CFRA

Industry Surveys

Communications Equipment

DECEMBER 2022

Keith Snyder
Equity Analyst

Navin Kalaiselvam
Industry Analyst

CONTENTS

Contacts

Sales Inquires & Client Support
800.220.0502
cservices@cfraresearch.com

Media Inquiries
press@cfraresearch.com

CFRA
977 Seminole Trail, PMB 230
Charlottesville, VA 22901

Contributors

Raymond Jarvis
Senior Editor

Atifi Kuddus, Geraldine Tan
Associate Editors

Marc Bastow
Contributing Editor

CHARTS & FIGURES

NEW THEMES

What's Changed: We added a new chart listing the estimated economic value of adoption of the Internet of Things in 2030 on page 17.

What's Changed: As of Q2 2022, the revenue for worldwide Ethernet switch market increased by 14.6% to $8.5 billion. Check out the top five Ethernet switch companies on page 20.

EXECUTIVE SUMMARY

Our fundamental outlook for the Communications Equipment sub-industry is positive over the next 12 months. Here we highlight key themes for 2023. We note that Cisco is the giant in the sub-industry, and as such, we continue our practice of breaking out Cisco metrics where appropriate and relevant to avoid skewing data and results.

The Global Semiconductor Shortage is Still Impacting the Industry

The Covid-19 outbreak has devastated supply chains across the Communications Equipment industry. The semiconductor industry is struggling to keep up with demand, causing problems for almost every industry. Communication equipment companies are struggling to secure key components and are reporting extended lead times on products. Arista Networks has lead times of up to 80 weeks on some components. We expect these shortages to last into 2023 and for lead times to continue to expand as companies burn through their raw material inventories. Given that this is an industry-wide problem, we do not expect to see customers moving to new suppliers. While we are beginning to see improvements in the supply chain, we note rising Covid-19 case numbers in China could spur another wave of lockdowns in the region, undoing the improvements we have seen.

5G Taking Center Stage

Despite the Covid-19 outbreak and subsequent Delta and Omicron variants, spending on 5G deployments remained strong in 2022 and we expect to see slightly higher spending levels in 2023, with a shift towards network core deployments. AT&T, T-Mobile, and Verizon have all claimed to have achieved nationwide 5G coverage. 5G device selection continues to expand, and there have been a number of devices released in the past year at affordable price points, including the iPhone 13 and iPhone 14, both of which support 5G. Consumer adoption of 5G is not expected to be driven by the benefits of the technology itself, but rather by the fact that recent phone models are 5G capable by default, meaning 5G adoption will be a result of the normal phone upgrade cycle. According to Cisco Systems, by 2023, about 10% of global mobile devices/connections will be 5G capable.

Growth in the Number of Connected Devices Will Continue to Create Headaches for Network Administrators

According to Cisco Systems, the number of devices connected to IP networks will be more than three times the global population by 2023. Meanwhile, global IP traffic will increase at a 26% CAGR between 2017 and 2022. The number of connections and traffic creates strain on all parts of a network. These stresses will only worsen with the growing number of machine-to-machine connections, such as smart meters, video surveillance, and health care monitoring. As in the case of mobile networks, video devices can have a multiplier effect on traffic. In addition, the adoption of a hybrid work environment by many companies will continue to stress networks due to the heightened use of video conferencing tools.

Network Security is a Top Priority

According to a Fortune Business Insights report, the global cyber security market is expected to grow at a 12.6% CAGR from $112.0 billion in 2019 to $281.7 billion in 2027. Growth is being driven by a rapid rise in the number of attacks on businesses, which continue to be increasingly more complex and costly. With the growth in remote employees caused by hybrid work arrangements, endpoint security will be increasingly important, especially for small- and medium-sized enterprises that were not fully prepared to deal with a majority of employees working from home. According to a survey conducted by IDC, 60% of small- and medium-sized businesses plan to increase their spending on endpoint security products.

COMMUNICATIONS EQUIPMENT

Outlook: Positive

MARKET CAP BREAKDOWN*

RANK NO.	COMPANY NAME	MARKET CAP ($ billion)
1	Cisco	198.3
2	Motorola	44.2
3	Arista	40.9
4	Juniper	10.3
5	F5	9.0
	Others†	31.6

Source: CFRA, S&P Global Market Intelligence
**Data as of November 30, 2022.*
†Refer to the "Comparative Company Analysis" section of this survey for the list of companies.

ETF FOCUS

VGT Vanguard Info. Technology	AUM ($M) 41,309.0	Expense Ratio 0.10
XLK Technology Select Sector SPDR	AUM ($M) 40,056.7	Expense Ratio 0.10
IYW iShares US Technology	AUM ($M) 8,229.2	Expense Ratio 0.39
FTEC Fidelity MSCI Information Technology Index	AUM ($M) 5,184.1	Expense Ratio 0.08
PNQI Invesco NASDAQ Internet	AUM ($M) 444.5	Expense Ratio 0.60

BY THE NUMBERS

$967.9 billion
Projected size of the global communication equipment market in 2030

$51.3 billion
Projected capex spending in 2022 by AT&T, Verizon, and T-Mobile

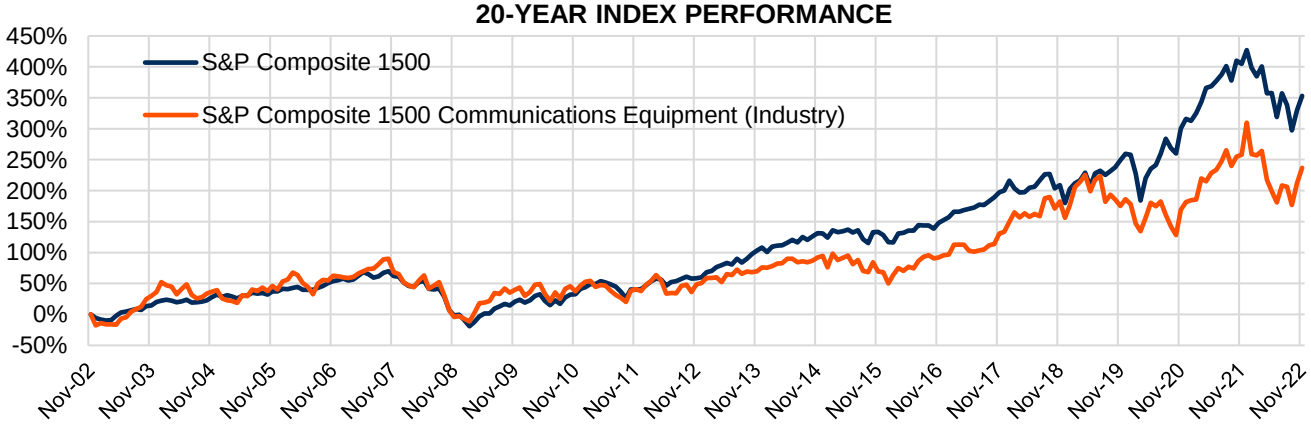
86 exabytes
Expected monthly global mobile data traffic in 2022

100 megawatts
Power consumption of a large data center – enough to power 80,000

5.3 billion
Number of total internet users by 2023

85%
Percentage of employees who want a hybrid work environment

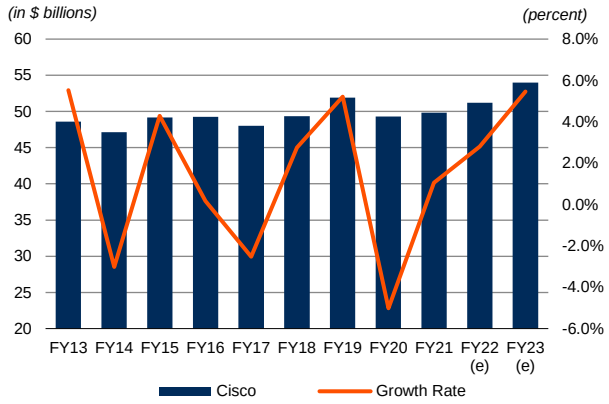
20-YEAR INDEX PERFORMANCE



Data through November 30, 2022.
Source: S&P Global Market Intelligence.

FINANCIAL METRICS (CISCO)

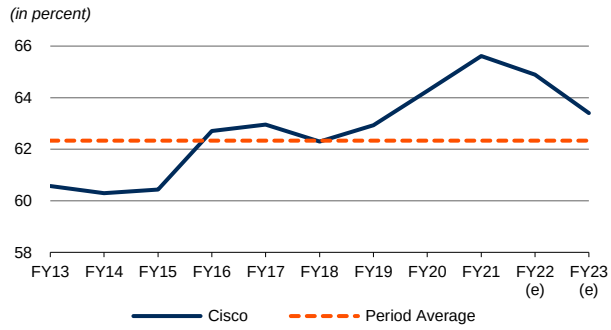
Revenue



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

- CFRA expects Cisco's revenue to rise by 2.8% in 2022 and 5.5% in 2023, following a dismal 1.0% increase in 2021 due to the pandemic period, which is still ongoing in many countries. Nonetheless, there is strong demand for campus switching, enterprise routing, and wireless products.
- However, supply chain issues have put a dent in Cisco's short-term revenue, with shortages of memory chips and power supplies as well as higher shipping costs being contributing factors. As the outlook for IT spending in the enterprise segment is looking strong, CFRA expects its security segment will continue to be a bright spot in 2023 on strong demand for its Duo and Umbrella offerings.

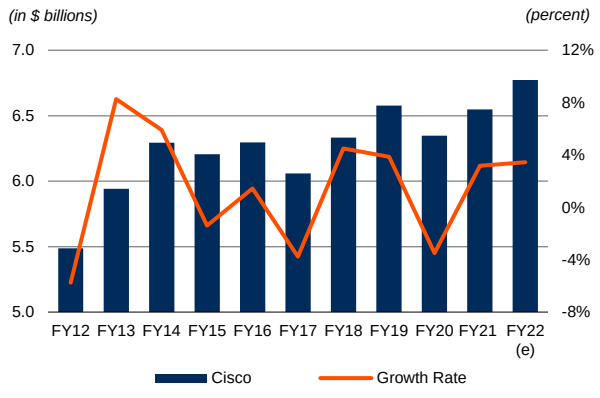
Gross Margin



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

- We expect Cisco's gross margin to be 64.9% in 2022 and 63.4% in 2023, versus the peak in 2021 at 65.6%. Cisco announced it would cut over $1 billion from its cost structure over the next few quarters.
- Cisco has made significant progress on its business transformation (software and subscriptions) to focus its investment in next-generation products and growth areas to cushion the legacy-margin decline.

R&D Expenditures

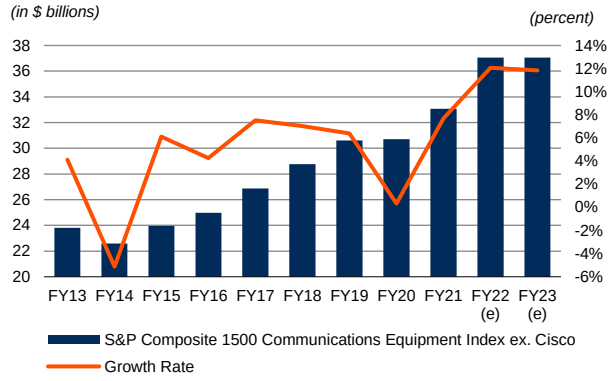


e-Estimate
Source: CFRA, S&P Global Market Intelligence.

- Cisco, with its intense emphasis on R&D spending, repeatedly releases ground-breaking products that enhance the company's product portfolios and raise its market share.
- 2021 saw Cisco's R&D spending increase by 3.2%. R&D for 2022 is expected to rise by 3.4%, as the company is buoyant coming off a record largest quarterly revenue in October 2022 in their history alongside improvements in the supply chain. We think Cisco's R&D spending will focus on accelerating the transition of the company's product portfolio to be delivered as a service.

FINANCIAL METRICS (INDUSTRY EX. CISCO)

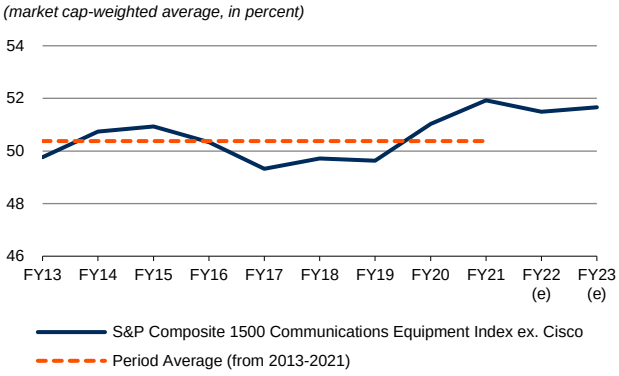
Total Revenue & Growth



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

- CFRA expects revenue for the industry (ex. Cisco) to increase by 12.1% in 2022 and 11.8% in 2023, as strong secular demand trends toward cloud computing, wireless, visualization, data center transformation, and increasing spending on network security.
- We expect continued rapid consumption of network capacity, buoyed by the proliferation of tablets and smartphones, as a solid long-term growth driver for the industry, and we see an improving operating outlook in 2023.

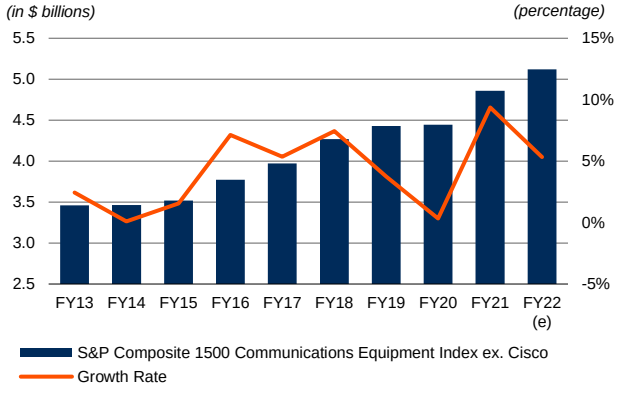
Gross Margin



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

- The average industry gross margin has been hovering between the range of 49% and 52% from 2013 to 2021. Margins during the last decade were affected by both increasing component costs and pricing pressure.
- CFRA forecasts an average industry gross margin of 51.5% in 2022 and 51.7% in 2023 as business prospects turn brighter in the years ahead.

R&D Expenditures



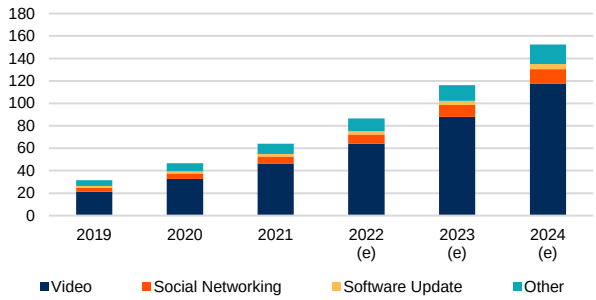
e-Estimate
Source: CFRA, S&P Global Market Intelligence.

- Industry (ex. Cisco) R&D expenditure registered at $4.9 billion in 2021. With a continued shift to software-based solutions, companies are forced to elevate spending to keep up with the ever-accelerating pace of innovation in the space.
- Global demand for communications equipment is expected to have stable growth for the next few years, and CFRA believes R&D expenditure will continue to increase as the need for new technologies – such as 5G in the wireless space, cloud computing, network security, and big data – continues to grow.

