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1. Global Macroeconomic Variables & IT Industry
1.1. Global Macroeconomic Variables

Through the pandemic, the global economy has demonstrated remarkable resilience, recovering earlier than anticipated. Despite social distancing, households and businesses have maintained a surprising level of activity and spending during the pandemic, generally exceeding expectations. As vaccination efforts increased across the globe in 2021, we were already gradually shifting from an emergency mode to a recovery mode.

Economic recovery post-COVID-19 will be structured around answering several fundamental questions. As the worst of the pandemic is finally behind us, nations across the globe have started to address more pressing economical and other macro-stabilization issues. The fact that we are able to discuss about an economic rebound indicates how things have improved, and despite the presence of risks and uncertainties, the optimism towards handling risks is much higher.

Economic activity has been largely facilitated by digital technology and e-commerce during the crisis, with businesses stepping up digitalization efforts to sustain corporate operations and revenue streams. Digital transformation, which affects how goods and services are created, sold, and consumed, is accelerating due to the increasing adoption of new technologies across industries. Digitization has become a surprise index for the global economy which showed an amalgamation of the difference between expected and realized economic growth.

GDP Growth (2015-2024)

Global public debt increased because of the COVID-19 induced recession, and as central banks raised interest rates, so did the costs associated with servicing sovereign debt, making it particularly difficult for developing nations whose debt is denominated in the US dollars, which is currently appreciating. Geopolitical uncertainties will make it challenging for the world economy to navigate the coming years.

Exhibit 1: Global GDP Growth (CY2015-2024)

![GDP Growth Chart]

Note: Advanced economies include regions such as United States, Germany, France, Italy, Spain, Japan, United Kingdom
Emerging economies include regions such as China, India, ASEAN-5, Russia, Brazil, Mexico, Saudi Arabia, Nigeria, South Africa
SOURCE: IMF, World Economic Outlook (WEO), April 2023
**World GDP Growth**: Global growth is projected to fall from an estimated 3.4 percent in 2022 to 2.8 percent in 2023, then rise to 3.0 percent in 2024.

The rise in central bank rates to fight inflation and Russia’s war in Ukraine continue to weigh on economic activity. The rapid spread of COVID-19 in China dampened growth in 2022, but the recent reopening has paved the way for a faster-than-expected recovery.

After a shaky recovery in 2021, the global economy witnessed a contraction in 2022 as risks started to materialise. The second quarter of 2022 witnessed a decline in global GDP output due to downturns in China and Russia, while US consumer spending fell short of expectations. An already fragile global economy has been hit by several shocks, including higher-than-expected global inflation, particularly in the United States and major European economies, tighter financial conditions, a worse-than-expected slowdown in China due to COVID-19 outbreaks and subsequent lockdowns, and more detrimental effects from the conflict in Ukraine. However, it is anticipated that these sporadic shocks will be resolved in the short- to medium-term, and that, with proper fiscal stimulus and inflation control, the world GDP will eventually improve.

**Advanced Economies GDP Growth**: Following increased vaccination efforts, advanced economies were the quickest to recover from the pandemic in 2021. The accelerated recovery in 2021 was followed by a moderated growth during the first half of 2022 fuelled by higher interest rates and lower corporate valuations. However, in advanced economies such as Germany and Japan, investment is recovering with the rebound of industrial production and release of pent-up demand.

**Emerging Markets and Developing Economies GDP Growth**: The growth projections for emerging market and developing economies have not accelerated, primarily considering India's economic development moderating and China's GDP slowing down. A more robust recovery has led to an increase in the GDP forecast for Latin America and the Caribbean in 2022.

**GDP growth rate of Key Select Economies, Global, 2022-2024**

The COVID-19 pandemic is expected to impact all the regions globally and consequentially the GDP growth within these regions as well. Barring a few emerging markets such as India and China, most of the other regions are expected to witness a significant impact on their GDP that could turn negative.
Exhibit 2: GDP Growth, Key Countries, Global (CY 2022, CY 2023 (E), CY 2024 (P))

<table>
<thead>
<tr>
<th>Country</th>
<th>2022</th>
<th>2023 E</th>
<th>2024 P</th>
</tr>
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<tr>
<td>Canada</td>
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<td>1.5</td>
<td>3.4</td>
</tr>
<tr>
<td>UK</td>
<td>-0.3</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>USA</td>
<td>2.1</td>
<td>1.6</td>
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<tr>
<td>Mexico</td>
<td>1.8</td>
<td>1.6</td>
<td>3.1</td>
</tr>
<tr>
<td>Germany</td>
<td>-0.1</td>
<td>1.8</td>
<td>1.1</td>
</tr>
<tr>
<td>Brazil</td>
<td>0.9</td>
<td>1.5</td>
<td>2.9</td>
</tr>
<tr>
<td>S. Africa</td>
<td>0.1</td>
<td>2</td>
<td>1.8</td>
</tr>
<tr>
<td>India</td>
<td>6.8</td>
<td>5.9</td>
<td>6.3</td>
</tr>
<tr>
<td>China</td>
<td>-2.1</td>
<td>3</td>
<td>5.2</td>
</tr>
<tr>
<td>Russia</td>
<td>0.7</td>
<td>1.3</td>
<td></td>
</tr>
</tbody>
</table>

Note: GDP Growth rates are expressed in percentage
E - Estimated P - Projections

SOURCE: IMF, April, 2023 World Economic Report

Impact of COVID-19 on the IT sector / spend:

The Covid-19 pandemic served as evidence that investing in technology has a significant positive impact on business resilience and risk management. The advantages of "as a service" model are well-established, and the economic benefits of cloud are accelerating the adoption of a wide range of solutions, including managed cloud and private cloud deployments. Going forward, tech spending is expected to be a top priority for company investment, and rising cloud adoption is providing stability in some regions.

Cloud/SaaS Services: Business spending is changing into a post-COVID "new normal" that emphasises digital transformation even more, more cloud computing, and remote and flexible work patterns. Cloud-first policies and cloud migration, particularly in enterprise environments, will be the main drivers of cloud economics. As a result, businesses are rapidly expanding their workload and spending in public / hybrid cloud.

Software: In 2022, it is anticipated that productivity software, which is useful for linking and assisting people to collaborate from anywhere, would account for majority of software
investments. Spending on security software has increased dramatically over the last two years as concerns over protecting endpoint devices and remote users have grown.

**Services:** With investments in digital and cloud technology as well as the momentum of 2021, IT services is predicted to expand substantially more quickly than they did before the pandemic. For instance, consulting opportunities are created by IT services for data management, software security, and privacy. Accenture, Wipro, and Infosys experienced the fastest rates of revenue growth for IT services in FY22, with growth rates of 22%, 27.3%, and 21.1%, respectively. Some of the mid-cap companies such as Happiest Minds saw a revenue growth of 41.4% in FY22 which was much higher than that of most large-cap companies.

**Emerging digital services:** Low code / No code, democratization of AI, customer data platforms (CDP) and business automation are some of the services expected to dominate in the upcoming years. With the advent of 5G, most of the emerging technologies are expected to create new use cases.

**Cybersecurity:** The soaring online activity during the pandemic put a severe strain on many existing networks and systems. Unfortunately, it also opened vast new opportunities for cyberfraud. As a result, global demand for enhanced cybersecurity solutions and better online identity (digital ID) technologies increased from 2020 to 2021. Zero trust architecture, Infrastructure and security as code, secure software development etc., are some of the emerging cyber trends.

**Global Technology Market Outlook**

The technology sector’s reorganisation of operations and recovery from the COVID-19 impact, which had previously resulted in restrictive containment measures involving social distancing, remote work, and closure of commercial activities that created operational challenges, are primarily responsible for the growth.

Two years ago, when the pandemic first began, industry executives were compelled to reconsider where and how digital expenditures needed to be made and to concentrate on enhancing transparency, flexibility, and robustness as 2021 got underway. To fully utilise emerging technologies like AI and ML and enhance remote work capabilities, organisations also had to reorient and reskill their workforces. The pandemic's effects on workforce challenges and shifting IT requirements are hastening the shift to services.

Software-as-a-service(S-a-a-S), infrastructure-as-a-service(I-a-a-S), and platform-as-a-service(P-a-a-S) will all continue to grow in popularity, and hardware-as-a-service will gain ground as a means for companies to offer integrated services to their hybrid workforces. Additionally, Everything-as-a-service(X-a-a-S) is expected to become essential to digital transformation and developing novel solutions and business models that will succeed in the new normal.
India: World’s Fastest Growing Economy

Indian Economy - From a Crisis in 1991 to the World’s Fastest Growing Major Economy: India’s successful economic transformation story is evident from its emergence from the 1991 crisis to its present-day position as a global emerging market heavyweight.

Exhibit 3: Real GDP Growth (%)

Source: World Economic Forum; The World Bank; International Monetary Fund; International Labour Organization; World Trade Organization; Ministry of Finance; Frost & Sullivan
India to Become the 4th Largest Economy by 2030 (Baseline scenario): India is expected to move from being the 7th largest economy in 2018 to the 3rd (optimistic scenario) or 4th (baseline scenario) largest by 2030, depending on scenario conditions, driven by factors such as strong consumer demand and structural reforms.

Exhibit 4: Top 10 Countries Based on Nominal GDP, Global, 2014, 2018, 2030

By 2030F India to overtake Japan to become the 3rd largest economy!

Source: IMF; Frost & Sullivan

India: Covid-19 Impact on GDP

India continues to have the world's fastest-growing major economy, according to the International Monetary Fund's (IMF) GDP projections. India economic trajectory is projected to have a healthy growth in 2022, surpassing China's 3 percent to become the world’s fastest-growing major economy. IMF estimates show that India surpassed the UK to become the fifth-largest economy in the world, behind only the US, China, Japan, and Germany in terms of total GDP.

The economic development of the nation has been significantly impacted by the Covid-19 pandemic’s two waves, with the effects currently being felt across a variety of industries. So far, the pandemic's macroeconomic management has led to a robust recovery, and it is anticipated that this trend will continue until Covid-19's effects start to fade.
India is anticipated to have a rise in pent-up demand notwithstanding recent economic losses. Rural consumption is anticipated to remain high as trade conditions improve and India sends its agricultural products to more recent markets in the Middle East and Africa. Thanks to focused monetary and macro-financial policies, the nation has been able to fully recover from the economic repercussions of the previous several years.

1.2. Global IT Industry

Overview

The global IT Industry was estimated to be USD 4,817 Bn in FY 2022. The market is forecasted to be USD 5,156 Bn in FY 2023 and is forecasted to reach USD 7,846 Bn by FY 2029 with a CAGR of 7.2% over the forecast period (FY2023-2029).

Two years ago, when the COVID-19 epidemic first emerged, it propelled some enterprises into the future and sharply accelerated their efforts at digital transformation. As remote work became more prevalent and market demands altered, workplace environments quickly transformed. The following subjects will be fundamental in 2022 and subsequent years.

Cloud and Everything-as-a-Service will reach to the Next Level - When it comes to allowing everything-as-a-service (XaaS) and fostering innovation, the cloud is quickly replacing traditional infrastructure. It powers improved wireless connections, intelligent edge services, and AI capabilities. To expand access to best-in-class technology, reduce vendor lock-in, optimise costs, and improve resilience and reliability, many enterprises are using a hybrid, multicloud strategy. Organizations will require a mechanism to effortlessly integrate and manage a variety of cloud-based applications and data from a single platform or dashboard due to the complexity of this strategy. We anticipate the market for orchestration solutions to expand over the coming years as a result of tech businesses stepping up to fulfil this expanding requirement.

Throughout the course of the forecast period, the market for private cloud server solutions is anticipated to rise as a result of rising worries about data security and disaster recovery, as well as the continuous adoption of the bring your own device (BYOD) trend and the use of a mobile workforce. The increasing importance placed on assuring real-time and quick access to data is also anticipated to fuel market expansion. A private cloud server envisions a delivery system for hosted services that is entirely dedicated to a single company. With a high level of data security and privacy protection, it provides all the advantages of public clouds, including agility, scalability, and the capacity to build many virtual machines for complicated computing activities. As a result, the single-tenant environment offered by a private cloud server enables enterprises to take advantage of all the benefits linked to a public cloud server as well as more secure and adaptable hosted resources, such as storage, computing power, and networking.

Building of the Next Iteration of the Hybrid Workforce - Tech businesses will probably adapt their cultures and speed up experimenting with collaborative solutions as they get more collective experience with mixed workforces. Technology organisations are attempting to combine the best aspects of both working from home and working in an office to attract and keep talent by striking a balance between the flexibility that individuals want and the organisational needs. Tech businesses that don't change risk losing their ability to foster a sense
of community, belonging, and justice among their staff in terms of career opportunities and pay. Companies should concentrate on three things to solve this problem: making in-person and virtual work equivalent, encouraging meaningful involvement, and defining guidelines for when and how to co-locate.

Exhibit 5: Global IT Industry (USD Bn) - FY 2019-2022E (Historical and Estimated years)

![Chart showing historical and estimated global IT industry revenue from FY 2019 to FY 2022E with a CAGR of 4.5%]

Source: Frost & Sullivan Analysis

Exhibit 6: Global IT Industry (USD Bn) - FY 2023F-2029F (Forecasted years)

![Chart showing forecasted global IT industry revenue from FY 2023F to FY 2029F with a CAGR of 7.2%]

Source: Frost & Sullivan Analysis

Global IT Industry Market by Segment

Global IT market by computation type is segmented into HPC Systems, Workstations, other devices infrastructure, software, IT business services, Emerging tech and telecom services. IT Business services had the second largest share in FY 2022 and is expected to reach USD 2,353.7 Bn by FY 2029 at a CAGR of 7.9%.

The need for IT services in the sector is demonstrated by rising IT investment globally, the increasing usage of software-as-a-service, and a surge in cloud-based offerings. Increased data
dangers are linked to improved IT infrastructure (data breaches). This is encouraging the use of
contemporary security solutions rather than antiquated ones. As a result, companies have
started to invest more money in enhancing their advanced security services. Emerging
technology developments including 5G, Blockchain, augmented reality, and artificial intelligence
are anticipated to influence the IT service offerings. Businesses will likely be able to construct
networks on their land as 5G technology develops. It’s projected that the digital transition would
make it possible to either upgrade existing networks to LTE or launch brand-new networks
utilising regional frequencies. Real-time IT locations need to be built in order to enable the
automation and autonomy of complex systems.

During the predicted period, it is also anticipated that HPC Systems would grow significantly,
which will help the IT Industry grow. Significant new discoveries that increase human
understanding and huge competitive advantages are produced by HPC workloads. For instance,
artificial intelligence (AI) simulations and algorithms that analyse terabytes of data pouring from
IoT sensors, radar, and GPS systems in real time and make split-second choices are executed on
HPC. Additionally, HPC is used to sequence DNA, automate stock trading, and execute human
genome simulations. These algorithms and simulations make it possible to create self-driving
cars. For instance, compared to the initial attempt, which took 13 years, modern HPC systems
can sequence a human genome in less than a day. Rapid cancer diagnosis, molecular modelling,
and drug discovery and design are other HPC applications in healthcare and life sciences.

Workstations segments include the AI & EW, which are projected to aid in the rise of the IT
industry during the projection period. AI workstations are utilised to tackle a variety of innovative
investigations in a methodical, targeted manner. Focused AI enables flexibility in AI design,
training, processes, and operations by including both local parallel processing capabilities and the
same in clouds and data centres. When cost is not an issue, highly scalable servers and cloud
platforms may be necessary to execute AI applications at their quickest rates. On the other hand,
workstations can be beneficial in circumstances where data security is essential but where time
restrictions are less strict and prices are not a big factor. Thus, the increased demand for AI
workstations will fuel the expansion of the IT industry.

In recent years, software solutions have become increasingly prevalent due to the growth of e-
commerce, important technological advancements like artificial intelligence and the Internet of
Things, and an increase in the number of linked devices. There is an increasing need for
sophisticated cybersecurity software that provides cutting-edge and diverse cybersecurity tools
and solutions since malware and attack techniques are becoming more complex and accessible.
As a result, it is projected that rising software solution acceptability would aid in the expansion
of the IT sector over the course of the projection year. The COVID-19 epidemic has helped the
software industry. Numerous examples and incidents of cybercrime were found in a number of
enterprises during the COVID-19 outbreak. The trend toward remote employment has increased
the probability of cyber hazards for businesses. Businesses have been urged to instal software
solutions and build malware protection, detection, and mitigation methods due to the growing
worry about cyberthreats, which will also assist the IT industry grow.

Other devices infrastructure – Another segment expected to drive the overall Global IT industry
during the forecast period is the other devices infrastructure market. Other devices infrastructure
market is expected to be majorly driven by growth in the cloud infrastructure market. The factors driving the growth of the cloud infrastructure market are the rising demand for cloud services globally and the rise in cloud service providers, the quick rise in cloud computing demand, the rising demand for hybrid cloud platforms and AI cloud, and the quick adoption of AI to solve business problems.

Exhibit 7: Global IT Industry Market by Segment (USD Bn) - FY 2019-2022E (Historical and Estimated years)
Global IT Industry Market by Geography/Region

Global IT Industry market by geography is segmented into North America, Europe, Asia Pacific (APAC), South America, and Middle East and Africa (MEA). North America held the largest share (39%) in FY 2022 with a market size of USD 1,855 Bn and is expected to reach USD 2,824.5 Bn by FY 2029 at a CAGR of 6.2%. APAC emerged as the second largest region with a share of 27% in FY 2022 and a market size of USD 1,298 Bn in FY 2022.

Due to the widespread use of Enterprise Resource Planning (ERP) and cloud services for data management, North America will continue to lead the worldwide IT market in 2022. The region's growth is accelerated by the need for suppliers to use services like inventory control, data analytics, reporting, and loyalty management due to the expansion of the retail industry in the region. Additionally, most foreign-owned U.S. affiliate companies are making significant investments in the development of IT professional services, which will support the expansion of the IT industry in the region.

Asia Pacific is anticipated to grow at a CAGR of 8.5% over the forecast period (FY2023-2029), making it one of the fastest-developing regional markets. The legal & advisory, and accounting service industries in this region are likely to have exponential development in demand for knowledge-based services, which will spur expansion over the anticipated period. Additionally, developing economies like China and India are concentrating on IT development, creating a
plethora of prospects for IT professional services throughout APAC. In terms of total internet users, China surpasses countries like India and the United States. According to World Population Reviews, China has 1.02 billion internet users in January 2022 compared to its 1.45 billion total population. Because the internet is an essential tool for international communication, education, and business, a large internet user base benefits the IT sector in all respects. A considerable number of Small & Medium enterprises (SMEs) are also present in the Asia Pacific region, and they heavily rely on professional services including project-oriented services, ITO services, IT support, and training services to carry out their everyday operations without incident.

Asia is a formidable technological force. According to a new study from the McKinsey Global Institute, the region has contributed to 52% of the growth in global IT firm revenues over the past ten years, 43% of startup funding, 51% of spending on research and development, and 87% of patent filings (MGI). Asia is not a homogenous region, and there are still big technological divides within it. For instance, as compared to other significant economies, India has less substantial tech enterprises. Yet, four of the top ten technological businesses in the world according to market capitalization are led by Indians.

Although it still depends on foreign inputs for fundamental technology, China leads the way in tech entrepreneurship in Asia, home to 26% of the world’s unicorns (startups valued at $1 billion or more). Advanced Asian economies like Japan and South Korea, however, have a smaller number of unicorns despite having significant digital companies and a substantial knowledge base. Although Asia’s emerging economies continue to make comparatively small investments in innovation, they do offer expanding markets for the products and services developed by Asia’s tech titans. Asian nations have been forced to make a virtue out of cooperation in order to overcome fragmentation and address technological disparities. And they have advanced quite a bit in recent years. Importantly, they have made significant investments in strong regional technology supply chains and regional tech startups, with around 70% of such investments coming from within Asia. Asia’s technological supply chains are constantly changing as the continent grows, although most of the changes have taken place there. (For instance, the region’s industrialised economies and China have increased their investment in the manufacturing sectors of emerging nations.) This significantly contributed to Asia’s superior adaptability during the COVID-19 crisis. Much stronger intraregional linkages may result from the recently agreed Regional Comprehensive Economic Partnership.

India is no far behind, as of August 29, 2022, there were approximately 77,000 DPIIT-recognized startups in 656 districts around India, making it the third-largest startup ecosystem in the world. Among middle-income economies, India comes in second for innovation quality and first for the calibre of its universities and scientific publications. India’s innovation is not restricted to a few industries. With 13% coming from IT services, 9% from healthcare and life sciences, 7% from education, 5% from professional and commercial services, 5% from agriculture, and 5% from food and beverages, we have identified entrepreneurs solving issues in 56 different industrial areas.

In today’s fast-paced and dynamic market, Indian unicorns are thriving. In addition to creating cutting-edge products and technologies, these businesses also create a significant number of jobs. Up until the fiscal year 2016–17, about one unicorn was added yearly. This number has been rising rapidly for the past four years (from FY 2017–18), with an astounding 66% Year-on-Year
growth in the number of new unicorns introduced each year. India is home to 107 unicorns as of September 7, 2022, with a total worth of $340.79 billion. Out of the total, 44 unicorns worth a combined $93.00 billion were born in 2021, while 21 unicorns worth a combined $26.99 billion were created in 2022. The direct-to-consumer (D2C), quick service restaurant (QSR), and electric car market and infrastructure still offer promise this year, especially for early-stage platforms, while the Indian startup ecosystem goes through a churn as VCs tighten money. In 2023 startups will have a more cash-conservative mentality, putting an emphasis on revenue and growth. The rising spending by Indian unicorns is expected to drive the country’s growth in the forecast period.

It is projected that as businesses work to replace antiquated infrastructure, acceptance of innovative technologies will dramatically expand throughout Europe. Public cloud giants like Google and AWS require on-demand, dynamic, and enormous scalability solutions. The deployment of 5G is predicted to fulfill the need for efficient and scalable network infrastructure. Around 16 of the largest companies are located in early 5G coverage zones, and by 2025, 55% of them are expected to have adopted 5G in Europe. Fifth-generation networks are being introduced, which is causing the current IT infrastructure in the telecoms, automotive, AR/VR, mobile connection, and other industries to change. The user experience is changing across fintech industries as a result of rising P2P transfers and payments, the use of contactless bank cards, and cryptocurrency administration via digital channels. This makes scalable IT infrastructure more appealing.

Exhibit 9: Global IT Industry Market by Geography/Region (USD Bn) - FY 2019-2022E (Historical and Estimated years)

<table>
<thead>
<tr>
<th>Year</th>
<th>North America</th>
<th>Europe</th>
<th>APAC</th>
<th>Latin America</th>
<th>MEA</th>
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<td></td>
</tr>
</tbody>
</table>

Source: Frost & Sullivan Analysis
Market Drivers, Restraints, Opportunities & Challenges

Market drivers

I. Rapid Technology Development – Throughout the historical period, technological advancement was a major force behind the IT business. Interactive computers, biometric authentication for laptops and desktops, block chains, low-code development, cyber security, transportation, wearable technologies, robotics, and networking were specific development areas. Tablet computers are becoming a more popular alternative to PCs and laptops among consumers. The IT support services are also progressively incorporating developments in artificial intelligence, virtual agents, augmented reality, and several other sectors. These innovations enabled for the creation and application of AI-powered conversation platforms, VR-based knowledge graph-guided question-answering, and other customer support strategies. Future IT industry growth is anticipated to be driven by these technological advancements.

II. Green technologies adoption – Green technologies have been developed as a result of the rapid rise in energy consumption, which has posed a serious danger to environmental preservation and sustainable development. For instance, between 2% to 4% of the world's carbon emissions are attributable to communications equipment. Data traffic has greatly expanded as a result of the availability of high-speed internet made possible by next-
generation wireless networks and the rise in smartphone use. As a result, network infrastructures have grown significantly, and energy consumption have gone up. To cut carbon emissions, environmentally friendly batteries, renewable energy sources, and smart power system management are being developed. For instance, YTL Data Center Holdings declared in 2022 that construction had begun on the first 72 MW of its 500 MW data centre facility in JOHOR. The data centre is an environmentally friendly one that solely relies on solar power. As a result, the global IT sector is anticipated to be driven by the adoption of green technologies.

**Market restraints**

I. Software piracy is a significant limitation on the market's expansion. Software companies have experienced revenue losses due to unauthorised copying and distribution of their products. Soft lifting, client-server abuse, hard-disk loading, and copying are examples of common software piracy methods. Online piracy is also widespread and often entails downloading illicit software from blogs, online auctions, or peer-to-peer networks. Software piracy causes IT companies to lose a lot of money, which is why it is a major barrier to this sector's expansion.

**Market opportunities**

I. Faster economic growth – Stable economic growth is anticipated in many developed and developing countries, which benefits the IT business. It is anticipated that recovering commodity prices, which experienced a considerable decrease in the recent past, will support market expansion. Additionally, consistent growth is anticipated in developed economies over the predicted period. Additionally, during the projected period, emerging markets are anticipated to grow faster than developed markets. Stable economic growth is anticipated to boost end-user market spending and accelerate the digitalization process, propelling the market throughout the forecast period.

II. Increasing investments in smart cities - The rapid expansion of investments in smart city initiatives across various nations in the world is anticipated to support the IT market. Information and communication technology are used in "smart cities" to effectively manage and run urban services including water supply, law enforcement, and transportation systems. IoT technology makes these technologies possible. IoT is the convergence of digital, mechanical, and computing-based objects. With the use of this method, data can be transferred over a network with little to no or no human-to-computer interaction. The integration of smart city technologies with electrical and electronic parts, communications hardware, and software benefits the market's players. In India, more than 5000 smart city projects totalling approximately USD 26.3 billion were in development in 2022. Additionally, poorer countries are gaining popularity for the idea of smart cities. For instance, more than 1,000 pilot smart city initiatives are either ready for deployment or are currently being built worldwide, with 500 of these projects located in China.

**Challenges**

I. Impact of E-waste - Rising rules governing the recycling and disposal of electrical and electronic waste (e-waste), which is now the waste stream with the fastest rate of growth,
are projected to impede the expansion of the IT sector, and particularly the computer hardware sector. There is a general absence of uniform law or enforcement surrounding e-waste, making its environmentally responsible treatment risky and expensive. Around 57.1 million tonnes of e-waste are produced annually around the world, and most of it is dumped in the regular trash stream. E-waste is recycled in these areas via crude methods. E-waste has negative effects on the environment and human health. For instance, although it makes up only 2% of the solid trash dumped in landfills worldwide, it contains up to 70% of the hazardous elements. Future threats to this sector may come from labour challenges, safety and health concerns, and regulatory frameworks relating to the treatment of e-waste.

**Key players in the global IT Industry market**

Table 1: Key players in the global IT Industry market (1/2)

<table>
<thead>
<tr>
<th></th>
<th>IBM</th>
<th>Cisco Systems</th>
<th>HPE</th>
<th>Accenture</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Company Type</strong></td>
<td>Public</td>
<td>Public</td>
<td>Public</td>
<td>Public</td>
</tr>
<tr>
<td><strong>Headquarters</strong></td>
<td>Armon, New York, US</td>
<td>California, USA</td>
<td>Texas, USA</td>
<td>Dublin, Ireland</td>
</tr>
<tr>
<td><strong>Geographical Presence</strong></td>
<td>Operates in over 175 countries</td>
<td>Americas, EMEA, APJC</td>
<td>North America, Africa, Middle East, APAC, Europe</td>
<td>Americas, Europe, MEA, Asia</td>
</tr>
<tr>
<td><strong>No. of Employees (as on 2022)</strong></td>
<td>~288,300</td>
<td>~83,300</td>
<td>~60,200</td>
<td>~721,000</td>
</tr>
<tr>
<td><strong>Key Products/Services</strong></td>
<td>Storage, IT Automation, DevOps, Compute &amp; Servers, Network, AI machine learning, Security and Identity</td>
<td>Networking, software, IoT, Mobility and Wireless, Data Center, Cloud and Computing</td>
<td>Compute, Networking, Software, Services, cloud and Security</td>
<td>Artificial Intelligence, security, Software, cloud,</td>
</tr>
<tr>
<td><strong>Business Strategy</strong></td>
<td>Acquisition and Organic investment in R&amp;D</td>
<td>Acquisition, Investment, Alliances</td>
<td>Merger and Acquisition</td>
<td>Merger and Acquisition</td>
</tr>
<tr>
<td>Key Partnerships/Mergers/Acquisitions</td>
<td>IBM</td>
<td>Cisco Systems</td>
<td>HPE</td>
<td>Accenture</td>
</tr>
<tr>
<td>--------------------------------------</td>
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<td>-----</td>
<td>-----------</td>
</tr>
<tr>
<td></td>
<td>2021 - Total acquisitions -15, total spent on acquisition - $3 Bn. Inorganic investments focused on critical hybrid cloud and sustainability software assets, such as Instana, Turbonomic and Envisi. In Consulting, acquisitions are focused on digital innovation including 7Summits, Taos, BoxBoat Technologies and BlueTab Solutions.</td>
<td>Acquisition - Completed 13 acquisitions during fiscal 2021. For e.g., Acacia, IMImobile. Opsani (2022) - will allow Cisco AppDynamics to expand its product and technical teams even further. Alliances - Companies with which strategic alliances were expanded during fiscal 2021 include Apple Inc., Equinix Inc., Google LLC, International Business Machines Corporation, Microsoft Corporation, Samsung Electronics Co., Ltd., and Amazon Web Services LLC, among others.</td>
<td>Acquisition, Hewlett Packard Enterprise announced that it acquired Zerto, an industry leader in cloud data management and protection with a net cash purchase price at closing of $374 million. It also acquired Determined AI, a startup that delivers a powerful and robust software stack to train AI models faster, at any scale, using its open-source machine learning (ML) platform.</td>
<td>In January 2023, the company acquired Determined AI, a San Francisco-based startup that delivers a powerful and robust software stack to train AI models faster, at any scale, using its open-source machine learning (ML) platform. It has also acquired Fiftyfive5, a customer insights and advisory business. The move will strengthen Accenture Song’s (formerly Accenture Interactive) ability to help clients tap data insights and performance marketing to accelerate growth and innovation across Australia and New Zealand.</td>
</tr>
<tr>
<td>Total revenue</td>
<td>USD 60.5 Bn (2022)</td>
<td>USD 51.6 Bn (2022)</td>
<td>USD 28.5 Bn (2022)</td>
<td>USD 61.6 Bn (2022)</td>
</tr>
</tbody>
</table>

Source: Annual Reports, Secondary Sources, Frost & Sullivan Analysis

Note: Revenues are consolidated ones

Financial Calendar:

IBM: January – December; CISCO: August – July; HPE: November – October, Accenture: September - August
Table 2: Key players in the global IT Industry market (2/2)

<table>
<thead>
<tr>
<th></th>
<th>Microsoft Corporation</th>
<th>Oracle</th>
<th>SAP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Company Type</strong></td>
<td>Public</td>
<td>Public</td>
<td>Public</td>
</tr>
<tr>
<td><strong>Headquarters</strong></td>
<td>Washington, US</td>
<td>Texas, USA</td>
<td>Walldorf, Germany</td>
</tr>
<tr>
<td><strong>Geographical Presence</strong></td>
<td>Global</td>
<td>Global</td>
<td>Global</td>
</tr>
<tr>
<td><strong>No. of Employees (as on 2022)</strong></td>
<td>~2,21,000</td>
<td>~1,43,000</td>
<td>~1,11,961</td>
</tr>
<tr>
<td><strong>Key Products/Services</strong></td>
<td>Software, PCs &amp; Devices, Entertainment, Microsoft Cloud, Hardware and Software, On-premise applications, Oracle data bases</td>
<td>Artificial Intelligence, Data and Analytics, Financial Management</td>
<td></td>
</tr>
<tr>
<td><strong>Business Strategy</strong></td>
<td>Partnership</td>
<td>Partnership</td>
<td>Partnership</td>
</tr>
<tr>
<td><strong>Key Partnerships/ Mergers/ Acquisitions</strong></td>
<td>In December 2022, Microsoft partnered with Viasat to help deliver internet access to 10 million people around the globe, including 5 million across Africa.</td>
<td>In January 2023, Saadia Group, a family-owned holding group with a diverse portfolio of leading consumer brands including Lord &amp; Taylor, Le Tote, and S3 Holding, selected Oracle NetSuite to help it change the retail and brand landscape for current and future generations.</td>
<td>In January 2023, the company extended 25-Year Partnership with Lockheed Martin. This would help in transforming the mission-critical business systems.</td>
</tr>
<tr>
<td><strong>Total revenue</strong></td>
<td>USD 204 Bn (2022)</td>
<td>USD 49.9 Bn (2022)</td>
<td>USD 33 Bn (2022)</td>
</tr>
</tbody>
</table>

Source: Annual Reports, Secondary Sources, Frost & Sullivan Analysis

Note: Revenues are consolidated ones

Financial Calendar:

Microsoft: July – June; Oracle: April – March; SAP: January - December
2. India IT Industry
2.1. India IT Industry Overview

The India IT Industry market was USD 2,01,000 Mn in FY 2022. The market is forecasted to be USD 2,25,000 Mn in FY 2023 and is forecasted to reach USD 3,72,706 Mn by FY 2029 with a CAGR of 8.8% over the forecast period (FY2023-2029).

A stable economy, the expansion of e-commerce, the upgrade of mobile networks to 4G and 5G, and the implementation of "Make in India" and PLI Schemes are some of the elements that will contribute to the expansion of the IT industry in India. In the next five years, India's share of global trade is expected to increase manifolds which would further advance the growth of the country's IT sector.

Government of India is expected to make strategic technological investments in the below mentioned sectors, which is expected to drive the India IT industry.

The India oil and gas industry witnessed a growth rate of over 5% between FY 2020 and FY 2021 and is expected to grow with a CAGR of over 3% by FY 2027. The major regions contributing to the growth are Telangana, Andhra Pradesh, Uttar Pradesh and Gujarat and the Union Territory of Jammu & Kashmir, where governments are proposing to / expected to make larger strategic investments in technology. India is the third largest oil & gas consumer in the world. India consumed 204.23 MMT petroleum products and 63.9 BCM natural gas in FY 2021-22.

India’s refining capacity stands at about 251.2 MMTPA as of April 2022, comprising 23 refineries—19 under the public sector, 3 under the private sector, and 1 in a joint venture. Refinery capacity utilization is about 96% for the year 2021-22. The refining industry in India has grown dramatically over time. The nation, which was in a deficit in 2001, became self-sufficient in refining and is now a significant exporter of high-quality petroleum products. With a refining capacity of about 251.2 MMTPA, India is currently the fourth-largest country in the world, behind China, the United States, and Russia. In order to increase local output and reduce reliance on imported fuel, India will more than quadruple the area that is under exploration and production of oil and gas to 0.5 million square kilometres by 2025 and to 1 million square kilometres by 2030. Additionally, the largest oil producer in India, ONGC, forecasts a 4-5% increase in crude oil production for the April 2023–March 2024 fiscal year, which, if achieved, would mark the fastest expansion in two decades. Further, India is buying cheaper crude oil from Russia, which in turn is reducing the dependency of buyer countries on Middle East nations. Hence, India will be capturing the discounts from the Russian market and hence is expected to grow even further.

The Indian Oil & Gas industry is on a rapid expansion spree as the Government of India plans to invest INR 7.5 trillion (US$ 102.49 billion) on oil and gas infrastructure as announced by Prime Minister Mr. Narendra Modi in February, 2021. Further, In September 2021, the Indian government approved oil and gas projects worth Rs. 1 lakh crore (US$ 13.46 billion) in Northeast India. These projects are expected to be completed by 2025.

India could also likely witness an investment of USD 58 billion in finding and producing oil and gas resources in 2023, as per Indian Oil Minister Hardeep Singh Puri. The minister added that global energy majors like Chevron Corporation, Exxon Mobil and Total Energies are keen to invest in the Indian O&G industry.
Growth in the Oil & Gas industry in India is expected to drive the use of high-end computing solutions, such as supercomputers and AI. Oil & Gas companies are increasingly relying on powerful computers/supercomputers to process complex data faster and that enables these companies to cut costs while boosting productivity and success rates of projects. Supercomputers also help these companies develop advance imaging algorithms that help fetch better images of the sub-surface where oil could be found. Below are some of the areas where technology is being utilized or expected to be used in the oil & gas industry in India – 1. Seismic data analysis - Data Processing and Storage: When a well is drilled it is not just a hole in the ground. There are thousands of equipment like cranes, pipes, trucks, drill pipes, tanks etc. All this equipment needs to be logged and maintained and even if 1 goes missing it is a huge loss. A supercomputer has programs for continuous reminders ensuring maintainable tests and measures are taken; 2. Simulation - Simulations are required to monitor what is happening for e.g., 15000 feet below the ground. The Temperature, pressure, flow of water and oil are what gets monitored using simulations. Simulations are run on smart Software which use complex equations and give results almost instantly; 3. Safety - Drilling is a very risky task. There are risk analysis Software and computer-based automations that helps maintain safety while drilling.

The Indian automobile industry is expected to grow at approximately at 8-10% till 2027. As the automobile industry is crucial to both macroeconomic expansion and technological advancement, it has historically been a reliable barometer of how the Indian economy is performing. Due to India’s large proportion of young people and expanding middle class, the two-wheeler category dominates the industry in terms of volume. Also, the expanding interest of businesses in investigating the rural markets contributed to the sector’s expansion. The demand for commercial vehicles is developing as a result of expanding passenger and logistical sectors. New trends, such as the electrification of vehicles, especially three-wheelers and small passenger cars, are expected to fuel market expansion in the future. Between April 2021 and March 2022, the automobile industry manufactured a total of 22.93 million vehicles, including passenger cars, commercial trucks, three-wheelers, two-wheelers, and quadricycles. India is the largest tractor, second-largest bus, and third-largest heavy truck manufacturer in the world, giving it a significant position in the global heavy vehicle market. Currently, the automobile industry contributes 7.1% of India’s GDP and 49% of its manufacturing GDP. (Source: Investindia). Growth in the automobile industry in India is expected to get driven by the use of high-end computing solutions, such as supercomputers and AI. Many automotive manufacturers are using industrial all-in-one computers equipped with RFID scanners to track a car’s place in the manufacturing process. These systems can read these RFID tags of each model, compare them to a central database, and grab the correct parts each and every time from the inventory. Car manufacturers use artificial intelligence in just about every facet of the car-making process. Examples of AI in the automotive industry include industrial robots constructing a vehicle and autonomous cars navigating traffic with machine learning and vision. AI is being effectively implemented in the automotive value chain, including manufacturing, design, supply chain, production, post-production, ‘driver assistance’ and ‘driver risk assessment’ systems. On top of that, AI has been proactively transforming aftermarket services like predictive maintenance and insurance. The Indian BFSI sector is expected to grow at a CAGR of 27-30% till 2025.
The rate of global adoption of fintech is highest in India. One of the world's Fintech markets with the quickest growth rates is India. In India, there are currently more than 2,000 DPIIT-recognized Financial Technology (FinTech) businesses, and this number is rapidly increasing. The market for Indian fintech is expected to be worth $50 billion in 2021 and $150 billion by 2025. By 2023, the Indian fintech industry is anticipated to have $1 trillion in assets under management (AUM) and $200 billion in revenue. The most popular sectors were payments, lending, and insurtech (2021). Till mid of 2022, the Indian fintech market has attracted $29 Bn in capital across 2,084 deals, earning 14% of the worldwide funding and ranking second in terms of deal volume. $8.53 billion (in 278 deals) was invested in India's Fintech industry in FY22. India has 23 fintech startups that, as of July 2022, have achieved "Unicorn Status" with a valuation of over $1 Bn.

With life insurance penetration at 3.2% and non-life insurance penetration at 1%, India's insurance penetration was estimated to be 4.2% in FY21 (up from 3.76% in 2019–20). Private sector businesses increased their market share in the non-life insurance industry from 15% in FY2004 to 49.3% in FY2021.

Algorithmic trading is expected to revolutionize stock market trading in India. The use of algorithmic trading in India just began about 2010 and was initially limited to institutions and brokers. In contrast, the retail industry now has free access to constructing algorithms thanks to the expansion of digital discount brokers and API solutions, and the possibilities are unlimited. Growth in the BFSI industry in India is expected to get driven by the use of high-end computing solutions, such as supercomputers and AI. Artificial intelligence in financial services helps banks to process large volumes of data and predict the latest market trends, currencies, and stocks. Advanced machine learning techniques help evaluate market sentiments and suggest investment options.

Despite global upheavals, India's banking system has historically been one of the most stable in the world. Via a number of measures designed to expand access to banking for the nation's unbanked citizens, the government has continually worked to promote financial inclusion. (FY21–FY26) Personal Loan Origination to rise at a CAGR of 27%; Digital Lending to expand at a CAGR of 48%. The banking industry in India has received support from the Indian government, particularly when it comes to the financial inclusion objective. The Pradhan Mantri Jan Dhan Yojana (PMJDY), a flagship initiative, was introduced in August 2014 with the goal of providing universal banking services to the unbanked through the creation of bank accounts and the issuance of payment cards to everyone. For five important programs—Aadhaar (the government's biometric identity database), e-KYC, e-signing, privacy-protected data sharing, and the UPI—the government required an open API policy, known as India Stack, as part of the Digital India effort. Almost 450 million bank accounts have been opened as part of the Pradhan Mantri Jan Dhan Yojana, and beneficiaries have received approximately $22 billion in deposits. After loans and advances, investments made up the second-largest portion of the assets side of all banks’ balance sheets, mostly due to government securities. The capital adequacy of Indian banks remained above regulatory standards as of 2020, and the RBI further loosened the leverage ratio enabling banks to increase lending. Growth in the banking sector in India is expected to get driven by the use of high-end computing solutions, such as supercomputers and AI. The uses of AI in banking industry are incredible. banks are investing heavily in AI and predictive analytics to make better decisions and provide customised services. The banks are implementing AI for detecting frauds, enhancing
customer experience, tracking customer behavior for recommending more personalized services, analyzing customer credit histories to predict risks associated with allotting loans, and many more.

The growth in the above-mentioned sectors with increasing usage of technology and technological innovations is expected to drive the India IT industry.

Exhibit 11: India IT Industry Market (USD Mn) - FY 2019-2022E (Historical and Estimated years)

![Chart showing CAGR 4.3%]

Source: Frost & Sullivan Analysis

Exhibit 12: India IT Industry Market (USD Mn) - FY 2023F-2029F (Forecasted years)

![Chart showing CAGR 8.8%]

Source: Frost & Sullivan Analysis

A remarkable year for India's IT sector was FY2022. Platformization and XaaS were crucial in boosting tech adoption, and it was also the year of the start-ups, when Tech start-ups jumped into scale-up mode. Digital and innovation combined was the industry's winning recipe. To address margin constraints, the industry increased its focus on operational efficiency, and the O+O model (Offline and Online) gained more penetration in the eCommerce sector. Another significant milestone for the sector was reaching 5 million total direct employees, with a net increase of 445 thousand more than ever. Tech firms quickly adapted to hybrid work models thanks to the industry's "people first, employee-centric" strategy, and the industry's digital capacity/capability building programmes have expanded. A third of employees are now digitally proficient, cementing India’s status as the world's leading nation of digital talent. Today, the proportion of digital revenue to overall revenue is between 22% and 30%. India's market share
in global sourcing has increased to 59% as a result of these factors, which is evidence of India's new tech value proposition.

**High-end Computing Solutions (HCS)**

High-end computing solutions make it possible for organizations to create more efficient operations, reduce downtime and improve worker productivity. For example, high performance computing (HPC) is a high-end computing solution that provides faster AI model iterations, flexible deployment, and open innovation among other benefits over the traditional solutions.

