input layer receives various forms of information from the outside world. This is the data that the network aims to process or learn about. From the input unit, the data goes through one or more hidden units with the aim of transforming the input into something the output unit can use.
Object detection	An object detection software identifies real-world objects (such as humans, buildings, or cars) in digital images and videos. It is powered by algorithms that follow the same process of image classification described above.
Operating system (OS)	Software that supports a computer's basic functions, such as scheduling tasks and managing peripherals. Examples include Microsoft Windows, Apple's iOS, and Google's Android.
Organic light-emitting diode (OLED)	A light-emitting diode (LED) in which the emissive electroluminescent layer is a film of organic compound that emits light in response to an electric current.
Projection-based AR	A type of AR that works by projecting images, which can be computer generated or photographic and either pre-rendered or generated in real-time, onto real-world surfaces.
Proximity sensors	A sensor able to detect the presence of nearby objects without any physical contact.
QR code	A type of contactless payment where a barcode is scanned from a mobile app to perform the payment.
Radio frequency (RF) chip	Integrated circuits designed to transmit or receive radio signals.
Refresh rate	The frequency with which the image on a computer monitor or similar electronic display screen is refreshed, usually expressed in hertz (Hz).

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Term	Definition
Round-trip time (RTT)	The duration in milliseconds (ms) it takes for a network request to go from a starting point to a destination and back to the starting point.
Sensor	A device that detects or measures a physical property and then responds accordingly.
Simultaneous localization and mapping (SLAM)	A technology that allows a device (such as a robot) to create a map of its surroundings and orient itself within this map in real-time.
Six degrees of freedom (6DoF)	Refers to the freedom of movement of a rigid body in three-dimensional space.
Smart glasses	Computerized eyewear with internet connections that conveys task-specific information and services in the user's field of view (FOV) or into their ears. The devices are typically worn as traditional spectacles and perform user-requested, or predefined automated, tasks using augmented reality and audio technologies.
Social media	Computer-mediated technologies that facilitate the creation and sharing of information, ideas, interests, and other forms of expression via virtual communities and networks.
Software development kit (SDK)	A collection of software used to develop applications for a specific device or operating system.
Special purpose acquisition company (SPAC)	A company that is created solely to merge or acquire another business and take it public.
Speech recognition	Methodologies and technologies that enable a machine or program to identify words and phrases in spoken language and convert them to a machine-readable format.
Streaming	A broadcasting process that allows for a multimedia file to be accessed without being downloaded first.
Superimposition-based AR	A type of AR technology that replaces the view of a physical space with a partially or entirely superimposed view of a virtual object.
System on a chip (SoC)	A microchip that contains all the components required for a given electronic system, such as a computer, on a single integrated circuit. Its components usually include a graphics processing unit (GPU), a central processing unit (CPU), and system memory.
Ultra-wideband (UWB)	A short-range wireless communication protocol to track the location of objects within less than half an inch distance.
Virtual reality (VR)	Technology that aims to immerse the user in an entirely artificial world, which has the illusion of reality. It uses special equipment such as headsets or gloves fitted with sensors to simulate a user's physical presence in a 3D environment.
Vision processing unit (VPU)	VPUs are processing units designed to run machine vision algorithms.
Source: GlobalData	

