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Authors:
Markus Müller
Chief Investment Officer ESG &
Head of Global Chief Investment Office

Sebastian Janker
Head of Chief Investment Office EMEA

Heval Ag
Investment Officer EMEA

Long-term investment theme Digitisation: going to the next level

Key messages

01 Introduction

02 The drivers of digitisation

03 Where we are

04 Moving towards a cyber-physical world

05 Implications for investors

06 Conclusion

- Digitisation has transformed many elements of society, not only enhancing communication, innovation, and efficiency but also creating substantial privacy and environmental concerns.
- Various digitisation-related innovations enable the reliable and timely data collection that is crucial for ESG integration in business operations and transparent reporting as well as for promoting stakeholder confidence and trust.
- The integration of physical, digital information, and spatial interaction layers, which results in a more interactive and immersive reality, represents the transition to a cyber-physical world.
- For investors, digitisation provides a wide range of investment alternatives, with business activities such as cloud computing, Internet of Things (IoT), digital entertainment, and others showing substantial growth potential – although their valuations and challenges vary.

01 Introduction

Digitisation, at its core, refers to technologies that generate data and convert non-digital information into a digital format. This distinguishes it from artificial intelligence, which is centred on utilising data. Digitisation provides the foundations of the modern digital landscape.

Digitisation has already transformed many aspects of how we work and live. These include enhanced communication, digital provision of existing and new goods and services, and the ensuing digital transformation of many everyday activities and routines. Claimed benefits include enhanced accessibility, efficiency and innovation. But digitisation also poses challenges to personal privacy and the environment.

Where is digitisation leading next? There are two main trends.

First, individuals interacting with the digital world around them in a more direct way than via a computer screen – virtual reality is just one aspect of this.

Second, the digital interaction between small and large objects (from jewellery to cities) enables the digital management of how we live – and provides a “digital twin” for us to interact with.

Ultimately, this could lead to the creation of what some are calling a “cyber-physical world” – managed and interacted with digitally, possibly through seamlessly interconnected networks, on the basis that a network’s value grows in proportion to the square of its size.¹ The implications of this would be huge, both economically and socially.



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02 The drivers of digitisation

In the past, digitisation drivers have included advances in affordability, computational power and miniaturisation, and connectivity enabling the development and adoption of productivity-enhancing innovations.

Affordability. Digitisation is becoming increasingly affordable due to fundamental technological advances in computer memory, storage, and processing power. These, in turn, are the results of advances in manufacturing materials and processes, miniaturisation, economies of scale, innovation, and competition. Sharp falls in the cost of SSD storage and memory (down 92% and 43% USD per terabyte respectively during the last decade) are examples of this (see Figure 1).²

Computational power and miniaturisation. In parallel, the computational power of microprocessors has improved tremendously. The number of transistors on a single microprocessor now averages around 60bn – compared to just over 2,000 five decades ago (see Figure 1).³ Whereas the quantity of transistors has increased substantially, the size of semiconductors has shrunk considerably since 1971, falling from 10,000 nm⁴ to a negligible 3 nm by 2022.^{5,6} Miniaturisation has allowed the development of smaller and more powerful devices, which has enabled the creation of new applications and services.

Connectivity. The evolution of connectivity technology, from wired connections to modern fibre-optic and wireless technologies (such as Wi-Fi, cellular data networks, and satellite-based systems), has transformed how people and businesses interact.

Productivity. The development and adoption of innovations enabled by these advancements has generated productivity gains – especially for organisations that have had greater access to critical technical, managerial, and organisational expertise. In general, these businesses were already more productive than the average organisation; digitisation has contributed to the expansion of their competitive advantage. Furthermore, the powerful network effects and low marginal costs inherent in specific digital activities tend to favour a limited number of exceptionally productive firms, thereby rendering it progressively more challenging for other firms to contend even in sectors characterised by low digital intensity, such as hospitality and food services.²⁹ Competitive pressure is forcing businesses to digitise their processes and models.

Manufacturing companies, for example, have made several operational productivity gains. The implementation of technologies such as robotics and IoT devices has been useful in streamlining production processes and eliminating downtimes. On the other hand, retailers have used digital platforms (e-commerce) and data analytics to adjust and improve inventory management, marketing campaigns and their customers omnichannel experiences. Additionally, companies have been enabled to monitor and track products throughout the entire value chain, improving quality control and ensuring timely deliveries.

This has created an environment where businesses are spending more on digital transformation in response to the competitive pressure and opportunities created by digitisation as well as the expectations of their customers.

Spending is rising sharply: it is predicted that spending on digital transformation will grow over 50% from USD2.2tn in 2023 to USD3.4tn in 2026.⁸ As is well known, the result of all this has been a data explosion. Approximately 330 million terabytes of data are already created each day, and this is projected to increase quickly as seen in figure 2.⁷

03 Where we are

Digital infrastructure: the backbone. Initially, computers were large-scale servers accessible only to enterprises but later evolved into personal devices with end-user friendly software and operating systems. This shift made computers more economically significant, transforming them into portals for shared media and global information access.

Now we are in an era of cloud computing, where computers are once again servers, but now affordable and accessible on an unprecedented scale – 94% of enterprises use cloud services and almost 67% of enterprise infrastructure is now cloud-based.⁹ Obtaining access to supercomputing power in the cloud has therefore become as easy as hailing a cab.

