

Private 5G  
Cloud Native  
Broadband  
Mobility  
XaaS

Infrastructure  
Data Analytics  
CRM  
Internet  
Modem  
SD-WAN  
AI TRISM  
NMS RAM  
Spectrum  
Regulations  
Massive MIMO  
Data Center  
Telecom Bill  
Network  
DSL  
FTTx  
Cloud  
Forecast  
Virtualization  
Generative AI

OTT  
VSAT  
OSS/BSS  
Revenue  
Teledensity  
WIFI  
ARPU  
Big Data  
Broadcasting

Bluetooth  
Telecom  
Service  
5G

# PRÉVISION



# P'25

## ANNUAL TELECOM FORECAST

22<sup>ND</sup> EDITION

### CASE STUDIES :

#### THE SPECTRUM BLUEPRINT :

NAVIGATING INDIA'S TELECOM EVOLUTION

#### FROM GRAPHICS TO AI :

TRANSFORMATIONAL JOURNEY

### SPECIAL FEATURE :

#### AI TRISM :

AI TRUST, RISK AND SECURITY MANAGEMENT



## SYMBIOSIS INSTITUTE OF DIGITAL AND TELECOM MANAGEMENT

CONSTITUENT OF SYMBIOSIS INTERNATIONAL (DEEMED UNIVERSITY)

(Established under section 3 of the UGC Act, 1956) | Re-accredited by NAAC with 'A ++' grade | Awarded Category - I by UGC





We at SIDTM are committed to developing world-class Digital and Telecom Business Leaders, who can effectively handle the dynamic and ever-changing technological and business dynamics with absolute ease and authority. The team at SIDTM firmly believes in strong academics combined with industry exposure through visits from several experts from the industry. The programs offered by SIDTM integrate a competitive learning environment through a broad curriculum encompassing classroom teaching, valuable industry inputs, research projects, seminars, workshops, and a myriad of extracurricular activities. In the pursuit of excellence and to give the curriculum its distinctive flavor, the syllabus is continually revived based on inputs from the faculty, industry, and alumni.

All the programs follow an intensive case studies-based approach. SIDTM lays deep emphasis on the all-round development of an individual, which includes improving communication skills, nurturing teamwork, and inculcating a persuasive attitude. The Digital and Telecommunication systems form the backbone of any company; hence, managing them effectively and strategically is a need of the hour. SIDTM has a 3300+ strong alumni network, and most of our alumni are holding middle-level to senior management positions in companies. Last but not least, we strive to instill human values to make better citizens with moral courage and zeal to follow their hearts, make a difference, and help them achieve their true potential.

# DIRECTOR'S MESSAGE



**Dr. CA. Abhijit Chirputkar**  
Director, SIDTM

SIDTM, now in its 29th year of existence, is a pioneer educational institution in Asia, imparting management education to aspiring digital and telecom managers. SIDTM has consistently endeavoured to take up new initiatives in both business and research domains. One such effort is *Prévision*, SIDTM's Annual Telecom Forecast. *Prévision* aims at providing the industry a neutral and insightful single point of view regarding emerging trends in the Digital & Telecom sector for the forthcoming year. The Digital & Telecom domain continues to witness new emerging technologies and business models and all of this is making forecasting a challenge. The forecasts are presented at the flagship event of SIDTM, International Digital and Telecom Seminar. It is noted that the forecasts presented in this report are very well received by the industry. *Prévision* involves accumulating inputs from detailed research into contemporary Digital and Telecom technologies, telecom business and other determinants of change and meticulously analysing them and forecasting future trends. It is a culmination of the collective endeavour of SIDTM students with 1500+ man hours of effort put in by them. The student forecast team is guided by SIDTM faculty and some of our esteemed alumni. As part of ongoing process improvement for *Prévision*, SIDTM students for the past 9 years have been conducting the Expert Interaction Program. The insights gained from such interactions with Industry Subject Matter Experts have improved the quality of our forecasts and the students have benefitted immensely from their knowledge & experience. At the release of the 22nd edition of *Prévision* during the 29th year of existence of our institute, I would like to thank the SIDTM Alumni community and the telecom industry for sharing their valuable insights with the *Prévision* team. Your contribution has helped us in improving the quality of the forecasts.

# MESSAGE FROM FACULTY IN-CHARGE



**Prof. Giri G Hallur**  
Deputy Director &  
Faculty In-Charge of  
Prévision, SIDTM

[dydirector@sidtm.edu.in](mailto:dydirector@sidtm.edu.in)

It gives me immense pleasure to present to you the 22nd edition of Prévision, SIDTM's Annual Telecom Forecast. SIDTM curriculum places a lot of emphasis on nurturing the research aptitude of the students in the form of Summer Projects and Research Projects. Prévision is an extension of this thought process. It provides the students with a platform to understand the linkages between theoretical learning and dynamic industry trends. Through the Prévision research process, the students can understand the effect of macroeconomic, technological & regulatory factors on the Digital and telecom industry in India, as well as the world. Prévision, which is in its 22nd year, was conceptualised in 2003 by one of our esteemed alumni Mr. Kundan Das (Batch 1998 - 2000), who then teamed up with two other Alumni, Mr. Rahul Sharma (Batch 1999 - 2001) & Mr Aniruddha Harne (Batch 2002 - 2004). The Alumni team, over the years, has grown with active participation by Alumni from subsequent batches, who have continuously guided the student team. Prévision was started to provide the industry with a neutral and insightful single point of view regarding emerging telecom trends. This year's Prévision is yet another step in that direction. The three-step research process starts with data collection, followed by data analysis with the help of statistical models and finally culminates into a forecast after incorporating inputs from SIDTM Alumni and faculty. The MBA 1st year students, through the activity of data collection under the guidance of the 2nd year students, get initiated into the forecast process. At the data analysis stage, the 2nd year students get an opportunity to assimilate knowledge from statistics, technology and experiential learning gained during their summer internships. Whitepapers, written by the students at the end of the second stage are reviewed by some of our Alumni, SIDTM faculty and industry mentors. The final Prévision document incorporates the comments/changes suggested by them.

In Prévision 2025, we have, in our special feature on AI Trism (AI Trust Risk & Security Management) discussed the challenges and risks involved in the application of Artificial Intelligence by various sectors of the industry. After detailed discussions with industry experts, we have also highlighted ways to address these challenges and suggested risk management strategies based on ethical principles, and legal frameworks to protect business interests, organizational integrity, and consumer data. For the past 21 years, the SIDTM Alumni community has guided and provided the Prévision team with insights on key trends in the telecom domain. I thank the SIDTM Alumni for their continued support. I also express my gratitude to the telecom fraternity for its support. We look forward to your comments/feedback.

# PREFACE

Prévision is an endeavour by the students of SIDTM, under the guidance of our alumni, industry experts, and faculty members. Prévision strives to achieve perfection every year through process improvisation and comprehensive parameter analysis. We have included the 'Expert Interaction Program' for 5 verticals and the Special feature. For this, we have contacted numerous industry experts. As a gesture of our gratitude, we would like to mention all the experts who helped us enrich the content and insights of this research report through their valuable time and constant guidance.