KEY INDUSTRY DRIVERS

Global Mobile Data Traffic Forecast

(exabytes per month)

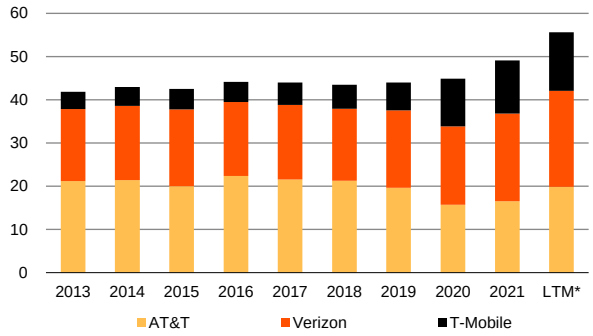


Traffic refers to aggregated traffic in mobile access networks and does not include DVB-H, Wi-Fi, or Mobile WiMax traffic.
Source: Ericsson.

- The major forces for industry growth are the rapid adoption and market penetration of internet video and social media content, the proliferation of smartphones, and the widespread migration toward a more virtualized network environment for both enterprises and service providers.
- Global mobile data traffic grew 36.2% in 2021, reaching 67.3 exabytes per month at the end of 2021, according to Ericsson, which also projected that mobile data traffic would reach 90 exabytes per month by the end of 2022.

Service Providers Capital Expenditures

(in $ billions)



*Last twelve months through Q3 2022.
Source: CFRA, S&P Global Market Intelligence.

- We expect capital spending to increase slightly in 2022, with accelerated equipment funding related to cloud computing, data centers, and core network infrastructure upgrades from enterprise.
- The shift to 4G wireless technology called Long Term Evolution (LTE) has been a catalyst for wireless infrastructure spending, although spending in North America and most other developed nations has almost completely shifted to 5G deployments at this point, with the only remaining spending on 4G being network maintenance.

U.S. Business Confidence Index

(amplitude adjusted, long-term average = 100)

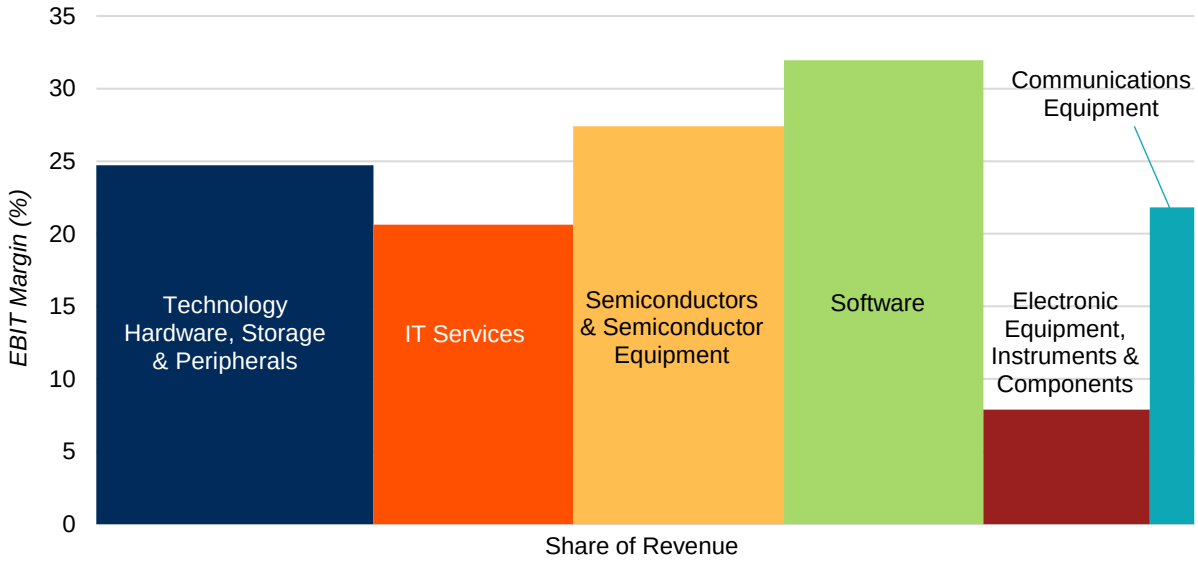
*Data through October 2022.
Source: Organisation for Economic Co-operation and Development.

- Business confidence in the U.S. dropped to 99.3 in October 2022. The index has been on a downward trajectory since October 2021, which was one of the highest since the onset of the pandemic in 2020.
- Businesses have turned pessimistic since the start of 2022 due to high inflation and supply chain issues hitting hard since the Russia-Ukraine conflict. As business confidence increases, companies will invest more in network upgrades to support growth, with an eye toward a strong recovery in 2023.

INDUSTRY TRENDS

Competitive Environment

PROFIT SHARE MAP OF INFORMATION TECHNOLOGY INDUSTRY
(for the last twelve months ended third quarter of 2022)



*Companies within the S&P Composite 1500 Index as of November 8, 2022.
Source: CFRA, S&P Global Market Intelligence.

The Communications Equipment industry serves service providers (telecommunications and cable operators) and the enterprise segment, with select vertical markets such as government agencies or education institutions. Cisco dominates the industry in terms of market capitalization and revenues.

The key industry drivers are tied to broadband, data networking, cloud computing, and data security. These industry drivers benefit distinct customer markets and lead to the convergence of enterprise and service provider markets, as well as wireless substitution for wireline networks.

The Industry Titan: Cisco Systems, Inc.
Among the constituents in the S&P 1500 Communications Equipment Index, the one significant outlier is communications and IT giant Cisco Systems, Inc., whose market capitalization represents a hefty 58.2% of the index (as of November 8, 2022). Putting this into perspective, the company's revenue in 2021 of $49.8 billion is more than the other 18 index constituents combined.

Cisco is synonymous with routers, high-speed networking, and switching equipment, and carries the title of the world's largest supplier of high-performance computer networking systems. Cisco's products are mission-critical for network performance, security, and stability. Cisco is proliferating software, analytics, wireless, and security offerings to satisfy nascent trends, and we see Cisco as the only one-stop-shop networking vendor. Cisco is uniquely positioned, by CFRA's analysis, to weave together complementary necessities, like networking and security, to provide comprehensive solutions for clients. Cisco's huge worldwide installed base gives it tremendous economies of scale and pricing power, with $19.8 billion in cash and investments as of November 22, 2022, and cash flow from operations for the first quarter of financial year 2023 was $3.9 billion. In other words, Cisco dominates the industry.

Porter's Five Forces

The Communications Equipment industry is highly competitive, with a concentration of select equipment providers. Most of these companies have a global presence, a proprietary learning curve, intellectual capital through their protected patents, diversified network solutions, and brand identity with key customer accounts.

Porter's Five Forces Analysis	
Threat of New Entrants or New Entry (Moderate)	One of the challenges in the fast-changing Communications Equipment industry is to harvest the profitability of network solutions with short product cycles. Rivalry within the industry reduces profitability and is most acute during market downturns. Innovation is a driver of competitive advantage, in CFRA's view. The incumbent firms want to keep customers and increase revenues through new product enhancements or replace them with new platform solutions. New entrants are trying to be market disruptors through breakthrough innovation that makes their new product a more robust or lower-cost solution than the incumbents. Cisco's success has led numerous employees to leave and form their own competing companies. One of the most successful of these companies is Arista Networks, which was founded in 2004 by several former Cisco employees; Arista produces data center switches based on merchant silicon.
Bargaining Power of Suppliers (Moderate)	Suppliers of commodity hardware generally have limited bargaining power due to the larger number of producers, but suppliers of specialized, proprietary hardware are generally able to charge a premium. There are some cases when commodity hardware producers gain bargaining power, such as during component shortages, like we saw with memory prices and what we have seen during the supply chain disruptions caused by the Covid-19 outbreak. However, there has been modest improvement in certain component availability as shortages continue to ease, although there are still bottlenecks for some items that are needed to complete the entire product.
Bargaining Power of Buyers (Moderate)	Customer concentration varies by market, with the service provider market highly concentrated in all major regions. On the other hand, the enterprise market is a dispersed market where a single customer is rarely 10% or more of a communications equipment provider's total revenues. For customers, macroeconomic trends play more into sales volumes, inventory control, and supply chain management. Pricing power comes from predominant buyers such as AT&T, China Mobile, Verizon Wireless, and Vodafone, as well as large data center operators like Facebook, Google, Amazon, and Microsoft. The sheer size of each region's largest service providers indicates a significant level of global capital spending for communications equipment. CFRA thinks enterprise and other commercial markets take advantage of price elasticity, but it is not the primary driver for vendor selection.
Degree of Rivalry/Competition (Moderate)	The Communications Equipment industry is dominated by a small number of manufacturers based around the world. In broadband access, enterprise networking, and infrastructure areas, leading Chinese manufacturers such as Huawei and ZTE have moved into the global ranks. In response to slow growth in capital spending by traditional service providers, companies have entered a series of mergers to either gain scale or increase presence in all regions. In contrast to the oligopolistic structure of data networking and wireless infrastructure segments, highly competitive small- and mid-sized firms generally provide a focused network solution in areas related to access equipment, switching, core and edge routers, new cloud computing solutions, or wireless technologies.
Threat of Substitutes (Moderate)	With the rise of open-source networking equipment, the threat of substitution has increased in recent years. Open-source hardware is designed to work with various pieces of equipment from other producers, making it simple to switch.

Operating Environment

In the next few years, spending priorities will likely shift to the early stages of the fifth generation for wireless applications, in our view, driven by a rapid rise in mobile broadband and the increased use of smartphones and tablets. CFRA expects accelerated wireless equipment funding related to the emerging demand for wireless connectivity to both enterprise and household applications.

Taking 5G Network to the Next Level

The rapid consumer adoption of smartphones and tablets places unprecedented demands on mobile networks. As a result, telecommunications spending has shifted from wireline to the wireless portion of the network.

Wireless operators in the U.S. and other developed countries are trying to accelerate the deployment of fifth-generation (5G) technology in the U.S. In the U.S., telecommunication companies such as AT&T, Verizon Wireless, and T-Mobile have completed their LTE rollouts and have now shifted their focus to 5G network deployments. Meanwhile, consumer buying trends in the handset market have shifted toward powerful smartphone devices, given the enticing functionalities now available through mobile devices that were previously available only from wired broadband connections.

In the December 2020, the Federal Communications Commission's (FCC) C-band auction, Verizon, AT&T, and T-Mobile walked away with the vast majority of the C-band licenses.

In November 2022, the FCC adopted new rules banning communications equipment that is deemed to pose unacceptable risk to national security from being authorized for importation or sale in the United States. The companies affected by this ban are Huawei Technologies, ZTE Corporation, Hytera Communications, Hangzhou Hikvision Digital Technology, and Dahua Technology.

Verizon: Verizon spent the most to double its existing mid-band spectrum holdings by a whopping $45.5 billion for 161 MHz of C-band spectrum. Verizon plans to spend $10 billion more over three years to deploy C-band, initially using its existing macro network grid for early deployments. It currently covers over 160 million POPs (points-of-presence) and has a target of 200 million within the first quarter of 2023. Its acquisition of C-band spectrum puts Verizon on a more equal footing with T-Mobile and AT&T in 5G by allowing it to deploy its high-speed services over a broader region. As forecasted by CFRA in the last iteration of this survey, Verizon Business added capacity helped to restore growth in postpaid net additions, with the company adding 360,000 postpaid users, including 197,000 phone net additions in the third quarter of 2022. As of October 2022, Verizon targets to cover 200 million people within the first quarter of 2023.

AT&T: Similarly, AT&T secured 80 MHz in the FCC's C-band auction with a total bidding amount of $23.4 billion. The company indicates that they are deploying mid-band 5G spectrum with a year-end target of 130 million people. The acquisition of C-band spectrum would help to strengthen the company's competitiveness in the years ahead. As of October 2022, AT&T's 5G network now covers 100 million Americans with a target of more than 130 million by end-2022.

T-Mobile: T-Mobile announced that it had won an average of 40 MHz of C-band with a cost of $9.3 billion in the FCC's C-band auction, selectively acquiring additional mid-band spectrum it will use to roll out 5G network. As of the third quarter of 2022, T-Mobile covers over 250 million people with its Ultra Capacity 5G and sets a target of covering 300 million in 2023. T-Mobile is the first global mobile carrier to launch a standalone 5G network with nationwide coverage. T-Mobile's standalone 5G network is built upon the foundation of the company's low-band spectrum (600 MHz) 5G rollout, which started in 2019 with non-standalone, but also leverages the company's mid-band spectrum (2.5 GHz) and high-band spectrum (28 GHz or mmWave). Notably, T-Mobile gained the mid-band spectrum with the acquisition of Sprint, which

has roughly 160–200 MHz of that spectrum nationwide. Even as its competitors spent billions in the C-band auction, T-Mobile maintains its leadership on mid-band spectrum.

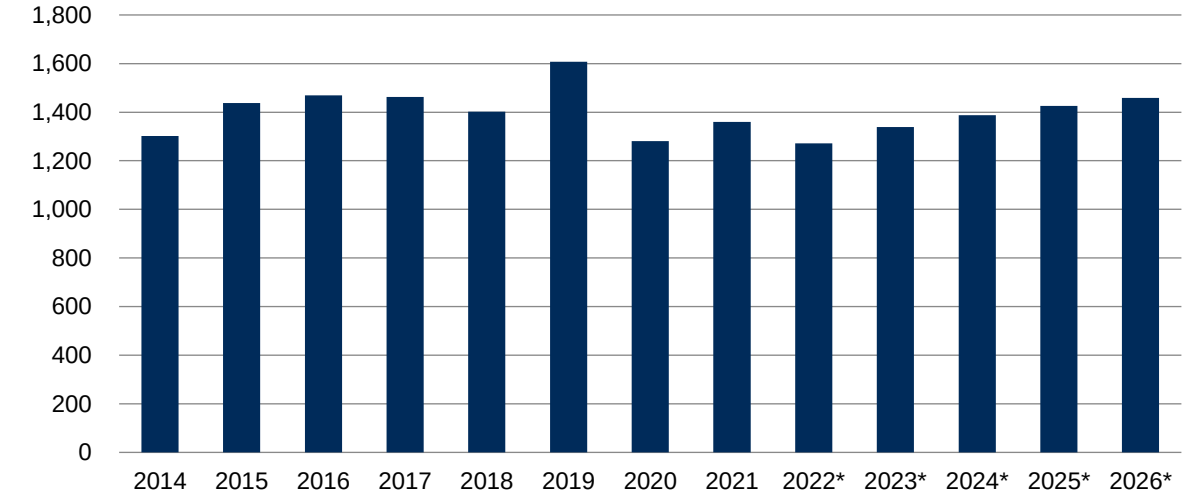
Dish: After establishing itself as the fourth U.S. mobile carrier, Dish bid extensively in the FCC's C-band auction for mid-band 5G spectrum but walked away with only one license that cost $2.5 million. The company is also planning to build its 5G standalone network using VMware's telco cloud platform. As a stipulation of the T-Mobile acquisition of Sprint, Dish will have access to T-Mobile's network until 2027 to operate as a mobile virtual network operator (MVNO). However, this partnership between Dish and T-Mobile turned sour due to T-Mobile's plan to shut down its 3G CDMA network. Dish has taken the drastic step of partnering with AT&T to provide MVNO service and making AT&T its primary network services partner. Dish has agreed to pay AT&T $5 billion over 10 years for network access. Dish initially expected to own 15,000 sites for its 5G network by June 14, 2022, though likely more will be necessary to meet the FCC's build-out requirements of its 700-MHz and AWS-4 spectrum. However, as of the end of the third quarter of 2022, Dish has only deployed 10,000 sites, capable of providing coverage to 35% of the U.S. population. CFRA expects the company to press forward aggressively with building out its network as it is already in discussions with tower operators. Yet, we doubt that Dish's $10 billion budget will be enough for a multi-year 5G build-out. Verizon, for example, spent nearly twice that amount on capital expenditure. In May 2022, Dish started its 5G services live in Las Vegas. It also expanded its service to more than 120 markets across the country by the June FCC deadline.