We are making increased use of this access, helped by the improvements in communications technology. Mobile data usage per smartphone is forecast to rise from 21 GB per month in 2023 to 56 GB per month in 2029, with the 5G share of mobile data traffic rising from 25% to 76% over this period.¹⁰ 5G coverage is forecast to increase from 46% of the global population in 2023 to 86% in 2029, while mobile data traffic is expected to more than triple (see Figures 3 and 4).¹⁰ Rising demand is being driven largely by data-intensive video activities like cloud gaming, video streaming, and AR/VR applications illustrated in Figure 5.¹⁰

Digital infrastructure: associated ecosystems. Digitisation (and the rise in subscription services) has already led to profound changes in how we consume media, benefiting streaming services and interactive entertainment. Global revenues for advertising and subscription video-on-demand are expected to increase from USD39bn and USD108bn in 2023 to USD69bn and USD127bn in 2029 respectively.¹¹ The digital gaming market, which is less dependent on subscriptions than the video market, is expected to grow from USD210bn in 2023 to USD242bn in 2024; mobile gaming is expected to have a share of about 64%.¹² This has been accompanied by a rapid increase in internet ad spending, whose global volume is forecast to increase by USD73bn between 2023 and 2025 and reach close to USD580bn – a share of 59% of the total global advertising market.¹³

E-commerce is following behind. Its share of total retail revenues is estimated to have risen from 13.8% pre-Covid in 2019 to 17.8% in 2020 and is expected to rise to 22.2% in 2026.¹⁴ Associated digital payments have disrupted the checkout, point-of-sale, and remittance processes in the financial industry, replacing traditional payment methods like cash and credit or debit cards with digital wallets.

Digital infrastructure: getting everyday objects to interact. The so-called Internet of Things (IoT) is the interconnection of computing devices embedded in everyday objects, enabling them to send and receive data and play increased roles in areas such as smart cities and smart homes.



It is estimated that between 2023 to 2029, the number of connected IoT devices will rise from around 16bn to 39bn, including connected cars, machines, meters, sensors, point-of-sale terminals, consumer electronics, and wearables.¹⁰ Some 6bn of these devices are predicted to be cellular IoT devices connected to the same network as mobile phones.¹⁰ By comparison, there are expected to be only 11bn traditional connected devices (e.g. computers, mobile phones) over this forecast period, as shown in Figure 6.¹⁰ The annual revenue of the IoT market is expected to grow from USD806bn in 2023 to over USD1tn in 2026.¹⁵

Digitisation: two major concerns

Environmental: Data centres and data transmission networks currently account for 1% of energy-related GHG emissions and 2-2.8% of global electricity use, excluding cryptocurrency mining (0.4%).¹⁶ These shares are likely to increase with growing demand for data storage and processing despite efforts to promote sustainable practices such as renewable energy sources and improved energy efficiency.

Estimates suggest that sustainable practices by information and communication technology firms have resulted in only a moderate increase in emissions since 2010, notwithstanding the exponential growth of digital service demand.¹⁷ This is partially attributable to the fact that energy consumption does not increase proportionally with traffic volume.¹⁸

Furthermore, digitisation contributes to increasing e-waste. It is estimated that annual e-waste will increase by over 20% and reach 75mn metric tons in 2030 – that is 9 kg of e-waste per capita.¹⁹ Trends like the IoT and the update cycles of electric devices are major contributors to the increase in e-waste.

Privacy and security. Digitisation raises a host of privacy concerns, with issues like consent, data ownership, and ethical use at the forefront. As companies collect more data, there is increasing public concern about data usage and collection levels.²⁰ The situation is made more acute by escalating cyber threats to individuals, companies, and governments. The average cost of data breaches rose to USD4.5mn in 2023.²¹ The proliferation of IoT devices complicates the security landscape, particularly as many are seen as intrinsically vulnerable to attack, opening up new avenues for crime.²²

- Our daily interactions with tangible environments, which comprise the physical layer, will be augmented by IoT devices, sensors, and actuators that capture data and interact with the digital information layer.
- The digital information layer is responsible for storing the digital duplicates of physical objects via sensorisation and digital mapping. The outcomes are observable via dashboard and screen devices, BCI, and AR/VR.
- The spatial interaction layer integrates physical and digital layers by providing contextual real-time data accessible by various signals such as speech, computer vision, and gestures.

Three significant advances will lead us to a cyber-physical world.²⁴

- Interaction technologies that provide immersive experiences using sophisticated interfaces.
- Infrastructure technologies that provide the necessary processing power and connectivity.
- Data management technologies that ensure secure and efficient service using blockchain and P2P technologies.

Interaction technologies like AR and VR will coexist. AR embeds synthetic elements, including text, images, and animations, by superimposing digital data onto the physical environment. VR provides access to an entirely virtual environment, which replaces the physical world. A BCI may also establish a direct channel of communication between the brain and an external device, with the intention of enhancing sensory-motor or cognitive functions. BCIs may be non-invasive or invasive, and their primary difficulty lies in the precise translation of intricate neural signals into real-time actions.

Infrastructure technologies will draw on edge computing, a distributed computing framework that brings computation closer to the location needed, improving response times and bandwidth. This approach is particularly beneficial for real-time processing applications like IoT devices, autonomous vehicles and smart city technologies. 6G – another infrastructure technology – is expected to provide dependable, fast data speeds, and lower latency than its predecessor.

Higher-frequency bands, improved network efficiency, and support for novel applications such as AR/VR, holographic communications, and IoT are among the anticipated advancements in 6G technology. The deployment of 6G is expected to begin around 2030.²⁵ However, different 6G technologies are possible as a result of China's ban on foreign 5G technology²⁶ and the bans imposed by many western nations on the use of Chinese 5G technology in their domestic markets.²⁷ 6G networks are becoming increasingly susceptible to disparate standards and fragmentation²⁸.

