CFRA

Industry Surveys

Technology Hardware, Storage & Peripherals

OCTOBER 2022

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CHARTS & FIGURES

NEW THEMES

What's Changed: We think growth in smartphone units will decline in 2022 due to softer demand, inflation, geopolitical tensions, and supply chain constraints. Check out page 18.

What's Changed: Although the concept of the metaverse is not new, we believe device sales related to AR/VR could increase significantly in 2022 and may prove to be a tangible revenue opportunity for hardware/semiconductor companies over the next year. Read more on page 22.

EXECUTIVE SUMMARY

Our fundamental outlook for the Technology Hardware, Storage & Peripherals sub-industry for the next 12 months is neutral. While the hardware space has had to contend with a number of external factors in recent years (e.g., a global pandemic and trade wars), we see healthy enterprise spend, demand for wearables, and emerging themes like the metaverse driving sales. We note that Apple is the 800-pound gorilla in the sub-industry. As such, we have included a section to solely discuss the key drivers for Apple.

We Expect Smartphone Units to Decline by At Least 5% in 2022 and See Anemic Growth Thereafter

We anticipate that smartphone units will decline by about 5% to 7% in 2022 after rising by 5.7% in 2021. The decline is being led by softer consumer demand (specifically at the low end of the market), inflation, and geopolitical tensions. We conservatively forecast a no-growth environment for smartphones in 2023 and see a long-term growth rate of 0%-2% as the industry has matured and remains below peak unit shipments seen in 2016. We expect the market for 5G mobile phones to represent more than half of all sales in 2022. The premium segment of the market continues to perform better than expected, supporting higher average selling prices, as longer refresh rates have consumers opting for devices that will last longer than three years and support more capabilities than previous flagships.

Apple's 2022 Fall Line-Up of Hardware Devices to Drive Average Selling Prices Higher

At Apple's annual September event, it announced updates to iPhones, Watch, and AirPods. On the iPhone 14 and Pro devices, pricing was unchanged, but ditching the mini in favor for a 6.7-inch Plus device naturally increases the average selling price (starts at $799), while pushing more capabilities into the Pro devices (essentially widening the gap) should also improve the mix toward the Pros. New Pro features include the Dynamic Island, Always-On Display, A16 Bionic, and 48MP camera (standard phones keep 12MP camera and A15). We note already aggressive telco plans should further motivate consumers. On the Apple Watch Series 8, new sensors (namely a temperature sensor that can track ovulation) and improved battery life were notable positives, while Apple also unveiled a new second Generation SE (starts at a lower $249) and premium Apple Watch Ultra (starts at $799) for avid athletes/fitness gurus. Ditching the Series 3 Watch and unveiling a premium Watch further supports our thesis that Apple is stepping up initiatives to incrementally boost average selling prices.

We Remain More Bullish on PCs than Tablets in a Post-Pandemic Environment but See Declines for Both

We see more focus on thinner and lighter devices as well as on gaming but see combined PC/tablet units declining about 10% in 2022 (no growth for 2023) after a 15% rise for 2021. Rising demand for PCs and tablets from businesses, schools, and consumers in a post-pandemic world has had a permanent positive impact on the installed base for these devices. We see a more tempered demand landscape for Chromebooks and other consumer-driven PCs following a surge in 2020 and 2021.

Momentum for Wearables Appears Healthy, as Adoption Rates Increase and New Product Categories Evolve

CFRA anticipates shipments of wearable devices to grow at a high-single-digit percentage basis through 2024, as we see future growth driven by greater adoption of smartwatches and increasing capabilities of sensors within these devices (e.g., glucose monitoring system). Greater focus on health care initiatives will likely support long-term demand and open opportunities from corporate wellness programs, in our view. We also expect ear-worn devices like AirPods to gain traction with consumers, reflecting the ongoing shift away from wired devices.

More Affordable Solid-State Prices to Increase Enterprise Adoption

CFRA sees an explosion of data growth having mixed results on the storage space, with growth in the public cloud to command a greater share of the market. While the storage market is seen growing at a low-single-digit percentage pace in the long term, we expect a mixed picture for different storage types. All-flash will likely increase at a 10%-plus annual pace over the next four years, while hard disk drives are seen losing market share to solid states every year for the foreseeable future. The enterprise market will be the most important market in size for storage, while Asia Pacific will be the key driver from a geographic perspective.

Wide Range of Multiples Given Varying Growth Prospects Across the Hardware Space

As we progress through 2022 and into 2023, we see downside risk to consensus views given macro concerns, a strengthening dollar, and persistent inflationary headwinds. These issues, combined with a rising interest rate environment, are likely to keep multiples compressed in the intermediate term. Traditional PC and printing companies generally trade at lower multiples due to the low growth and mature nature of their businesses, while companies exposed to higher growth areas or provide better earnings visibility like Apple trade at higher multiples.

Technology Hardware, Storage & Peripherals

Outlook: Neutral

MARKET CAP BREAKDOWN*

RANK NO.	COMPANY NAME	MARKET CAP ($ billion)
1	Apple	2,423.0
2	HP	25.1
3	Hewlett Packard	15.5
4	NetApp	13.6
5	Seagate	11.5
	Others†	13.6

Source: CFRA, S&P Global Market Intelligence.
*Companies included in Comparative Company Analysis; as of September 26, 2022.
†Refer to the Comparative Company Analysis section of this survey for other companies in the industry.

ETF FOCUS

VGT Vanguard Information Technology	AUM ($M) 44,486.9	Expense Ratio 0.10
XLK Technology Select Sector SPDR	AUM ($M) 41,688.16	Expense Ratio 0.12
IYW iShares US Technology	AUM ($M) 6,847.98	Expense Ratio 0.43
METV Roundhill Ball Metaverse	AUM ($M) 493.9	Expense Ratio 0.59

BY THE NUMBERS

700M+
Projected 5G smartphone units in 2022

10%-13%
Three-year annualized revenue growth for Apple Services

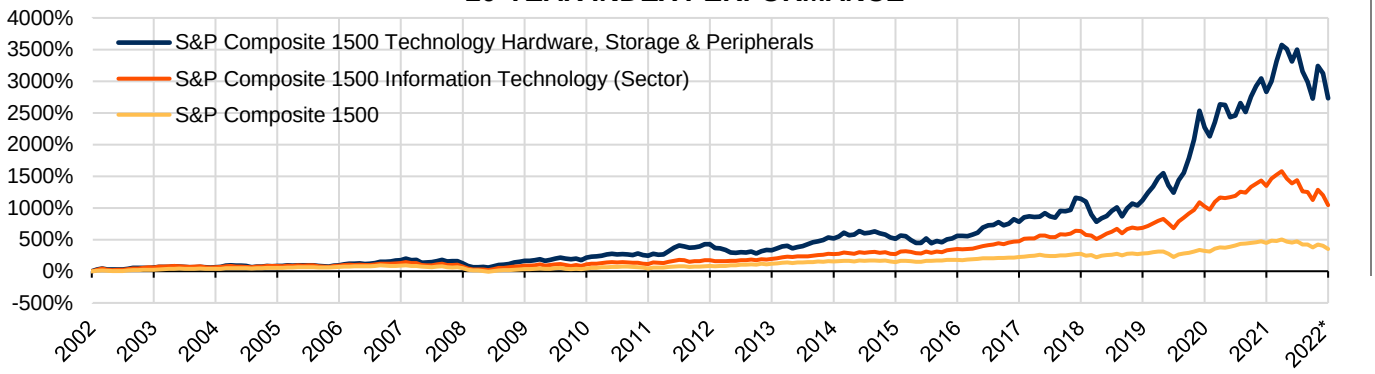
6%
Projected 5-year CAGR for Wearables

-8 to -12%
Expected drop in combined PC/tablet units from 2021 to 2023

1.6B units
Estimated size of 2023 mobile phone market (84% smartphone)

50%-55%
Percentage of Hardware revenue to originate from Asia in 2023

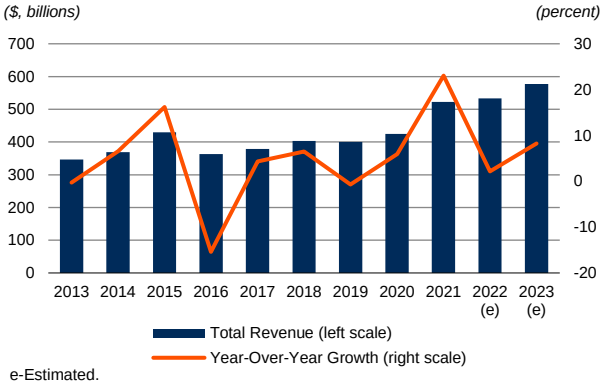
20-YEAR INDEX PERFORMANCE



*Data through September 30, 2022.
Source: CFRA, S&P Global Market Intelligence

FINANCIAL METRICS

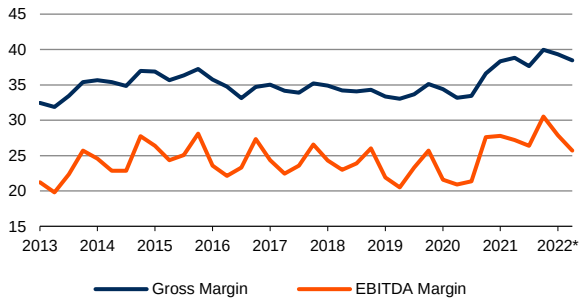
Revenue Growth



e-Estimated.
Source: CFRA, S&P Global Market Intelligence.

- CFRA expects industry revenues to grow 8.3% in 2023 following our outlook for a 2.2% increase in 2022. We see growth largely being driven by healthy growth prospects for Apple but acknowledge the recent strength of the dollar poses significant risk to growth assumptions.
- CFRA believes that macro concerns will lead to declines for both the smartphone and PC markets through the first half of 2023. We expect weakness will be driven primarily by the low end of the consumer market.
- Apple's revenue share is estimated to increase to 75% of industry revenues in 2022 from 72% in 2021, which we anticipate will be driven by greater demand within the company's services segment and wearables business.

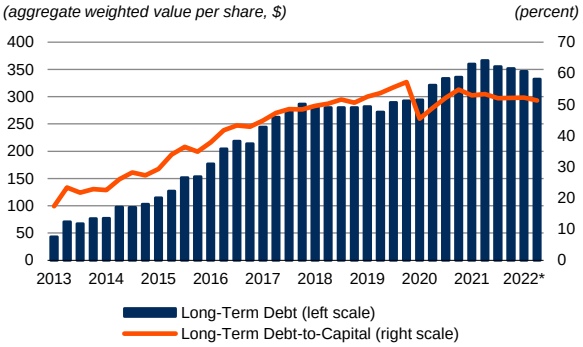
Gross and Operating Margins



*Data as of second quarter 2022.
Source: CFRA, S&P Global Market Intelligence.

- Gross margins are expected to gradually expand in the coming years but we do acknowledge inflationary headwinds in the intermediate term. PC vendors like HP will likely continue to post below industry average margins. A strengthening dollar provides a headwind to margins for hardware makers like Apple.
- Apple's gross margin has widened in recent years (39% in 2021 vs. 34% in 2020), supported by the favorable product mix shift to its Services business and currency tailwinds. We expect focus on managing component costs and see robust growth from Apple's higher-margined Services business.
- EBITDA margins for the industry are expected to dip below 25% in 2022 and 2023 due to a combination of higher logistic costs and rising prices for components amid supply constraints.

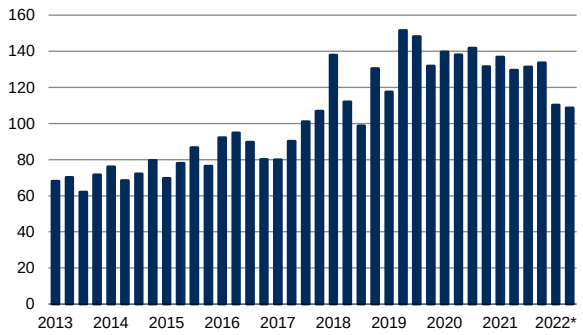
Debt Profile



*Data as of second quarter 2022.
Source: CFRA, S&P Global Market Intelligence.

- Long-term debt has been on the rise since early 2013, when Apple began to actively issue debt. This approach, at the time, was a change in the company's capital structure, as Apple did not hold long-term debt in prior years.
- CFRA expects debt issuance to be more tempered going forward as interest rates are on the rise. Overall, debt structures are manageable, as the largest companies in this industry generate very attractive free cash flow.

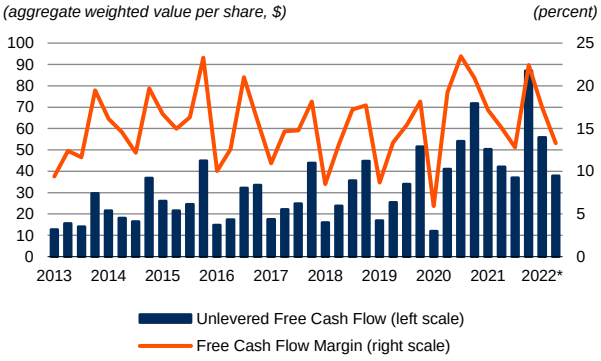
Cash & Cash Equivalents



*Data as of second quarter 2022.
Source: CFRA, S&P Global Market Intelligence.

- Historically, cash has been an important line item because behemoth technology companies have so much of it and generate a significant amount of free cash flow.
- We attribute the recent decline in cash balance to Apple's aim to become "net cash neutral" in the coming years by returning excess cash to shareholders. As of June 2022, we calculate Apple has returned more than $630 billion of cash to shareholders and note the company began returning cash in calendar year 2012.
- CFRA expects industry cash levels to remain healthy in the foreseeable future. However, rather than focus on increasing their cash position, manufacturers will likely look to sustain cash at stable or flat levels while focusing on returning more excess cash to shareholders.

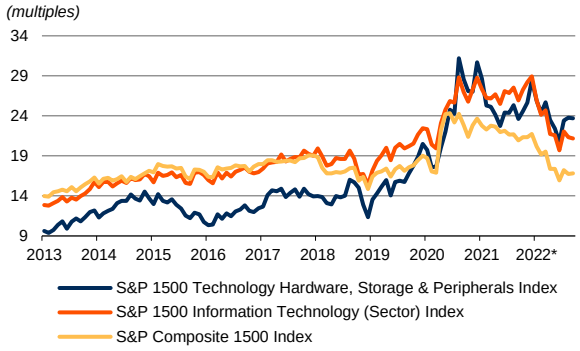
Free Cash Flow



*Data as of second quarter 2022.
Source: CFRA, S&P Global Market Intelligence.

- Free cash flow margin of 13.3% in Q2 2022 is below-average return compared to the industry average, which hovers around 15% to 20% in the past few years. CFRA thinks this is an important metric for investors to consider, as we see an increasing portion of free cash flow being returned to investors via share repurchases and dividends.
- CFRA expects free cash flow to remain robust in 2022 and 2023, on higher revenue, which should support higher dividends and share repurchases.

Forward P/E Ratio



*Data through September 8, 2022.
Source: CFRA, S&P Global Market Intelligence.