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Further Reading

GlobalData reports

Publication date	Report title
Mar 2024	Thematic Intelligence: Digital Twins (2024)
Mar 2024	Thematic Intelligence: Inflation in Medical Devices (2024)
Feb 2024	Thematic Intelligence: Patient Empowerment
Feb 2024	Thematic Intelligence: DTx in Medical (2024)
Feb 2024	Thematic Intelligence: Augmented Reality (2024)
Dec 2023	Thematic Intelligence: The State of the Biopharmaceutical Industry 2024
Dec 2023	Thematic Intelligence: Internet of Things in Healthcare 2023
Nov 2023	Thematic Intelligence: Synthetic Biology
Oct 2023	Thematic Intelligence: Digital Therapeutics
Oct 2023	Artificial Intelligence in Pharma
Oct 2023	Thematic Intelligence: Artificial Intelligence – Executive Briefing (Second Edition)
Oct 2023	Thematic Intelligence: AI in Clinical Practice – Patient Perspective 2023
Oct 2023	Thematic Research: Artificial Intelligence in Medical (2023)
Sep 2023	Thematic Research: Virtual Care and Telemedicine (2023)
Sep 2023	Thematic Research: Cloud Computing in Medical (2023)
Apr 2023	Thematic Intelligence: The Metaverse in Healthcare (2023)
Mar 2023	Thematic Intelligence: Cloud Computing in Healthcare (2023)
Feb 2023	Thematic Intelligence: Artificial Intelligence
Jan 2023	Thematic Intelligence: Global Environmental Trends in Healthcare, 2022
Dec 2022	Thematic Research: Digital Health (2022)
Oct 2022	Digital Transformation and Emerging Technology in the Healthcare Industry
Jun 2022	Thematic Research: Artificial Intelligence in Drug Discovery
Apr 2022	Thematic Intelligence: Augmented Reality in Healthcare (2022)
Dec 2021	Thematic Research: Digital Health in Immunology
Aug 2021	Thematic Research: Virtual Trials
Mar 2021	Thematic Research: Digital Health in Neurology
Source: GlobalData	

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Our Thematic Research Methodology

Companies that invest in the right themes become success stories. Those that miss the important themes in their industry end up as failures.

Viewing the world's data by themes makes it easier to make important decisions

We define a theme as any issue that keeps a senior executive awake at night. GlobalData's thematic ecosystem is a single, integrated global research platform that provides an easy-to-use framework for tracking all themes across all companies in all sectors. It has a proven track record of identifying critical themes early, enabling companies to make the right investments ahead of the competition and secure that all-important competitive advantage.

Traditional research does a poor job of picking winners and losers

The difficulty in picking tomorrow's winners and losers in any industry arises from the sheer number of technology cycles—and other themes—that are in full swing right now. Companies are impacted by multiple themes that frequently conflict with one another. What is needed is an effective methodology that reflects, understands, and reconciles these conflicts.

That is why we developed our thematic engine

At GlobalData, we have developed a unique thematic methodology for ranking all major companies in all major sectors based on their relative strength in the big themes that are impacting their industries.

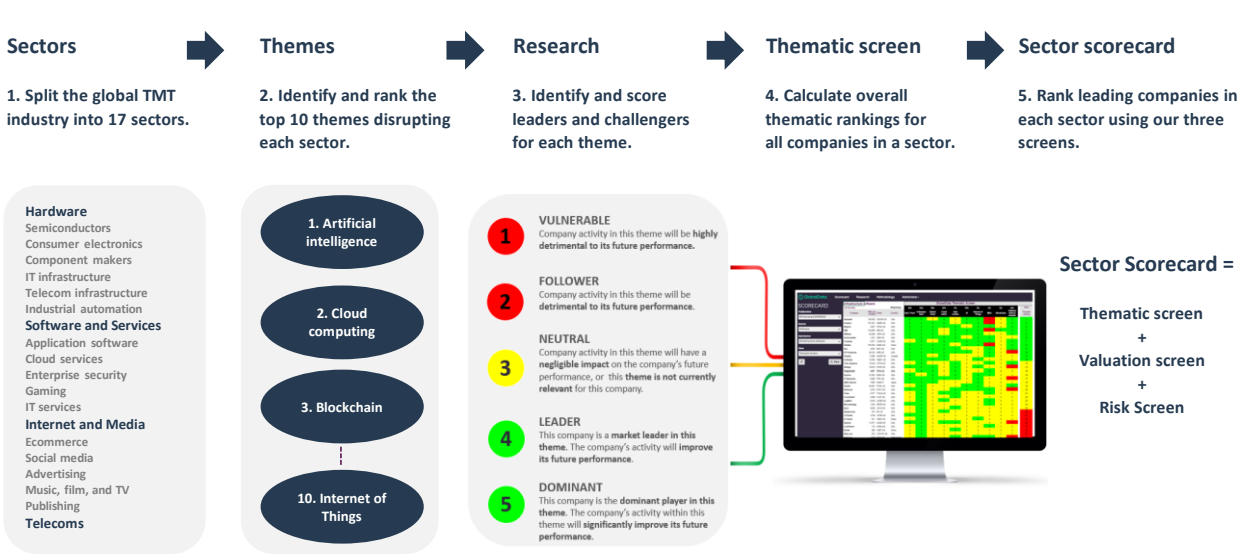
Our thematic engine tags over 180 million data items across six alternative data sets—patents, jobs, deals, filings, social media, and news—to themes. The vast datasets within our thematic engine help our analysts to produce sector scorecards that identify the companies best placed to succeed in a future filled with multiple disruptive threats.