Decentralised blockchains may become the tool of choice for data management. Data integrity and security are protected by distributed ledger technology, which securely records transactions across several computers. P2P technology enhances security and resilience by enabling direct data interchange between network systems without relying on a central server. Blockchain and P2P technology may enable safe and transparent systems for supply chain management, identity verification, and voting.

04 Moving to a cyber-physical world

Digitisation is likely to lead to what has been called a “cyber-physical” world, where digital and physical realities are integrated, creating a more interactive, personalised, and immersive experience.

This cyber-physical world can be seen as composed of interrelated layers – including the physical, digital information, and spatial interaction layers – working together to create a seamless blend.²³



Digitisation: ESG data collection

Real-time and reliable data collection is essential for the integration of ESG into the processes of business operations, transparent reporting and decision-making. This, in turn, provides companies with a faster and more detailed method of tracking ESG performance, identifying where they are deficient and comparing their performance with peers as well as allocating resources accurately. Reliable and timely data is particularly essential to create stakeholder confidence and promote trust internally.

Continuous sensorisation is a step in that direction. Sensors attached to devices generate data available in real time, which creates a suitable data source for ESG indicators. Automated ESG reporting processes can then reduce the time and resources used for data collection and analysis, improving efficiency.

There are several successful examples:

- Smart waste management systems use RFID tags, sensors, actuators, wireless sensor networks, near-field communications, GPS, and various other automatic data collection methods to monitor garbage build-up levels and clear them remotely.
- Smart energy systems offer real-time monitoring of energy usage and centralised remote maintenance, helping to reduce operating costs and environmental impact.
- IoT solutions enable air quality, water quality and soil moisture to be monitored with ease. Existing facilities can make use of wireless sensors and connected devices, which transfer the information either to a centralised database or cloud platform.

Many of these sectors may offer long-term growth potential (see Figure 8) as technology advances and technology deployment continues steadily. New investment avenues that are closely linked to existing, more established sectors are opening up with the emergence of new technologies and services, such as edge computing, AR/VR, and more.

The investment consensus is to see these as high-growth industries. Many industries (e.g. semiconductors and semiconductor manufacturing, broadband retail, entertainment) are currently experiencing rapid growth in their earnings, reflecting strong market demand and significant perceived expansion potential within the digitisation theme. However, as seen in their high price/earnings (P/E) ratios, these industries come with very high valuations. While these industries may be susceptible to short-term profit-taking, their technological and/or market leadership frequently provide long-term advantages.

Earnings growth in other digitisation-related industries might appear relatively modest but it is still high compared to the broad stock market. Above-average growth potential may exist in the technology hardware, storage and peripherals, interactive media and services, and software industries as a result of ongoing innovation and shifting market demands in the context of digitisation. Valuations vary across these industries. The software industry is the most expensively valued, while the technology hardware, storage, and peripherals industry is the only industry with a valuation below the all-sectors global average.

Industries undergoing a phase of moderate, yet consistent expansion include financial services and IT service providers that supply internet-dependent companies with infrastructure such as data centres, cloud networking, storage, and web hosting.

At present, these industries are undergoing a phase of moderate yet consistent expansion. Many of these firms may offer well-established business models and apparently stable market positions but these industries are valued relatively highly. Although valuations are inflated, the primary determinant of share price performance remains earnings. Technology companies have consistently exhibited the capacity to not only disrupt with but also profit from innovation. The swift commercialisation of innovations is of the utmost importance in high-interest-rate environments and periods of economic uncertainty.

In the current environment of low economic growth, industries offering significant growth combined with pricing power have obvious appeal. In this context, some U.S./Asian megacaps involved in digitisation-related activities would appear to have a competitive advantage due to economies of scale and dominant market positions. However, it is crucial for investors to be aware that market dominance, privacy, and security issues may attract regulatory scrutiny.

Industries characterised by substantial margins, including software, semiconductors and semiconductor equipment, interactive media and services (see Figure 9), can leverage their pricing power amidst persistently high inflation.

Alternatively, industries that are currently traded at a discount but exhibit above-average earnings growth may present opportunities in the near future, if current economic uncertainties abate.

05 Implications for investors

The long-term investment theme of digitisation presents a diverse landscape of investment opportunities and challenges.

Investment can be focused on the foundational technologies and services that enable many other innovations. Investors may seek to diversify their portfolios by considering several sectors and industries that are central to this theme, but it should be noted that short-term tech sector investment performance is often closely correlated across sectors.

The main industries involved in digitisation are information technology, communication services, consumer discretionary, and financials.

These industries include software; semiconductors and semiconductor equipment; IT services; technology hardware, storage, and peripherals; interactive media and services; entertainment; broadband retail; and financial services. Over the long term, most of these sectors have demonstrated substantial outperformance in comparison to the worldwide stock market (see Figure 7). However, they also encountered significant drawdowns as central banks started hiking, indicating a pronounced sensitivity to interest rates.



06 Conclusion

The advent of the modern internet which started with the linking of commercial networks and enterprises in the early 1990s and the introduction of the World Wide Web was the starting point of rapid digitisation – the start of a paradigm shift in the way the world functions. The factors that have propelled this shift – affordability, computational prowess, miniaturisation, connectivity, productivity – will drive the convergence of the digital and physical domains.

Digitisation is now central to a wide range of industries, each presenting distinct investment prospects. Business activities such as e-commerce, digital entertainment, cloud services and semiconductors are not merely participating in the digital transformation; they are influencing its future direction.