High-end computing solutions, such as HPC, HCI, AI&EW, Data Center Servers etc., are expected to witness growth during the forecast period leading to increased adoption of technology in various end use industries plus increased investment by public and private players in these solutions. Government of India under the Union Budget Speech 2023-24 announced that a National Data Governance Policy will be brought out, which will unleash innovation and research by start-ups and academia – further helping the growth of the high-end computing solutions market in India.

High-end computing solutions industry is a rapidly evolving and technologically advanced industry that requires the vendors to stay abreast of the developments and improve & customise their designs, and hardware and software offerings. The nature of the industry and the rapidity of technological advancement necessitates continual innovation, improvement, and customisation of their solutions. Modification of designs and changes in implementation of the offerings requires technical skill set and expertise which is a significant entry barrier in the industry for new entrants. The industry is R&D intensive and relies significantly on technically qualified resources.

OEM products, parts, and services increase the lifespan of the partnering company’s product, preserving peak performance, reducing the need for replacement parts, and boosting the bottom line of the business. The consumer who purchases the bundled product or system typically benefits from the cost reductions. Managing numerous goods, systems, and providers may prove to be a challenging chore for the end user. The technical support and maintenance model expands dramatically when a business adopts new technologies. They could be servicing their hardware and software products through dozens of OEMs and third-party suppliers. A centralised support and service approach helps many firms simplify the complexity of their OEM and vendor relationships.

### 2.2. India IT Market by Segment

India IT market by computation type is segmented into HPC Systems, Workstations, other devices infrastructure, software, IT business services, Emerging tech and telecom services. Emerging tech had the largest share in 2022 and is expected to reach USD 1,26,720.0 Mn by 2029 at a CAGR of 9.1%.
Software – The rise of the software market is being driven by security software. These programmes' main goals are to secure and safeguard individual computers, information systems, online conversations, transactions, and networks. Security software is responsible for managing access, safeguarding data and networks, and defending against viruses, intrusions, and other system-level security issues. The demands of remote working have raised spending on...
cybersecurity software. With extremely sophisticated plans and methods of attack, software developers are retaliating. Software exports by the IT firms affiliated with STPI (Software Technology Park of India) were Rs. 1.20 lakh crore (US$ 16.29 billion) in the first quarter of FY22.

HPC Systems – HPC systems have gained popularity over time due to their ability to handle large multidimensional datasets (big data) and solve complex problems at breakneck speeds by utilising clusters of powerful processors. Generally speaking, HPC systems outperform commodity desktop, laptop, and server computers with speeds more than a million times faster. The Industrial Internet of Things (IIoT), artificial intelligence (AI), and engineering, which require electronic design automation (EDA), as well as rising usage of HPC products and services in drug discovery and healthcare, are all anticipated to drive investments in the global HPC market over the course of the forecast period.

Telecom Services - 5G services would be further driving the telecom services. The 5G technology's faster data rates and extremely low latency will improve the user experience while using 5G services for a variety of use cases, including VR and AR gaming, seamless video calling, and Ultra-high Definition (UHD) films. The adoption of 5G services is anticipated to increase over the projected period due to rising need for high-speed data connectivity for unified Internet of things (IoT) applications, such as smart home energy management. Additionally, it is predicted that the growing emphasis of 5G system integration providers on forming alliances with telecom carriers will accelerate the uptake of 5G services.

Workstations: Workstations comprises of artificial Intelligence and enterprise workstations. They are expected to witness high growth in India because of the following reasons: Defense and government activities are supported by AI & EW systems for enhanced decision-making and productive work performance in India. Additionally, it aids in enhancing government payment schemes that make precise, practical, and safe payments for child support, pensions, and unemployment insurance. The Indian BFSI sector is dominating the global market in terms of technology adoption. The BFSI industry's usage of AI & EW for analytics and machine learning on massive, streaming datasets aids in the financial sector's ability to make more effective judgements. India is also experiencing growth in the studied market due to major manufacturers' investments and product launches as per “Make AI in India” and “Make AI work for India”, government initiatives.

Hardware: The Government of India attaches high priority to electronics hardware manufacturing, and it is one of the important pillars of both ‘Make in India’ and ‘Digital India’ programmes of Government of India. Besides the economic imperative, focus on electronics hardware manufacturing up to the integrated circuit or chip level is required due to the growing security concerns. The ESDM industry is of strategic importance as well. (Source: National Policy on Electronics 2019) The Government of India has also in CY 2021 announced the IT Hardware PLI Scheme and Telecom and Networking PLI Scheme, respectively.

2.3. Production Linked Incentive (PLI) Scheme (Policy initiatives driving Domestic Production in India):
The scheme was initially announced in the year 2019 by the Government of India to boost domestic manufacturing, curb cheap imports and improve cost competitiveness of domestically manufactured goods.

While the Production Linked Incentive Scheme (PLI) for IT Hardware was notified in March 2021, the PLI Scheme 2.0 for IT Hardware, effective as of May 2023, is anticipated to result in broadening and deepening of the manufacturing ecosystem by encouraging the localization of components and sub-assemblies and allowing for an extended period to develop the supply chain within the country. In addition to providing applicants with increased flexibility and options, the scheme is attached to incremental sales and investment thresholds to further encourage growth. In addition, the PLI Scheme 2.0 for IT Hardware includes incentive-based components for semiconductor design, IC manufacturing, and packaging.

The scheme seeks to incentivise companies to utilise the existing installed capacity to fulfil the increasing domestic demand. The PLI scheme for this second phase has a budget of INR 170 billion spread over a tenure of six years and aims to boost electronics manufacturing in India.

Table 3: Production Linked Incentive Scheme (PLI) for IT Hardware, India, March 2023
Source: MeitY

<table>
<thead>
<tr>
<th>Category</th>
<th>Incremental Investment after 31.03.2023</th>
<th>Incremental Sales of Manufactured Goods over Base Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global IT Hardware Companies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(i) Laptops (Invoice value of INR 30,000 and above),</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(ii) Tablets (Invoice value of INR 15,000 and above),</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(iii) All-in-One PCs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(iv) Servers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(v) Ultra Small Form Factor (USFF)</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>after 31.03.2023 INR 500 Crore over 6 Years Cumulative Minimum (Crore):</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Year 1: INR 50 Crore</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Year 2: INR 150 Crore</td>
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<tr>
<td></td>
<td>Year 3: INR 250 Crore</td>
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<tr>
<td></td>
<td>Year 4: INR 350 Crore</td>
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<td></td>
<td>Year 5: INR 450 Crore</td>
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<td>Year 6: INR 500 Crore</td>
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<tr>
<td></td>
<td>Year 1: INR 1,000 Crore</td>
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<tr>
<td></td>
<td>Year 2: INR 2,500 Crore</td>
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<td>Year 3: INR 5,000 Crore</td>
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<td></td>
<td>Year 4: INR 10,000 Crore</td>
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<td></td>
<td>Year 5: INR 12,000 Crore</td>
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<tr>
<td></td>
<td>Year 6: INR 15,000 Crore</td>
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</tbody>
</table>
### Hybrid (Global/Domestic)

<table>
<thead>
<tr>
<th>Companies</th>
<th>INR 250 Crore over 6 Years; Cumulative Minimum (Crore)</th>
<th>Year 1: INR 500 Crore</th>
<th>Year 2: INR 1,250 Crore</th>
<th>Year 3: INR 2,500 Crore</th>
<th>Year 4: INR 5,000 Crore</th>
<th>Year 5: INR 6,000 Crore</th>
<th>Year 6: INR 7,500 Crore</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) Laptops (Invoice value of INR 30,000 and above)</td>
<td>Year 1: INR 25 Crore Year 2: INR 75 Crore Year 3: INR 125 Crore Year 4: INR 175 Crore Year 5: INR 225 Crore Year 6: INR 250 Crore</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>(ii) Tablets (Invoice value of INR 15,000 and above)</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>(iii) All-in-One PCs</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(iv) Servers (v) Ultra Small Form Factor (USFF) Domestic Companies</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Domestic Companies

| Companies | Cumulative Minimum (Crore) | Year 1: INR 50 Crore Year 2: INR 100 Crore Year 3: INR 200 Crore Year 4: INR 300 Crore Year 5: INR 400 Crore Year 6: INR 500 Crore |
|-----------|-----------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|
| (i) Laptops | Year 1: INR 4 Crore Year 2: INR 8 Crore Year 3: INR 12 Crore Year 4: INR 15 Crore Year 5: INR 18 Crore Year 6: INR 20 Crore | | | | | |
| (ii) Tablets | | | | | | |
| (iii) All-in-One PCs | | | | | | |
| (iv) Servers | | | | | | |
| (v) Ultra Small Form Factor (USFF) | | | | | | |

Note: Year 1 (FY21-22) and so on till Year 4 (FY2024-25)

**Production Linked Incentive Scheme (PLI) for Networking and Telecom, India**

With the objective to boost domestic manufacturing, investments and export in the telecom and networking products, Department of Telecommunications (DoT) notified the “Production Linked Incentive (PLI) Scheme” on 24th February 2021. The PLI Scheme will be implemented within the overall financial limits of ₹ 12,195 Crores only (Rupees Twelve Thousand One Hundred and Ninety-Five Crore only) for implementation of the Scheme over a period of 5 years FY 2021-22 to FY 2025-26. For MSME category, financial allocation will be ₹1000 Crores. Small Industries Development Bank of India (SIDBI) has been appointed as the Project Management Agency (PMA) for the PLI scheme. The scheme will be effective from 1st April 2021.
Target Segment

Support under the Scheme will be provided to companies who will manufacture specified telecom and networking products in following 4 product categories in India:

1. Core transmission Equipment
2. 4G/5G, Next Generation RAN and Wireless Equipment
3. Access & CPE, IoT Access Devices and Other Wireless Equipment
4. Enterprise Equipment: Switch and Router

Table 4: Specified telecom and networking products (w.e.f. 01.04.2022)

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Product Category</th>
<th>Description of Goods</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Core Transmission Equipment</td>
<td>Dense Wavelength Division Multiplexing (DWDM), Optical Transport Network (OTN), Multi Service Provisioning Platform (MSPP), Synchronous Digital Hierarchy (SDH), Packet Transport Network (PTN)/ Multi-Protocol Label Switching (MPLS), Gigabit Passive Optical Networks (GPON)/ Next Generation- Passive Optical Network (NG-PON) Optical Line Terminal (OLT), Digital Microwave Radio, Millimeter Radio, E/V-band Radios, Satellite Gateway (Hub /Earth station) Equipment, Free Space Optics Communication Equipment</td>
</tr>
<tr>
<td>3</td>
<td>Access &amp; Customer Premises Equipment (CPE), IoT Access Devices and Other wireless Equipment</td>
<td>Unified Communications Platforms, IP Multimedia Subsystem, Soft Switch, GPON Optical Network Terminal (ONT), Wireless Fidelity (Wi-Fi) Access Point and Controller, LTE CPE, 5G CPE, Short Range Devices and Associated Electronics in new technologies like 4G/5G/Fibre To The Home (FTTH) etc., Internet Set Top Box, Satellite CPEs for accessing Internet, VSAT Equipment, NG-PON-ONT, Telecom modules of IOT/M2M Access Devices</td>
</tr>
<tr>
<td>4</td>
<td>Enterprise equipment: Switches, Routers</td>
<td>Switches, Routers, Internet protocol (IP) and Packet Switching and Routing Apparatus</td>
</tr>
<tr>
<td>5</td>
<td>Any Other Product- As decided by the EGoS</td>
<td></td>
</tr>
</tbody>
</table>
**Eligible Applicants**

APPLICATION CAN BE MADE UNDER FOLLOWING TWO CATEGORIES:

a) **MSME:** Companies registered as Micro, Small & Medium Enterprises (MSME) with the Ministry of MSME, Government of India.

b) **Non MSMEs:** Companies which do not fall under the MSME category will be classified as Non MSMEs. The Non MSMEs category shall be further sub-divided in two categories:

   1. **Domestic Company:** As per the Scheme Guidelines, a company is considered as ‘Owned’ by resident Indian citizens if more than 50% of the capital in it is beneficially owned by resident Indian citizens and / or Indian companies, which are ultimately “owned” and “controlled” by resident Indian citizens. Such a company will be defined as “Domestic Company” for the purpose of these guidelines.

   2. **Global Company:** Global Company means a company which does not qualify as Domestic Company as defined above and is having business in one or more than one country either by itself or including its Group Companies as defined in the Scheme guidelines.

**Table 5: Incentive Outlay & Eligibility Threshold**

<table>
<thead>
<tr>
<th>Year (A)</th>
<th>Proposed Incentive Rate (B)</th>
<th>Cumulative Investment (C)</th>
<th>Minimum Eligible Incremental Net Sales of Manufactured Goods over the Base Year (D)</th>
<th>Maximum Eligible Incremental Net Sales of Manufactured Goods over the Base year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>MSMEs- Minimum Threshold of Investment Rs. 10 Crores</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>7%</td>
<td>Greater than or equal to 20% of X</td>
<td>3*(20% of X)</td>
<td>20*(20% of X)</td>
</tr>
<tr>
<td>2</td>
<td>7%</td>
<td>Greater than or equal to 40% of X</td>
<td>3*(40% of X)</td>
<td>20*(40% of X)</td>
</tr>
<tr>
<td>3</td>
<td>6%</td>
<td>Greater than or equal to 70% of X</td>
<td>3*(70% of X)</td>
<td>20*(70% of X)</td>
</tr>
<tr>
<td>4</td>
<td>5%</td>
<td>Greater than or equal to X</td>
<td>3*X</td>
<td>20*X</td>
</tr>
<tr>
<td>5</td>
<td>4%</td>
<td></td>
<td>3*X</td>
<td>20*X</td>
</tr>
<tr>
<td><strong>Other than MSMEs- Minimum Threshold of Investment Rs. 100 Crores</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>6%</td>
<td>Greater than or equal to 20% of X</td>
<td>3*(20% of X)</td>
<td>20*(20% of X)</td>
</tr>
<tr>
<td>2</td>
<td>6%</td>
<td>Greater than or equal to 40% of X</td>
<td>3*(40% of X)</td>
<td>20*(40% of X)</td>
</tr>
<tr>
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<td></td>
</tr>
<tr>
<td>3</td>
<td>5%</td>
<td>Greater than or equal to 70% of X</td>
<td>3*(70% of X)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>20*(70% of X)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>5%</td>
<td>Greater than or equal to X</td>
<td>3*X</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>20*X</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>4%</td>
<td></td>
<td>3*X</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>20*X</td>
<td></td>
</tr>
</tbody>
</table>

Where X = Committed Total Investment by the Company / entity over a period of four years

MSMEs = Micro, Small and Medium Enterprises as defined by the Government of India

# As defined under Clause 2.20 of the Scheme Guidelines.

An additional incentive of 1% over and above the applicable rates of incentive for products qualified under Design-led Manufacturing, as defined at Clause 2.8A, in each year.

Source: https://pli-telecom.udyamimitra.in/

**Government of India’s ‘Make in India’ initiative to boost local manufacturing and also contribute to the growth of IT industry in the country**

In 2014, the government of India announced the initiative to make India a global manufacturing hub, by facilitating both domestic as well as international companies to set up manufacturing bases in India. As per the scheme, the government released special funds to boost local manufacturing of mobile phones and electronic components. It has also introduced multiple new initiatives, including promoting foreign direct investment, implementing intellectual property rights, and developing the manufacturing sector. The Make in India initiative, a part of the ‘Atmanirbhar Bharat Abhiyan’ (Self-reliant India), would provide an additional boost to the country’s business operations by encouraging the substitution of imports of low-technology products from other countries and generating demand for local manufacturing.

**China +1 Strategy**

Over the past ten years, there has been a great deal of research done on supply chain management, particularly in light of China's growth as a manufacturing superpower and the growing China-centricity of global supply chains. The weaknesses brought on by reliance on a single supplier for manufacturing have been underlined by this, together with China's increasingly revisionist and authoritarian behaviour in the region. COVID-19 has served as a wake-up call and demonstrated that key global powers like the United States (US), India, Japan, Australia, South Korea, and others also rely heavily on China in terms of supply chains. This realisation has encouraged an immediate focus on the concept of "China Plus One" in the global supply chain (GSC) network, particularly given the likelihood of a complete decoupling from China.

Simply put, the "China Plus One" strategy aims to increase the number and variety of GSCs by creating new manufacturing facilities outside of China. The COVID-19 epidemic has driven stronger execution by governments, both individually and regionally via international venues. Over the past ten years, countries have debated and gradually implemented this policy. For instance, during the epidemic, Japan was among the first developed nations to provide subsidies to its businesses so they could shift production from China to states in adjacent Southeast Asia. Similar to this, the India-Japan-Australia trilateral's Supply Chain Resilience Initiative (SCRI), which
aims to de-risk supply chains and build a sustainable GSC network, has signalled a shift in policy towards group efforts to implement a "China Plus One" approach.

**The China Plus One Plan is expected to benefit the Indian IT sector in the future**

Tech companies are slowly shifting production away from China - The shift is a response to growing concerns about the geopolitical tensions and pandemic-induced supply chain disruptions that have involved China in the last few years.

For example, Apple has started manufacturing its latest iPhone 14 in India. Apple has been ramping up production of iPhones in India as it looks to widen its manufacturing capabilities and reduce dependence on China. Three Apple contract manufacturers – Foxconn, Wistron and Pegatron – are making iPhones in India. All the three are selected under the production-linked incentive (PLI) for smartphone manufacturing. US-China trade tensions kicked off the production relocation cycle and the search for a ‘China+1’ manufacturing approach for the Apple supply chain from late 2018 benefitting India. Another example is of Foxconn, which is one of Apple’s largest supplier and a major manufacturer of iPhone components. Foxconn will build a new 300-acre facility in Bengaluru, India, as part of an ongoing effort to pivot away from China. It is expected to invest about $700 million for the same. This is in line with how US companies continue to re-evaluate their reliance on China in the wake of mounting tension between the US and the Chinese government.

### 2.4. Market Drivers, Restraints, Opportunities & Challenges

#### Drivers –

I. Strong policy support

The Digital India efforts, which have fuelled the Indian IT business, have received strong support from the Indian government. The Indian IT sector has benefited from the open system for raising financing, seed money, and ease of doing business. Additionally, the Indian government has declared plans to establish a national AI portal and to start a national AI initiative. The budget for the IT and telecom sector in the most recent Union Budget for 2022–2023 was Rs. 88,567.6 crore (US$ 11.6 billion). The STP Scheme, which is a 100% export-oriented programme for the creation and export of computer software, including the export of professional services utilising communication links or physical media, has also been implemented by the government. The epidemic has increased demand for cloud services globally as digital transformation spreads across all industries, and the Internet has turned into a lifeline for people both for work and enjoyment. Hyper-scale data centre investments have increased as a result of the shift to cloud services; by 2025, it is predicted that annual global investments would approach US$ 200 billion.

#### Restraints –

I. Lack of cybersecurity professionals

One of the key causes of an increase in cyberattacks is the lack of trained cybersecurity employees in all businesses. Particularly in Asia-Pacific, there are less competent cybersecurity specialists available than are required. Experienced cybersecurity experts are required to manage cyber threats for financial institutions, governmental organisations, and private sector/industrial businesses. India has a small cybersecurity workforce. However, due to the high degree of
commercial activity there, the region is the most alluring country for cyberattacks. Furthermore, there is a lack of clarity in the region’s cyber laws. Most cybersecurity specialists in this region lack the requisite expertise to deal with the seriousness of incoming cyber threats. The lack of trained security personnel and security infrastructure caused by these companies’ lesser financial capacities further hinders the adoption of new technologies and corporate security solutions. Small firms are burdened by the proper management of expected budget funds for numerous operational concerns and business continuity plans.

Opportunities –

I. Growing opportunities in different industries

Different sectors need IT solutions. The demand for IT services has recently increased across India due to innovations in telemedicine, health, remote monitoring tools, and clinical information systems. India saw the emergence of more than 20 public digital platforms in 2021, helping to foster innovation and give the nation a distinctive edge. By 2019-25, it is anticipated that the rollout of fifth generation (5G) wireless technology by telecommunications operators will generate at least US$ 10 billion in international business for Indian IT enterprises. Software Technology Parks of India (STPI) has established 57 centres across the nation to offer infrastructural services and one window clearance. Excise duty exemptions are available to STPI units when buying locally produced goods. HPC has seen higher adoption over the years as it employs clusters of powerful processors to handle enormous multidimensional datasets (big data) and solves complicated problems at exceptionally fast rates. HPC systems generally outperform commodity desktop, laptop, and server computers at speeds more than a million times faster.

Adoption of HPC in the automobile sector; Increased usage of HPC products and services to drug discovery and healthcare; and Increasing investments in the Industrial Internet of Things (IIoT), artificial intelligence (AI), and engineering, which demand electronic design automation (EDA), are likely to drive the global HPC market over the forecast period.

Challenges –

I. Lack of data security

Security concerns regarding cloud-based network access have impeded the adoption of IT solutions across a number of industrial sectors. When businesses choose between cloud-based and on-premises solutions, security is one of the most important factors to take into account. IT solutions are having trouble synchronising due to complicated networks and applications. Outsourcing network connectivity could therefore compromise organisational security. Businesses frequently believe that connectivity based on IT could expose their sensitive information and cause them to lose control of their network architecture. As a result, businesses are hesitant to use cloud-based networking services.
2.5. **Key players in the India IT Industry market**

**Table 6: Key players in the India IT Industry market (1/3)**

<table>
<thead>
<tr>
<th>Company Type</th>
<th>IBM</th>
<th>Cisco Systems</th>
<th>HPE</th>
<th>Accenture</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Presence in India</strong></td>
<td>Headquarters in Bangalore. Present in 20 more cities in India</td>
<td>Present in 7 locations in India</td>
<td>Present in multiple locations in India</td>
<td>Present in 9 locations in India</td>
</tr>
<tr>
<td><strong>No. of Employees in India (2022)</strong></td>
<td>~150,000</td>
<td>~13,000</td>
<td>~5,000-10,000</td>
<td>~2,50,000</td>
</tr>
<tr>
<td><strong>Key Products/Services</strong></td>
<td>Storage, IT Automation, DevOps, Compute &amp; Servers, Network, AI machine learning, Security and Identity</td>
<td>Networking, software, IoT, Mobility and Wireless, Data Center, Cloud and Computing</td>
<td>Artificial Intelligence, security, Software, cloud,</td>
<td>Storage, IT Automation, DevOps, Compute &amp; Servers, Network, AI machine learning, Security and Identity</td>
</tr>
<tr>
<td><strong>Business Strategy</strong></td>
<td>Acquisition</td>
<td>Acquisition, Investment, Alliances</td>
<td>Merger and Acquisition</td>
<td>Acquisition</td>
</tr>
<tr>
<td><strong>Key Partnerships/Mergers/Acquisitions</strong></td>
<td>Expanded relationships with partners like Infosys, Tech Mahindra, Wipro, TCS, HCL, Persistent Systems and LTI to strengthen secure Hybrid Cloud ecosystem</td>
<td>Cisco India looks to acquire capabilities in cybersecurity, 5G, app development (2022); Partnership with Google to launch free high-speed public wi-fi in the world, starting India (2019-20); Agreement is between Tata Communications and Cisco Meraki</td>
<td>Sify Technologies partners with HPE to strengthen cloud computing services in India (2022); SAIL Bokaro and ONGC have recently signed partnership with HPE and deployed the HPE GreenLake edge-to-cloud platform to accelerate their digital transformation efforts (2022)</td>
<td>In 2019, Accenture was the biggest acquirer in 2019, making around 30 deals which were 50% more than the previous years</td>
</tr>
</tbody>
</table>
IBM to empower enterprises with simple and easy to deploy, manage, and analyse IT infrastructure for delivering anywhere, anytime access (2021); Wipro, Cisco partners to deliver hybrid cloud as-a-service (2022)

<table>
<thead>
<tr>
<th>Company</th>
<th>Type</th>
<th>Presence in India</th>
<th>No. of Employees in India (2022)</th>
<th>Key Products/Services</th>
<th>Business Strategy</th>
<th>Key Partnerships/Mergers/ Acquisitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microsoft Corporation</td>
<td>Public</td>
<td>Washington, US</td>
<td>Offices in Chennai, Bangalore, Delhi and Pune</td>
<td>Software, PCs &amp; Devices, Entertainment, Microsoft Cloud, Developer &amp; IT, Others</td>
<td>Investment</td>
<td>In August 2021, Microsoft collaborated with Invest India, Government of India’s national investment promotion</td>
</tr>
<tr>
<td>Oracle</td>
<td>Public</td>
<td>Texas, USA</td>
<td>Offices in Pune, Bangalore and Mumbai</td>
<td>Oracle Cloud Infrastructure, Hardware and Software, On-premise applications, Oracle data bases</td>
<td>Acquisition</td>
<td>In August 2022, Oracle acquired Adi Insights which would be providing guidance to customers in accordance with Oracle’s</td>
</tr>
<tr>
<td>SAP</td>
<td>Public</td>
<td>Walldorf, Germany</td>
<td>Offices in Bangalore, Gurgaon, Pune, Mumbai and Hyderabad.</td>
<td>Artificial Intelligence, Data and Analytics, Financial Management</td>
<td>Investments</td>
<td>In January 2023, the company claimed that they were scaling up its investments in India.</td>
</tr>
</tbody>
</table>
and facilitation agency, to support tech startups in the country.

Revenue India

<table>
<thead>
<tr>
<th>Company</th>
<th>Microsoft Corporation</th>
<th>Oracle</th>
<th>SAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>USD</td>
<td>1758.2 Million</td>
<td>1890.5 Mn</td>
<td>695 Mn</td>
</tr>
</tbody>
</table>

Source: Annual Reports, Secondary Sources, Frost & Sullivan Analysis
Note: Revenues are consolidated ones at company level,
USD = 78.6 INR (average exchange rate for Year 2022)
Financial Calendar: April – March 2021-22 (For all companies)

Table 8: Key players in the India IT Industry market (3/3)

<table>
<thead>
<tr>
<th>Company</th>
<th>TCS</th>
<th>Infosys</th>
<th>Tech Mahindra</th>
<th>Wipro</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Public</td>
<td>Public</td>
<td>Public</td>
<td>Public</td>
</tr>
<tr>
<td>Presence in India</td>
<td>Mumbai, India</td>
<td>Bangalore, India</td>
<td>Pune, India</td>
<td>Bangalore, India</td>
</tr>
<tr>
<td>No. of Employees in India (2022)</td>
<td>614,795</td>
<td>343,234</td>
<td>152,400</td>
<td>256,921</td>
</tr>
<tr>
<td>Key Products/Services</td>
<td>Cloud, Cognitive Business Operations, Consulting, Cybersecurity, Data and Analytics, Enterprise Solutions,</td>
<td>Blockchain, Infosys Cobalt, Data Analytics, Mainframe Modernization</td>
<td>Infrastructure &amp; Cloud services, Network Services, SAP, Data Analytics, Cybersecurity, AI, Intelligent Automation, Telecom Product Engineering, Testing Services</td>
<td>Cybersecurity, Data Analytics, Business Process, Business Solutions, Cloud, Artificial &amp; Augmented Intelligence</td>
</tr>
<tr>
<td>Business Strategy</td>
<td>Partnership</td>
<td>Collaboration</td>
<td>Product Launch and Partnership</td>
<td>Product Launch and Partnerships</td>
</tr>
<tr>
<td>Key Partnerships/Mergers/Acquisitions</td>
<td>In January 2023, TCS partnered with M&amp;G, an international savings and</td>
<td>In January 2023, the company announced that it has signed a memorandum of understanding</td>
<td>In December 2022, the company announced the launch of Cloud BlazeTech, an integrated, sector-agnostic platform, to</td>
<td>In November 2022, Wipro launched a new financial services advisory capability in India. Capco, a Wipro company, will</td>
</tr>
<tr>
<td>TCS</td>
<td>Infosys</td>
<td>Tech Mahindra</td>
<td>Wipro</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>investments business, to help the latter transform towards a cloud-only organisation by 2025. (MoU) with the Jawaharlal Nehru Technological University – Kakinada (JNTU-K) to accelerate digital and life skills development across India through its online learning platform, Infosys Springboard. The platform is already delivering corporate-grade learning experiences by orchestrating closer educator-learner collaboration.</td>
<td>maximize business value for cloud-powered enterprises globally. In July 2022, the company partnered with FireCompass, a leader in Autonomous Red Teaming and External Attack Surface Management. The partnership will launch CARTA-as-a-service to help enterprises discover cyber-vulnerabilities and secure business-critical assets against cyber-attacks.</td>
<td>supplement Wipro’s presence in the Indian financial services sector through its business in Mumbai to jointly offer end-to-end transformation services for this sector. In October 2022, Wipro teamed up with Outokumpu, a leading multinational stainless-steel manufacturer, have announced a strategic deal to accelerate Outokumpu’s cloud transformation for applications.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Total revenue | USD 27.9 Bn (2022-23) | USD 18.2 Bn (2022-23) | USD 6.6 Bn (2022-23) | USD 11.04 Bn (2022-23) |

Source: Annual Reports, Secondary Sources, Frost & Sullivan Analysis

Note: Revenues are consolidated ones at company level; USD = 78.6 INR (average exchange rate for Year 2022)

Financial Calendar: April – March for TCS, Infosys, Tech Mahindra & Wipro
3. Global High Performance Computing Market
3.1. Global High-Performance Computing Market Overview

Scope & Definition

High Performance Computing (HPC) technology uses clusters of powerful processors, working in parallel, to process massive multi-dimensional datasets (big data) and solve complex problems at extremely high speeds. There are three different types of high-performance computation - parallel computing, distributed computing and exascale computing.

Overview

The global high-performance computing (HPC) market was USD 43.1 Bn in FY2022. The market is forecasted to be USD 45.0 Bn in FY2023 and is expected to reach USD 58.2 Bn by FY2029 with a CAGR of 4.4% over the forecast period (FY2023-2029).

HPC has seen higher adoption over the years as it employs clusters of powerful processors to handle enormous multidimensional datasets (big data) and solves complicated problems at exceptionally fast rates. HPC systems generally outperform commodity desktop, laptop, and server computers at speeds more than a million times faster.

Adoption of HPC in the automobile sector; Increased usage of HPC products and services to drug discovery and healthcare; and Increasing investments in the Industrial Internet of Things (IIoT), artificial intelligence (AI), and engineering, which demand electronic design automation (EDA), are likely to drive the global HPC market over the forecast period (FY2023-2029).

Major players in the global HPC market are HPE, IBM, DELL Technologies, and Lenovo.

Exhibit 15: Global High-Performance Computing Market (USD Bn) - FY 2019-2022E (Historical and Estimated years)

Source: Frost & Sullivan Analysis
3.2. Global HPC Market by Computation Type

Global HPC market by computation type is segmented into parallel computing, distributed computing, and exascale computing. Parallel computing had the largest share in FY2022 and is forecasted to reach USD 34.4 Bn by FY2029 at a CAGR of 4.1%.

Parallel computing is preferred over distributed computing globally because parallel computing conducts numerous processes on multiple computer servers or processors at the same time to improve the execution speed of computationally expensive applications.

Distributed computing on the other hand, uses multiple computers primarily to improve functionality, capability, or robustness. But has two major challenges because of which it is less preferred – 1. Cluster management, which includes cluster installation and update; 2. Difficulty in usage, which requires application programmer and user need to manage resources they use.

Exascale computing is also witnessing faster adoption. Exascale computing refers to computing systems that can execute at least $10^{18}$ IEEE 754 Double Precision (64-bit) operations (multiplications and/or additions) per second. It is a notable milestone in computer engineering because it enables greater scientific applications and prediction accuracy in areas such as weather forecasting, climate modelling, and personalised medicine. Frontier, the world's first public exascale computer, was announced in 2022. It is the world's fastest supercomputer as of June 2022.
3.3. Global HPC Market by Application

Global HPC market by application is segmented into Government & Defence, BFSI, IT & ITES, Telecommunications, Media, Oil & Gas, and Others. HPCs application in the government and defense sector had the highest share at 39% in FY2022 and is expected to reach a value of USD 22.1 Bn by FY2029. Adoption of HPC in the BFSI sector is expected to grow with the highest CAGR of 5.2% during the forecast period (FY2023-2029).

BFSI - More industries, especially the BFSI, are switching to high performance computing because of growing data needs in these sectors. The banking sector is expected to greatly benefit from the integration of AI with an HPC infrastructure in the coming years.
Telecommunications, Media - Given the prospects provided by machine and deep learning, businesses and telecom firms are now having difficulty managing the enormous and complicated data sets as well as the specific number of simultaneous activities. Thanks to the rising HPC workloads and the efficiently accelerated infrastructure, businesses may completely own their data. It is intended to aid in the development of the following generations of these multifunctional supercomputing systems.

Oil & Gas – Employment of precise, clever, sequential, and extremely quick instruments in the oil and gas business is required to obtain an exact identification and associated cost of setup activities. That would contribute to increased operational flexibility and efficiency. Supercomputers are essential to the oil and gas industry because they can choose the optimal place for a well to be dug, resulting in a higher return with less expense.

Automobile - Using totally interoperable and automotive-grade systems, high performance computing is expediting the development of autonomous vehicles in order to maximise safety. To perceive the environment surrounding the vehicle more correctly and reliably and to enable better and safer decisions, an increasing number of sensors, including cameras, radars, lidars, and V2X communications, should be processed (or fused together).

The following are some of the industries using HPC and the types of workload being performed:

Aerospace: Creating complex simulations, such as airflow over the wings of planes

Manufacturing: Executing simulations, such as those for autonomous driving, to support the design, manufacture, and testing of new products, resulting in safer cars, lighter parts, more-efficient processes, and innovations

Financial technology (fintech): Performing complex risk analysis, high-frequency trading, financial modeling, and fraud detection

Genomics: Sequencing DNA, analyzing drug interactions, and running protein analyses to support ancestry studies

Healthcare: Researching drugs, creating vaccines, and developing innovative treatments for rare and common diseases

Media and entertainment: Creating animations, rendering special effects for movies, transcoding huge media files, and creating immersive entertainment

Oil and gas: Performing spatial analyses and testing reservoir models to predict where oil and gas resources are located, and conducting simulations such as fluid flow and seismic processing

Retail: Analyzing massive amounts of customer data to provide more-targeted product recommendations and better customer service.
3.4. Global HPC Market by Geography/Region

Global HPC market by geography is segmented into North America, Europe, Asia Pacific (APAC), South America, and Middle East and Africa (MEA). North America held the largest share (48.5%) in FY 2022 with a market size of USD 20.9 Bn and is expected to reach USD 26.2 Bn by FY 2029 at a CAGR of 3.3%. APAC emerged as the third largest region behind North America and Europe with a share of 16.5% in FY 2022 and a market size of USD 7.1 Bn in FY 2022.

HPC is expected to see increased adoption in Europe as The EU has determined that its spending in HPC will dramatically rise in the next Multiannual Financial Framework (2021-2027). Over the course of seven years, it is anticipated that over €8 billion will be invested, enhancing the bloc's
capability for HPC innovation and supercomputing. The RISC2 initiative, which is supported by the EU, encourages the sharing of HPC best practises.

The industry in Asia Pacific (APAC) is developing and is the fastest-growing region for the global HPC market. APAC is predicted to grow the most and capture the most market share in the next years. This is mostly due to industry participants' increasing focus on meeting the needs for increased processing power with dependable and faster response time. The largest HPC markets in APAC are China and Japan. This region’s market will expand quickly. Over the projection period, the expansion of HPC market in APAC will be facilitated by an increase in the number of data centres in the region and improved infrastructure. The India high-performance computing (HPC) market was USD 492.9 Mn in FY2022. The market is forecasted to be USD 538.8 Mn in FY2023 and is expected to reach USD 918.6 Mn by FY2029 with a CAGR of 9.3% over the forecast period (FY2023-2029).

South America continues to lag other nations in terms of the volume and frequency of their expenditures in HPC. South America is still in the early stages of adopting HPC technologies. Only six of the top 500 High Performance Computing Systems in the world are in the region.

Exhibit 21: Global HPC Market by Geography/Region (USD Bn) - FY 2019-2022E (Historical and Estimated years)

<table>
<thead>
<tr>
<th></th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022E</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEA</td>
<td>38</td>
<td>40</td>
<td>41</td>
<td>43</td>
</tr>
<tr>
<td>Latin America</td>
<td>2.6</td>
<td>2.8</td>
<td>3</td>
<td>3.1</td>
</tr>
<tr>
<td>APAC</td>
<td>7.6</td>
<td>8</td>
<td>8.4</td>
<td>8.9</td>
</tr>
<tr>
<td>Europe</td>
<td>18.9</td>
<td>19.6</td>
<td>20.2</td>
<td>20.9</td>
</tr>
<tr>
<td>North America</td>
<td>3</td>
<td>3</td>
<td>3.1</td>
<td>3.1</td>
</tr>
</tbody>
</table>

Source: Frost & Sullivan Analysis

Exhibit 22: Global HPC Market by Geography/Region (USD Bn) - FY 2023F-2029F (Forecasted years)
3.5. Market Drivers, Restraints, Opportunities & Challenges

Market Drivers

I. Adoption of HPC in the automobile sector – HPC is expected to provide critical lifesaving tools to the future automobiles. Having HPC capabilities is the foundation for accelerating autonomous vehicles and connected car technology, reframing the design process, automating, and accelerating testing, and launching new functionality. For e.g., 1) Autonomous vehicles require complicated technology using multiple sensor systems that simulate a range of external conditions like road conditions, other vehicles, or unexpected obstacles. HPC helps accelerate the data-intensive process of the vehicles’ response systems; 2) Connected car software provides the ability to use data to create better predictive and preventative maintenance tools and other experiential services like infotainment, convenience mapping and parking services. With the ability to implement HPC at scale, exponential adoption and the ‘always-on’ high-speed reliability of the services build trust through safety and value and thus generate loyalty.

II. Increased usage of HPC products and services to drug discovery and healthcare – Cloud-based technology, such as HPC, is increasingly being used by pharma organisations to probe vast amounts of raw human biological data to discover new insights into complex clinical causes of human disease and new opportunities for diagnosis and treatment. Furthermore, the complexity of R&D processes often requires collaboration between multiple, global sites, with
contract research organisations (CROs), or through partnerships with other pharma or academic institutions. This involves data collection, storage, transmittance, management, analysis, and interpretation. These complex projects need to ensure that the data is secure, safe, and handled with a robust, reliable, and scalable infrastructure. Moreover, they need the ability to easily provision technology, analyse complex information, and output results in a desirable format for downstream applications.

Table 9: Challenges and outcomes related to HPC

<table>
<thead>
<tr>
<th>Core Pharma Challenges</th>
<th>HPC Value</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Accelerate drug discovery and the treatment development process</strong></td>
<td>Enable analysis of larger quantities of data from clinical studies, DNA, genetic testing, and EMRs, facilitating discoveries not previously possible</td>
<td>Drive faster time to value, and reduce time needed to conduct complex network analysis from months to weeks</td>
</tr>
<tr>
<td><strong>Rapidly analyse and interpret data streams derived from clinical studies</strong></td>
<td>Reverse engineer data-driven models of human disease progression and drug responses</td>
<td>Put control directly in the hands of the research teams that consume HPC infrastructure</td>
</tr>
<tr>
<td><strong>Identify new therapies for disease sufferers not served by standard treatments</strong></td>
<td>Simulate models to discover novel drug targets</td>
<td>Support effective and productive partner collaborations to facilitate quicker outcomes</td>
</tr>
<tr>
<td><strong>Match the right treatment(s) to the right patients more effectively</strong></td>
<td>Automate components of the end-to-end R&amp;D process</td>
<td>Save on cost, which can contribute to more-competitive pricing</td>
</tr>
<tr>
<td></td>
<td>Gain the ability to increase capacity to meet spikes in activity and reduce waiting times</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pay for resources consumed only as they are consumed</td>
<td></td>
</tr>
</tbody>
</table>

Note: Secondary sources (Whitepaper, Oracle; Flinders University press release; EPSRC press release; Manchester University NHS Foundation Trust press release), F&S Analysis

Use cases of HPC in drug discovery, screening of potential candidate molecules, etc. — Flinders University have designed a novel COVID-19 vaccine candidate. The research team used HPC, and analysed computer models of the SARS-CoV-2 spike protein and its human receptor ACE2 to identify how the COVID-19 virus infects human cells at a pace that was dramatically increased. In another example, the University of Bristol recently discovered a synthetic vaccine to the mosquito-borne chikungunya virus in a fraction of the time and at a much lower cost than previously thought possible, leveraging on-demand access to many ‘one of HPC providers’ Cloud Infrastructure processors to perform large scale simulation.
III. Increasing investments in the Industrial Internet of Things (IIoT) - Investment in the Internet of Things (IIoT) is set to overtake cloud computing, next generation security, big data analytics and other digital transformation technologies in the coming years. IIoT projects currently save organisations 9% of the yearly costs, but this is expected to rise to an average of 15% cost-savings in the coming years (as per Inmarsat Global’s research paper and Futureiot.tech’s publically available press release article). HPC market will get windfall from both the processing requirements of IoT and edge devices; and, from greater investment in HPC hardware as well as the engineering software tools that have generally served the HPC set. This is expected to drive HPC market.

IV. AI augmented HPC expected to drive HPC adoption - The architecture required for HPC implementations has many similarities with AI implementations. Key HPC use cases are benefiting from advanced AI capabilities, including Analytics for financial services (FSI) such as risk and fraud detection, logistics, and manufacturing; Industrial product design, computational fluid dynamics (CFD), computer-aided engineering (CAE); and computer-aided design (CAD); Weather, meteorology, and climate science, etc. Many of the current use cases for AI are limited to edge or data center deployments, such as intelligent traffic systems that lean heavily on smart cameras for AI object recognition. HPC plays an important role in addressing the challenges of AI, as these can help accelerate AI to achieve useful results, can also help in applying expert-level heuristics via deep learning inference to thousands of transactions, workloads, or simulations per second.

Market restraints

I. Cost and Cost Management: For many organizations, the cost of running HPC is a major concern which is one of the reasons for its hesitant adoption. The cost of buying HPC equipment is around 1/3 of the true cost of owning an HPC. Below is rough idea of a cost of an on-premises HPC:

Table 10: On premises cost

<table>
<thead>
<tr>
<th>On-premises Cost ($/core-hour, HPC+ like system)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment Only</td>
<td>$0.04</td>
</tr>
<tr>
<td>Equipment+Electricity</td>
<td>$0.06</td>
</tr>
<tr>
<td>Equipment+Electricity+Labor</td>
<td>$0.09</td>
</tr>
<tr>
<td>Equipment+Electricity+Labor+Facilities</td>
<td>$0.12</td>
</tr>
</tbody>
</table>

Source: Rescale.com, F&S analysis

The above cost assumes roughly 100% utilization, approximately 10Kwh, and a 40% discount on hardware. If an organization has a utilization of 80% of capacity, then the actual cost is
$0.15/core-hour versus $0.12/core-hour, a big difference. It quickly becomes apparent that supporting an HPC for peak usage becomes cost prohibitive because low utilization rapidly increases per core-hour cost. Also, the true cost of electricity plays a non-trivial role in the true cost since electricity costs are roughly 15% of total costs.