- **Mr. Rahul Gadde**  
Delivery Manager  
Centiro
- **Mr. Buland Khan**  
Chief Technologist  
Wipro Limited
- **Ms. Pratima Upadhyay**  
Senior Software Engineer  
Airbnb
- **Mr. Balkrishna Dubey**  
MS Network Engineer  
NTT Global Data Centers and Cloud Infrastructure
- **Anurag Bhandarkar**  
Infrastructure Architect  
Cognizant
- **R Kumar**  
Senior Data Analyst  
EY
- **Satwik Bakshi**  
Manager  
McKinsey & Company
- **Arvind Mishra**  
Senior Business Development Consultant  
Tech Mahindra
- **Piyush Tiwari**  
Engineering Leader  
Zipy
- **Mr. Sushanth Jambu**  
Senior AR/VR developer  
Imaginate
- **Mr. Chetan Kandpal**  
Head- FAE & Technical Sales | Home Appliance BG  
CVTE (Guangzhou Shiyuan Electronics Co. Ltd.)
- **Ms. Kripashree Rajkhowa**  
Founder & Head of Technology  
Glazer Games Inc.
- **Mr. Vinit Jhavar**  
Co-founder & CEO  
CarsDaily
- **Mr. Nisarg Patel**  
Business Development Manager, APJC Partner Sales  
Cisco
- **Mr. Amal Nair**  
Privacy Program Manager  
Microsoft
- **Mr. Akash Kanojia**  
Product Manager  
HCL Tech
- **Mr. Souva Majumder**  
Director cum Technical Consultant of AI Governance,  
Apollonius Computational Business Solutions  
OPC Pvt. Ltd

# PILLARS OF PRÉVISION

## PRÉVISION PIONEERS

- Kundan Das  
4.0SmartIndustry Advisory
- Rahul Sharma  
Regional VP @ Sirion : AI : SaaS :  
Strategy & Transformation, Germany
- Aniruddha Harne  
Vodafone Group, UK

## FACULTY MENTOR

### STATISTICS

- Dr. Sandeep Prabhu (Professor)

### TELECOM AND DIGITAL

- Ramamurthy Venkatesh  
(International Adjunct Faculty)

## FACULTY IN CHARGE

- Prof. Giri Hallur (Dy. Director, SIDTM)

## STUDENTS IN CHARGE

- Kranti Shingate (Chief Coordinator)
- Varinda Sharma (Vice Chief Coordinator)

## STUDENTS IN CHARGE (TECHNOLOGY)

- Prashant Pajiyar
- Pritesh Gharat
- Yatharth Pandey
- Sanak Majumdar
- Miti Jain
- Sidharth Sahoo

## STUDENTS IN CHARGE (STATISTICS)

- Kolluru Sriharsha
- Devanshu Dhapwal
- Mansha Bhatia
- Rohan Deshmukh
- Lisha Purbey
- Amudula Sai Durga

## STUDENT EDITORS

- Shrishti Bajpai
- Himani Dhiman
- Atri Mazumdar
- Skanda C Kesarkar
- Akanksha Sahu

## STUDENTS IN CHARGE (DESIGN)

- Soumali Pal
- Venkata Sai Praneeth Garudadri
- Varun Ganjoo
- Lisha Purbey

## STUDENTS IN CHARGE (BRANDING)

- P.V.S.Vaishnavi
- Hrishikesh Mohan
- Krishnaveni Konar

## STUDENT TEAM

### GLOBAL TELECOM

#### SENIOR TEAM

- Mansha Bhatia (Head)
- Krishna Nand Patel
- Deshmukh Rohan Rajesh
- Pushpesh Kumar
- Radhika Gupta
- Susmit Baidya

#### JUNIOR TEAM

- Jagan Upadhyaya
- Anamitra Das
- Jiya Sehgal
- Aditi Chopra
- S.Yagya Narayanan
- Derrick Davis

### INDIAN TELECOM

#### SENIOR TEAM

- Vaibhav Kosode (Head)
- Shruti Jaiswal
- Goli Yatharth
- Venkata Sai Praneeth Garudadri
- Sidharth Sahoo

#### JUNIOR TEAM

- Jitu Choudhary
- Shantanu Rajesh Shinkre
- Siddhesh Sunil Patil
- Fuzail Qureshi
- SIDDHARTH KUMAR
- Mayuresh Sonawane

### CONSUMER ELECTRONICS

#### SENIOR TEAM

- Keshava Sharma (Head)
- Himani Dhiman
- Pritesh Gharat
- Yatharth Pandey

#### JUNIOR TEAM

- Tanya Manchanda
- Pankaj Karamchandani
- Yashika Gakkhar
- Ayushi Saxena
- Pranav S Raj

## TELECOM TECHNOLOGIES

### SENIOR TEAM

- Amudala Sai Durga (Head)
- Rashmi Sinha
- Devanshu Singh Dhapwal
- Shrishti Bajpai
- Ritam Chatterjee

### JUNIOR TEAM

- Yash Neekhar
- Kalvala Nikhil Sai Radhesh
- Prafull Nayan
- Suryansh Thakur
- Pratik Hemraj Dhande

## BROADBAND

### SENIOR TEAM

- Lisha Purbey (Head)
- Varun Ganjoo
- Soniya Mansukh
- Skanda C Kesarkar
- Ankush Sen
- Hitesh Raiwal

### JUNIOR TEAM

- Subham Kumar Bal
- Abhishek Bhattacharjee
- Vedant Rajendra Patil
- Ramji Gupta

## COMMUNICATION INFRASTRUCTURE

### SENIOR TEAM

- Hrishikesh Mohan (Head)
- Kolluru Sriharsha
- Mudit Shrivastava
- Aina Sharma
- Soumali Pal
- Abhinav Wadia

### JUNIOR TEAM

- Rishikesh Sanjay Bhagate
- Nishant Kumar
- Yashika Verma
- Sushant Nikhare
- Ananya Bhattacharya
- Kasbe Gaurav Pravin

### Disclaimer

*In no event shall Symbiosis Institute of Digital and Telecom Management, Pune, hereafter referred to as SIDTM, be liable for any indirect, punitive, incidental, special or consequential damages arising out of or in any way with any content (or any material provided here under) whether biased or on contract, tort, strict liability or otherwise even if SIDTM has been advised of the possibility of the damages.*

*Note to readers: The financial year for India is taken from April to March, whereas for the rest of the world, the calendar year is taken from January to December.*

*©1996, Symbiosis Institute of Digital and Telecom Management. All rights reserved. This publication is the sole property of SIDTM. No part of it may be circulated, quoted, copied or otherwise reproduced without the written approval of SIDTM.*