While standards for 5G are 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 through 2022. CFRA thinks the consequences of falling behind are too great, and thus, scheduling the 5G build-outs will remain a strategic priority for the carriers.

Global Smartphone Shipments Show Recovery on Effective Vaccine Deployment

Smartphone vendors are expected to ship a worldwide total of 1.27 billion smartphones in 2022 and 1.34 billion smartphones in 2023, from the 1.36 billion units shipped in 2021, according to IDC. The 5.2% growth in 2023 is expected to be driven by increased adoption of 5G units, as the segment will make up 54% of all smartphone shipments by the end of the year. Looking past 2022, the shift to 5G will continue to drive growth throughout the forecast period (2021-2026) at an average of 16.4%. IDC expects strong end-user demand from carriers and end-users, more vendors transitioning their product portfolios to highlight smartphones, and, more importantly, the arrival of more affordable 5G handsets. By 2026, the final year of IDC's forecast period, smartphone shipments will reach a total of 1.53 billion units worldwide, resulting in a CAGR of 1.4% for 2021–2026.

WORLDWIDE SMARTPHONE SHIPMENTS
(millions of units)



*Estimated.
Source: IDC, September 2022.

In terms of 5G mobile phones, the shipments are expected to reach 688.7 million units in 2022, up 23.6% from the 557.4 million units shipped in 2021. Shipments of 5G mobile phones will steadily increase throughout the forecast period as more affordable models enter the market that will eventually displace 4G units. The future of 5G mobile phones will consist of smartphones only, as feature phones will not adopt 5G technologies. 5G-enabled mobile phones are expected to make up 71.1% of all mobile phone shipments in 2026. IDC believes that, by 2026, total 5G mobile phone shipments will reach 1,154.4 million units.

Massive Surge in Unified Communications and Collaboration

Unified Communications and Collaboration (UCC) is a platform that takes various methods used for conferencing, such as text messaging, audio, video, and virtual whiteboards, and makes them available through a single interface that can be accessed by both desktop and mobile device users.

Following the Covid-19 pandemic, many large enterprises are expanding the scope of UCC deployment. UCC environments are being stretched to the limit at the moment; no one anticipated that enterprises worldwide would be working remotely more or less overnight, leveraging voice, video, and collaboration tools for business continuity. Since the spread of the Covid-19 outbreak, UCC vendors and service providers have been reporting an overwhelming jump in demand from enterprises for guidance in provisioning and enhancing video conferencing and collaboration solutions for work-from-home employees.

The worldwide UCC market is expected to grow by 11.8% year-over-year to $61.6 billion by the end of 2022, according to IDC. In 2022 and beyond, IDC expects worldwide UCC growth to be driven by customers across all business size segments with interest, especially in video, collaboration, mobile applications, and digital transformation projects. CFRA forecasts that established companies like Microsoft, Cisco, and Zoom will continue to benefit from this growth, given they offer both on-premises and cloud/hosted solutions, and have large existing customer bases. However, we note the increased competition in the cloud space from smaller companies like 8X8 and Fuze, as well as larger companies like Google and Nokia.

Wireless Growth in Emerging Markets

Despite the unfavorable macroeconomic environment in 2020 and 2021, Gartner expects worldwide IT spending to reach $4.6 trillion in 2023, up 5.1% over 2022. CFRA expects mobile data to increase rapidly in emerging markets in the long term, given that their severely limited fixed infrastructures leave mobile access as the primary route for internet connectivity.

The ultra-fast wireless connectivity and ultra-low latency enabled by 4G and 5G technology have the potential to transform the communication industry in emerging markets, particularly in regions with huge populations like China and India. In China, the mobile subscriber base reached its peak at 1.68 billion by the end of October 2022, according to the Ministry of Industry and Information Technology (MIIT).

In June 2019, China granted 5G licenses to the country's three state-owned wireless carriers (China Mobile, China Unicom, and China Telecom) as well as state-owned broadcaster China Broadcasting Network Corp Ltd, approving full commercial deployment. Since then, China's three state-owned wireless carriers have been reporting impressive growth in 5G subscriber additions. As of October 2022, China Mobile has the largest 5G package customers with a total of 571.5 million customers, while China Unicom and China Telecom reported 205 million and 256.9 million 5G subscribers, respectively.

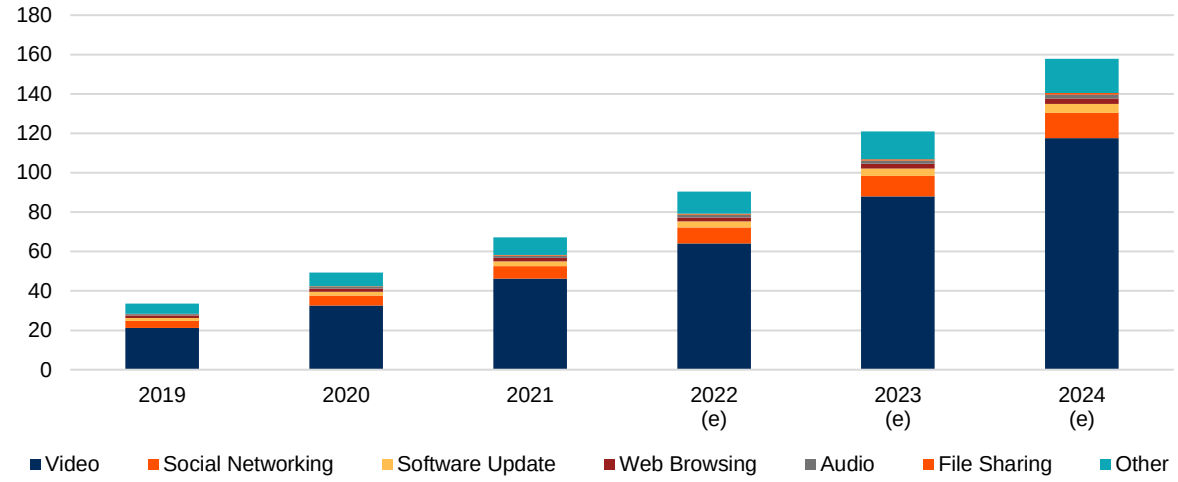
Bundled Services Include Internet and Video Services

The rapidly growing use of internet sites providing video-generated content (such as YouTube, Netflix, and Hulu), the increasing popularity of social media sites (such as Facebook and Twitter), and the emergence of new data-geared consumer devices and tablets (such as Apple Inc.'s iPhone and iPad) are fueling an exponential increase in the transport of video over the network. IP video is multimedia-intensive and thus a significant occupier of bandwidth, with the potential to strain the transport network. In contrast to standard broadband data transport, video delivery requires increased attention to quality: managing traffic characteristics such as latency and quality of service becomes critical.

Video is also becoming an important factor in the bundling of service offerings from telecom operators, as well as an established medium of communication for businesses. Video traffic accounted for 70.8% of total mobile data traffic in 2022 (latest available), according to Ericsson Mobility Visualizer, and it is estimated to account for 79% of all mobile data traffic by 2027. The Covid-19 outbreak caused a surge in data traffic due to the rapid work-for-home shift. Use of video conferencing tools rose sharply, as did the use of video streaming services like Netflix, Hulu, and Disney+. In the long term, annual global mobile data traffic is expected to increase by a factor of 4 between 2021 and 2027, from 90 exabytes per month to 288 exabytes per month.

GLOBAL MOBILE DATA TRAFFIC

(Exabytes per month)



Traffic refers to aggregated traffic in mobile access networks and does not include DVB-H, Wi-Fi or Mobile WiMax traffic.

Source: Ericsson.

In addition, the wireless network is rapidly becoming a common medium for data transport. Increased adoption of netbooks and smartphones, changes in pricing structures, and improving network speeds have begun to spur interest among the consumer segment about the power of mobile broadband as a secondary access method beyond wired broadband. Average monthly traffic per smartphone is expected to grow from 15 gigabytes (GB) to 46 GB between 2022 and 2028, with aggregate smartphone traffic growing at a 24% CAGR, according to Ericsson. Mobile data traffic for tablets and PCs is projected to grow to 23.7 GB per month and 28.8 GB per month in 2027, respectively. Ericsson forecasts that total global mobile data traffic will reach 90.4 exabytes per month by 2022.

Virtualization: Cloud Computing Is a Leading Growth Market

CFRA sees the transition toward cloud computing as a positive for the industry, given that it will likely fuel an increase in customer bandwidth requirements and related equipment purchases.

The computing and networking market is shifting toward virtualized cloud computing, a process in which computing services are supplied over the internet without the need for internal hardware or platform support. In this technology, the “cloud”—used as a metaphor for the internet—would provide the various tools, such as servers, switches, and storage, needed to build an application environment.

Cloud computing provides clear cost advantages to businesses that can lease computing and data storage capacity from web-based providers: It reduces their capital investments in equipment and software and lowers operational maintenance. In addition, cloud computing is massively scalable, with an on-demand model that lets businesses pay-as-you-go. One of the most visible cloud-computing patrons is Amazon Web Services, which uses the technology to support its numerous application offerings.

Spending on whole cloud services has been increasing due to the improvement in performance and security. Whole cloud spending worldwide is expected to grow at a 16.9% five-year CAGR from $597.2 billion in 2020 (latest available) to nearly $1.3 trillion in 2025, according to IDC.

On the equipment side, vendors will need to adapt to the new reality of computing by converting their equipment and licensing models to virtual appliances. Furthermore, software functionality will play a more critical role in differentiating product solutions.

Public and Private Cloud Deployments

In the public cloud Infrastructure-as-a-Service (IaaS) market, service providers own and manage the physical IT hardware and make the resources available to the public over the internet. According to IDC, public cloud PaaS spending will be the fastest-growing category of cloud spending with a CAGR of 26% for the period of 2021 to 2026, reaching $283 billion in 2026. Enterprises are increasingly accepting public cloud PaaS as a viable alternative to traditional on-premises IT hardware. Traditional hardware deployments typically require an in-house IT team to set up and monitor the network, with high upfront capital expenditures on hardware. With the public cloud, an enterprise usually pays on a per-user or total usage basis, while the service provider's staff monitors the network. This model also enables companies to scale up in minutes rather than the days it takes to purchase and deploy new on-premises hardware.

For enterprises with security concerns or that want greater control over the network, private cloud deployments offer many of the same benefits as public clouds. Private clouds can be deployed both on- and off-premises, while the hardware can be purchased and managed by the enterprise or rented from a service provider. The hosted private cloud services market is expected to increase to $11.3 billion in 2025 from $2.8 billion in 2020 (latest available), a five-year CAGR of 12%.

Software-Defined Networking

As technology shifts, traditional network architectures are increasingly ill-equipped to deal with the modern trends of growth in mobile devices and content, virtualization, and the development of cloud services. Carriers and IT departments alike face the challenges of changing traffic patterns, consumerization of IT, the rise of cloud services, and increased data usage, while trying to maintain a flat or reduced capital budget. The increasingly complex networking structures result in more complexity, an increased difficulty to implement a network-wide policy, and a dependence on vendors.

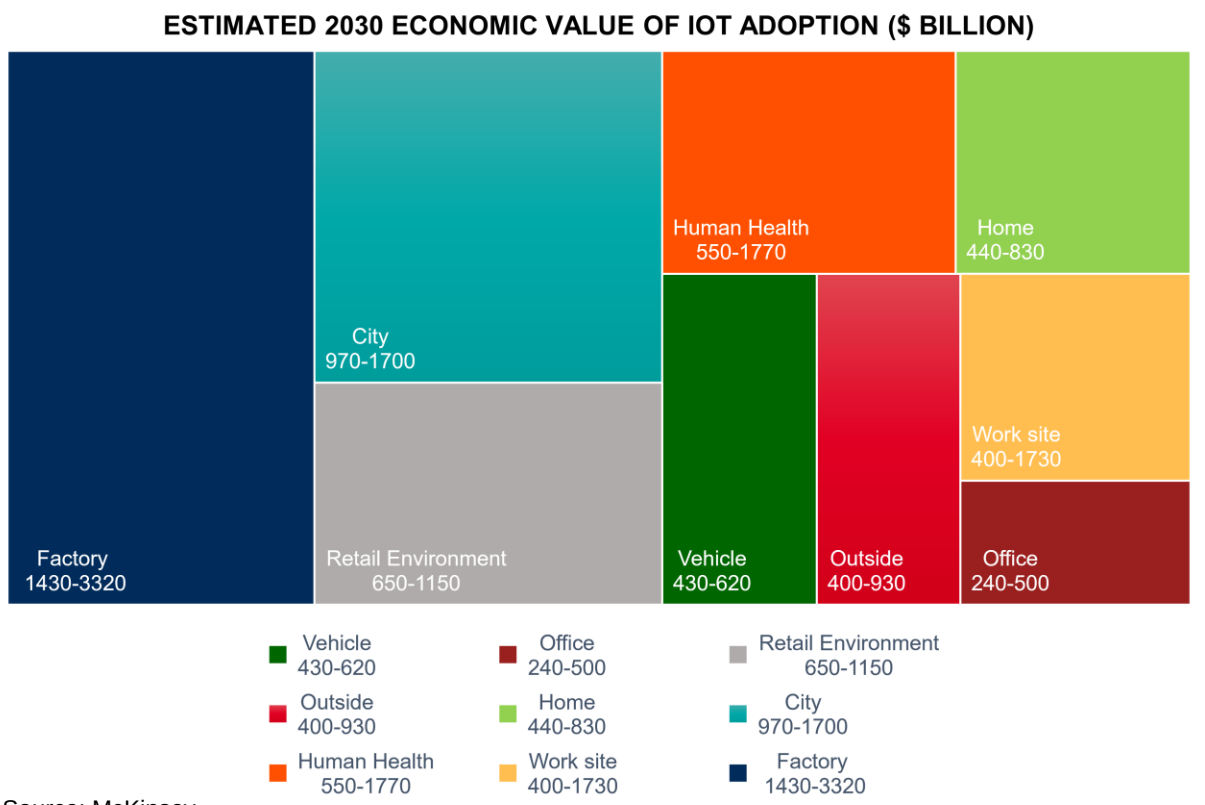
Software-defined networking (SDN) is an emerging network architecture where control of the network is separated from forwarding data and is directly programmable. More specifically, it is the separation of network data traffic processing from the logic and rules controlling the flow, inspection, and modification of data. Traditionally, network hardware such as switches and routers perform these functions separately in data and control planes. SDN pulls apart these functions and executes them as a distinct software application. Packet processing such as data movement and forwarding is still handled in hardware.

For many years, we have seen the telecom industry changing rapidly. With the evolvement of 4G technology, there was still a need for a more agile, speedier, and flexible network, which makes the base of 5G technology. In the future, 5G technology is sure to rely on SDN and we think this will make 5G technology and open-source networks a hot combo in the telecom industry worldwide. Most importantly, the combination of 5G technology and SDN will help to improve customer experience across many platforms.

Many enterprises are now moving to the cloud. SDN will help companies to enable virtualization of their networking infrastructure. By adopting SDN, it could help enterprises to shift to cloud technology easily. In fact, SDN has evolved into mainstream cloud infrastructure options across the entire spectrum of enterprise and service provider infrastructure. By using SDN technology, the enterprise also can solve traditional networking challenges like latency problems and bottlenecks and thus create a more responsive network strategy.