- The industry forward P/E of 23.7x, as of September 8, 2022, is higher than its five-year historical range of 19.9x. We note that most multiples across the industry have compressed due to macro concerns lowering EPS estimates. However, Apple has been able to sustain its above-market multiple as it is seen as a safe haven and would be able to combat inflationary pressures better than most market participants.
- We believe Apple still has room to expand its multiple as its services segment contributes a bigger percentage of overall profit margin, but we think a tough bar in its core business in 2022 could keep its P/E multiple range bound at the moment.

S&P 1500 Technology Hardware, Storage & Peripherals Index Constituents

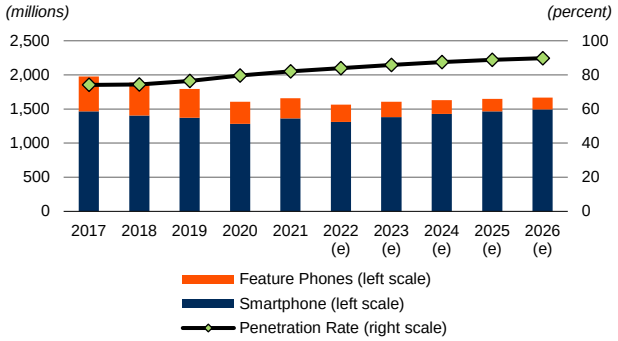
The table below details our forward P/E and EPS outlook for companies in the industry. As we progress through 2022 and into 2023, we see downside risk to consensus views given macro concerns, a strengthening dollar, and persistent inflationary headwinds. These issues, combined with a rising interest rate environment, are likely to keep multiples compressed in the intermediate term. Traditional PC and printing companies generally trade at lower multiples due to the low growth and mature nature of their businesses, while companies exposed to higher growth areas or provide better earnings visibility like Apple trade at higher multiples.

COMPANY NAME	MARKET CAPITALIZATION†	FORWARD P/E		EPS	
		2022*	2023*	2022*	2023*
Apple Inc.	2,438,897	24.9	22.8	6.1	6.7
HP Inc.	25,128	6.5	6.5	3.8	3.8
Hewlett Packard Enterprise Company	15,492	6.0	5.7	2.0	2.1
NetApp, Inc.	13,592	11.6	10.7	5.4	5.8
Seagate Technology Holdings plc	11,760	11.1	8.7	5.1	6.5
Western Digital Corporation	10,290	7.4	9.2	4.4	3.6
Xerox Holdings Corporation	2,178	12.7	7.5	1.1	1.9
3D Systems Corporation	1,068	NM	NM	-0.2	-0.1
Diebold Nixdorf, Incorporated	217	NM	1.7	-0.3	1.6
S&P Composite 1500 Information Technology (Sector)		20.2	18.3		
S&P Composite 1500		15.9	14.8		

*Estimated.
†As of September 28, 2022.
Source: CFRA, S&P Global Market Intelligence

KEY INDUSTRY DRIVERS

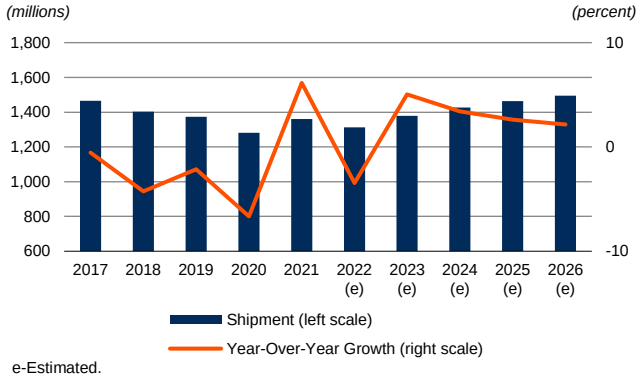
Worldwide Mobile Phone Shipments



e-Estimated.
Source: IDC, June 2022.

- IDC forecasts worldwide mobile phone shipments will decline 5.4% in 2022 and is expected to grow modestly going forward. Smartphones are expected to drop 3.5% in 2022 and experience growth of 5.0% in 2023, while non-smartphones will decline 14.6% and 9.4%, respectively, over the same period.
- According to IDC, 44.7% of all mobile phone shipments by the end of 2022 will be 5G. Android devices will be the bulk of 5G shipments; however, rising competition from Chinese brands will put pressure on Korean giant Samsung. CFRA expects Chinese brands like Huawei, Oppo, and Vivo to benefit from the pullout of Samsung and Apple in Russia.

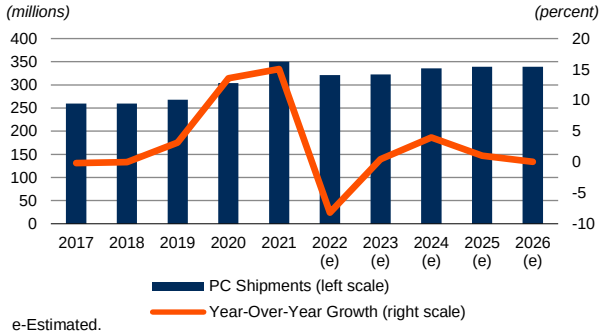
Worldwide Smartphone Shipment Growth



e-Estimated.
Source: IDC, June 2022.

- The growth rate for smartphone shipments in 2022 is expected to decline by 3.5%. The decline is mainly due to inflation and weakening demand as consumers hold on to their phones longer. Besides that, consumers have noticed innovation has been limited and devices are built to be more durable than ever.
- We do believe the adoption of 5G is stabilizing replacement cycles, supporting modest growth in the coming years. CFRA expects e-sports and mobile gaming will contribute in a significant way to the increase in 5G smartphone shipments globally.

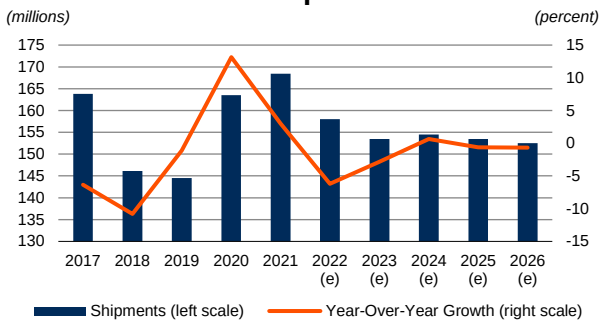
Worldwide Personal Computer Shipments



e-Estimated.
Source: IDC, June 2022.

- According to IDC's forecast, PC shipments are expected to decline by 8.2% in 2022 and to grow 0.4% in 2023, mainly due to macroeconomic headwinds. Prolonged lockdowns in major cities in China are not helping the supply chain either.
- While we expect demand for PCs to moderate on the consumer side given the large influx of demand seen since the pandemic started, we believe orders from the enterprise space will remain elevated. We note the enterprise segment carries significantly higher selling prices, offering greater opportunities for PC vendors to still grow revenue in a muted unit growth environment. While we see opportunities related to thinner and lighter devices as well as from gaming, we think longer replacement cycles will likely hinder growth for the space.

Worldwide Tablet Shipments

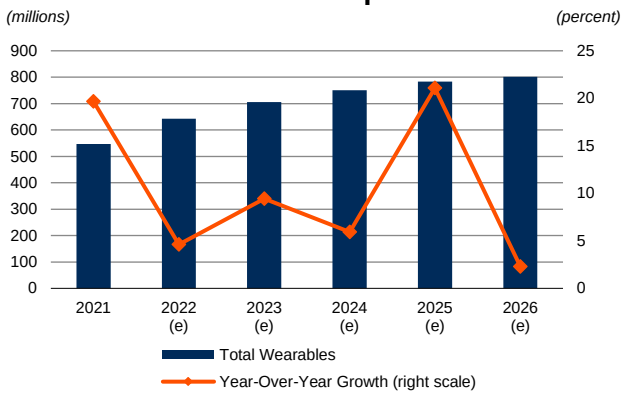


e-Estimated.

Source: IDC, June 2022.

- We think detachable tablets have broadened their presence in the market as the emphasis on productivity, flexibility, and ease of use is now greater than ever before and sales for this category were often in direct competition with notebooks.
- Tablet shipments are expected to decline by 6.2% in 2022 and 2.8% in 2023, as the category follows similar trends as the PC market. In fact, many consumers have purchased iPad Pros as another option for PCs in a market where supply for devices is relatively tight in many regions. However, tablet shipments are expected to decline over the next few years due to the delay in upgrading older devices and also increasing screen size of mobile phones, which puts potential tablet customers in limbo.

Worldwide Wearables Shipments



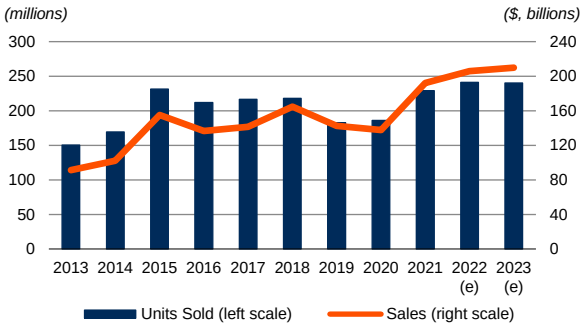
e-Estimated.

Source: IDC, July 2022.

- Shipments of wearable devices are expected to increase 4.6% in 2022 and 9.4% in 2023, based on IDC estimates.
- Driving the wearables market forward is a combination of incumbents and new vendors gaining more share at the expense of other vendors leaving the market, emerging products gaining prominence, as well as robust demand for hearables and smartwatches. While the focus of the wearables space has historically been on fitness, we see significant opportunities related to health care capabilities. For instance, the new Apple Watch Ultra includes a heart rate monitor, sleep tracker, and ECG readings.
- Ear-worn devices have also become an important driver to demand driven by Apple's AirPods product line. AirPods Pro 2, which is the second-generation model for the earbuds launched in September 2022, is expected to experience moderate growth in this space due to modest upgrades from the previous generation earbuds.

KEY DRIVERS – APPLE INC.

iPhone Sales

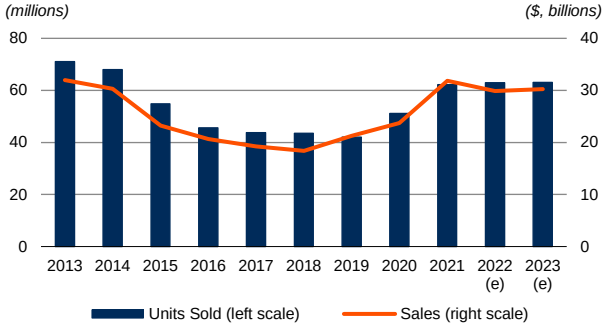


e-Estimated.

Source: CFRA, company report.

- Apple's September event saw the introduction of yet another new model, the iPhone 14. Given our long-term negative outlook for the smartphone space, we have a modest unit growth outlook for iPhones. CFRA projects 0%-3% growth for iPhones in the long term. Despite our conservative forecast, we expect average selling prices should rise at a compounded annual pace of 0%-3% as well, as consumers continue to shift to devices that provide greater content.
- Apple's greater focus on larger screens will naturally drive higher average selling prices. With Apple ditching the iPhone mini (which is widely understood to be a flop since it was released two years ago), the entry level iPhone's screen size is now at 6.1 inches compared to the dismal 5.4 inches of the mini.
- CFRA expects demand for the Pro and Pro Max models will make up a major portion of the iPhone sales compared to the iPhone 14 and 14 Plus. Reports on pre-orders for the iPhone 14 in China showed similar volume as the iPhone 13 last year. The competitive environment in the smartphone market in China is expected to further erode Apple's market share as the likes of Vivo and Xiaomi make further inroads to capturing market share in China.

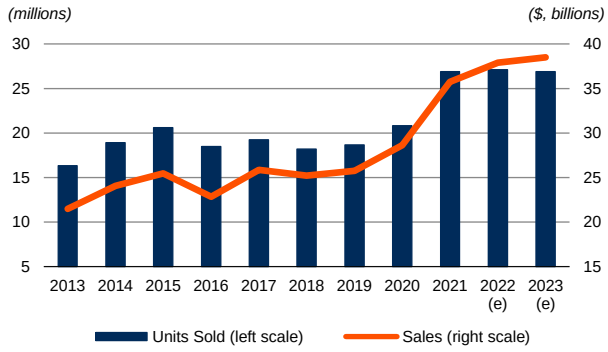
iPad Sales



e-Estimated.
Source: CFRA, company report.

- iPad sales are set to normalize in 2022 and 2023 after becoming an in-demand consumer technology in 2020 and through the first half of 2021. Apple also benefitted from a surge in demand from the education space during the pandemic, which has begun to cool down.
- Apple unveiled its ninth-generation iPad (starting at $329) last fall, which also happens to be the most affordable tablet in its lineup. CFRA believes this price point will allow Apple to gain more market share in the tablet market, shutting out advances from Microsoft, Samsung, and Amazon.
- Apple is expected to launch two new pro models – a 12.9-inch model and a 11-inch model – by the end of 2022. CFRA strongly believes the lackluster demand for iPads will be due to less upgrades from previous generation iPads.

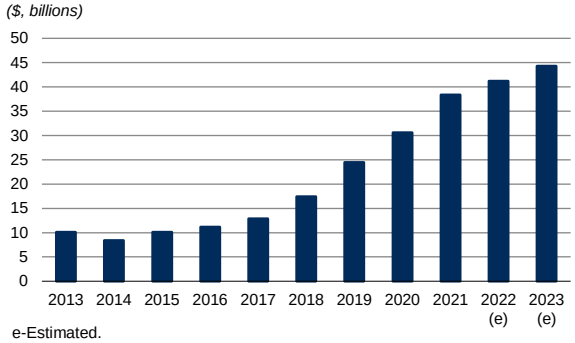
Mac Sales



e-Estimated.
Source: CFRA, company report.

- Apple began shipping its newest upgrades to the Mac product line during the December quarter. Apple's two new laptops come with notable upgrades to the display (14-inch and 16-inch), two internal chip designs that offer superior processor/GPU models (M1 Pro and M1 Max) and more. CFRA believes both these devices saw robust demand, but constraints are likely limited upside. From our observation, PCs continue to have healthy backlogs, with low retail channel inventory.
- The company announced its most powerful internally designed chip at its Spring Event in March, the M1 Ultra (connects two M1 Max chips) that Apple claims is 8x faster than the M1. These chips are available alongside a newly unveiled desktop Mac Studio (starts at $1,999 with M1 Max/$3,999 with M1 Ultra) and can be combined with a new monitor, called Studio Display (works with any Mac), that starts at $1,600 (includes 27-inch 5K Retina screen, A13, USB-C ports). We think Apple's advancements on the chip design side gives it a major competitive advantage over peers.
- While traditional Windows-based PCs account for about 85% to 90% of the total market, CFRA expects Apple's Mac products to outperform the total space. Given the Mac's higher selling prices and margins, it remains an important business for the company.
- At the WWDC in June, Apple unveiled the new MacBook Air ($1,199 start price) and MacBook Pro ($1,299), which came with Apple's newly announced M2 chip. We think the M2 further distances it from competitor/Intel processors.