**Market opportunities**

I. FinTech – HPC will witness increased adoption in automatic and high-frequency trading, AI-based credit card fraud detection, real-time tracking of stock trends, complex risk analyses, and self-guided tech support, etc. This is a result of digitization of the Fintech sector and increased investment in the areas supporting digitization. For example, as per reports from Accenture and as quoted in Science Direct, overall investment in Fintech in Europe increased around 120% between 2014 and 2015 and the number of deals increased by 51%. Also, the WealthTech sector raised the most amount of capital in H1 2022 with $13.9bn, an 18% share of the $76.8bn raised in global FinTech deals as per top investors in Europe in 2022 listed by FinTech Global. On the other hand, in Asia-Pacific, investment more than quadrupled in 2015 to $4.3 billion, with most of those investments taking place in China ($1.97 billion) and India ($1.65 billion). Investment in fintech is thriving in the Asia-Pacific region, with total investment in APAC's fintech sector more than doubling to record levels in the first half of 2022. Investment in APAC reached a record US$41.8bn, up more than 50% from USD19bn (as per KPMG’s Business Chief Asia report). Fintech investment in North America grew 44% to $14.8 billion in 2015, and the U.S. continued to dominate the sector with 667 Fintech deals, an increase of 16%. The US accounted for $34.9 billion of fintech investment in the Americas during H2'22, a drop from $49.7 billion in H1'22 (as per KPMG).

II. Healthcare – Increasing use of HPC in Genomics research (vaccine research, testing drugs and new cures, speeding up screening techniques, analysing patient diagnoses, developing new therapies, studying disease patterns, etc.). HPC systems has increased the speed, accuracy, and reliability, of genomic research by efficiently analysing a large amount of sequencing data. For example, the UK government has announced Over £175 million for cutting-edge genomics research to support patients with cancer and children born with treatable rare genetic diseases (as per NHS).

III. Detecting anomalous weather trends and making storm predictions- Since it enables them to create numerical atmospheric models with higher spatial resolutions and more intricate physical processes, high-performance computing (HPC) helps atmospheric scientists to more accurately anticipate weather and climate. In order to run the models on any HPC machine they have available, they create numerical weather/climate models (hereinafter referred to as weather models).
Challenges

I. Cyber security concerns - This remains as one of the main challenges HPC is facing is the increasing amount of data to be processed very quickly and securely. With the current trend of HPC workloads and infrastructure increasingly becoming cloud-like (e.g., resource pooling, rapid elasticity, on-demand self-service), or interacting with the cloud (e.g., bursting), security has become a great concern at an accelerating rate. Companies are therefore taking some of the mentioned steps to minimize risk: 1) Creation of network segments to separate different services within the cluster; 2) Implementation of specialist authentication software designed for HPC users; 3) Encryption can be a useful way of protecting data, but it should be used strategically, or it will impede HPC performance.

Listing of top supercomputers globally

I. **Frontier** - HPE Cray EX235a, AMD Optimized 3rd Generation EPYC 64C 2GHz, AMD Instinct MI250X, Slingshot-11, HPE

II. **Supercomputer Fugaku** - Supercomputer Fugaku, A64FX 48C 2.2GHz, Tofu interconnect D, Fujitsu

III. **LUMI** - HPE Cray EX235a, AMD Optimized 3rd Generation EPYC 64C 2GHz, AMD Instinct MI250X, Slingshot-11, HPE

IV. **Leonardo** - BullSequana XH2000, Xeon Platinum 8358 32C 2.6GHz, NVIDIA A100 SXM4 64 GB, Quad-rail NVIDIA HDR100 Infiniband, Atos

V. **Summit** - IBM Power System AC922, IBM POWER9 22C 3.07GHz, NVIDIA Volta GV100, Dual-rail Mellanox EDR Infiniband, IBM

VI. **Sierra** - IBM Power System AC922, IBM POWER9 22C 3.1GHz, NVIDIA Volta GV100, Dual-rail Mellanox EDR Infiniband, IBM / NVIDIA / Mellanox

VII. **Sunway TaihuLight** - Sunway MPP, Sunway SW26010 260C 1.45GHz, Sunway, NRCPC Perlmutter - HPE Cray EX235n, AMD EPYC 7763 64C 2.45GHz, NVIDIA A100 SXM4 40 GB, Slingshot-10, HPE

VIII. **Selene** - NVIDIA DGX A100, AMD EPYC 7742 64C 2.25GHz, NVIDIA A100, Mellanox HDR Infiniband, Nvidia

IX. **Tianhe** - 2A - TH-IVB-FEP Cluster, Intel Xeon E5-2692v2 12C 2.2GHz, TH Express-2, Matrix-2000, NUDT

Source: World Economic Forum Article
3.6. Key players in the global HPC market

Table 11: Key players in the global HPC market (1/2)

<table>
<thead>
<tr>
<th>Company Type</th>
<th>IBM</th>
<th>ATOS SE</th>
<th>Dell</th>
<th>Lenovo</th>
<th>HPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geographical Presence</td>
<td>Operates in over 175 countries</td>
<td>Americas, EMEA, APJC</td>
<td>Americas, Europe, MEA, Asia</td>
<td>Over 180 markets (including Americas, Europe, Middle East-Africa (EMEA), and China)</td>
<td>APAC, America's, EU, MEA</td>
</tr>
<tr>
<td>Key Products/Services</td>
<td>IBM Power9, Storage servers for HPC workloads, IBM Spectrum Conductor, IBM Spectrum Symphony, IBM Spectrum LSF, BullSequana X Series, Nimbia Supercomputing Suite, ThinkAI, Center of Excellence in advanced computing, Mobull</td>
<td>R system, Verne Global, DXC global, Gen-Z Consortium, Dell EMC PowerEdge</td>
<td>Lenovo Neptune, Rear Door Heat Exchanger (RDHX), Thermal Transfer Module (TTM), Energy Aware Runtime Software (EAR), ThinkSystem SR675 V3 Rack Server, ThinkSystem SD665 V3 High-Density Server, ThinkSystem SD665-N V3 High-Density Server, ThinkSystem SD650 V2 High-Density Server</td>
<td>HPE Cray EX2500, HPE Cray XD2000</td>
<td></td>
</tr>
<tr>
<td>Business Strategy</td>
<td>Product Launch</td>
<td>Partnerships</td>
<td>Product Launch and Partnerships</td>
<td>Partnerships</td>
<td>Partnerships</td>
</tr>
<tr>
<td>Key Partnerships/Mergers/Acquisitions</td>
<td>In November 2022, IBM launched 400 Qubit-Plus Quantum Processor and Next-Generation IBM Quantum System Two. They also announced that German conglomerate Bosch has joined the IBM Quantum Network to explore a variety of quantum</td>
<td>In November 2022, ATOS partnered with Aspen Systems form reseller alliance to power HPC and quantum market in North America. In November 2022, ATOS partnered with Sylabs to support Nimbia Federated supercomputing suite, a set of flexible and secure high-performance computing</td>
<td>In November 2022, Dell launched PowerEdge server portfolio additions accelerate high-performance computing and artificial intelligence outcomes. In November 2022, Dell partnered with Broadcom to revamp the high-performance computing space on the</td>
<td>In March 2022, Lenovo partnered with Kyndryl to develop and deliver scalable hybrid cloud solutions and edge computing implementations.</td>
<td>In October 2022, HPE partnered with National Renewable Energy Laboratory’s (NREL’s) to house a new high-performance computing (HPC) system—or supercomputer—and push NREL into the leading edge of high-performance computing. In February 2022, HPE partnered with Ayyar Labs on photonics research and commercial development to</td>
</tr>
<tr>
<td>IBM</td>
<td>ATOS SE</td>
<td>Dell</td>
<td>Lenovo</td>
<td>HPE</td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>---------------------</td>
<td>---------------</td>
<td>----------------</td>
<td>-----------------</td>
<td></td>
</tr>
<tr>
<td>projects using HPC.</td>
<td>computing (HPC) solutions that provide customers with added agility for their compute-intensive workloads.</td>
<td>foundation of its low latency and high speed.</td>
<td>develop next-generation HPC and AI solutions</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Total revenue | USD 60.5 Bn (2022) | USD 12.2 Bn (2022) | USD 101.2 Bn (2022) | USD 62 Bn (2022) | USD 28.5 Bn (2022) |

Source: Annual Reports, Secondary Sources, Frost & Sullivan Analysis
Note: 1 Euro=1.0538 USD (Average exchange rate for year 2022)
Note: 1. Company revenues are consolidated revenues. 2. Lenovo and IBM have been shown as 2 distinct companies in the above table. Lenovo completed the acquisition of IBM x86 in 2014 and IBM’s Personal Computing Division in 2010. Lenovo operates in the HPC products and services through its ISG division and IBM operates in the HPC products and services under its Infrastructure division through IBM Z.

Financial Calendar:
IBM: January – December; ATOS SE: January – December; Dell: February – January; Lenovo: April – March; HPE: November – October
4. India High-Performance Computing Market
4.1. India High-Performance Computing Market

Overview
The Indian high-performance computing (HPC) market was USD 492.9 Mn in FY2022. The market is forecasted to be USD 538.8 Mn in FY2023 and is expected to reach USD 918.6 Mn by FY2029 with a CAGR of 9.3% over the forecast period (FY2023-2029).

Exhibit 23: India High-Performance Computing Market (USD Mn) - FY 2019-2022E (Historical and Estimated years)

Source: Frost & Sullivan Analysis

Exhibit 24: India High-Performance Computing Market (USD Mn) - FY 2023F-2029F (Forecasted years)

Source: Frost & Sullivan Analysis
Indian HPC Market Outlook focused on national supercomputing mission

The National Supercomputing Mission was announced in 2015, with an aim to connect national academic and R&D institutions with a grid of more than 70 high-performance computing facilities at an estimated cost of ₹4,500 crores over the period of seven years. Only 16.67% of the total budget of ₹4,500 crore, was utilised during the first four-and-a-half years for execution of the mission. The remaining allocation would be used in next few years.

It supports the government's vision of 'Digital India' and 'Make in India' initiatives.

The National Supercomputing Mission was launched to enhance the research capacities and capabilities in the country by connecting them to form a Supercomputing grid, with National Knowledge Network (NKN) as the backbone. The National Supercomputing Mission is setting up a grid of supercomputing facilities in academic and research institutions across the country. Part of this is being imported from abroad, and part built indigenously, the latter being increased with time. The Mission is being jointly steered by the Department of Science and Technology (DST) and the Ministry of Electronics and Information Technology (MeitY) and implemented by the Centre for Development of Advanced Computing (C-DAC), Pune, and the Indian Institute of Science (IISc), Bengaluru.

PARAM Shivay, the first supercomputer assembled indigenously, was installed in IIT (BHU), followed by PARAM Shakti, PARAM Brahma, PARAM Yukti, PARAM Sanganak at IIT-Kharagpur IISER, Pune, JNCASR, Bengaluru and IIT Kanpur, IIT Hyderabad, NABI Mohali, CDAC Bengaluru respectively.

India’s march towards leadership position in supercomputing found a fresh dimension with the convergence of HPC and Artificial Intelligence (AI). A 200 AI PF Artificial Intelligence supercomputing system created and installed in C-DAC can handle incredibly large-scale AI workloads, increasing the speed of computing-related to AI several times. PARAM Siddhi - AI, the high-performance computing-artificial intelligence (HPC-AI) supercomputer, has achieved global ranking of 63 in the TOP 500 most powerful supercomputer systems in the world.

The mission has also created the next generation of supercomputer experts by training more than 11,000 HPC aware manpower and faculties. To expand the activities of the HPC training, four National Supercomputing Mission Nodal Centres for training in HPC and AI have been established at IIT Kharagpur, IIT Madras, IIT Goa, and IIT Palakkad. These centres have also conducted online training programs in HPC, AI, and other areas.

Powered by the National Supercomputing Mission, India’s network of research institutions, in collaboration with the industry, is scaling up the technology and manufacturing capability to make more and more parts in India, taking indigenous manufacturing to 85%.

This mission will provide access to High-Performance Computing (HPC) Facilities to 100 several institutions and more than thousands of active researchers, academicians working through Nation Knowledge Network (NKN) - the backbone for supercomputing systems.
Some of the large-scale applications which are being developed under National Supercomputing Mission include the following.


III. Flood Early Warning and Prediction System for River Basins of India.

IV. HPC Software Suite for Seismic Imaging to aid Oil and Gas Exploration.

V. MPPLAB: Telecom Network Optimization.

As part of its tireless journey of success, National Supercomputing Mission has now deployed “PARAM Ganga”, a supercomputer at IIT Roorkee, with a supercomputing capacity of 1.66 Petaflops. The system is designed and commissioned by C-DAC under Phase 2 of the build approach of the National Supercomputing Mission. Substantial components utilized to build this system are manufactured and assembled within India along with an indigenous software stack developed by C-DAC, which is a step towards the Make in India initiative of the Government.

How has Indian HPC Market Transformed Over the Years

I. In 1986, National Aeronautical Limited (NAL) developed the "Flosolver Mk1" for the solution of computational fluid dynamics and aerodynamic problems.

II. In 1991, the Centre for Development of Advanced Computing (C-DAC) created its first supercomputer, "PARAM 8000," for use in long-range weather forecasting, remote sensing, drug creation, and molecular modelling.

III. In 1991, the Bhabha Atomic Research Centre (BARC) created the "ANUPAM" supercomputer, which is used for Molecular Dynamics Simulation, Crystal Structure Analysis, Neutron Transport Calculations, Gamma Ray Simulation, and Finite Element Analysis, among other things.

IV. In 1995, the Defense Research and Development Organization (DRDO) unveiled the "Processor for Aerodynamic Computations and Evaluation (PACE)" supercomputer developed by Advanced Numerical Research and Analysis Group (ANURAG). It was used for Computational Fluid Dynamics in aircraft design, weather forecasting, automobile and civil engineering design, and molecular Biology.

V. India is presently one of the countries driving the growth of Asian high-performance computing sector. IMSC Kabru was installed in 2004. Kabru is a supercomputer that has a 2.4 GHz Pentium Xeon Cluster and Linux with Rpeak of 1,382.4 GFlop/s and Rmax of 1,002 GFlop/s. It was manufactured by Netweb and deployed at the Institute of Mathematical Sciences (IMSc) in Chennai, India. Kabru, when commissioned, was one of the top 500 most powerful supercomputing systems in the world.

VI. Some of the real-time applications of HPC in India are in:
• Real time weather systems (RTWS) - "Anuman" comprises daily operational weather products in real time. It provides high-resolution (12x4 km grids) weather simulations over Indian sub-continent along with daily and 6-hourly weather forecasts over nearly 50,000 locations. Real time operational forecasts have been carried out daily using C-DAC’s PARAM Yuva-II. Cyclone Roanu was formed on May 17, 2016 and dissipated on May 23, 2016. The case was simulated with Real Time Weather System (RTWS) data. The track forecast was simulated well by the model. Outputs from Anuman are also being used to provide micro climatic data which is very useful for farmers.

• Seasonal Monsoon Forecast and Near time urban flood forecasting - Since 2005, C-DAC is one of the stakeholders in Extended Range Monsoon Prediction Program of DST. In collaboration with IIT Bombay and support from Ministry of Earth Sciences (MoES), C-DAC started development of urban flood forecasting system in Mumbai using regional weather model along with hydrology modeling system. Sensitivity analysis of WRF-UCM model was setup on PARAM Yuva-II and simulation of heavy rainfall cases were carried out.

• RNAseq analysis of breast cancer data

• OpenFOAM is an open-source general purpose software suite for Computational Fluid Dynamics (CFD) computation and is fully parallelized using MPI. It is widely used in academia, R&D institutes and industries. The code was ported and benchmarked on GPGPU as well as on MIC architecture to run it in native and symmetric modes. In native mode, it runs on the Xeon-Phi coprocessor, whereas in symmetric mode it runs on both the host processors as well as on Xeon-Phi co-processors.

• Others

4.2. India HPC Market by Computation Type

India HPC market by computation type is segmented into parallel computing, distributed computing, and exascale computing. Parallel computing had the largest share in FY 2022 and is expected to reach USD 542 Mn by FY 2029 at a CAGR of 8.9%.

Exhibit 25: India HPC Market by Computation Type (USD Mn) - FY 2019-2022E (Historical and Estimated years)

<table>
<thead>
<tr>
<th>Year</th>
<th>Parallel Computing</th>
<th>Distributed Computing</th>
<th>Exascale Computing</th>
</tr>
</thead>
<tbody>
<tr>
<td>2019</td>
<td>143.4</td>
<td>2.8</td>
<td>377.5</td>
</tr>
<tr>
<td>2020</td>
<td>230.3</td>
<td>157.2</td>
<td>413</td>
</tr>
<tr>
<td>2021</td>
<td>250.8</td>
<td>172.3</td>
<td>451</td>
</tr>
<tr>
<td>2022</td>
<td>273.3</td>
<td>188.8</td>
<td>493</td>
</tr>
</tbody>
</table>

Source: Frost & Sullivan Analysis
4.3. India HPC Market by Application

HPC power is leveraged by both public and private sectors in India. Presently, some of the key sectors like Education, Agriculture, Energy and Power, Drug Design are adopting HPC for their growth while many Automobile Industries, Construction Industries, Atmospheric Sciences, Bioinformatics, and Computational Fluid Dynamics domains etc., are making continuous progress by utilizing HPC.

India HPC market by application is segmented into Government & Defence, BFSI, IT & ITES, Telecommunications, Media, Oil & Gas, and Others. Adoption of HPC in the Government and IT & ITES sectors held the largest share in FY2022.

India is fast evolving as a frontrunner in high power computing with the National Super Computing Mission (NSM) with Supercomputing infrastructure already installed in 10 premier institutions like IITs, IISc, IISER Pune, JNCASR Bengaluru, various C-DACs, NABI Mohali, and benefitting researchers from several other institutions too. The final stage installation work is being carried out in 5 more institutions. This will not only help meet the increasing computational demands of academia, researchers, MSMEs, and start-ups in areas like oil exploration, flood prediction as well as genomics, and drug discovery, but also firm up indigenous capability of developing supercomputers.

In the process of enhancing the supercomputing capabilities Government of India has committed a one-billion-dollar initiative in developing the next generation supercomputer. Planning Commission of India has set up a “National Council on Supercomputing” which has proposed the cloud-based supercomputer model. The proposed supercomputing model can be used by institutions across India for different research purposes like space exploration, weather prediction, Bioinformatics, computational biology etc., which require huge computational power.
Exhibit 27: India HPC Market by Application (USD Mn) - FY 2019-2022E (Historical and Estimated years)

Exhibit 28: India HPC Market by Application (USD Mn) - FY 2023F-2029F (Forecasted years)

Source: Frost & Sullivan Analysis

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Government & Defense - Nov 2022, EU and India signed an “Intent of cooperation on High Performance computing and Quantum Technologies”. The intent of cooperation is aimed at establishing collaboration using HPC application using Indian European supercomputers in the areas of Biomolecular medicines, COVID Therapeutics, mitigating climate change, predicting natural disasters and quantum computing.

Modern banking began in India in the 18th century in an uncontrolled setting and has progressed significantly since. India is experiencing a banking transformation and is ideally positioned to become a worldwide leader in Fintech. India dominates the Fintech market in terms of technological innovation and acceptance, with a high adoption rate of 87% (India Fintech report by E&Y). Beyond temporary solutions to ensure business continuity, artificial intelligence, and high-performance computing (HPC) enable financial institutions to further streamline and automate processes, improve data management and utilisation, and ultimately enjoy efficiencies and build resilience to weather future storms.

Telecommunications - Given the prospects provided by machine and deep learning, businesses and telecom firms are now having difficulty managing the enormous and complicated data sets as well as the specific number of simultaneous activities. Thanks to the rising HPC workloads and the efficiently accelerated infrastructure, businesses may completely own their data. It is intended to aid in the development of the following generations of these multifunctional supercomputing systems. Netweb Technologies, one of the leading companies in high-performance computing (HPC) market, is developing 5G solutions to enable end-to-end solutions when the technology eventually arrives. Ceremorphic has created a novel architecture that can support next-generation applications such as AI model training, HPC, drug discovery, and metaverse processing. Our architecture, which is designed in accordance with modern silicon geometry, addresses high-performance computing demands in terms of reliability, security, and power consumption at scale.

All these factors will lead to higher adoption and growth of HPC in India.

Table 12: List of some of the top supercomputers in India so far

<table>
<thead>
<tr>
<th>Sr No</th>
<th>Name of the supercomputer</th>
<th>Deployed at</th>
<th>Built in</th>
<th>Rank (when commissioned)</th>
<th>Designed / Commissioned by</th>
<th>Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PARAM Siddhi-AI</td>
<td>CDAC</td>
<td>2015</td>
<td>Rank 63 (Global, Nov-2022)</td>
<td>C-DAC</td>
<td>4.6 PF (Rmax) / 5.26 PF (Rpeak)</td>
</tr>
<tr>
<td>2</td>
<td>Pratyush</td>
<td>IITM, Pune</td>
<td>2018</td>
<td>78 (Global)</td>
<td>NA</td>
<td>6.8 PF (Rpeak)</td>
</tr>
<tr>
<td>3</td>
<td>Mihir</td>
<td>NCMRWF</td>
<td>2018</td>
<td>120 (Global)</td>
<td>NA</td>
<td>2.5 PF (Rpeak)</td>
</tr>
<tr>
<td>4</td>
<td>SAHASRAT</td>
<td>IISc, Bengaluru</td>
<td>2015</td>
<td>NA</td>
<td>Cray Inc.</td>
<td>901.54 TF (Rpeak)</td>
</tr>
<tr>
<td>5</td>
<td>AADITYA</td>
<td>IITM, Pune</td>
<td>NA</td>
<td>116 (Global)</td>
<td>IBM</td>
<td>719.2 TF (Rpeak)</td>
</tr>
<tr>
<td>6</td>
<td>Color Blossom</td>
<td>TIFR, Hyderabad</td>
<td>NA</td>
<td>145 (Global)</td>
<td>Cray Inc.</td>
<td>558.7 TF (Rpeak)</td>
</tr>
<tr>
<td></td>
<td>Supercomputer Name</td>
<td>Institution</td>
<td>Year</td>
<td>Rank (Global, Month-Year)</td>
<td>Source</td>
<td>Performance (Rmax), (Rpeak)</td>
</tr>
<tr>
<td>---</td>
<td>-------------------</td>
<td>-------------</td>
<td>------</td>
<td>--------------------------</td>
<td>--------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>7</td>
<td>PARAM YUVA-II</td>
<td>CDAC</td>
<td>2013</td>
<td>69 (Global, June-2013)</td>
<td>Netweb</td>
<td>529.38 TF (Rpeak) / 386.71 (Rmax)</td>
</tr>
<tr>
<td>8</td>
<td>PADUM</td>
<td>IIT, Delhi</td>
<td>NA</td>
<td>166 (Global)</td>
<td>NVIDIA+IIT Delhi</td>
<td>NA</td>
</tr>
<tr>
<td>9</td>
<td>VIRGO</td>
<td>IIT Madras</td>
<td>2015</td>
<td>NA</td>
<td>IBM</td>
<td>97 Tf (Rpeak)</td>
</tr>
<tr>
<td>10</td>
<td>PARAM Shivay</td>
<td>IIT BHU</td>
<td>2015</td>
<td>NA</td>
<td>CDAC</td>
<td>0.43 (Rmax) / 0.84 (Rpeak)</td>
</tr>
<tr>
<td>11</td>
<td>Agastya</td>
<td>IIT Jammu</td>
<td>2020</td>
<td>27th fastest supercomputer in India</td>
<td>Netweb</td>
<td>161 TF (Rmax) / 256 TF (Rpeak)</td>
</tr>
<tr>
<td>12</td>
<td>PARAM Ambar</td>
<td>ISRO</td>
<td>2019</td>
<td>4th fastest supercomputer in India</td>
<td>Netweb</td>
<td>919.6 TF (Rmax) / 1384.85 TF (Rpeak)</td>
</tr>
<tr>
<td>13</td>
<td>PARAM Shakti</td>
<td>IIT-Kharagpur</td>
<td>2022</td>
<td>NA</td>
<td>C-DAC</td>
<td>1.66 PF (Rmax)</td>
</tr>
<tr>
<td>14</td>
<td>PARAM Brahma</td>
<td>IISER, Pune</td>
<td>2019</td>
<td>NA</td>
<td>C-DAC</td>
<td>.85 (Rmax) / 1.7 (Rpeak)</td>
</tr>
<tr>
<td>15</td>
<td>PARAM Yukti</td>
<td>JNCASR, Bengaluru</td>
<td>NA</td>
<td>NA</td>
<td>C-DAC</td>
<td>833 TF</td>
</tr>
<tr>
<td>16</td>
<td>PARAM Sanganak</td>
<td>IIT Kanpur</td>
<td>2020</td>
<td>NA</td>
<td>C-DAC</td>
<td>1.67 PF (Rmax)</td>
</tr>
<tr>
<td>17</td>
<td>PARAM Pravega</td>
<td>IISC</td>
<td>2022</td>
<td>NA</td>
<td>C-DAC</td>
<td>3.3 PF (Rmax)</td>
</tr>
<tr>
<td>18</td>
<td>Kohinoor 3</td>
<td>TIFR – TCIS, Hyderabad</td>
<td>2016</td>
<td>20th fastest supercomputer in India</td>
<td>Netweb</td>
<td>43.59 TF (Rmax) / 70.85 TF (Rpeak)</td>
</tr>
<tr>
<td>19</td>
<td>Kalinga, Upgrade</td>
<td>NISER, Bhubaneshwar</td>
<td>2016, 2020</td>
<td>26th fastest supercomputer in India</td>
<td>Netweb</td>
<td>161.42 TF (Rmax) / 249.37 TF (Rpeak)</td>
</tr>
<tr>
<td>20</td>
<td>Hartree</td>
<td>NISER, Bhubaneshwar</td>
<td>2018</td>
<td>29th fastest supercomputer in India</td>
<td>Netweb</td>
<td>38.87 TF (Rmax) / 51.9 TF (Rpeak)</td>
</tr>
<tr>
<td>21</td>
<td>Airawat</td>
<td>CDAC</td>
<td>2023</td>
<td>Rank 75 (Global, May-2023)</td>
<td>Netweb</td>
<td>8,500,000 GF (Rmax) / 13,169,860 GF (Rpeak)</td>
</tr>
</tbody>
</table>

Source: Secondary sources, Analytics Drift, 2021. Topscdadcb.in

Note: The list is complete but not exhaustive. The list covers some of the top as well as fastest supercomputers of India.
4.4. **Market Drivers, Restraints, Opportunities & Challenges**

**Drivers**

I. Increasing cloud-based monitoring will drive adoption of HPC in India

Cloud adoption is expected to play a pivotal role in helping Indian businesses and the government accelerate their digital transformation through infrastructure, platform, and software solutions. Large-scale cloud adoption is expected to account for about 8% of India’s Gross Domestic Product (GDP), contributing $380 billion by 2026 as per NASSCOM. Cloud-based monitoring will require large data to be handled.

**Restraints**

I. High CAPEX and OPEX

For many organizations, the cost of running HPC is a major concern. Demand for on-premises HPC resources often exceeds capacity and lost productivity due to an over utilized system has massive implications for organizations that place high value on the pace of innovation. Moving HPC workloads to the cloud also eliminate the need for periodic technology and infrastructure refresh cycles every three to five years, ensuring that innovation continues at a rapid pace.

**Opportunities**

I. Urban Modelling, Flood forecasting, Seismic imaging, Genomics & Drug discovery, and Material Science

Creation of supercomputing infrastructure is being done across the country at educational and research institutions, including a National AI facility at CDAC Pune. Some of these systems are being deployed with indigenously designed systems and would be serving many institutes across the nation. Under R&D, the supercomputer basic building blocks (Compute node, Interconnect switch, System software stack) have been indigenously developed, tested, and demonstrated. Development of indigenous HPC processor based on Arm architecture has been initiated. Applications development for national need has been initiated in consortium mode in various domains and is at various stages of development. The domains include Urban Modelling, Flood forecasting, Seismic imaging, Genomics & Drug discovery, and Material Science.

**Challenges**

I. Requires specific skillset

It needs specific skillset to run as the workloads are complex on-site HPC cluster. A highly complicated, data-intensive operation called an HPC workload is distributed among multiple computing resources, each of which executes a portion of the task in parallel. Using terabytes (TB) of data at a time, an HPC system may run millions of scenarios simultaneously, assisting businesses in gaining insights more quickly.

4.5. **Key players in the India HPC market**

**Table 13: Key Players in the India HPC market**
<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>IBM</th>
<th>ATOS</th>
<th>Lenovo</th>
<th>HPE</th>
<th>Netweb</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Company Type</td>
<td></td>
<td>Company Type</td>
<td>Presence in India</td>
<td>Presence in India</td>
</tr>
<tr>
<td></td>
<td>(Public or Private)</td>
<td></td>
<td></td>
<td>Headquarter in Bangalore</td>
<td>Headquarter in</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Present in 20 more cities in</td>
<td>Bangalore</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>India</td>
<td>Present in 7 locations</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>in India</td>
<td>in India</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1 manufacturing center, Head</td>
<td>Over 19 offices,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>office in India - Bangalore</td>
<td>present in 6+ cities</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>in India</td>
</tr>
<tr>
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<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of Employees in India (2022)</td>
<td>~150,000</td>
<td>~10,000</td>
<td>~1,000-5,000</td>
<td>~30,000</td>
<td>~270 (March, 2023)</td>
</tr>
<tr>
<td>Key Products/Services</td>
<td>IBM Power9, Storage servers for HPC workloads, IBM Spectrum Conductor, IBM Spectrum Symphony, IBM Spectrum LSF,</td>
<td>BullSequana X Series, Nimbis Supercomputing Suite, ThinkAI, Center of Excellence in advanced computing, Mobull</td>
<td>Lenovo Neptune, Rear Door Heat Exchanger (RDHX), Thermal Transfer Module (TTM), Energy Aware Runtime Software (EAR), ThinkSystem SR675 V3 Rack Server, ThinkSystem SD665 V3 High-Density Server, ThinkSystem SD665-N V3 High-Density Server, ThinkSystem SD650 V2 High-Density Server</td>
<td>HPE Cray EX2500, HPE Cray XD2000</td>
<td>Tyrone Camarero DIT400 Series, SDI100 series</td>
</tr>
<tr>
<td>Business Strategy</td>
<td>Partnership and Alliances</td>
<td>Partnership and Alliances</td>
<td>Collaboration</td>
<td>Collaboration, Partnerships</td>
<td>Collaboration</td>
</tr>
<tr>
<td>Key Partnerships/Mergers/Acquisitions</td>
<td>Partnership with Airtel. The partnership will leverage 5G technology and enhance the business value delivered by edge computing (2022)</td>
<td>Expanded relationships with partners like Infosys, Tech Mahindra, Wipro, TCS, HCL, Persistent Systems and LTI to strengthen secure Hybrid Cloud ecosystem.</td>
<td>Atos signed a cooperation agreement with C-DAC (Centre for Development of Advanced Computing) for technology advancement in quantum computing, artificial intelligence and exascale computing.</td>
<td>In November 2022, Lenovo partner with Rashi Peripherals to enhance their Infrastructure Solutions Group (ISG), a server and storage division of Lenovo to offer data center solutions to enterprise customers.</td>
<td>Sify Technologies partners with Hewlett Packard Enterprise to strengthen cloud computing services in India (2022); Public sector entities like the Steel Authority of India Ltd (SAIL), SAIL Bokaro and Oil and Natural Gas Corporation (ONGC) have recently signed partnership with HPE and deployed the HPE GreenLake edge-to-cloud platform to accelerate their digital transformation efforts, respectively (2022);</td>
</tr>
<tr>
<td>Revenue India</td>
<td>USD 3189 Million (FY2020-21)</td>
<td>Not listed in India</td>
<td>USD 1316.5 Million (FY2021-22)</td>
<td>USD 532.8 Mn (FY2021-22)</td>
<td>USD 56.6 Mn (FY2022-23)</td>
</tr>
</tbody>
</table>

Source: Annual Reports, ROC, Secondary Sources, Frost & Sullivan Analysis
Note: Revenues are consolidated ones at company level, 1 USD =78.6 INR (average exchange 2022)
Financial Calendar: April – March
The HPC market in India is composed of major global companies such as ATOS, HPE (CRAY), Dell and India’s indigenous HPC solutions provider such as Netweb, widely known for its implementation of the PARAM Yuva II, one of India’s fastest and largest Hybrid supercomputer till date. With over 30,000 processing cores and a total 14TB of memory, the next-generation PARAM Yuva II System at the Centre for Development of Advanced Computing (C-DAC) is enabling entirely new possibilities for research in India. Moreover, Netweb’s recent AI Supercomputer ‘AIRAWAT’, installed at C-DAC, Pune has been ranked 75th in the world and puts India on top of AI Supercomputing nations worldwide. The supercomputer has been named in the 61st edition of Top 500 Global Supercomputing List released in June 2023. Airawat PSAI, stands as India’s largest and fastest AI supercomputing system, with a remarkable speed of 13,170 teraflops (Rpeak). Three of Netweb’s supercomputer have been listed 11 times in the world’s top 500 supercomputers.

Netweb is one of India’s leading Indian origin owned and controlled OEM in the space of High-end computing solutions (HCS) providing – Supercomputing systems, private cloud and HCI, data centre servers, AI systems and enterprise workstations and High-Performance Storage solutions – with fully integrated design and manufacturing capabilities under the ‘Make in India’ initiative of the Government of India. Netweb is one of the few players in India who can offer a full stack of product and solution suite with comprehensive capabilities in designing, developing, implementing and integrating high performance computing solutions.

Netweb is one of India’s largest manufacturers of Supercomputing systems. In terms of number of HPC installations, Netweb is one of the most significant OEMs in India along with the likes of ATOS and HPE Cray. The HPC offerings from Netweb include HPC clusters, supercomputers with GPU optimization, HPC on-cloud, SMP solutions, and other management tools. The company takes pride in being at the forefront of developing homegrown compute and storage technologies and deploying supercomputing infrastructure to meet the rising computational demands of business, academia, and research organisations alike, particularly under India’s National Supercomputing Mission (NSM).

Local development of servers and products contributes to the technical advancement and growth of the HPC ecosystem in India. All these products contribute to the government’s vision of Atmanirbhar Bharat by fostering an Indian hardware and software ecosystem that, in the long run, would boost both domestic consumption and export-related income.

Hewlett Packard Enterprise (HPE) is a leading technology company that offers a range of solutions for high-performance computing (HPC). Over the years, HPE has developed several innovative technologies and solutions such as HPE Apollo systems that are purpose-built for HPC workloads and are designed to deliver extreme performance, scalability, and efficiency. These systems feature latest technologies such as high-speed interconnects, powerful processors, and advanced cooling solutions. Further HPE offers software-defined infrastructure solutions that enable organizations to automate and optimize their HPC environment.

IBM HPC solutions offer industry-leading innovation within and across the system stack. From servers, accelerators, network fabric and storage, to compilers and development tools, cluster
management software and cloud integration points, solution components are designed for superior integration and total workflow performance optimization. IBM’s HPC solution can help with – 1) faster insights: let users process large amount of data quickly, leading to faster insights and the ability to stay ahead of competition; 2) cost savings; 3) secure and reliable: provides industry-leading reliability to ensure users HPC environments stay up and running. Similarly, ATOS HPC solution accelerates customer’s HPC workload innovation and production through Atos cloud and on-premises HPC software and hardware solutions. Lenovo HPC solutions are based primarily on 2 key benefits – customer centric approach (Instead of a one-size-fits-all approach, our HPC solutions are tailored to your specific workload, workflow, and community) and from exascale to everyscale.
5. Global Private Cloud & Hyper Converged Infrastructure (HCl) Market
Scope & Definition

Hyperconverged infrastructure (HCI) is a combination of servers and storage into a distributed infrastructure platform with intelligent software to create flexible building blocks that replace legacy infrastructure consisting of separate servers, storage networks, and storage arrays. More specifically, it combines commodity datacenter server hardware with locally attached storage devices (spinning disk or flash) and is powered by a distributed software layer to eliminate common pain points associated with legacy infrastructure.

Private cloud is the public cloud experience like flexibility, consumption model, scalability, usability in a private data center.

The section here has market estimates which are inclusive of Hyperconverged Infrastructure (HCI) market & Private Cloud market both.

5.1. Global Private Cloud & Hyper Converged Infrastructure (HCI) Market Overview

The global private cloud & Hyperconverged infrastructure (HCI) market was USD 194.7 Bn in FY 2022. The market is forecasted to be USD 228 Bn in FY 2023 and is expected to reach USD 592.6 Bn by FY 2029 with a CAGR of 17.3% over the forecast period (FY2023-2029).

Exhibit 29: Global Private Cloud & Hyperconverged Infrastructure (HCI) Market (USD Bn) - FY 2019-2022E (Historical and Estimated years)

Exhibit 30: Global Private Cloud & Hyperconverged Infrastructure (HCI) Market (USD Bn) - FY 2023F-2029F (Forecasted years)
Private cloud & Hyperconverged infrastructure is expected to witness wider adoption in the forecast period as it provides solutions to some of the issues businesses run into when implementing technology in tiny offices, branch offices, or distant sites. It is expected that in coming years and with wider adoption of Private Cloud and HCI, companies may reduce operating and capital costs, boost business and information technology (IT) agility, and enhance application performance.

Since, Private Cloud and HCI is a software-defined, unified system that incorporates all the components of a typical data centre: storage, computation, networking, and administration; it is expected to efficiently compute, store, and manage data with its adoption.

**Private Cloud**

A private cloud is a cloud computing infrastructure that is exclusively used by one client. Many of the advantages of cloud computing are combined with the security and management of on-premises IT infrastructure in this method. The term "private cloud" refers to a cloud computing environment where all hardware and software resources are exclusively allocated to and accessed by a single customer (sometimes referred to as an internal cloud or corporate cloud). Private clouds combine the access control, security, and resource customisation of on-premises infrastructure with many of the advantages of cloud computing, such as elasticity, scalability, and ease of service delivery. According to the Nutanix Enterprise Cloud Index report, enterprise workloads quickly move off traditional data center infrastructure, dropping from 41% to 18% in two years as cloud usage accelerates. The retail industry has the second largest penetration of hybrid cloud deployments at 21%, with 93% identifying hybrid cloud as the ideal model, outpacing the global average for other industries.

**Benefits of Private Cloud**
1. Full control over hardware and software choices - Private cloud customers are free to purchase the hardware and software they prefer; vs. the hardware and software the cloud provider offers.

2. Freedom to customize hardware and software in any way - Private cloud customers can modify servers in any way they want and can customize software as needed with add-ons or through custom development.

3. Greater visibility into security and access control because all workloads run behind the customers’ own firewall.

4. Fully enforced compliance with regulatory standards - Private cloud customers aren’t obligatory to rely on the industry and regulatory compliance offered by the cloud service provider.

Major players operating in the global private cloud & Hyperconverged infrastructure market are HPE, Dell, Nutanix, and others.

5.2. Global Private Cloud & HCI Market by Application

Private Cloud and HCI collaborates with cloud computing while also providing many of the benefits of cloud computing on-premises in terms of simplicity and ease-of-management. In fact, for most organizations, HCI may be the optimal private cloud option for their needs. Like cloud computing, Private Cloud and HCI is easy to operate and enables IT managers to focus on apps and workloads, rather than be tied down managing infrastructure all day. HCI is not only quick and simple to build, but it can also be scaled very quickly as needed.

Global Private Cloud and HCI market by application is segmented into Government & Defence, BFSI, IT & ITES, Telecommunications, Media, Oil & Gas, and Others.

HCI application in the BFSI held the largest share (24%) in FY 2022 and is forecasted to be USD 55 Bn in FY 2023. The said application in the BFSI segment is expected to reach USD 137 Bn by FY 2029 with a CAGR of 16.4% over the forecast period (FY2023-FY2029).

Exhibit 31: Global Private Cloud & Hyperconverged Infrastructure (HCI) Market by Application (USD Bn) - FY 2019-2022E (Historical and Estimated years)
Exhibit 32: Global Private Cloud & Hyperconverged Infrastructure (HCI) Market by Application (USD Bn) - FY 2023F-2029F (Forecasted years)
Government & Defence – Higher adoption of HCI in Defence is expected in the coming years as it provides much needed agility and speed to military. The key challenge that military faces today is SWAP - Size, Weight and Power. Military expects small deployable communications systems that allows them to take their applications and data into the war field so that they can access them locally. There are a few products providing solution to this problem. One such product is Dtech from VMWare, that is small, lightweight and uses hyperconverged infrastructure and that enables several small components to replace traditional rackmount, 19 inch, very large servers; and that can be deployed anywhere. They can be taken in a backpack into the real war field and can be configured on the fly to support larger installation. For this, Military in many countries like USA are using VMWare's vSAN that has HCI infrastructure enabled. HCI enabled vSAN allows more compute, more storage, for critical missions. HCI gives military the ability to add components on the fly to meet the changing requirements.

BFSI - HCI has seen huge growth in interest across the financial services sector over the years and the trend is expected to continue over the forecast period as it can enable the seamless connection of systems, bulletproof the protection of data, and significantly increase agility, as well as reduce associated costs overall. HCI is enabling financial services organisations to decentralise the workload and collect and process data at the edge or nearest to where the work is occurring, which can overcome the “last mile” latency issues.

IT & ITES - HCI transforms traditional IT operational models with simple, unified resource management, delivering three key benefits: Increased IT efficiency - Replace manual processes and siloed operational expertise with a converged IT team that can monitor and manage resources. HCI pools and allocates resources dynamically to improve capacity, performance, and protection; Better storage at lower cost - Reduce the company’s CAPEX with scalable architecture that requires only standard servers—not expensive, purpose-built networking. HCI scales without disruption and overprovisioning, reducing infrastructure costs; and Greater ability to scale - Respond to rapidly changing business needs in real time—with HCI, the companies can set up hardware in hours and spin up workloads in minutes. Now the companies can accelerate business-critical applications like relational databases with HCI, which scales to meet specific application needs.

Telecommunications – Telcos are expected in the forecast period to better adopt hyperconverged technology to deliver demanding new services, as HCI provides a combination of software-defined infrastructure on the same white-box host.

5.3. Global Private Cloud & HCI Market by Geography/Region

Global Private Cloud & HCI market by geography is segmented into North America, Europe, Asia Pacific (APAC), South America, and Middle East and Africa (MEA). North America region held the largest share in FY 2022 and is expected to reach USD 329.8 Bn by FY 2029 at a CAGR of 16.7%. The APAC and the European markets are expected to almost triple over the forecast period (FY2023-2029) and reach USD 102.3 Bn and 111 Bn respectively growing at a CAGR of 19.6% and 16.9%.
Exhibit 33: Global Private Cloud & Hyperconverged Infrastructure (HCI) Market by Geography/Region (USD Bn) - FY 2019-2022E (Historical and Estimated years)

Source: Frost & Sullivan Analysis

Exhibit 34: Global Private Cloud & Hyperconverged Infrastructure (HCI) Market by Geography/Region (USD Bn) - FY 2023F-2029F (Forecasted years)

Source: Frost & Sullivan Analysis
5.4. Market Drivers, Restraints, Opportunities & Challenges

Drivers

I. Ease of Deployment

HCI is sometimes described as “turnkey” technology. That might be overstating matters, but easier deployment is a large part of HCI’s appeal. As the key technology elements – server, storage, and potentially networking and virtualisation – are pre-installed and pre-configured by the supplier, an HCI system is easier to deploy than separate technologies. This will suit remote or branch office location, with no local IT staff. It is also an attractive model for small and medium-sized enterprises (SMEs). In both cases, HCI systems will ship with remote management, so the central IT team or reseller can fine-tune settings. Ease of deployment also appeals to start-ups and other fast-growing organisations, where being able to roll out or scale up IT matters more than squeezing out the last drop of performance. This is especially important for hyper-converged storage. Storage is the leading use case for HCI.