Internet of Things (IoT) : Unlocking The Trillion Dollar Opportunity

The emergence of the internet has changed the way people communicate, do business, entertain, educate, and retrieve information. It has changed from fixed computing to become mobile and on multiple devices. Currently, we are in the Internet of Things (IoT) era, where more than a billion devices are connected to the internet, including not only smartphones, TVs, tablets, and PCs, but also refrigerators, doorbells, lighting fixtures, and the like. The internet is in the process of evolving into the "Internet of Everything" (IoE), connecting people, processes, and things. In this state, not only would people connect to devices, but devices would also communicate with each other. Examples of IoE include better monitoring of pavement and bridge conditions by using intelligent sensors, traffic management, health care monitoring, education, and agriculture.



Source: McKinsey.

According to McKinsey's report on IoT, the potential economic value that IoT could unlock is estimated to be around $5.5 trillion to $12.6 trillion (not equivalent to industry revenue or GDP because they include value captured by customers and consumers) in value globally, including the value captured by consumers and customers of IoT products and services.

The future of IoE depends on its ability to handle big data, its capacity to connect objects through sensor networks, and collaboration. Technologies such as 5G and edge computing have also enhanced the capabilities of IoT devices, boosting data transport speed and reducing data latency. Given that, the number of devices connected to the internet is also expected to grow to 49 billion in 2026 from 34.8 billion in 2021, according to IDC. The rapid increase in the number of connected devices in the home has brought about greater use of newer Wi-Fi technology like 802.11ax or Wi-Fi 6. Some of the advancements of the 802.11ax standard are making dense Wi-Fi environment more efficient for multiple devices to connect to each access point, as well as improve battery efficiency in connected devices.

Network Security Spending

As more networked connections are made, the number of points for potential security breaches increases. Security is vital to protect valuable information from unwanted intruders.

With the rapid growth in the number of devices connecting to enterprise networks, attackers, with more tools at their disposal than ever before, have many more targets to choose from to gain network access. The worldwide network security market is expected to grow at a CAGR of 7.2% between 2020 and 2025, reaching $25.6 billion by 2025, according to IDC (latest available). This growth will be driven by the rising cost and frequency of data breaches, ransomware infections, and phishing attacks.

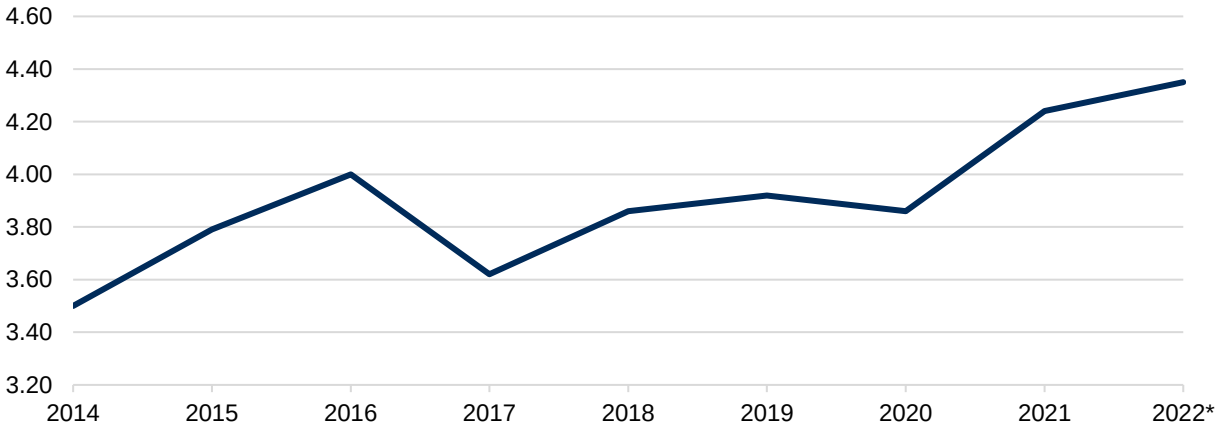
The global average total cost of a data breach has increased to $4.35 million in 2022 (highest in record), versus $4.24 million in 2021, according to a survey conducted by IBM and the Ponemon Institute. The average cost paid for each lost or stolen record was $164 in 2022, which is a 1.9% increase from $161 in 2021. CFRA expects large security vendors, such as Cisco, to benefit from these constraints, as companies look to purchase from vendors with end-to-end product offerings in an effort to reduce the number of suppliers.

Other than data breaches, ransomware is becoming an increasingly expensive nuisance for many companies. A prevalent form of ransomware is crypto-ransomware, which is malware that installs covertly on a device and then holds the victim's data hostage using encryption, until a ransom is paid. CFRA thinks companies such as Cisco, which offers advanced threat detection services, will benefit from increased spending on firewall and unified threat management (UTM) products that can detect and block data containing malware before it poses a threat. The worldwide firewall or UTM market is expected to increase at a 7.4% CAGR between 2020 and 2025 to reach $20.7 billion, according to IDC (latest available).

The increase in data breaches and malware attacks can be partly attributed to a booming online marketplace for stolen data and malware. The rise of these markets has been facilitated by cryptocurrencies such as bitcoin, which allows secure, untraceable payment for stolen data. Prices for various pieces of data fluctuate based on supply and demand, as well as the amount of personal information they contain. The price of data such as credit card numbers and health records plunged following a string of large-scale breaches. According to Experian, credit card numbers and patient health records are currently priced at $5–$110 and $1–$1,000, respectively, depending on how complete the records are on the dark web.

GLOBAL AVERAGE TOTAL COST OF A DATA BREACH

(in $ millions)



*Data as of March 2022.

Source: IBM, the Ponemon Institute.

Endpoint Security

Endpoint security is the practice of securing entry points of end-user devices such as desktops, laptops, and mobile devices from any cybersecurity threats. The growth of number of mobile devices has changed the way employees connect to their enterprise networks. Mobile devices are becoming increasingly attractive targets for cyber-criminals, who can leverage them as access points to corporate networks. Employee-owned business-use smartphone shipments are expected to increase to 280.2 million units by the end of 2026, from 250.6 million units in 2021, according to IDC.

Traditional endpoint security products work on a client-server model, with security software running on a centrally managed gateway within the network, plus client software installed on each endpoint device. When the endpoint device tries to access the network, the gateway authenticates the credentials and updates the client software if needed. While endpoint security is different from antivirus software, many vendors offer systems that include firewall, antivirus, and other security software to protect and encrypt data on endpoint devices. The corporate endpoint security market is projected to expand at a 14.9% CAGR between 2021 and 2026, from $10.3 billion to $20.6 billion.

The Covid-19 pandemic has forced many firms to mobilize around work from home as a means to slow the spread of the virus. Unfortunately, work-from-home practices can also increase the spread of cyber-viruses and the potential and severity of cyber incidents. Most enterprises are also expanding their scope of security infrastructure to encompass these remote endpoints. To mitigate the cyber risks of work-from-home mobilization, CFRA notes that many endpoint security vendors, such as BlackBerry and Cisco, briefly offered complimentary endpoint security products within a specific limited period.

Converged and Hyper-Converged Networking Infrastructure

When designing a traditional network, IT personnel typically take a silo approach, selecting server, networking, and storage solutions from one or more vendors. One benefit of this method is its easy scalability and increased flexibility. One of the biggest downsides to this approach is the fact that an IT department needs to spend a considerable amount of time designing the network to avoid hardware compatibility issues. In addition, if the equipment is purchased from different suppliers, managing warranties and support becomes more complicated.

Converged infrastructure has simplified the process of building out a network by combining the server, networking, and storage hardware in a pre-configured package. All hardware is pre-tested for compatibility, while support and warranties are managed by a single company, although all the hardware does not necessarily have to be from one supplier. Converged systems can be installed and running within hours, compared with the days needed to install traditional systems. Monitoring for converged systems is done with a single piece of software, rather than multiple pieces for a traditional system, resulting in lower IT personnel costs and a 70% reduction in downtime hours, according to an IDC survey.

The major downsides to converged infrastructures are the lack of flexibility due to vendor lock-in and higher prices due to the use of proprietary hardware and software. The converged infrastructure market is fairly concentrated, and CFRA thinks the top companies in the industry will benefit from the rapid growth in this market, as they are mostly larger companies with a wide range of product offerings, making them more attractive when customers are selecting a single vendor.

Hyper-converged infrastructure (HCI) is the next step in networking, where the server, networking, and storage components are combined in a single box, also called a node. These nodes are built using commodity parts, keeping hardware costs down. Since the server, networking, and storage components are virtualized using software, adding additional capacity is as easy as adding another node to the stack.

HCI continues to gain popularity in the data center market. Many enterprises that want to trim down their overhead costs are moving to HCI platforms. In the longer view, HCI will become crucial in the market

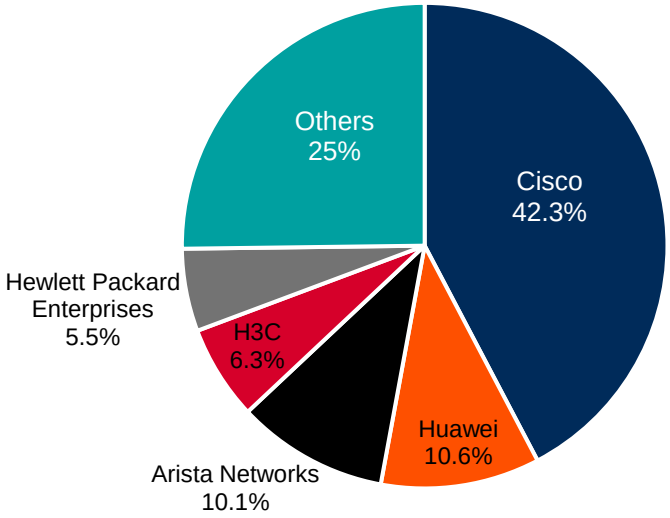
and pushing out less efficient and outdated technologies. Within the hyper-converged market, the top three companies – VMware, Nutanix, and HPE/H3C – controlled 72.9% of the market in the second quarter of 2022, according to IDC. CFRA expects larger hardware companies to benefit from growth in the hyper-converged market, which is expanding at a greater rate than the traditional infrastructure market.

Ethernet Switching

By the end of the second quarter of 2022, the revenue for worldwide Ethernet switch market increased by 14.6% to $8.5 billion. In the medium to long term, CFRA thinks the growth of the Ethernet switch market will be driven by high-speed switching platforms, such as 200/400 GbE and 100 GB Ethernet switches. We note that Cisco's market share increased by 10.2% in the second quarter of 2022 on an annualized basis. On a brighter note, Huawei's market share went up by 9.4% for the second quarter of 2022. CFRA thinks Huawei's long-term growth will be positive, as its expansion is linked to the high-growth Asia-Pacific market.

With the overall switch market projected to continue to expand, we forecast companies will have to shift their focus to newer demands by customers. No longer will switching vendors' competitive differentiation hinge on just speeds and technical functionalities, but rather how these capabilities enable digital transformation and corporate goals of deeper customer engagement and more efficient IT operations. To serve this demand, the leading vendors have made advances in developing next-generation monitoring, management, and verification systems that incorporate machine learning elements to create intelligent and autonomous networks.

WORLDWIDE TOP 5 ETHERNET SWITCH COMPANIES BY MARKET SHARE, Q2 2022

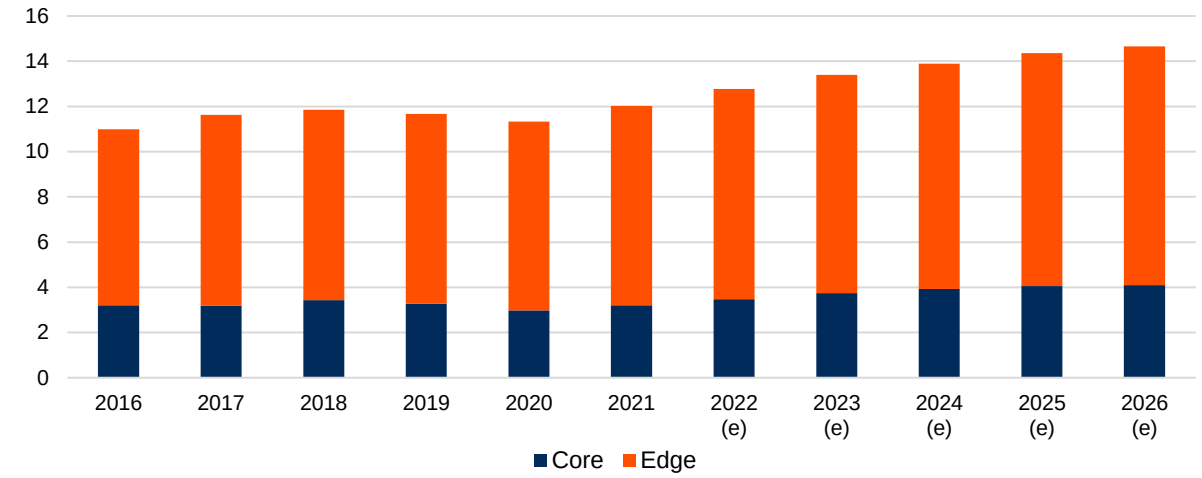


Source: CFRA, IDC.

Routing Market

The worldwide service provider routing equipment market will continue to grow. Much like the Ethernet switch market, service providers are also investing in higher-bandwidth 100G and 400G routing capacity in the core to handle increased data traffic. Investments in edge routing hardware are aimed at building more density in metro networks, as adoption of more cloud-based services drives expanded metro capacity, and consumers and businesses demand more streaming digital content. Much of this demand is being driven by the build-out of 5G networks as carriers look to have the transport backbone in place ahead of the expected surge in data. The worldwide service provider routing equipment market is projected to expand at a 3.7% CAGR between 2021 and 2026, from $12.2 billion to $14.6 billion, according to IDC. The capacity requirements for both core and edge routers will double over the next two to three years to accommodate the high growth rate in data applications and mobile broadband. This is pushing the router refresh cycle closer to three years from the typical five-year cycle, which will benefit the market leaders.

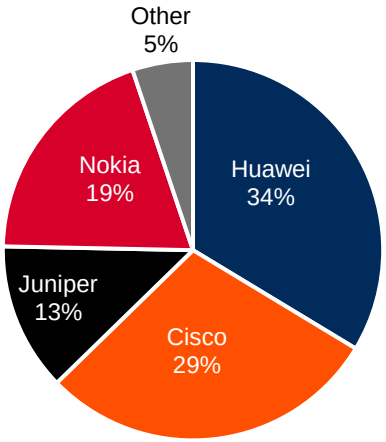
WORLDWIDE CARRIER ROUTING EQUIPMENT REVENUE BY CONNECTIVITY, 2016-2026
($, billions)



e-Estimate
Source: IDC.

Routing equipment revenue share continues to shift towards Huawei. Huawei is the clear overall market share leader, controlling 33.7% of the total revenue share in 2021 – a clear 4.6% ahead of Cisco. Meanwhile, Cisco's revenue share was 29.1%. Nokia and Juniper's 2021 revenue market share remained almost flat at 19.5% and 12.6%, respectively. Despite virtually no exposure to the U.S., Huawei was still able to keep ahead of Cisco. This indicates that the company is vastly outperforming all other vendors in every other region, especially the Asia-Pacific area. This will be a strong headwind for Cisco and Juniper in the long term, but we note the addition of Huawei to the U.S. Entity List could provide a brief opening for the two companies to win back business. Cisco has the greatest opportunity to capitalize on this window as its product portfolio is best positioned, we think, to compete with Huawei's. Much like in the switching market, it has become critical for vendors to provide software solutions along with the routing portfolio that can collect streaming data from the routing stack, analyze it, and utilize the insight to configure and optimize the routing solutions dynamically, which is an area in which Cisco has made strides.