## DIGITAL MOBILE SERVICES

### SENIOR TEAM

- Sidharth Kohli (Head)
- Sunayana Tiwari
- Jassi Jumani
- P.V.S.Vaishnavi
- Akanksha Sahu

### JUNIOR TEAM

- Pratik Shirkar
- Aditi Nema
- Atharva Mohite
- Piyush Dinesh Chaudhari
- Jay Kishun Mandal
- S Tharun Ganesh

## TELECOM SOFTWARE

### SENIOR TEAM

- Adrija Bose (Head)
- Atri Mazumdar
- Miti Jain
- Vishruth Bhat
- Parv Bajaj

### JUNIOR TEAM

- Satyadeep Harwal
- Vipul Lanjewar
- Nisha Kumari
- Udit Saha
- Ayush Verma

## SPECIAL FEATURE

### SENIOR TEAM

- Sanak Majumdar (Head)
- Krishnaveni Konar
- Aakshi Gera
- Prashant Pajiyar
- Rushikesh Bhandari

### JUNIOR TEAM

- Harish Ramchandra Patil
- Harshith M
- Prachi Dukale
- Vineeth Chirla
- Sweety
- Ronak Jhalaria



# EXECUTIVE SUMMARY

## DIGITAL MOBILE SERVICES

The digital mobile services market is proliferating as customers seek convenience, personalization, and mobile-first interaction. In 2024, UPI transactions exceeded 9 billion per month in India, accounting for more than 75% of the nation's digital payments - a drastic shift to mobile-based financial services in the post-pandemic world. Innovations in AI-powered customer support through banking and the rise of decentralized finance (DeFi) further highlight the drift away from traditional banking models in the industry. Indian pilot expansion for the digital rupee had reached over 1 million users by 2024, which was clear proof that blockchain-based financial applications could gain acceptance. Several critical public health applications, reaching an adoption level of 90% amongst all smartphone users, have emerged as a shining showcase for mobile technology to make healthcare and services more accessible. Digital mobiles will transform industries by applying cloud technology and user-centric design, further offering more inclusive and personalized experiences across finance, healthcare, and government services. This trend promises to provide a future where all aspects of digital solutions will seamlessly integrate into meeting ever-evolving user needs.

## CONSUMER ELECTRONICS

There has been a mix of growth and decline across various consumer electronic domains in the last two years. The smartphone industry promises growth with the support of Gen AI and a huge demand. Similarly, despite the high procurement cost, the tablet industry displays a boost with the rollout of 5G infrastructure and AI innovations. A victim of market saturation, the set-top box industry shows hope, with customers preferring OTT service. With a direct impact on television sales, there's an increase in smart television demand but an overall decline in the industry. A general preference for OLED screens in both devices could be observed. The digital camera sector has been adversely affected due to heavy competition from smart devices and a lack of innovation. The AR/VR headsets industry captured a steep decline of 23.5% in global shipments in 2023. This could be attributed to economic pressures on households and preference for Mixed and Extended Reality handsets. Launching compelling products and direct competition from the gaming consoles sector for entertainment and stress-relieving purposes couldn't support these declining sales numbers. Technological advancements are expected to elevate sales for IoT devices like wearables and smart home appliances by

managing affordability. With the government taking initiatives to raise cyber awareness, markets for security appliances and connected vehicles will likely grow.

## TELECOM TECHNOLOGIES

Rapid telecom technologies, on account of the growth in the adoption of 5G and cloud-based infrastructures, will continue to evolve due to the accelerated development of AI. Telecommunications Act 2023 ensures an overhaul in India's telecom sector regarding easy spectrum utilization, smooth infrastructure access, and overall development of universal services for hitherto uncovered areas. In 2024, the number of IoT will rise to 18.8 billion. This also propels IP Media Subsystems, VoLTE, and VoWiFi. Open RAN and SDN/NFV are making network flexibility cost-saving for MNOs. Massive MIMO is increasing 5G capacity, and FWA enhances 5G by fixed wireless access. It has simplified the management of networks. IPV6 standards ensure global connectivity, and all these help achieve efficient, scalable telecom networks for new digital demands. The focus areas here are adding AI to the networks to optimize and automate customer service, which promises cost savings and user benefits. Deployments of edge computing in telecom operations are rising, allowing data processing closer to users in real-time. This means that telecom technologies can be more innovative, efficient, and secure, giving the sector a new role in worldwide digital transformation.

## INDIAN TELECOM

The Indian telecom sector showed strong growth in FY24, with the overall subscriber base crossing 1.2 billion, driven by the expansion of 4G and the launch of 5G services. The sector has continued to witness healthy year-on-year growth of 9.25% in adjusted gross revenue, driven by increasing data consumption and effective pricing policies, further improving the average ARPU to ₹185. This has been the year 5G deployment saw a big roll-out; more than 200 million subscribers have experienced high-speed connectivity, most notably during big events like the IPL. More than 65 million MNP requests were processed, forcing operators to bring out their best service qualities. Heavy FDI inflows continued in the sector, supported by reforms such as the Telecommunications Bill 2023, which modernized the regulations and emphasized rural connectivity. Moreover, new technologies such as Wi-Fi calling have gained momentum, particularly in underserved areas—clear testimony to industry commitment to bridging the digital divide. FY24 laid the strong foundation for the futuristic developments in the Indian telecom sector; mobile data traffic is expected to grow by 40%, US\$ 30

billion is expected to be invested in 5G technology, and 6G is likely to be rolled out in 2030, steering towards a more robust and customer-focused ecosystem.

## TELECOM SOFTWARE

Telecom software is thriving as service providers prioritize seamless connectivity, personalization, and new-age service delivery. One defining industry trend is shifting toward cloud-native 5G core technology. It empowers operators with highly flexible and scalable networks that reduce equipment needs and bring out network slicing and edge computing capabilities. The outcome is in greater alignment with the industry overall as it moves towards more virtualized, automated infrastructures and provides the foundation for future markets such as healthcare and retail to leverage high-speed and low-latency communications. Technologies like CRM, real-time data analytics, service delivery platforms (SDP), service assurance and billing, application infrastructure middleware (AIM), AI/BI, OSS/BSS, network management systems (NMS), and cloud billing are all integral to this evolution. The CRM industry is adopting a cloud-based product, which has triggered explosive growth through better effectiveness and a customer-centric approach. Along with this, real-time analytics of big data are appearing rapidly to help telecom service providers make strategic decisions while optimizing their networks better. Moving forward, an evolving telecom software landscape that leans towards digital-first, cloud-first solutions equips the telecom industry to gear up for future challenges well in advance.