How do we create our sector scorecards?

First, we split each industry into sectors because a different set of themes drives each sector. Taking the TMT (technology, media, and telecom) industry as an example, we split this industry into the sectors shown in the graphic below.

Our five-step approach for generating a sector scorecard

Here we use tech, media, and telecom as an example sector for illustration purposes



Source: GlobalData

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Second, we identify and rank the top 10 themes for each sector (these can be technology themes, macroeconomic themes, or industry-specific themes). Third, we publish in-depth research on specific themes, identifying the winners and losers within each theme. The problem is that companies are exposed to multiple investment themes, and specific themes' relative importance can fluctuate. So, our fourth step is to create a thematic screen for each sector to calculate overall thematic leadership rankings after taking account of all themes impacting that sector. Finally, to give a crystal-clear picture, we combine this thematic screen with our valuation and risk screens to generate a sector scorecard used to help assess overall winners and losers.

What is in our sector scorecards?

Our sector scorecards help us determine which companies are best positioned for a future filled with disruptive threats. Each sector scorecard has three screens:

- **The thematic screen** tells us who are the overall leaders in the 10 themes that matter most, based on our thematic engine.
- **The valuation screen** tells us whether publicly listed players appear cheap or expensive relative to their peers based on consensus forecasts from investment analysts.
- **The risk screen** tells us who the riskiest players in each industry are, based on our assessment of four risk categories: operational risk, financial risk, industry risk, and country risk.

How do we score companies in our thematic screen?

Our thematic screen ranks companies within a sector based on overall leadership in the 10 themes that matter most to their industry, generating a leading indicator of future earnings growth.

Thematic scores predict the future, not the past. Our thematic scores are based on our analysts' assessment of their competitive position in relation to a theme, on a scale of 1 to 5:

1	**Vulnerable**	The company's activity in this theme will be highly detrimental to its future performance.
2	**Follower**	The company's activity in this theme will be detrimental to its future performance.
3	**Neutral**	The company's activity in this theme will have a negligible impact on the company's future performance, or this theme is not currently relevant for this company.
4	**Leader**	The company is a market leader in this theme. The company's activity in this theme will improve its future performance.
5	**Dominant**	The company is a dominant player in this theme. The company's activity in this theme will significantly improve its future performance.

How do our research reports fit into our overall thematic research ecosystem?

Our thematic research ecosystem is designed to assess the impact of all major themes on the leading companies in a sector. To do this, we produce three tiers of thematic reports:

- **Single theme**: These reports offer in-depth research into a specific theme (e.g., artificial intelligence). They identify winners and losers based on thematic leadership, market position, and other factors.
- **Multi-theme**: These reports cover all themes impacting a sector and the implications for the key players in that sector.
- **Sector scorecard**: These reports identify those companies most likely to succeed in a world filled with disruptive threats. They incorporate our thematic screen to show how conflicting themes interact with one another, as well as our valuation and risk screens.

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About GlobalData

GlobalData is a leading provider of data, analytics, and insights on the world's largest industries. In an increasingly fast-moving, complex, and uncertain world, it has never been harder for organizations and decision makers to predict and navigate the future. This is why GlobalData's mission is to help our clients decode the future and profit from faster, more informed decisions. As a leading information services company, thousands of clients rely on GlobalData for trusted, timely, and actionable intelligence. Our solutions are designed to provide a daily edge to professionals within corporations, financial institutions, professional services, and government agencies.

Unique Data

We continuously update and enrich 50+ terabytes of unique data to provide an unbiased, authoritative view of the sectors, markets, and companies offering growth opportunities across the world's largest industries.

Expert Analysis

We leverage the collective expertise of over 2,000 in-house industry analysts, data scientists, and journalists, as well as a global community of industry professionals, to provide decision-makers with timely, actionable insight.