WORLDWIDE SERVICE PROVIDER ROUTING EQUIPMENT MARKET SHARE, 2021



Source: IDC, May 2022.

HOW THE INDUSTRY OPERATES

The Communications Equipment industry provides the electronic products – from hand-held telephones to large-scale computer and telephone network infrastructure – that people use daily to communicate. These products may operate with a wired or wireless connection to the public communications network. The electronic signals they receive and transmit may be either analog or digital.

The primary drivers of the industry are corporate information technology spending and telecommunications capital expenditures. Products sold to enterprise customers (such as large corporations, government agencies, and educational institutions) to help connect computer information systems are usually classified as networking equipment. With the increasing convergence of communications and computing, most equipment is commonly able to serve both markets.

Wireline Communications

Wireline service providers employ a variety of media, including copper, fiber-optic, and coaxial cables, to carry data and voice traffic. The equipment employed to send and receive this traffic is critical to the process. Customers for network equipment – public or private network operators – typically purchase their equipment in large quantities under long-term contracts with producers. Due to the complexity of communications systems and the high cost of developing and maintaining in-house expertise, today's network operators are demanding integrated turnkey installations.

Transport Media

Wireline media has three basic types – copper, fiber, and coaxial – which have distinguishing characteristics.

◆ **Fiber-optic cable.** This medium transmits signals as light pulses; just like digital technology, the signals are binary in nature. A single fiber-optic strand constructed of very pure glass and no thicker than a human hair can transmit a thousand times more information than all of today's radio frequencies combined. A half-inch fiber-optic cable can contain up to approximately 72 pairs of fibers that together have a capacity of up to 3.5 million phone calls. In terms of data capacity, modern fiber cables are capable of speeds of 20 terabits per second across a single fiber pair, which is equivalent to roughly 1,000 hours' worth of movies per second.

Fiber-optic lines are immune to signal interference and can handle longer distances better than copper. Fiber is more expensive than copper, however, so it has traditionally been used primarily for long-distance (rather than local) networks. With the telecom carriers expanding into the video market, optical fiber deployments are beginning to extend all the way to the consumer's home.

◆ **Coaxial cable.** Coaxial cable consists of a single strand of copper wire surrounded by a sheath or shielding made of foam. Over this sheath is yet another layer of insulation. The different layers of the cable help to prevent signals, such as television transmissions, from leaking out. In general, coaxial has higher capacity than copper wire but lower than fiber-optic cable. Within many cable operators' networks, coaxial cable is tied together with fiber-optic cable, creating a hybrid fiber-coax network. The coaxial portion is used to deliver cable signals directly to the home, while fiber forms the backbone of the network.

◆ **Copper wire.** Conventional copper wire transmits signals as electrical pulses; a standard three-inch copper cable can transmit about 14,400 phone calls at once. While copper is the most cost-effective of the media, it also has the greatest limitations: signals weaken the further they travel down a copper wire, and they commonly encounter signal interference. Copper wire is also referred to as a "twisted pair" because two wires are often twisted together to reduce interference from other sets of wires. A twisted

pair is the most common form of connection from a home to the local telephone company and from a personal computer (PC) to a local area network (LAN) wiring closet. Like coax, copper lines are being replaced by fiber optic in new network deployments.

Packet-Based Networks

Packet-based networks offer a more efficient means of transport by breaking data into small "packets" for transmission. Originally designed to manage the flow of data in a computer network, they are increasingly used to handle voice traffic. Packet switching technology uses bandwidth more efficiently by supporting both voice and data simultaneously and by not consuming the network resources when no information is being sent. Perhaps the most important attribute of packet switching is its ability to offer new multimedia services to the mature telephony market.

Protocols

A protocol is a set of standardized procedures for the formatting and the timing of transmission of communications between two pieces of equipment. As telephone companies install packet-based networks, they are realizing tremendous efficiencies, as the same network that carries voice can carry data and video as well. There are currently two main switching protocols to packetize traffic: Asynchronous Transfer Mode (ATM) and Internet Protocol (IP).

◆ **Asynchronous Transfer Mode.** A high-speed switching service that can be built into the core of new data networks, Asynchronous Transfer Mode (ATM) works by chopping all traffic into 53-byte cells. (A byte is a sequence of eight bits – enough to represent one character of alphanumeric data – processed as a single unit of information.) Each cell contains a header that lets the ATM switch know what kind of traffic it carries (voice, video, or data). The switch then funnels the traffic down a predetermined pathway to its destination. ATM, known for its superior quality of service, has become the backbone technology among very large organizations, common carriers, and internet providers.

◆ **Internet Protocol.** Much like ATM, Internet Protocol (IP) chops up voice or data traffic into bits, but of variable length, whereas ATM data are transmitted in equal amounts. Compared with ATM, this system allows network resources to be used more efficiently, as many different transmission signals can be routed simultaneously over the same path.

Linking Networks

Specifications are also needed to link networks. We detail the main specifications below.

◆ **Ethernet.** Ethernet is effectively a shared medium, where only one Ethernet end station can transmit at any one time. Invented in May 1973, Ethernet is the predominant protocol of traditional corporate local area data networks. Their popularity is partly due to their relatively low cost. The development of new Ethernet standards has progressed extremely rapidly, driven by explosive growth in data center traffic. Back in the 1990s, the Fast Ethernet standard was capable of speeds up to 100 megabits per seconds. By 2002, Ethernet speeds were 1,000 times higher, with 10 gigabit deployments beginning to gain traction. The 100 gigabit standards, such as 100GBASE-KP4 and 100GBASE-CR2, was first released in 2010 and is now commonplace in most large data centers. Demand for this standard began to take off in 2017 and 2018, as the cost of hardware decreased, and data center operators saw the opportunity to use the standard as a means to decrease power and space requirements. The 10, 25, and 40 gigabit standards are still used for smaller deployments. The industry starting to look towards the 400-gigabit standard, which was released in 2018, and began initial deployments late in 2021.

◆ **Routers.** The router is an advanced interconnection device to link local area networks (LANs) that use different protocols and generally have more functionality than a switch. After evaluating and compensating for such factors as network congestion and the distance between a transmission's source and destination, the router picks the best path for moving a packet of information closer to its destination.

- ***Core routers*.** These offer high capacity at high speeds and are configured in a modular architecture. In general, routers with slots of more than 2.5 gigabits per second (Gbps) can be grouped under the broad core router definition. Revenues of core routers were about $3.3 billion in 2021 and is expected to grow to $4.1 billion in 2026, according to IDC. Given its position in the network, core routers require less intelligent routing functionality. As of 2021, Cisco is the largest player in this segment, with 39.4% of revenue share, followed by Huawei and Juniper with 38.3% and 17.9% of revenue share, respectively.

- ***Edge routers.*** Routers with slots of 2.5 Gbps or less can be grouped in the edge router segment. Since they help aggregate traffic to the end subscribers, reliable and flexible routing intelligence is a key requirement. Revenues of service provider edge routers were $8.9 billion in 2021 and are expected to increase to $10.5 billion by 2026, according to IDC. As of 2021, Huawei leads the service provider edge router market with 31.9%, followed by Nokia at 25.3% and Cisco at 25.2%. Owing to intensifying competition and extreme pricing pressure, profit margins in the edge router market are often lower than in the core market.

Transmission Systems

The distances between different central offices, as well as between a central office and a local telco office or end office, are served by wireline transmission equipment. The major transmission equipment suppliers include Nokia's Alcatel-Lucent, Cisco Systems, Ciena Corp., and Fujitsu Ltd.

Transmission systems use multiplexing techniques to send voice, data, image, and video communications over fiber-optic cables. Multiplexing involves sending numerous signals simultaneously on the same transmission path. The two main methods are time-division multiplexing (TDM) and dense wavelength-division multiplexing (DWDM).

◆ **Time-division multiplexing.** This is the most common multiplexing technology. It separates a voice conversation into pieces, which it then weaves, along with pieces of other conversations, onto a broadband circuit for transport to various destinations. Time-division multiplexing (TDM) works by assigning portions of bandwidth (slots) to devices such as telephones or computers.

The downside to this equipment category is that it employs the TDM technology as designed for predictable voice traffic. It does not scale to support data traffic and is tailored for specific speeds. If a carrier wishes to upgrade a network to a higher speed, a "forklift" upgrade is necessary: all the old equipment must be replaced with expensive new equipment.

◆ **Dense wavelength-division multiplexing.** The dense wavelength-division multiplexing (DWDM) system provides a more robust form of multiplexing than TDM systems. DWDM uses lasers to divide light (data traffic) into eight or more separate wavelengths before sending them through fiber-optic networks. Some of the most advanced DWDM systems can split traffic into 160 wavelengths over a single strand of fiber. By contrast, synchronous optical networking equipment employs the use of only one wavelength. DWDM systems allow service providers to add capacity without installing new fiber-optic cables.

Terminal Equipment Sold to End Users

Terminal equipment is a generic term that is also known as customer premises equipment (CPE). The largest CPE product sectors are private branch exchanges (PBXs), key systems, voice processing equipment, video communications equipment, call center systems, telephones, facsimile products, and modems.

◆ **Private branch exchanges.** Private branch exchanges (PBXs) and key systems (a type of PBX) are telephone operations that route calls between people within an organization and between an organization and the public telephone network. Voice processing equipment includes voice messaging and voice

response devices. Video communications equipment consists of videophones and videoconferencing hardware and software.

◆ **Call centers.** Located on the customer's premises, call center systems integrate the hardware and software associated with computing, telephony, messaging, and response applications. These centers are the initial entry point for customers accessing a business's telephone sales and support operations. Companies seek to differentiate themselves from competitors by offering superior customer service on the telephone.

Access Equipment in the Local Loop

Access equipment is designed to connect subscribers to the public switched telephone network through the local loop. The local loop is the portion of the public telecommunications network that extends from the network's end office to residential and business users. Demand for access equipment has risen in recent years as internet usage has grown.

◆ **Digital loop carrier.** A digital loop carrier (DLC) is broadband equipment that helps minimize the amount of copper wire needed in a network. Fiber is extended from the public network's central office to a remote terminal near the subscriber that contains the DLC equipment. There, it connects to the copper wiring that traditionally runs into each home.

◆ **Cable modems.** Cable modems allow high-speed connections to the internet via cable TV that completely bypasses the public telephone system. Because coaxial cable can support higher bandwidth than a twisted pair of copper wires, cable modems typically deliver higher internet access speeds than digital subscriber lines (DSLs). First, however, cable TV systems must be upgraded to carry two-way traffic. An aggressive network upgrade effort by cable companies has led to a sharp increase in the total number of cable modem users.

Wireless Communications

Wireless communications equipment comprises two general categories: infrastructure (network equipment) and handsets (comparable to terminal equipment in the wireline world). Infrastructure products are typically made in the vendor's home country, whereas handsets are often produced at overseas locations where costs are lower.

Infrastructure Equipment and Standards

Wireless infrastructure systems include switches and base stations for cellular, personal communications services, Wireless Local Loop, and paging services, microwave antenna systems, and Earth station antennas for satellite transmission.

Base stations contain a radio transceiver that establishes wireless communication with a mobile telephone. They are arranged geographically so that mobile customers can be handed off seamlessly from one station to the next while traveling. Instruments housed in mobile switching systems, which connect the base stations to the public telephone network, accomplish this relay. Ericsson, Motorola Inc., and Nokia compete in the cellular and personal communications service wireless infrastructure segment.

◆ **Digital wireless.** These systems work on a hodgepodge of competing standards that are often incompatible. They include the global system for mobile communication (GSM), code division multiple access (CDMA), and third-generation (3G), fourth-generation (4G), and fifth-generation (5G) platforms.

- ***3G platforms*.** The two primary standards in 3G networks are wideband code division multiple access (WCDMA) and CDMA2000. WCDMA is derived from the European digital cellular standard (the global system for mobile communication, or GSM), while CDMA2000 is based on the 3G technology developed by Qualcomm Inc. Alternative 3G technologies include two developed in China: TD-CDMA and TD-SCDMA. The latter combines elements of TDMA and CDMA.

- ***4G platforms.*** 4G is now the most prominent standard used by wireless providers; these systems provide mobile ultra-broadband internet access to mobile devices. Two kinds of 4G systems are commercially deployed: the WiMAX (Worldwide Interoperability for Microwave Access) standard, and the first-release Long Term Evolution (LTE) standard. The biggest carriers in the U.S. – AT&T, Verizon Wireless, T-Mobile – have deployed 4G LTE networks.
- ***5G platforms.*** Latest technology advancements have paved its way for the 5G era – characterized by the GSM Association as the "age of boundless connectivity and intelligent automation". The new generation of mobile network driven by the 3GPP (3rd Generation Partnership Project) is expected to enhance and expand its support for a diverse range of devices and services; interconnecting and control machines, objects, and devices; connect new industries with improved performance, efficiency, and cost.

HOW TO ANALYZE A COMPANY IN THIS INDUSTRY

At CFRA, we recommend a top-down approach to valuation. An examination of the industry drivers outlined on page 8 – global mobile data traffic, service providers capital expenditures, business confidence – is a good starting point.

Industry Drivers

◆ **Real GDP growth.** GDP, the broadest measure of aggregate economic activity, is the market value of all goods and services produced by labor and capital in the U.S. The U.S. Department of Commerce reports GDP data each month. Economic activity may accelerate traffic volume over the public telephone network rises. In the corporate arena, fluctuations in GDP influence expenditures for customer premises equipment (CPE), including private branch exchanges (PBXs) and call centers.

◆ **Capital expenditures by telephone companies.** Capital expenditure forecasts by major telephone companies can serve as a proxy for overall end-user demand for communications equipment.

◆ **Cellular penetration and global growth of wireless subscribers.** The cellular penetration rate – the percentage of a given population that uses wireless services – indicates the portion of the potential market for wireless infrastructure equipment and handsets that are not yet served in a given area. Thus, penetration has a big influence on the prospects for overall industry growth.

◆ **Growth of internet users and traffic.** Use of the internet is calculated both in numbers of users and in hours of use. Growth in both measures has strained the capacity of existing networks, requiring additional bandwidth. Thus, fluctuations in the user and usage data will influence the capital expenditure budgets of the major telephone companies.

Company Analysis

When analyzing a communications equipment company, investors must consider both financial and nonfinancial factors. The investor must closely examine the income statement and the balance sheet for early signs of trouble or improvement.

Several key factors that influence a company's prospects should be considered, such as management expertise and experience. Communications equipment purchases typically come in the form of large orders from major domestic and international customers. The effectiveness and scope of a company's marketing and distribution channels can determine the firm's ability to build a solid reputation and win large contracts.

Analyzing Financial Statements

A company's financial statements give the analyst important insight into its current position and prospects for growth. The following discussion highlights some of the key line items and financial ratios found on the income statement and balance sheet.

Income Statement Analysis

The income statement portrays the operating results of a company over a stated period. Trends in growth rates – and any aberrations from the norm – should be assessed. Investors look at sales, gross margin, and certain expenses.

◆ **Sales.** Quarterly results should be compared with the year-earlier quarter, and on a sequential basis (*i.e.*, compared with the preceding quarter). Year-to-year changes reveal longer-term trends, while sequential fluctuations give clues about sales momentum and short-term trends. In making these

comparisons, the seasonality of sales must be kept in perspective. Sales of communications equipment are typically heavier toward the end of the calendar year and weaker during the summer months.