Apple Wearables, Home & Accessories

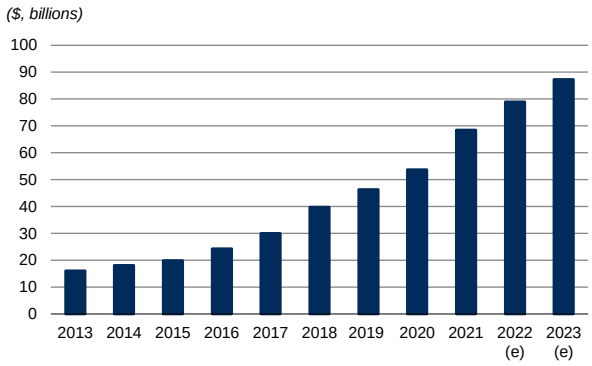


e-Estimated.

Source: CFRA, company report.

- CFRA thinks Apple looks to extend market share in existing markets for products in this category and expand into new addressable markets. Overall, we think Apple continues to do a great job sustaining its brand and steadily growing its revenue across existing core markets (e.g., iPhones, iPads, Macs).
- Although we expect this to still be the case, supported by a growing installed base, we think growth in Apple's core markets will decelerate to a snail's pace (0%-3%), with most of the revenue increases across these categories to be supported by higher average selling prices as Apple pushes more content to the customers.
- In 2023, we see potential for Apple to expand into addressable markets like gaming, with a mixed reality headset. Longer-term opportunities also include AR glasses that could expand both its hardware and software revenues.

Apple Services



e-Estimated.

Source: CFRA, company report.

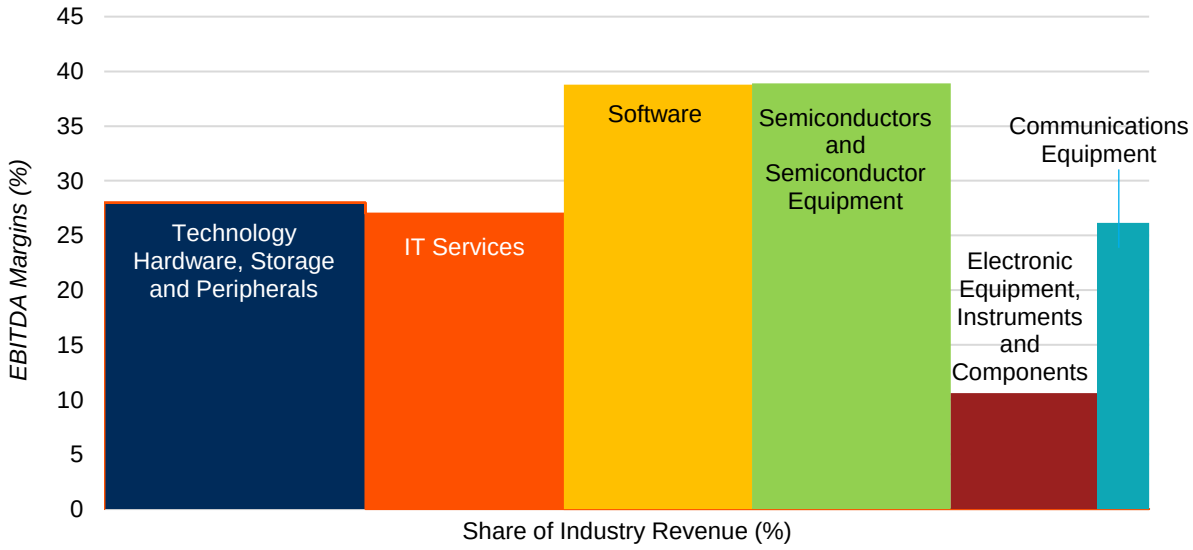
- Apple services revenue is expected to experience growth of 15% for FY 22 and 11% for FY 23, despite tougher comparisons and forex headwinds. Its services revenue has the potential to more than double over the next six years as we highlight three major growth opportunities – advertising, gaming, and bundling.
- Mobile in-game advertising will drive App Store growth, while new hardware capabilities in gaming could help support its subscription gaming business.
- Apple's bundling strategy provides more recurring-based revenue opportunities and consumers with greater savings. Hardware-as-a-Service could provide greater traction for Apple's bundles and shorten hardware replacement cycles.
- Apple's ecosystem and brand make it well positioned in the long term, as it has the potential to significantly expand its addressable market given it remains highly underpenetrated in many high-growth areas of tech. Apple's growing installed base/paid subscribers provides ample room to further monetize the iOS platform and expand its margin profile, a story that we believe remains underappreciated.

INDUSTRY TRENDS

2022 has so far been the complete opposite to 2021's growth story as headwinds from geopolitical tensions, rising inflation and interest rates, higher energy prices, and Covid-19 lockdowns in major cities in China did not help the growth of the technology hardware space. We conservatively forecast a no-growth environment for smartphones in 2023 and see a long-term growth rate of 0%-2% as we see the industry has matured and remains below peak unit shipments seen in 2016. Despite the expected decline in the PC/tablet market, we do see enterprise demand supporting sales, which we note command higher price points relative to consumer devices.

For 2022 and 2023, we expect supply constraints and new product releases tied to the metaverse and wearables to be among the most important developments to monitor for the space. Demand for data storage will be driven by content digitization of old media, the growing popularity of social networking websites, and longer record retention for compliance with government regulations, in our view. We think the storage software market will be driven by business continuity and disaster recovery efforts, compliance and risk management activities, and the increasing prevalence of data mining and related analytics. We see products related to all-flash arrays gaining momentum in the data center space.

PROFIT SHARE MAP OF INFORMATION TECHNOLOGY SECTOR*



*Companies within the S&P Composite 1500 Index as of September 22, 2022.
Source: CFRA, Company Reports.

The Technology Hardware, Storage & Peripherals industry is the largest industry (in terms of total revenue; 26%) in the Information Technology sector but had the third-lowest EBITDA margin (28%) in the 12 months ended September 22, 2022. Apple is the biggest revenue contributor for the industry, representing over 75.4% of industry revenue in the period. CFRA also notes that the iPhone maker has the highest EBITDA margin (33.9%) among its industry peers (10%-20%). Note that our analysis in this section is based only on constituents of the S&P Composite 1500 index.

PROFIT SHARE MAP OF TECHNOLOGY HARDWARE, STORAGE & PERIPHERALS INDUSTRY*

*Companies within the S&P Composite 1500 Index as of September 22, 2022.
Source: CFRA, Company Reports

Competitive Environment

Porter's Five Forces
Porter's five forces, which provide a framework for industry analysis, were formulated by Michael E. Porter of Harvard Business School in 1979. Below we describe the five parameters on which an industry can be analyzed, and how these apply to the technology hardware, storage & peripherals industry.

◆ **Threat of new entrants (Low-Medium).** To establish a business to compete with hardware manufacturers like Apple or HP requires a significant amount of capital and initial investments for technological resources and infrastructures. It is also difficult to create a strong brand to rival the existing incumbents within the hardware space. Nevertheless, large firms with the financial resources and solid distribution channels like Google could have the ability to enter the market. Hence, industry players will need to constantly innovate to remain competitive against the threat of new competition.

◆ **Threat of substitute (Low).** We think the threat of substitute varies considerably across different hardware within the industry but is generally low considering the industry. For example, many functions of traditional PCs can be easily substituted by smartphones or tablets but there are not many substitutes for these hardware products from other industries.

◆ **Bargaining power of customers (Medium).** Given the ample variety of products and multiple brands available in the market for technology hardware offerings, switching cost and customer loyalty is low, strengthening the bargaining power of customers. However, as most customers are individual buyers, each purchase is relatively small compared to a company's total sales. Overall, we think customers have a moderate bargaining power for the industry.

◆ **Bargaining power of suppliers (Low).** Many of the industry players have a large global supply chain that allows access to many suppliers across the world. Also, the concentration of technology hardware players is much higher compared to supplier concentration, which limits suppliers' power and influence over the industry.

◆ **Intensity of competitive rivalry (High).** The competition within the industry is strong across nearly all end-markets. Companies in this industry expend significant capital on research and development (R&D) and marketing. The rising competition from Chinese manufacturers has contributed to the intensified competitive landscape for companies in the industry. Low product differentiation and switching cost has also pushed manufacturers to resort to aggressive marketing and price cuts in efforts to attract and retain customers.

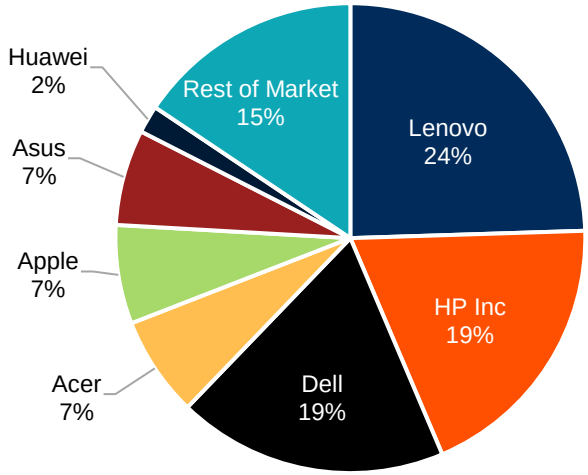
Russia-Ukraine Conflict – Impact Expected to be Minimal to Revenue

From CFRA's observation, impact from the current Russia-Ukraine crisis should be minimal to industry revenue (about less than 2% of total devices across the globe exposed to these regions). The bigger impact is certainly higher commodity costs, which could get pushed across the supply chain and to hardware manufacturers, which in turn will be pushed to the consumer. Sanctions have been placed globally alongside companies taking proactive measures to withdraw or suspend operations in Russia. Apple has pulled out of Russia and stands to forgo $1.14 billion annually from its Russian operations. HP Inc. noted that this crisis will have a negative impact to its top and bottom line in Q2 2022.

Personal Computers

Economic headwinds and recession fears have muted consumer sentiment and stopped IT projects, which reduced demand for worldwide personal computers (PCs) across the globe. According to IDC, the largest drivers of demand continue to be hybrid workforce and business recovery as remote users need PCs and this work model is here to stay; and recovery in business segments had gained steam. In Q2 2022, worldwide PC (desktop, notebook, and workstation) shipments fell 15.7% year-over-year to 71.1 million units. IDC expects education PC shipments continue to drop as there is a pivot toward in-class returns.

WORLDWIDE PC MARKET SHARE, Q2 2022



Source: IDC.

Lenovo remained the market share leader in Q2 2022, selling 17.4 million PCs, with a 24.5% share of global shipments (compared to 23.7% in Q2 2021). HP Inc. was in second, with 13.5 million PC shipments for a market share of 19.1% (22.1% in Q2 2021). In third, Dell sold 13.2 million devices for an 18.6% share (16.6% in Q2 2021) while Acer followed in fourth, shipping 4.9 million PCs for a 6.9% share (7.3% in Q2 2021). In fifth, Apple had a 6.8% market share (7.3% in Q2 2021), shipping about 4.8 million devices. Also, in the sixth spot is Asus with a 4.7% market share in Q2 2022 (5.9% in Q2 2021), shipping 4.7 million units.

The drivers for this year's growth centered around work from home, even as workplaces are welcoming back employees. We note gaming PCs, gaming notebooks, and monitor sales are at highs while Chrome-based devices are expanding beyond education into the consumer market. The pandemic has significantly expanded the installed base for the PC market and also fueled market expansion, both which should support a much more favorable sales growth for the industry in the years to come. Traditional desktop sales are expected to decrease going forward as notebook sales will increase further.

Feature Phones and Smartphones

CFRA anticipates that smartphone units will decline by about 5% to 7% in 2022 after rising by 5.7% in 2021. The decline is being led by softer consumer demand (specifically at the low-end of the market), inflation, geopolitical tensions, and supply chain constraints.

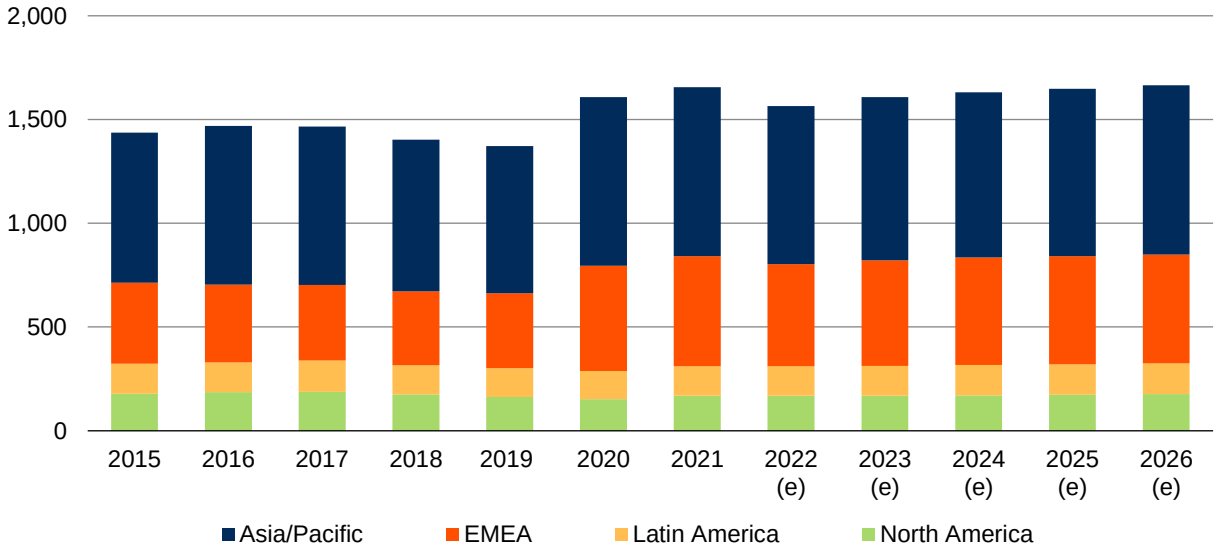
We conservatively forecast a no-growth environment for smartphones in 2023 and see a long-term growth rate of 0%-2% as the industry has matured and remains below peak unit shipments seen in 2016. We expect the market for 5G mobile phones to represent more than half of all sales in 2022. The premium segment of the market continues to perform better than expected, supporting higher average selling prices, as longer refresh rates have consumers opting for devices that will last longer than three years and support more capabilities than previous flagships.

In addition, IDC predicts that feature phone shipments will decline at a 10.4% CAGR from 295.7 million units in 2021 to 170.5 million units in 2026, whereas smartphone shipments will grow at a 1.9% CAGR from around 1.36 billion units in 2021 to 1.49 billion units in 2026. In 2022, feature phone shipments are projected to decline by 14.6% to 252.5 million units as a result of vendors and mobile operators transitioning their products portfolios away from feature phones and toward affordable entry-level smartphones. Telecom operators around the world are also urging users to upgrade their devices to smartphones. 5G phones are expected to make up 53.3% of all smartphone shipments by the end of the year. By 2026, 5G devices are expected to make up 69.6% of the worldwide mobile phone shipments, with 1,159.4 million units.

IDC forecasts average selling prices (ASPs) for smartphones will grow 3.5% in 2022, with an average price of $401.79 (a record high), up from $388.25 in 2021. From there, ASPs are expected to fall to $366.41 by 2026 as prices will fall due to more affordable 5G devices enter the market, according to IDC.