II. Flexibility

HCI is flexible, both in how it’s deployed and how it is purchased. Businesses can buy HCI as self-contained systems from suppliers, build their own or even rely on software-defined systems. New purchasing models have added to HCI’s appeal too. HCI systems can form part of hybrid cloud infrastructure, or even – as it is essentially software – run entirely in the cloud. And on-premises suppliers are starting to move towards pay-per-use models for their hardware, leading with hyper-converged. For example, HPE’s GreenLake and Dell’s Project Apex. The number of options open to organisations buying HCI largely offsets the reduced hardware choices within an HCI system, as well as potentially supplier lock-in. Software-defined hyper-converged infrastructure reduces the risks from supplier lock-in, as software-based systems can run on multiple suppliers’ hardware.

Restraints

I. Supplier lock-in

Companies going ahead with HCI need to assess carefully how much (potential) performance they are sacrificing by buying an integrated system or appliance, against best-of-breed technology. The key is identifying the right hyper-converged infrastructure supplier – whether that is a software or hardware supplier. The heart of HCI is the software, but hardware has its own place in the solution. Suppliers would like their clients to believe their respective components matter the most, and this causes a lot of confusion for tech buyers.

Opportunities

I. Oil & Gas Industry

Apart from the applications and opportunities HCI has in the Military, IT & ITES, and BFSI industry, HCI is expected to fuel digital transformation in the Oil & Gas industry as well by: Drilling optimization and automation – Drilling is a major expense in oil & gas production, representing between 20 to 30% of total production costs. Enhanced connectivity could also enable remote or semi-automatic drilling, drastically reducing the number of people required on the rig itself.;
Optimizing production – For e.g., A major production facility of a large oil & gas company operating in the North Sea gained a 2% increase in production without increasing emissions after it used real-time advanced analytics to improve the settings of the production facilities booster, export compressor, and component splitter.; Smart Maintenance; Enhanced field operations; and Digitally enabled logistics.

**Challenges**

I. Requirement of more than one type of HCI

HCI’s flexibility brings its own challenges. Companies opting for HCI need to decide whether to configure their own hardware, buy appliances outright, focus on software, opt for a rental model, use the cloud, or all those elements. With the hyper-converged market still maturing, it is quite possible that organisations will need to use more than one type of HCI to meet their business goals.

### 5.5. Key players in the Global Private Cloud & HCI market

**Table 14: Key players in the global Private Cloud & HCI market (1/2)**

<table>
<thead>
<tr>
<th>Company Type</th>
<th>Nutanix</th>
<th>HPE</th>
<th>Cisco</th>
<th>VMWare, Inc.</th>
<th>Dell</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headquarters</td>
<td>San Francisco, USA</td>
<td>Texas, USA</td>
<td>California, USA</td>
<td>California, USA</td>
<td>Texas, USA</td>
</tr>
<tr>
<td>Geographical Presence</td>
<td>APAC, America's, EU, MEA</td>
<td>APAC, America's, EU, MEA</td>
<td>Americas, EMEA, APJC</td>
<td>111 offices worldwide</td>
<td>Americas, Europe, MEA, Asia</td>
</tr>
<tr>
<td>No. of Employees (2022)</td>
<td>6,320</td>
<td>60,200</td>
<td>83,300</td>
<td>38,300</td>
<td>~1,33,000</td>
</tr>
<tr>
<td>Key Products/Services</td>
<td>Nutanix Cloud Infrastructure</td>
<td>HPE Alletra dHCI, HPE GreenLake for HPE SimpliVity, HPE SimpliVity, Alletra dHCI</td>
<td>HyperFlex, Cisco HyperFlex Express, Cisco HyperFlex with AMD EPYC, Cisco HyperFlex Hybrid Nodes, Cisco HyperFlex All Flash and All NVMe Nodes,</td>
<td>VMWare HCI</td>
<td>VxBlock 1000, VxRail, VMware Cloud Foundation on VxRail, vSAN Ready Nodes, PowerFlex, XC Family</td>
</tr>
<tr>
<td></td>
<td>Nutanix</td>
<td>HPE</td>
<td>Cisco</td>
<td>VMWare, Inc.</td>
<td>Dell</td>
</tr>
<tr>
<td>--------------------------------</td>
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<td>--------------</td>
<td>------</td>
</tr>
<tr>
<td><strong>Business Strategy</strong></td>
<td>Product Launch</td>
<td>Acquisition</td>
<td>Product Launch</td>
<td>Product Launch</td>
<td>Product Launch</td>
</tr>
<tr>
<td><strong>Key Partnerships/Mergers/Acquisitions</strong></td>
<td>In February 2022, the company launched hyper-converged infrastructure software to deliver a consistent cloud operating model for enterprise.</td>
<td>In January 2023, HPE acquired Pachyderm, a startup that delivers software to automate reproducible machine learning (ML) pipelines that target large-scale hyperconverged infrastructure solutions</td>
<td>In March 2022, the company launched Cisco HyperFlex™ Express, lowering the entry point for hyperconverged solutions; Delivers new hardware platforms using the latest AMD EPYC™ processors.</td>
<td>In August 2022, VMware expanded vSphere and vSAN software that would keep pace with enterprise interest in hybrid cloud infrastructure for applications and workloads.</td>
<td>In August 2022, the company launched VxRail to boost application and networking performance with industry-first jointly engineered HCI solution support for Data Processing Units (DPUs) while new models expand VMware edge capabilities with smallest-ever systems</td>
</tr>
<tr>
<td><strong>Revenue</strong></td>
<td>USD 1.58 Bn (2022)</td>
<td>USD 28.5 Bn (2022)</td>
<td>USD 51.6 Bn (2022)</td>
<td>USD 13.4 Bn (2022)</td>
<td>USD 101.2 Bn (2022)</td>
</tr>
</tbody>
</table>

Source: Annual Reports, Secondary Sources, Frost & Sullivan Analysis

Note: Company revenues have been reported at consolidated level

Financial Calendar:
Nutanix: August – July; HPE: November – October; Cisco: August – July; VMware: February - January; Dell: February - January
Table 15: Key players in the global Private Cloud & HCI market (2/2)

<table>
<thead>
<tr>
<th></th>
<th>Microsoft</th>
<th>Huawei</th>
<th>StorMagic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Company Type (Public or Private)</strong></td>
<td>Public</td>
<td>Public</td>
<td>Private</td>
</tr>
<tr>
<td><strong>Headquarters</strong></td>
<td>Washington, USA</td>
<td>Shenzhen, China</td>
<td>Bristol, UK</td>
</tr>
<tr>
<td><strong>Geographical Presence</strong></td>
<td>APAC, America’s, EU, MEA</td>
<td>APAC, America’s, EU, MEA</td>
<td>UK, USA and Canada</td>
</tr>
<tr>
<td><strong>No. of Employees (2022)</strong></td>
<td>2,21,000</td>
<td>207,000</td>
<td>75,900</td>
</tr>
<tr>
<td><strong>Key Products/Services</strong></td>
<td>Hyper V, Remote Desktop, Failover Clustering, Software Defined Networking, Azure Stacked HCI</td>
<td>FusionCube 1000 Cabinet, FusionCube 1000 Hypervisor &amp; Data</td>
<td>vSphere, Hyper-V and Linux KVM</td>
</tr>
<tr>
<td><strong>Business Strategy</strong></td>
<td>Partnerships</td>
<td>Product Launch</td>
<td>Partnership</td>
</tr>
<tr>
<td><strong>Key Partnerships/Mergers/Acquisitions</strong></td>
<td>Partnerships with Citrix Systems, Elastic, and SolarWinds (2021) to strengthen the subscription based HCI business model</td>
<td>In April 2022, Huawei proposed the &quot;Green and Low Carbon&quot; concept for its Huawei CloudFabric 3.0 Hyper-Converged Data Center Network (DCN) Solution, with the aim of using lossless networks to improve computing efficiency and reduce computing footprint.</td>
<td>In March 2020, the company partnered with Insight Public Sector that would reduce the prices of Hyperconverged Solutions for less than $10,000</td>
</tr>
<tr>
<td><strong>Revenue</strong></td>
<td>USD 198 Bn (2022)</td>
<td>USD 92.3 Bn (2023)</td>
<td></td>
</tr>
</tbody>
</table>

Source: Annual Reports, Secondary Sources, Frost & Sullivan Analysis
Note: Company revenues have been reported at consolidated levels

Financial Calendar:
Microsoft: July – June; Huawei: January – December; StorMagic: April - March
6. India Private Cloud & Hyper Converged Infrastructure (HCI) Market
6.1. India Private Cloud & Hyper Converged Infrastructure (HCI) Market Overview

The India private cloud & Hyperconverged infrastructure (HCI) market was USD 2,369.2 Mn in FY 2022. The market is forecasted to be USD 2,796.8 Mn in FY 2023 and is expected to reach USD 8,007.4 Mn by FY 2029 with a CAGR of 19.2% over the forecast period (FY 2023-2029).

Exhibit 35: Table 6: India Private Cloud & Hyperconverged Infrastructure (HCI) (USD Mn) - FY 2019-2022E (Historical and Estimated years)

Source: Frost & Sullivan Analysis

Exhibit 36: India Private Cloud & Hyperconverged Infrastructure (HCI) (USD Mn) - FY 2023F-2029F (Forecasted years)

Source: Frost & Sullivan Analysis
Indian Private Cloud & Hyperconverged Infrastructure (HCI) Market Outlook

HCI in India is expected to witness wider adoption in the forecast period. Its major application is expected in streamlining IT architecture in the country.

It makes data centre management easier than before. Reduced management complexity is easily one of the most essential aspects. Modern firms' urgent demands consume significant IT resources in terms of designing, deploying, and maintaining technology. IT teams may use hyper-convergence to shift away from managing scattered, outdated systems and toward more strategic efforts. Major cities such as Mumbai, Bangalore, and Hyderabad are seeing significant HCI investments from both domestic and foreign players in the Indian industry.

State and municipal governments have a mandate to provide the best answers to their residents. However, new technology can be costly, out of reach for governments with limited finances. Traditional, hardware-centric infrastructure, on the other hand, comes at a high cost, necessitating time-consuming administration and jeopardising performance. Modernizing next-generation applications will be paved with the help of hyper-converged infrastructure.

For mission-critical systems, private cloud solutions combine the economic feasibility of the public cloud with the predictability of the private cloud, as well as strong security, control, and great performance. Many companies in India offer a straightforward and scalable environment with as-you-use billing, whether hosted on-premises or in one of our international data centres. They provide complete control over security, compliance, and performance so that systems are always available. Clients prevent capital outlays and save a tonne of time with our Private Cloud solutions.

Why adoption of private cloud has been increasing in India:

Private Clouds offer the same control and security as traditional on-premises infrastructure. Here are some reasons why organizations opt for private cloud computing:

Security: Traffic to a private cloud is often restricted to the organization's own transactions, which enhances private cloud security. Public cloud providers must manage simultaneous traffic from millions of users and transactions, increasing the likelihood of fraudulent traffic. The company has superior control over the server, network, and application security because private clouds are made up of specialised physical infrastructure.

Predictable performance: Workload performance is predictable and unaffected by other businesses sharing infrastructure or bandwidth because the hardware is dedicated rather than multi-tenant.

Long-term savings: The infrastructure needed to host a private cloud can be costly to set up, but it may be worthwhile in the long run. In comparison to paying monthly fees to use other people's servers on the public cloud, a private cloud can be significantly more cost-effective over time if an organisation already possesses the gear and network needed for hosting.
Predictable costs: Based on consumption, storage fees, and data egress fees, public cloud expenses might vary greatly. Regardless of the workloads a business is running or how much data is transported, private cloud prices are the same every month.

Government initiatives are also expected to drive the adoption of HCI in India. For example, in collaboration with Nuntanix, a virtual roundtable on "Building a Digital India through Hyperconvergence (HCI) and Multi-Cloud" was organized, which focused on the evolution of digital transformation through data centers, modernization of the role of hyperconvergence in PSU environments, and how to simplify and unify PSU cloud management strategy.

**How Indian Private Cloud & Hyperconverged Infrastructure (HCI) Market has transformed over the years?**

Adoption of HCI in IT industry - Most forward-thinking companies in India are striving to create a hybrid cloud IT environment for their operations, which is one of the most challenging jobs owing to the problems in managing the numerous products and components. HCI enables a one-stop shop for business application deployment and flexible resource deployment in any location when natively coupled with larger virtualization, container, and cloud platforms.

Adoption of HCI in BFSI sector – Banks, such as RBL have recently adopted HCI for smooth banking operations.

### 6.2. India Private Cloud & HCI Market by Application

India private cloud and HCI market by application is segmented into Government & Defence, BFSI, IT & ITES, Telecommunications, Media, Oil & Gas, and Others. Adoption of HCI in the Government and Defense sector witnessed maximum growth in FY 2022 and is expected to reach USD 1,203.8 Mn by FY 2029 at a CAGR of 20.4%.

**Exhibit 37: India Private Cloud & Hyperconverged Infrastructure (HCI) Market by Application (USD Mn) - FY 2019-2022E (Historical and Estimated years)**
Exhibit 38: India Private Cloud & Hyperconverged Infrastructure (HCI) Market by Application (USD Mn) - FY 2023F-2029F (Forecasted years)

Source: Frost & Sullivan Analysis
Government & Defense -

Increased internet usage, smart device adoption, and social media development have encouraged both the federal and state governments in India to shift from traditional service offerings to digital platforms. The federal government has underlined the need of growing cloud and data centre investment in the Indian market in its budget.

The ET Aerospace and Defence Summit 2022 revealed the development and abundant potential prospects in India's Aerospace & Defense sector. The Summit addressed development potential and the role of technology in assisting India's A&D sector to reach a projected growth of $70 billion by 2030.

The iDEX programme of the government promotes innovation and research in the defence sector. The budding start-ups and entrepreneurs working under the aegis of iDEX to remove barriers in the defence sector are especially inspiring. If implemented properly, the Make in India initiative has the potential to transform India into a global manufacturing powerhouse. By emphasizing India's appropriate demographics and skills that can assist the country in achieving a digital future in addition to the $5 trillion aim.

Telecom

HCI and private cloud will witness greater adoption in the India Telecom sector with increasing investment in 5G.

At ~1.1 Bn, India has 2nd highest number of telecom users in the world, of which 740 Mn are 4G customers. Indian telecom ARPU is on an accelerated path, with 3X growth expected between 2018-2025

India expected to have 500 Mn+ 5G users by 2027. 5G can contribute up-to 2% of India’s GDP by 2030, a~$180 bn impact 5G opportunity is expected to be spread across consumers and enterprises in different verticals, involving both public and private 5G networks.

Over the past few years, large and mid-size enterprise organizations have recognized the value of HCI due to the simplicity of deployment, ease of scaling and cost efficiencies. Both large and small enterprises are looking forward to implementing and benefiting from the HCI. For e.g.,

In 2018, Uttarakhand Chief Minister inaugurated the country’s first Hyper Converged Infrastructure State Data Centre in Dehradun. It is a 3-tier State Data Centre, developed by the Information Technology Development Agency (ITDA) of the Uttarakhand government. It is the first data centre in the country with cent percent software-based Hyper Converged Infrastructure (HCI) technology. It has 105-terabyte form, which can be expanded up to 12 petabyte.

RBL Bank, India took Nutanix’s help to create an agile private cloud environment that could quickly respond to business VM requests. This aided in lowering the requirement for manual infrastructure management and provided a resilient architecture that supports the bank’s operations.

6.3. Market Drivers, Restraints, Opportunities & Challenges
Drivers

I. Reliability

Reliability is the calling card for single-supplier HCI. Buying off-the-shelf pushes, the integration back to the manufacturer. This is more so for appliances. Combine HCI with data backup in the cloud and replacing a defective hyper-converged unit in a remote office could be as simple as connecting the power and local area network (LAN). In-house developed HCI might not hit the same reliability, as systems will not be pre-tested. But because hyper-converged is based around nodes and clusters, IT teams can design inherently more resilient systems, however they source their hardware.

II. Unified management, and automation

Unified management, and with that, ease of operational management, is where HCI really comes to the fore. “It’s possible with converged systems, but it pretty much defines HCI. The fact that compute, storage, and networking is all software-defined or software-driven means it can be run as a whole, as a single entity.” Unified management promises to reduce the number of tools needed to run IT infrastructure, and it should cut training requirements – IT teams will no longer need to learn multiple suppliers’ technologies and management applications. Automation is also easier because HCI is homogenous. As the system is software-defined, it is easier to automate tasks such as provisioning and de-provisioning. Automation, along with unified management, makes HCI easier to scale. A business can add more nodes, or reallocate resources within a cluster, on the fly. Setting up systems in a new office, or even a new territory, could be as simple as delivering the appliances and cloning the configuration.

Unified management also applies to hybrid environments. Again, as HCI is software-defined, the same tools can manage on-premises hardware, hybrid, and public cloud. As the business grows, adding more compute capacity or storage is just a question of adding more nodes either locally or in the cloud. The emerging market for HCI infrastructure on-demand is a further benefit for organisations that need to stand up infrastructure quickly to support innovation.

Restraints

I. Greater power requirement

HCI architectures include a lot of workloads in a limited space, which can often mean they draw more power than data centers have been designed for. While this can be tackled by offloading some workloads to the cloud where possible, administrators may need to look at reorienting their locations to ensure there are enough power and cooling solutions in place to meet demands, which can come with its own costs.

Opportunities –

I. BFSI

Apart from numerous applications HCI has in Government and Defence sector and IT industry, HCI also witnesses demand in the India BFSI sector.

Financial institutions are focusing on rapidly modernizing and scaling up infrastructure to address rising demand, as part of their key strategy to drive operational efficiency and customer
engagement. Furthermore, increased interest in digital banking, especially in India, has made banking a smooth and transparent process. These institutions are leveraging advanced IT solutions to modernize and scale up their IT infrastructure to meet the rising demand. RBL Bank, an Indian private sector bank, has been implementing HCI and has upgraded its operating platform system to a more agile system capable of addressing various challenges associated with the underutilization of existing IT infrastructure, opting for a more robust solution that can cater to the rapidly changing demand scenario.

RBL Bank took Nutanix’s help to create an agile private cloud environment that could quickly respond to business VM requests. This aided in lowering the requirement for manual infrastructure management and provided a resilient architecture that supports the bank’s operations.

**Challenges**

I. Compatibility issues

It’s important not to confuse the virtualization capabilities offered by HCI tools with a true cloud computing solution and therefore expect them to work seamlessly side by side. It can prove challenging for some HCI environments to effectively share resources across multiple systems and offload specific operations to cloud services. This is especially true when businesses are using equipment from multiple manufacturers.

II. Hardware interconnectivity

Many HCI services are built around the idea that everything comes as a package from the same manufacturer, and if one is not careful, this can lead to issues such as vendor lock-in to guarantee performance. While it’s usually possible to expand an HCI environment using low-cost commodity hardware, this is likely to lead to performance issues, as this won’t work as well as a fully converged platform that’s been configured specifically to work in that environment. This can often leave businesses facing a choice between price and performance when they come to scale up their systems.

### 6.4. Key players in the India Private Cloud & HCI market

**Table 16: Key players in the India Private Cloud & HCI market**

<table>
<thead>
<tr>
<th>Company Type</th>
<th>VMware</th>
<th>Nutanix</th>
<th>Suse</th>
<th>RedHat (Acquired by IBM)</th>
<th>Netweb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presence in India</td>
<td>Mumbai, Pune, Chennai, New Delhi, Bengaluru</td>
<td>Ahmedabad, Bengaluru, Chennai, Mumbai, Delhi, Pune,</td>
<td>Bangalore, India</td>
<td>Bangalore and New Delhi, and offices in Mumbai and Pune</td>
<td>Presence in 13 locations in India</td>
</tr>
<tr>
<td>No. of Employees (2022)</td>
<td>~5,001 to 10,000</td>
<td>~1000</td>
<td>N/A</td>
<td>~19,000</td>
<td>~270 (March, 2023)</td>
</tr>
<tr>
<td>------------------------</td>
<td>-------------------</td>
<td>-------</td>
<td>-----</td>
<td>---------</td>
<td>------------------</td>
</tr>
<tr>
<td>Key Products/Services</td>
<td>VMWare HCI</td>
<td>Nutanix Cloud Infrastructure (NCI), Hybrid Multicloud Infrastructure</td>
<td>Cloud-Native Hyperconverged Infrastructure, Harvester</td>
<td>Redhat virtualization, Red Hat Gloster Storage, redhat Ansible</td>
<td>HCI cloud (Skylus), KUBYTS Platform, Skylus Cloud for HCI</td>
</tr>
<tr>
<td>Business Strategy</td>
<td>Acquisition, Mergers</td>
<td>Product Launch</td>
<td>Partnership</td>
<td>Partnerships</td>
<td>Innovation/Alliance</td>
</tr>
<tr>
<td>Key Partnerships/Mergers/Acquisitions</td>
<td>Acquisitions such as Carbon Black and Pivotal Software (2020) to strengthen HCI portfolio; Vmware is expected to carry out many M&amp;A activities to support its multi-cloud portfolio (2022 onwards)</td>
<td>In February 2022, the company has built an enterprise-ready, unified cloud platform with its market leading HCI (hyperconverged infrastructure) solution as the foundation.</td>
<td>SUSE partnered with Infosys that will help businesses accelerate their digital transformation journey.</td>
<td>IBM and Bharti Airtel, communications solutions provider in India with more than 358 million subscribers, announced their intent to work together to deploy Airtel's edge computing platform in India.</td>
<td>Netweb’s Tyrone provides High Performance Servers, File Servers, Clusters, Network Attached Storage Servers (NAS), HPC’s &amp; Firewall.</td>
</tr>
<tr>
<td>Revenue</td>
<td>USD 671.4 Million</td>
<td>USD 151.7 Million</td>
<td>USD 7.2 Million</td>
<td>USD 150.2 Million</td>
<td>USD 56.6 Mn (2022-23)</td>
</tr>
</tbody>
</table>

Source: Annual Reports, ROC, Secondary Sources, Frost & Sullivan Analysis
Note: Revenues are consolidated ones at company level,
USD = 78.6 INR (average exchange rate for Year 2022)
Financial Calendar: April – March 2021-22 (For VMWare, Nutanix, Suse and RedHat)

Enterprises in India are constantly looking for hyperconverged cloud solutions which set up as pre-cursors for a very quick private cloud that is easily scalable. HCI is becoming more popular in India as companies search for more economical and effective ways to manage their IT infrastructure.

The HCI market in India is composed of major global companies such as Nutanix, VMWare, Redhat and India’s indigenous solutions provider Netweb.

Nutanix Hyperconverged Infrastructure (HCI) provides the benefits of a cloud model but within the user’s own data centre or computer room. Key benefits of Nutanix HCI are turnkey infrastructure, powerful platform, fast deployment, superior performance and resilience, software driven, and flexibility. VMWare’s hyperconverged infrastructure stack is completely extensible to public cloud, for a true hybrid cloud implementation that supports customers modern application needs. Red Hat is one of many vendors that offers hyper-converged infrastructure, but the company takes a slightly different approach than most. It is based on
leading open-source technologies such as Linux, OpenStack and Ansible. In addition, RHII is a software-only product, not a fully equipped appliance. Red Hat offers two distinct HCI products: Red Hat Hyperconverged Infrastructure for Virtualization and Red Hat Hyperconverged Infrastructure for Cloud. As a result, organizations can choose between a more traditional approach to HCI or one that provides a cloud computing environment.

Netweb's HCI cloud offering gives its clients the quickest route to a private or hybrid cloud (For this offering, the company is also focusing on the core cloud and edge cloud.) This helps customers scale the cloud easily and have the flexibility to add compute-only GPU nodes dynamically. HCI Cloud provided by Netweb is very simple to manage in contrast to a more complicated, conventional installation. With Netweb's HCI solution - the complexity of maintaining, administering, and moving complicated workloads onto the cloud can be reduced.
Scope & Definition
An artificial intelligence (AI) workstation is a computer system that is specifically designed for AI-related tasks, such as machine learning, deep learning, natural language processing, and computer vision. AI workstations typically feature powerful processors, large amounts of memory, and high-performance graphics processing units (GPUs) to enable faster and more accurate training of machine learning models. They also often have specialized hardware such as Tensor Processing Units (TPUs) or Field-Programmable Gate Arrays (FPGAs) that can accelerate specific AI workloads. In addition to hardware, AI workstations may also come with pre-installed software, libraries, and frameworks optimized for AI development. NVIDIA DGX Station is an example of an AI workstation. Overall, an AI workstation provides a powerful and dedicated platform for data scientists, researchers, and developers to design, test, and deploy advanced AI applications.

7.1. Global AI Systems & Enterprise Workstations (AI & EW) Market Overview
The global AI Systems & Enterprise Workstations (AI & EW) market was estimated to be USD 6.0 Bn in FY 2022. The market is forecasted to reach USD 6.3 Bn in FY 2023 and is expected to reach USD 8.2 Bn by FY 2029 with a CAGR of 4.5% over the forecast period (FY 2023-2029).

Exhibit 39: Global AI Systems & Enterprise Workstations (AI & EW) Market (USD Bn) - FY 2019-2022E (Historical and Estimated years)

Source: Frost & Sullivan Analysis

Exhibit 40: Global AI Systems & Enterprise Workstations (AI & EW) Market (USD Bn) - FY 2023F-2029F (Forecasted years)
Individual data scientists, data engineers, and AI researchers often use a personal AI or data science workstation in the process of building and maintaining AI applications. These are known as AI workstations. This tends to include data preparation, model design, and preliminary model training. Most AI workstations used for machine learning, deep learning, and AI development are Linux-based.

The graphics processing unit (GPU) has become an essential element in modern AI systems and enterprise workstations. Unlike central processing unit (CPUs), GPUs can increase the throughput of data and number of concurrent calculations within an application. GPUs were originally designed to accelerate graphics rendering. Because GPUs can simultaneously process many pieces of data, they have found new modern uses in machine learning, video editing, autonomous driving, and more. Although AI workloads can be run on CPUs, the time-to-results with a GPU may be 10x to 100x faster. The complexity of deep learning in natural language processing, recommender engines, and image classification, for example, benefits greatly from GPU acceleration.

GPU demand is driven by a range of reasons, including an increase in gaming demand and the cryptocurrency mining market. The cryptocurrency mining market is the most significant source of short-term risk, and while total sales remain strong despite a drop in cryptocurrency prices, future sales may not be as durable should prices remain down. But now, despite these issues, GPU demand remains strong. According to analysts, growth in the GPU market can increase anywhere from 25%-35% over the next couple of 5–6-year period. Therefore, the growing demand of GPUs in high-end gaming consoles and personal computers is expected to drive the AI systems and enterprise workstation market.

Other key drivers of the AI systems and enterprise workstation market are rising investments in the video game industry, the development of technologies like AI, the move toward actual analysis, and the increased need for high-end graphics and computing applications. Due to the sharp increase in 3D animation, networking and graphics, and digital content creation; the global market for AI workstations is expanding at a very rapid rate.

### 7.2. Global AI Systems & Enterprise Workstations (AI & EW) Market by Application
Over the years, AI Systems & Enterprise Workstations have witnessed adoption in the Defense & Intelligence, Media & entertainment, and IT & telecommunications sectors as these sectors deal with a huge amount of data. The market for AI Systems & Enterprise Workstations in the telecommunication sector was USD 3.7 Bn in FY 2022 and is expected to reach USD 4.9 Bn by FY 2029 at a CAGR of 3.9% over the forecast period (FY2023-2029).

Exhibit 41: Global AI Systems & Enterprise Workstations (AI & EW) Market by Application (USD Bn) - FY 2019-2022E (Historical and Estimated years)

Exhibit 42: Global AI Systems & Enterprise Workstations (AI & EW) Market by Application (USD Bn) - FY 2023F-2029F (Forecasted years)
IT & Telecommunications – The telecommunication industry is now a center of technological advancements. However, the time when this business was limited to telephones and internet services – is long gone. Nowadays, the focus is on Artificial Intelligence. It has been a decade now since AI has taken over telco, successfully replacing the traditional and complicated ways with new algorithms. As a result, the development of analysing and processing colossal amounts of data collected from multiple consumer bases through computer vision techniques is much faster and more efficient. For all the right reasons, AI is becoming integral to the future digital marketplace. The impact of AI on the telecom industry enabled enterprises to deliver enhanced customer experience and boost business value. In addition, this new technological advancement allows CSPs to manage, maintain and optimize infrastructure while supporting all other operations. Telecommunication companies are making the most of the unlimited data collected over the years from extensive customer bases – mostly coming from – devices, mobile apps, networks, geo location, service usage, detailed customer profiles, billing information etc. By analysing and processing the massive volumes of Big Data – telco organizations can obtain some somewhat actionable insights, providing better customer experiences, improved operations, and increased revenue while building new services and products. Therefore, the increasing usage of AI in the telecommunication industry is expected to drive the requirement for AI based workstations.

Others - Media & entertainment as well as tourism & leisure are included in the others sector. The increased use of electronic devices by consumers has led to new demands for customer service and communication platforms. The advent of cloud-based voice, messaging, video, speech analytics with AI, and Chatbot/Voice Bot solutions in the tourism and hospitality sectors gives an intelligent way for customers to communicate across various channels, which contributes to growing customer base. These factors will help drive AI & EW market during the forecast period (FY2023-2029).

7.3. Global AI Systems & Enterprise Workstations (AI & EW) Market by Geography/Region

Global AI Systems & Enterprise Workstations (AI & EW) market by geography is segmented into North America, Europe, Asia Pacific (APAC), South America, and Middle East and Africa (MEA). North America region held the largest share in FY 2022, followed by APAC, and is expected to reach USD 2.9 Bn by FY 2029 at a CAGR of 3.9%.

Exhibit 43: Global AI Systems & Enterprise Workstations (AI & EW) Market by Geography/Region (USD Bn) - FY 2019-2022E (Historical and Estimated years)
North America is one of the major investors and innovators in the global AI & EW market owing to the increasing domestic adoption and expanding regional data center, gaming, and AI market among consumers. Compared to other regions, the region is experiencing a large increase in demand for advanced technologies, such as machine-to-machine communication, data center servers, and AI, which could create huge opportunities for the AI & EW market. By automating user onboarding, provisioning network and endpoint devices, putting network and security rules into place, and troubleshooting problems, many businesses have increased productivity. In this cloud-enabled network-as-a-service (NaaS) paradigm, organizations can employ networking capabilities dynamically without having to purchase, build, or operate the infrastructure themselves. For instance, according to Central Technology Association (CTA) more than 38% of
businesses cited the ability of the NaaS model to continuously offer them the most advanced networking technologies and capabilities as a key factor in their decision to embrace it. This is also contributing significantly to the AI & EW market in North America. North America has always remained the early adopters of latest technology and this is the major reason why the region has captured the largest AI & EW market.

Due to significant investments in gaming, data centres, cloud computing, autonomous vehicles, and AI and VR technologies, Europe is one of the market’s fastest expanding regions. The region is growing as a prominent investor in the AI & EW market due to strong demand in digital content creation workstation, economic/finance workstation, engineering workstation, scientific workstation, software engineering AI workstation and various another commercial purposes. Expansion in these segments will directly influence the global market for AI & EW market over the forthcoming years. Additionally, in November 2021, HPE announced that it would build AI workstations that would be installed and run at CINES (National Computing Center for Higher Education), one of France's three HPC facilities. GENCI, a national French organization that finances and provides HPC resources to aid France's academic and industrial research groups, purchased the new supercomputer.

### 7.4. Market Drivers, Restraints, Opportunities & Challenges

#### Drivers

I. Increasing usage of AI workstations by Data scientists, Mobile data scientist, and AI developers

Increasing usage of AI workstations by Data scientists has been seen over the years as AI workstations equip data scientists to tackle the most complex data science initiatives and demanding schedules. Netweb provides Tyrone Janus a new generation workstation that are optimized for applications requiring powerful graphics capabilities including rendering, image processing, scientific and engineering tasks. Other companies provides ultimate scalability and performance for a data scientists analytics and AI initiatives. They deliver data scientists comprehensive hardware solutions that are optimized to run the industry’s latest AI software, including Data Science software suites validated on Dell Precision Data Science Workstations (DSWs).

Increasing usage of AI workstations by mobile data scientists has been seen over the years as AI workstations frees mobile data scientists to tackle the most complex data and artificial intelligence initiatives.

Increasing usage of AI workstations by AI developers has been seen over the years as AI workstations can provide AI developers with the power required to accelerate new development challenges associated with AI initiatives, whether wrangling massive amounts of unstructured data or training complex algorithms against it.

#### Restraints

I. Limited capabilities of available AI & EW to perform crucial operations
It is definitely an accepted truth that AI & EW require some of the industry’s fastest GPUs for efficient performance. Even with modern on-chip architectures, the GPU used for computing in AI & EW is a separate processor that is connected to the host system as an I/O device. The GPU is not a programmable system device with this interface; hence an OS cannot directly schedule or manage a GPU. This places a real-time system under several restrictions. Digitalization has made it mandatory for the AI & EW manufacturers to adopt fast and smoother GPUs. The modern GPUs still lack the advancement; however, it is expected that the GPUs would become fast which would resolve this issue. Thus, it has limited capabilities of available AI & EW to perform crucial operations in analytics which will restrain the market growth.

Opportunities

I. Growing applications of AR, VR, Blockchain and AI

The increasing need for cutting-edge technologies like AR, VR, and AI is driving AI & EW demand since these applications require high-speed analysis for which the AI & EW are perfect option. In terms of performance and energy efficiency, AI & EW have overtaken other traditional workstations. Due to the pandemic’s profound impact on businesses worldwide, investing in digital transformation is advantageous for firms. According to Gartner, around USD 1.5 trillion is expected to be spent globally on digital transformation by 2022. Advanced AI & EW enable AR and VR experiences on the highest resolution, head mounted screens. The need for AI workstations is increasing as cloud technologies, machine learning, and deep learning are increasingly being used. Additionally, NVIDIA asserts that for AI workloads, GPUs are 20 to 25 times more energy-efficient than typical CPU servers. China and other nations make significant investments in GPU technology to develop their AI programmes.

Blockchain and artificial intelligence is transforming industries across globe. Blockchain is a solution to provide insights into AI’s framework and model to meet the challenge of transparency and data integrity may be through the immutable digital records. By storing and disseminating AI with an integrated audit trail, blockchain technology can improve data security and integrity. The Global Blockchain market is estimated to be USD ~11 Bn in 2022. The market is forecasted to reach USD ~71 Bn by 2025 at a CAGR of ~86%.

Challenges

I. High initial investments

The production of AI & EW has become more expensive and requires sophisticated machinery. Although the cost of the raw material is low, the companies must pay more in the beginning to create the testing and manufacturing lab. Depending on the type of requirement (e.g., abstract vs. figurative art), image resolution (HD vs. low-resolution output images), and deployment approach, the cost of building an AI & EW could reach $19-34 thousand. Research & development receives the bulk of the early expenditure, followed by production facilities, equipment, marketing, and events. The cost of production, the intricacy of the design, and the state of the market all have an impact on product pricing. Additionally, due to agreements between workstation suppliers and graphics makers, the prices of GPU remain constant. Thus, it is anticipated that NVIDIA and AMD graphics card costs would rise in the forecast period due to
rising demand of AI & EW. This would also be due to market’s extreme concentration and scarcity of GPU manufacturers.

7.5. **Key players in the Global AI Systems & Enterprise Workstations (AI & EW) market**

Table 17: Key players in the global AI Systems & Enterprise Workstations (AI & EW) market

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>HPE</th>
<th>AMD</th>
<th>Dell</th>
<th>NVIDIA</th>
<th>Lenovo</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Company Type (Public or Private)</strong></td>
<td>Public</td>
<td>Public</td>
<td>Public</td>
<td>Public</td>
<td>Public</td>
</tr>
<tr>
<td><strong>Headquarters</strong></td>
<td>Texas, USA</td>
<td>California, USA</td>
<td>Texas, USA</td>
<td>California, U.S.</td>
<td>Quarry Bay, Hong Kong</td>
</tr>
<tr>
<td><strong>Geographical Presence</strong></td>
<td>APAC, America’s, EMEA</td>
<td>Americas, EMEA, APJ</td>
<td>Americas, Europe, MEA, APAC</td>
<td>Operations in over 171 countries</td>
<td>Americas, APAC, EMEA, LA</td>
</tr>
<tr>
<td><strong>No. of Employees (as of 2022)</strong></td>
<td>~60,200</td>
<td>~25,000</td>
<td>~1,33,000</td>
<td>26,196</td>
<td>75,000</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>HPE</td>
<td>AMD</td>
<td>Dell</td>
<td>NVIDIA</td>
<td>Lenovo</td>
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</tr>
<tr>
<td></td>
<td>Display, Z40c G3 WUHD Curved Display</td>
<td>Acquisition</td>
<td>Alliances - To gain a competitive edge</td>
<td>Acquisition and Partnerships</td>
<td>Innovation</td>
</tr>
<tr>
<td><strong>Business Strategy</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Key Partnerships/ Mergers/ Acquisitions/ Innovation</strong></td>
<td>HPE acquires Determined AI to accelerate AI innovation with fast and simple ML modelling (2021), HPE and NVIDIA have collaborated to produce Engineering Virtual Workstation solution to optimize graphic-intensive workloads (2019)</td>
<td>AMD acquired both Xilinx [$49 billion] and Pensando [$1.9 billion] in 2022. With the acquisitions - AMD is expanding beyond its purview of CPUs and GPUs with a large portfolio of reprogrammable chips called FPGAs, that will significantly expand the company’s opportunities in data centers, embedded computing and telecommunications (Xilinx); Expands its Data Center Solutions Capabilities (Pensando)</td>
<td>-NA-</td>
<td>Excelero (Mar 2022), Bright Computing (Jan 2022), Oski Technology (Oct 2021) – The acquisitions will strengthen the company’s High-Performance computing, Digital ICs, and Enterprise Storage portfolio</td>
<td>Lenovo unveiled 25 new ThinkSystem and ThinkAgile server and hyperconverged solutions powered by Intel’s 4th Generation Xeon Scalable Processors as part of its recently announced Infrastructure Solutions V3 portfolio</td>
</tr>
<tr>
<td><strong>Revenue</strong></td>
<td>USD 28.5 Bn (2022)</td>
<td>USD 23.6 Bn (2022)</td>
<td>USD 101.2 Bn (2022)</td>
<td>USD 26.9 Bn (2022)</td>
<td>USD 62 Bn (2022)</td>
</tr>
</tbody>
</table>

Source: Annual reports, Frost & Sullivan Analysis

Note: Company revenues are at a consolidated level

Financial Calendar:

HPE: November - October; AMD: January - December; Dell: February - January; Nvidia: February - January; Lenovo: April - March
8. India AI Systems & Enterprise Workstations (AI & EW) Market
8.1. India AI Systems & Enterprise Workstations (AI & EW) Market Overview

The India AI Systems & Enterprise Workstations (AI & EW) market was USD 261.6 Mn in FY 2022. The market is forecasted to reach USD 333.6 Mn in FY 2023 and is expected to reach USD 1,456.4 Mn by FY 2029 with a CAGR of 27.8% over the forecast period (FY 2023-2029).

Exhibit 45: India AI Systems & Enterprise Workstations (AI & EW) Market (USD Mn) - FY 2019-2022E (Historical and Estimated years)

Source: Frost & Sullivan Analysis

Exhibit 46: India AI Systems & Enterprise Workstations (AI & EW) Market (USD Mn) - FY 2023F-2029F (Forecasted years)

Source: Frost & Sullivan Analysis

Indian AI Systems & Enterprise Workstations (AI & EW) Market Outlook

India’s AI and EW industry is expanding because of increased demand from a variety of end users. India is also experiencing growth in the studied market due to major manufacturers’ investments and product launches there. Government of India in the budget for Fiscal 2024 has announced that “for realizing the vision of “Make AI in India and Make AI work for India”, three centres of excellence for Artificial Intelligence will be set-up in top educational institutions. Leading industry players will partner in conducting interdisciplinary research, develop cutting-edge applications
and scalable problem solutions in the areas of agriculture, health, and sustainable cities. This will galvanize an effective AI ecosystem and nurture quality human resources in the field.” (Budget Speech, Minister of Finance, February 1, 2023.)

8.2. India AI Systems & Enterprise Workstations (AI & EW) Market by Application

India AI Systems & Enterprise Workstations (AI & EW) market by application is segmented into electronics, IT & Telecommunications, Defense & Intelligence, Media & Entertainment and Others. Maximum adoption of AI Systems & Enterprise Workstations (AI & EW) will happen in the IT & Telecommunications sector with a highest CAGR of 27.3% during the forecast period (FY2023-2029).

Exhibit 47: India AI Systems & Enterprise Workstations (AI & EW) Market by Application (USD Mn) - FY 2019-2022E (Historical and Estimated years)

Exhibit 48: India AI Systems & Enterprise Workstations (AI & EW) Market by Application (USD Mn) - FY 2023F-2029F (Forecasted years)
Defense & Intelligence - Defense and government activities are supported by AI & EW systems for enhanced decision-making and productive work performance in India. Additionally, it aids in enhancing government payment schemes that make precise, practical, and safe payments for child support, pensions, and unemployment insurance. The GPU that is an integral part of the AI & EW is utilised in government supercomputers and hyper converged infrastructure applications to boost mobility, increase security, and cut maintenance costs. Additionally, it fortifies the Cybersecurity position against an increasing number of online attacks. In the government IT sector, AI & EW solutions are utilised to provide seamless, secure, and dependable services, reduce costs, and boost operational effectiveness. The defence industry also makes use of it. The GPU-intensive AI is expected to be a key component of numerous military deployments. Typically, geospatial visualisation, video filters, and Geo-fuses FMV analytics with intelligence data, real-time full motion video, and WAMI augmentation and analytics, require the usage of defence and intelligence software. As a result, the segment's rise, which in turn propels the growth of the AI & EW market in the years to come, is being fuelled by the widespread deployment of AI & EW in government organisations.

Others – The Indian BFSI sector is dominating the global market in terms of technology adoption. In the financial services sector, next-generation GPU computing is creating new possibilities for intelligent, real-time analytics. The BFSI industry's usage of AI & EW for analytics and machine learning on massive, streaming datasets aids in the financial sector's ability to make more effective judgements. A growing number of applications in the banking and financial sector use AI and ML to improve client experience, portfolio management, risk management, automation, and process efficiency. As a result, it generates a lot of data that needs to be processed and examined with the use of AI & EW. Thus, growth prospects in the Indian BFSI industry are anticipated to drive the demand for AI & EW over the coming years.

Source: Frost & Sullivan Analysis
8.3. Market Drivers, Challenges & Opportunities

Drivers

I. AI driven workstations conveniently available as fully integrated AI hardware and software solution

Most of the purpose-built AI workstations are powered by at least four GPU’s. These GPUs deliver ~400-500 teraFLOPS (TFLOPS) of deep learning performance—the equivalent of hundreds of traditional servers—conveniently packaged in a workstation form factor built on technology. Most of the workstations available are water-cooled and whisper-quiet, fitting neatly under consumer’s desk. These workstations use deep learning software stack, so developers and researchers can experiment and tune their models, iterate fast, and deploy their work effortlessly on a workstation in the data center for larger-scale production training. These workstations are a great solution for organizations that want an integrated hardware and software solution, with full-stack optimization for maximized performance.