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, large shipments at period-end, a change in revenue recognition policy, and a change in the interpretation of the revenue recognition policy.*

◆ **Gross margin.** This ratio – the percentage of sales remaining after the cost of goods sold is subtracted from total sales – is a key area to watch when examining income statement trends. Communications equipment makers generally provide high value-added products that require significant human capital and heavy investment in research and development (R&D). Increasingly, these products also include a low-cost software component. Because average selling prices (ASPs) for sophisticated communications equipment are high and relatively stable, the industry enjoys wide gross margins.

◆ **Operating expenses.** The major operating expense line items – selling, general, and administrative (SG&A) costs and R&D – can yield important information regarding the efficiency and technological leadership of a communications equipment company.

◆ **Employee stock option expense.** Although stock options do not use monetary resources, they can potentially dilute the existing share base. Changes in financial reporting rules mean that companies must now expense options on the income statement.

Watch Out! *Companies are required to expense the grant date fair value of stock options over the vesting period. Assumptions used in valuing stock options offer several earnings management opportunities. All else equal, decreases in expected stock volatility, expected option-life or risk-free rate assumptions and/or increases in the dividend yield assumption reduce stock option fair value and can provide temporary cost reduction and earnings boosts.*

Many companies exclude stock-based compensation from non-GAAP earnings on the basis that the expense is non-cash. We note that this practice likely overstates sustainable earnings because it ignores the potential dilutive effect of outstanding grants, or the potential cash outflows in future periods in order to offset the dilutive effect.

Balance Sheet Analysis

The balance sheet provides valuable clues about demand for a company's products. Among areas to watch are the cash position, inventories, accounts receivable, debt load, and vendor financing.

◆ **Cash position.** The level of a company's cash and marketable securities should be followed closely to assess short-term liquidity. Larger, more established companies with strong cash flows prefer to have cash on hand to repurchase shares or to make acquisitions without diluting earnings per share. A declining cash balance over time could signal competitive pricing pressures or company-specific operational problems.

For smaller, younger growth companies that are expected to post losses in the near term, an absolute decline in cash – called cash burn – can be a major issue. Cash burn occurs when a company is

spending more on operating costs (usually R&D) than it can replenish. A sequential decline in cash burn points to improving prospects for the company's ability to remain solvent.

◆ **Inventories.** The inventory turnover ratio (cost of goods sold divided by average inventory) provides a measure of a company's inventory management. A higher ratio indicates that inventory turns rapidly; that is, that products move quickly from manufacture to sale.

The number of inventory days (365 days divided by the inventory turnover ratio) shows how long goods are retained until they are sold. The lower this number, the faster products are getting to customers. A decreasing number can signal a pickup in demand. If it gets too low, however, it could indicate that a company risks losing sales due to an inventory shortfall.

Given the rapid product cycles and technological advancements that can render older inventory obsolete, absolute inventory levels should also be monitored. Many high-technology companies build inventories in the early stages of a new product cycle. Inventory levels that continue to increase faster than sales growth, however, may signal that existing products are not selling well.

Watch Out! *A substantial increase in inventory may be a leading indicator of an upcoming decline in margins. Specifically, when a company's inventory rises faster than cost of goods sold, CFRA cautions that the inventory growth may be due to the company's inability to sell the inventory (which raises the risk of future obsolescence charges) or that the company may be leaving costs on its balance sheet in the form of inventory rather than expensing these costs on its income statement, raising concerns about the sustainability of earnings and margin growth.*

Watch Out! *The inventory obsolescence reserve is an estimate that is based on the expected salability of current inventory. Inventory obsolescence provisions are generally included in cost of sales and are subject to a high degree of management discretion. A large inventory charge would hurt earnings in the current period but could lead to higher margins and earnings if, as a result of the charge, a company reduces its inventory obsolescence provision in subsequent periods. Additionally, if a company sells this reserved inventory in later periods, it would receive a boost to gross margins and earnings as the cost basis for the product would be artificially low.*

◆ **Accounts receivable.** A careful analysis of the accounts receivable line can show how well a company's products are selling. A rising level of accounts receivable may indicate that a significant portion of sales was made in the last few weeks of the quarter. While many high-technology companies experience this back-end sales trend during a quarter, such a trend could signal that price concessions or generous payment terms had to be extended to accelerate the sales process. In addition, as the communications equipment industry becomes more global, accounts receivable could trend higher as logistical issues create delays in the receipt of payments. Nevertheless, the analyst should closely follow the company's level of accounts receivable, comparing it with the industry's composite rate and watching for any significant deviation from that rate.

◆ **Debt load.** The ratio of long-term debt to total capital should be monitored. Any sudden change in a company's attitude toward taking on debt should be investigated thoroughly. In the past, networking vendors could avoid tapping the debt markets due to their strong cash balances, and they funded acquisitions largely through equity or an exchange of shares. When networking vendors enjoyed healthy valuations versus the broader market, a company's stock represented strong currency.

GLOSSARY

Bandwidth—The range of electrical frequencies a device can handle without distortion, measured in kilohertz; determines the kinds of communications that can be carried on the channel.

Broadband—A transmission facility with a bandwidth greater than four kilohertz (a voice-grade line); it can carry numerous voices, video, and data channels simultaneously.

Cloud computing—A delivery model for computing resources in which various servers, applications, data, and other resources are integrated and provided as a service over the internet.

Code division multiple access (CDMA)—Digital cellular system technology invented by Qualcomm Inc. that features up to 10 times the capacity of traditional analog wireless technologies.

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.

Ethernet—A 10 Mbps standard for network communications; the most popular standard in local area network (LAN) networking. It allows only one device at a time to send data, which it broadcasts over the entire network.

Endpoint security—An approach to the protection of computer networks that are remotely bridged to client devices.

Fast Ethernet—Also known as 100BaseT, Fast Ethernet is a high-speed version of Ethernet, transmitting at speeds of 100 Mbps rather than 10 Mbps.

Fiber-optic cable—Thin filaments of glass through which light beams can be sent; capable of transmitting enormous amounts of data over long distances.

Gigabit Ethernet—A high-speed version of Ethernet, with transmission speeds of one Gbps.

Hertz (Hz)—A unit of frequency equal to one cycle per second. Kilohertz (kHz): one thousand cycles per second. Megahertz (MHz): one million cycles per second. Gigahertz (GHz): one billion cycles per second.

Infrastructure as a service (IaaS)—A virtualized computer environment delivered as a service over the internet by a provider. Infrastructure can include servers, network equipment, and software.

Internet of Things (IoT) —The Internet of Things refers to electronics devices that collect some kind of data from sensors that are attached to it. The device is also connected to the internet so that it can send the data it collects from sensors to a larger, more powerful processor or server.

Local area network (LAN)—Computing devices that are connected so that they can share data and peripherals.

Platform as a service (PaaS)—A computing platform delivered as a service over the internet by a provider. An example is an application development environment that you can subscribe to and use immediately.

Private cloud—Services offered over the internet or over a private internal network to only select users, not the general public.

Protocols—Rules regulating the transmission of information on a computer network. Different systems are employed to deliver signals from one device to another and to prevent packets of information from crashing into one another.

Public cloud—Services offered over the public internet and available to anyone who wants to purchase them.

Router—A device that connects two LANs. Routers are similar to bridges, but provide additional functionality, such as the ability to filter messages and forward them to different places based on various criteria.

Software as a service (SaaS)—An application delivered over the internet by a provider. The application does not have to be purchased, installed, or run on users' computers. SaaS providers were previously referred to as application service providers.

Software-defined networking (SDN)—An architecture that gives networks more programmability and flexibility by separating the control plane from the data plane.

Switch—A device that opens or closes circuits, completes or breaks an electronic path, or selects paths or circuits.

Unified Communications and Collaboration (UCC)—A combination of enterprise communication tools assembled into a single interface and integrated into a single management system.

Virtualization—The act of creating a virtual rather than a physical version of a computing environment, including computer hardware, operating system and storage devices.

Voice over Internet Protocol (VoIP)—Internet telephony; refers to communications services (voice, facsimile, and/or voice messaging applications) that are transported via the internet, rather than the public switched telephone network (PSTN).

Wi-Fi—A brand originally licensed by the Wi-Fi Alliance to describe the underlying technology of wireless local area networks (WLANs) based on the IEEE 802.11 specifications.

INDUSTRY REFERENCES

TRADE ASSOCIATIONS

CTIA
ctia.org
International nonprofit membership organization representing all sectors of wireless communications; compiles comprehensive data on cellular industry revenues, market penetration, pricing, and other issues.

Global Mobile Suppliers Association
gsacom.com
Trade group representing mobile suppliers worldwide – firms engaged in infrastructure, semiconductors, devices, services and applications development, and support services.

GSMA
gsma.com
Trade group representing the interests of GSM, satellite, and 3G network operators, manufacturers, and suppliers; responsible for the development, deployment, and evolution of the GSM standard.

Telecommunications Industry Association
tiaonline.org
Trade association focused on driving the convergence of communications and computing.

MARKET RESEARCH AND CONSULTING FIRMS

IDC Research Inc.
idc.com
Leading provider of information technology data, analysis, and consulting; a division of International Data Group.

IDC Research Inc.
mckinsey.com
A global management consulting company that provides advice and consultation to most influential businesses and institutions. Its alumni work in virtually every business sector in 120 countries.

GOVERNMENT AGENCIES

Federal Communications Commission
fcc.gov
U.S. agency in charge of regulating the telecommunications industry, particularly interstate communications by radio, television, wire, satellite, and cable.

International Telecommunication Union
itu.int
International organization within the United Nations' system of government and private sector participants; coordinates global telecom networks and services.

National Bureau of Statistics of China
stats.gov.cn
Agency under the State Council of the People's Republic of China, in charge of statistics and economic accounting.

Ministry of Industry and Information Technology
miit.gov.com
State agency of the People's Republic of China responsible for regulation and development of the internet, wireless and communications.

ONLINE RESOURCES

Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2017–2022
cisco.com
White paper, part of the Cisco Visual Networking Index (VNI) Forecast, an ongoing initiative to track and forecast the impact of visual networking applications on global networks.

Cost of Data Breach Study 2020
ibm.com
Benchmark research on the global trends and costs of data breaches, sponsored by IBM and independently conducted by Ponemon Institute.

Ericsson
ericsson.com
One of the leading providers of Information and Communication Technology (ICT) to service providers, Ericsson enables the full value of connectivity by creativity game-changing technology and services that are easy to use and adopt.

Fortune Business Insights
fortunebusinessinsights.com
Provides market research data, customized services, analysis, and recommendations for diverse industry verticals.

COMPARATIVE COMPANY ANALYSIS

				Operating Revenues														
				Million $							CAGR (%)			Index Basis (2012=100)					
Ticker		Company	Yr. End	2021	2020	2019	2018	2017	2016	2015	10-Yr.	5-Yr.	1-Yr.	2021	2020	2019	2018	2017	2016
COMMUNICATIONS EQUIPMENT																			
ADTN	[]	ADTRAN HOLDINGS, INC.	DEC	563.0	506.5	530.1	529.3	666.9	636.8	600.1	(2.4)	(2.4)	11.2	94	84	88	88	111	106
ANET	[]	ARISTA NETWORKS, INC.	DEC	2,948.0	2,317.5	2,410.7	2,151.4	1,646.2	1,129.2	837.6	35.6	21.2	27.2	352	277	288	257	197	135
CALX	†	CALIX, INC.	DEC	679.4	541.2	424.3	441.3	510.4	458.8	407.5	7.0	8.2	25.5	167	133	104	108	125	113
CIEN	§	CIENA CORPORATION	OCT	3,620.7	3,532.2	3,572.1	3,094.3	2,801.7	2,600.6	2,445.7	7.6	6.8	2.5	148	144	146	127	115	106
CLFD		CLEARFIELD, INC.	SEP	140.8	93.1	85.0	77.7	73.9	75.3	60.3	14.9	13.3	51.2	233	154	141	129	123	125
CSCO	§	CISCO SYSTEMS, INC.	JUL	49,818.0	49,301.0	51,904.0	49,330.0	48,005.0	49,247.0	49,161.0	1.4	0.2	1.0	101	100	106	100	98	100
CMTL	[]	COMTECH TELECOMMUNICATIONS COR	JUL	581.7	616.7	671.8	570.6	550.4	411.0	307.3	(0.5)	7.2	(5.7)	189	201	219	186	179	134
DGII	§	DIGI INTERNATIONAL INC.	SEP	308.6	279.3	254.2	226.9	181.3	203.0	203.8	4.2	8.7	10.5	151	137	125	111	89	100
EXTR	[]	EXTREME NETWORKS, INC.	JUN	1,009.4	948.0	995.8	983.1	607.1	519.8	552.9	11.7	14.2	6.5	183	171	180	178	110	94
FFIV	†	F5, INC.	SEP	2,603.4	2,350.8	2,242.4	2,161.4	2,090.0	1,995.0	1,919.8	8.5	5.5	10.7	136	122	117	113	109	104
HLIT	†	HARMONIC INC.	DEC	507.1	378.8	402.9	403.6	358.2	405.9	377.0	0.3	4.6	33.9	135	100	107	107	95	108
JNPR	[]	JUNIPER NETWORKS, INC.	DEC	4,735.4	4,445.1	4,445.4	4,647.5	5,027.2	4,990.1	4,857.8	0.6	(1.0)	6.5	97	92	92	96	103	103
LITE	§	LUMENTUM HOLDINGS INC.	JUL	1,742.8	1,678.6	1,565.3	1,247.7	1,001.6	903.0	837.1	NA	14.1	3.8	208	201	187	149	120	108
MSI	§	MOTOROLA SOLUTIONS, INC.	DEC	8,171.0	7,414.0	7,887.0	7,343.0	6,380.0	6,038.0	5,695.0	3.6	6.2	10.2	143	130	138	129	112	106
NTGR	†	NETGEAR, INC.	DEC	1,168.1	1,255.2	998.8	1,058.8	1,039.2	1,143.4	1,300.7	(0.1)	0.4	(6.9)	90	97	77	81	80	88
NTCT	†	NETSCOUT SYSTEMS, INC.	# MAR	855.6	831.3	891.8	909.9	986.8	1,162.1	955.4	11.1	(2.7)	(6.8)	90	87	93	95	103	122
VSAT	[]	VIASAT, INC.	# MAR	2,787.6	2,256.1	2,309.2	2,068.3	1,594.6	1,559.3	1,417.4	10.9	9.7	(2.3)	197	159	163	146	113	110
VIAV	†	VIAVI SOLUTIONS INC.	JUL	1,198.9	1,136.3	1,130.3	875.7	805.0	906.3	873.9	(3.9)	5.8	5.5	137	130	129	100	92	104