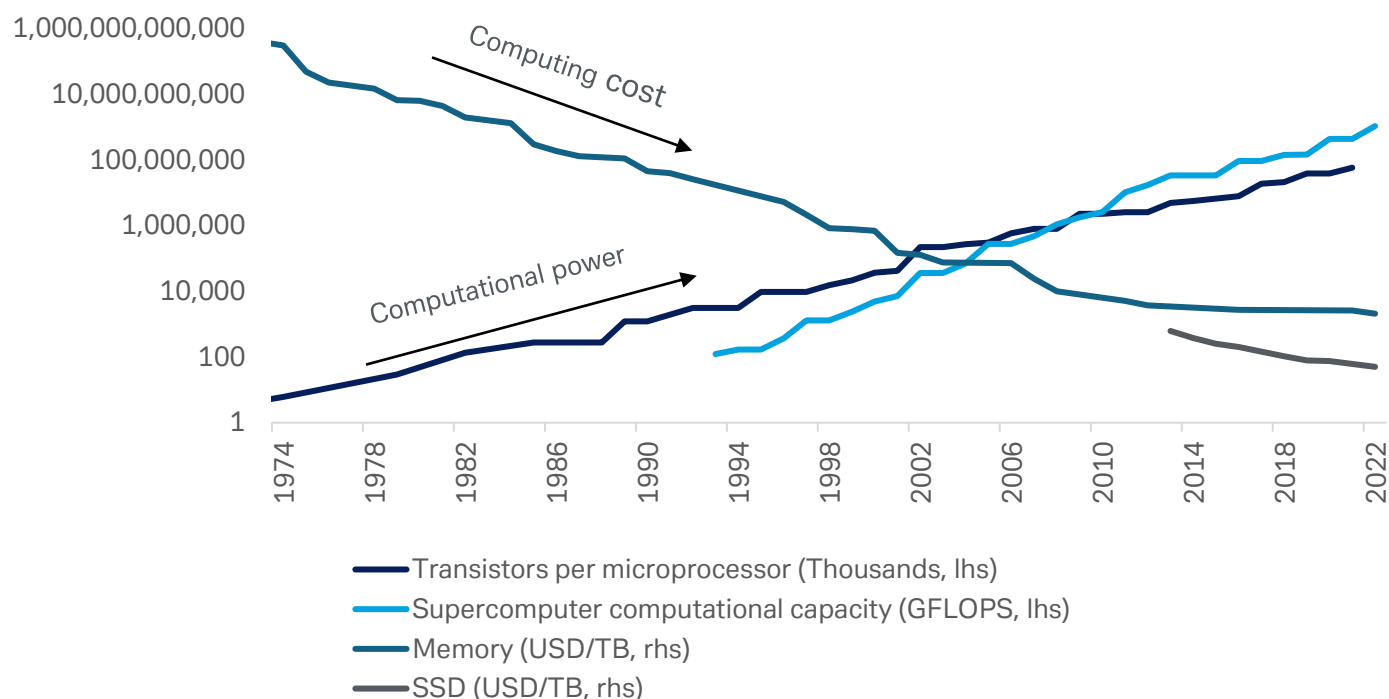
Investing in these sectors requires an assessment of market valuations, likely growth trajectories, potential developments and so on. Striking a balance between valuation and growth prospects as well as high margins will be key. Special attention should be paid to strategically diversifying digitisation investments within portfolios.

Investors should also be aware of the side-effects of digitisation, in particular its environmental repercussions and political and social implications, for example through threatening individual privacy and security. Some areas might be subject to additional and regionally diverging regulation.

Digitisation is an investment theme that is certain to grow in importance. It is central to a future that is digital and interconnected and investors have the opportunity to be part of this transformative journey.