By region, Asia Pacific will continue to lead the worldwide smartphone market throughout IDC's forecast period because of its sheer size, healthy replacement rates in growing nations, and the expected availability of low-cost smartphones. By the end of 2022, Asia Pacific will account for 48.6% of all mobile phone shipments worldwide. Following at a distant second is EMEA, which will account for 31.4% of all smartphone shipments by 2022 and will dip slightly to 31.4% by the end of 2026. North America will stay ahead of Latin America for smartphone shipment volumes and share throughout the forecast period, with a combined market share of 19.5% by the end of 2026.

WORLDWIDE SMARTPHONE SHIPMENTS BY REGION
(in millions)



e-Estimated.
Source: IDC, June 2022.

Tablets

Worldwide tablet shipments declined 5.1% year-over-year in Q1 2022 as demand slowed, according to preliminary data from the International Data Corporation (IDC). For the full year 2022, total tablet shipments were expected to decline by 6.2% for a total of 158 million units.

Detachable tablets are expected to decline by 0.5% Y/Y for total shipments of 76.7 million units for 2022 as the main driving forces for detachable tablets are gaming and content creation. According to IDC, vendors continue to expect supply challenges throughout 2022 and will experience market recovery in 2023.

Android tablets are expected to dominate total tablet volume shipped during 2022 with 40% of total market around 94 million units. The tablet market went from high growth to a mature market over the last few years. This device category appears to be squeezed by the surge of large and foldable smartphones which turns to phablets (tablets in full mode), longer user ownership cycles, partially offset by the growing millennial workforce who are showing higher adoption rates of new technologies, including detachable and convertible notebooks.

Wearables – Robust Growth in 2022 and Beyond

Worldwide wearable shipments are expected to reach a total of 558.2 million units in 2022, making a 5% increase from the 533.6 million units shipped in 2021. The worldwide pandemic forced companies and customers to reassess their perspectives on wearables, citing the need for hearables for personal audio content consumption and interaction, smartwatches and wristbands with an expanded focus on health, and availability of lower-cost devices to meet tighter budgets.

By region, Asia Pacific will lead all the regions in wearable shipments, with its total volume comprising 54.6% of the total worldwide shipping volume in 2022. Asia Pacific hosts a multitude of successful companies that have sold low-cost wearable devices into specific markets, such as China. Thus, IDC forecasts the wearable shipments of Asia Pacific will grow by a five-year CAGR of 9.0%, to 404.2 million units by 2026. Latin America trails Asia Pacific, showing higher a CAGR (6%) than the worldwide market.

According to IDC, hearables are expected to account for the majority of all wearable devices for 64.3% of all volumes in 2022. By 2026, hearables will comprise about 63.4% of all wearable device shipments. Apart from audio content delivery of hearables, CFRA expects hearables to play a major role in the hearing-aid sector of health care. Watches and wristbands will follow next throughout IDC's forecast, standing collectively at 35.3% in 2022 and growing to 36% by 2026. Easy visibility and interaction with a device and keeping users' hands free to complete other tasks show that watches will have the upper hand and wristbands will lose market share gradually. Watches, meanwhile, will experience continued growth from the increasing popularity of smartwatches, hybrid watches, and kids' watches.

CFRA thinks the potential for wearables is exponential. The largest market to likely benefit from wearable devices is health care. Heart-rate monitoring, glucose monitoring, and sleep pattern recognition are a few of the many features wearable devices have implemented in recent years. This pandemic is believed to have accelerated the advances of wearable devices that focus more on health care.

Operating Environment

5th Generation Wireless Technology Driving Smartphone Demand

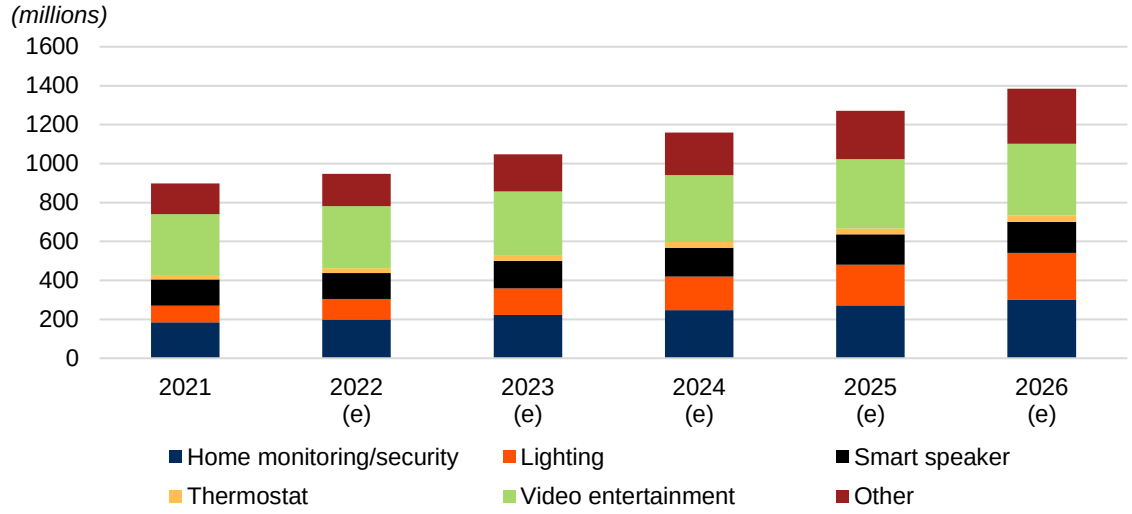
While some of the standards for 5G are still being established, all of the major U.S. carriers are fully focused on their 5G strategy, with AT&T, T-Mobile, and Verizon launching 5G networks and aggressively expanding those networks in 2022. CFRA thinks the coming 5G cycle should turn 2022 into a stronger year than it would have been.

CFRA expects strong end-user demand from carriers and end-users as more vendors transition their product portfolios to highlight 5G smartphones, and, more importantly, the arrival of affordable 5G handsets. For more information regarding 5G technology and the telecom industry, please refer to CFRA's industry surveys on *Telecommunications: Asia, Telecommunications: Europe*, and *Telecommunications: U.S*.

Greater Adoption of the Connected Home

Smart home technology enables nearly everything in our homes – whether it be our alarm system, air-conditioners, thermostats, lights, and garage doors – to be connected to the internet and be remotely controlled with our phones or smart speakers. CFRA believes that the biggest drivers to smart homes will be greater access to high-speed internet, with the rollout of 5G of course potentially creating a better-connected home experience, as well as the emergence of smarter assistants like Amazon Alexa and Google Assistant. We see adoption for the connected home growing quickly as these smart assistants become smarter and consumers increasingly become aware of the conveniences, cost savings, and energy efficiencies that smart home devices can provide. Growth will further be driven in part by high broadband penetration and increasing numbers of wireless home networks.

WORLDWIDE SMART HOME DEVICE SHIPMENTS



e-Estimated.
Source: IDC, August 2022.

CFRA notes that privacy and security concerns remain the biggest inhibitor to the connected home market as smart home systems will have access to a large amount of consumer data that could be transmitted incorrectly. We believe privacy and security concerns could potentially constrain demand for smarter devices in the near term and manufacturers will need to design with security/privacy in mind, but we think privacy concerns will alleviate over time like that seen in other areas of technology as the value proposition is well understood. Separately, high costs for many smart devices (e.g., smart bulbs) are currently an inhibitor and will need to come down over time to help spur adoption.

The market opportunity for the connected home has the potential for significant growth over the next few years. IDC projects that the number of smart home devices worldwide will grow to 947.2 million units in 2022 and 1.4 billion by 2026, compared to only 897.6 million units shipped in 2021. This would represent a growth of 5.5% in 2022 and a five-year CAGR of 5.7%. We envision the biggest growth opportunities coming from lighting, home monitoring/security, thermostat, and smart speakers, while the more mature video entertainment category witnessing the lowest growth trajectory. We note other devices – which include connected appliances, health monitoring devices, and sprinkler valve systems – are projected to grow at a robust CAGR of 8.2% over the next five years, but growth rates will be constrained by long replacement cycles.

From a geographic perspective, APAC is seen driving global shipments for connected devices. North America is seen comprising the largest share of smart home device shipments in 2022, at 47%, with an annual growth pace of 2.7% over the next five years. We believe the U.S. market is best positioned for growing adoption in the connected home given better access to high-internet speed, more federal incentives to improve energy efficiencies, and a wealthier nation capable on purchasing some of these higher priced items. The APAC region will comprise about 31.3% of connected device shipments in 2022 and the growth trajectory is seen at a CAGR of 15.6% over the next five years. However, CFRA thinks the lack of high-speed internet access coupled with the lack of affordability for these devices will limit upside potential from these regions. Latin America and EMEA are also seen growing at an annual pace of 9.1% to 12% over the next five years but coming from much lower levels.

Catch you in the Metaverse! Consumer Interest in Metaverse to Propel AR/VR Handsets

Although the concept of the metaverse is not new, we believe device sales related to AR/VR could increase significantly in 2022 (11.2 million units sold in 2021) given the commitment by Meta Platforms to drive consumer awareness along with our belief that Apple is poised to finally unveil its own mixed reality headset (design issues could push a release into 2023). Many believe the metaverse could emerge as the next evolution of the internet, presenting trillions of dollars of opportunities, and will be seen as a tangible revenue opportunity for hardware/semiconductor companies over the next year while it represents a longer tail for social media firms.

IMPORTANT TECHNOLOGIES THAT WILL BE THE CATALYST FOR A NEW SET OF PERIPHERALS

AUGMENTED REALITY	VIRTUAL REALITY
◆ Augmented Reality (AR) is a partly immersive experience in which users interact directly with a 3D overlay onto the external reality in real time ◆ Examples of AR technology devices include AR projections from phone devices, AR windshield on cars, and AR glasses ◆ Capabilities needed to advance this technology include common use higher resolution displays (e.g., 8K), more precise eye sensing and tracking technology to reduce lags and errors in display overlay, etc.	◆ Virtual reality (VR) is a fully immersive digital experience in which computer-graphics-rendered virtual worlds replace the real word ◆ Examples of VR technology devices include headsets for a fully immersive VR experience ◆ Capabilities needed to accelerate this technology include specialized lower-latency hardware, improved sensors that allow for full-body virtual tracking, etc.

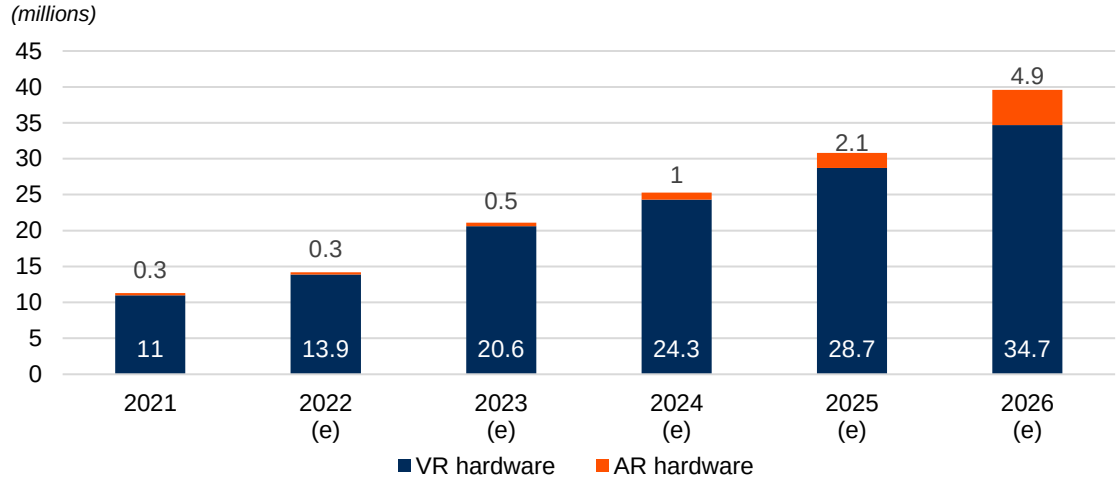
Source: McKinsey Technology Trends Outlook 2022.

Peripherals Market Poised for Expansion 10-20x From Today

Peripherals	Description
On-body sensors	On-body sensors are tools to track and identify users and the objects around them to accurately reflect their limb movements and the physical objects around them in the virtual world (e.g., devices that are handheld or concealed in wearables)
Off-body sensors	Off-body sensors allow for more precise recreation of elements of the physical world in virtual spaces with consumer applications like Nintendo Wii or enterprise applications such as spatial-mapping hardware
Haptics	Haptic devices (e.g., haptic gloves or vests) convey the sense of touch to the user with vibrations to augment virtual experiences
Holography and volumetric video	Holograms and volumetric video diffract light across multiple wave fronts to display high quality, 3D representations that can be seen without using a headset (e.g., Microsoft Mesh or Google Project Starline)
Electromyography (EMG)	EMG is a neuro technology that detects and records electrical activity from muscles to control movement and manipulate objects in virtual spaces and is being used in wearables to augment AR/VR headset devices
Microelectromechanical system (MEMS)	MEMS uses midair ultrasonic waves to allow users to physically feel tactile experiences without any wearables

Source: McKinsey Technology Trends Outlook 2022.

WORLDWIDE AUGMENTED AND VIRTUAL REALITY HARDWARE



Source: IDC, July 2022.

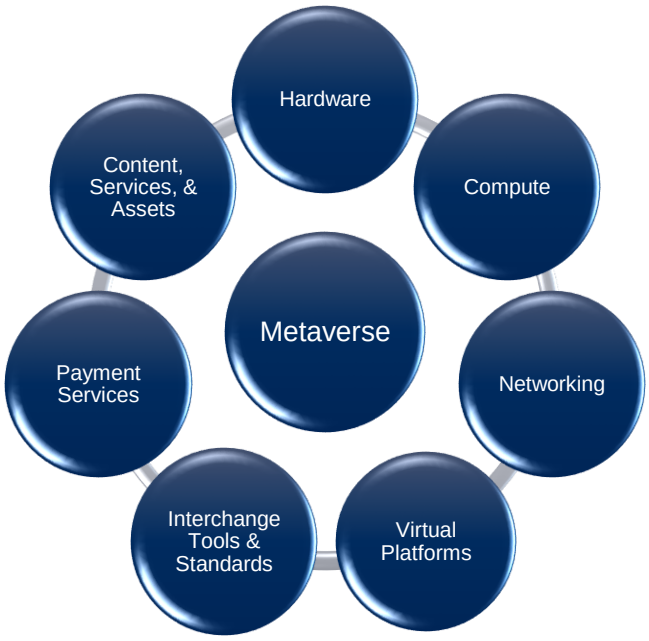
Some of the affordable hardware available in the market currently range from Google Cardboard's cheapest model Vusion V3 priced at $8.95, to the mid-range $399.99 Oculus Quest 2 headset and higher quality $999 Valve Index VR.

Metaverse is a word that was coined by author Neal Stephenson in his 1992 sci-fi novel Snow Crash. In the novel, Stephenson defined metaverse to be an all-encompassing digital world that exists parallel to the real world. Matthew Ball, a venture capitalist and angel investor, is one of the leading experts in the metaverse universe. In his own words, Metaverse is best understood as 'a quasi-successor state to the mobile internet' since Metaverse will not fundamentally replace the internet but will build upon and iteratively transform it.