Note: Data as originally reported. CAGR-Compound annual growth 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 following 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 (2012=100) 2021	2020	2019	2018	2017	2016
COMMUNICATIONS EQUIPMENT																				
ADTN	[]	ADTRAN HOLDINGS, INC.		DEC	(8.6)	2.4	(53.0)	(19.3)	23.8	35.2	18.6	NA	NM	NM	-46	13	-284	-104	128	189
ANET	[]	ARISTA NETWORKS, INC.		DEC	840.9	634.6	859.9	328.1	423.2	184.2	121.1	37.8	35.5	32.5	694	524	710	271	349	152
CALX	†	CALIX, INC.		DEC	238.4	33.5	(17.7)	(19.3)	(83.0)	(27.4)	(26.3)	NA	NM	611.9	-905	-127	67	73	315	104
CIEN	§	CIENA CORPORATION		OCT	500.2	361.3	253.4	(344.7)	1,262.0	72.6	11.7	NA	47.1	38.4	4,287	3,097	2,172	NM	10,816	622
CLFD		CLEARFIELD, INC.		SEP	20.3	7.3	4.6	4.3	3.8	8.0	4.7	12.7	20.5	178.7	434	156	98	91	82	171
CSCO	§	CISCO SYSTEMS, INC.		JUL	10,591.0	11,214.0	11,621.0	110.0	9,609.0	10,739.0	8,981.0	5.0	(0.3)	(5.6)	118	125	129	1	107	120
CMTL	[]	COMTECH TELECOMMUNICATIONS CORP.		JUL	(73.5)	7.0	25.0	29.8	15.8	(7.7)	23.2	NA	56.9	NM	-316	30	108	128	68	-33
DGII	§	DIGI INTERNATIONAL INC.		SEP	10.4	8.4	10.0	1.6	9.4	16.7	6.6	(0.6)	(9.1)	23.2	157	128	151	25	143	254
EXTR	[]	EXTREME NETWORKS, INC.		JUN	1.9	(126.8)	(25.9)	(46.8)	(1.7)	(36.4)	(71.6)	(3.3)	NM	NM	-3	177	36	65	2	51
FFIV	†	F5, INC.		SEP	331.2	307.4	427.7	453.7	420.8	365.9	365.0	3.2	(2.0)	7.7	91	84	117	124	115	100
HLIT	†	HARMONIC INC.		DEC	13.3	(29.3)	(5.9)	(21.0)	(83.0)	(72.3)	(15.7)	4.2	NM	NM	-85	187	38	134	530	462
JNPR	[]	JUNIPER NETWORKS, INC.		DEC	252.7	257.8	345.0	566.9	306.2	592.7	633.7	(5.1)	(15.7)	(2.0)	40	41	54	89	48	94
LITE	§	LUMENTUM HOLDINGS INC.		JUL	397.3	135.5	(36.4)	248.1	(102.5)	9.3	(3.4)	NA	111.9	193.2	NM	NM	1,071	NM	3,015	-274
MSI	§	MOTOROLA SOLUTIONS, INC.		DEC	1,245.0	949.0	868.0	966.0	(155.0)	560.0	610.0	0.7	17.3	31.2	204	156	142	158	-25	92
NTGR	†	NETGEAR, INC.		DEC	49.4	58.3	25.8	(9.2)	19.4	75.9	48.6	(6.0)	(8.2)	(15.3)	102	120	53	-19	40	156
NTCT	†	NETSCOUT SYSTEMS, INC.	#	MAR	35.9	19.4	(2.8)	(73.3)	79.8	33.3	(28.4)	(6.3)	NM	NM	-126	-68	10	258	-281	-117
VSAT	[]	VIASAT, INC.	#	MAR	(15.5)	3.7	(0.2)	(67.6)	(67.3)	23.8	21.7	(20.4)	(29.9)	NM	-71	17	-1	-311	-310	109
VIAV	†	VIAVI SOLUTIONS INC.		JUL	67.5	49.0	5.4	(48.6)	160.2	(99.2)	(88.1)	(0.6)	NM	37.8	-77	-56	-6	55	-182	113

Note: Data as originally reported. CAGR-Compound annual growth 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 following 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
COMMUNICATIONS EQUIPMENT																					
ADTN []	ADTRAN HOLDINGS, INC.		DEC	NM	0.5	NM	NM	3.6	5.5	NM	0.5	NM	NM	3.6	5.3	NM	0.6	NM	NM	4.9	7.3
ANET []	ARISTA NETWORKS, INC.		DEC	28.5	27.4	35.7	15.3	25.7	16.3	14.7	13.4	20.5	10.6	17.2	10.7	23.0	20.4	34.1	17.2	30.6	19.4
CALX †	CALIX, INC.		DEC	35.1	6.2	NM	NM	NM	NM	32.1	7.8	NM	NM	NM	NM	56.2	15.4	NM	NM	NM	NM
CIEN §	CIENA CORPORATION		OCT	13.8	10.2	7.1	NM	45.0	2.8	10.3	8.6	6.5	NM	31.9	2.5	18.1	15.4	12.4	NM	87.0	10.5
CLFD	CLEARFIELD, INC.		SEP	14.4	7.8	5.4	5.5	5.2	10.6	16.1	7.7	5.6	5.8	5.5	11.4	21.8	9.2	6.4	6.4	6.1	14.1
CSCO §	CISCO SYSTEMS, INC.		JUL	21.3	22.7	22.4	0.2	20.0	21.8	10.9	11.8	11.9	0.1	7.4	8.8	26.7	31.4	30.3	0.2	14.8	17.4
CMTL []	COMTECH TELECOMMUNICATIONS CORF		JUL	NM	1.1	3.7	5.2	2.9	NM	NM	0.8	2.8	3.5	1.9	NM	NM	1.3	4.8	6.0	3.3	NM
DGII §	DIGI INTERNATIONAL INC.		SEP	3.4	3.0	3.9	0.7	5.2	8.2	1.7	1.6	2.5	0.4	2.7	5.0	2.5	2.3	2.9	0.5	3.0	4.7
EXTR []	EXTREME NETWORKS, INC.		JUN	0.2	NM	NM	NM	NM	NM	0.2	NM	NM	NM	NM	NM	6.5	NM	NM	NM	NM	NM
FFIV †	F5, INC.		SEP	12.7	13.1	19.1	21.0	20.1	18.3	6.6	6.6	12.6	17.4	17.0	15.9	14.4	15.4	28.1	36.1	34.9	29.2
HLIT †	HARMONIC INC.		DEC	2.6	NM	NM	NM	NM	NM	1.9	NM	NM	NM	NM	NM	4.8	NM	NM	NM	NM	NM
JNPR []	JUNIPER NETWORKS, INC.		DEC	5.3	5.8	7.8	12.2	6.1	11.9	2.8	2.7	3.9	6.1	3.1	6.1	5.7	5.6	7.3	11.9	6.4	12.4
LITE §	LUMENTUM HOLDINGS INC.		JUL	22.8	8.1	NM	19.9	NM	1.0	11.2	4.1	NM	15.7	NM	1.3	21.3	8.3	NM	28.8	NM	2.0
MSI §	MOTOROLA SOLUTIONS, INC.		DEC	15.2	12.8	11.0	13.2	NM	9.3	10.2	8.7	8.2	10.3	NM	6.6	NM	NM	NM	NM	NM	NM
NTGR †	NETGEAR, INC.		DEC	4.2	4.6	2.6	NM	1.9	6.6	4.6	5.3	2.7	NM	1.6	6.4	7.1	9.0	4.2	2.6	NM	9.3
NTCT †	NETSCOUT SYSTEMS, INC.	#	MAR	4.2	2.3	NM	NM	8.1	2.9	1.1	0.6	NM	NM	2.4	0.9	1.8	1.0	NM	NM	3.5	1.4
VSAT []	VIASAT, INC.	#	MAR	NM	0.2	NM	NM	NM	1.5	NM	0.1	NM	NM	NM	0.8	NM	0.8	0.7	NM	NM	1.5
VIAV †	VIAVI SOLUTIONS INC.		JUL	5.6	4.3	0.5	NM	19.9	NM	3.4	2.8	0.3	NM	7.6	NM	9.2	6.8	1.1	NM	21.5	NM

Note: Data as originally reported. CAGR-Compound annual growth 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 following calendar year.

Souce: S&P Capital IQ.

Ticker	Company	Yr. End	Current Ratio						Debt/Capital Ratio (%)						Debt as a % of Net Working Capital					
			2021	2020	2019	2018	2017	2016	2021	2020	2019	2018	2017	2016	2021	2020	2019	2018	2017	2016
COMMUNICATIONS EQUIPMENT																				
ADTN []	ADTRAN HOLDINGS, INC.	DEC	2.4	3.4	2.8	3.0	3.9	2.8	0.0	0.0	0.0	5.2	4.9	5.3	0.0	0.0	0.0	10.4	8.4	11.8
ANET []	ARISTA NETWORKS, INC.	DEC	4.3	5.0	5.8	4.5	4.3	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CALX †	CALIX, INC.	DEC	3.2	2.6	1.2	1.2	1.3	1.8	0.0	0.0	19.5	19.7	20.7	0.0	0.0	0.0	105.9	96.5	87.9	0.0
CIEN §	CIENA CORPORATION	OCT	3.5	3.4	2.8	2.2	1.9	2.3	18.5	21.9	24.4	26.2	21.5	57.2	30.1	38.1	45.7	58.2	60.3	91.2
CLFD	CLEARFIELD, INC.	SEP	3.5	5.0	6.4	8.3	9.7	7.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CSCO§	CISCO SYSTEMS, INC.	JUL	1.5	1.7	1.5	2.3	3.0	3.2	17.9	23.4	38.9	32.1	31.5	27.8	70.2	63.5	116.4	58.6	51.6	45.5
CMTL []	COMTECH TELECOMMUNICATIONS CORP	JUL	1.4	1.7	1.9	1.7	1.7	1.6	28.6	21.4	23.6	22.7	26.8	33.8	239.5	127.4	122.3	129.4	182.0	200.8
DGII §	DIGI INTERNATIONAL INC.	SEP	4.2	2.8	4.3	4.6	9.7	8.2	8.8	13.7	0.0	0.0	0.0	0.0	24.4	54.2	0.0	0.0	0.0	0.0
EXTR []	EXTREME NETWORKS, INC.	JUN	1.1	1.0	1.2	1.2	1.4	1.1	85.3	98.7	59.4	62.6	39.0	29.3	990.3	2408.1	197.5	277.4	93.9	214.7
FFIV †	F5, INC.	SEP	1.2	1.4	1.4	1.5	1.5	1.5	12.9	14.2	0.0	0.0	0.0	0.0	159.3	73.1	0.0	0.0	0.0	0.0
HLIT †	HARMONIC INC.	DEC	1.4	1.6	1.3	1.4	1.2	1.5	27.6	35.1	28.7	35.8	36.0	30.2	114.3	153.8	170.7	211.2	414.3	162.9
JNPR []	JUNIPER NETWORKS, INC.	DEC	1.6	1.5	2.1	2.5	2.4	2.3	28.1	27.3	26.8	27.1	31.3	30.1	156.4	153.7	101.3	65.3	87.3	95.4
LITE §	LUMENTUM HOLDINGS INC.	JUL	3.7	7.2	4.5	5.3	5.1	2.8	28.6	39.0	35.8	24.8	31.0	0.0	44.6	63.4	80.5	36.6	42.6	0.0
MSI §	MOTOROLA SOLUTIONS, INC.	DEC	1.3	1.2	1.2	1.4	1.3	1.3	100.4	111.7	115.5	131.8	164.2	127.7	421.6	615.5	689.7	449.7	433.7	549.0
NTGR †	NETGEAR, INC.	DEC	2.6	2.4	2.5	2.2	2.4	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NTCT †	NETSCOUT SYSTEMS, INC. #	MAR	1.9	1.8	1.7	2.1	1.8	1.9	14.5	14.9	18.8	21.0	22.5	11.0	78.5	112.5	172.6	130.6	176.9	76.1
VSAT []	VIASAT, INC. #	MAR	1.5	1.4	1.7	1.8	1.3	1.9	47.4	42.2	47.0	42.1	34.6	32.8	621.4	617.5	413.0	346.8	669.7	293.2
VIAV †	VIAVI SOLUTIONS INC.	JUL	1.5	3.9	3.2	2.1	7.3	5.4	22.7	46.0	45.4	43.2	54.2	45.8	61.4	88.7	95.5	92.7	64.8	59.2

Note: Data as originally reported. CAGR-Compound annual growth 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 following calendar year.

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
COMMUNICATIONS EQUIPMENT																				
ADTN []	ADTRAN HOLDINGS, INC.	DEC	NM - NM	306 - 103	NM - NM	NM - NM	49 - 39	32 - 23	NM	728.9	NM	NM	72.9	49.9	2.1 - 1.4	2.8 - 1.5	7.0 - 2.8	4.2 - 2.0	2.9 - 1.6	1.9 - 1.5
ANET []	ARISTA NETWORKS, INC.	DEC	54 - 24	35 - 19	29 - 16	70 - 43	42 - 15	37 - 20	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
CALX †	CALIX, INC.	DEC	20 - 8	58 - 10	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
CIEN §	CIENA CORPORATION	OCT	19 - 12	26 - 15	28 - 18	NM - NM	3 - 2	48 - 30	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
CLFD	CLEARFIELD, INC.	SEP	31 - 13	42 - 17	47 - 26	46 - 33	75 - 40	33 - 20	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
CSCO §	CISCO SYSTEMS, INC.	JUL	22 - 14	22 - 13	22 - 15	2036 - 1336	18 - 15	15 - 11	58.2	53.6	51.4	5425.5	57.4	44.2	3.6 - 2.3	4.0 - 2.7	4.2 - 2.4	3.3 - 2.3	3.8 - 2.5	3.7 - 3.2
CMTL []	COMTECH TELECOMMUNICATIONS	JUL	NM - NM	133 - 41	35 - 20	28 - 14	29 - 14	NM - NM	NM	142.7	39.1	32.0	119.2	NM	4.6 - 1.5	3.0 - 1.3	3.4 - 1.1	1.9 - 1.1	2.3 - 1.2	12.6 - 2.1
DGII §	DIGI INTERNATIONAL INC.	SEP	79 - 46	64 - 22	41 - 26	234 - 157	40 - 24	20 - 12	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
EXTR []	EXTREME NETWORKS, INC.	JUN	769 - 243	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
FFIV †	F5, INC.	SEP	39 - 22	31 - 18	28 - 17	27 - 16	23 - 18	23 - 16	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
HLIT †	HARMONIC INC.	DEC	93 - 52	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
JNPR []	JUNIPER NETWORKS, INC.	DEC	45 - 28	33 - 22	29 - 23	19 - 15	38 - 30	18 - 14	102.5	102.4	75.4	44.0	49.1	25.7	3.3 - 2.2	3.7 - 2.5	4.6 - 3.1	3.4 - 2.5	3.0 - 1.4	1.6 - 1.3
LITE §	LUMENTUM HOLDINGS INC.	JUL	21 - 13	52 - 27	NM - NM	19 - 11	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
MSI §	MOTOROLA SOLUTIONS, INC.	DEC	37 - 23	33 - 22	35 - 21	22 - 15	NM - NM	25 - 18	38.7	45.9	43.7	34.9	NM	50.0	1.6 - 1.2	1.7 - 1.1	2.1 - 1.4	2.1 - 1.3	2.3 - 1.6	2.4 - 2.0
NTGR †	NETGEAR, INC.	DEC	28 - 16	20 - 8	62 - 29	NM - NM	99 - 69	26 - 15	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
NTCT †	NETSCOUT SYSTEMS, INC. #	MAR	119 - 76	NM - NM	NM - NM	42 - 28	106 - 59	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
VSAT []	VIASAT, INC. #	MAR	1086 - 550	NM - NM	NM - NM	NM - NM	179 - 139	169 - 126	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
VIAV †	VIAVI SOLUTIONS INC.	JUL	61 - 39	75 - 42	622 - 395	NM - NM	17 - 10	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

Note: Data as originally reported. CAGR-Compound annual growth 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 following calendar year.

Souce: S&P Capital IQ.