Challenges

I. Inability of integrated GPU to facilitate intensive graphic designing software

The use of integrated GPUs is widespread in wearables and portable electronics, including smartphones, tablets, laptops, handheld gaming consoles, and many more. They are compact, use less electricity, and lengthen the life of the apparatus. For applications like HD image processing and 3D or 2D gaming, these are perfect. However, if intensive graphic computation is required, integrated GPUs are not appropriate for platforms for artificial intelligence, supercomputers, play stations, and VR & AR systems. The inability of integrated GPUs to support intensive graphic designing software is anticipated to be resolved during the forecast period, despite the fact that key players in the market are conducting research to facilitate the advancement of integrated GPUs and make them compatible for high graphic processing.

Opportunities

I. Availability of Open-Source Solutions and Growing Applications Areas

The market is expected to develop faster than average throughout the projected period because of the growing trend toward open-source AI & EW solutions that offer analytical applications flexibility, high quality, much lower cost, and increased security. Adopting database solutions may have opportunities if specialised GPU solutions are used that enable high Q performance for computing in a particular vertical range. Nvidia introduced version 2.1 of its AI Enterprise software suite to allow the operation of AI and ML workloads for enterprise use cases. Nvidia AI Enterprise, a set of supported AI and ML solutions that run smoothly on Nvidia’s technology, became generally available in August 2021. Thus, Nvidia AI Enterprise 2.1’s improved support for open source is accelerating market expansion. The market is being driven by the expanding use of AI & EW across numerous applications. For instance, in February 2022, Uber unveiled AresDB, an open-source real-time analytics engine that uses graphics processing units (GPUs) as an unorthodox power source to handle the increasing demands of analysis at scale while also integrating, streamlining, and enhancing Uber's current solutions. Additionally, Cloudera, a provider of enterprise cloud data services, declared in April 2021 that Apache Spark 3.0 would
incorporate RAPIDS Accelerator into Cloudera Data Platform (CDP). As a result, the market is being driven by this expanding use across numerous applications.

8.4. Key players in the India AI Systems & Enterprise Workstations (AI & EW) market

Table 18: Key players in the India AI Systems & Enterprise Workstations (AI & EW) market

<table>
<thead>
<tr>
<th></th>
<th>NVIDIA</th>
<th>NetWeb</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Company Type</strong></td>
<td>Public</td>
<td>Private</td>
</tr>
<tr>
<td><strong>Presence in India</strong></td>
<td>Bangalore</td>
<td>Offices: New Delhi, Faridabad, Bangalore, Chennai, Kolkata, Hyderabad, Mumbai, Pune, Ahmedabad, Roorkee, Dehradun, Bhubaneswar, Gurugram</td>
</tr>
<tr>
<td><strong>No. of Employees (2022)</strong></td>
<td>~1000</td>
<td>~270 (March, 2023)</td>
</tr>
<tr>
<td><strong>Key Products/Services</strong></td>
<td>NVIDIA RTX Desktop Workstations, NVIDIA RTX in Professional Laptops, DGX Station, NVIDIA RTX Data Science Workstation</td>
<td>Tyrone Janus workstation Solutions</td>
</tr>
<tr>
<td><strong>Business Strategy</strong></td>
<td>Partnership and alliances</td>
<td>Partnership &amp; Innovation</td>
</tr>
<tr>
<td><strong>Key Partnerships/Mergers/Acquisitions</strong></td>
<td>IITH collaborated with Nvidia to kickstart AI tech center (2020), Expanded relationships with partners like Infosys, Tech Mahindra, Wipro, TCS, HCL, Persistent Systems and LTI to strengthen secure Hybrid Cloud ecosystem (2021), Nvidia partners with Deutsche Bank to encourage AI scope in Finance (2022)</td>
<td>NetWeb Technologies has partnered with NVIDIA for AI &amp; enterprise workstations</td>
</tr>
<tr>
<td><strong>Revenue</strong></td>
<td>USD 389.1 Million</td>
<td>USD 56.6 Mn (2022-23)</td>
</tr>
</tbody>
</table>

Source: Annual Reports, ROC, Secondary Sources, Frost & Sullivan Analysis
Note: Revenues are consolidated ones at company level,
USD = 78.6 INR (average exchange rate for Year 2022)
Financial Calendar: April – March 2021-22 (For NVIDIA)

Netweb is one of the first India OEMs to enter workstations market in India. Netweb provides new generation workstations that are optimized for applications requiring powerful graphics capabilities including rendering image processing, scientific and engineering tasks. Supporting scalable processors and multiple GPUs, these workstations provide high performance and
response while its memory modules expand the memory footprint per processor, boosting productivity for users across industries such as manufacturing, media and entertainment, and energy. Netweb’s workstations have efficient and rugged designs with a wide range of more than 50 models and wide application support across AI, CFD, MD, CAD/CAM along-with unique containerized application repository. Powered with rich multimedia features, these systems extend the use case to digital entertainment.

NVIDIA manufacturers primarily 2 types of workstations – desktop workstation and virtual workstation. NVIDIA desktop workstations provide unparalleled desktop experience with the world’s most powerful GPUs for visualization, featuring large memory, advanced enterprise features, optimized drivers, and certification for over 100 professional applications. NVIDIA virtual workstations supports NVIDIA RTX technology, bringing advanced features like ray tracing, AI-denoising, and Deep Learning Super Sampling (DLSS) to a virtual environment.

OpenAI’s launch of ChatGPT in late 2022 sparked a tidal wave of interest in all forms of AI, particularly Generative AI, and sparked a race among many companies to develop and implement their own chatbots powered by GenAI. As the market leader in graphics processing units (GPUs), Nvidia benefits from the increased demand for conventional AI and GenAI chatbots. For example, thousands of Nvidia GPUs were used to create OpenAI’s ChatGPT. In April, Tesla CEO Elon Musk also reportedly secured GPUs from Nvidia for his AI startup. These are specialized processors that can process large quantities of data more effectively and affordably than conventional semiconductors. GPUs are ideal for GenAI applications because GenAI models utilize enormous datasets and require significant computing capacity for training and content generation.
9. Global Data Centre Server Market
Scope & Definition

Data centers usually store, process, and manage data. They're more cost-effective than deploying and maintaining application software on individual client systems. Data centre servers are solutions that are designed to reduce the complexity of managing critical and heavy workloads. These servers can deploy & integrate different cloud services.

These servers are advanced AI powered that allow intelligent and efficient data processing and storage. They are most critical systems as they are essential for the continuity of daily tasks such as storage, continuity and processing.

9.1. Global Data Centre Server Market Overview

The global data centre server market was USD 103.5 Bn in FY 2022. The market is forecasted to be USD 113.6 Bn in FY 2023 and is expected to reach USD 198.3 Bn by FY 2029 with a CAGR of 9.7% over the forecast period (FY 2023-2029).

Exhibit 49: Global Data Centre Server Market (USD Bn) - FY 2019-2022E (Historical and Estimated years)

Source: Frost & Sullivan Analysis

Exhibit 50: Global Data Centre Server Market (USD Bn) - FY 2023F-2029F (Forecasted years)

Source: Frost & Sullivan Analysis
Businesses either operate on their own servers or rent them out from data centers, enabling them to store online files -- like those that make up a website -- and make them globally accessible. On the lower end, a small, in-house data center could have somewhere near 1000 servers. Most data centers are quite large, however, and a more typical number is close to 100,000 servers.

A server in a data center is essentially one of its most important components, as it is a specialized computer that handles computational workloads for the data center as one unit of many. Not only this, but the servers also communicate together to handle the demands of applications and storage via high-speed networking connections. These are two of the most important reasons why the adoption of data centre servers has grown over the years.

Major players operating in the global data centre server market are HPE, Dell Inc., Lenovo, IBM, Cisco, Inspur, Huawei Technologies.

9.2. Global Data Centre Server Market by Application

Over the years, data centre servers have witnessed adoption in the Government & Defence, BFSI, IT & ITES, Telecommunications, Media, and Oil & Gas sectors as these sectors deals with a huge amount of data. Usage of data centre servers for various transactions in the Government and Defense sector has only increased over the years and it has had the largest share in FY 2022, by application, and is expected to reach USD 55.5 Bn by FY 2029 at a CAGR of 9.0%.

Exhibit 51: Global Data Centre Server Market by Application (USD Bn) - FY 2019-2022E (Historical and Estimated years)

<table>
<thead>
<tr>
<th>Year</th>
<th>Government &amp; Defense</th>
<th>BFSI</th>
<th>IT &amp; ITES</th>
<th>Telecommunications</th>
<th>Media</th>
<th>Oil &amp; Gas</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>2019</td>
<td>78.3</td>
<td>1.6</td>
<td>11.7</td>
<td>16.0</td>
<td>23.5</td>
<td>2.3</td>
<td></td>
</tr>
<tr>
<td>2020</td>
<td>85.9</td>
<td>1.7</td>
<td>12.8</td>
<td>17.1</td>
<td>25.6</td>
<td>2.7</td>
<td></td>
</tr>
<tr>
<td>2021</td>
<td>94.3</td>
<td>1.9</td>
<td>13.9</td>
<td>18.7</td>
<td>27.9</td>
<td>3.1</td>
<td></td>
</tr>
<tr>
<td>2022E</td>
<td>103.5</td>
<td>2.1</td>
<td>15.0</td>
<td>20.4</td>
<td>30.4</td>
<td>3.6</td>
<td></td>
</tr>
</tbody>
</table>

Source: Frost & Sullivan Analysis
Government & Defence – IoT and 5G-based initiatives are being supported by governments all over the world, which will accelerate the use of advanced IT infrastructures. Advanced servers will be crucial for the adoption of compute-intensive technologies like IoT, 5G, and deep learning. The development of powerful servers that can handle massive amounts of data is anticipated to be given top priority by data centre operators, which will increase the demand for data centre servers over the forecast period (FY2023-2029).

For instance, IoT technologies—sensors, gateways, routers, applications, and the cloud—are enabling energy reduction and new business models in the fields of smart metering and EV charging. When it comes to the adoption of these technologies, Europe has been at the forefront. By 2026, it’s anticipated that 158 million new smart metres might be placed all throughout Europe. Smart metre adoption is increasing both in Europe and the US, but in Europe it is required by rules set by the EU and member states’ governments. According to the EU’s Energy Efficiency Directive (EED), all EU members must make a commitment to lowering greenhouse gas emissions and energy use. By 2027, all metres must be remotely readable, according to the EED. Metering service providers may streamline billing and reading procedures with IoT-enabled smart metres, and users gain precise insights into their consumption patterns, encouraging energy conservation and cost-cutting habits. Therefore, new cloud platforms and data centre servers are needed to support the millions of additional IoT (and IIoT) sensors and other endpoints, which will increase demand for data centre servers over the projected period.

BFSI - In the financial sector, data centres ensure that businesses have the control to meet all market and regulatory requirements necessary for the firm to operate efficiently. The ability for
users to access, distribute, and analyse their data more rapidly and effectively is increased by deploying to these high-performance IT environments. For instance, the Asian Infrastructure Investment Bank (AIIB), a multilateral bank, will invest $150 million in the construction of data centres that will mostly serve rising Asia. The ultimate closing of Keppel Data Centre Fund II is marked by AIIB’s investment of $100 million through a parallel fund structure and $50 million through co-investments (KDCF II). According to an article by Business Standard, the fund is concentrated on strategic investments in the rapidly expanding data centre industry with a concentration on Asia Pacific.

IT & ITES – IoT and 5G technologies, which will enhance the demand for data centre servers throughout the projected period. Through 2024, businesses from all industry sectors expect to invest an average of US$2 million in IoT (as per research conducted by Inmarsat, global mobile satellite communications provider). According to the survey, companies want to devote 10% of their IT resources to IoT initiatives over the next three years, an increase of 3% from the usual 7% budgeted between 2017 and 2020. Planned investments in IoT are notably higher than those earmarked for other Industry 4.0 technologies. IoT projects is expected to save organizations an average of 9% of their yearly costs.

Overall, the IoT provides a strong justification for all the expenditures made in big data analytics, global networks, cloud computing, data centres, and power-efficient devices. Out of Cisco's $49 billion in revenue, $2.4 billion comes from its 10,000 connected equipment clients (2020). IoT has the potential to generate $19 trillion in global economic value by 2024, according to estimates from Cisco Consulting Services. This value could be generated through new innovations, revenue streams, improved customer experiences, better asset utilisation, increased employee productivity, and effective supply chain and logistics operations. As a result, the market for data centre servers is anticipated to be driven by investments in IoT.

Telecommunications – The market size for data centre servers in the IT & Telecom sector is expected to reach USD 28.8 billion by 2029, driven by the increasing global adoption of the internet and smartphones. The increased use of social media platforms and optimized video content is growing data traffic, prompting businesses to incorporate committed and dependable data centre technologies to prevent data loss and maintain business continuity.

9.3. Global Data Centre Server Market by Geography/Region

Global data centre server market by geography is segmented into North America, Europe, Asia Pacific (APAC), South America, and Middle East and Africa (MEA). North America held the largest share (38%) in FY 2022 with a market size of USD 39.7 Bn and is expected to reach USD 73.4 Bn by FY 2029 at a CAGR of 9.2%. APAC emerged as the second largest region with a share of 37% in FY 2022 and a market size of USD 38.5 Bn in FY 2022.
The demand for robust data security and storage systems is expected to drive significant growth in the North American data centre server market through 2029. Utilizing cutting-edge technologies like IoT and AI, large-scale enterprises generate a lot of data flow across many networks. By 2023, there will be approximately 5 billion networked devices and connections in...
North America, up from the 3 billion connections made in 2018, according to the Cisco Annual Internet Report. The need for a reliable and high-performing data centre server will increase since MNCs in North America need a sizable infrastructure to handle the huge volume of data traffic.

Large-scale businesses are developing cutting-edge technologies for data centre servers to transform them into intelligent machines, including Cisco Systems Inc., Dell Technologies Inc., IBM Corp., ATOS SE, and NEC Corp. To construct data centre infrastructure that is effective, reliable, and high-performing when it comes to handling enormous amounts of data, they are working with other businesses to obtain their know-how.

There were around 8,000 data centres worldwide as of January 2021, according to statistics from 110 countries provided by CloudScene. Six of these host most data centres: the United States (33 percent of the total), the United Kingdom (5,7%), Germany (5,5%), China (5,2%), Canada (3,3%), and the Netherlands (3,4%). Additionally, roughly 64% of the data centres are in nations that are members of the North Atlantic Treaty Organization (NATO) and nearly 77% are in OECD member states.

9.4. Market Drivers, Restraints, Opportunities & Challenges

Drivers

I. Increased installation of hyperscale data centers

Installation of hyperscale data centres is significantly increasing throughout the world, particularly in North America. Massive-scale data operations require support from these data centres, which can be large. Hyperscale data centres are used by tech behemoths like Amazon, Google, IBM, Facebook, and Microsoft to extract and deliver enormous volumes of data. Due to the widespread use of their services by top-performing businesses in the region, many cloud service providers in North America are establishing sizable data centres. For instance, Google LLC declared in May 2021 that it intended to spend about $600 million to enhance its data centre infrastructure in Canada by buying a facility in Quebec. To support hyperscale data, the demand for data centre servers will increase.

II. Large-scale commercialization of 5G networks

Data centre server market growth has been positively impacted by the advent of 5G technology and the expanding commercialization of these networks. In terms of providing 5G technology to its clients, the U.S. is anticipated to keep a leading position. These networks are being widely adopted by four of the country's telecom pioneers: T-Mobile, Verizon Wireless, DISH Wireless, and AT&T Mobility. As a result of the adoption of 5G technology, businesses have had to develop cutting-edge, high-capacity data centre servers to handle the daily volume of data traffic. To manage the massive amount of data, this will increase demand for data centre servers.

Restraints

I. Cybersecurity threats

According to a 2022 article in cybercrime Magazine, by 2025 cybercrime will cost the global economy $10.5 trillion per year. One of the most serious reasons for data centre outage is
cyberthreats, such as phishing and ransomware attacks. Cyber criminals might gain access to sensitive data by taking advantage of organisational flaws, revealing crucial information and jeopardising business. There are other data-related flaws, such as the theft of private information, data alteration, or outright data loss.

According to a recent report by IBM on data breaches, hostile assaults are to blame for more than half (52%) of all data breaches. The underlying reasons are compromised credentials, phishing, cloud misconfiguration, vulnerability in third-party software, and physical security compromise. However, as of 2021, these dangers are no longer the most expensive malicious data breaches. From a cost perspective, Business Email Compromise is now at the top of the list, followed closely by Phishing and Malicious Insider. Therefore, it is essential to build reliable and trustworthy counterattack software to guard against future security breaches caused by dishonest people. To guarantee that the data is secure, it is also essential to establish a regular schedule for cyber security testing.

Cybersecurity threats therefore is one of the reasons leading to restricting the growth of the data center server market globally.

Opportunities

I. OTT services fuel the demand for micro data center servers

Micro data centre servers will be widely used by end users in North America. Consumers in the region are increasingly requesting over-the-top (OTT) streaming services. For instance, as of February 2021, Netflix Inc. had approximately 73.9 million paid customers in the United States and Canada. The COVID-19 pandemic has significantly changed how entertainment is consumed, forcing consumers to turn to internet services like Netflix, Amazon Prime, and Hulu. It has prompted numerous businesses in North America to put up mini data centre servers to provide fast virtual streaming services.

II. Demand of data centre servers in the BFSI sector

In North America, the BFSI industry will put up data centre servers to accommodate the burgeoning digital transformation age. Customers in the area are increasingly embracing contactless and online payments. For instance, a lot of banks in the US provide Fitbit Pay, enabling customers to make payments using their Fitbit devices. The BFSI sector’s players are deploying cutting-edge technologies to improve the banking experience for customers, which is creating a lot of data flow. To effectively handle the vast influx of information, banks and other financial institutions are increasing their investments in large-scale data centre infrastructure. These data centers will help the users in processing and supplying data in a safe and secure manner. They will offer the users high flexibility in data operations.

Challenges –

I. Power outages, natural element interference, outdated firmware, configuration settings, etc.

Adoption of data centre servers are restricted by factors that leads to loss of data, such as Power outages, natural element interference, outdated firmware, and configuration settings, etc.
Power outages - Surges and power failures instantly affect the power of the servers, which often causes a complete interruption of workflow and file access. In some cases, even when power is restored, it takes some time for the server to reboot; Natural element interference - When it comes to storing hardware, some businesses opt to place their servers in a less frequented place. This means moisture, dust build-up or heat could contribute to downtime. Aside from downtime, if the server is packed up due to an overload of heat or moisture, this poses a risk to the safety of employees if a short circuit occurs; Outdated firmware - The technology used daily performs well because of regular and frequent updates to the physical models. This applies to server hardware, too. Older server hardware models are more challenging to troubleshoot as the physical parts deplete over time and may function less effectively. Subsequently, slow and poor performance becomes a given. Configuration settings - One common technical error causing disturbances in business servers is the wrong configuration settings. In most if not all cases, servers require very precise and specific settings. Even if one small setting is incorrect, it could cause the entire system to remain offline.

9.5. Key players in the Global Data Center Server market

Table 19: Key players in the global Data Centre Server market

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>HPE</th>
<th>Cisco</th>
<th>Lenovo</th>
<th>Dell</th>
<th>IBM</th>
<th>Inspur</th>
<th>Huawei Technologies</th>
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<td>Company Type</td>
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<td>Public</td>
<td>Public</td>
<td>Public</td>
<td>Public</td>
<td>Public</td>
</tr>
<tr>
<td>Headquarters</td>
<td>Texas, USA</td>
<td>California, USA</td>
<td>Hong Kong, China</td>
<td>Texas, USA</td>
<td>New York, USA</td>
<td>Jinan, China</td>
<td>Shenzhen, China</td>
</tr>
<tr>
<td>Geographical Presence</td>
<td>APAC, America's, EU, MEA</td>
<td>Americas, EMEA, APJC</td>
<td>NA, SA, APAC, EU</td>
<td>America, Europe, MEA, APAC</td>
<td>Operations in over 171 countries</td>
<td>Present in over 120+ countries</td>
<td>Americas, APAC, China, EMEA, Other</td>
</tr>
<tr>
<td>No. of Employees (as of 2022)</td>
<td>~60,200</td>
<td>~83,300</td>
<td>~75,000</td>
<td>~1,33,000</td>
<td>2,88,300</td>
<td>~7,160</td>
<td>~1,95,000</td>
</tr>
<tr>
<td>Key Products/Services</td>
<td>Secure and agile servers, storage, networking, management and services, hybrid cloud data centre infrastructure</td>
<td>Data center computing - Cisco HyperFlex - HCI, Cisco Intersight Infrastructure Service, Cisco UCS - Servers</td>
<td>Data center networking - 400G data center and cloud networking, Cisco ACI, Cisco Nexus Dashboard, Cisco NX-OS,</td>
<td>Rack servers, tower servers, edge servers, mission critical servers, blade servers, high-density servers, software-defined infrastructure</td>
<td>Modular Data Center Micro 8-Series, DSS 8440 Machine Learning Server, DSS 7000 Storage Server</td>
<td>Linux servers - IBM® LinuxONE Emperor 4, IBM® Power® E1080, IBM® Power® E1050, IBM® Power® S1024, IBM® Power® S1022, IBM® Power® S1014</td>
<td>Rack servers, Multi-node server, rack scale systems</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>HPE</td>
<td>Cisco</td>
<td>Lenovo</td>
<td>Dell</td>
<td>IBM</td>
<td>Inspur</td>
<td>Huawei Technologies</td>
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<tr>
<td><strong>Business Strategy</strong></td>
<td>Partnerships</td>
<td>Product Launch</td>
<td>Partnership and product expansion</td>
<td>Partnership and Product Launch</td>
<td>Partnership</td>
<td>Partnership</td>
<td>Product Launch</td>
</tr>
<tr>
<td><strong>Key Partnerships/Mergers/Acquisitions</strong></td>
<td>GRC and HPE went into an OEM partnership agreement to integrate its ICEraQ liquid-immersion cooling system with HPE servers (2019), HPE and Ayar Labs announced a multi-year strategic collaboration to usher in a new era of data center innovation by developing silicon photonics solutions based on optical I/O technology (2022)</td>
<td>In June 2022, Cisco announced Cisco Catalyst and Cisco Nexus Cloud, two new cloud management services for its campus networking and data centre switch products, respectively</td>
<td>Lenovo Data Centre Group announced a range of new and updated HCI solutions and Lenovo Cloud Services to adapt their hybrid cloud strategy and modernize their data center infrastructure (2022), Lenovo launched dozens of new servers, storage systems and HCI appliances (2022) to strengthen its data center infrastructure portfolio</td>
<td>Dell launched PowerEdge servers with 4th Generation AMD EPYC processors with increased application performance and data storage (2022), Nvidia announced a new data center solution with Dell Technologies designed for the era of AI (2022)</td>
<td>IBM announced it was teaming up with SAP to provide technology and consulting expertise, which would allow migration to SAP S/4HANA® on IBM Cloud from on-premises data centers (2022), Inspur, jointly announced with the Open Compute Project (OCP) an OCP Standard Rack Server solution to help drive the transformation of traditional data centers to hyper-scale data centers based on open infrastructure (2018)</td>
<td>At APAC Digital Innovation Conference 2022, the company announced launch of new data centres in APAC</td>
<td></td>
</tr>
</tbody>
</table>

**Revenue (2022)**

<table>
<thead>
<tr>
<th>HPE</th>
<th>Cisco</th>
<th>Lenovo</th>
<th>Dell</th>
<th>IBM</th>
<th>Inspur</th>
<th>Huawei Technologies</th>
</tr>
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<tbody>
<tr>
<td>USD 28.5 Bn</td>
<td>USD 51.6 Bn</td>
<td>USD 62 Bn</td>
<td>USD 101.2 Bn</td>
<td>USD 60.5 Bn</td>
<td>USD 9.7 Bn</td>
<td>USD 92.3 Bn</td>
</tr>
</tbody>
</table>

Source: Annual reports, Frost & Sullivan Analysis
Note: The revenues are at consolidated company level

Financial Calendar:

HPE: November - October; Dell: February - January; Lenovo: April – March; Cisco: August – July; IBM: January – December; Inspur: April – March; Huawei: January - December
10. India Data Centre Server Market
10.1. India Data Centre Server Market Overview

The India data centre servers’ market was USD 3,264.8 Mn in FY 2022. The market is forecasted to be USD 3,414.0 Mn in FY 2023 and is expected to reach USD 4,563.5 Mn by FY 2029 with a CAGR of 5.0% over the forecast period (FY 2023-2029).

Exhibit 55: India Data Centre Server Market (USD Mn) - FY 2019-2022E (Historical and Estimated years)

Source: Frost & Sullivan Analysis

Exhibit 56: India Data Centre Server Market (USD Mn) - FY 2023F-2029F (Forecasted years)

Source: Frost & Sullivan Analysis

Indian Data Centre Server Market Outlook

India is reaching a turning point in its transition to a fully digital economy. Indian data centres would experience an increase in capacity with investments of up to Rs 1.20 lakh crore, according to an article from the Economic Times 2022 and a whitepaper from ICRA. The capacity of the Indian data centre industry is anticipated to grow by a factor of five as 3,900–4,100 MW of capacity are added overall. Large hyper-scalers like Amazon Web Services, Google, Microsoft, Facebook, IBM, Uber, and Dropbox are leading the growth of the Indian data centres (DC) market by outsourcing their storage requirements to independent DC providers.
Since the epidemic, India has seen a significant increase in the use of smart gadgets, IoT, and digital commerce. Because the country's youth are tech aware, it is projected that their use of digital devices will increase, producing a vast volume of data that would eventually necessitate the use of data centres and data centre servers. To secure the data of its customers, the Indian government has also suggested classifying the sector of data centres with key infrastructure, such as highways, trains, and power. Additionally, it is offering incentives for the construction of data centres, which is luring other enterprises to take advantage.

How Indian Data Centre Server Market has transformed over the years?

From being behind in the race for digital adoption, India currently has 161 data centres spread across 26 locations (as per datacentermap.com)

Strong data centres are required as India's digital population increases. India is dedicated to becoming a hub for global data centres and a digital economy. It is advancing technologically, and in recent years, a significant movement from traditional forms to the digital platform has taken place. The transition is seen in everything from e-payment to digital universities, from roadways to Krishi platforms. In addition, the government is concentrating on developing a digital talent ecosystem in accordance with market demands.

In the budget for 2022, it was stated that farmers would receive digital and high-tech services in a PPP model for the agriculture and food processing industries. It was also stated that a digital university would be established and that the National Digital Health Ecosystem would be implemented in the health industry. Additionally, 75 Digital Banking Units will be established by Scheduled Commercial Banks in 75 districts, and 100% of post offices will be connected to the core banking system, among other things. Additionally, it was suggested in the budget that data centres and energy storage systems be added to the unified list of infrastructure.

Considering this, the Ministry of Electronics and Information Technology put forth a draft data centre policy in 2020 with the goal of making India a global hub for data centres, encouraging investment in the field, fostering the expansion of the digital economy, enabling the provision of reliable hosting infrastructure, and facilitating the provision of cutting-edge services to the public.

Driven by several factors, including the data explosion brought on by the massive digitisation efforts spearheaded by the pandemic, internet penetration to the last mile, cloud adoption, the transformation of business processes using emerging technologies, such as AI/ML, IoT, Big Data and Analytics, 5G, etc., and evolving digital customer engagements, among others. These tendencies affect all organisations, regardless of size or sector, including all tiers of government. They are not exclusive to any industry. The Data Protection Bill, which may soon become law, may lead to a significant onshoring of Indian citizen's data from offshore data centres to Indian data centres (as stored on the servers of social media platforms, gaming platforms, etc., where Indian users make up a significant percentage of users). This presents a significant opportunity for the Indian data centre industry and will ultimately drive India data centre server market during the forecast period (FY2023-2029).
Tier 2 and Tier 3 cities, for instance, are virtually untapped in terms of data centre investments in India, according to a whitepaper from Yotta Data Services Pvt. Ltd. However, they are now being recognised as important places for setting up Edge Data Center networks and Disaster Recovery sites. For instance, Yotta Infrastructure intends to spend Rs. 900 crores over the course of three to four years to build 100 Edge data centres throughout the nation. Tier 2 and Tier 3 cities, including Nagpur, Coimbatore, Ranchi, and Jaipur, are the focus of the first phase.

A. Investments:

In direct proportion to the growth in data consumption and acceptance of the cloud, the necessity for data centres increased tremendously. A JLL study found that to achieve the six million square feet of development, the Indian data centre industry will need to invest USD 3.7 billion in total over the next three years. Indian firms are optimistic about data centres despite the significant capital required. The Adani group pledged INR 8,000 crore in April 2022 to the construction of a cutting-edge data centre at Rajarhat in West Bengal. The complex will be erected on a 51.8-acre plot of land over the course of three years. The plot's size is more than the data centre being built by Reliance as part of the Bengal Silicon Valley project.

Adani Group said in July 2022 that it would invest up to INR 70,000 crore to create solar-powered data parks in Andhra Pradesh. Global tech behemoths began collaborating with Indian conglomerates as cloud adoption accelerated in India to take advantage of the potential.

Oracle announced Gen 2 cloud locations in Hyderabad and Mumbai for 2019. Microsoft and Reliance Industries have partnered to offer cloud services to the nation's small and medium businesses. Yotta Infrastructure was established by Hiranandani Group to construct data centres in Mumbai and Chennai. The real estate firm intended to invest INR 14,000 crore over a five- to seven-year period. The firm stated that it would increase its investment in Yotta by the end of 2021.

With data centres slated for Chennai, Mumbai, Noida, Vizag, and Hyderabad, the Gautam Adani-led business has established a 50-50 joint venture with US-based EdgeConneX. The group has received approval for its 409-acre project close to Vizag. The corporation declared last November that it will invest USD 70 billion in renewable energy by 2030 and that it would use green energy to run its data centres. According to reports, renewable energy would also be used to power the Rajarhat complex.

B. Government support:

The Indian government is doubling down on digital initiatives to create conducive conditions for data centres. The big push towards data localisation would ensure 75% of the data remains within the country.

Sensing the prospects in the industry, the Ministry of Electronics and Information Technology, or MEITY, created a data centre policy in 2020 that accords data centres an equivalent level of "infrastructure status" to that of highways, railroads, and power. The new policy intends to streamline the data centre clearance procedure. Right now, opening a data centre in the nation requires up to 40 clearances. Cloud data centres would be designated as special economic zones, or SEZs, according to MEITY. Land, water, and power would be provided by the government to
make doing business easier. States like Maharashtra, Telangana, Karnataka, and Uttar Pradesh also provide concessions on land costs for data centres, as well as exemptions from stamp and electricity duty.

10.2. India Data Centre Server Market by Application

India Data Centre Server market by application is segmented into Government & Defence, BFSI, IT & ITES, Telecommunications, Media, Oil & Gas, and Others. Government and Defense application held the largest share in FY 2022 and is expected to reach USD 912.7 Mn by FY 2029. Maximum adoption of data center server will happen in the BFSI sector with a highest CAGR of 11.4% during the forecast period.

Exhibit 57: India Data Centre Server Market by Application (USD Mn) - FY 2019-2022E (Historical and Estimated years)

Exhibit 58: India Data Centre Server Market by Application (USD Mn) - FY 2023F-2029F (Forecasted years)
**Government**

The number of e-Governance Projects being launched by the Government has increased over the years. This has led to the growth of data centres and servers in the country. Examples of e-governance projects include Digital India initiative, National Portal of India, Prime Minister of India portal, Aadhaar, filing and payment of taxes online, digital land management systems, Common Entrance Test etc. Some of the recent Government initiatives to promote e-Governance in India are - MyGov Initiative, National Scholarships Portal (NSP), Darpan Portal, DigiLocker, National Center of Geo-informatics, National e-Governance Plan.

Data Centers are the backbone of a digital revolution. The Government of India’s proposed Draft Data Center Policy aims to make India a ‘Global Data Center Hub’. This will provide long-term funds for investments in the sector. State Governments have also been providing incentives to industry players for setting up data center parks. The synergy of technology, legislation, demand, and investments is expected to usher in an era of high growth for India’s DC industry in coming years and government is going to play a vital role in this.

**BFSI**

Indian BFSI institutions are enhancing their competitiveness by utilising the cloud. As an illustration, many financial institutions currently use cloud-based AI-based algorithms to better detect fraud and handle complex consumer enquiries. Customer service has been altered by cloud. Customers frequently use AI-based chatbots that are hosted in the cloud today to receive answers to their complicated questions. Insurance service providers also utilise chatbots to automatically settle disputes. The damage to the car is automatically estimated and approved by insurers utilising AI-based underwriting tools. Like this, insurance firms can use IoT to reduce premiums for drivers who follow safe driving practises by monitoring their habits with sensors.

Many BFSI institutions today exploit the capabilities of the cloud for a range of use cases, including:

- Utilizing AI-driven underwriting to issue loans to unsecured enterprises as soon as possible.
- Using AI to develop a recommendation engine that is tailored to each customer.
- Conducting credit-risk simulations to assess the stability of clients’ finances.
- Migrating workloads to assure global presence and increase operational efficiencies.
- Using automation to cut expenses and make optimal use of developing technologies.

Large businesses, like banks, are increasingly utilising the services of cloud-based data centres. The majority of BFSI consumers now use the cloud in some capacity, although banking institutions were hesitant to make the switch in the past. Banking institutions are also using the cloud for improving their infrastructure-related security (cloud-based firewalls, IPS systems, backup systems in the cloud etc.) and application security (cloud-based penetration testing, vulnerability scanning etc). Banks can choose from four alternative cloud adoption models, each with a different level of security risk: private cloud, community cloud, public cloud, or hybrid cloud. Indian institutions are currently experimenting with private clouds, prioritising security
over cost and scalability. To retain sensitive data inside bank firewalls and to comply with laws, some major banks have already migrated their core services to the cloud and employed private or hybrid cloud models with leading providers like Amazon and Microsoft.

10.3. Market Drivers, Restraints, Opportunities & Challenges

Drivers

I. China plus one and make in India promoting growth

Government measures aimed at driving digital infrastructure growth, including the Digital India initiative. Some of the digital India initiative programmes are: DigiLocker, E-hospitals, E-Pathshala, BHIM etc. Digital India Initiative Benefits include: 1) Encouraging growth of electronic transactions related to e-Government; 2) As part of the Bharatnet programme, over 1.1 lakh gramme panchayats are connected by an optical fibre measuring 2,74,246 kilometres; and A common service centre that offers access to information and communication technology has been established by the government as part of India's national e-governance project. 3) Internet accessibility has made it simpler for the common service centre to provide multimedia content related to e-governance, education, health, telemedicine, entertainment, and other public and private services. 4) The internet is mostly used for service delivery, and metropolitan regions have a 64% internet penetration rate. The Indian government is looking to turn India into a hub for global data centres. Moreover, Smt. Nirmala Sitharaman, the Union Minister for Finance and Corporate Affairs, suggested including data centres and energy storage systems in the unified list of infrastructure in the Union Budget 2022–23. China plus one strategy is another important factor that includes diversifying the investment from China in the business sector and looking for alternative destinations. China Plus One strategy of diversifying manufacturing and production to new locations has gained momentum since the pandemic. Supply chain disruptions amidst COVID-19 lockdowns, rising labour costs and growing strategic concerns around the concentration of production, have provided a fresh impetus to this shift. All these factors are expected to drive the requirement of data centres and data centre servers.

II. Government measures aimed at driving digital infrastructure growth (Classification of data centers as infrastructure assets)

The government of India classified data centres in the country as ‘infrastructure’ from 1 April 2022. The decision intends to simplify the process of raising money for data centres through loans and investments. This list of infrastructure will include data centres and energy storage systems, including dense charging infrastructure and grid-scale battery systems. This will make it easier to get credit for sustainable energy storage and digital infrastructure. Since banks have relaxed their requirements for maintaining capital sufficiency for infrastructure lending, classifying data centres will ensure better access to capital borrowings at a lower rate.

Restraints

I. Power usage rules

The ecosystem surrounding data centres must deal with "exorbitantly expensive" power expenses. While the power consumption (critical IT load) of a data centre range from 15 Mw to
100 Mw, the average power demand of a district is roughly 500 Mw. It is difficult to create a data centre in a mixed-use power zone or even in an industrial estate since, according to Nasscom, a power distribution network is typically not intended to fulfil this kind of demand in such an area. According to executives in the industry, the difficulties facing the data centre industry are exacerbated by restrictions on the maximum capacity for power banking and commissioning power from solar plants, as well as delays in obtaining necessary high tension power connections.

Opportunities

I. Data Centres for Banks and Financial Institutions

A digital economy's fundamental building elements are data centres. An organization's important information technology (IT) applications are hosted in a data centre, which also supports network and security operations. The IT infrastructure for storing and processing online transactions is hosted at a backend data centre, where everything that occurs online is transmitted back and forth. To operate the computers and keep the data centre at the ideal temperature using powerful air conditioning systems, these facilities must operate continuously and require a tremendous amount of power. The need for dedicated data centres with cutting-edge technology is rising as banks and other financial institutions employ IT solutions more and more in their core business activities. The rise of the retail payment system Unified Payments Interface (UPI), the availability of the National Electronic Funds Transfer (NEFT) System around-the-clock Real Time Gross Settlement System (RTGS), and other factors are projected to lead to further growth in this area.

Challenges

I. Lack of clarity around building codes

Data centres and energy storage devices, such as grid-scale battery systems and dense charging infrastructure, have been proposed for inclusion in the budget's unified list of infrastructure. This is done to make it easier to get credit for sustainable energy storage and digital infrastructure. Typically, data centres require sizable, enclosed spaces with high cooling needs. They must have storage for fuel and electricity supplies even though they only contain a small portion of the people intended for commercial buildings. However, they have been classified as commercial structures, which has caused delays in several safety approvals. Together with organisations like the Bureau of Construction Statistics, Nasscom has been requesting actions to reduce construction-related delays as part of the 2021 MeitY working group for the adoption of a building code for data centres.

10.4. Key players in the India Data Centre Server market

Table 20: Key players in the India Data Centre Server market

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Company Type</th>
<th>HPE</th>
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<th>Dell</th>
<th>NetWeb</th>
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<th>IBM</th>
<th>Dell</th>
<th>NetWeb</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Over 19 offices, present in 6+ cities in India</td>
<td>1 manufacturing center, Head office in India - Bangalore</td>
<td>Headquarters in Bangalore. Present in 20 more cities in India</td>
<td>Present in 8 locations in India</td>
<td>Present in New Delhi, Faridabad, Bangalore, Chennai, Kolkata, Hyderabad, Mumbai, Pune, Ahmedabad, Roorkee, Dehradun, Bhubaneswar, Gurugram</td>
</tr>
<tr>
<td>No. of Employees (as of 2022)</td>
<td>~30,000</td>
<td>~1,001 to 5,000</td>
<td>~1,50,000</td>
<td>~25,000</td>
<td>~270 (March, 2023)</td>
</tr>
<tr>
<td>Key Products/Services</td>
<td>HPE ProLiant servers, HPE Alletra 4000 servers, HPE Apollo 4000 servers</td>
<td>IdeaCentre AIO 5i (Intel), IdeaCentre 3i Gen 7 (Intel), IdeaCentre AIO 3i (24, Intel), ThinkCentre Neo 50s (Intel) SFF, ThinkCentre M75t Gen 2, ThinkCentre Neo 501 Tower (Intel)</td>
<td>Modular Data Center Micro 8-Series, DSS 8440 Machine Learning Server, DSS 7000 Storage Server</td>
<td>Rack, tower, modular, rugged servers</td>
<td>Data Center Server – Camarero series</td>
</tr>
<tr>
<td>Business Strategy</td>
<td>Collaboration, Partnerships</td>
<td>Investments</td>
<td>Partnership</td>
<td>Partnership</td>
<td>Partnership</td>
</tr>
<tr>
<td>Key Partnerships/Mergers/Acquisitions</td>
<td>Sify Technologies partners with HPE to strengthen cloud computing services in India (2022)</td>
<td>In 2018, company decided to invest in R&amp;D on artificial intelligence to expand data centre business in India</td>
<td>In April 2020, the company partnered with Tamil Nadu Newsprint and Paper Limited to upgrade its data centre with IBM POWER9 series of servers</td>
<td>In October 2022, Dell collaborated with PhonePay to launch green data centre in India</td>
<td>Netweb’s Partnership with technology providers like Intel, AMD, &amp; Nvidia</td>
</tr>
<tr>
<td>Revenue</td>
<td>USD 532.8 Million (FY2021-22)</td>
<td>USD 1316.5 Million (FY2021-22)</td>
<td>USD 3189 Million (FY2020-21)</td>
<td>NA</td>
<td>USD 56.6 Mn (FY2022-23)</td>
</tr>
</tbody>
</table>

Source: Annual Reports, ROC, Secondary Sources, Frost & Sullivan Analysis
Note: Revenues are consolidated ones at company level,
USD = 78.6 INR (average exchange rate for Year 2022)
Financial Calendar: April – March 2021-22 (For all companies except IBM, NetWeb)

India is quickly gaining sovereignty in the development of sophisticated business process computing technologies. Such success largely owes itself to the considerable boost from cutting-edge technologies made by Indian IT manufacturing enterprises.

In terms of competition HPE, Lenovo, Dell and IBM are the major competitors of Netweb in for data centre server market in India. HPE provides a complete data centre infrastructure operative task across IT and facilities. They provide insights for servers, where admin can deploy hotfixes on ProLiant Gen 10 servers or later without manually downloading SPP or hotfix components. Further, they have improved their login experience over the years. On the other hand, IBM
provides IBM Cloud for data centre servers, that allow data centres in different regions to deploy their resources. Further, Dell provides agile and efficient data centre server solutions. For instance, Twelfth-generation Dell PowerEdge servers are designed to optimize energy efficiency, streamline management, and enhance compute power for heightened application performance, with abundant memory capacity to support virtualization and increasingly complex workloads.

Netweb has come up with path-breaking innovations in their data center server capabilities. The company is capable of manufacturing servers suitable for building private cloud solutions, High-Performance Computing Clusters, and modern data centres. Netweb has consistently focused on developing products that start with made-in-India servers. As a result of this, the company also bagged an award from the Ministry of Electronics & IT (MeitY) in contribution to the manufacturing of servers in India. Netweb delivered a state-of-the-art supercomputing facility at IIT Jammu which is a unique blend of HPC, Big Data, AI, and Cloud Infrastructure.

Netweb is one of the few OEMs in India eligible to seek production linked incentives in terms of the Government of India’s IT Hardware for the manufacturer of servers and Networking and Telecom PLI Schemes for the manufacture of networking and telecom products.
11. Global Enterprise STORAGE Systems Market
Scope & Definition

Enterprise storage is a centralized repository for business-critical information that provides data sharing, data management and data protection across multiple (and often dissimilar) computer systems.

Enterprise storage comprises of High-performance storages such as cloud storage & high-performance storage area network (SAN). They are a storage management system designed for moving large files and large amounts of data around a network. High performance storage is especially valuable for moving around large amounts of complex data or unstructured data like large video files across the network. Used with both direct-connected and network-attached storage, high performance storage supports data transfer rates greater than one gigabyte per second and is designed for enterprises handling large quantities of data - in the petabyte range.

11.1. Global Enterprise Storage Systems Market Overview

The global Enterprise Storage Systems market was USD 63.0 Bn in FY 2022. The market is forecasted to be USD 65.0 Bn in FY 2023 and is expected to reach USD 78.8 Bn by FY 2029 with a CAGR of 3.3% over the forecast period (FY 2023-2029).

The most popular and widely used technique of storing digital data is enterprise storage. It serves as a central store for corporate data and offers connectivity to other computer systems as a shared resource for data sharing, management, and security. It is intended to process significant workloads of important business data.