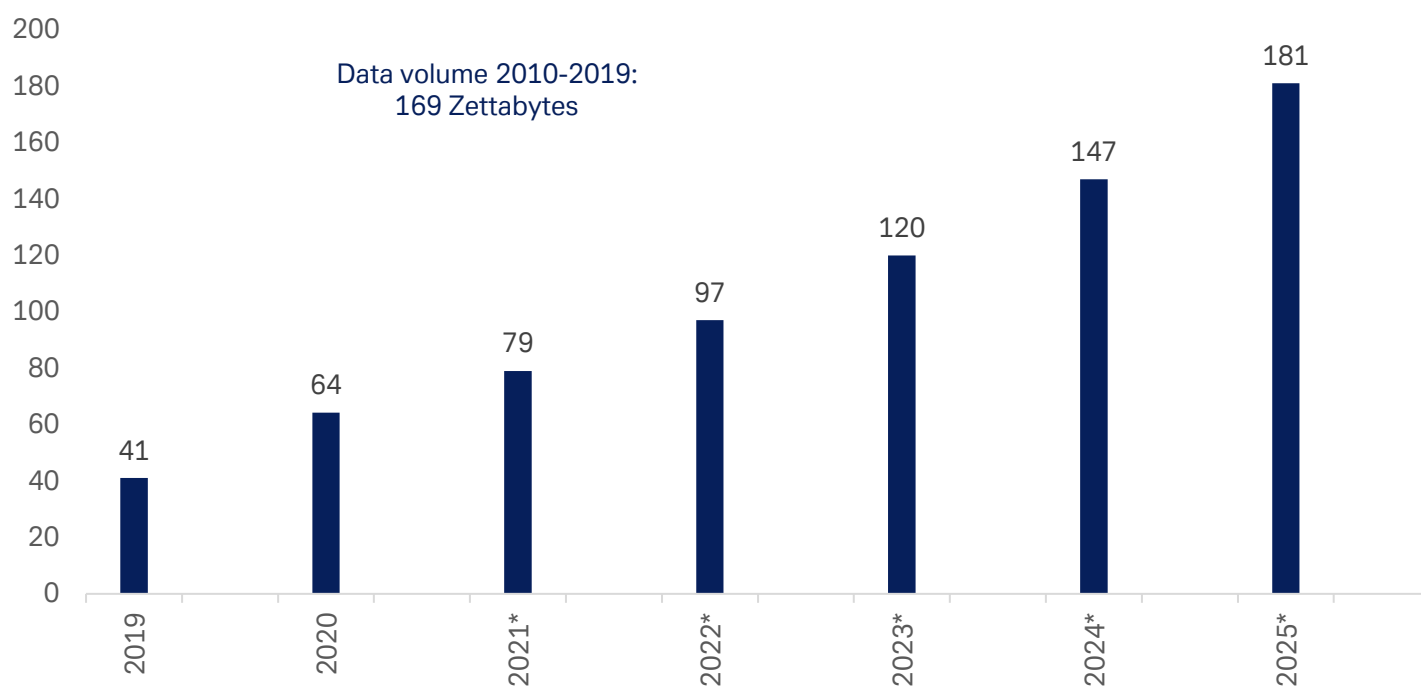


Figure 1: Improving computational power and computing costs



Source: J. C. McCallum, K. Rupp. Data as of 2022.

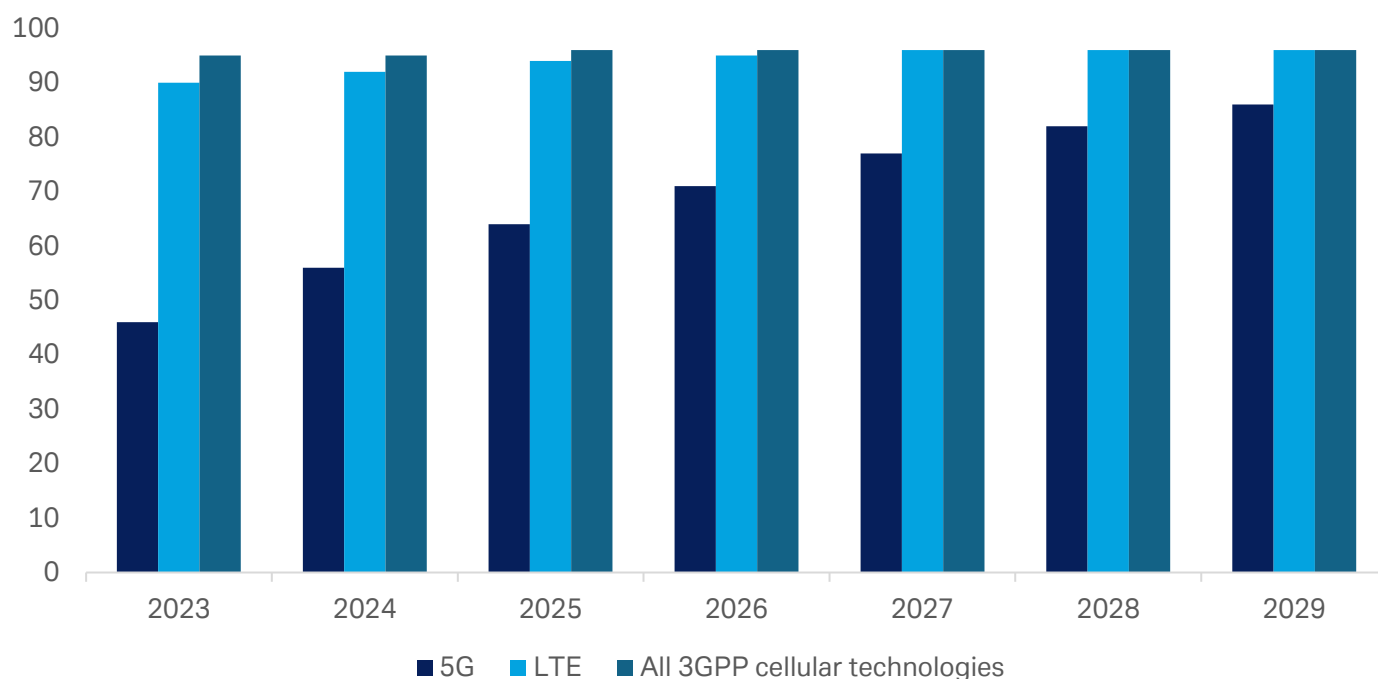
Figure 2: Rising data volume and number of IoT devices



Source: Microprocessor Trend Data, TOP500 SCDB. Data as of 2022.



Figure 3: Forecasted mobile data coverage of the global population by technology



Source: Ericsson. Data as of November 2023.