Ticker	Company		Yr. End	Earnings per Share ($)						Tangible Book Value per Share ($)						Share Price (High-Low, $)					
				2021	2020	2019	2018	2017	2016	2021	2020	2019	2018	2017	2016	2021	2020	2019	2018	2017	2016
COMMUNICATIONS EQUIPMENT																					
ADTN []	ADTRAN HOLDINGS, INC.		DEC	(0.2)	0.0	(1.1)	(0.4)	0.5	0.7	6.7	7.1	7.2	8.5	10.1	9.7	24.8 - 14.4	16.2 - 4.8	17.8 - 8.1	20.5 - 10.2	25.1 - 18.7	23.8 - 16.3
ANET []	ARISTA NETWORKS, INC.		DEC	2.6	2.0	2.7	1.0	1.3	0.6	12.0	9.9	9.1	6.7	5.6	3.9	148.6 - 65.5	73.4 - 39.2	82.8 - 43.3	78.3 - 46.8	61.4 - 21.8	24.7 - 13.1
CALX †	CALIX, INC.		DEC	3.5	0.5	(0.3)	(0.4)	(1.7)	(0.6)	6.9	2.5	0.5	0.7	0.6	2.0	80.9 - 28.6	33.1 - 5.6	11.3 - 5.6	10.7 - 5.6	7.8 - 4.7	8.2 - 5.6
CIEN §	CIENA CORPORATION		OCT	3.2	2.3	1.6	(2.5)	7.5	0.5	17.1	13.6	11.4	9.6	12.4	2.5	78.3 - 47.5	61.5 - 30.6	46.8 - 32.8	36.6 - 20.7	28.0 - 19.4	25.2 - 15.6
CLFD	CLEARFIELD, INC.		SEP	1.5	0.5	0.3	0.3	0.3	0.6	6.9	5.4	4.8	4.3	4.5	4.2	86.7 - 23.6	28.3 - 8.3	16.8 - 9.9	15.3 - 8.4	21.5 - 11.0	21.6 - 12.3
CSCO§	CISCO SYSTEMS, INC.		JUL	2.5	2.6	2.6	0.0	1.9	2.1	(0.1)	0.6	(0.5)	1.9	6.8	6.9	64.3 - 43.4	50.3 - 32.4	58.3 - 41.0	49.5 - 37.4	39.0 - 29.8	32.0 - 22.5
CMTL []	COMTECH TELECOMMUNICATIONS COR		JUL	(2.9)	0.3	1.0	1.2	0.7	(0.5)	(4.4)	(1.6)	(1.5)	(1.1)	(3.1)	(4.4)	30.4 - 20.1	37.3 - 11.5	38.0 - 20.9	36.9 - 20.6	23.9 - 10.5	25.1 - 9.5
DGII §	DIGI INTERNATIONAL INC.		SEP	0.3	0.3	0.4	0.1	0.4	0.6	3.8	1.4	5.8	5.0	6.6	7.2	25.6 - 16.3	19.9 - 6.2	19.0 - 10.0	14.7 - 9.3	14.0 - 8.5	14.2 - 7.7
EXTR []	EXTREME NETWORKS, INC.		JUN	0.0	(1.1)	(0.2)	(0.4)	(0.0)	(0.4)	(2.5)	(3.3)	(0.6)	(0.9)	0.2	(0.0)	16.6 - 6.7	8.0 - 1.4	8.6 - 5.4	15.6 - 4.8	14.3 - 5.1	5.2 - 2.3
FFIV †	F5, INC.		SEP	5.3	5.0	7.1	7.3	6.5	5.4	(1.5)	2.4	9.7	11.6	10.1	8.9	249.0 - 173.4	178.1 - 79.8	173.4 - 121.4	199.7 - 131.3	149.5 - 114.6	148.3 - 86.0
HLIT †	HARMONIC INC.		DEC	0.1	(0.3)	(0.1)	(0.2)	(1.0)	(0.9)	0.5	0.1	0.1	(0.3)	(0.6)	0.1	12.2 - 6.7	8.6 - 4.4	8.4 - 4.5	6.3 - 2.9	6.2 - 2.8	6.1 - 2.5
JNPR []	JUNIPER NETWORKS, INC.		DEC	0.8	0.8	1.0	1.6	0.8	1.5	0.8	1.9	3.2	4.6	4.0	4.6	35.9 - 22.4	26.5 - 15.2	28.8 - 22.4	30.8 - 23.6	31.0 - 23.9	29.2 - 21.2
LITE §	LUMENTUM HOLDINGS INC.		JUL	5.1	1.8	(0.5)	3.8	(1.7)	(0.1)	18.7	14.2	9.6	14.5	9.7	8.0	112.1 - 65.7	101.3 - 59.1	80.5 - 38.7	74.4 - 37.0	68.6 - 34.2	45.3 - 18.1
MSI §	MOTOROLA SOLUTIONS, INC.		DEC	7.2	5.5	5.0	5.6	(1.0)	3.2	(22.0)	(23.7)	(24.0)	(24.7)	(22.0)	(15.3)	273.6 - 165.6	187.5 - 120.8	182.3 - 110.6	134.0 - 89.2	95.3 - 76.9	87.6 - 59.1
NTGR †	NETGEAR, INC.		DEC	1.6	1.9	0.8	(0.3)	0.6	2.2	21.0	19.9	17.3	16.8	20.6	20.4	46.4 - 26.1	42.6 - 15.0	40.7 - 23.7	78.3 - 45.7	61.4 - 41.5	60.8 - 33.4
NTCT †	NETSCOUT SYSTEMS, INC.	#	MAR	0.5	0.3	(0.0)	(0.9)	0.9	0.4	(1.3)	(3.0)	(5.1)	(4.1)	(5.9)	(2.3)	34.9 - 24.8	29.6 - 19.1	30.3 - 20.9	31.8 - 21.6	38.5 - 27.7	33.8 - 18.8
VSAT []	VIASAT, INC.	#	MAR	(0.2)	0.1	(0.0)	(1.1)	(1.2)	0.5	25.8	28.2	25.9	24.7	24.1	23.5	68.8 - 31.2	74.1 - 25.1	97.3 - 56.6	80.3 - 55.9	75.9 - 57.8	82.2 - 56.0
VIAV †	VIAVI SOLUTIONS INC.		JUL	0.3	0.2	0.0	(0.2)	0.7	(0.4)	1.2	0.8	0.6	0.7	2.7	2.1	18.1 - 14.7	16.1 - 8.1	16.4 - 9.5	12.8 - 8.5	11.9 - 8.1	8.8 - 4.7

Note: Data as originally reported. CAGR-Compound annual growth 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 following calendar year.

Souce: S&P Capital IQ.

Disclosures

CFRA's Industry Surveys Reports (the "Industry Surveys") have been prepared by Accounting Research & Analytics, LLC and/or one of its affiliates. The Industry Surveys are published and distributed by Accounting Research & Analytics, LLC d/b/a CFRA with the following exceptions: In the European Union/European Economic Area, the Industry Surveys are published and distributed by CFRA UK Limited (company number 08456139 registered in England & Wales with its registered office address at PO Box 698, Titchfield House, 69–85 Tabernacle Street, London, EC2A 4RR, United Kingdom), which is regulated by the UK Financial Conduct Authority (No. 775151); in Malaysia, the Industry Surveys are published and distributed by CFRA MY Sdn Bhd (formerly known as Standard & Poor's Malaysia Sdn Bhd) Company No. 683377-A and regulated by Securities Commission Malaysia, No. CMSL/A0181/2007 ("CFRA Malaysia"). CFRA Malaysia is a wholly-owned subsidiary of CFRA US. For Recipients in Canada: This report is not prepared subject to Canadian disclosure requirements and may not be suitable for Canadian investors.

The content of this report and the opinions expressed herein are those of CFRA based upon publicly-available information that CFRA believes to be reliable and the opinions are subject to change without notice. This analysis has not been submitted to, nor received approval from, the United States Securities and Exchange Commission or any other regulatory body. While CFRA exercised due care in compiling this analysis, CFRA AND ALL RELATED ENTITIES SPECIFICALLY DISCLAIM ALL WARRANTIES, EXPRESS OR IMPLIED, to the full extent permitted by law, regarding the accuracy, completeness, or usefulness of this information and assumes no liability with respect to the consequences of relying on this information for investment or other purposes.

No content (including ratings, credit-related analyses and data, valuations, model, software or other application or output therefrom) or any part thereof (Content) may be modified, reverse engineered, reproduced or distributed in any form by any means, or stored in a database or retrieval system, without the prior written permission of CFRA. The Content shall not be used for any unlawful or unauthorized purposes. CFRA and any third-party providers, as well as their directors, officers, shareholders, employees or agents do not guarantee the accuracy, completeness, timeliness or availability of the Content.

Past performance is not necessarily indicative of future results. This document may contain forward-looking statements or forecasts; such forecasts are not a reliable indicator of future performance.

This report is not intended to, and does not, constitute an offer or solicitation to buy and sell securities or engage in any investment activity. This report is for informational purposes only. Recommendations in this report are not made with respect to any particular investor or type of investor. Securities, financial instruments or strategies mentioned herein may not be suitable for all investors and this material is not intended for any specific investor and does not take into account an investor's particular investment objectives, financial situations or needs. Before acting on any recommendation in this material, you should consider whether it is suitable for your particular circumstances and, if necessary, seek professional advice.

CFRA may license certain intellectual property or provide services to, or otherwise have a business relationship with, certain issuers of securities that are the subject of CFRA research reports, including exchange-traded investments whose investment objective is to substantially replicate the returns of a proprietary index of CFRA. In cases where CFRA is paid fees that are tied to the amount of assets invested in a fund or the volume of trading activity in a fund, investment in the fund may result in CFRA receiving compensation in addition to the subscription fees or other compensation for services rendered by CFRA, however, no part of CFRA's compensation for services is tied to any recommendation or rating. Additional information on a subject company may be available upon request.

CFRA's financial data provider is S&P Global Market Intelligence. THIS DOCUMENT CONTAINS COPYRIGHTED AND TRADE SECRET MATERIAL DISTRIBUTED UNDER LICENSE FROM S&P GLOBAL MARKET INTELLIGENCE. FOR RECIPIENT'S INTERNAL USE ONLY.

The Global Industry Classification Standard (GICS®) was developed by and/or is the exclusive property of MSCI, Inc. and S&P Global Market Intelligence. GICS is a service mark of MSCI and S&P Global Market Intelligence and has been licensed for use by CFRA.

Certain information in this report is provided by S&P Global, Inc. and/or its affiliates and subsidiaries (collectively "S&P Global"). Such information is subject to the following disclaimers and notices: "Copyright © 2022, S&P Global Market Intelligence (and its affiliates as applicable). All rights reserved. Nothing contained herein is investment advice and a reference to a particular investment or security, a credit rating or any observation concerning a security or investment provided by S&P Global is not a recommendation to buy, sell or hold such investment or security or make any other investment decisions. This may contain information obtained from third parties, including ratings from credit ratings agencies. Reproduction and distribution of S&P Global's information and third-party content in any form is prohibited except with the prior written permission of S&P Global or the related third party, as applicable. Neither S&P Global nor its third-party providers guarantee the accuracy, completeness, timeliness or availability of any information, including ratings, and are not responsible for any errors or omissions (negligent or otherwise), regardless of the cause, or for the results obtained from the use of such information or content. S&P GLOBAL AND ITS THIRD-PARTY CONTENT PROVIDERS GIVE NO EXPRESS OR IMPLIED WARRANTIES, INCLUDING, BUT NOT LIMITED TO, ANY WARRANTIES OF

MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR USE AND ALL S&P INFORMATION IS PROVIDED ON AN AS-IS BASIS. S&P GLOBAL AND ITS THIRD-PARTY CONTENT PROVIDERS SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, EXEMPLARY, COMPENSATORY, PUNITIVE, SPECIAL OR CONSEQUENTIAL DAMAGES, COSTS, EXPENSES, LEGAL FEES, OR LOSSES (INCLUDING LOST INCOME OR PROFITS AND OPPORTUNITY COSTS OR LOSSES CAUSED BY NEGLIGENCE) IN CONNECTION WITH ANY USE OF THEIR INFORMATION OR CONTENT, INCLUDING RATINGS. Credit ratings are statements of opinions and are not statements of fact or recommendations to purchase, hold or sell securities. They do not address the suitability of securities or the suitability of securities for investment purposes, and should not be relied on as investment advice."

Certain information in this report may be provided by Securities Evaluations, Inc. ("SE"), a wholly owned subsidiary of Intercontinental Exchange. SE is a registered investment adviser with the United States Securities and Exchange Commission (SEC). SE's advisory services include evaluated pricing and model valuation of fixed income securities, derivative valuations and Odd-Lot Pricing that consists of bid- and ask-side evaluated prices for U.S. Municipal and U.S. Corporate Securities (together called valuation services). Such information is subject to the following disclaimers and notices: "No content (including credit-related analyses and data, valuations, model, software or other application or output therefrom) or any part thereof (Content) may be modified, reverse engineered, reproduced or distributed in any form by any means, or stored in a database or retrieval system, without the prior written permission of SE. The Content shall not be used for any unlawful or unauthorized purposes. SE and any third-party providers, as well as their directors, officers, shareholders, employees or agents (collectively SE Parties) do not guarantee the accuracy, completeness, timeliness or availability of the Content. SE Parties are not responsible for any errors or omissions (negligent or otherwise), regardless of the cause, for the results obtained from the use of the Content, or for the security or maintenance of any data input by the user. The Content is provided on an "as is" basis. SE PARTIES DISCLAIM ANY AND ALL EXPRESS OR IMPLIED WARRANTIES, INCLUDING, BUT NOT LIMITED TO, ANY WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR USE, FREEDOM FROM BUGS, SOFTWARE ERRORS OR DEFECTS, THAT THE CONTENT'S FUNCTIONING WILL BE UNINTERRUPTED OR THAT THE CONTENT WILL OPERATE WITH ANY SOFTWARE OR HARDWARE CONFIGURATION.

In no event shall SE Parties be liable to any party for any direct, indirect, incidental, exemplary, compensatory, punitive, special or consequential damages, costs, expenses, legal fees, or losses (including, without limitation, lost income or lost profits and opportunity costs or losses caused by negligence) in connection with any use of the Content even if advised of the possibility of such damages. Credit-related and other analyses and statements in the Content are statements of opinion as of the date they are expressed and not statements of fact or recommendations to purchase, hold, or sell any securities or to make any investment decisions. SE assumes no obligation to update the Content following publication in any form or format. The Content should not be relied on and is not a substitute for the skill, judgment and experience of the user, its management, employees, advisors and/or clients when making investment and other business decisions. SE's opinions and analyses do not address the suitability of any security. SE does not act as a fiduciary or an investment advisor. While SE has obtained information from sources it believes to be reliable, SE does not perform an audit and undertakes no duty of due diligence or independent verification of any information it receives. Valuations services are opinions and not statements of fact or recommendations to purchase, hold or sell any security or instrument, or to make any investment decisions. The information provided as part of valuations services should not be intended as an offer, promotion or solicitation for the purchase or sale of any security or other financial instrument nor should it be considered investment advice. Valuations services do not address the suitability of any security or instrument, and securities, financial instruments or strategies mentioned by SE may not be suitable for all investors. SE does not provide legal, accounting or tax advice, and clients and potential clients of valuation services should consult with an attorney and/or a tax or accounting professional regarding any specific legal, tax or accounting provision(s) applicable to their particular situations and in the countries and jurisdictions where they do business. SE has redistribution relationships that reflect evaluated pricing, derivative valuation and/or equity pricing services of other unaffiliated firms with which SE has contracted to distribute to its client base. Pricing and data provided by these third-party firms are the responsibilities of those firms, and not SE, and are produced under those firms' methodologies, policies and procedures. Valuations services provided by SE and products containing valuations services may not be available in all countries or jurisdictions. Copyright © 2022 by Intercontinental Exchange Inc. All rights reserved."