Metaverse is a massively scaled and interoperable network of real-time rendered 3D virtual worlds that can be experienced synchronously and persistently by an effectively unlimited number of users, and with continuity of data, such as identity, history, entitlements, objects, communications, and payments, according to Ball. Recently, McKinsey predicted that the metaverse could generate up to $5 trillion in impact by 2030. Despite the big players like Meta and Google wanting to create metaverse, there is a growing sense of the "open metaverse" concept.

CFRA agrees with Ball's prediction that a full-fledged metaverse is decades away. Nonetheless, the hardware ecosystem that supports emerging technologies and trends could bring about an experience never seen before.

Core Enablers of the Metaverse



Source: Ball Metaverse Index

The Internet, Digitization, and Regulation Drive Enterprise Data Storage

The amount of data that enterprises generate is growing at an exponential rate. Business processes that used to be done on paper are being computerized. For example, all modern airplanes are designed using computer-aided design (CAD) software. This software enables testing to be done in a computer simulation rather than the traditional method of building physical prototypes, resulting in faster analysis and lower production costs.

There are several other drivers for the data storage explosion, in CFRA's view. In addition to the pervasive use of computing technology, we think the growth of the internet and e-commerce has increased the need to record data. We also think the increased usage of rich media content, which includes broadcast and shared audio, graphics, and video, has been a major factor for increased demand on data storage.

Globally, CFRA thinks the growth in emerging markets is also driving the increased need for regulation and oversight, as is the case with the enactment of the Japanese version of Sarbanes-Oxley, which requires firms to submit internal control reports on a consolidated basis starting with the fiscal years commencing on or after April 1, 2008. The requirements for J-Sox, as it is popularly known, will be modeled on the U.S. version in many ways and will therefore require many of the same data storage, archival, and retrieval technologies.

These requirements will likely boost overall interest in storage-related products because existing levels of capacity are likely to be insufficient to hold ever-expanding quantities of data. Under Sarbanes-Oxley, information needs to be stored for at least seven years. In addition, information must be protected, unaltered, well organized, and easily accessible. The protection aspect is a key component of the new law: It requires that records be stored in an unalterable way for them to be certified. Although the overall impact of compliance with these measures is still being determined, it will certainly force IT managers to reevaluate their ability to handle the potential inflow of large quantities of vital information.

Partially offsetting the rapid growth in the demand for enterprise data storage is the price decline in the cost per gigabyte of storage. Most critical data are stored on hard disk drives (HDDs). Due to new developments in HDD technology, such as perpendicular recording, the aerial density of disk storage devices has increased dramatically, similar to Moore's law in computing hardware, thus enabling more data to be stored on the same amount of physical space.

The Evolution of the Data Center

The way we compute has evolved through the years. During the 1970s and 1980s, the dominant computing platform was the mainframe computer. Mainframe computers were displaced in the late 1980s and early 1990s with the rise of PCs and low-cost servers, which established the model of distributed computing. As applications become more mission critical, the servers were moved into formal data centers, a facility used to house computers, networks, and storage systems. It generally includes redundant or backup power supplies, redundant data communications connections, air conditioning, and fire suppression and security devices. It also contains automated systems that constantly monitor server activity, Web traffic, and network performance. The growth in the number of servers has accelerated due to the rise of the internet.

The task of managing a data center has become increasingly difficult. Many data centers have simply run out of space. Another problem has been rising energy costs, which typically account for 40% of the cost of operating a data center. These two issues have been exacerbated by the fact that most servers are using only a fraction of their processing power. Data center operators describe the condition of having many servers running at very low utilization as "server sprawl."

Virtualization can alleviate server sprawl by consolidating many different types of workloads and operating systems onto virtual environments, all running on a single hardware platform. Using servers more efficiently involves fewer processing cycles; this, in turn, reduces cooling and ventilation requirements, along with energy usage. These benefits are consistent with the drive to be "green," or environmentally friendly.

HDDs Versus SSDs

Hard disk drives (HDDs), which store data magnetically on rotating rigid platters on a motor-driven spindle, offer several key advantages over other forms of electronic data storage. They can provide high storage capacity at relatively low costs, along with relative high-speed performance.

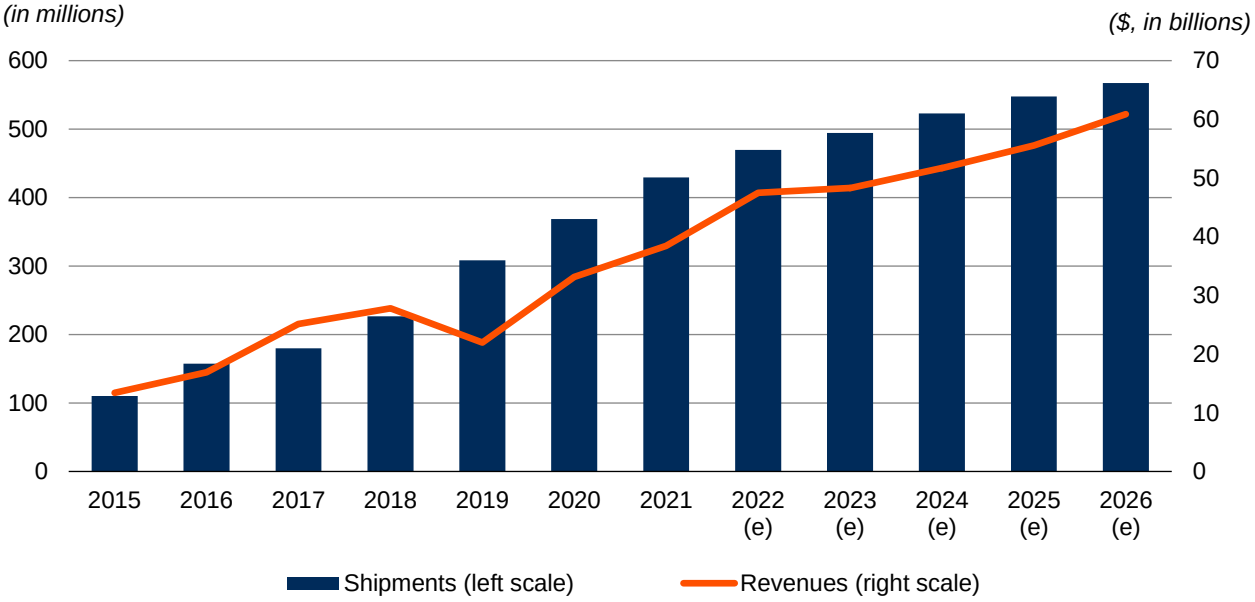
Solid-state drives (SSDs) are an alternative to HDDs. SSDs record, store, and retrieve digital data using integrated circuits (ICs) rather than magnetic. Because they do not have any moving parts, SSDs have faster read/write speeds. They also generate less heat and have lower power consumption. SSDs can come in smaller form factors than HDDs. However, SSDs are currently much more costly per GB and are available in much lower capacity points than hard drives.

With the rise in work/learn-from-home trends and digital infrastructure modernization, the demand for SSD is at its highest to-date. While it is expected for SSDs to continue making inroads in PCs, tablet computers, smartphones, and other mobile consumer electronic devices on the consumer side, we also see SSDs targeting enterprise applications, where the value proposition is based on cost per transaction or cost per input/output (I/O), rather than on cost per megabyte.

Below, IDC forecasts worldwide SSD units will grow at a CAGR of 5.7% between 2021 and 2026, with shipments exceeding 567 million units by 2026. In terms of revenue, worldwide SSD revenue expected to grow at a CAGR of 9.6% during the same period, reaching more than $60.8 billion in 2026.

WORLDWIDE SOLID-STATE DRIVE SHIPMENTS AND REVENUES

(in millions)



e-Estimated.

Source: IDC, May 2022.

HOW THE INDUSTRY OPERATES

Computer Form Factors

Just about every kind of computer comes in a variety of “form factors”—physical designs that play a large role in determining the computer’s potential uses and markets. The most common form factor distinction in the PC market is that between desktop and laptop (or portable) computers. Laptops contain similar electronics as desktops, but they must also meet a unique set of requirements, such as reduced power usage and heat generation.

Tablet computers are a form factor somewhere between netbooks and laptops. In 2010, Apple scored a hit in the tablet category with the introduction of its iPad product. (Note that many market researchers, including International Data Corp. (IDC), count devices like the iPad as a media tablet, and not as a tablet PC, which has a more robust, PC-like operating system.) The high consumer appetite for tablets has essentially eliminated the netbook market following the boom of 2009 and early 2010.

Servers and workstations also come in a variety of form factors. In the past decade, “blade” or rack-optimized servers, which are simply circuit boards designed to standard specifications, have become popular with corporations and other enterprises. They allow customers to create standardized, expandable computer racks and easily add or remove individual servers.

Over the last few years, smartphones, or mobile phones with increased functionalities (internet access, media player, global navigation system (GPS), mobile payment, to name a few) and applications have been replacing traditional mobile phones. Most smartphones now have touchscreen interface, which was revolutionized by the launch of the first iPhone in 2007. Android is the dominant operating system for the smartphones, followed by iOS.

Among the promising devices in recent years are wearables. These devices can be used as accessible extensions of other consumer devices such as smartphones, tablets, or PCs.

Assemblers, Distribution, Marketers, and Manufacturers

Technology hardware, storage & peripherals manufacturers look to sell innovative and differentiated products and to employ knowledgeable salespeople who can convey the value of the hardware and software integration and demonstrate the unique solutions that are available on its products.

Some technology hardware, storage & peripherals manufacturers, such as Apple, look to build and improve their distribution capabilities by expanding the number of their own retail stores worldwide. These retail stores are typically located at high-traffic locations in quality shopping malls and urban shopping districts. By operating its own stores and locating them in desirable high-traffic locations, Apple is well positioned to ensure a high-quality customer buying experience and attract new customers.

Companies like Apple and Microsoft are also committed to delivering solutions to help educators to teach and students to learn. These manufacturers believe that effective integration of technology into classroom instruction can result in higher levels of student achievement, and they have designed a range of products, services, and programs to address the needs of education customers. Manufacturers such as Apple and Microsoft sell their products to the education market through their direct sales force, select third-party resellers, and their online and retail stores.

Achieving the proper balance between direct and indirect sales initiatives can be problematic. Direct sales can lower costs but maintaining a strong partnership with distributors is critical to computer hardware vendors serving the enterprise market. In addition, sales of hardware through retail outlets—including manufacturers’ retail locations as well as mass merchandisers, consumer electronics retailers, computer superstores, warehouse clubs, and office products stores—have accelerated as consumer purchases

have accounted for a growing percentage of hardware sales. Growth in this area has come at the expense of other distribution channels.

Companies in the technology hardware, storage & peripherals industry also sell their hardware and software products to enterprise and government customers in different geographic segments. These customers often choose products based on performance, productivity, ease of use, and seamless integration into information technology environments.

Seasonal Sales Can Make or Break the Year

Technology hardware, storage & peripherals manufacturers face a variety of seasonal influences on their sales. These factors include differences in customs and business practices in other parts of the world, the retail cycle, and the year-end sales push for corporate hardware.

For vendors, the fourth quarter is traditionally the most significant revenue and earnings period. This is due to several factors. First, because most businesses close their books in December, managers often seek to deplete their capital spending budgets for fear of funding cutbacks the following year. Second, vendors often put significant financial incentives in place to spur the industry's legions of sales representatives to meet year-end sales goals. The fear of forfeiting large cash bonuses usually results in a sales surge during the fourth quarter.

With shipments to consumers accounting for a number approaching half of the worldwide total, the consumer market also plays a role in the seasonality of the technology hardware, storage & peripherals industry. Manufacturers now focus on gearing up for the back-to-school selling season and the later push for holiday purchases. Most vendors make substantial advertising and marketing outlays during the third and fourth quarters to capitalize on these important seasons.

In addition, many U.S.-based technology hardware, storage & peripherals vendors derive more than 40% of their revenues from international markets. This has a significant seasonal impact on sales, as well. For example, European businesses typically experience a summer slowdown in business activity. Most vendors have adjusted their business models and expectations to reflect the longer sales cycles and uneven demand patterns during the summer period in Europe.

Demand for Data Storage Exploding

Over the past decade, the volume of data being created has exploded. CFRA attributes this to the expansion of a variety of data-intensive applications (including online transactions), multimedia devices, and, particularly, multimedia content on the internet. For example, trillions of e-mails are generated on an annual basis. The growth in the number of instant messages and weblogs (or blogs) has only added to this phenomenon. As a result, fast and reliable data storage has become ever more vital.

This explosion of data has increased the complexity involved in managing secure access to information, leading to increased emphasis on storage software solutions. Environmental concerns also have become a key economic driver, with storage vendors addressing ways in which they can reduce the energy requirements of data centers by making storage more efficient.

Product Overview: Storage

The computer storage industry is a broad and dynamic market. CFRA's discussion focuses on the following categories: storage systems, software, components (host bus adapters (HBAs) and switches), disk drives, flash memory, and tape products.

Disk Storage Systems

The storage systems market is broad. Products in this arena serve the entire market spectrum, from low-end applications up to and including the enterprise segment. These systems are used for a variety of functions, including the storing, backup, prioritization, management, and disposal of critical pieces of information.

A growing portion of the systems market is focused on devices that are networked, rather than attached directly to a server. Networked devices may be based on storage area network (SAN) architecture or network-attached storage (NAS) architecture (both described below). Certain operating environments use both technologies, making them complementary storage solutions.

◆ **Storage area network.** This architecture involves the creation of a private network that moves data in block format directly to servers. The storage area network (SAN) exists as a complementary network to the local area network (LAN): The creation of the SAN allows the LAN to offload some of its data-intensive traffic, thereby improving overall performance and creating a central hub for storage management.

◆ **Network-attached storage.** This architecture is attached directly to the network through a high-end server. A network-attached storage (NAS) setup converts the block data to files and delivers them over a LAN to servers or PCs.

Software

In recent years, software has become an increasingly relevant offering for storage vendors. Many companies have looked to software to supplement their existing product lines. Software has numerous advantages over hardware, including less labor-intensive manufacturing and higher gross margin potential. Intuitively, the move to distribute software makes sense. Customers that are interested in purchasing a particular hardware product often need software to run the necessary applications. A storage company that develops its own hardware/software solution can seize the opportunity to satisfy all the customer's requirements.

Hardware providers have incorporated the "open system" concept—configuring their software so it can run on other companies' machines—into their software portfolios. In the past, they typically required customers to purchase both the storage hardware and software in a bundled package, meaning the customer had to use the same vendor for both. Today, a customer that wants to use EMC's hardware has the option to use another company's storage software.

Components

Components are parts used in the configuration of networked storage architectures. The two main categories within this field are HBAs and switches.

◆ **HBAs.** Cards that fit into a computer, server, or mainframe, and are linked to a storage device or storage network to allow servers to connect to storage networks. The two principal competitors in this industry segment are Emulex Corp. and QLogic Corp., which combined, dominate the market.

◆ **Switches.** Switches are devices that filter packets of information between LAN segments. There are two primary types: fabric and director class. Fabric switches typically provide fewer than 32 ports and are deployed at the edge of a SAN. Director-class switches offer 32 or more ports and are installed within the SAN. The two major providers in this field are Brocade Communications Systems Inc. (including acquired McData Corp.) and Cisco Systems Inc.