Figure 4: Forecasted annual mobile data traffic in exabytes by technology

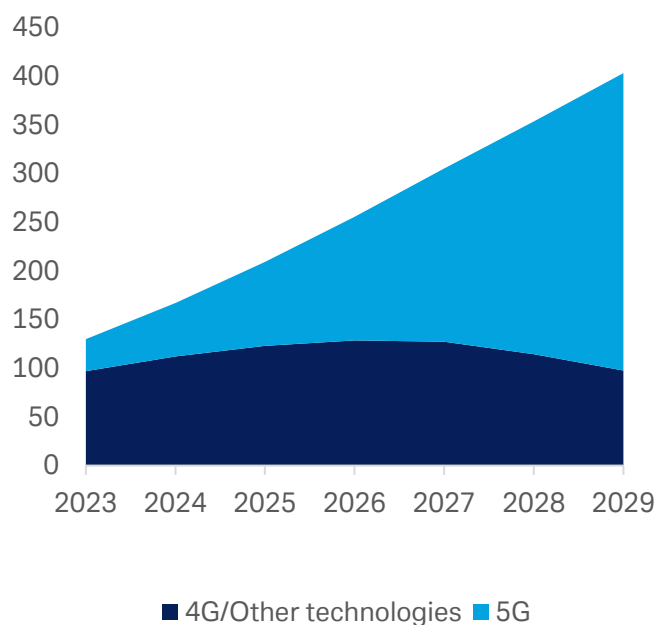
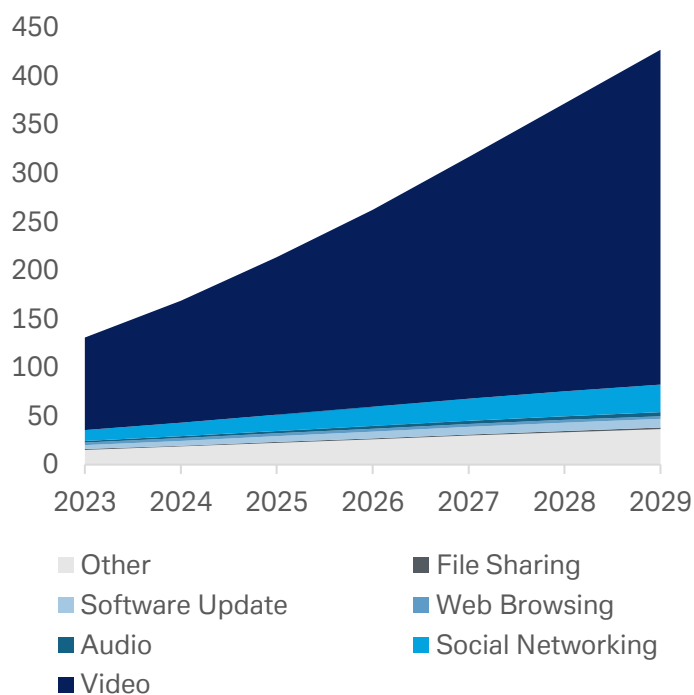


Figure 5: Forecasted annual mobile data traffic in exabytes by application category

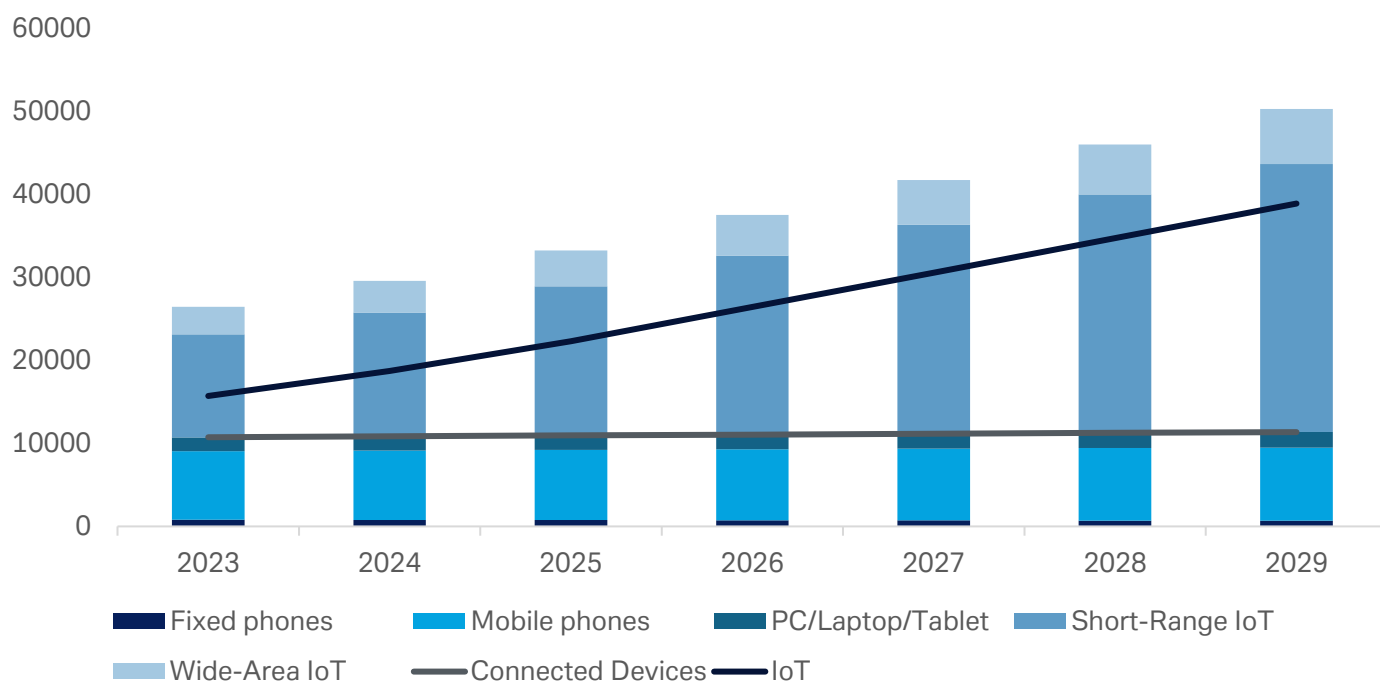


Source: Ericsson. Data as of November 2023.