Exhibit 59: Global Enterprise Storage Systems market (USD Bn) - FY 2019-2022E (Estimated and Historicalyears)

Source: Frost & Sullivan Analysis
Enterprise storage system, created as a solution for businesses dealing with significant workloads of mission-critical data, is anticipated to be expandable for workloads of up to 300 gigabytes without relying on excessive cabling or the development of subsystems. The business storage system's limitless connectivity and support for all the active platforms are additional crucial features.

Instead of using a distributed enterprise storage system, enterprise storage systems use storage area networks (SANs), which offer advantages like high availability and disaster recovery, data sharing, effective, dependable backup and restoration functions, centralised administration, and remote support. Multiple paths are established to all data through the corporate storage area network (SAN), ensuring that access to crucial data is never lost in the event of a server failure.

Direct-attached storage (DAS) systems, network-attached storage (NAS) systems, storage area networks (SAN) systems, software-defined storage systems, and cloud storage systems are a few prominent categories of enterprise storage systems. DAS - DAS is a type of data storage that may be accessed by connecting an external drive directly to a computer. Examples include external HDDs, which need to be linked to a computer through a connection, and SSDs, which utilise either a cable or a motherboard M.2 connector. One of the least adaptable techniques of data storage is DAS. It cannot be scaled. NAS - NAS devices hold hard drives with stored files, such as documents, videos, music, and photos. A couple of the best NAS devices even support M.2 SSDs. NAS is a good choice for businesses that want lower storage costs than what cloud providers will offer. NAS is a good choice for smaller enterprises that need on-premises backups. SAN - SAN are high-speed data storage networks created between a group of specified devices. These devices can be in multiple locations. SANs are popular with businesses that need to store important applications, such as databases, and need fast connection to those applications. SANs are also a good choice for enterprises because the size of the network is scalable. Software Defined Storage (SDS) is a flexible storage option, for companies with data centers, as it allows more hardware options. SDS infrastructure can run on a variety of hardware. Cloud Storage - Cloud storage makes stored data accessible from a distance in such a way that it’s backed up and
still available if hardware fails. Cloud storage is more scalable than on-premises server storage. It’s available from more than one location and backs up the data, providing more safety in case of disaster.

The most popular storage networking architecture used by businesses for mission-critical applications requiring high throughput and low latency is called a storage area network (SAN). When compared to spinning disc, all-flash storage offers superior performance, consistent low latency, and lower total cost, and its use in SAN deployments is rapidly increasing. SANs give businesses the ability to use uniform approaches and tools for security, data protection, and disaster recovery because data is stored in centralised shared storage.

About two-thirds of the market for networked storage is made up of SANs. SANs are made to be highly available and resilient by eliminating single points of failure. A SAN with good design may readily endure the breakdown of several devices or components.

Storage area networks (SANs) have been increasingly popular in enterprise data centres in recent years and are demonstrating their efficiency in serving a variety of applications across a wide range of sectors. Performance, dependability, and versatility of SAN storage are highly praised. The majority of large businesses consider SAN to be a crucial asset since it offers improved performance and greater capacity due to quicker networks, more potent processors, and solid-state storage. Simplifying Storage Migration is one of the most notable advantages of SAN storage solutions.

Applications that require high performance and are business-critical typically use storage area networks, such as:

Oracle databases - These usually require the greatest levels of performance and availability since they are business-critical.

Microsoft SQL Server databases - Similar to Oracle databases, MS SQL Server databases frequently house the most valuable data in an organisation, therefore they demand the highest levels of performance and availability.

Large virtualization deployments using VMware, KVM, or Microsoft Hyper-V - Thousands of virtual machines frequently make up these environments, which are home to a variety of operating systems, applications, and applications with various performance requirements. Because many applications are concentrated in virtualized environments, infrastructure dependability is even more crucial because a failure might result in many application failures.

Large virtual desktop infrastructures (VDIs) - These environments frequently consist of tens of thousands of virtual machines, each of which is running a separate operating system and application with a different set of performance requirements. Because virtualized settings concentrate several applications, infrastructure stability is even more crucial because a failure can result in the loss of several applications.

SAP or other large ERP or CRM environments - Enterprise resource planning and customer resource management workloads are perfect for SAN infrastructures.

Major players in this space are Dell Technologies, HPE Incorporated, NetApp, Lenovo, Hitachi Data Systems Corporation.
11.2. Global Enterprise Storage Systems market by Application

Global Enterprise Storage Systems market by application is segmented into Government & Defence, BFSI, IT & ITES, Telecommunications, Media, Oil & Gas, and Others. Telecommunications application in the enterprise storage systems had the largest share in FY 2022 and is expected to reach USD 23.6 Bn by FY 2029 at a CAGR of 2.5%.

Exhibit 61: Global Enterprise Storage Systems market by Application (USD Bn) - FY 2019-2022E (Estimated and Historical years)

Exhibit 62: Global Enterprise Storage Systems market by Application (USD Bn) - FY 2023F-2029F (Forecasted years)
Telecommunication – As per AI Multiple, the telecommunication sector is a ~$1.5 trillion market that makes communication possible worldwide. Massive improvements to wireless and wired connectivity across mobile networking, Wi-Fi, and broadband are causing the global telecommunications industry to experience a time of fast transition. Fresh commercial prospects and new technologies are brought about by faster networks and increased capacity. For telecommunications organisations, the advantages of digital transformation include better customer experiences, data-driven insights, agile networks, and automation. The telecoms industry is changing because of digital technologies like conversational AI platforms and artificial intelligence.

NAS for data mobility, storage virtualization, backup, and recovery across the industry is the segment's growth driver. Digital media material, which includes user-generated audio files, photos, documents, videos, and other digital content, is expanding quickly in this sector. Since the data is significant to both the supplier and the customer, telecom firms have an increased need for dependable and secure data storage solutions.

11.3. Global Enterprise Storage Systems market by Geography/Region

Global Enterprise Storage Systems market by geography is segmented into North America, Europe, Asia Pacific (APAC), South America, and Middle East and Africa (MEA).

Exhibit 63: Global Enterprise Storage Systems market by Geography/Region (USD Bn) - FY 2019-2022E (Estimated and Historical years)

Source: Frost & Sullivan Analysis
North America region holds the largest share in 2022 and is expected to reach USD 35.5 Bn by FY 2029 at a CAGR of 2.6%. The North America enterprise storage systems market, specifically NAS market presents significant opportunities due to rising number of colocation data centers in the region. The growth of the NAS market in the region is also attributed to the increasing unstructured data generated from mobile computing devices such as smartphones, PC’s, and laptops.

APAC is expected to witness a growth CAGR of 4.7% during the forecast period (FY2023-2029). The expansion of micro, small, and medium-sized enterprises (MSME’s) across the APAC area is what is fuelling its growth. Small and medium-sized enterprises (SME) made up 99.6% of all businesses in Asia in 2021, according to the Asian Development Bank (ADB) report, Asia Small and Medium Sized Enterprise Monitor 2021. The region's high concentration of MSMEs has increased the production of unstructured data volumes, necessitating the use of contemporary data storage solutions to keep secure backups across IT infrastructures. The usage of NAS enterprise storage systems/solutions in MSME’s throughout APAC is anticipated to increase as a result in the upcoming years.

### 11.4. Market Drivers, Restraints, Opportunities & Challenges

Cloud storage, hyper-converged storage, and flash technologies like non-volatile memory express (NVMe) are some of the more recent enterprise storage strategies and technologies that have seen growth over the past several years. Additionally, the need for storage for containers is growing, and enterprise storage based on composable, and disaggregated infrastructure principles is beginning to gain traction. Additionally, soon, enterprise storage should be
significantly impacted by storage-class memory (SCM), artificial intelligence (AI), and machine learning in the field of predictive analytics.

Drivers
I. Increased Adoption of Enterprise Cloud Storage

A public cloud service provider's storage space is used for enterprise cloud storage. Businesses frequently use cloud storage to modernise data centre infrastructure, lower or eliminate exorbitant on-premises storage expenses, and simplify storage management. Microsoft Azure, Google Cloud, and Amazon Web Services (AWS) are the three main public cloud storage providers. Others include a slew of local service providers, Alibaba Cloud, Netweb, IBM's Bluemix, Oracle, and Rackspace. Many traditional software businesses now offer cloud storage services for their programmes and services, in addition to systems integrators, managed providers, and other cloud service providers. Finally, cloud gateway providers like Panzura have integrated management as a service (MaaS) into their products, and storage management providers have also done the same. As a result, the market for enterprise storage systems is anticipated to be driven by the uptake of enterprise cloud storage.

Restraints
I. Performance related issues associated with enterprise storage systems

Low performance and problems expanding the system capacity in comparison to SAN and DAS are the key factors holding back the adoption of enterprise storage systems, particularly NAS solutions. The NAS has limited resources; as NAS users visit the system more frequently, it gets slow and has performance problems. Due to the need for specialised NAS protocols like server message blocks (SMB) and network file systems, these systems cannot scale up or out quickly (NFS). Due to issues with high latency and limited throughput, these protocols are too slow for high performance applications. Furthermore, NAS depends on networks, and files are shared across a local area network (LAN). The LAN network transfers data from one location to another through the data pockets by dividing them into several parts and sending them to any terminals. However, if the data pocket gets delayed or sent out of order, the file may not open correctly.

Opportunities
I. Increasing Adoption of Disaggregated and Composable Storage

The development of HCI is thought to progress to composable infrastructure and disaggregated infrastructures in the future. They maintain the advantages of hyper-convergence, such as the ability to physically combine computing resources into a framework that is easily expandable via nodes, while making it simpler to independently add more storage and computation gear. The process of disaggregation involves breaking down various computer components into independent pools of CPU, cache, fabric, memory, and storage resources that may be made available to certain applications on demand. It integrates these discrete resources at the hardware level and then assembles them using application programming interfaces at the software level (APIs). Consumable hardware resource sets are created or composed by composable infrastructure, which then integrates them into a virtualized whole. Composable infrastructure therefore combines these distinct pools of resources into a single virtual
infrastructure unit that a software entity manages, as opposed to disaggregating these components, including storage, into virtual resources at the hardware level and then serving storage, memory, and compute up separately using software like disaggregated infrastructure. Therefore, the market for enterprise storage systems has a huge opportunity because of the advantages of disaggregated and composable storage that are driving up adoption.

**Challenges**

I. **Lack of proper infrastructure to secure data**

Since the world is currently moving toward digitization, data has become a new asset. Enterprises are under pressure from increased data volume to invest in suitable infrastructure for securing and utilising the data generated. Data loss or theft is a possibility when there is insufficient infrastructure. It can often be more expensive for businesses to implement an appropriate infrastructure. However, enterprises are being forced to make suitable infrastructure investment plans because of the rising demand for data protection. Additionally, the IT teams are having trouble setting up the infrastructure because of cases of work from home and hybrid work practices. Therefore, one of the biggest obstacles to the expansion of the NAS market is a lack of adequate infrastructure.

### 11.5. Key players in the Global Enterprise Storage Systems market

**Table 21: Key players in the global Enterprise Storage Systems market (1/2)**

<table>
<thead>
<tr>
<th>Company Type</th>
<th>HPE</th>
<th>NetApp</th>
<th>Lenovo</th>
<th>Dell</th>
<th>HITACHI Data Systems corporation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headquarters</td>
<td>Private</td>
<td>Public</td>
<td>Public</td>
<td>Public</td>
<td>Tokyo, Japan</td>
</tr>
<tr>
<td>Geographical Presence</td>
<td>APAC, America's, EU, MEA</td>
<td>Worldwide</td>
<td>NA, SA, APAC, EU</td>
<td>Americas, Europe, MEA, Asia</td>
<td>Present in 26 countries</td>
</tr>
<tr>
<td>No. of Employees (2022)</td>
<td>60,200</td>
<td>12,000</td>
<td>~75,000</td>
<td>~1,33,000</td>
<td>3,68,247</td>
</tr>
<tr>
<td>HPE</td>
<td>NetApp</td>
<td>Lenovo</td>
<td>Dell</td>
<td>HITACHI Data Systems corporation</td>
<td></td>
</tr>
<tr>
<td>-----</td>
<td>--------</td>
<td>--------</td>
<td>------</td>
<td>---------------------------------</td>
<td></td>
</tr>
<tr>
<td><strong>Business Strategy</strong></td>
<td>Partnership and Acquisition</td>
<td>Partnership and Product Launch</td>
<td>Partnership</td>
<td>Product Launch</td>
<td></td>
</tr>
<tr>
<td><strong>Key Partnerships/Mergers/Acquisitions</strong></td>
<td>HPE acquired Nimble Storage bolstering a higher growth segment of the market for data storage (2017), HPE partnered with Systel, Inc. to explore opportunities to strengthen storage, and edge compute solutions (2022)</td>
<td>NetApp launched BlueXP a unified control plane delivering a simple hybrid multicloud experience for storage and data services across on-premises and cloud environments (2022), Partnered with Kyndryl to co-design advanced storage infrastructure-as-a-service solutions (2022)</td>
<td>In July 2022, Lenovo partnered with Kyndryl for IT server projects for PCs, servers, storage and next generation edge compute technologies</td>
<td>In July 2022, Hitachi launched Virtual Storage Software Block, a new software-defined data platform that extends Hitachi’s virtual storage platform to cloud native applications</td>
<td></td>
</tr>
<tr>
<td><strong>Revenue</strong></td>
<td>USD 28.5 Bn (2022)</td>
<td>USD 6.32 Bn (2022)</td>
<td>USD 62 Bn (2022)</td>
<td>USD 101.2 Bn (2022)</td>
<td>USD 84.1 Bn 2022</td>
</tr>
</tbody>
</table>

Source: Frost & Sullivan Analysis

Note: Revenues are at a consolidated level

Financial Calendar:

HPE: November - October; Dell: February - January; Lenovo: April – March; Hitachi: April - March
### Table 22: Key players in the global Enterprise Storage Systems market (2/2)

<table>
<thead>
<tr>
<th></th>
<th>Oracle</th>
<th>IBM</th>
<th>Huawei Technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Company Type</strong></td>
<td>Public</td>
<td>Public</td>
<td>Public</td>
</tr>
<tr>
<td><strong>Headquarters</strong></td>
<td>Texas, USA</td>
<td>New York, USA</td>
<td>Shenzhen, China</td>
</tr>
<tr>
<td><strong>Geographical Presence</strong></td>
<td>Worldwide</td>
<td>Worldwide</td>
<td>APAC, Americas, EU, MEA</td>
</tr>
<tr>
<td><strong>No. of Employees (2022)</strong></td>
<td>1,43,000</td>
<td>2,88,300 (2021)</td>
<td>~1,95,000</td>
</tr>
<tr>
<td><strong>Key Products/Services</strong></td>
<td>Oracle’s Zero Data Loss Recovery Appliance, Oracle ZFS Storage Appliance, Oracle StorageTek tape libraries</td>
<td>IBM Spectrum® Scale, IBM Cloud® Object Storage, IBM Spectrum Discover, IBM Elastic Storage® System, IBM FlashSystem® family, IBM SAN Volume Controller, IBM Storage Insights, IBM Spectrum Control, IBM Spectrum Virtualize for Public Cloud, IBM Spectrum Storage Suite, IBM Storage Suite for IBM Cloud Paks, IBM FlashWatch, IBM Spectrum Protect, IBM Spectrum Protect Plus, IBM Spectrum Copy Data Management, IBM Spectrum Archive, IBM Tape Solutions</td>
<td>All-Flash storage, Hybrid flash storage, distributed storage, OceanProtect data protection</td>
</tr>
<tr>
<td><strong>Business Strategy</strong></td>
<td>Product Launch</td>
<td>Acquisition</td>
<td>Product Launch</td>
</tr>
<tr>
<td><strong>Key Partnerships/Mergers/Acquisitions</strong></td>
<td>In June 2022, the company announced the storage expansion. Oracle Database Appliance X8, X7, and X6 offer flexibility on the storage capacity of the systems.</td>
<td>In October 2022, the company announced that it will add Red Hat storage product roadmaps and Red Hat associate teams to the IBM Storage business unit, bringing consistent application and data storage across on-premises infrastructure and cloud.</td>
<td>In September 2022, Huawei launched a range of storage products and solutions featuring scenario-specific technologies for different industries, at Huawei Connect 2022.</td>
</tr>
<tr>
<td><strong>Revenue</strong></td>
<td>USD 49.9 Bn (2022)</td>
<td>USD 60.53 Bn (2022)</td>
<td>USD 92.3 Bn (2022)</td>
</tr>
</tbody>
</table>

Source: Frost & Sullivan Analysis

Note: Revenues are at a consolidated level

Financial Calendar:

Oracle: April – March; IBM: January – December; Huawei: January – December
12. India Enterprise STORAGE Systems Market
12.1. India Enterprise Storage Systems Market Overview

The India Enterprise Storage Systems market was valued at USD 677.8 Mn in FY 2022. The market is forecasted to be USD 708.8 Mn in FY 2023 and is expected to reach USD 947.5 Mn by FY 2029 with a CAGR of 5.0% over the forecast period (FY 2023-2029). The market witnessed a muted growth between FY 2019-22 due to the pandemic, but going forward it is expected to witness a CAGR of 5% over the forecast period owing to increased investment in the Indian data center market.

Exhibit 65: India Enterprise Storage Systems market (USD Mn) - FY 2019-2022E (Estimated and Historical years)

Source: Frost & Sullivan Analysis

Exhibit 66: India Enterprise Storage Systems market (USD Mn) - FY 2023F-2029F (Forecasted years)

Source: Frost & Sullivan Analysis
The market for corporate storage systems in India has grown as a result of investments in emerging technologies, modernization programmes, and capacity expansion of existing technologies. The government, professional services, and BSFI were the key verticals that fueled demand for storage goods and services.

A data flood brought on by the expansion of the Digital India programme in recent years has led businesses to look into updating their IT infrastructure.

The enterprise storage systems market in India is still dominated by Dell Technologies. Due to its end-to-end storage portfolio and solutions-centric strategy, which helps organisations to realise their full potential and get ready for the future, the company maintained its leadership position.

How has India Enterprise Storage Systems market transformed over the years?

The pandemic accelerated digital transformation initiatives in India

The way Indians produce and consume data has undergone tectonic changes recently. The stakes have greatly increased for the organisations that rely on IT infrastructure and ecosystem, whether it be because of the widely adopted Digital India project, the trend toward cashless payments, or the innovations being offered by the developing entrepreneurial ecosystem. India is anticipated to soon rank among the top national data users due to its rising economy and expanding population. However, such massive production and consumption of data demand state-of-the-art facilities for its administration, distribution, and storage. To ensure uniformity of IT protocols and ease of access for users, these workloads may also need to be deployed across public and private clouds, urban and distributed data centres, and will ultimately drive the demand for storage systems. Due to the need for them to be more dependable and scalable to satisfy changing and increasing demands for their services, enterprise data centres and storage systems need to be redefined because of this transformation.

The demand to reimagine enterprise data centres and storage systems is also being fueled by several cutting-edge technologies of the present. The development of cloud technology has shown a potent method for producing, storing, and consuming data. However, given the constraints of current IT budgets and the scarcity of resources, it appears that Indian data centres are now having trouble keeping up with the data explosion. Additionally, because of current innovations like digitalization, IoT, AI, and others that have increased data generation dramatically, the traditional method of storing or computing data is no longer practical for the digital organisation. The capacity to increase connectivity via bandwidth while lowering prices is a big challenge as well.

Enterprise data centres and technologies have evolved dramatically over the past ten years as a result of these problems. Businesses have been able to unleash significant business opportunity as a result of disruptions like wearable technology, big data, and local IoT to cloud gathering systems simply by reframing and altering their existing data centres and systems. Organizations have discovered creative strategies to transform in order to optimise costs and lessen the growing pains of this transition. While internal data centres and systems were once the norm, many businesses are increasingly utilising the public cloud and creating hybrid IT architectures. A
increasing option for businesses who want to save capital expenses is to lease space in colocation facilities.

Furthermore, when it comes to redefining the enterprise data centre and systems, a CIO is presented with several alternatives. Data centres initially were developed to serve as hosts for IT infrastructure for online firms as e-commerce industry was growing. Data centres and storage systems are increasingly moving toward hyperscale, nevertheless, to accommodate a larger increase. By enabling an economy of scale and supplying capacity that is scalable, efficient, and resilient, this also enables them to offer a seamless service. Therefore, by moving their current infrastructure to the cloud, businesses can avoid network bandwidth and capacity constraints and subsequently provide a better experience to their consumers.

Over time, the nation’s use of All-Flash Arrays (AFA) has increased. In order to manage all of their main workloads, Indian banking firms have experienced an increased acceptance of AFA. In 2021, rising investments from the banking, governmental, and manufacturing sectors led to an increase in entry-level storage systems; this trend is anticipated to continue for the course of the forecast period.

**12.2. India Enterprise Storage Systems market by Application**

India Enterprise Storage Systems market by application is segmented into Government & Defence, BFSI, IT & ITES, Telecommunications, Media, Oil & Gas, and Others. BFSI application had the largest share in FY 2022 and is expected to reach USD 265.3 Mn by FY 2029 at a CAGR of 3.6%.

**Exhibit 67: India Enterprise Storage Systems market by Application (USD Mn) - FY 2019-2022E (Estimated and Historical years)**

Source: Frost & Sullivan Analysis
Storage levels in 2022 were driven by significant expenditures made in the telecom sector, which was supported by banking, IT/ITeS, manufacturing, and government. The primary workloads/use cases for storage deployments in India that drove the market growth included technology upgrades, ERP upgrades, surveillance, digital transformation, and 5G rollouts.

The use of SSDs (Solid State Drives) over HDDs (Hard Disk Drives) has grown in popularity across industries due primarily to their superior performance, increased durability, and cost-effective power efficiency. Additionally, to support both capacity and performance in a single array, Hybrid Flash Arrays (HFA) are continuously increasing the ratio of SDD to HDD. For their performance-critical applications, the Telecom, Banking, and IT/ITeS industries all saw a considerable growth in the adoption of All Flash arrays. The deployment and use of technologies like software defined storage, virtualization, compression, de-duplication, and thin provisioning are expanding due to the exponential expansion of data and occasionally to optimise the existing storage infrastructure. Cloud based back-up/ disaster recovery solutions are also gaining traction across organizations to avail best in class services with minimal CAPEX in the country.

Enterprise storage has emerged as the most popular and effective way to store digital data, particularly for small and medium-sized businesses. It uses industry-standard security techniques to secure data, making it safer than local storage. Additionally, it saves money and space, is available everywhere, enables speedy file sync and sharing, and guards against data loss. Smaller companies that want on-site backups should choose NAS (a form of corporate storage solution). Users of NAS devices can also implement access controls to manage employee file access, which is a crucial function for business security. NAS solutions are used by large and small enterprises
across a wide range of industries because they provide efficient, scalable, and affordable storage. Compared to other servers, NAS file servers give faster data access and are easier to configure and manage. They can support various business applications, including private email systems, accounting databases, payroll, video recording and editing, data logging, and business analytics.

Enterprise storage is used by large enterprises for high availability, disaster recovery, cross-platform data sharing, and backup and restore services.

12.3. Market Drivers, Opportunities & Challenges

Drivers

I. Increasing investment in data centers

The increasing investments in data centers is one of the key factors driving the growth of the India enterprise storage systems market. According to a whitepaper from ICRA and an article from the Economic Times 2022, investments of up to Rs 1.20 lakh crore will result in a 5-fold increase in capacity for Indian data centres. As 3,900-4,100 MW of capacity are added overall, it is predicted that the capacity of the Indian data centre industry will increase by a factor of five. Due to the increased use of cloud services and the significant volume, variety, veracity, and velocity of data being produced by businesses, there is an increasing need for data centres. Many businesses, like Google, Amazon.com, Apple, and Facebook, are making major investments to construct their own data centres. Enterprise storage solutions are used by these businesses as clients. These businesses turn to enterprise storage system suppliers and data centre building services for design, engineering, and mechanical services because they must create their own data centres. The development of the India enterprise storage systems market would therefore benefit from an increase in the investments made by businesses in the construction of their own data centres.

Opportunities

I. Growth of Hyper converged infrastructure in India

The expansion of hyper-converged infrastructure will stimulate the market for business storage solutions in India. Enterprises no longer need to rely on various storage, compute, and networking systems thanks to hyper-converged infrastructure, which enables all three to operate in a virtualized environment to maximise resource usage. Additionally, it optimises space and lowers power usage, which improves data centres' agility, speed, and efficiency. Small & Medium Enterprises (SMEs) benefit greatly from hyper-converged infrastructure since it allows for central management of network, storage, and compute services. During the forecast period, it is anticipated that HCI usage would expand in India. It is envisaged that its main application will be to simplify the country's IT architecture. Data centre management is now easier than ever. One of the most important aspects is undoubtedly the decreased management complexity. The urgent needs of modern businesses require enormous IT resources in terms of technology design, deployment, and maintenance. Hyper-convergence may be used by IT teams to move away from overseeing dispersed, old systems and toward more strategic initiatives. Significant investments in the Indian economy are being made in major cities like Mumbai, Bangalore, and Hyderabad by
both domestic and foreign firms. The adoption of HCI in India is anticipated to be accelerated by government initiatives. For instance, a virtual roundtable on "Building a Digital India through Hyperconvergence (HCI) and Multi-Cloud" was organised in partnership with Nutanix and focused on how to modernise the role of hyperconvergence in PSU environments, as well as how to streamline and converge PSU cloud management strategy.

**Challenges**

I. Increasing data center consolidation activity

One of the main factors limiting the growth of the India enterprise storage systems market is the rising data centre consolidation activity. IaaS is a crucial cloud concept that allows several businesses to use virtualized computing resources via the Internet. Digital Ocean, Linode, Rackspace, Amazon Web Services (AWS), Cisco Metapod, Microsoft Azure, and Google Compute Engine (GCE) are a few instances of IaaS. Data centres have been consolidated as a result of the rapid rise of IaaS. Companies that use the notion of datacenter consolidation concentrate on shrinking the size of a data centre facility or even merging several of them. The main justification for this is to lower their operating costs. A universal cloud platform is being adopted by many software companies, which will eliminate the need for separate data centres. Several businesses, including Salesforce, Tableau, and SAP, have made plans to use the IaaS deployment option in the public cloud.

**12.4. Key players in the India Enterprise Storage Systems market**

<table>
<thead>
<tr>
<th>Company Type (Public or Private)</th>
<th>HPE</th>
<th>NetApp</th>
<th>HITACHI Data Systems Corporation</th>
<th>Dell</th>
<th>NetWeb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presence in India</td>
<td>Public</td>
<td>Private</td>
<td>Private</td>
<td>Public</td>
<td>Private</td>
</tr>
<tr>
<td>Over 19 offices, present in 6+ cities in India</td>
<td>Bengaluru, Karnataka</td>
<td>New Delhi, Delhi NCR</td>
<td>Present in 8 locations in India</td>
<td>Has offices in New Delhi, Faridabad, Bangalore, Chennai, Kolkata, Hyderabad, Mumbai, Pune, Ahmedabad, Roorkee, Dehradun, Bhubaneswar, Gurugram</td>
<td></td>
</tr>
<tr>
<td>No. of Employees (2022)</td>
<td>~30,000</td>
<td>~1000-5000</td>
<td>~1,001-5,000</td>
<td>~25,000</td>
<td>~270 (March, 2023)</td>
</tr>
<tr>
<td>Key Products/ Services</td>
<td>HPE</td>
<td>NetApp</td>
<td>HITACHI Data Systems corporation</td>
<td>Dell</td>
<td>NetWeb</td>
</tr>
<tr>
<td>------------------------</td>
<td>-----</td>
<td>--------</td>
<td>-----------------------------------</td>
<td>------</td>
<td>--------</td>
</tr>
<tr>
<td>All-Flash and Hybrid Storage, Data Storage Servers, Storage Networking</td>
<td>InNetApp AFF A-Series, NetApp EF-Series, NetApp AFF C190, NetApp AFF, All SAN Arrays, OS—ONTAP—to the broadest portfolio of systems. NVME is a storage access and transport protocol</td>
<td>Cloud Storage for Applications, Hybrid Cloud Infrastructure, Hybrid Cloud with VMware, Infrastructure as a Service</td>
<td>HCI appliance combines all data center components—storage, compute, networking and management—within a single, pre-configured hardware box</td>
<td>FS2, Verta, Storage Array, Collectivo, Parallel Stor</td>
<td></td>
</tr>
<tr>
<td>Business Strategy</td>
<td>Investment</td>
<td>Investments</td>
<td>Acquisition/ merger</td>
<td>Product Launch</td>
<td>NA</td>
</tr>
<tr>
<td>Key Partnerships/ Mergers/ Acquisitions</td>
<td>In July 2019, HPE India claimed that they will spend $500m in India over the next five years to expand its operations in the country. This would further enhance their portfolio.</td>
<td>In December 2021, NetApp claimed that they would be furthering its focus on India by enabling its Indian entity to conduct business locally and directly with its vibrant customer base in India via its strong partner network. This would further strengthen their enterprise storage portfolio in India.</td>
<td>In August 2022, the company claimed that they were looking at acquisitions and partnerships in India to foray into newer areas such as technologies for battery storage and other emerging areas in the energy space.</td>
<td>In August 2022, Dell launched AppSync v4.5 software for Copy Data Management (CDM) that allows multiple copies of data to be issued to users and when it’s needed without impacting business operations.</td>
<td>NA</td>
</tr>
<tr>
<td>Revenue</td>
<td>USD 532.8 Million</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>USD 56.6 Mn (2022-23)</td>
</tr>
</tbody>
</table>

Source: Annual Reports, ROC, Secondary Sources, Frost & Sullivan Analysis
Note: Revenues are consolidated ones at company level,
USD = 78.6 INR (average exchange rate for Year 2022)
Financial Calendar: April – March 2021-22 (For all companies except NetWeb)

The era of having multiple units for different storage needs is passing as diverse storage products prevent optimum utilisation and can be complex to manage. Enterprises are compelled to modify their present IT architectures to be adaptable, efficient, and workload secure. In addition, the distribution of workloads to the edge further complicates matters for organisations. Technology
refresh/capacity expansion, modernization activities, and investments in emerging technologies fuel the incremental growth of the enterprise storage systems market.

HPE is one of the top vendors in enterprise storage systems. They provide hybrid storage solutions such as HPE Alletra 5000. Additionally, they offer hybrid cloud data protection, edge-to-cloud disaster recovery, and optimized storage systems for customized needs. NetApp is one of the market leaders offering NAS, SAN, and object environments to arrays built for dedicated, high-bandwidth applications like data analytics and disk-based backup solutions. They offer solutions in All-flash category that includes NetApp AFF A series, NetApp AFF-C Series, NetApp EF-Series, NetApp AFF All SAN Arrays series. They also offer hybrid flash that include NetApp FAS Series and NetApp E-Series. Hitachi Vantara offers various storage systems that include primary block storage, file & object storage and mainframe storage. Dell caters its clients via primary storage, unstructured data storage and software-driven storage. Primary storage offer integration from edge to cloud while decreasing application outages and reducing storage requirements with advanced deduplication. While, unstructured data storage efficiently consolidates a wide range of file and object storage workloads at any scale while enhancing the performance of the most demanding workloads.

Netweb provides next generation high performance enterprise storage solutions along-with flexible scalability, data protection and redundancy with great ease of integration and management.

Netweb provides storage solutions that supports high performance computing, provides multiple configurations, and delivers best results (10 million IOPs, 450 GBps) that are cost effective. By unifying network-attached storage (NAS) and storage area network (SAN) into a single box, it provides the flexibility to use it as a NAS, SAN, or both thus ensuring best performance-per-dollar and per-square-feet while lowering the total cost of ownership and energy consumptions. These solutions also consolidate all storage requirements in a single all-in-one storage solution and bundle enterprise class features such as extremely high scalability and redundancy along with a very high performance. They can serve the diverse requirements from high performance computing to post-production and broadcast industry with end-to-end support.

With high compatibility, Netweb’s storage solutions support legacy infrastructure and seamlessly integrate with ADS & NIS with a very intuitive and easy to use web-based management UI.
13. Global Cloud Managed Services Market
Definition

Cloud Managed Services are the partial or complete management and control of a client’s cloud platform, including migration, maintenance, and optimization. Cloud deployment includes deploying an application through one or more hosting models.

Software as a service (SaaS), platform as a service (PaaS) and/or infrastructure as a service (IaaS) leverage the cloud. Cloud migration is a process of moving a company’s digital assets, services, databases, IT resources, and applications either partially, or wholly, into the cloud. Cloud migration is also about moving from one cloud to another. The optimization of cloud includes correctly selecting and assigning resources to a workload or application. By using a managed cloud service provider, a business can ensure its cloud resources run efficiently. Outsourcing cloud management also allows businesses to avoid new hiring and training costs. Managed cloud services can provide private, public and hybrid cloud environments. Working with a managed cloud services provider is a collaborative process.

13.1. Global Cloud Managed Services Market Overview

The global Cloud Managed Services market was USD 79.7 Bn in FY 2022. The market is forecasted to be USD 90.0 Bn in FY 2023 and is expected to reach USD 189.5 Bn by FY 2029. The market is expected to grow at a CAGR of 13.2% over the period (FY 2023-2029).

For public and hybrid systems, managed cloud services provide full or partial cloud management services. For business cloud needs including migration, optimization, security, configuration, and optimization solutions and services, managed cloud services are provided. Choosing managed cloud services has several benefits, including improved resource efficiency, cloud integration, and flat, predictable costs. The global market for cloud-managed services is expanding due to the increase in demand for cloud applications. The market for cloud managed services is also anticipated to develop as a result of decreasing cloud service costs and hyper-scaling capabilities. However, worries over data security and privacy could impede business expansion. On the other hand, throughout the projected period, the rising demand for cloud computing and cloud services in SMEs is anticipated to present lucrative prospects for the growth of the cloud managed services market.

Cloud Deployment: The process of delivering an application using one or more cloud-based hosting models, such as infrastructure as a service (IaaS), platform as a service (PaaS), and/or software as a service (SaaS), is known as cloud deployment. This includes designing, organising, putting into practise, and managing cloud-based workloads. Some of the advantages of cloud deployment include:

- Faster and simplified deployments- Automate resource provisioning as well as builds that deliver code, databases, and application releases.
- Cost savings- Utilize consumption-based pricing to reduce costs and get rid of on-premises setups with high capital expenditures.
- Platform for growth- Use the worldwide infrastructure offered by cloud service providers (CSPs) to expand your company’s reach into new regions.
- New digital business models- Utilize the features and services that CSPs are constantly releasing, incubate new technologies, and develop innovative digital business models.
• Business resiliency- In order to make the business resilient, applications should be designed for the availability and fault-tolerance that CSPs provide.

Cloud Migration- A collection of procedures known as cloud migration aid end users in moving their company operations, procedures, and applications to cloud infrastructure or a cloud computing environment. Migration typically involves moving one's outdated IT infrastructure to a public cloud environment. Many sectors, like BFSI and healthcare, prefer private or hybrid cloud migration solutions due to the high level of protection they offer.

Storage space is increased by obsolete and faulty legacy infrastructure. As a result, many sectors have implemented cloud migration services, which entail upgrading all business activities to the cloud, to promote business growth and agility. As a result, it is anticipated that the market for cloud migration services would expand significantly during the next few years. Leading cloud migration service providers include Microsoft Azure and AWS services.

Cloud Optimization- The process of accurately choosing and allocating the appropriate resources to a task or application is known as cloud optimization. Efficiency is attained when workload performance, compliance, and cost are accurately and consistently balanced against the best-fit infrastructure in real-time. The infrastructure requirements for each application and workload are distinct, and these requirements change over time. When choosing resources for a workload, domain knowledge is generally used to achieve baseline performance. However, machine intelligence can benefit and further improve all workloads that have been manually matched to cloud resources.

Rise in demand for cloud managed in business continuity; Increase in need for business agility and automation; and Faster and easier deployment of applications with pay-as-you-go model are likely to drive the global Cloud Managed Services market over the forecast period (FY2023-2029).

Major players in the global cloud managed services market are Google LLC, Amazon Web Services, Microsoft Corporation, NTT Data Corporation, and CISCO Systems.

Exhibit 69: Global Cloud Managed Services Market (USD Bn) - FY 2019-2022E (Estimated and Historical years)

<table>
<thead>
<tr>
<th>Year</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>55.2</td>
<td>62.4</td>
<td>70.5</td>
<td>79.7</td>
</tr>
</tbody>
</table>

CAGR 13.0%

Source: Frost & Sullivan Analysis

Exhibit 70: Global Cloud Managed Services Market (USD Bn) - FY 2023F-2029F (Forecasted years)
13.2. Global Cloud Managed Services Market by Application

Global Cloud Managed Services market by application is segmented into Government & Defence, BFSI, IT & ITES, Telecommunications, Media, Oil & Gas, and Others. Cloud Managed Services application in the BFSI sector held the largest share in FY 2022 and is expected to reach a value of USD 43.6 Bn by FY 2029. Adoption of cloud services in the IT & ITES sector is expected to grow with the CAGR of 14.1% during the forecast period (FY2023-2029). Cloud Managed Services application in the IT & ITES sector held the second largest share in 2022. A typical IT setup necessitates the installation of servers, hardware, licences, and software. These can be expensive to buy and keep up, and their acquisition and maintenance might take a long time and money. The cloud managed services help in staying updated, providing stepped up security, ensure back up and offer better scalability and flexibility.

BFSI - The BFSI sector's adoption of cloud managed is being driven by a rise in the demand for security and risk management. Data storage architecture also needs security against attacks from hackers and cybercriminals. A committed team is required for this to ensure ongoing vigilance and improvement. By using cloud services with security and risk management tools, banks and other financial organisations can avoid cyberattacks and be protected from online risks. For instance, Murex, a pioneer in risk management, trading, and processing solutions for the financial markets, partnered with Amazon Web Services, Inc. (AWS) in December 2021 to oversee its operations. As per estimates, the worldwide spending on cloud services will increase to around ~30 billion by 2024.

IT & ITES- To administer and provide services, the IT sector primarily relies on a sizable computing infrastructure running a variety of applications. To lessen their reliance on internal computing resources, IT & ITES service providers are moving to the cloud. By lowering internal costs, revenue streams can be expanded. Moreover, the cloud is offering communication services in the form of cloud-based applications that let users set up conference calls, enable video conferencing, and more. Examples of these products are Microsoft Teams and Zoom.

Telecommunications - To administer and supply services, telecom companies primarily rely on a sizable computing infrastructure running a variety of apps. To lessen their reliance on internal computing resources, IT and telecom service providers are moving to the cloud. By lowering internal costs, revenue streams can be expanded. Additionally, the cloud is offering
communication services in the form of cloud-based applications that let users set up conference calls, enable video conferencing, and more. Examples of these products are Microsoft Teams and Zoom. 5G is the major driver of the cloud managed services market around the world. According to Verizon, it is expected that the worldwide capital spending on 5G services will amount to US$ 10 Bn by 2025.

Media – Customers in the digitally oriented media and entertainment sector need quick access to videos and other media content, regardless of their location or platform of choice. The customer demand is erratic, with peaks and valleys in viewership that must be handled immediately. The media and entertainment industry needs the level of flexibility and scalability that cloud computing’s on-demand features provide to efficiently meet this erratic viewership demand. For instance, Disney+ using technology to offer bundled packs with ESPN (in the US) to consumers. It had 44.9 million subscribers in 2020 and it had increased to 54.9 million subscribers in 2021.

Exhibit 71: Global Cloud Managed Services Market by Application (USD Bn) - FY 2019-2022E (Estimated and Historical years)

Source: Frost & Sullivan Analysis
13.3. Global Cloud Managed Services Market by Geography/Region

Global Cloud Managed market by geography is segmented into North America, Europe, Asia Pacific (APAC), South America, and Middle East and Africa (MEA). North America region held the largest share in FY 2022 and is expected to reach USD 109.9 Bn by FY 2029 at a CAGR of 13.0%. APAC is expected to witness highest CAGR of 14.7% during the period (FY 2023-29).

Cloud services have evolved because of digital transformation in North America, forcing businesses to concentrate on cloud managed services. Companies in North America are actively transferring their business activities to the cloud and employing a variety of digital strategies as part of this transition, with cloud managed services serving as the primary enabler. For instance, an American e-commerce firm called Etsy finished migrating 5.5 petabytes of data—roughly 40 billion photos—from 2,000 on-premises servers to the Google cloud in February 2020. Following this transition to the cloud, Etsy is utilising the machine learning capabilities and compute capacity of Google Cloud to operate more quickly and effectively while providing a better customer experience (News article, Google Cloud).

The UK, Germany, France, Russia, Italy, and the rest of Europe make up the European region's market for cloud managed services. The governments are concentrating on sovereignty for cloud technology because it represents a slow rate of advancement and lags North America. Furthermore, as the international cloud service providers expand their operations in Europe, the region is seeing an increase in the adoption of multi-cloud and hybrid cloud setups.

China, India, Japan, South Korea, Australia, and the rest of Asia-Pacific are all included in the analysis of the cloud managed services market in the region. Asia-Pacific is seeing an increase in
demand for public cloud application services as businesses look to enhance their digital transformation. Businesses are also utilising cloud services for business applications including corporate asset management, compliance & risk management, big data analytics, and business intelligence.

Latin America, the Middle East, and Africa are all considered in the analysis of the LAMEA region's cloud managed market. With the use of artificial intelligence (AI), the Internet of Things (IoT), and big data, cloud managed services are growing throughout Latin America. Governments in the gulf region are sponsoring public cloud efforts to enhance cloud service accessibility and Middle Eastern SMEs' adoption of cutting-edge technologies. For instance, growing popularity of service-oriented architecture (SOA) will propel the cloud managed services market in Latin America. It provides an IT framework that permits organizations to manage their IT infrastructure with better flexibility and also helps them in reducing time required for implementing cloud-based solutions.

Exhibit 73: Global Cloud Managed Services Market by Geography/Region (USD Bn) - FY 2019-2022E (Estimated and Historical years)

Exhibit 74: Global Cloud Managed Services Market by Geography/Region (USD Bn) - FY 2023F-2029F (Forecasted years)
13.4. Market Drivers, Restraints, Opportunities & Challenges

Market drivers

**Rising demand for cloud managed services for business continuity** – In order to preserve business continuity, this epidemic has forced many firms to upgrade their infrastructure with cloud technologies. Additionally, during the last ten years, numerous digital and transformational strategies have put business continuity plans of enterprises across all industries to the test. Major industries like banks have admitted that requiring their workers to work remotely puts a technological load on them. The BFSI sector has seen a growth in online banking activity, which further initiated the money lenders to adopt digital transformation where cloud computing has played a vital role in this strategy of the lending sector. Cloud computing has accelerated the business across the BFSI sector and helps organizations reduce costs, stimulate innovations, improve client relationships and flexibility. The COVID-19 pandemic has transformed the way people interact and do business daily. Technological advancements have continued to influence the adoption of cloud-based services across the BFSI sector. Thus, cloud managed services are being widely used in the BFSI sector.

**Increase in need for business agility and automation** – Many companies have understood how important it is to go to the cloud. This is explained by the fact that the cloud has established itself as the best option for enabling employees to operate remotely by centralising data for remote access. Therefore, it is anticipated that the flexibility to work remotely and cooperatively with co-workers from different locations that cloud technology provides would have a beneficial impact on market growth. Furthermore, cloud advantages like increased employee experience and disaster recovery make it easier and more seamless. Automating staff onboarding processes improves employee experience. This type of business process automation made possible by the
cloud enables the IT department to concentrate and take the initiative on important staff needs, such developing efficient new technology training and enhancing security awareness.