Switches and HBAs both use a networking technology known as Fibre Channel (FC), which facilitates the transmission of data between computer devices. Introduced in 1994, FC was the first networking technology to be widely adopted by the major industry participants. It typically transmits data at speeds of up to four gigabits per second. Of late, the internet small computer interface (iSCSI) protocol is becoming increasingly popular as a SAN interconnect technology. From a host storage interface perspective, iSCSI tends to be less expensive. FC, on the other hand, provides more flexibility in terms of distance, flexible topologies, and the number of devices and servers that can be attached.

Hard Disk Drives

Despite their multitude of uses, all hard disk drives (HDDs) employ the same basic technology. One or more hard disks are attached to a spindle assembly, which is powered by a spindle motor that rotates the disks at a constant speed around a hub. The disks are the sites at which data are retrieved and stored.

Demand for HDDs is influenced by a number of factors, including improvements in computing price-to-performance ratios, the digitization of printed information, the increase in file sizes, growth in emerging economies, and expansion of this technology into consumer electronics equipment. HDD performance is often measured in terms of aerial density, which is the storage capacity per square inch on the recording surface of a disk.

Consolidation over the last few years has caused the disk drive industry to become more concentrated. Today, HDD manufacturers Seagate Technology and Western Digital dominate about 79.5% of the total market.

Storage capacity can vary widely, depending on the product offering and end market being served, and it has increased greatly since mid-2006. New technologies, like perpendicular magnetic recording, are responsible for increasing drive capacities. Technological innovation has also reduced the number of components used in making HDDs, which significantly lowers their cost and increases their reliability.

Flash Memory/Solid-State Drives

Other products receiving more attention today are devices based on flash memory technology—a type of nonvolatile memory in which the memory pattern is erased by very large arrays of bytes. There are two main kinds of flash memory. The first is NAND, which is primarily used for storing large quantities of data. The second, NOR, offers faster read speeds and is more suitable for applications such as cellular phones. Because flash memory has been incorporated into a host of consumer-related products, it has broadened the storage industry's addressable market.

In January 2009, SanDisk Corp. announced the availability of a 240 GB solid-state drive (SSD) for PCs. Compared with conventional platter HDD technology, the SSD has no moving parts and consumes less power. As a result, SSDs allow laptop battery charges to last longer and the laptop battery's useful life to be extended (due to fewer charging cycles and the longer intervals between recharges).

Because SSDs are based on flash memory technology, they provide faster access times and generate less heat—both of which are differentiating advantages. CFRA thinks that ongoing pricing declines have now made SSDs a serious threat to conventional HDDs.

Tape Products

Tape-based storage is another option for customers in need of information management solutions. This process involves reading data and then writing the data onto tape. Tape-based storage tends to be used for data that are less relevant to the ongoing operations of a business and need to be accessed infrequently.

Tape storage is sometimes combined with a disk-based backup system to provide an additional layer of protection and replication. The advantage to using tape is that it is typically less expensive and more energy efficient than disk storage. On the downside, tape's speed and functionality, while improving, are generally not as robust as those of similar disk-based products.

Operational Factors

The operations of a company in the technology hardware, storage & peripherals industry are influenced by a variety of factors. The following section details what CFRA thinks are some of the most important considerations for firms in this industry.

Production Requirements

Successful companies in the hardware/storage industry must make significant investments in components, equipment, people, and real estate. They may manufacture their products internally or by outsourcing, and they can operate in locations throughout the world, depending on the costs, customer requirements, and supply chain logistics. Asia has become a particularly attractive manufacturing location, with its growing economies, lower labor and materials costs, tax incentives, and well-educated workforce.

Given the complex nature of the space, companies must hire workers with highly specialized backgrounds and skill sets to develop state-of-the-art offerings and stay competitive. Company research teams are usually characterized by an abundance of engineers, many of whom possess PhDs. In addition, companies typically offer ongoing training to ensure that employees stay abreast of current marketplace trends.

Customer Base

Traditionally, many of the larger hardware/storage providers have focused their resources on the so-called enterprise market: large organizations, such as corporations and government agencies. Products for this market offer massive amounts of capacity, as well as state-of-the-art capabilities with respect to efficiency, reliability, and speed, and can cost as much as several hundred thousand dollars. More recently, the industry has enhanced its focus on the middle and lower tiers of the market by presenting products that offer many of the same high-end features, but at a fraction of the price.

Competition

A variety of factors influences the competitive landscape of the technology hardware, storage & peripherals industry. From evolving technologies, to pricing pressures, to research and development (R&D), the sector is in a state of perpetual motion. For these reasons, size matters, and the industry's entry barriers are high.

◆ **Scale.** Despite inherent differences, the industry's product segments have many similarities in terms of competition. First, size matters. The leading companies can meet the changing needs of their customers, given the breadth of their product lines and devotion to investing in R&D. The biggest firms can initiate and/or weather price reductions because of their more efficient operating structures. These manufacturing efficiencies are attributable not only to economies of scale, but also to cost-reduction initiatives implemented after the bursting of the internet bubble.

◆ **Barriers to entry.** The industry has high barriers to entry. The level of technical expertise required and the amount of money that must be allocated toward R&D make it exceedingly difficult for new entrants to gain traction in this market. In addition, established companies typically have experienced management teams that can develop successful business strategies and stave off upstart companies. Many existing companies have developed multiple patents to protect their intellectual property.

Pricing Trends

Pricing trends differ based on what area of the technology hardware, storage & peripherals industry a company is exposed to. However, pricing is typically biased to the downside in almost all cases. Oftentimes, the degree of price swings will be dependent on supply/demand imbalances, new product introductions, and individual company strategies.

During the market downturn in 2000 and 2001, price competition grew vicious in many parts of the space as demand evaporated with very little warning. Companies were forced to offer their products at drastic discounts to stimulate customer interest. This defensive strategy eroded profitability by pressuring gross margins. However, proactive companies were able to offset some of this shortfall by implementing major cost-reduction efforts and lowering corporate operating expenses. While the severity of price discounting has largely subsided, there are still pockets of the industry that are experiencing intense pricing battles.

In the past, makers of HDDs tended to experience more abrupt price swings than other areas of the storage market, in CFRA's estimation. We think this resulted from the difficulty in anticipating near-term demand and the limited lead times often associated with the production process. However, we note that consolidation has moderated annual price declines.

Product Cycles

The ability to determine the life cycle of a particular product is a key management consideration. If a product is allowed to stay in the marketplace for an excessive period, the company risks declining revenues and the ceding of market share to peers with more formidable offerings. At the same time, pulling a product too quickly in favor of an updated version may result in unnecessary expenses and the cannibalization of a company's wares.

Product cycle times can vary from just a few months to several years, depending on the level of competition, companies' emphasis on R&D, and consumer demand. Customers tend to watch these cycles closely; if they are interested in purchasing a new device, but expect an updated version to be released soon, they may decide to wait to take advantage of the newer offering.

Distribution and Alliances

Storage systems and components are sold through multiple outlets, including directly to original equipment manufacturers (OEMs) and through various partner and channel relationships. In most instances, partnerships create "win-win" opportunities for the affiliated companies. One example is the ongoing relationship between EMC and Dell. Their agreement involves joint product manufacturing, marketing, and collaboration on product design and technologies. EMC has been able to take advantage of Dell's world-renowned production capabilities and to expand its global reach by leveraging Dell's customer base. In turn, Dell has been able to build out its storage product portfolio by relying on EMC's broad experience and technical expertise.

Inventory

Inventory levels are an important consideration when determining product demand and the success of a company's sales strategies. There is considerable risk in shipping too many products based on the assumption that demand is likely to improve in the near term. If a company or one of its channel partners incorrectly forecasts demand trends, it may have to cut prices to stimulate purchases and to reduce product levels to avoid obsolescence. Conversely, keeping inventory levels too low can result in missed opportunities, should demand patterns exceed expectations.

HOW TO ANALYZE A COMPANY IN THIS INDUSTRY

Rapid technological changes make it imperative for analysts and investors to go beyond traditional quantitative methods in assessing the outlook of a company in the technology hardware, storage & peripherals industry. To be sure, financial statement analysis is a critical ingredient in determining the prospects of any company. However, qualitative judgments must also be made about technology, competition, business and marketing strategies, and the credibility and potential of a company's management team, as well as prospects for the industry.

Analysis of the quantitative and qualitative aspects of a company in the technology hardware, storage & peripherals industry should be considered within the context of the omnipresent threats and opportunities posed by new technology. Again, rapid changes are key characteristics of the industry, and how well a company manages this variable can determine whether it emerges as an industry leader, becomes a second- or third-tier player, or fails to make the grade.

The history of the computer industry contains vivid examples of companies with dominant franchises that failed to keep up with technological shifts away from their core markets. Apple Inc., Digital Equipment Corp. (DEC), and International Business Machines Corp. (IBM) all dominated key segments of the technology hardware, storage & peripherals industry, only to see their positions deteriorate as the market shifted toward faster, cheaper, and more functional products. Their declining positions eventually showed up on the companies' financial statements, but an investor attuned to industry dynamics would have been alerted by earlier clues.

Knowledge of general economic conditions affecting business in general and the computer industry in particular is essential in determining conditions within the data storage industry. A key indicator within the overall economic picture is the level of spending by enterprise customers, which determines the near-term flow of dollars to the storage industry. To assess an individual company's situation within this environment, it is important to consider both qualitative and quantitative factors affecting its condition, as detailed below.

Comparative Analysis Is Critical

An investor must identify a company's competitive advantages—and its disadvantages. What are the company's key products and markets, and how does it differentiate itself from its peers? How does its current strategy compare with its plans for the future, and how do they both compare with the strategies of competitors? Has management been able to articulate strategy, and does its past performance indicate it will be successful in executing its plans? Does the company have an edge over its competitors? If so, is it likely to maintain that edge?

An investor needs to understand how each company has positioned itself concerning these factors and whether the strategy makes sense, given the trend seen for overall market demand.

Peer Comparisons

An important consideration when looking at relative valuation measures—such as price-to-earnings (P/E), price-to-sales (P/S), or any other metric that involves comparing a company with its peers—it is important to find the best like-for-like comparison. In order to ascribe a multiple based on relative valuation to a particular vendor in the storage group, it is important to consider the makeup of its revenue and earnings and decide which of its peers compare most closely. Barring major structural or fundamental differences, companies with the same product focus and addressing common target markets tend to be valued similarly.

Growth Is Relative

How does a company's financial performance compare with others in its peer group? Again, while absolute numbers are an important part of the financial assessment of any company, comparing

performance and financial ratios with those of its peers is critical. For example, it is clearly a cause for concern if a company achieved revenue growth of 5% in a year in which the average industry growth rate was 10%. Why did the company underperform? Similarly, if a company's growth outpaces the average, investors will want to uncover the reasons. Is that above-average growth rate sustainable?

The next step is to consider the growth rate for the particular industry segments in which the company participates. The outlook for mainframe computers, for example, differs from the higher growth prospects for PCs and servers.

Finally, the financial results of a company should always be considered within the context of the markets it serves. Does the company primarily serve the consumer or corporate market for PCs? In which geographic areas does it participate? What is the company's growth relative to its competition in these geographic areas and the market's overall growth potential? A company's geographic footprint can affect its effective tax rate, as well as revenue potential and production cost levels; tax rates typically head lower as more operations occur outside the U.S.

Quantitative Analysis: Looking at Financial Statements

Analyzing a company's principal financial documents—the income statement and the balance sheet—provides an important base for assessing its overall performance.

An investor can gauge the fundamental strength of a storage vendor by identifying the markets in which it competes and understanding their dynamics. What are the overall growth expectations for those markets? It is also important to determine the level of competition in a company's particular market segments. Who are its major competitors? Are there many small competitors or a few large firms wielding significant resources? How does the company stack up against them, and what are its particular advantages? One possible advantage is size; another might be the overall breadth of its product line.

The ability to adapt quickly to technological change is another key factor. As faster and more efficient products pique the interest of customers, it is critical that a company respond proactively to deliver those products in a timely manner. Companies that are unable to do so risk losing market share and may face additional expenses related to obsolete inventory. Somewhat related to technological change is the effect of regulatory issues placed on the business needs of the customer base. More specifically, absent a standard or technical specification, vendors within the industry can often differentiate themselves from competitors by their approach to satisfying storage-related compliance issues.

A further qualitative point to research is management ability. Clues about a company's management team can be obtained by looking at its history. What is its record? How long have the high-ranking managers been with the company? If they recently took control, what have they done previously? It is also preferable for managers to own stock or options in the company. This helps to ensure that they have the incentive to do what is best for the shareholders—that is, to create shareholder value.

Key Elements on the Income Statement

A company's income statement shows its operating results over a specific period and thus is a key part of any analytical endeavor. An investor should determine the components and trends of a company's profits, and then compare these results with those of its competitors.

◆ **Sales trends.** Beginning at the top of the income statement, investors should look at short-term and long-term growth trends in revenues. Ideally, sales in the current period should show growth from the year-earlier period. Moreover, if the company participates in a high-growth industry, or if it is in the early stage of a new product cycle, sequential growth (from one quarter to the next) would be expected, though seasonal factors should also be considered. In addition, sales growth should be compared with that of direct competitors and against the overall industry rate. Revenues derived by data storage vendors tend to follow a seasonal pattern, in which the last quarter of the calendar year is often the strongest. CFRA

thinks this is largely the result of corporate information technology (IT) departments accelerating their level of spending late in the year to use up allotted funds—a process often referred to as a budget flush.

Watch Out! *When companies accelerate revenue into the current period, they are essentially "stealing" revenue from future periods. As such, the reported revenue growth during a period in which revenue has been accelerated is likely unsustainable. There are many available tactics that management can use to accelerate revenue, some of which include allocating a higher proportion of transaction price to elements delivered upfront in contracts with multiple deliverables or performance obligations, faster recognition of deferred revenue, or large shipments at period-end.*

◆ **Gross profit margin.** This is arguably one of the most important profitability measures to consider in assessing a company in the technology hardware, storage & peripherals industry. Gross margins (the percentage of sales remaining after subtracting the cost of goods sold or costs such as materials, labor, and overhead) can be affected by a number of variables, including sales mix, sales volumes, pricing pressures, and component costs.

Significant gross margin pressure has been the norm in the technology hardware, storage & peripherals industry in recent years, as pricing competition has intensified. Successful companies have been able to counter margin pressure somewhat by adding a higher-margin mix of products, improving their manufacturing efficiency, and maintaining lean inventory levels.

A drop in gross margin may reveal that a vendor has changed its bidding policies to use price as a competitive weapon to win contracts. Although price cuts reduce a contract's profitability, they often increase the company's overall business volume.

◆ **Expense line items.** These include selling, general, and administrative (SG&A) costs, and research and development (R&D) costs, which should be evaluated relative to industry norms. Ideally, expenses should increase more slowly than sales. However, technology companies with high-growth prospects sometimes must expand their workforce rapidly to support sales growth and/or new product development. In such years, their expenses can rise faster than sales.