## COMMUNICATION INFRASTRUCTURE

Telecom and digital infrastructure industries have developed greatly on an international level, satisfying the needs of fast, safe communication and technologies (such as 5G, IoT, AI), as well as governmental connectivity programs. Optical fibers, smart cities, Satellite Communication, optical fiber, and Layered Data center Compact structures are the cornerstones of future connectivity. Hollow-core fiber and new-generation DWDM have brought changes in optical fiber for greater speed and fiber geometry. New programs like US\$ 65 billion US broadband infrastructure and BharatNet by the Indian Government for rural connectivity are dramatically increasing connectivity. Data centers also continue to expand to accommodate the AI and IoT needs with major commitments to renewable power, the highlight of a sustainable data center model. As mentioned, the passive and active infrastructure-sharing models have

enabled the operators to cope with this increasing data traffic while cutting their expenditures. Such trends as Massive MIMO, artificial intelligence in networks, and Open Radio Access Networks (Open RAN) maintain accurate cross-technology connections. On the same note, satellite communication and smart poles have added to the urban and remote network coverage. Altogether, it points to the end of the beginning of a coherent trend of creating effective and efficient digital platforms. These technologies are for further deployment in the nation and in the entire world, with support from the government to accommodate current telecommunication demand and respond to the future flow of technologies.

## BROADBAND

In 2024, the broadband sector in India witnessed robust growth, driven by advancements in wireless, fiber, and cloud technologies. Mobile broadband continues to expand, growing to US\$ 689.72 billion with an annual growth rate of 6.3%. TRAI data indicates 914 million mobile broadband subscribers as of March 2024, vastly outnumbering wired connections. Government initiatives like BharatNet and PM-WANI have been pivotal, with BharatNet reaching 3.84 lakh villages and PM-WANI deploying 207,642 public Wi-Fi hotspots. Fiber-to-the-home (FTTH) is progressively replacing legacy DSL and cable technologies, addressing the surging demand for high-speed, low-latency connectivity. FTTH adoption is accelerated by Jio and Airtel's 5G-FWA, which achieved speeds up to 4.7 Gbps in trials. Telecom operators are moving into 5G Standalone (SA) networks, and this opens the way to more efficient and widespread use of Fixed Wireless Access (FWA) solutions based on Customer Premises Equipment devices capable of working in both SA and Non-Standalone technologies, ensuring smooth connectivity and future-readiness. A major giant like AWS is planning a massive investment in India's rapidly growing cloud infrastructure. Emerging technologies like Wi-Fi 7 and 5G are positioned to shape the connectivity landscape, enhancing network resilience and capacity across India's urban and rural sectors.

## GLOBAL TELECOM

Developments in technologies like 5G, IoT, and cloud computing have aided the growth of the telecom sector around the world. Countries like China, Singapore, and the U.A.E. are leaders in 5G deployment, and China has the largest 5G network in the world. On the other side, Australia and Argentina have strong connectivity and high internet consumption. Saturated markets

like France, the U.K., and Japan are witnessing stable growth because of government-backed initiatives. Kenya and Nigeria are experiencing growth in mobile usage and telecom investments despite the economic hurdles, while Argentina and Russia are facing economic volatility and geopolitical issues. Countries like South Korea and Switzerland are more focused on the development of smart city innovations and digital infrastructure. The U.S.A. is witnessing steady growth in its telecom sector, although the challenge of high operational costs still persists.

## **SPECIAL FEATURE**

Artificial Intelligence Trust, Risk, and Security Management (AI TRiSM) is a strategic framework to enhance the governance of AI systems with trust, risk mitigation, and security. Organizations that place AI transparency, trust, and security at the top of their list will achieve a 50% increase in adoption rates, business

goals, and user acceptance. The global market for AI TRiSM, which is estimated to be US\$ 1.96 billion in 2023, is projected to expand at a compound annual growth rate (CAGR) of 21.3% from 2024 to 2030. AI TRiSM covers the major aspects of regulatory compliance, risk management, and use cases in practice across multiple industries. In addition, the successful implementation of AI TRiSM enhances the confidence of the stakeholders and improves operational efficiency. Business houses can align AI strategy with governance policies having a strong emphasis on ethics and risk management by implementing the AI TRiSM framework. This holistic approach not only ensures responsible innovation but also places organizations strategically in the competitive landscape. The fundamental role of AI TRiSM would therefore, be to provide a foundation to create trust and ensure the responsible usage of AI in business operations, thus making all of its business operations compliant with regulatory standards while reaping maximum benefits from AI technologies.

# FORECAST METHODOLOGY

On a year-on-year basis, the Prevision team maintains a record of data points across various topics and technologies, spread across various domains. The team tracks this movement both qualitatively and quantitatively. Qualitative factors are tracked in the form of drivers and restrainers for each data point to get a picture of how a value has been driven positively or negatively. Approximately, 800+ man hours go into comprehensively researching and evaluating the impact of economic, political, technological, regulatory and cultural impact on each technology and topic covered. Over the years, Prévision has built a repository of annual, quarterly or monthly data on each covered topic. This data is used to perform time-series forecasting through ARIMA modelling.

ARIMA, which stands for Autoregressive Integrated Moving Average, is a popular and powerful statistical method for time-series forecasting. It combines autoregression (AR), differencing (I), and moving averages (MA) to model and forecast time-series data. ARIMA models are widely used in various fields such as finance, economics, and engineering for predicting future values based on past observations.

## Key components of ARIMA:

### 1. AutoRegressive (AR) Component (p):

- AR represents the autoregressive part of the model, which implies that the future value of the time series is a linear combination of its past values.
- The parameter 'p' in ARIMA(p, d, q) represents the order of the autoregressive component, indicating how many past observations are considered in the model.

### 2. Integrated (I) Component (d):

- The integrated component represents the differencing step needed to make the time series stationary. Stationarity is crucial for ARIMA models because they work best with stationary time series data.
- The parameter 'd' in ARIMA(p, d, q) denotes the order of differencing required to achieve stationarity.

### 3. Moving Average (MA) Component (q):

- The moving average component represents the weighted sum of past forecast errors in predicting the current value of the time series.
- The parameter 'q' in ARIMA(p, d, q) denotes the order of the moving average component, indicating how many past forecast errors are considered in the model.

## The steps involved in forecasting time-series data using ARIMA are as follows:

### 1. Check for Data Stationarity:

- A stationary time series data is one whose properties do not depend on time. That is why time series with

trends, or with seasonality, are not stationary. The trend and seasonality will affect the value of the time series at different times. Hence, it is required to make the data stationary before we start forecasting it. The stationarity of the data is determined through a formal test called the Phillips-Perron Test.

### 2. Data Pre-processing:

- It is ensured that the time series is stationary by applying a difference if necessary. This involves subtracting the previous value from the current one until stationarity is achieved.
- If the time series is not stationary after differencing, additional differencing is applied.