**Faster and easier deployment of applications with pay-as-you-go model** - The fundamental pay-per-use cloud model gives consumers the freedom to scale their infrastructure and application services. Additionally, cloud computing makes it possible to subscribe to or rent any platforms, infrastructure, systems, technologies, and data services to aid businesses in scaling up or down in accordance with their needs, which is anticipated to accelerate market expansion in the years to come. Additionally, cloud managed services offer on-demand scalability, which is particularly useful during seasonal traffic surges. Development and testing are facilitated by DevOps collaboration tools, which has significantly increased the demand for these services among small enterprises. Additionally, using the cloud enables collaboration between various teams and data repositories, giving an organisation the chance to deliver services more quickly and more effectively. AWS offers over 200 cloud services, each of which has its own pay-as-you-go pricing system. These are industries highest selling pay as go platforms in the world (as per AWS website).

**Market restraints**

Enterprise application’s cloud compatibility and interoperability issues: Although cloud technology offers a wide range of advantages and functions, compatibility and interoperability issues are the main barriers to its adoption. This is attributable to the high expense of upgrading the hardware necessary for the upgrade of outdated infrastructure. Market expansion is also somewhat constrained by proprietary formats and protocols, reliance on proprietary services, and a lack of data "export" functionality. Deploying cloud services also necessitates high-tech user interfaces with proprietary APIs, tools, frameworks, and platform dependencies, which increases the need for compatible interfaces like PaaS frameworks. Additionally, it is anticipated that limited operating system support, proprietary APIs, and proprietary hypervisors in IaaS services may slow the market’s expansion.

**Market opportunities**

Healthcare – Healthcare & life sciences companies are observing a shift in their way of functioning with an embracement of automated machine systems. In the healthcare industry, companies are providing e-prescriptions and telemedicine to enhance data traceability, to improve the patient experience, and to save unnecessary administrative costs. In the life sciences industry, biotech & pharmaceutical companies are adopting digital solutions to optimize their drug development process. Cloud services have the potential to generate tremendous value for healthcare companies. The major driver of this value lies in enabling them to innovate more effectively (for example, new use cases in analytics, IoT, and automation), digitize (for example, stakeholder journey transformation), and realize their strategic objectives.

Cloud managed delivers manufacturing execution systems (MES), enterprise resource planning (ERP), and analytics services to the manufacturing industry. Timely information is important for decision-making, which is why numerous manufacturers are prioritizing migration paths for cloud platform. Salesforce apps and ERP software are run and stored in the cloud to ensure that stakeholders get the right data when they need it.
Challenges

Cyber security concerns - One of the main challenges of Cloud Managed Services is facing is the increasing amount of data to be processed very quickly and securely. With the current trend of Cloud Managed Services workloads and infrastructure increasingly becoming cloud-like (e.g., resource pooling, rapid elasticity, on-demand self-service), or interacting with the cloud (e.g., bursting), security has become a great concern at an accelerating rate. Companies are therefore taking some of the mentioned steps to minimize risk: 1) Creation of network segments to separate different services within the cluster; 2) Implementation of specialist authentication software designed for Cloud Deployment/Migration Services users; 3) Encryption can be a useful way of protecting data, but it should be used strategically, or it will impede cloud managed services performance.

13.5. Key players in the global Cloud Managed Services market

Table 24: Key players in the global Cloud Managed Services market

<table>
<thead>
<tr>
<th>Company Type</th>
<th>IBM</th>
<th>Cisco Systems</th>
<th>Google LLC</th>
<th>Amazon</th>
<th>Microsoft</th>
<th>NTT Data Corporation</th>
<th>VMware</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headquarters</td>
<td>Armon, New York, US</td>
<td>California, USA</td>
<td>Mountain View, California, U.S.</td>
<td>Seattle, Washington, United States</td>
<td>Quarry Bay, Hong Kong</td>
<td>Quarry Bay, Hong Kong</td>
<td>Tokyo, Japan California, USA</td>
</tr>
<tr>
<td>Geographical Presence</td>
<td>Operates in over 171 countries</td>
<td>Americas, EMEA, APJC</td>
<td>More than 70 offices in 50 countries</td>
<td>Americas, Europe, MEA, Asia</td>
<td>Over 190 countries</td>
<td>North America, Europe, APAC, MEA, LA</td>
<td>North America, Europe, APAC, MEA, LA</td>
</tr>
<tr>
<td>No. of Employees (as on 2022)</td>
<td>~288,300</td>
<td>~83,300</td>
<td>~190,711</td>
<td>~1,608,000</td>
<td>~75,000</td>
<td>1,39,500</td>
<td>38,300</td>
</tr>
<tr>
<td>Key Products/Services</td>
<td>Hybrid cloud consulting, application migration &amp; modernization</td>
<td>AppDynamics Cloud, Cloud ACI, Catalyst 8000 V, CSR 1000 V</td>
<td>Google Services and Google Cloud</td>
<td>Amazon Web Services</td>
<td>Microsoft Azure</td>
<td>Cloud advisory, cloud implementati on, cloud management services, cloud security</td>
<td>VMware cloud foundation, VMware cloud AWS, VMWare Cloud</td>
</tr>
<tr>
<td>Key Partnerships/Mergers/ Acquisitions</td>
<td>2021 - Total acquisitions - 15, total spent on acquisition - $3 Bn. Inorganic investments focussed on</td>
<td>Acquisition - Completed 13 acquisitions during fiscal 2021. For e.g., Acacia, INMobile.</td>
<td>Google Cloud acquired Cornerstone Technology, a high-quality technology solutions provider to</td>
<td>In 2020, NTT DATA Services, a leader in global technology services, collaborated</td>
<td>In January 2023, Microsoft teamed up with OpenAI through a multiyear, multibillion</td>
<td>In 2020, Red Hat, the world’s leading provider of open-source solutions, today</td>
<td>In November 2022, announced innovations, new offerings, services and expanded partnerships</td>
</tr>
</tbody>
</table>
critical hybrid cloud and sustainability software assets, such as Instant, Turbonomic and Envisi. In Consulting, Acquisitions are focussed on digital innovation including 7Summits, Taos, BoxBoat Technologies and BlueTab Solutions.

Opsani (2022) - will allow Cisco AppDynamics to expand its product and technical teams even further.

Alliances - Companies with which strategic alliances were expanded during fiscal 2021 include Apple Inc., Equinix Inc., Google LLC, International Business Machines Corporation, Microsoft Corporation, Samsung Electronics Co., Ltd., and Amazon Web Services LLC, among others.

the IT industry. The acquisition will migrate customers’ mainframe workloads to Google Cloud in 2020. In 2019, Google LLC partnered with SADA Systems Inc. With this partnership, SADA will deliver more consulting services to enterprises looking to adopt Google Cloud.

with Amazon Web Services, Inc. (AWS) to deliver new products, services, and solutions designed to accelerate cloud transformaions. In 2019, F5 Networks, the provider of hybrid cloud application services, collaborated with Amazon Web Services (AWS) to allow customers to use F5 for new cloud-native application workloads and extend their existing F5 investments on AWS.

dollar investment. As OpenAI’s exclusive cloud provider, Azure will power all OpenAI workloads across research, products and API services. announced that NTT DATA Corporation has used Red Hat’s open hybrid cloud technologies to drive digital transformatioin.

that further enable customers to optimize their journey to multi-cloud.

| Total revenue | USD 60.5 Bn (2022) | USD 51.6 Bn (2022) | USD 282.8 Bn (2022) | USD 514 Bn (2022) | USD 198 Bn (2022) | USD 25 Bn (2022) | USD 13.4 Bn (2022) |

Source: Annual Reports, Secondary Sources, Frost & Sullivan Analysis
Total Revenues are at consolidated / company level

Financial Calendar:
Cisco: August – July; IBM: January – December; Google LLC: January – December; Amazon: January – December; Microsoft: July – June; NTT: April – March; VMware: February - January
14. India Cloud Managed Services Market
14.1. India Cloud Managed Services Market Overview

The India Cloud Managed Services market was USD 910.6 Mn in FY 2022. The market is forecasted to be USD 1,121 Mn in FY 2023 and is expected to reach USD 3,900.7 Mn by FY 2029 with a CAGR of 23.1% over the forecast period (FY 2023-2029). The Indian market for cloud migration services has grown significantly in recent years and now represents a sizable portion of the worldwide cloud computing market. Organizations in India are increasingly in need of cloud migration services due to the desire to save costs, boost scalability, and improve agility.

Large international organisations, regional IT service providers, and specialised cloud migration service providers are just a few of the major players in India's cloud migration services market. These businesses provide a variety of services that assist businesses in moving their IT systems and apps to the cloud.

Exhibit 75: India Cloud Managed Services Market (USD Mn) - FY 2019-2022E (Estimated and Historical years)

Exhibit 76: India Cloud Managed Services Market (USD Mn) - FY 2023F-2029F (Forecasted years)

Source: Frost & Sullivan Analysis
How Indian Cloud Managed Services Market Has Evolved Over the Years

To improve their capacity for service delivery, cloud service providers continued to establish a stronger presence in India by announcing new data centres and cloud regions. Service providers noticed a surge in demand from other sectors, including as the public sector, media, and gaming, as well, with industries like BFSI and manufacturing driving the public cloud adoption.

BFSI sector- According to Nutanix, Cloud migration services in BFSI sector are expected to grow around 39% in the forecast period. In addition, around 43% of financial services companies are planning to increase their investment in cloud migration services.

Telecommunications: The accelerated digital transformation due to 5G is revolutionizing cloud migration services in telecommunications sector. By 2025, 95% of data workloads up from 30% in 2021-will be migrated on the cloud, according to Gartner research. By 2025, they estimate that more than 95% of enterprises will be utilising cloud migration services.

Applications for collaboration, computing, storage, customer relationship management, enterprise resource management, and security are some of the most in-demand public cloud service categories. Additionally, the use of cloud-based AI platforms and the creation of cloud-native applications increased. It supports the government’s initiatives of 'Digital India' and 'Make in India'.

14.2. India Cloud Managed Services Market by Application

Cloud managed services are expected to increase in 2023 with digital innovation driving Indian enterprises' main business goals. Cloud managed services are still gaining ground across industries, driven by the demand for digital technologies' agility, flexibility, and quick access. Additionally, businesses now have access to technologies that are based on a cloud foundation, which allows them to exploit data wisely. India Cloud Managed Services market by application is segmented into Government & Defence, BFSI, IT & ITES, Telecommunications, Media, Oil & Gas, and Others. Adoption of Cloud Managed Services in the IT & ITES and Government sectors held the largest share in 2021.

Exhibit 77: India Cloud Managed Services Market by Application (USD Mn) - FY 2019-2022E (Estimated and Historical years)
Government & Défense - A national government cloud programme known as "MeghRaj" was unveiled by the Ministry of Electronics and Information Technology in 2020. MeghRaj was created with the intention of utilising and harnessing the advantages of cloud computing and
ensuring the spread of cloud services among public sector organisations and government agencies in a way that improved their e-governance frameworks. MeitY introduced a series of guidelines (the "MeitY Guidelines") to highlight key considerations - particularly, data protection and security compliance requirements - for public procurement of cloud services as part of this initiative and specifically to facilitate government procurement and adoption of cloud computing services.

BFSI - Modern banking began in India in the 18th century in an uncontrolled setting and has progressed significantly since. India is experiencing a banking transformation and is ideally positioned to become a worldwide leader in Fintech. India dominates the Fintech market in terms of technological innovation and acceptance, with a high adoption rate of 87% (India Fintech report by E&Y). Beyond temporary solutions to ensure business continuity, artificial intelligence, and cloud migration services enable financial institutions to further streamline and automate processes, improve data management and utilisation, and ultimately enjoy efficiencies and build resilience to weather future storms.

All these factors will lead to higher adoption and growth of cloud managed services in India.

14.3. Market Drivers, Restraints, Opportunities & Challenges

Drivers
I. Need for lower CapEx and OpEx

A corporation may modernise with agility and flexibility when it invests heavily in IT. Many businesses purchase operational expenses (OpEx) and compare capital expenses (CapEx) for public cloud services that use a pay-as-you-go model, which offers the most flexibility for controlling costs. This is due to the increase in need to thrive in ever-changing markets and to meet changing client needs at high speed. The locking into a long-term cloud strategy is also a requirement for many firms, although OpEx flexibility offers a flexible approach to IT infrastructure with pay-as-you-go cloud service. The main elements are thus anticipated to propel the market for cloud managed services throughout the forecasted timeframe. Additionally, because cloud managed services make it possible for businesses to provide, de-provision, and deploy IT infrastructure in a seamless and cost-effective manner, they aid in accelerating the development of IT projects and time-to-market software. For instance, the use of cloud computing services can reduce total cost of ownership by up to 50–60%, according to a survey done by management and IT consulting company Booz Allen Hamilton. The results of another study done by CIO Magazine reveal what company executives think about the deployment of cloud computing services in terms of cost-cutting.

Restraints
I. High risk of vendor lock in

When a business is restricted as a result of its excessive reliance on a service offered by a single vendor, this is known as vendor lock-in. In spite of the fact that businesses are choosing cloud computing services, it is crucial that they do not ignore the ramifications of switching providers.
later on. Technology infrastructure and reliance on a single proprietary vendor may to some extent limit industry expansion. There are several legal and financial duties associated with migration operations, and there is a significant chance of a provider failing overnight. In cloud computing, certain functions of software or computing infrastructure are delegated to a cloud provider, who then provides them over the internet as a service. For instance, whereas cloud-hosted applications provide software-as-a-service, cloud-hosted servers offer infrastructure-as-a-service (IaaS) (SaaS). As a result, there is a strong reliance on the vendor, particularly when moving databases in a cloud environment where data reformatting is necessary when the environment changes. Therefore, vendor lock-in situations could impede market expansion, although many large organisations have addressed the lack of standardisation with multi-cloud and hybrid cloud deployments.

**Opportunities**

I. **Shift from data centre outsourcing is an opportunity for the cloud managed services market**

There has been a significant shift toward hybrid infrastructure services, as evidenced by the expansion of cloud and industrialised services and the loss of traditional data centre outsourcing (DCO). While spending on colocation and hosting as well as infrastructure utility services is quickly rising, the conventional DCO market is contracting. This is anticipated to fuel the transition to cloud hosting and IaaS. The most significant migration in recent years has involved PaaS, IaaS, and Saas.

DevOps capabilities and automation are increasingly viewed as essential to achieving the technical and commercial benefits of cloud adoption as businesses adopt them.

The increased scalability, flexibility, remote collaboration, work automation, improved mobility, and reliable data protection are blamed for the rise in demand for cloud managed services. Furthermore, there has been a tremendous increase of data due to the expanding network of linked devices. As a result, it is anticipated that more people would choose cloud managed services as there is a rising need for an affordable data storage option. According to IT survey of data centre outsourcing published by Uptime institute, the data centre outsourcing decreased by 4% from 2020 to 2022.

**Challenges**

I. **Lack of data security**

Lack of data security, can lead to leak of personal information

II. **Various regulations**

Additionally, because cloud managed services make it possible for businesses to provide, de-provision, and deploy IT infrastructure in a seamless and cost-effective manner, they aid in accelerating the development of IT projects and time-to-market software. For instance, the use of cloud computing services can reduce total cost of ownership by up to 50–60%, according to a survey done by management and IT consulting company Booz Allen Hamilton. The results of another study done by CIO Magazine reveal what company executives think about the deployment of cloud computing services in terms of cost-cutting.
### 14.4. Key players in the India Cloud Managed Services market

#### Table 25: Key Players in the India Cloud Managed Services market

<table>
<thead>
<tr>
<th>Company Type</th>
<th>HCL Tech</th>
<th>Accenture</th>
<th>Cognizant</th>
<th>Tech Mahindra</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presence in India</td>
<td>Present in Bengaluru, Chennai, Coimbatore, Gurugram, Hubli, Hyderabad, Kochi, Kolkata, Lucknow, Madurai, Mumbai, Nagpur, Noida, Pune, Vijaywada</td>
<td>Presence in Bengaluru, Chennai, Gurgaon, Hyderabad, Kolkata, Mumbai, New Delhi, Noida and Pune</td>
<td>10 offices in India</td>
<td>Presence in 11 offices in India</td>
</tr>
<tr>
<td>No. of Employees in India (2022)</td>
<td>~18,000</td>
<td>~250,000</td>
<td>~200,000</td>
<td>~50,001 - 1,00,000</td>
</tr>
<tr>
<td>Key Products/Services</td>
<td>Managed Cloud Services, Application Modernization, Connected Cloud, Cloud Migration Services</td>
<td>Accenture Cloud First, Migration to AWS, Google and Microsoft Azure</td>
<td>Core Infrastructure Management, Cloud Infrastructure Modernization and Management, Digital Workplay Services</td>
<td>Data Cloud Migration</td>
</tr>
<tr>
<td>Business Strategy</td>
<td>Collaboration</td>
<td>Collaboration</td>
<td>Collaboration</td>
<td>Service Launch</td>
</tr>
<tr>
<td>Key Partnerships/Mergers/Acquisitions</td>
<td>In October 2022, HCL Tech collaborated with Google Cloud to expedite enterprise migration to Google Cloud.</td>
<td>In December 2022, Accenture collaborated with AWS to launch Velocity – a platform to Help Clients Drive up to 50% faster business transformation by removing the complexity of building and operating enterprise-scale applications and estates in the cloud.</td>
<td>In June 2021, Cognizant announced the creation of a new, dedicated Google Business Group (GBG) to help accelerate shared customers' cloud modernization journeys.</td>
<td>In December 2022, Tech Mahindra launched Cloud blazeTech, sector agnostic platform in India.</td>
</tr>
<tr>
<td>Revenue India</td>
<td>USD 12.6 Bn</td>
<td>-NA-</td>
<td>-NA-</td>
<td>USD 6.6 Bn</td>
</tr>
</tbody>
</table>

Source: Annual Reports, Secondary Sources, Frost & Sullivan Analysis
Note: Revenues are consolidated ones at company level,
USD = 78.6 INR (average exchange rate for Year 2022)
Financial Calendar: April – March 2022-23 (For all companies)
India’s IT industry is expanding at a fast rate, indicating a promising future for cloud administration. There are millions of Small and Medium-Sized Businesses (SMBs) in India that require a robust application to help them establish and expand their businesses. The leading IT companies in India, TCS, Infosys, Tech Mahindra, and Wipro, have cloud ventures to their names. The competition is fierce as the market is expanding and global giants such as IBM and Microsoft have also commissioned efforts.

Frequently, Indian businesses encounter concerns with cloud managed services, including vendor lock-in, security worries, storage location, deployment expertise, integration challenges, and pricing, to name a few.

Netweb has positioned itself as a unique provider of cloud managed services in this regard, acknowledging that a one-size-fits-all strategy does not provide client satisfaction. Whether businesses are migrating their existing application to the cloud or building a cloud-native platform, Netweb is well-equipped to migrate and manage business-critical workloads on multi-cloud computing platforms, assisting them in each phase of the cloud development life cycle, such as assessing the infrastructure, designing a cloud data migration roadmap, and ensuring its maintenance. Netweb conducts a comprehensive analysis of the enterprise IT landscape and develops a comprehensive road map for their cloud journey.

Tech Mahindra has been actively developing cloud managed services in India. In 2020, Tech Mahindra announced a strategic partnership with AWS to develop cloud-based solutions for businesses. The partnership aims to help customers migrate to the cloud, optimize their workloads, and accelerate innovation. The company’s cloud migration framework includes assessment, planning, and execution phases to ensure a smooth transition. Implementing DataOps as a part of data modernization process; rationalization of data and its pipelines before migration to cloud; & automation of data and data pipeline migrations and minimization of business disruption with failover plans are some of the best offerings by Tech Mahindra. Cognizant has a strategic partnership with Microsoft to deliver cloud-based solutions to customers. The partnership includes the development of industry-specific cloud solutions, migration of applications to the cloud, and modernization of legacy applications. Cognizant Cloud Migrate is a comprehensive migration offering that helps enterprises fast track their cloud strategy with a holistic, structured, and agile migration factory approach for full-stack migration that includes infrastructure, security, apps and DevOps.

Accenture offers cloud migration framework that brings industrialized capabilities for industry-specific tools, methods, and automation across all cloud models and multiple delivery methods (IaaS, PaaS, and SaaS). The company scans and access infrastructure, application & data to determine services based on strategic business needs. HCL Technologies multi-cloud management platform provides unified visibility and control over cloud resources. HCLTech has added public cloud solutions to its current portfolio of cloud services including MCOD-AWS, SAPoD, MyCloud™, DryICE™, MyXalytics™, Cloud Inception, SDI Innovation Garage, RecoverNXT, BackupNxt, ElasticOps etc. These solutions will allow development of new workloads besides migrating existing ones with management of cloud environments.
15. Global Enterprise Networking Market
**Scope & Definition**

Enterprise Network is made up of routers, switches, and wireless access points and works by mediating data transfers between desktop, servers, and other devices. It is the backbone for any organization’s communication channels and helps in connecting devices within departments. They are usually configured to facilitate access to data and gain insights, which help employees in finding solutions in analytics.

A network switch is a networking tool used to link several computer network devices together. It forwards data between devices, unlike routers, which forward data between networks. It connects users, applications, and equipment across a network so that they can communicate with one another and share resources. The simplest network switches offer connectivity exclusively to devices on a single local-area network (LAN). Some of the different types of network switches include managed, modular, unmanaged, and stackable.

**15.1. Global Enterprise Networking Market Overview**

The global enterprise networking market was USD 67.3 Bn in FY 2022. The market is forecasted to be USD 70.8 Bn in FY 2023 and is expected to reach USD 96.7 Bn by FY 2029 with a CAGR of 5.3% over the forecast period (FY 2023-2029).

Transferring data between computers, servers, and other devices is made easier by the enterprise network, which is made up of wireless access points, routers, and switches. It acts as the cornerstone for all organisational channels of communication and makes departmental device connectivity easier. They are usually designed to make it simple to access data and gather insights, which allows staff to quickly find solutions to analytics-related issues. Government has taken steps to speed it up digital transformation have also increased the need for router, switch, and wireless LAN networks, which is expected to drive market expansion in the future. The higher-speed segments of Ethernet switch market continue to see strong growth due to hyperscalers and cloud providers. The market for 200/400 GbE switch grew consecutively by 67.4% during the first and second quarters of 2022, with port shipments increasing by 89.5%. Sales of 100GbE switches made for 26.2% of the market's overall revenue in the second quarter of 2022; these revenues increased by 28.3% year over year, while port shipments increased by 23.4%. Revenues for 25/50 GbE increased by 22.1% year over year in the second quarter of 2022, while port shipments rose by 5.4%.

Major players in the global enterprise networking market are CISCO, Huawei, and Hewlett Packard Enterprises.

Exhibit 79: Global Enterprise Networking Market (USD Bn) - FY 2019-2022E (Historical and Estimated years)
Market Drivers, Restraints, Opportunities & Challenges – Enterprise Networking

Market drivers

I. Increased adoption of cloud services among organizations – The demand for cloud-based solutions is growing as a result of the growth of technological applications and consumer preference for the cloud, which enables distant data access. The demand for cloud-based solutions among companies is being pushed by an increasing awareness amongst companies of the significance of saving money and resources by shifting their data to the cloud rather than building and maintaining on-premise infrastructure. Due to these advantages, cloud-based solutions are now being used by both large corporations and SMEs more frequently. In the years ahead, public cloud and virtualisation will be able to reduce the initial cost of software by dividing them, that will surely result in less hardware to be used. By 2021, cloud data centres are expected to process 94% of all loads and computing instance, opposed to only 6 for datacentres, based on the CISCO Global Cloud Index. This shows the future potential for help desk deployment in the cloud around the globe. It is expected that major sectors, like banking, will use cloud-based service deployment more and more. This is a result of the IT industry’s ongoing search for optimised infrastructures and the capability of solutions builders to build a hybrid cloud-based solution from a variety of suppliers, thereby boosting the studied market growth.
II. Augmentation in software-defined networking (SDN) integration with existing network infrastructures – Network management is separated from necessary network hardware in software defined networking, a type of networking architecture. Administrators can alter the network traffic flow in response to technological advancements thanks to software defined network (SDN). SDN accelerates the installation of services and applications while decreasing the complexity of statically described networks. In order to improve networking capabilities, SDN architecture is widely employed in 5G infrastructure. It also makes the deployment and updating of network resources easier. To service a wide range of clients and increase their market share in different end user industries, companies are collaborating with other companies in alliances or developing new products. For e.g., In March 2022, Vodafone and Nokia took proof-of-concept tests in Europe. Based on the success of these testing, Vodafone and Nokia intend to roll out the technology more widely in the coming years. In October 2021, Pluribus Networks, a company specializing in software-defined networking and open connectivity secured USD 20 million in a round headed deal by Morgan Stanley Expansion Capital. The money is expected to fuel R&D investment for multiple new product initiatives along with sales and marketing resources that will further accelerate the company’s penetration into the distributed cloud market, while supporting expansion into adjacent sectors. It will also enable expansion of company into new markets as service providers in the coming years.

Market restraints
I. Enterprise application's cloud compatibility and interoperability issues: The main obstacles to the adoption of cloud technology are compatibility and interoperability issues, despite the fact that it offers a wide range of advantages and capabilities. This can be due to the high expense of replacing the hardware required for updating obsolete infrastructure. The use of filetypes and protocols, reliance on proprietary services, and a dearth of data "export" functionality all contribute to some market restraint. The need for compatible interfaces like PaaS frameworks grows as a result of the need for high-tech user interfaces with unique APIs, tools, frameworks, and platform dependencies while deploying cloud services. IaaS services' limited operating system support, proprietary APIs, and proprietary hypervisors are additional issues that might limit the market's development.

Market opportunities
I. Increasing digital transformation – Because of the accelerating digital transformation facilitated by data and networking such as IoT, blockchain, cognitive technologies, and advanced analytics, the adoption of connection advancements is accelerating throughout many industries. Thanks to network-as-a-service, businesses can gain from increased flexibility and even speed gains in their network infrastructure. Businesses can be more cost-conscious with on-demand purchasing by only spending money on the networking services they require actual. Because they won’t have to start from zero when building their networks or contracts, companies that want more provisioning options may benefit from network-as-a-service. Due to the growing in need of wireless communication in industrial and commercial activities, the market for network as a service is predicted to soon benefit from new
possibilities. A cloud delivery strategy called "network as a service" makes it simpler for businesses to maintain their networks.

Key Challenges

I. Privacy and data security concerns - Even though NaaS offers major benefits, some problems, like dependability worries, may limit the market's growth over the forecast period. Hiring a third-party network infrastructure vendor to host crucial business infrastructure entails having faith in the viability of the provider's business. Businesses relying on the providers may have to completely replace important infrastructure if they are not able to sustain competition in the market, as this would render it impossible to operate. Furthermore, organisations are likely to be worried about the security risks. Its activities might be handled by an outside company. The third-party managers have so far taken the utmost caution when delivering the services. However, the threat of data breaches is always on, which also challenges market growth. Privacy concerns are expected to grow as a result of cybercriminals' efforts to penetrate security outer perimeter and move inside them. Companies that only use on-premises firewalls and VPNs are unable to deliver timely end-to-end security coverage due to a lack of visibility, solution integration, and agility. As proof, the number of large-scale, multi-vector mega attacks is rising, causing havoc on businesses and people everywhere. According to recent Microsoft survey, companies adopted zero trust security during the COVID 19 pandemic, reducing cybersecurity costs. The pandemic has placed many businesses in a difficult predicament. To accommodate the shift to remote work, they must simultaneously improve their cybersecurity processes while keeping costs down as a fragile economy lowers their budgets. According to a recent Microsoft poll, businesses have embraced zero trust cybersecurity and broadly adopted multi factor authentication However, many are running into budget constraints as they look to go all in on cloud-based security.

15.2. Overview on the Global Network Switches market

One of the markets expected to grow under enterprise network is the enterprise network switches market.

The global network switches market is expected to be USD ~8.3 Bn as of FY 2023. The market is expected to grow with a CAGR of 6.5% between FY 2023 and FY 2029.

The market for network switches is anticipated to grow because of the increased need for data centres worldwide, the need for simpler networking communication management & automation, and rising investment in digital platforms. Also, the necessity for effective administration of telecom services has grown as a result of the fierce rivalry among telecom service providers worldwide. The need for network switches is anticipated to rise as the number of data centres run by telecommunications service providers, cloud-based solution providers, and government organisations increases.

Additionally, it is predicted that the market will rise during the forecast period due to rising internet penetration. However, it is projected that concerns with device compatibility and bandwidth fluctuation will impede the growth of the global market for network switches. Unfortunately, the market for network switches is also being constrained by their high operational costs.
Exhibit 81: Global Enterprise Network Switches Market (USD Bn) - FY 2019-2022E (Historical and Estimated years)

Source: Frost & Sullivan Analysis

Exhibit 82: Global Enterprise Network Switches Market (USD Bn) - FY 2023F-2029F (Forecasted years)

Source: Frost & Sullivan Analysis

Market Drivers & Challenges – Enterprise Network Switches

Market Drivers

I. Enterprise network switches deliver performance, automation, and built-in analytics to support current and future business needs. For example, most of the switches has – 1) A single OS for simplicity – that deliver a consistent operator experience, simplify network design, and unify management by giving IT the flexibility they need to deploy the same hardware and software, from Edge access to data center; 2) Automation to improve efficiency – can leverage the agility of cloud-native software, promote programmability, reduce manual tasks, and enjoy error-free configurations; 3) Enable always-on networks — even during upgrades; 4) Faster troubleshooting

Market Challenges

II. They are more expensive than network bridges.

III. Network connectivity issues on network switches are difficult to trace.
IV. Cyber attackers can capture IP addresses or spoof Ethernet frames when the switch is in promiscuous mode.

15.3. Key players in the global enterprise network switches market

Table 26: Key players in the global enterprise network switches market

<table>
<thead>
<tr>
<th></th>
<th>CISCO</th>
<th>Arista</th>
<th>Juniper</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Company Type</strong></td>
<td>Cisco Systems</td>
<td>Public</td>
<td>Public</td>
</tr>
<tr>
<td><strong>Headquarters</strong></td>
<td>Public</td>
<td>California, US</td>
<td>California, US</td>
</tr>
<tr>
<td><strong>Geographical Presence</strong></td>
<td>California, USA</td>
<td>North America, Latin America, Europe, Middle East, APAC</td>
<td>North America, Europe</td>
</tr>
<tr>
<td><strong>No. of Employees (2022)</strong></td>
<td>~83,300</td>
<td>~ 3,612</td>
<td>~ 10,901</td>
</tr>
<tr>
<td><strong>Key Products/Services</strong></td>
<td>Managed software-defined WAN (SD-WAN) and network access including wireless to security, unified communications services, and more—either in a public cloud or on virtualized customer premise equipment (vCPE)</td>
<td>Arista EOS Router, CloudVision, Cogbitive WiFi, Arista 7280R3, Arista 7500R3, Arista 7800R3 Series</td>
<td>EX Switches, EX4100 Multigigabit Ethernet Switch, EX4100 Ethernet Switch, EX4100-F Ethernet Switch, EX4400 Multigigabit Ethernet Switch, EX4400 Ethernet Switch, EX4300 Multigigabit Ethernet Switch, EX 4300, EX 3400, EX 2300, EX 2300 Multigigabit,</td>
</tr>
<tr>
<td><strong>Business Strategy</strong></td>
<td>Managed software-defined WAN (SD-WAN) and network access including wireless to security, unified communications services, and more—either in a public cloud or on virtualized customer premise equipment (vCPE)</td>
<td>Product Launch</td>
<td>Partnership</td>
</tr>
<tr>
<td><strong>Key Partnerships/ Mergers/Acquisitions</strong></td>
<td>Acquisition, Investment, Alliances</td>
<td>In November 2022, the company announced a comprehensive network automation solution with the Arista Continuous Integration (CI) Pipeline. Built on Arista's EOS Network Data Lake (NetDL™), the Arista CI Pipeline helps enterprise customers adopt a modern network operating model.</td>
<td>In January 2023, Juniper partnered with NEC corporation to deliver electricity and gas to over 1.1 million customers, linked up to its grid via 28,441km of electricity lines and cables, as well as over 6,100km of gas pipes to enhance WiFi experience.</td>
</tr>
<tr>
<td><strong>Total Revenue</strong></td>
<td>51.6 Bn (2022)</td>
<td>USD 4.38 Bn (2022)</td>
<td>USD 5.3 Bn (2022)</td>
</tr>
</tbody>
</table>

Source: Annual Reports, Secondary Sources, Frost & Sullivan Analysis; Note: Revenues are consolidated ones.
16. India Enterprise Networking Market
16.1. India Networking market Overview

The India Enterprise Networking market was USD 1,269.4 Mn in FY 2022. The market is forecasted to be USD 1,382.4 Mn in FY 2023 and is expected to reach USD 1,984.1 Mn by FY 2029 with a CAGR of 6.2% over the forecast period (FY 2023-2029).

Exhibit 83: India Enterprise Networking Market (USD Mn) - FY 2019-2022E (Historical and Estimated years)

![CAGR 12.1%]

Source: Frost & Sullivan Analysis

Exhibit 84: India Enterprise Networking Market (USD Mn) - FY 2023F-2029F (Forecasted years)

![CAGR 6.2%]

Source: Frost & Sullivan Analysis

Companies, such as CISCO Systems is witnessing greater adoption as an enterprise networking service provider in India in areas, such as defence, weather and climate prediction, academic research, semiconductor industry, automotive industry, and oil & gas sectors.

16.2. India Enterprise Networking Market by Product Type

India Enterprise Networking market by product is segmented into Ethernet Switches, Routers and WLAN. Ethernet Switches held the largest share in FY 2022 and is expected to reach a value of USD 1011.9 Mn by FY 2029 at a CAGR of 5.6% over the forecasted period (FY 2023 - FY2029).

Exhibit 85: India Enterprise Networking Market (USD Mn), by Product type - FY 2019-2022E (Historical and Estimated years)
Exhibit 86: India Enterprise Networking Market (USD Mn), by Product type - FY 2023F-2029F (Forecasted years)

Source: Frost & Sullivan Analysis
Ethernet Switches - Due to factors including the increasing need for strong communication infrastructure in the automotive and transportation industries, as well as the increased use of industrial Ethernet switches because of their benefits, the market is poised to grow. An increase in the use of these switches in industrial infrastructure such as smart grid, intelligent rail & traffic, security & surveillance, and other services is yet another reason for the expansion of industrial Ethernet switch market. The Indian government estimates the FDI in the telecom sector grew by 150% between 2014 and 2021, at USD 8.3 billion in 2014 to USD 20.7 billion in 2021. Several companies that provide telecom infrastructure and services, like Basic Cellular, United Access Services, and Commercial V-Sat, have engaged in the sector. CISCO captured around ~57% market share in the ethernet switches followed by Hewlett Packard Enterprise (HPE) and Juniper at 4.5% and 4.4%, respectively in 2021.

One of the key drivers for growth of indigenous OEMs is government initiative of Make in India which is aimed at stimulating the local economy and bringing Indian made products and services to the global market-place.

While the market is poised for growth for reasons discussed above, Frost & Sullivan believes security is an important reason for the government to push for make in India switches. There have been many instances of cyberattacks in the past which either resulted in power outage / blackout (cyberattack on India’s power grid that caused Mumbai blackout in 2020) or crippled the digital patient management system of a hospital (like the one on AIIMS Delhi which took all its servers offline). Hence the Government wants to take measures, such as use of make in India switches to reduce such threats. There have been many other instances of such cyberattacks where foreign involvement is suspected, and which targeted India’s critical infrastructure. Such security concerns would likely enhance the demand of Make in India Network switches and as these would be manufactured at a lower cost in India than imported network switches, it will further drive the market of make in India switches for the forecast period.

The growth in the ethernet switches market and networking market as a whole is also expected to happen as a result of supplier displacement which will lead to higher than industry growth rate for Indian manufacturers of network switches. Tejas Networks in 2020 was selected as communication equipment supplier and bagged a 66 crore order for Indian defence network project from L&T construction.

Other example is of Digisol, which is a made in India IT networking brand that offers Network switches among other products. Some of the switching solutions provided by the company are managed switch, unmanaged switch, full managed switch, Industrial switch, and PON module.

Fujitsu India has developed a suite of top-of-rack switches that support flexible and efficient scale-out server infrastructure, especially in combination with new modular servers. This approach is expected to result in several improvements, including infrastructure efficiency for cloud computing, end-to-end virtualization, and consolidation. Fujitsu is doing close partnerships with network technology partners that will complement its portfolio for building complete IT infrastructures for the country. Storage-area networks (SANs) will continue to be the backbone of the data center network in India for the next investment cycle, but they need enhancements in terms of bandwidth and management functions. To do this, Fujitsu partnered with Broadcom, which recently acquired Brocade, the leading provider of SAN switches. And a lot of new use
cases are based on Ethernet networks, with bandwidths of up to 100 Gbit and increasingly virtualized fabric architectures for building dynamic data centers. Fujitsu also partnered with Extreme Networks, which offers the best of breed, high performance IP Networking Switches.

Routers - The Indian router market is expanding quickly as a result of the enormous popularity of online games and the Internet of Things (IOT), which will drive market growth over the next five years. The availability of a wide variety of router types, compelling product offers, and increasing consumer demand for web-enabled devices are a few of the key main factors driving the growth of this market. All these reasons are anticipated to fuel the growth of the Indian router market by 2028. For instance, the Indian government predicts that there will be 23 million IoT devices. In order to invest roughly 4.5 lakh crores by 2024, the government introduced the 100 Smart Cities Mission in 2018. CISCO also holds a market share of ~63% in the router market, followed by Nokia and Juniper at 15.2% and 10.8%, respectively.

WLAN - Due to the drop in mobile phone costs, there are now significantly more connected devices in the wireless local area network market. Over the anticipated period, there will be significant rises in the number of devices connected to wireless local area networks all over the world, including tablets, speakers, laptops, personal computers, smart TVs, smart set-up boxes, wearable tech like smartwatches, smartglasses, and smartfit bands, as well as smart home appliances like fans, air conditioners, and LED lights. For instance, according to Counterpoint Research, shipments of smart TVs increased by about 33% over the previous year in 2022, that has further increased WLAN device adoption in India. All these factors will lead to higher adoption and growth of Network-as-a-Service (NaaS) in India. The market was fairly dominated by TP Link that held a market share of ~28% in this segment, followed by HPE with 10.0%.

16.3. Overview of India Network Switches market

The India network switches market expected to be USD ~146 Mn as of 2023. Market growth in India can be attributed to increasing government initiatives, rising number of colocation data centers, and growing adoption of digital technologies.

The growth of network switches in India is driven by several factors, including the increasing adoption of digital technologies, the growing demand for cloud-based services, and the rise of the Internet of Things (IoT) and edge computing. Indian organizations across industry verticals are increasingly embracing digital transformation. This is driving the adoption of cloud-based services, which in turn is driving the need for high-speed and reliable network infrastructure. Network switches are a critical component of this infrastructure, and the demand for them is expected to grow in line with the growth of cloud-based services. The adoption of IoT and edge computing is on the rise in India, driven by the need for real-time data analytics and decision-making. These technologies require a high-speed and low-latency network infrastructure, which again drives the demand for network switches.

India is rapidly increasing its connectivity with the rest of the world, driven by initiatives such as BharatNet and submarine cable projects. This increased connectivity is expected to drive the demand for network switches and related infrastructure. The e-commerce industry is growing rapidly in India which in turn is driving the need for high-speed and reliable network
infrastructure, which again drives the demand for network switches. Overall, network switches market is poised to grow in India driven by factors such as digital transformation, IoT and edge computing, government initiatives, increasing connectivity, and the growth of the e-commerce.

**Make in India initiative to drive network switches market in India**

India imports a significant portion of its network switches, which leads to high import costs. By promoting local manufacturing, "Make in India" initiative can reduce these costs and make network switches more affordable for Indian consumers. The initiative will help develop local expertise in the manufacturing of network switches and lead to development of local supply chains, research and development facilities, and a pool of skilled workers. Overall, "Make in India" initiative has the potential to create a positive impact on the manufacturing of network switches in India by promoting local manufacturing, reducing import costs, boosting the economy, and developing local expertise.

**Supplier displacement to benefit indigenous manufacturers**

The growth in the network switches market for Indian manufacturers is also expected to be driven by supplier displacement as more and more switches get sourced locally from indigenous manufacturers. This will also result in higher than industry growth rate for Indian manufacturers of network switches. Supplier displacement can occur for reasons such as change in demand pattern, new technology adoption, and the need to improve supply chain efficiency. But one of the main drivers for supplier displacement in India is concerns around security. This bodes well for indigenous companies manufacturing network switches in the country. Further, initiatives such as ‘Make in India’ will promote domestic manufacturing and encourage companies to source components locally. The initiative will will lead to the emergence of new suppliers of network switches in India, and also help reduce costs and improve supply chain efficiency.

**Market Drivers & Opportunities – Enterprise Network Switches**

**Drivers –**

I. **Augmented demand for data centers in India**

Growth in data centers in India is expected to drive the demand for Network switches in the country. India presently has 161 data centres spread over 26 locations, having fallen behind other countries in the fight for digital adoption. India's journey towards becoming a completely digital economy is nearing a turning point. According to a whitepaper from ICRA and an article from the Economic Times 2022, investments of up to Rs 1.20 lakh crore might boost the capacity of Indian data centres. As 3,900-4,100 MW of capacity are added overall, it is predicted that the capacity of the Indian data centre industry will increase by a factor of five.

Since the outbreak, smart devices, IoT, and online shopping have been increasingly popular in India. The country's young people are expected to use digital gadgets more frequently since they are tech savvy, which will result in a huge amount of data that will eventually require the use of data centres and data centre servers. The Indian government has also advised categorising the sector of data centres with critical infrastructure, such as highways, trains, and power, in order
to secure the data of its consumers. In addition, it is providing incentives for the building of data centres, which is enticing other businesses to benefit.

II. Introduction of 5G in India

With the introduction of 5G in India, web traffic flows are changing and moving toward the metro and network edge which is driving the need for common routing and switching aggregation platforms - thus driving the demand for network switches. The growth in Network switches is due to rise in 5G use cases and applications that enable video streaming, mobile gaming, and augmented reality.

III. Lack of data security

Security is one more reason for government pushing the make in India switches. Some of the below mentioned cyberattacks are a result of hacking of unprotected and compromised switches. Network switches are often overlooked by security teams but can become a gateway for hackers because switch infrastructure is a large web of interconnected data highways and therefore can be easily targeted or compromised by hacker groups. Government also suspects that Chinese malware attacks are increasing and hence it is time to take measures, such as use of make in India switches to reduce such threats. For e.g., Chinese cyberattack on India’s power grid that caused Mumbai blackout in 2020 after the tension at Galwan valley in Ladakh. Another example is of AIIMS Delhi that has been forced back in time after a cyber-attack took all its servers offline crippling the hospital’s digital patient management system. AIIMS confirmed the hack and added that data restoration took time leading to inconvenience and difficulty in managing patients. With the server being down, the OPD and sample collection were handled manually but the sample system for those who do not have a Unique Health Identification were affected. Some other recent cyberattacks with alleged Chinese involvement that targeted India’s critical infrastructure are - Chinese hackers targeted seven Indian centers in Ladakh responsible for carrying out electrical dispatch and grid control, UIDAI Database suffered intrusions by Chinese hacking groups through June and July 2021, although it was not clear what data was stolen, etc. Therefore, Government believes that using ‘Make in India’ switches can lower the number of such malware and cyberattacks.