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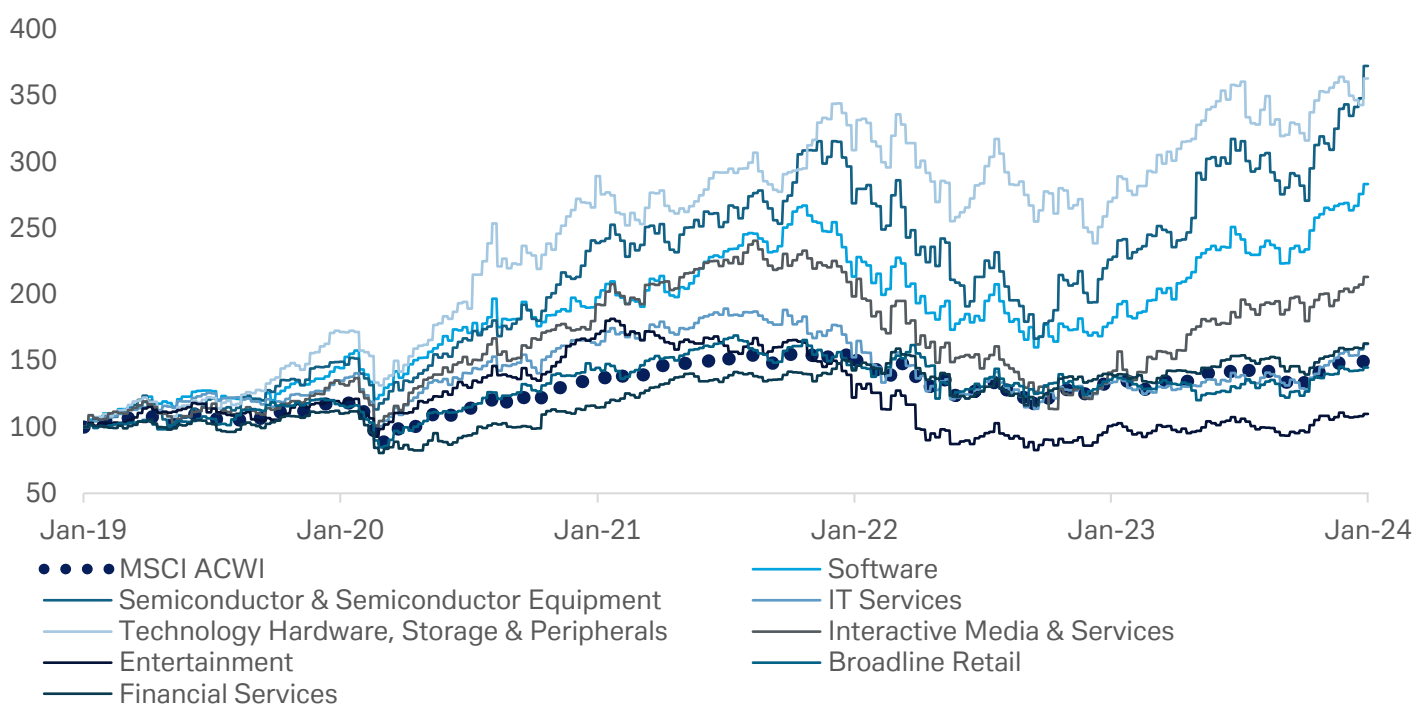


Figure 6: Forecasted number of connected and IoT devices worldwide in million units



Source: Ericsson. Data as of November 2023.

Figure 7: Indexed price performance of MSCI ACWI and MSCI ACWI industry indices



Source: LSEG Datastream. Data as of January 31, 2024.