### 3. Identification of Parameters (p, d, q):

- Involves the examination of the autocorrelation function (ACF) and partial autocorrelation function (PACF) plots to identify potential values for 'p' and 'q'.
- Order of differencing 'd' is determined by checking the stationarity of the differenced series

### 4. Model Fitting:

- Identified values of 'p', 'd', and 'q' fit into the ARIMA model
- For developing the model input data for each topic goes as far back as 2010

### 5. Model Evaluation:

- Various models are evaluated and compared based on multiple criteria including the significance of each coefficient, log-likelihood, Akaike Information Criterion (AIC), Bayesian information criterion (BIC), etc.
- Models with the highest scores across all these criteria are taken further

### 6. Diagnostic Testing:

- Diagnostic tests are performed to determine if the errors in forecasting are white noises or if they are significant

### 7. Forecasting:

- Once the model is validated, it is used to make forecasts on unseen data

### 8. Model Refinement (if needed):

- The model is refined by adjusting parameters or testing other models if the forecast performance is not satisfactory

### 9. Finalising Forecasts:

- Forecast figures are finalised if the movement in forecasted value is in line with domain knowledge, expert forecasts and qualitative research
- The above process happens in the form of a discussion between students and faculty members of SIDTM

TELECOM SOFTWARE 87.77%

87.17%

CONSUMER ELECTRONICS

TELECOM TECHNOLOGIES 80.80%

**OVERALL**

86.37%

**ACCURACY**

98.35%

INDIAN TELECOM

DIGITAL MOBILE SERVICES 76.83%

88.09%

COMMUNICATION INFRASTRUCTURE

BROADBAND 85.59%

# INDEX



**DIGITAL MOBILE SERVICES** PAGE **13**



**CONSUMER ELECTRONICS** PAGE **26**



**TELECOM TECHNOLOGIES** PAGE **40**



**INDIAN TELECOM** PAGE **52**



**TELECOM SOFTWARE** PAGE **65**



**COMMUNICATION INFRASTRUCTURE** PAGE **74**



**BROADBAND** PAGE **83**



**GLOBAL TELECOM** PAGE **95**



**SPECIAL FEATURE** PAGE **105**

# DIGITAL MOBILE SERVICES



## Student Team

Sidharth Kohli | Jassi Jumani | Akanksha Sahu | PVS Vaishnavi | Sunayana Tiwari

## SNAPSHOT

- ▶ Blockchain's rise to US\$ 7.54 billion in 2023 shows its expanding role in securing digital assets, finance, and digital identity worldwide
- ▶ Digital wallets captured nearly 50% of global e-commerce (US\$ 3.1 trillion) and 30% of POS spending (US\$10.8 trillion) in 2023, as AI, IoT, and cross-border integrations drive payment innovation globally
- ▶ India's 820 million internet users, including 442 million rural users, highlight mobile internet's growth in 2023, with 70% of m-commerce purchases on apps fueled by secure payments, AR, and omnichannel experiences
- ▶ UPI adds 6 million users monthly, with 13.9 billion transactions in June 2023, driven by AI security and global expansion, despite risks like phishing and PIN misuse
- ▶ The M-Gaming market, valued at US\$ 100.54 billion, thrives on microtransactions and 5G growth, with India's 568 million gamers leading globally despite 2022's revenue dip from inflation
- ▶ The mHealth market is growing, driven by telecom investments and smartphone usage, with India's segment reaching US\$2.49 billion, showcasing its potential to enhance healthcare quality and sustainability.
- ▶ The In-Vehicle Infotainment sector is expanding, driven by advancements like AI, with India's passenger vehicle sales increasing from 3.07 million to 3.89 million in FY 2022-23
- ▶ The Global Super App Market grew from US\$ 61.30 billion in 2022 to US\$ 75.5 billion in 2023, and the growth was due to the implementation of emerging technologies and the rising adoption of smartphones
- ▶ The M-Education market reached US\$ 60.71 billion, with annual app downloads crossing more than 939 million in 2023
- ▶ The Global Mobile Banking market reached US\$ 1.16 billion in 2023, with an increase of 51% from 2022, with the Indian market leading the way with record-breaking transactions in the world
- ▶ Global consumer spending on Mobile Apps hit an all-time high, with iOS and Google Play crossing over US\$ 35 billion in Q1 2024, and India led with the most app downloads
- ▶ The Worldwide mobile entertainment industry is expected to develop significantly, valued at US\$ 228.9 billion in 2023 with a CAGR of 15%. This rise is driven by the proliferation of smartphones and the rising consumption of mobile content
- ▶ Location Based Services (LBS) market was valued at US\$ 26.22 billion in 2023, and the market has shown significant growth with a strong annual growth rate of 19.5%, propelled by increased smartphone and GPS device usage
- ▶ The biometric technology market showed strong growth from US\$ 52.65 billion in 2023 to US\$ 59.76 billion in 2024 due to rising demand for security and fraud prevention

- The Global market size of social networking reached US\$ 251.45 billion in 2024, with India and China having the most active users
- The rising demand for M-Governance is due to increased demand in rural areas and the use of personalized and localized information services that are available anywhere

## DOMAIN 1: DIGITAL PAYMENTS

### UPI BASED APPS

CURRENT STATISTICS FOR FY 2023-24	PRÉVISION FORECAST FOR FY 2024-25
Transaction Volume: ₹ 16443 Crores	Expected to reach: ₹ 21283.41 Crores*
Transaction Value: ₹ 2428 Lakh Crores	Expected to reach: ₹ 2789.531 Lakh Crores*

\*Time-series Analysis

The digital payment growth continues to surge, and Unified payments Interface (UPI) is now adding up to 60 lakh new users every month. The stupendous growth in UPI transactions has been fuelled by the RuPay credit card on UPI and the launch of the service in foreign countries. According to the latest National Payments Corporation of India (NPCI) data, the number of transactions on the UPI platform went up 49% year-on-year to 13.9 billion in June, and the transaction value rose 36% to ₹ 20.1 trillion.

Google Pay, PhonePe, and Paytm are just some of the popular applications that have seen increased customer usage; 90% of all electronic commerce operations occur through these services today. UPI has a real-time, centralised anti-fraud solution built on AI and NLP that may decrease the number of fraudulent transactions. Hyper-polarization of payment applications to drive end-user adoption and make payment applications relevant for the underserved. However, as with any online transaction, concerns about security and potential fraud are natural and valid. Unsolicited calls for money, the risk of sharing OTPs and UPI PINs, phishing, downloading of unauthorized applications, and misusing information on social media are some of the risks related to UPI transactions.

In addition, brings the scales of security and efficiency in transactions to real-time monitoring and authentication through advanced methods like biometrics. With further scaling up and cost improvements, UPI global scale-up will improve access to digital payments and create an even more inclusive financial ecosystem.