Watch Out! *Technology Hardware, Storage, & Peripherals companies generally incur substantial costs related to R&D. Under US GAAP, R&D costs must be expensed as incurred. A sharp decline in R&D costs relative to sales raises concern that a company may be delaying or cutting back on R&D costs in the current period to boost earnings. This practice may benefit current period earnings at the expense of future earnings as the company suffers due to inadequate investment in new products resulting from lower R&D. Management should be questioned in any instance where R&D costs are not being expensed as incurred, and any boost to earnings growth from abnormally low R&D expense should be deemed unsustainable.*

◆ **Net profit margin.** This is the bottom line and is calculated as net income divided by total sales. Along with operating performance, it reflects a company's taxes and its nonoperating income and expense items, such as interest income and interest expense. As many companies have reduced debt levels and improved operating efficiencies, net profit margins have improved in recent periods.

Watch Out! *Significant and/or recurring use of special charges is a red flag that a company may be using special charges to flatter non-GAAP results. Specifically, we caution that companies may boost non-GAAP earnings in the current period by bundling normal, recurring costs into the special charges.*

Balance Sheet Provides Clues to Future Results

How strong is a company's financial position? The balance sheet offers a snapshot of the company's financial position at a specific moment in time. Some factors to study include the ratio of long-term debt-to-capital, current assets, the current ratio, inventories, and accounts receivable.

◆ **Ratio of long-term debt-to-capital.** Long-term debt as a percentage of total capital varies widely among computer makers. Low debt levels give a company the financial flexibility to acquire emerging technologies or other technology companies and minimize interest expense.

◆ **Cash and investments.** This metric indicates a company's ability to meet near-term debt obligations, make acquisitions, repurchase stock, and/or pay dividends. This line item has become more of a focal point in recent years, as many data storage vendors have looked to expand their product lines by making strategic acquisitions.

◆ **Current assets.** Also important in the analysis of a technology company is a careful examination of current assets. Is the company headed for a potential cash crunch? The level of cash and marketable securities is usually a good starting point for assessing a company's short-term liquidity. Because the technology hardware, storage & peripherals industry is subject to wide swings in profitability, most companies require a reasonable level of cash and cash equivalents for emergency liquidity and growth needs.

◆ **Current ratio.** Another check on liquidity is the current ratio (the ratio of current assets to current liabilities), also called the working capital ratio. A healthy working capital ratio helps to ensure that the company can adequately meet its current liabilities; this ratio should be greater than one. Any meaningful degradation in the current ratio from previous reporting periods should be closely examined.

◆ **Inventories.** Given the technology hardware, storage & peripherals industry's tendencies toward rapid price declines and inventory obsolescence, the level and health of a company's inventory position must be constantly monitored. When inventory levels increase faster than the rate of sales growth, it can signal either potential opportunity or potential trouble. For example, it may be that the company is gearing up for heightened business activity, such as in the early stages of a new product cycle. Alternatively, it could be a red flag signaling that existing products are not selling well.

How fast is the company turning over its inventory? This is a critical question companies are increasingly asking themselves on two levels: as a clue to manufacturing efficiency and as a tool for cash-management optimization. Product sitting on a shelf in a warehouse ties up assets that could be better deployed (*e.g.,* put toward investments in future growth). A key measure to watch is the inventory turnover ratio (the annualized cost of goods sold divided by the value of average inventory), which measures the average speed at which inventories move to sales. Any meaningful change in inventories or turnover rates should be investigated.

Watch Out! *Inventory represents one of the most substantial assets on the balance sheets of Technology Hardware, Storage, & Peripherals companies and can be a leading indicator of financial condition. Therefore, a company's choices with respect to inventory accounting can have a significant impact on its results. Analysts should assess whether a company has changed its inventory costing methodology, as this can impact comparability (and potentially flatter results) versus prior periods. Similarly, when analyzing a company relative to its peers, it is important to identify any differences in inventory costing policies between the companies.*

◆ **Deferred revenue.** This metric encompasses revenue that has been received by the company for work that it has not yet performed. Such revenue is classified as a liability on the balance sheet until the product or service is provided to the customer. CFRA thinks that this category is useful to investors, as it offers a peek into a company's revenue potential.

◆ **Accounts receivable.** An analysis of accounts receivable can provide insight into how well a company's products are selling. A rise in the level of accounts receivable may indicate that a significant portion of sales was made in the last few weeks of the quarter. Although many technology companies experience this type of sales trend (sometimes described as a "hockey stick"), it could signal that price concessions or generous payment terms had to be extended to pump up sales. However, as the technology hardware, storage & peripherals industry becomes more global, accounts receivable could generally trend higher as a matter of logistics. One way to track accounts receivable is by measuring the days' sales outstanding. Simply divide accounts receivable by sales for a given quarter and multiply by 91.

Free Cash Flow

When valuing a data storage firm, an important measure is free cash flow—the amount of excess cash the company has available after paying off its obligations. The investor should determine how the company expects to use its free cash flow. Possible strategies include repurchasing shares of the company's common stock, paying dividends to shareholders, reinvesting the cash in the business, or pursuing acquisitions. Generally, a company in a growth stage will pump its cash back into the business to fuel further growth. Mature companies that do not earn a high enough return on their invested capital may elect to pay out the cash to their shareholders through dividends or share repurchases.

Performance and Valuation Metrics to Consider

Drawing from both the income statement and the balance sheet, two important measures of a company's overall financial performance are return on assets (ROA) and return on equity (ROE). These measures, along with growth projections, provide key indicators for a valuation analysis.

In evaluating the relative attractiveness of a company's current stock price, performance metrics and growth rates should be considered alongside price-related valuation ratios such as price/earnings, price/sales, and price/cash flow. The investor should compare valuation ratios with the company's own historical ratios and with those of peer companies and the overall stock market.

◆ **ROA and ROE.** Any financial statement analysis would be incomplete without some discussion of return on investment, of which the two most popular measures are return on assets (ROA) and return on equity (ROE). ROA (net income divided by average total assets) measures a company's operating efficiency, or the return earned on assets under management's discretion. ROE (net income divided by average total shareholders' equity) measures the return earned on shareholders' capital. Both ratios measure management's ability to earn a reasonable profit on the assets and capital entrusted to them.

IBM struggled with these metrics in the early 1990s as customers transitioned away from the old-style mainframe platform to the more popular PC, and the company posted losses through 1993. Since then, newer IBM products and a strategy that emphasized higher growth opportunities in software and services have generated steady improvement in the company's ROA and ROE measures.

◆ **P/E and PEG.** The term price-to-earnings (P/E) refers to the P/E ratio of a stock. To arrive at this figure, simply take the stock price and divide by the current year's projected earnings. For a forward projection, one can use the forecasted earnings for the next year. A variation of this ratio, which can be used to weigh the strength of earnings growth as part of valuation assessments for a given company relative to its peers, is referred to as the P/E-to-growth (PEG) ratio, or the P/E divided by the company's projected average five-year earnings growth rate.

In CFRA's view, when the economic environment is relatively stable or on an uptrend, data storage companies are valued based on their profitability. In this environment, the most common valuation metrics used are P/E ratio and multiples of operating profits. Although the data storage industry is no longer viewed as a fast-growing segment, we project that it will outpace the rest of the IT industry and the overall market. Thus, we estimate that the average P/E ratio for the data storage industry should be above that of the overall market, reflecting its higher growth potential.

◆ **P/S ratio.** The price-to-sales (P/S) ratio is derived by dividing the current share price of the company by its projected revenues for the current year on a per-share basis. This ratio is used in times when earnings are not available (*e.g.*, the company is operating at a loss), or when earnings forecasts are in question.

◆ **P/CF ratio.** To calculate price-to-cash flow (P/CF) ratio, take the company's stock price, and divide it by the sum of the current year's forecasted cash flow. The most commonly used proxy for a company's cash flow is earnings before interest, taxes, and depreciation and amortization (EBITDA). The real-world use of this ratio is generally derived using the forecast of EBITDA for the next year. P/CF is typically used in cases where a company's earnings are penalized by high capital intensity.

GLOSSARY

Aerial density—A measure of storage capacity per square inch on the recording surface of a disk.

Architecture—The overall design of the computer; it governs the interrelations between the operating system and the physical hardware. Intel-compatible computers all have the same architecture, usually referred to as Standard Intel Architecture. Apple Macintosh computers, IBM mainframes, and Sun servers running UNIX each have different architectures. "Open architecture" allows other manufacturers to design compatible devices; a closed architecture, in contrast, has a proprietary design.

Broadband—A class of internet connections, including cable modems, digital subscriber lines, satellite systems, and Wi-Fi, that offer higher capacity and faster data transfer speeds than those available through a modem using ordinary telephone lines.

Channel—The group of distributors and resellers used by an original equipment manufacturer (OEM) to sell its product, as distinct from sales made directly to end users. Channel partners (*i.e.*, retailers or other marketers) may buy from the OEM directly or from a distributor.

Database—A computer-based collection of information or data files, organized and presented to serve a specific purpose.

Data center—A building, dedicated space within a building, or a group of buildings used to house servers and associated components, such as telecommunications and storage systems.

Detachable—This device is typically a fully-featured tablet, which is connected to a docking device to provide users with a full keyboard. When connected, the tablet becomes the "screen" of the laptop

Disk drive—An internal or peripheral device on which data can be stored and retrieved; used in all sizes of computers.

Fibre channel (FC)—A networking technology used to transmit data between computer devices. It is the primary connection type used in a storage area network (SAN).

Flash memory—A type of nonvolatile memory in which the memory pattern is erased by very large arrays of bytes.

Form factor—The physical form in which a computer's components are packaged. In the PC market, laptops have recently overtaken desktop computers as the predominant form factor, and mini notebooks (also known as netbook computers) are gaining popularity. Tablet computers, which are positioned between traditional laptops and the smaller, less robust netbooks, are also seeing new interest.

GB—One gigabyte, or 1,000 megabytes; a unit by which computer memory and data transfer speeds are measured.

Hard disk drive (HDD)—A device that reads and writes data on a hard disk. It is used for information storage and retrieval.

Hardware—The physical components of a computer system, as opposed to the software that makes the system or its applications run.

Internet—A public network connecting many computer networks and based on a common addressing and communications system called TCP/IP (transmission control protocol/internet Protocol).

Linux—A variant of the UNIX operating system that is "open source," meaning that users can freely modify it. Linux is increasingly popular for running corporate servers but is a lesser force in desktop computing. (See *UNIX*.)

Local area network (LAN)—Interconnected workstations sharing the resources of a single processor or server within relative proximity.

Mainframe—A large, expensive computer capable of supporting hundreds, or even thousands, of users simultaneously.

Network—A collection of hardware, communications facilities, and software that gives computers access to shared resources (*e.g.,* databases) and peripheral devices (*e.g.,* printers and modems).

Network-attached storage (NAS)—Storage attached directly to the network through a high-end server.

Operating system—Software that controls the inner workings of the computer. It performs basic housekeeping chores such as recognizing input from the keyboard, keeping track of files and directories, and controlling peripheral devices. Most PCs run on the same operating system, Microsoft Windows, but servers use a variety of different operating systems, including UNIX, Linux, and others, in addition to Windows.

Original equipment manufacturer (OEM)—In the computer industry, this term usually refers to a vendor that assembles computer systems with components made by other suppliers.

Peripherals—External devices attached to a computer; examples include printers, disk drives, display monitors, and keyboards.

Server—A computer or a device on a network that manages network resources. For example, a file server is a computer and a storage device dedicated to storing files; any user on the network can store files on the server. A print server is a computer that manages one or more printers.

Software—Computer programs that either direct the operation of a computer (system software) or accomplish user tasks (application software).

Solid-state drive (SSD)—A storage device that stores persistent data using integrated circuits (ICs) rather than magnetic or optical media.

Storage area network (SAN)—A dedicated network providing storage and backup solutions. The network establishes a connection between storage devices and the back end of a server.

Switches—Network devices that connect and filter pieces of a message (or “packets”) between LAN segments.

UNIX—An operating system developed by AT&T’s Bell Laboratories that has multiuser, multitasking, and networking capabilities. (See *Linux*.)

Virtualization—The creation of a virtual (rather than actual) version of something, such as an operating system, a server, a storage device, or network resources.

Wi-Fi—Short for wireless fidelity; refers to a set of wireless communications standards that provide broadband networking connections over short distances using unregulated radio waves.

Workstation—A single-user system for engineers and other technical professionals; it features a high-performance microprocessor and graphics capabilities, significant storage capacity, and networking facilities.

INDUSTRY REFERENCES

MARKET RESEARCH FIRMS

Gartner, Inc.
gartner.com
Provides worldwide market coverage on various sectors of information technology, including semiconductors, computer systems and peripherals, communications, document management, software, and services.

International Data Corp. (IDC)
idc.com
Leading provider of information technology data, analysis, and consulting.

PricewaterhouseCoopers (PwC)
pwc.com
Worldwide professional services firm providing market research that covers various sectors, such as information technology.

Ball Metaverse
ballmetaverse.co
Matthew Ball is a venture capitalist and also corporate advisor to many large firms in the gaming and technology industries. He is also a co-founder of Ball Metaverse Research Partners, which creates and maintains index behind Roundhill Ball Metaverse ETF(METV) .

GOVERNMENT AGENCIES

U.S. Bureau of Economic Analysis (BEA)
bea.gov
Agency within the U.S. Department of Commerce (DOC); its mandate is to collect economic data.

U.S. Department of Commerce (DOC)
commerce.gov
Cabinet-level department responsible for a variety of government agencies that monitor and regulate U.S. commerce.

PERIODICALS

Nikkei Asia
asia.nikkei.com
Provides coverage of Japan’s economy, industries, and markets. The Nikkei Group’s business portfolio includes publishing of the Nikkei 225 stock index.

COMPARATIVE COMPANY ANALYSIS

Operating Revenues

Ticker		Company		Yr. End	Million $ 2021	2020	2019	2018	2017	2016	2015	CAGR (%) 10-Yr.	5-Yr.	1-Yr.	Index Basis (2013=100) 2021	2020	2019	2018	2017	2016
TECHNOLOGY HARDWARE, STORAGE AND PERIPHERALS																				
DDD	§	3D SYSTEMS CORPORATION		DEC	615.6	557.2	636.4	691.5	646.1	633.0	666.2	10.3	-0.6	10.5	92	84	96	104	97	95
AAPL	[]	APPLE INC.		SEP	365,817.0	274,515.0	260,174.0	265,595.0	229,234.0	215,639.0	233,715.0	12.9	11.1	33.3	157	117	111	114	98	92
DBD	§	DIEBOLD NIXDORF, INCORPORATED		DEC	3,905.2	3,902.3	4,408.7	4,578.6	4,609.3	3,316.3	2,419.3	3.3	3.3	0.1	161	161	182	189	191	137
HPE	[]	HEWLETT PACKARD ENTERPRISE COMPANY		OCT	27,784.0	26,982.0	29,135.0	30,852.0	28,871.0	30,280.0	31,077.0	NA	-1.7	3.0	89	87	94	99	93	97
HPQ	[]	HP INC.		OCT	63,487.0	56,639.0	58,756.0	58,472.0	52,056.0	48,238.0	51,463.0	-6.7	5.6	12.1	123	110	114	114	101	94
NCR	†	NCR CORPORATION		DEC	7,156.0	6,207.0	6,915.0	6,405.0	6,516.0	6,543.0	6,373.0	3.1	1.8	15.3	112	97	109	101	102	103
NTAP	[]	NETAPP, INC.	#	APR	6,318.0	5,744.0	5,412.0	6,146.0	5,919.0	5,491.0	5,546.0	1.2	0.7	6.1	114	104	98	111	107	99
STX	[]	SEAGATE TECHNOLOGY HOLDINGS PLC		JUL	10,681.0	10,509.0	10,390.0	11,184.0	10,771.0	11,160.0	13,739.0	-0.3	-0.9	1.6	78	76	76	81	78	81
WDC	[]	WESTERN DIGITAL CORPORATION		JUL	16,922.0	16,736.0	16,569.0	20,647.0	19,093.0	12,994.0	14,572.0	5.9	5.4	1.1	116	115	114	142	131	89
XRX	†																			

Note: Data as originally reported. CAGR-Compound annual grow th rate.
[]Company included in the S&P 500. †Company included in the S&P MidCap 400. §Company included in the S&P SmallCap 600. #Of the follow ing calendar year.
Souce: S&P Capital IQ.