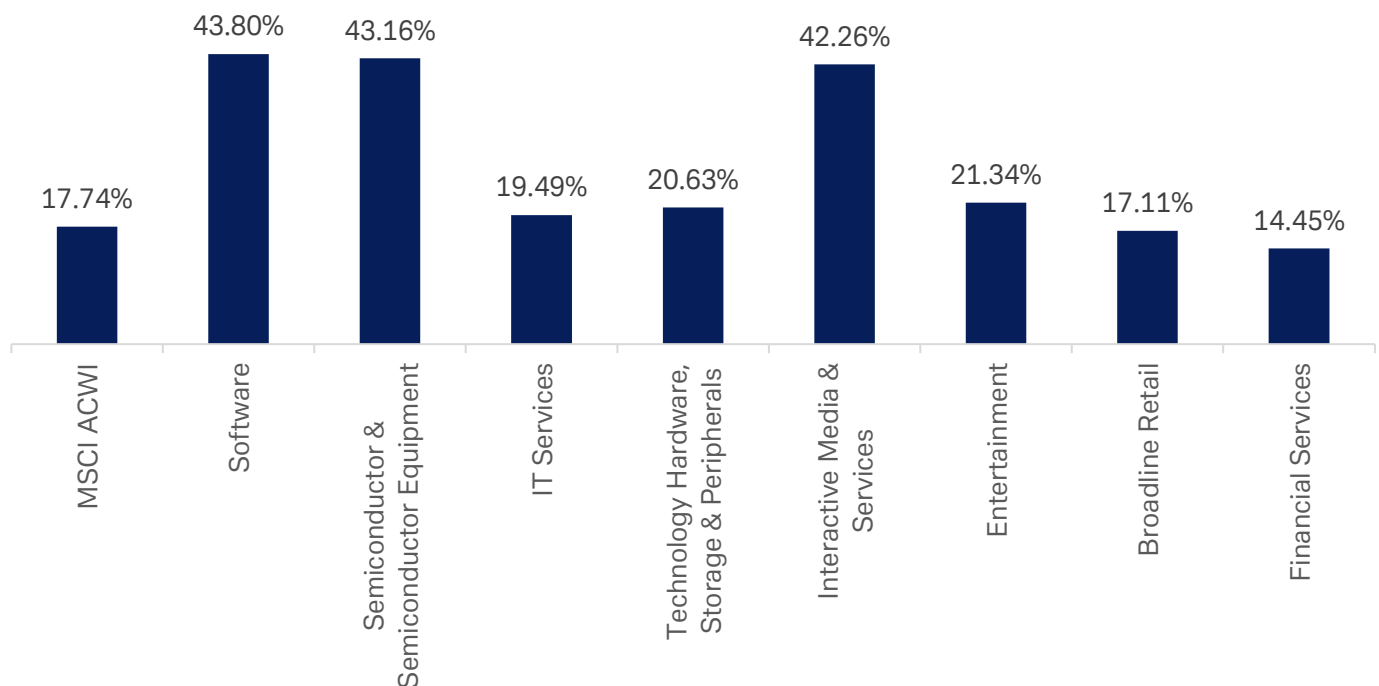


Figure 8: Earnings growth & valuations table

	EPS Growth (YoY, %)				Price/EPS			
	23E	24E	25E	12m f	23E	24E	25E	12m f
MSCI ACWI	-0.1	9.4	12.2	10.0	18.9	17.3	15.4	17.0
MSCI ACWI Sector Indices								
Information Technology	-5.2	19.3	19.3	20.3	32.8	27.5	23.0	26.4
Communication Services	23.3	15.5	14.0	15.5	21.4	18.5	16.3	18.4
Consumer Discretionary	35.7	10.2	14.6	11.6	20.2	18.4	16.0	18.2
Financials	13.3	6.5	9.6	6.9	12.3	11.5	10.5	11.4
MSCI ACWI Industry Indices								
Software	16.4	12.9	15.6	13.1	N/A	35.9	31.1	34.1
Semiconductor & Semiconductor Equipment	-10.2	29.7	27.9	32.2	33.4	25.7	20.1	24.7
IT Services	10.3	11.2	11.4	11.0	30.1	27.1	24.3	26.9
Technology Hardware, Storage & Peripherals	-20.3	18.0	15.5	19.0	11.4	9.6	8.3	9.3
Interactive Media & Services	36.6	18.3	15.5	18.0	25.5	21.6	18.7	21.3
Entertainment	N/A	37.4	25.5	36.4	N/A	29.3	23.4	28.4
Broadline Retail	N/A	24.2	25.2	25.7	32.4	26.1	20.9	25.8
Financial Services	15.1	11.3	12.3	11.6	22.6	20.3	18.1	20.0

Source: LSEG Datastream. Data as of January 31, 2024.

Figure 9: NTM Sales / NTM EBITDA ratio



Source: LSEG Datastream. Data as of January 31, 2024.



Glossary

AR/VR refers to computer-generated simulations that integrate the real world (AR) or are entirely self-contained (VR). AR applications let you move around in the real world. With VR, you have to remain in the same location because you cannot see your surroundings.

Blockchain is a digital database containing information that can be simultaneously used and shared within a large decentralized, publicly accessible network. It is defined as a ledger of decentralized data that is securely shared.

The **Consumer Price Index (CPI)** measures the price of a basket of products and services based on the consumption of a typical private household.

Cloud computing delivers cutting-edge computing technology over the internet for a fixed, recurring fee¹²³⁴. It processes data in centralized data centers across the globe. **Edge computing** processes data closer to the source, typically at the edge of the network or within local devices. It is used to process time-sensitive data.

Defensive stocks offer more consistent dividends and stable returns, regardless of the performance of the stock market as a whole.

The **European Central Bank (ECB)** is the central bank of the eurozone.

The **Euro (EUR)** is the only legal tender in the EU member states that have adopted it.

The **Eurozone** is made up of 20 member states of the European Union that have adopted the euro as their common currency and sole legal tender.

Earnings per share (EPS) is calculated as a company's net profit less the dividend for preference shares, divided by the total number of shares in circulation.

The **Federal Reserve (Fed)** is the central bank of the United States of America. The Federal Open Market Committee (FOMC) determines the Fed's monetary policy.

Growth stocks are companies that are likely to achieve above-average profit or sales growth.

The **Internet of Things (IoT)** refers to devices with sensors, processing capabilities, and software that connect and exchange data over the Internet or other communications networks.

In technology, **latency** is the time a system or functional unit takes to react to a given input.

The **price/earnings ratio (P/E ratio)** measures the current share price of a company in relation to its earnings per share.

Next twelve months (NTM) refers to any financial ratio forecast for the immediate next twelve months from the current date.

Computer **memory** operates at a higher speed than storage but is more expensive and lower in capacity.

A **solid-state drive (SSD)** uses integrated circuit assemblies to store data persistently. Compared with electromechanical drives, SSDs are typically more resistant to physical shock, run silently, and have higher input/output operations per second and lower latency.

The **Stoxx Europe 600** is an equity index that tracks the performance of the securities of a total of 600 of the largest companies from 17 countries in the European Union.

The **S&P 500** is a share index (price index) in the U.S.. It includes shares of the 500 largest and highest-turnover companies in the country.

U.S. is the designation for the United States.

USD is the currency code for the U.S. dollar.

The **volatility** of a financial asset is the degree of variation of its trading price series over time. It is usually measured by the standard deviation of logarithmic returns from the asset's average value.

In telecommunications, **5G** is the fifth-generation technology standard for cellular networks, which cellular phone companies began deploying worldwide in 2019, and is the successor to 4G technology that provides connectivity to most current mobile phones. Its successor is **6G**, the sixth-generation technology standard for cellular networks.



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