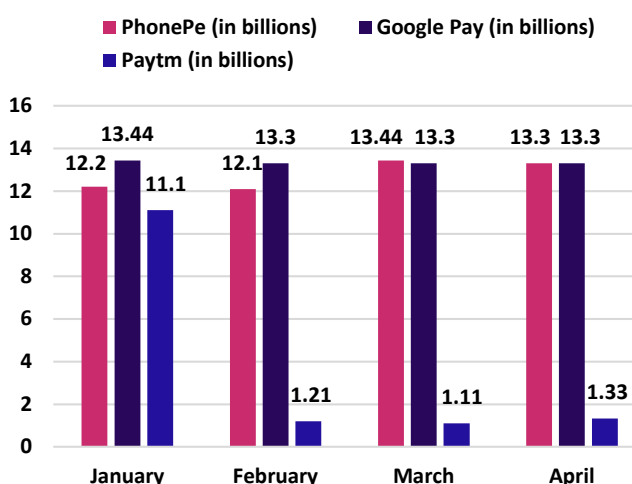
#### Influencing Factors:

- ▲ The digitalization push by the Indian government and the efforts put in by the National Payment Corporation of India has played a considerable role in promoting UPI

- ▲ The preference for UPI over mobile wallets was strongly influenced by its perceived higher security and ease of transaction
- ▲ For Mobile wallets, although less preferred, the ease of loading funds and the attraction of promotional offers were significant positive factors
- ▼ UPI faces challenges such as inconsistent user experiences, security vulnerabilities, interoperability issues, and scalability concerns
- ▼ The need for a stable internet connection has hindered the adoption of UPI-based apps in some segments of the population

### M-BANKING

#### UPI APPS TRANSACTION (VOLUME) TREND IN 2024



In 2023, the global mobile banking market was estimated to be worth US\$ 1.16 billion. Whereas in the year 2022, the market had a valuation of US\$ 772.96 million. In India, as of March 31, 2024, we witnessed a 12.6% increase in digital payments compared to last year. In May of 2024, there was a total transaction value of US\$ 376.79 billion using mobile banking apps in India. In terms of volume, the number of transactions reached a record in the month of May 2024 with 13,452.256 Units Mn from a record low of 1.080 Units Mn in April 2011.

In India, data is as low as INR 10 per GB, along with smartphone penetration and the expansion of 4G mobile banking, which is accessible to the public. There are over 1.2 billion mobile phone subscribers, and 1000 million users have smartphones. Due to the steady increase in mobile and internet usage, the adoption of mobile banking apps has increased. Mobile banking is used by 72% of millennials as their primary method



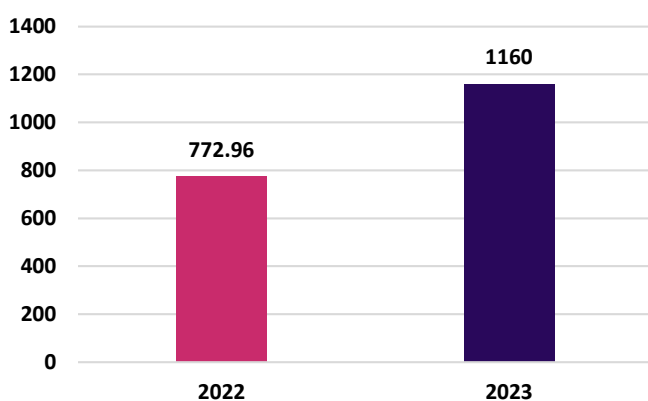
to manage finances. The integration of advanced technologies in the BFSI sector, like big data, chatbots, blockchain, biometrics, and artificial intelligence, has paved the way for the rise of digital-only services and neobanks. However, this has paved the way for cybersecurity threats and increased online fraud and data breaches, which are the major challenges faced in the industry, amounting to US\$ 3.61 billion. However, this has not stopped the government from introducing the Digital India initiative, through which it has added 431 million bank accounts through the Jan Dhan scheme to promote financial inclusion, and 318 million users have received direct benefit transfers through digital channels.

The global M-Banking market is growing due to consumers increasingly demanding convenient, fast, and 24/7 services, along with banks aggressively pursuing a mobile-first strategy. The increasing adoption of digital wallets and UPI, along with the integration of AI and machine learning for enhanced customer experience and security, will boost the implementation of M-banking services.

**Influencing factors:**

- ▲ Smartphone penetration and rollout and availability of high-speed wireless connectivity
- ▲ Government initiatives like Digital India, UPI, Jan Dhan Yojana
- ▲ Consumer demand for seamless banking
- ▲ Integration of advanced technologies
- ▼ The threat of cyber security breaches
- ▼ Lack of Digital literacy in some sections of society

**Global M-Banking Market (In US\$ million)**



**PAYMENT BANKS**

In 2023, Payment Bank's digital wallets accounted for nearly half of global e-commerce expenditure of US\$ 3.1 trillion and 30% of global Point of Sale (POS) spending of US\$ 10.8 trillion. The average Unified Payments Interface (UPI) volume for 2023 is around 9.8 billion, amounting to US\$ 181.45 billion. The average UPI volume in 2024 is around 13.25 billion.

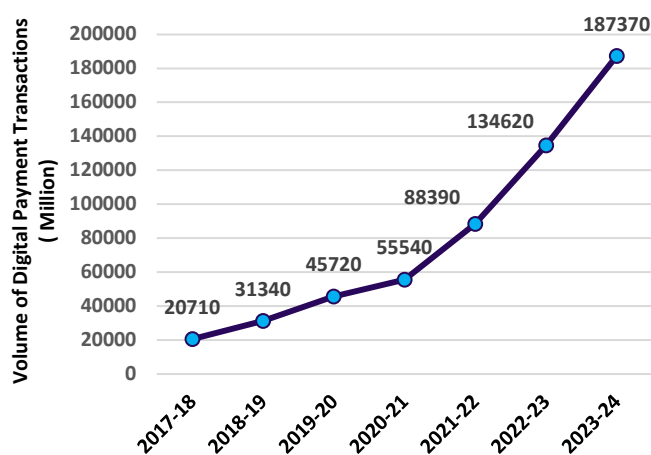
Payment banks integrated artificial intelligence into their workflow, fraud detection, KYC, and transaction monitoring policies. IoT devices, such as sound boxes and wearables, make payment possible and are efficient and convenient. India has invested in new-age payment facilities such as the Central Bank Digital Currency (CBDC) and Lightweight Payment and Settlement System (LPSS). CBDC is an inexpensive and risk-free central bank digital currency, while LPSS is an agency, not a payment hub, that will run with very little staff and only when needed. New business models of payment banks, such as data monetization, alternative pricing models, targeting customers, segmentation, and partnerships with FinTech and BigTech firms to develop their services more efficiently and capture more customers to stand firm within the competitive environment of payment services. Singapore and Thailand are integrating PayNow and PromptPay - their respective real-time payment systems - via mobile phones. This collaboration, originally intended to connect consumers and other businesses for payment purposes, is the foundation for future corporate payment expansions.

Mobile wallets will continue to dominate payment methods, while E-commerce payments, with the buy now, pay later (BNPL) concept, become the fastest-growing payment option, reflecting changing consumer preferences and technological advancements in the payment landscape. The emerging products include UPI, National Electronic Toll Collection (NETC), and National Automated Clearing House (NACH), which are expected to grow over the next 5 years.