Net Income

Ticker		Company		Yr. End	Million $ 2021	2020	2019	2018	2017	2016	2015	CAGR (%) 10-Yr.	5-Yr.	1-Yr.	Index Basis (2013=100) 2021	2020	2019	2018	2017	2016
TECHNOLOGY HARDWARE, STORAGE AND PERIPHERALS																				
DDD	§	3D SYSTEMS CORPORATION		DEC	322.1	-149.6	-69.9	-45.5	-66.2	-38.4	-655.5	24.7	NM	NM	-49	23	11	7	10	6
AAPL	[]	APPLE INC.		SEP	94,680.0	57,411.0	55,256.0	59,531.0	48,351.0	45,687.0	53,394.0	13.8	15.7	64.9	177	108	103	111	91	86
DBD	§	DIEBOLD NIXDORF, INCORPORATED		DEC	-78.8	-269.1	-341.3	-531.4	-241.5	-41.6	73.7	NA	13.6	-70.7	-107	-365	-463	-721	-328	-56
HPE	[]	HEWLETT PACKARD ENTERPRISE COMPANY		OCT	3,427.0	-322.0	1,049.0	1,908.0	344.0	3,161.0	2,461.0	NA	1.6	NM	139	-13	43	78	14	128
HPQ	[]	HP INC.		OCT	6,503.0	2,844.0	3,152.0	5,327.0	2,526.0	2,496.0	4,554.0	-0.8	21.1	128.7	143	62	69	117	55	55
NCR	†	NCR CORPORATION		DEC	97.0	-79.0	564.0	-88.0	232.0	270.0	-178.0	NA	-18.5	NM	-54	44	-317	49	-130	-152
NTAP	[]	NETAPP, INC.	#	APR	937.0	730.0	819.0	1,169.0	116.0	481.0	229.0	0.8	26.1	-10.9	409	319	358	510	51	210
STX	[]	SEAGATE TECHNOLOGY HOLDINGS PLC		JUL	1,314.0	1,004.0	2,012.0	1,182.0	772.0	248.0	1,742.0	9.9	39.6	30.9	75	58	115	68	44	14
WDC	[]	WESTERN DIGITAL CORPORATION		JUL	821.0	-250.0	-754.0	675.0	397.0	242.0	1,465.0	1.2	27.7	NM	56	-17	-51	46	27	17
XRX	†																			

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[]Company included in the S&P 500. †Company included in the S&P MidCap 400. §Company included in the S&P SmallCap 600. #Of the follow ing calendar year.
Souce: S&P Capital IQ.

Ticker		Company		Yr. End	Return on Revenues (%) 2021	2020	2019	2018	2017	2016	Return on Assets (%) 2021	2020	2019	2018	2017	2016	Return on Equity (%) 2021	2020	2019	2018	2017	2016
TECHNOLOGY HARDWARE, STORAGE AND PERIPHERALS																						
DDD	§	3D SYSTEMS CORPORATION		DEC	52.3	NM	NM	NM	NM	NM	20.8	NM	NM	NM	NM	NM	50.6	NM	NM	NM	NM	NM
AAPL	[]	APPLE INC.		SEP	25.9	20.9	21.2	22.4	21.1	21.2	27.0	17.7	16.3	16.3	12.9	14.2	147.4	73.7	55.9	49.4	36.9	36.9
DBD	§	DIEBOLD NIXDORF, INCORPORATED		DEC	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
HPE	[]	HEWLETT PACKARD ENTERPRISE COMPANY		OCT	12.3	NM	3.6	6.2	1.2	10.4	5.9	NM	2.0	3.4	0.6	4.0	19.0	NM	5.5	9.0	1.6	9.9
HPQ	[]	HP INC.		OCT	10.2	5.0	5.4	9.1	4.9	5.2	16.8	8.2	9.4	15.4	7.7	8.6	NM	NM	NM	NM	NM	22.0
NCR	†	NCR CORPORATION		DEC	1.4	NM	8.2	NM	3.6	4.1	0.8	NM	6.3	NM	3.0	3.5	6.9	NM	44.3	NM	15.4	18.5
NTAP	[]	NETAPP, INC.	#	APR	14.8	12.7	15.1	19.0	2.0	8.8	9.3	7.8	10.9	13.4	1.2	5.1	123.0	157.5	123.0	69.5	4.6	17.0
STX	[]	SEAGATE TECHNOLOGY HOLDINGS PLC		JUL	12.3	9.6	19.4	10.6	7.2	2.2	15.1	11.2	22.6	12.6	8.3	3.0	108.7	50.8	105.1	78.0	52.2	10.8
WDC	[]	WESTERN DIGITAL CORPORATION		JUL	4.9	NM	NM	3.3	2.1	1.9	3.1	NM	NM	2.3	1.3	0.7	8.1	NM	NM	5.9	3.5	2.4
XRX	†																					

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[]Company included in the S&P 500. †Company included in the S&P MidCap 400. §Company included in the S&P SmallCap 600. #Of the following calendar year.
Souce: S&P Capital IQ.

Ticker		Company		Yr. End	Current Ratio 2021	2020	2019	2018	2017	2016	Debt/Capital Ratio (%) 2021	2020	2019	2018	2017	2016	Debt as a % of Net Working Capital 2021	2020	2019	2018	2017	2016
TECHNOLOGY HARDWARE, STORAGE AND PERIPHERALS																						
DDD	§	3D SYSTEMS CORPORATION		DEC	5.8	2.0	2.3	2.4	2.1	3.3	34.7	4.3	8.1	4.1	0.0	0.0	52.3	10.6	21.5	10.7	0.0	0.0
AAPL	[]	APPLE INC.		SEP	1.1	1.4	1.5	1.1	1.3	1.4	66.8	63.2	53.6	52.6	47.2	41.0	1,230.4	270.5	171.3	685.9	392.3	299.8
DBD	§	DIEBOLD NIXDORF, INCORPORATED		DEC	1.1	1.1	1.2	1.4	1.4	1.4	159.6	153.6	130.5	100.7	65.5	64.3	1,630.5	1,128.1	724.2	350.0	264.3	223.1
HPE	[]	HEWLETT PACKARD ENTERPRISE COMPANY		OCT	0.9	0.9	0.8	1.0	1.1	1.3	33.8	44.1	36.3	33.6	31.5	28.8	NM	NM	NM	14,260.8	421.7	197.2
HPQ	[]	HP INC.		OCT	0.8	0.8	0.8	0.9	1.0	1.0	143.9	168.4	134.7	139.3	230.8	237.6	-98.6	NM	-94.4	NM	NM	NM
NCR	†	NCR CORPORATION		DEC	1.0	1.2	1.2	1.3	1.5	1.4	78.2	71.2	74.2	72.4	65.5	65.8	8,097.1	838.5	585.3	415.7	312.3	378.9
NTAP	[]	NETAPP, INC.	#	APR	1.5	1.7	1.2	1.5	2.0	1.5	74.0	79.3	120.2	62.4	50.5	35.3	119.8	103.3	253.5	79.9	56.3	59.9
STX	[]	SEAGATE TECHNOLOGY HOLDINGS PLC		JUL	1.3	1.5	2.0	1.4	1.8	1.5	88.6	69.9	66.3	72.2	78.6	72.0	530.8	298.6	199.6	350.1	222.4	329.1
WDC	[]	WESTERN DIGITAL CORPORATION		JUL	2.0	2.1	2.2	2.4	2.5	1.8	44.1	49.3	50.7	48.8	53.1	67.1	173.4	200.1	219.9	177.8	192.5	295.6
XRX	†																					

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Souce: S&P Capital IQ.

Ticker	Company	Yr. End	Price/Earnings Ratio (High-Low) 2021	2020	2019	2018	2017	2016	Dividend Payout Ratio (%) 2021	2020	2019	2018	2017	2016	Dividend Yield (High-Low, %) 2021	2020	2019	2018	2017	2016
TECHNOLOGY HARDWARE, STORAGE AND PERIPHERALS																				
DDD	§ 3D SYSTEMS CORPORATION	DEC	21 - 4	NM - NM	NM - NM	NM - NM	NM - NM	NM - NM	0.0	0.0	0.0	0.0	0.0	0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0
AAPL	[] APPLE INC.	SEP	28 - 19	41 - 17	19 - 12	19 - 13	18 - 11	15 - 11	15.3	24.5	25.6	23.0	26.4	26.6	0.7 - 0.5	0.8 - 0.6	1.5 - 0.6	2.1 - 1.3	1.7 - 1.3	2.2 - 1.5
DBD	§ DIEBOLD NIXDORF, INCORPORATED	DEC	NM - NM	NM - NM	NM - NM	NM - NM	NM - NM	NM - NM	0.0	0.0	0.0	NM	NM	NM	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	3.7 - 0.0	2.5 - 1.3
HPE	[] HEWLETT PACKARD ENTERPRISE COMPANY	OCT	6 - 3	NM - NM	22 - 16	16 - 10	119 - 63	13 - 7	18.2	NM	58.0	29.9	124.4	11.8	4.0 - 2.7	5.7 - 2.9	6.1 - 2.7	3.7 - 2.7	3.1 - 1.5	2.0 - 0.9
HPQ	[] HP INC.	OCT	7 - 3	12 - 7	12 - 8	8 - 6	15 - 9	19 - 6	14.4	35.1	30.8	16.9	35.4	34.4	4.0 - 2.4	4.1 - 2.2	5.4 - 3.0	3.6 - 2.1	2.8 - 2.1	3.6 - 2.7
NCR	† NCR CORPORATION	DEC	80 - 54	NM - NM	9 - 6	NM - NM	49 - 29	24 - 11	15.5	NM	0.0	0.0	0.0	0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0
NTAP	[] NETAPP, INC. #	APR	24 - 12	20 - 10	19 - 12	161 - 88	25 - 13	47 - 27	47.6	58.5	53.6	34.5	184.5	43.2	2.6 - 2.1	5.1 - 2.6	5.4 - 2.1	2.9 - 1.0	2.1 - 1.2	3.3 - 1.8
STX	[] SEAGATE TECHNOLOGY HOLDINGS PLC	JUL	19 - 8	17 - 11	8 - 5	15 - 8	19 - 12	63 - 23	49.4	67.0	35.4	61.4	72.7	293.1	4.1 - 2.4	5.9 - 2.6	6.4 - 4.0	7.0 - 4.3	8.1 - 4.1	10.9 - 5.0
WDC	[] WESTERN DIGITAL CORPORATION	JUL	29 - 13	NM - NM	NM - NM	47 - 31	69 - 31	85 - 35	0.0	NM	NM	87.9	144.6	191.7	0.0 - 0.0	0.0 - 0.0	4.2 - 0.0	5.7 - 2.5	2.6 - 1.9	4.6 - 2.1
XRX	†																			

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Souce: S&P Capital IQ.

Ticker	Company	Yr. End	Earnings per Share ($) 2021	2020	2019	2018	2017	2016	Tangible Book Value per Share ($ 2021	2020	2019	2018	2017	2016	Share Price (High-Low, $) 2021	2019	2018	2017	2016	2015
TECHNOLOGY HARDWARE, STORAGE AND PERIPHERALS																				
DDD	§ 3D SYSTEMS CORPORATION	DEC	2.6	-1.3	-0.6	-0.4	-0.6	-0.3	3.5	1.9	2.1	2.5	2.5	2.9	56.5 - 10.3	14.5 - 6.5	21.8 - 8.6	23.7 - 7.9	19.8 - 6.0	34.0 - 8.4
AAPL	[] APPLE INC.	SEP	5.6	3.3	3.0	3.0	2.3	2.1	3.8	3.8	5.1	5.6	6.5	5.6	182.1 - 116.2	73.5 - 35.5	58.4 - 36.6	44.3 - 28.7	29.7 - 22.4	33.6 - 23.0
DBD	§ DIEBOLD NIXDORF, INCORPORATED	DEC	-1.0	-3.5	-4.4	-7.0	-3.2	-0.6	-24.7	-26.7	-23.3	-20.5	-18.9	-15.2	17.3 - 7.9	14.7 - 2.4	19.1 - 2.4	31.9 - 16.0	29.8 - 21.1	38.9 - 29.2
HPE	[] HEWLETT PACKARD ENTERPRISE COMPANY	OCT	2.6	-0.3	0.8	1.2	0.2	1.8	0.5	-2.4	-1.8	2.0	3.1	8.8	16.7 - 11.5	17.6 - 12.5	19.5 - 12.1	24.9 - 12.8	24.8 - 11.6	18.5 - 13.1
HPQ	[] HP INC.	OCT	5.3	2.0	2.1	3.3	1.5	1.4	-8.5	-7.0	-5.6	-4.5	-5.5	-5.6	38.5 - 23.9	24.1 - 15.9	27.1 - 19.2	22.7 - 14.4	16.3 - 8.9	41.1 - 11.3
NCR	† NCR CORPORATION	DEC	0.6	-0.9	3.4	-1.2	1.0	1.7	-38.2	-21.4	-21.5	-27.1	-24.3	-24.5	50.0 - 31.3	35.4 - 22.4	38.7 - 20.9	49.9 - 29.2	42.1 - 18.0	36.5 - 21.8
NTAP	[] NETAPP, INC. #	APR	4.1	3.2	3.5	4.5	0.4	1.7	-7.5	-6.6	-7.2	-2.9	1.7	3.6	94.7 - 58.8	78.4 - 44.6	88.1 - 52.0	59.0 - 35.1	39.0 - 20.7	41.8 - 25.2
STX	[] SEAGATE TECHNOLOGY HOLDINGS PLC	JUL	5.4	3.8	7.1	4.1	2.6	0.8	-2.8	1.9	3.0	0.8	-0.5	-0.3	116.9 - 58.0	60.8 - 36.5	62.7 - 35.4	51.0 - 30.6	41.5 - 18.4	67.2 - 32.4
WDC	[] WESTERN DIGITAL CORPORATION	JUL	2.7	-0.8	-2.6	2.2	1.3	1.0	0.7	-4.8	-6.2	-4.1	-8.2	-13.5	78.2 - 48.6	65.3 - 35.0	107.0 - 33.8	95.8 - 68.6	72.0 - 35.0	113.9 - 57.9
XRX	†																			

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Souce: S&P Capital IQ.

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