Innovative Solutions

We help you work smarter and faster by giving you access to powerful analytics and customizable workflow tools tailored to your role, alongside direct access to our expert community of analysts.

One Platform

We have a single taxonomy across all of our data assets and integrate our capabilities into a single platform – giving you easy access to a complete, dynamic, and comparable view of the world's largest industries.

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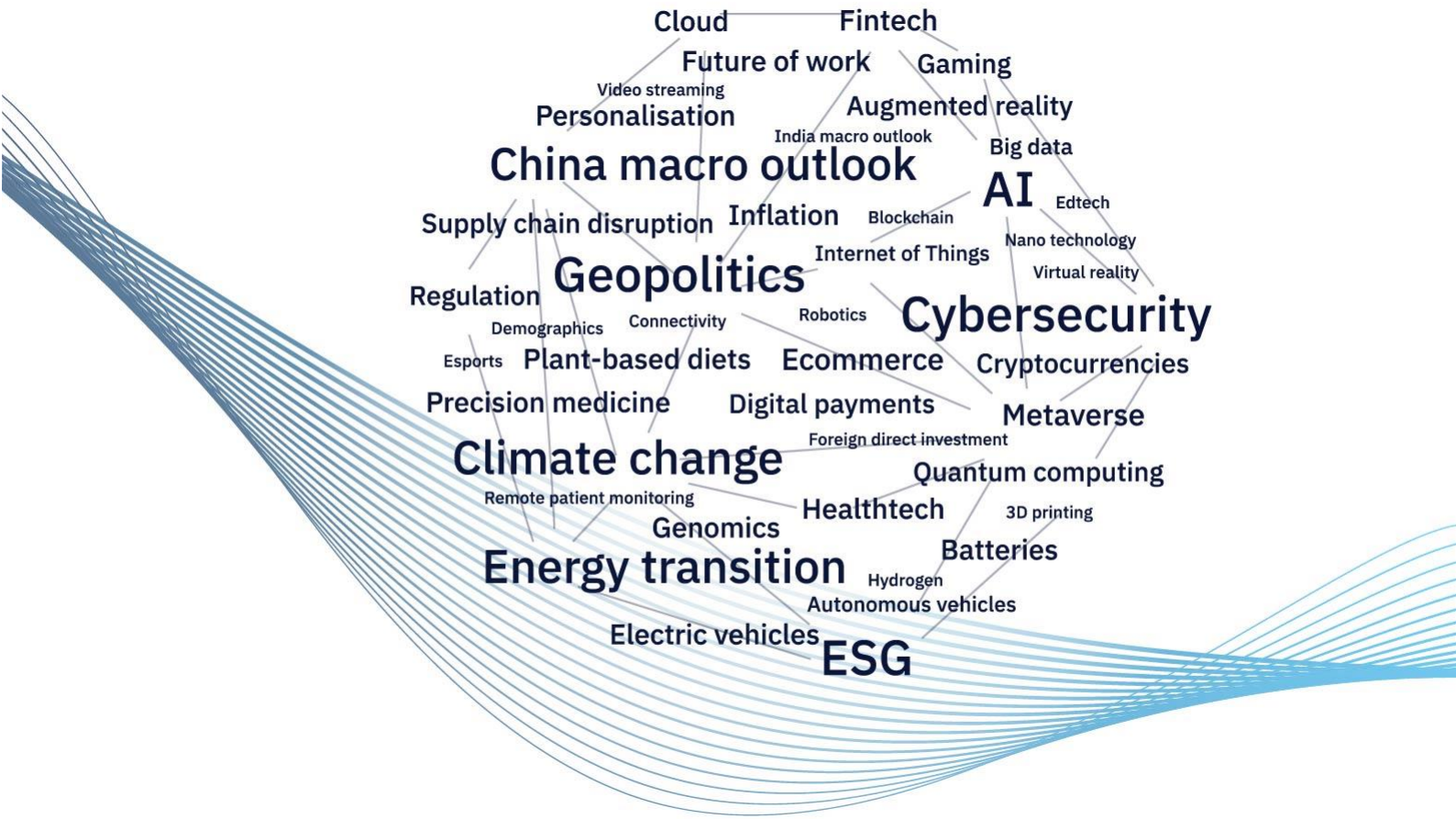

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