**Influencing Factors:**

- ▲ Increased Adoption of UPI
- ▲ Cross-Border Payments
- ▲ Buy Now, Pay Later (BNPL)
- ▼ Stress on Stakeholder Profitability
- ▼ Increase in Frauds
- ▼ Customer Trust and Education

**Volume of Digital Payment Transactions**



## M-BLOCKCHAIN

Initially valued at US\$ 6.56 billion in 2022, the global blockchain market increased to US\$ 7.54 billion in 2023 despite facing challenges implementing blockchain projects in 2019 and 2020. Digital assets are gaining broader recognition following the Securities and Exchange Commission's (SEC's) certification of Bitcoin Exchange Traded Funds (ETFs), which overall validates blockchain technology.

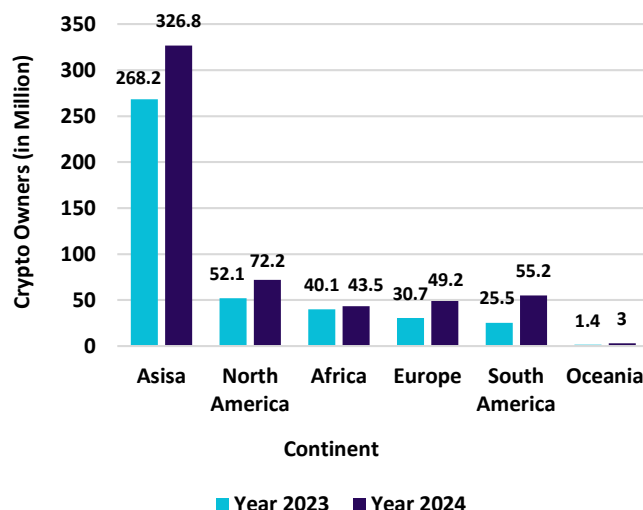
Retailers and the online payments industry are highly interested in the global blockchain and cryptocurrency market. Japan and the United States are at the forefront of the adoption and implementation of cryptocurrencies. The Indian government reports that blockchain technology is used in some components of the Central Bank Digital Currency (CBDC) pilot program that the RBI initiated in the retail sector. According to RBI, Distributed Ledger Technology (DLT) based architecture might be considered for the hybrid or indirect CBDC. The National Stock Exchange of India (NSE) India is experimenting with blockchain to manage KYC paperwork in partnership with some of the top banks in India. Digital Identity solutions, supported by blockchain innovation, permit people to share data on a reliable network, guarantee the security of identification transactions, and offer them complete privacy and control over their personal data.

Looking ahead to 2024, blockchain technology and other digital assets are anticipated to play a significant role. Many countries are now favoring the use of blockchain technology. Consequently, this trend is set to continue. The financial services industry will likely be among the first significantly influenced by the increased deployment of blockchain and associated distributed ledger technologies. It is anticipated that blockchain will continue to grow and expand in the upcoming years.

### Influencing Factors:

- ▲ Conducive regulatory environment
- ▲ Increased R&D Funding by both Govt and private companies
- ▲ Adoption of Digital Currencies by Central Bank
- ▼ Fragmentation in the Blockchain platforms and among vendors
- ▼ Development environment and security-related concerns
- ▼ Integration Challenges

## Crypto Ownership by Continent



## DOMAIN 2: INFOTAINMENT

### M-GAMING

CURRENT STATISTICS FOR FY 2023-24	PRÉVISION FORECAST FOR FY 2024-25
Global Revenue: <b>US\$ 76.7 billion</b>	Expected to reach: <b>US\$ 66.34896 billion*</b>

*\*Time-series Analysis*

The current M-Gaming industry market is US\$ 100.54 billion, which has been significantly growing. North America has the largest M-Gaming market share among all regions. Currently, the total number of mobile network subscriptions stands at nearly 7 billion, wherein India, China, and the USA are the current leaders.

As the number of mobile gamers is increasing, it has led to a rapid increase in the market capitalization of the Mobile gaming industry. Different monetization models have evolved within the gaming industry, helping developers and publishers establish new revenue streams. One of the most significant monetizing trends in M-Gaming is microtransactions, whereby players buy in-game currency for advanced customization. The Mobile Gaming Market is competitive due to the presence of key market players, including Tencent Holdings Limited, Activision Blizzard Inc., Zynga Inc., and others. Key corporations are developing new state-of-the-art technologies to stay in the mobile gaming market. India is considered a mobile gaming country, as almost 90% of the country's population plays mobile games. India has a total gaming base of 568 million gamers, with more than 15000 game developers and programmers in India. It also comprises 1400 companies with 500 gaming studios.

Despite advancements in technology, the revenue of M-Gaming saw a downfall in the year 2022 due to Inflation. The evolution of 4G and 5G has led to smooth

gaming and faster downloads. Hence, the global 5G subscriptions have reached 1.57 billion. Meanwhile, in India, the adoption of technology has led to a surge in the number of downloads. Low data prices and increased storage are leading to a boost to the Indian gaming industry.

The key constraints for the m-gaming industry are the difficulty of monetizing and the complexity of projecting revenue streams. In an attempt to monetize, game developers introduce in-app purchases and in-app advertising, both of which have been seen to affect user experience causing a drop in user engagement.

**Influencing Factors:**

- ▲ Growth in the number of online gamers due to technological advancement
- ▲ The rapid increase in market capitalization
- ▲ The evolution of 4G and 5G led to a better experience
- ▼ Difficulty of monetizing and complexity of projecting revenue streams

**M-COMMERCE**

CURRENT STATISTICS FOR FY 2023-24	PRÉVISION FORECAST FOR FY 2024-25
Global Revenue: <b>US\$ 1452 billion</b>	Expected to reach: <b>US\$ 1539.378 billion*</b>

*\*Time-series Analysis*

The global mobile phone market reached US\$ 1.4529 billion in 2023. India has around 936.16 million internet subscribers, including about 350 million mature online users actively engaging in transactions. The use of mobile internet is high in India, with 94% of smartphone users accessing it and 56 percent doing so multiple times.

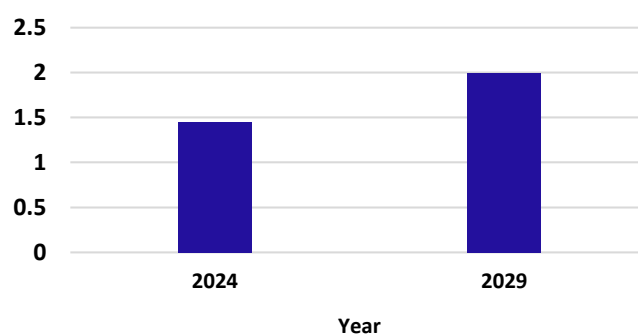
The adoption of new technology, Augmented Reality (AR), in the retail sector by various companies such as IKEA, Converse, and others is poised to create opportunities for the M-commerce market during the forecast period. The invention of secure and encrypted mobile payment systems has enhanced customer trust. Tokenization and biometric authentication are technologies that ensure safety in transactions. Shopping on mobile devices is still the same as shopping on websites; however, they bring in a lot of innovation, personalization, and user engagement. Voice shopping is a growing trend in m-commerce, enhancing shopping experiences. In the near future, mobile applications are going to drive omnichannel experiences, as they offer the power of integrating real-time reporting and analytics, among many other capabilities. Omnichannel mobile shopping will provide a seamless shopping experience from the desktop to in-app to in-store.