Opportunities –

I. PLI Scheme supporting Make in India Switches

The PLI Scheme for domestic manufacturing of telecom and networking products such as switches, routers, 4G/5G radio access network, wireless equipment, and other internet of things (IoT) access devices, has been made operational from 1st April 2021. The Scheme will be implemented within the overall financial limit of Rs 12,195 crore for 5 years. Objective of the scheme is to create global champions from India who have potential to grow using cutting edge technology and thereby penetrate the global value chains in telecom products and play an important role in the larger vision of “Digital India”. It offers manufacturing companies incentives on incremental sales from products manufactured in domestic units.

II. Push for Make in India Switches
In support of the Make in India initiative, US based Telcom gear maker, Ciena is working with its existing electronics manufacturing services partner, Flex to add additional manufacturing capacity for its Routing and Switching portfolio. The company expects to deliver first of its made in India switching and routing to customers in early 2023. With the introduction of 5G in India, web traffic flows are changing and moving toward the metro and network edge, increasing the need for common routing and switching aggregation platforms. Hence, Ciena’s move to manufacture in India supports the growing local demand for this specific category of products.

16.4. Key players in the India enterprise network switches market

Table 27: Key players in the India enterprise network switches market

<table>
<thead>
<tr>
<th>Company Type (Public or Private)</th>
<th>Arista</th>
<th>Cisco Systems</th>
<th>NVIDIA</th>
<th>Juniper</th>
<th>Tejas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presence in India</td>
<td>Pune, Mumbai</td>
<td>Present in 7 locations in India</td>
<td>Bangalore, India</td>
<td>Bangalore, India</td>
<td>Bangalore, Gurgaon, Mumbai, Kolkata</td>
</tr>
<tr>
<td>No. of Employees in India (2022)</td>
<td>~1,000</td>
<td>~1,000</td>
<td>~1,000-5000</td>
<td>~1,000-5000</td>
<td>~900</td>
</tr>
<tr>
<td>Key Products/Services</td>
<td>Modular 100/400G Spine Switches, 7816R3, 7808R3, Cloud Optimized 100G / 200G / 400G</td>
<td>Managed software-defined WAN (SD-WAN) and network access including wireless to security, unified communications services, and more— either in a public cloud or on virtualized customer premise equipment (vCPE)</td>
<td>Entire Network Security and Visibility, Full Solutions Stack Provider, Offload + Performance for Server and Storage</td>
<td>Enterprise WAN, SD-WAN, Wireless Access, Wired Access</td>
<td>Broadband access networks, premium enterprise connectivity</td>
</tr>
<tr>
<td>Business Strategy</td>
<td>Acquisition</td>
<td>Investments</td>
<td>Partnerships</td>
<td>Product Launch</td>
<td>Investment</td>
</tr>
<tr>
<td>Key Partnerships/Mergers/Acquisitions</td>
<td>In February 2020, the company acquired Big Switch Networks to strengthen the company’s enterprise networking</td>
<td>In June 2021, CISCO invested to USD 3.5 million in Indian enterprise NaaS start-ups for a minority stake. The company has a portfolio of about 10 start-ups that it has already invested in directly or through investment partnerships with VC funds.</td>
<td>In July s2022, Siemens and NVIDIA expanded their partnership to enable increased use of network technology</td>
<td>In August 2020, Juniper Networks expanded its network products lineup with launch of 802.11 ax wireless access points- AP63, AP33, AP32 and AP 12.</td>
<td>In November 2022, to invest Rs 750 Cr under design-led scheme for network enterprise industry</td>
</tr>
<tr>
<td>Revenue India</td>
<td>USD 33.5 Million</td>
<td>USD 1051.5 Million</td>
<td>USD 389.1 Million</td>
<td>USD 262.4 Million</td>
<td>NA</td>
</tr>
</tbody>
</table>

Source: Annual Reports, Secondary Sources, Frost & Sullivan Analysis
Note: Revenues are consolidated ones at company level,
USD = 78.6 INR (average exchange rate for Year 2022)
Arista offers modular spine switches with programmable support for over 2.5 million routes, unprecedented 400/100G and 25G density and flexible table sizes with a proven cloud-grade architecture. CISCO on the other hand offers Firewall 3100 Series, secureX and UCS X-Series. These are designed to support hybrid workers and make your Zero Trust more workable. NVIDIA offers switches, based on industry-leading application-specific integrated circuit (ASIC) technology, with a wide variety of modern network operating system choices, including NVIDIA Cumulus Linux, SONiC, and Linux Switch. Juniper offers optimized user and application experiences while improving networking economics with cloud-grade, high-density Ethernet switching across your data center, campus, and branch locations. These switches deliver agile, reliable, and scalable networks with AI-powered automation and insights. Tejas switches are suited for realizing an efficient access layer for enterprise, campus and industrial networks.
17. GLOBAL & India 5G and 5G ORAN MARKET
17.1. Overview of ORAN and 5G ORAN

O-RAN, or Open Radio Access Networks, is revolutionising the telecom sector. It replaces the conventional appliance-based RAN deployment with one that is more open, interoperable, standard-based, and virtualized. By removing vendor lock-in, O-RAN deployments let the telecom service providers save money, benefit from virtualization, and use telecom edge for cutting-edge apps and services. The O-RAN alliance, a global collaboration of mobile network operators, manufacturers, research teams, and academic institutions active in the Radio Access Network (RAN) business, developed the O-RAN architecture.

O-RAN has numerous benefits. A larger ecosystem results from an open environment, with more vendors contributing the constituent parts. More innovation and options for the operators are there in O-RAN. New services may also be added. The O-RAN specification complements 3GPP, ONAP and ETSI specifications. Open RAN aims to create easier interoperability on existing 3GPP RAN interfaces. In addition, the O-RAN Alliance is defining new interfaces not currently being specified by 3GPP. The O-RAN Alliance started in June 2018 and has rapidly gained momentum. The alliance inherited the activities of the previous xRAN and C-RAN forums. Nokia has contributed to both xRAN and C-RAN and was the first leading RAN vendor to join the O-RAN Alliance. Nokia is widely represented in all O-RAN working groups and co-chairs groups that are defining the O-RAN Fronthaul Interface and the O-RAN near-real-time RAN Intelligent Controller (RIC).

Additional advantages include increased customer choice and market competition, decreased equipment costs, and enhanced network performance. Vendors of radio access networks exclusively provide proprietary hardware and network features. To escape from this heritage, companies started creating open RAN standards in response to this. Typically, proprietary items cost more than their generic counterparts. A network operator is limited to using the products of one RAN vendor because there aren’t any third-party RAN components that can be integrated into the infrastructure of a RAN vendor. To leverage these benefits several MNCs are collaborating to provide seamless 5G services across the globe. For instance, In October 2022, Qualcomm collaborated with Vodafone to develop and test Next-Generation 5G Open RAN Infrastructure in Europe.

In fact, ORAN opens up new possibilities for radio access network technologies. Operators must take network security into account before using ORAN technology, though. A secure microservices-based architecture is required for a contemporary, cloud-native version of ORAN. Functional conformity to component requirements is offered by the O RAN Alliance. However, stakeholders need testing, verification, integration, and interoperability of the commoditized 5G RAN components for implementation. In order to support a plug-and-play paradigm, they are required. Therefore, in addition to the commoditization of services, effective orchestration of the many ORAN 5G components is also required. You can only ensure steady networks after that. The use of ORAN technology might make security issues worse. First, because an Open Radio Access Network may have several vendor apps, the API exposure grows. And each app will make its APIs available. The network will also be heterogeneous since different network types will host different apps. Therefore, when implementing, we cannot consider any network to be secure.
Services Segment

5G Cloud related services for EDGE

5G and edge computing are introducing a world of new revenue opportunities across manufacturing, transport, gaming and more. In the telecom industry, edge computing, also known as Mobile Edge Computing (MEC), or Multi-Access Edge Computing, offers execution resources (compute and storage) for applications with networking close to the end users, often within or at the boundary of operator networks.

Edge computing can also be installed in houses, vehicles, including trains, planes, and private cars, as well as at business locations, such as within factory facilities. Communication service providers or other sorts of service providers may oversee or host the edge infrastructure. Several use cases call for the deployment of separate apps at diverse locations. A distributed cloud, which can be thought of as an execution environment for applications across numerous sites with connection controlled as one solution, is helpful in such situations. Recently, Qualcomm has begun sampling the Qualcomm X100 5G RAN Accelerator Card and Qualcomm QRU100 5G RAN Platform to global customers and partners for integration and verification of next generation 5G mobile infrastructure solutions.

Communication Service Providers (CSP) are searching for new sources of income to expand their operations, particularly in the enterprise sector, which will become more crucial in the next years. They are now better equipped to offer new services thanks to the development of 5G and edge computing.

The enterprise opportunity should be viewed in its entirety to fully appreciate the edge computing opportunity. For example, edge computing will enable much more expansive use cases inside the Internet of Things (IoT) and may even be combined with other enterprise products like 5G private networks. The enterprise opportunity should be considered in its entirety when examining the edge opportunity because edge computing will be a key enabler for many more expansive use cases, such as those involving the Internet of Things (IoT) and may even be bundled with other enterprise products like 5G private networks. Edge computing's fragmented and rapidly changing ecosystem. Interfaces, standards, and business models for technical solutions are not yet established. To establish end-to-end solutions, several parties must work together, and CSPs must carefully assess which sectors they can expand their offerings into beyond connection.

Since solutions for new use cases require specialised domain expertise from industry participants outside of telecom, the edge application ecosystem is driven by third-party apps from outside the telecom business. As a result, developers and third-party application providers will have access to edge infrastructure, which will host a wide variety of applications, each with unique properties and requirements.

AI and ML workload related services

Unlike 4G, which has sector-based coverage, 5G, which is being deployed utilizing mm-wave for managing workloads. It has beam-based cell coverage. The 5G cell site can compute a list of potential beams that come from either the serving or a nearby cell site with the help of a
machine-learning algorithm. A set that has a high likelihood of containing the best beam has fewer beams overall and is considered optimum. The highest signal strength beam, also known as RSRP, is the best beam. The likelihood of locating the best beam rises with the number of active beams present, while more active beams use more system resources.

The serving cell site determines if the user equipment (UE) needs to be handed over to a neighboring cell site and which candidate beam after receiving measurements and reports from all the candidate beams from the user equipment (UE). Based on measurements of the Beam Reference Signal (BRS), which includes variables like the Beam Index (BI) and Beam Reference Signal Received Power, the UE reports the Beam State Information (BSI) (BRSRP). Finding the best beam using BI can result in a multi-class classification (MCC) problem, whereas finding the best beam using BRSRP can result in a multi-target regression (MRT) problem.

One crucial 5G technology is massive MIMO. Massive simply describes the base station antenna array's substantial number of antennas (32 or more logical antenna ports). By serving multiple spatially dispersed users with an antenna array in the same time and frequency resource, massive MIMO improves user experience by greatly improving throughput, network capacity, and coverage while decreasing interference.

Most resources in wireless networks today are wasted and not optimised for high-bandwidth and low-latency scenarios due to the one-size-fits-all approach to implementation. Fixed resource allocation for several apps with different requirements might not be the most effective way to use the network's resources. A common physical infrastructure is used to generate many dedicated virtual networks utilising network slicing, where each network slice can be independently managed and orchestrated.

Incorporating ML and AI into 5G networks can improve automation and adaptability, facilitating effective orchestration and dynamic network slice provisioning. In order to build smarter wireless networks, ML and AI are being applied to wireless technology, which is still in its infancy. The architecture, design, and propagation models of the 5G network will be complicated, as will the user's mobility and usage habits. With the expansion of IoT devices, ML and AI will be crucial in helping wireless operators develop, run, and manage 5G networks. In 5G systems, ML and AI will provide more intelligence and enable a transition from controlling networks to managing services. Wireless operators can shift from a human management model to self-driven automatic management by using ML and AI to meet a variety of use cases, which will alter network operations and maintenance procedures.

High levels of overlap exist between ML, AI, and 5G. They all deal with low latency use cases where data sensing and processing must be done quickly. These use cases include remote healthcare, time-sensitive industry automation, and self-driving autonomous cars. In comparison to 4G, 5G offers ultra-reliable low latency that is 10 times faster. However, a paradigm shift is required from the current centralised and virtualized cloud-based AI towards a distributed AI architecture where the decision-making intelligence is closer to the edge of 5G networks in order to achieve even lower latencies, to enable event-driven analysis, real-time processing, and decision making.
The global 5G ORAN market is estimated to be USD 0.8 Bn in FY 2022 and is expected to reach USD 14.5 Bn by FY 2029 at a CAGR of 51.5% between FY 2023 and FY 2029.

Exhibit 87: Global 5G ORAN Market (USD Bn) - FY 2019-2022E (Estimated and Historical years)

Exhibit 88: Global 5G ORAN Market (USD Bn) - FY 2023F-2029F (Forecasted years)

Source: Frost & Sullivan Analysis

What Is the Difference Between Enterprise 5G and 5G?

A corporate 5G model gives the business complete network control. The enterprise is the owner of the infrastructure, radio equipment, mobile core, and management software. In stark contrast to this are managed service providers and commercial 5G carrier services. Prior to this, only commercial carriers like AT&T or Verizon could be partnered with by enterprises to create private mobile networks. Businesses had little control over use prices, network accessibility, and data security under this paradigm. Due to complexity and spectrum licencing constraints, private organisations were unable to build their own 4G and 5G networks. Like how they own and manage Wi-Fi networks, businesses may now create their own private 5G networks.

A specialised wireless LAN solution called enterprise 5G was created to meet a company's needs. This makes it possible for a business to benefit from 5G in the following ways: speed up the transmission (up to 10 times 4G) Boost network capacity (Up to 10 times more capacity than 4G).
With its support for current technologies and ability to enable rapid and adaptable design, enterprise 5G is swiftly emerging as a crucial part of modern enterprise infrastructure. Enterprise 5G may be fully integrated into existing enterprise networks to help boost individual productivity, increase organisational competitiveness, and speed up workflows. Beyond the limitations of the modern workplace, 5G offers prospects for innovation that open new avenues for working, thinking, and resolving problems in the corporate world. The capacity to do any task remotely, regardless of how crucial it may be, and real-time control over all business processes are two significant common qualities that come to mind when thinking about the applicability of 5G for corporate transformation. Automating processes by using computational resources when necessary, running edge apps when appropriate, and attaining higher security levels without sacrificing overall performance.

17.2. Regional overview of the adoption of 5G globally

The fifth-generation mobile network, or 5G, is a brand-new wireless technology intended to deliver dependable, high-capacity connections with low latency. The global rollout of 5G networks has been significantly delayed. Mobile service providers from over 125 countries have already made investments in 5G technology. In addition, as of May 2020, 42 countries had launched 5G services. More than 2.6 billion 5G connections will exist globally by 2025, with North America, Northeast Asia, and Western Europe setting the pace for adoption.

**North America**

*American businesses did quite well in the 4G market.*

The 4G business in America was booming ten years ago. In America, 4G usage generated USD 250 billion in economic value through devices, mobile advertising, apps, and content, according to CTIA and Recon Analytics. This achievement was made possible by early domestic adoption of statewide 4G infrastructure, which unlocked and scaled new technologies, enabling them to eventually succeed on a worldwide scale. According to projections by BCG and CTIA, 5G in America is anticipated to have a USD 1.5 trillion economic impact this decade. Thanks in significant part to innovations developed by American companies on top of 5G, these numbers were initially reached domestically before spreading into a sizable global opportunity.

**Asia Pacific (APAC)**

Mobile service providers in the Asia Pacific region intend to invest USD 227 billion on 5G deployments between 2022 and 2025. That is a large chunk of cash, and it will have a sizable impact. These new networks are aiding in the transformation of business and manufacturing in addition to enabling cutting-edge new consumer services and fostering economic growth.

As the region works to recover from the epidemic, connectivity will be crucial to rebuilding Asia-Pacific economies and making them more resilient to shocks in the future. 5G networks, cloud services, edge computing, artificial intelligence (AI), big data, and the Internet of Things will all be key to fully achieving the promise of a post-pandemic digital economy. New 5G networks will significantly improve things.

**Europe**
The market-leading data and insights provided by European 5G Strategies may help communication service providers, technology vendors, and systems integrators support their market engagement by helping them develop and launch 5G B2B value propositions, use cases, and best practises. We also give data-driven forecasts of spending on private mobile networks and IoT use cases and suggestions that rely on 5G. Market shares and a forecast are also provided for the European unified endpoint management market.

Companies provide service providers, enterprises, and governments in Europe with quick, dependable, and high-quality connection as countries make the transition to 5G. They are laying the groundwork for the region's ongoing digital transformation by doing this. 5G Hubs have been set up all throughout Europe to give the innovation community a place to experiment with next-generation test apps, create new business models, and look at live test cases and pilots.

Further, the 5G market in European and Africa countries is expected to grow at a CAGR of 45.7% between FY 2023 and FY 2029. 5G is expected to drive growth in businesses globally.

**What differentiates 5G networks that are public from those that are private?**

Public 5G networks - Like the current mobile wireless networks, public 5G networks are controlled by mobile network providers and enable 5G in a specific location. Typical mobile wireless network providers prioritise giving as many users as possible enough bandwidth so they can stream 4K movies while they're on the road.

Private 5G networks - A private or local 5G network is directly maintained by the user, for instance, a company in the industrial sector, like how a WLAN is currently built. Private 5G networks can be tailored to satisfy the low latency and high availability requirements of industrial networks. Private 5G networks also offer data security because the owner has control over the data, and it stays inside the organisation in self-managed networks.

**17.3. Overview of the global 5G market by major end-use industries**

Applications ranging from straightforward ones like Virtual Reality (VR) and Augmented Reality (AR) gaming and Ultra-High Definition (UHD) video streaming to more sophisticated ones like robotic procedures, autonomous vehicles, and autonomous defence equipment are anticipated to be created because of the commercialization of 5G-enabled services. High-speed, low-latency data connection is projected to see a rise in demand because of next-generation technology. These factors are expected to increase demand for 5G services. The transformation to automated corporate operations is costing a lot of money in the manufacturing, healthcare, transportation, and logistics sectors.

For instance, it is anticipated that the use of robots to do jobs and procedures currently carried out by people will significantly transform the industrial environment. They would also need to have very low latency to be fully functional, carry out tasks efficiently, and adhere to safety standards. Benefits of 5G services, such as decreased latency and improved data connection, are anticipated to support such migrations.
**BFSI**

To meet consumer expectations and keep clients loyal, traditional banks are stepping up their digital transformation and modernization initiatives. Additionally, the global implementation of 5G networks will help banks achieve their new standards for customer care. Due to the epidemic, the banking sector today has no choice but to accelerate its digital transformation. 5G networks with high speeds can help banks run intricate procedures in real time and increase the efficiency of their websites and apps. For highly tailored IoT-enabled financial services and products, it holds immense promise. To deliver consistent interactions and a seamless customer experience across touchpoints, banks may connect devices like phones, wearables, and even autos. They may offer a complete omni-channel experience by combining the physical and digital banking channels.

**IT & ITeS**

Increased bandwidth and lower latency are features of 5G. High bandwidth and low latency are requirements for many applications. Driverless cars, telemedicine, remote medical treatments, video streaming, the larger entertainment business, and cutting-edge gaming are a few examples of application cases. Value-added services have started to be layered on by the intricate 5G ecosystem, which consists of network equipment providers, carriers, device manufacturers, and others. These services fulfil the promise of 5G while also boosting revenue. Tools and strategies for test and assurance have evolved to keep up with 5G's cutting-edge design and rapid deployment methods. Five critical ways that 5G will benefit the IT & ITES industries:

- **Automation** - Branch offices may be automated using cellular technology due to its increased speed and decreased latency. Alternatives to flexible dedicated connections.

- **MPLS and other dedicated lines** - which are typically used for latency-sensitive applications, can be replaced by 5G services, which are less expensive and more adaptable.

- **More users and gadgets** - 5G allows more users and connected devices in the same physical space without reducing availability because of its higher capacity.

- **Energy savings** - Being able to lower device power usage by up to 90% makes 5G an appealing IoT use case because certain IoT devices may have a 10-year remote battery life.

- **Improved security** - Thanks to greater security features like key management services, 5G is a more dependable option than 4G for IoT, branch, and other business traffic.

**Telecommunications**

It will take the telecom sector three to five years to completely develop 5G enterprise services, giving top companies an equal amount of time to conduct proof of concept and trials before deciding to completely rely on fifth-generation services for their business operations. The early trend suggests that private networking has garnered the most interest across all markets due to the diversity of benefits it will offer to businesses.

The scalability of IoT, cloud computing, and connectivity-as-a-service have been made possible by 5G, which has opened up major opportunities in the corporate sector. For the first time ever, the mobile communications industry is placing the business market first. In fact, serving
customers has been the only objective for the past 30+ years or more, but 5G is changing that. At the moment, mobile operators and their suppliers believe that serving enterprises rather than consumers offers a better chance for revenue growth. Telcos, manufacturers of network equipment, and independent software vendors (ISVs) can test these technologies with the aid of 5G Lab, prepare for wide-scale deployment, and confidently make investments. You may benefit from an open environment without the burden of manually integrating each component.

**Media**

Media consumption will increase dramatically with 5G. With video making up 90% of all 5G traffic, the average monthly traffic per 5G user will rise from 11.7GB in 2019 to 84.4GB in 2028. The global media market through cellular networks will grow from $170 billion in 2018 to $420 billion in 2028 ($124 billion in the US), showing a 9.8% CAGR over ten years. By 2028, consumer spending on mobile video, music, and gaming will nearly triple, hitting $150 billion worldwide ($29 billion in the US).

**Oil and Gas**

The oil and gas industry are growing on a global scale, and through 2024, gas consumption is expected to increase at a 1.6% annual pace. It is well known that the oil and gas industry depend largely on dependable, secure, and robust networks to support their daily operations. The new mission-critical applications for the sector are constructed on strong computing platforms. Although they use the same amount of bandwidth, these give the control centre more specific information. Network operators have continuously improved to offer technology that is both reliable and affordable to fulfil the demands of both legacy and new applications. Multiprotocol Label Switching (MPLS), which enables service-oriented virtual private networks (VPNs), has been addressing these demands by combining applications. In remote, climate-controlled operations centres, MPLS and VPNs were both used.

Industrial applications are already using LAN-based Ethernet, Wi-Fi, and LTE technologies. These technologies serve as a basis for the increasingly complex, revolutionary automation that will be supported by 5G networks. Thanks to 5G networks, enterprise private and exclusive networks may now be more precisely designed to meet their performance needs. Additionally, 5G standalone cellular-virtual campus network solutions and network slicing capabilities enhance network performance needs, data privacy, real-time control, large connection, and high bandwidth requirements. This is made possible by such networks' autonomy from open networks, increased command over the deployment environment, flexibility in network design for enhanced and real-time performance, increased network reliability and availability, and, most importantly, the capacity to implement more stringent security.

17.4. India 5G Market

5G ORAN Services in India

In preparation for upgrading their networks to 5G technology, Indian telecoms are looking at Open RAN as a potential way to reduce network-related expenses and customise. Indian software developers, equipment manufacturers, and system integrators now have more options to gain
market share in the expanding global 5G market thanks to the open RAN architecture. Telecom players can now choose to use products from other manufacturers due to Open RAN. In order to innovate with Open RAN and reduce reliance on existing providers, they are going beyond established vendors.

In order to innovate with Open RAN and reduce reliance on existing providers, they are going beyond established vendors. Companies would likely have to deal with a large number of base stations in order to have extensive coverage with the introduction of 5G, leaving little room for them to save money in that area. By supplying verified stack templates, virtualized, open networks will then make automation simpler. These will be automated to be safe, dependable, and maintained, making Open RAN deployment and upkeep of parallel wireless networks simpler and more affordable. For instance, in August 2022, Bharti Airtel announced its collaboration with Intel to accelerate 5G network rollout. They plan to leverage vRAN (virtualized Radio Access Network) and O-RAN to transform Airtel’s network and provide their customers with next generation technology.

As of August 2022, India's telecom sector had 1.17 billion users (wireless Plus wireline subscribers), making it the second largest in the world. India has an overall tele-density of 85.15%, of which the rural market, which is mostly untapped, has a tele-density of 58.44%, and the urban market has a tele-density of 134.71%. Affordable prices, increased accessibility, the introduction of Mobile Number Portability (MNP), changing subscriber consumption patterns, government initiatives to increase India’s domestic telecom manufacturing capacity, and a supportive regulatory environment have all contributed to the industry's exponential growth over the past few years. Network Switches and 5G ORAN Appliances are critical to the data center industry for enterprise IT, and the telecommunication industry for enabling 5G services, and are expected to (i) address the dearth in Indian network switch market which is devoid of an Indian network switch OEM; and (ii) reduce India’s dependency on foreign OEMs. Adoption of high throughput – low latency network switches in data centres and 5G networks has been proliferating at a very high pace which further necessitates higher security, reliability, and greater operational efficiencies with lower latencies. India 5G market is about to witness a high growth rate and the number of connections is expected to increase from 2Mn connection to 197Mn between 2021-2025 with a CAGR of 213%.

Launch of 5G in India

In October 22, Prime Minister Shri Narendra Modi introduced 5G services in India, advancing the country's connectivity and digital transformation to new heights. Additionally, he presented a number of 5G use cases from different telecom service providers in a variety of industries, including smart agriculture, education, health, and worker safety. Prior to that, he presented a homegrown 5G NSA Core created by the Centre for Development of Telematics (CDoT) and attended additional technical demonstrations of business 5G solutions, chipsets, and networking hardware made by Indian telecom start-ups, MSMEs, and large manufacturers. The Prime Minister's goal of promoting "Aatma Nirbhar Bharat," "Jai Anusandhan," and "Sabka Saath, Sabka Vishwas" is in line with this.

This significant achievement creates a wealth of high-tech prospects for India and paves the way for transformation in vital industries like financial inclusion, smart cities, industry 4.0, and the
agricultural, health, and educational sectors, among others. India’s position as a global economic and technological powerhouse will be strengthened and driven by 5G technology, creating new opportunities for start-ups to offer innovative solutions to present challenges, create employment, and support India’s economic resilience.

Only two of India’s three largest telecom companies are already offering 5G services. These are Jio and Airtel 5G. Regarding 5G services in the nation, Vodafone Idea has not yet offered an update. Jio’s True 5G network is a standalone (SA) network, in contrast to Airtel's 5G Plus service, which relies on the infrastructure of the current 4G network.

In several Tier I cities in India, 5G support is now available or will likely be available in the near future. Phased 5G support will be provided for additional Tier II and Tier III regions. By 2024, Airtel and Jio are anticipated to provide 5G service to the entire nation. Airtel: At this time, Delhi, Mumbai, Chennai, Bengaluru, Hyderabad, Siliguri, Nagpur, Varanasi, Panipat, Gurugram, and Guwahati all have access to Airtel 5G. Additionally, Airtel has stated that it will roll out 5G services in all major cities by the end of 2023 and in all metros by the end of this year. In addition to Delhi NCR, Mumbai, Varanasi, Nathdwara, Pune, Hyderabad, Bengaluru, Chennai, and Kolkata, Jio is currently accessible in these locations as well. Jio also declared earlier today that the 33 district heads in Gujarat now have access to its 5G network.

**How is India perceiving 5G as a service?**

Reduced latency and greater bandwidth are two benefits of 5G. Numerous applications require a large bandwidth and low latency. Application examples include telemedicine, remote surgery in healthcare, driverless vehicles, video streaming, the broader entertainment business, and sophisticated gaming, to name a few. Additionally, as the main focus of 5G is improved connectivity, it is anticipated that the deployment of enterprise private 5G networks will quicken during the next several years. A company is likely to have two options for forming business relationships. It can choose to connect to either a public or a private 5G network. In the second scenario, it can either build and maintain its own infrastructure or purchase its own infrastructure and hire a mobile operator to provide operational support.

Indian IT corporations will set up private 5G test beds on many campuses throughout the country. According to reports, private 5G networks would be implemented by Tech Mahindra, L&T Technology Services, and Tata Consultancy Services. A private 5G network gives businesses the ability to allocate bandwidth for extremely dependable, low-latency use cases like robotics and industrial IoT since it gives them control over data, security, and networks. Additionally, it can be modified to fit the requirements of specific enterprises and industries.

The majority of Indian businesses believe that 5G will be a key enabler of their digital transformation, hastening the process and significantly affecting their goals and business operations. The most important digital technology in the eyes of Indian enterprises is 5G, according to Ericsson India, even though commercial 5G services won’t be accessible all throughout India for several more months. 32% of responding organisations viewed 5G as the most important technology for the following two years, according to the Omdia poll results. They ranked 5G higher than cloud services, robotic process automation, artificial intelligence, and
machine learning, among other technologies. Research by Deloitte India found that 80% of Indian businesses consider 5G a priority technology. Additionally, 98% of Indian executives think 5G and/or Wi-Fi will have a significant impact on their companies during the next five years, while 88% think it will happen within the next three. According to the report, 53% of CEOs favour 5G for outdoor use cases. The survey estimates that 39% of Indian businesses will spend between $10 million and $50 million to improve their wireless technology infrastructure.

17.5. India 5G market by application

Government & Defense

The Indian armed forces would gain a lot from 5G during the coming ten years. It is widely acknowledged as state-of-the-art technology that will affect military operations. The Government of India (GoI) has not yet made a final choice over where to get 5G, though. China-based Huawei is still a potential provider of some 5G technology. Huawei’s 5G solution is fiercely competitive in a market where Qualcomm, Ericsson, and Nokia are also present. The Indian government made it clear in its most recent statement that it will not accept 5G equipment from "untrusted" sources, implying that Huawei and another Chinese company, ZTE, will not pass muster. However, the GoI has not yet decided whether it wants to specifically exclude the two Chinese 5G vendors.

BFSI

Companies in India including Netweb are expanding the range of their product offerings in the 5G space and, in particular, to focus on the BFSI segment, which is expected to emerge as the largest industry vertical for enterprise networking in India by 2027.

New Digital Era in Banking and Finance to Begin with 5G - A single tap on a smartphone screen is all that is necessary to make a transaction, pay a bill, or check the most recent bank statement. But this is just the tip of the iceberg. In comparison to 4G, 5G promises to deliver speeds 10 to 100 times faster, with a latency of less than 1 millisecond and enhanced connection. There will be cross-industry potential for impact. However, companies will need to adopt a strategic strategy if they want to make use of this cutting-edge technology. The bandwidth of mobile devices has increased with each new generation, enhancing user experience with more robust interfaces. Beyond merely enhancing user interfaces, 5G and future networks will have a significant impact. The 3-30 GHz 5G frequency range provides for customised usage for vertical demands including banking and finance, healthcare, automotive, gaming, Industry 4.0, and so on. Banking and financial services are expected to change as a result of the adoption of cloud computing as the new norm, as well as the growing use of AI/ML, Edge Computing, Virtual Reality (VR), Augmented Reality (AR), and other upcoming technologies, along with 5G.

IT & ITeS

The advent of 5G ushers in a new era of connectivity, allowing business to take advantage of its potential to digitally transform every facet of corporate operations. Edge computing, private networks, and other technologies, including 5G, would encourage organisations who don’t often invest heavily in building digital capabilities to do so. "Rather than companies concentrating on
technology, the majority of digital investments will come from companies with physical assets, more traditional sectors. Operators and the government work together in an unusual way in the Indian market. Indian consumers are also quite enthusiastic about 5G services. The Indian industry has already embraced digitization, which could open the door for upcoming 5G business applications.

**Telecommunications**

In order to expand their networks, telecom service providers have invested billions of rupees and will continue to do so. 30–40% of industry revenue comes from enterprise services. According to the Cellular Operators Association of India, private networks "once again disincentivize the telecom sector from investing in networks while continuing to pay high levies and taxes." Top Indian telecom service providers reportedly objected against the distribution of private 5G spectrum to businesses and organisations, arguing that doing so would jeopardize their future financial success. The Indian telecommunications market has grown exponentially and is expected to grow at a CAGR of 9.4% from 2020 to 2025. Fiscal 2023 witnessed the introduction of 5G network in the Indian market and the 5G market in India is expected to witness a high growth rate in the years to come and is projected to grow at a CAGR of over 90% from Fiscal 2024 to Fiscal 2028. The projected growth in the 5G market in India is also expected to result in an increased demand for servers and private cloud infrastructure in India.

**Media**

At the IMC 2022 conference in New Delhi, India officially showcased 5G network services in October, marking its entry into the market. With Indian telecom providers already planning billions of dollars in investments over the following few years, mostly in network enhancements like the establishment of edge-AI compute models, beamforming, and dynamic spectrum sharing, among other things, the launch of 5G services offers up a slew of new use cases. Even companies in other sectors are looking to profit from 5G technology's advantages.

Another sector in India that is anticipated to have rapid growth is the media and entertainment industry (M&E). Since the number of people watching digital media has surpassed that of traditional television programmes, media and entertainment companies are investing more money in digital platforms. For a wider audience, smartphones have already increased viewing and levelled the playing field. With the availability of 5G speeds and competitive subscription choices from digital platform providers and CSPs, viewership of live events and online streaming is projected to increase even further.

**17.6. Market Drivers, Restraints, Opportunities & Challenges**

**Drivers –**

Performance - In terms of speed, dependability, and capacity, 5G wireless networks perform better than their 4G predecessors. Because of how much 5G's performance has improved, it will serve as the basis for whole new services and goods. Robots, autonomous vehicles, and remote medical procedures all require 5G's ultra-low latency performance.
Flexibility - Enterprise 5G offers interference-free communication by operating on its own frequency on the CBRS band. Without having to worry about interfering with present Wi-Fi networks, businesses can create their own private 5G networks. This makes it possible for Wi-Fi and business 5G to coexist, with 5G service being saved for the most crucial programmes and services.

Security: In the cellular world, device identification and authentication are handled by the SIM card in place of a network password. Business 5G is a better secure option by default and a less desirable target for bad actors as a result of this one contrast. The SIM cards that we use to activate our new phones are widely known.

Cost: 5G chipsets are slightly more expensive than Wi-Fi cards, but they require less infrastructure to cover the same amount of ground thanks to their improved range and capacity. For the same coverage, this results in less hardware, maintenance, and management.

India’s need for high-speed data bandwidth is growing. The internet has developed into a pervasive information infrastructure during the past few years. A large number of data consumers have emerged as a result of information’s ubiquitous availability and simplicity of access. Additionally, its use for surfing, streaming videos, and video conferencing, among other things, has grown with the introduction of smartphones, tablets, and smart TVs. The need for high-speed internet access has increased as a result of the rising data traffic to provide customers with a seamless experience.

In India, the use of IOT devices for smart homes is growing. The Internet of Things (IoT) is an interconnected system of things that have the software, sensors, network connectivity, and other devices required to collect and distribute data. The networked devices are essential for creating automated business processes across several industrial verticals since they can control and manage a wide range of operations and functions remotely.

Restraints –

A corporation may find it challenging to set up a 5G network from scratch, especially if they have no idea where to start. Many businesses advertise "private 5G" or "company 5G," although they only provide a portion of the entire infrastructure. For instance, some businesses might sell network radios but not back-end management software. This can make it far more difficult to get started and create a complex multi-vendor environment.

Another significant challenge in the corporate 5G industry is finding a completely autonomous solution. A lot of private 5G networks are offered as managed services, which sometimes forgo management and visibility in favor of seeming simplicity.

High spectrum costs - To get a license or the right to transmit signals across specific bands of the electromagnetic spectrum, telecom service providers must pay a hefty premium to the government or telecom regulatory agencies. Furthermore, only a small number of bands are authorized for use by telecom operators by governments around the globe. These factors are expected to hinder the growth of the 5G services sector. For 5G spectrum in the 3300-3600 MHz range, the Telecom Regulatory Authority of India (TRAI) has proposed a starting price of INR 492 per MHz Higher subscription costs for 5G services are anticipated as a result of the rising cost of
5G spectrum and the significant infrastructure costs associated with implementing 5G services. There should be an instant effect from this.

**Opportunities –**

New Business Opportunities in Cloud Computing - The cloud computing sector will benefit greatly from 5G technology. This is because improvements in cloud-based technologies are more effective. Low to zero latency in the technology improves integration and improves connectivity. In addition, service providers utilising Cloud Native concepts and technologies want to achieve economies of scale and web size. Large corporations are investing on network cloudification, including IBM and Intel. To increase a network's agility and scalability, this entails spreading cloud platforms, technologies, and virtualization capabilities across the network. As consumer and business bandwidth demands rise, networks are utilising 5G to quickly transition to this software-defined architecture to meet operational and application requirements. Additionally, from healthcare applications to autonomous vehicles and even down to wearables and mobile apps, the cloud is a useful place for non-device storage. If these technologies use the cloud and have 5G connections, they will operate more effectively. Cloud-based products and services should become more dependable, effective, and efficient. These developments will cause an increase in business cloud spending. For instance, FloLive raised $15.5 million in funding in June 2021 to develop a cloud-based solution for connecting private, local cellular networks to build private global IoT 5G networks for its clients.

The funds will be used to increase the company's service offerings, which will include constructing a global SIM2Cloud and investing in and expanding the tech stack. According to statistics from Flexera's 2021 State of the Cloud Report, respondents believe that cloud spending will increase by 39% during the next 12 months.

**Challenges –**

*Technology Challenges for 5G*

More than 50 different frequency bands, all of which are below the 3.6 GHz range, are used by the present LTE system. One of the frequency options for early 5G rollout is in the sub-6 GHz region. Unlicensed spectrum below 6 GHz (600 MHz and between 3.5 GHz and 6 GHz) will be used for the first generation of 5G networks.

Huge Data Volume - As technology advances, each network's data volume continues to increase on an annual basis. Each network must be able to handle massive volumes of data because numerous apps provide high-definition video calling, live streaming, downloading, and other functions.

Security is among the most important elements of any wireless transmission system. Securing the network is a challenging task because there are so many devices connected to it and different technologies. End users must have security and privacy on the 5G network.

Growth in the servers and private cloud infra globally and in India due to 5G Market

**What is the significance of 5G?**
The advent of 5G has the potential to transform a variety of industries in today's hyperconnected society. Numerous connectable devices enable high data throughput, low latency, and high reliability characteristics. They also provide analytics and real-time control. In reality, the majority of industries are considering 5G and how technology might improve their processes. With cloud-based network administration, private 5G solutions streamline business processes, keep sensitive data on-premises, have updates with no downtime, and offer service-level agreements to guarantee excellent performance (SLAs).

As an illustration, the Private Cellular Network from L&T Smart World is built on 4G/5G radio and dual mode core technology, allowing a variety of use cases for both indoor and outdoor environments and seamlessly integrating with business procedures, tools, and apps. They offer unrivalled business agility, allowing any corporation to adjust to changing market trends. Using the inborn adaptability and built-in learning of the Private 5G network, one may immediately increase their business, technology, and capacity. Zero downtime, cloud-based network administration that accelerates business operations, and on-premises data preservation are all features of these private 5G solutions.

Major market players have made a number of advancements in response to the influence of 5G on cloud and data centres, which is further projected to increase demand for these services in the future. For example -

Based on a memorandum of understanding reached in November 2019, TIM and Google announced new collaboration covering cloud and edge computing services at the beginning of March 2020. At the time, TIM declared its intention to make €1 billion from cloud services by 2024, keeping up with the rapidly expanding cloud sector.

A managed service named AWS Private 5G was introduced by Amazon Web Services (AWS), Amazon's cloud computing platform, in December 2021. AWS will supply small cell radios, servers, 5G core and RAN software, SIM cards, and other components necessary to set up a private 5G network and link devices. The setup process is automated by the service, enabling the support of more devices.

In October 2021, Etisalat and Microsoft joined together as part of their strategic partnership to leverage Azure Multi-access Edge Compute to unleash new 5G scenarios. Through the agreement, enterprises will be able to deploy industry solutions on 5G edge compute plug-and-play infrastructures that take advantage of Etisalat Core Orchestration and Azure ARM capabilities.

Using IBM intelligent automation technologies and services, Telefónica and IBM established a multi-year strategic agreement in September 2021 to implement UNICA. The first cloud-native 5G core network platform from Telefónica will follow.
17.7. Key players in the Global & India 5G market

Table 28: Key players in the Global & India 5G market

<table>
<thead>
<tr>
<th>Company name</th>
<th>Samsung</th>
<th>Intel</th>
<th>Nokia</th>
<th>Huawei</th>
<th>Ericsson</th>
<th>ZTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company Type (Public or Private)</td>
<td>Public</td>
<td>Public</td>
<td>Public</td>
<td>Private</td>
<td>Public</td>
<td>Public</td>
</tr>
<tr>
<td>Headquarters</td>
<td>Seoul, South Korea</td>
<td>Santa Clara, California, U.S.</td>
<td>Espoo, Uusimaa Finland</td>
<td>Shenzhen, China</td>
<td>Kista, Stockholm, Sweden</td>
<td>Ontario, Canada</td>
</tr>
<tr>
<td>No. of Employees (as in 2022)</td>
<td>2,66,673</td>
<td>1,31,900</td>
<td>86,896</td>
<td>1,95,000</td>
<td>97,029</td>
<td>72,580</td>
</tr>
<tr>
<td>Key Products/Services</td>
<td>Radio Access, 5G RAN, Baseband, Massive MIMO Radio, Radio, Compact Macro, Compact Core, Cloud Orchestration</td>
<td>Intel 5G + AI + Edge, Intel 5G for Business, Intel 5G Networks</td>
<td>Routers, network processors, and products for telecom infrastructure, including the 5G network</td>
<td>5G Business Design and Network Consulting, 5G Precise Planning, 5G Digital Construction, 5G Digital Indoor Coverage Solution, 5G Core Network Integration, 5G Optimal Network Optimization, 5G Intelligent O&amp;M, 5G User Experience Management, 5G Monetization, 5G Talent Development</td>
<td>Ericsson Radio System allows operators to launch the new technology and grow 5G coverage fast, and Ericsson Spectrum Sharing allows for accelerated 5G rollouts using existing hardware</td>
<td>Equipment used by network operators (links and nodes, etc.) &amp; Equipment used to access networks (terminals), and services, which includes software, ISGC Private Core Network, ZTE 5G iCube (Industry Cube) AIO Cloud-Network solution</td>
</tr>
<tr>
<td>Business Strategy</td>
<td>Innovation, Acquisition</td>
<td>Acquisition</td>
<td>Partnerships</td>
<td>Collaboration</td>
<td>Acquisition</td>
<td>Innovation, Collaboration</td>
</tr>
<tr>
<td>Revenue</td>
<td>USD 234 Bn (2022)</td>
<td>USD 63.1 Bn (2022)</td>
<td>USD 26.9 Bn (2022)</td>
<td>USD 92.3 Bn (2025)</td>
<td>USD 25.2 Bn (2022)</td>
<td>USD 17.2 Bn (2022)</td>
</tr>
</tbody>
</table>

Source: Frost & Sullivan Analysis

Note: 1 USD to KRW= 0.0008 (Average exchange rate for year 2022), 1 Euro to USD = 1.05328 (Average exchange rate for year 2022), 1 Chinese Yen to USD = 0.1572 (Average exchange rate for year 2022), 1SEK to USD= 0.095583 (Average exchange rate for year 2022) and 1CAD to USD= 0.7688 (Average exchange rate for year 2022)

Note: Revenues are consolidated ones at company level and correspond to global revenue data for each company

Financial Calendar: January – December for all vendors: Samsung, Intel, Nokia, Huawei, Ericsson & ZTE
Note:
Market estimates in the report follows the financial year (FY) which runs from 1 April to 31 March the following year. For example, the financial year from 1 April 2020 to 31 March 2021 has been abbreviated as FY 2020-21.