In 2024, a surprising 70 percent of m-commerce purchases went through a mobile application rather than a mobile website. M-Commerce's ease of use leads to widespread adoption and swift buying habits. It also helps you connect with customers more. On the flip side, there are worries about privacy and the risk of scams, plus the hefty price tag of staying ahead in the game.

**Influencing Factors:**

- ▲ Mobile apps improve shopping with personalized content, push notifications, and easy interfaces
- ▲ Mobile apps and websites use algorithms based on data analytics and AI to give personal recommendations
- ▼ Security is a major challenge for mobile devices

**Mobile Commerce Market (In US\$ Trillion)**



**M-EDUCATION**

In 2023, the mobile learning market was estimated to be worth US\$ 60.97 billion. With close to 709 million users in 2023, there has been a constant rise in registered users. There are 389,000 education apps currently in the app stores. Annual downloads touched 939 million in 2023.

Electronic devices are being adopted by educational institutions at a rapid rate, opening the door for the implementation of technologies such as gamification in learning, artificial intelligence-enabled learning environments, automated assessment tools, user interaction tools, on-demand video learning, and adaptive learning through data analysis and AI. Mobile learning facilitates personalized educational experiences tailored to the needs of the learners and their learning paces, enhancing engagement and effectiveness. The increasing use of smartphones and tablets is the major driving factor for the adoption of mobile learning. The introduction of 5G and 4G network enhancement has connected people all around the world with high-speed networks. More than 70% of learners report feeling more motivated when training on mobile devices, and Mobile learning reduces training time by up to 40%. Users complete course material 45% faster on mobile devices than on computers. North America leads the charts in spending

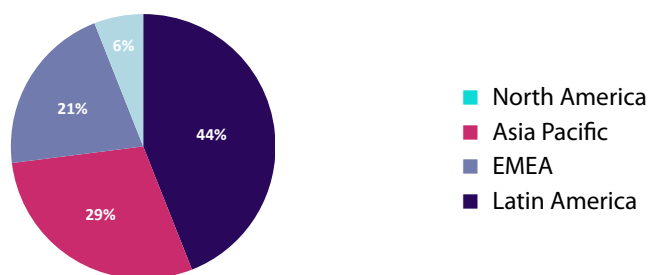
on mobile education with 44%, followed by Asia-Pacific with 29%, EMEA with 21%, and Latin America with 6%. The major players in this field are Duolingo with 148 million downloads, followed by Brainly with 46 million, and Photomath with 39 million downloads in the year 2023. India caters to over 300 million students globally with approximately 4,450 Edtech start-ups. Various initiatives of the Government of India, such as the SWAYAM platform for MOOCs, ePathshaala, DIKSHA, etc, have created awareness and offered learning opportunities to millions of students.

There has been a drastic increase in the adoption of mobile learning applications during the pandemic. The primary propellers in the industry are the advent of smart devices and network capability, which have brought education and knowledge to the doorstep of potential customers. The 21st century focuses on new-age technology, such as artificial intelligence, AR-VR, and cloud computing; these key technologies play a major role in the mobile education industry and could disrupt the traditional education model. The mobile learning market's growth faces constraints such as the undersupply of localized content affecting engagement with non-English speakers and culturally diverse learners. The other one is security and privacy concerns as m-learning platforms hold a lot of learners' personal data, necessitating strong security measures.

**Influencing Factors:**

- ▲ Implementation of 5G and adoption of smart devices
- ▲ Hybrid education model
- ▲ Various initiatives of the Government of India
- ▼ Lack of network infrastructure and devices in rural areas
- ▼ Undersupply of localised content for a diverse set of learners

**Education App spending by region 2023 (%)**



**M-HEALTH**

The global Mobile Health application market stands at US\$ 33.17 billion in 2023. North America is the largest player in M-Health applications with US\$ 10.07 billion in revenue in 2023. Meanwhile, in India, the current revenue for M-Health stands at US\$ 2.49 billion as of 2023. India constitutes 3.9% of the world's total mHealth revenue.

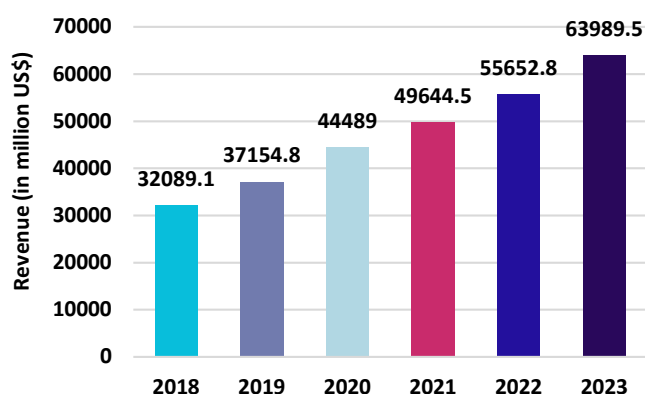
The mHealth market is experiencing growth due to the growing investments in global telecom and IT infrastructure, the increasing use of smartphones, and the rising awareness of mHealth apps. While different health systems and cultures may use different business models for the various telehealth technologies, the effectiveness of such models is assessed in practice. mHealth, considered under Telehealth, is more advanced in terms of technology. A four-component business model for mHealth services for chronic renal disease was designed based on the results of a study. This model's four constituent parts, which are data, data analysis/service, partner, and user, provided a professional and reasonably priced platform for illness support and management services in the end. Despite advancements, physicians faced certain barriers, such as Technological barriers, Individual barriers, and Organizational barriers, which affected their acceptance and adoption of mHealth technologies. In India, the applications are segmented based on M-Health apps, wearables, and connected devices, which cover the growth of several sub-segments.

Mobile health as a field has great potential to make a paradigm shift in the healthcare industry into one that will be greatly beneficial to both patients and stakeholders for better quality and sustainability of the healthcare system. With smartphones being on the increase, good network coverage and government programs such as Digital India DISHA, among others, also find favor in India. Still, there are 25000 villages in India that face the challenge of internet connectivity.

**Influencing Factors:**

- ▲ Increased investments in global telecom led to market growth
- ▲ Business models were introduced for future optimization
- ▼ Physicians faced certain barriers in accepting mHealth technologies
- ▼ Complexity and diversity of regulations across geographies

**M-Health Global Revenue**



## M-ENTERTAINMENT

The Worldwide mobile entertainment industry is expected to develop significantly, valued at US\$ 228.9 billion in 2023 and with an annual growth rate of 15% in the past 5 years. This rise is driven by high-speed network connectivity, the proliferation of smartphones, and the rising consumption of mobile content such as gaming, streaming video, and music.

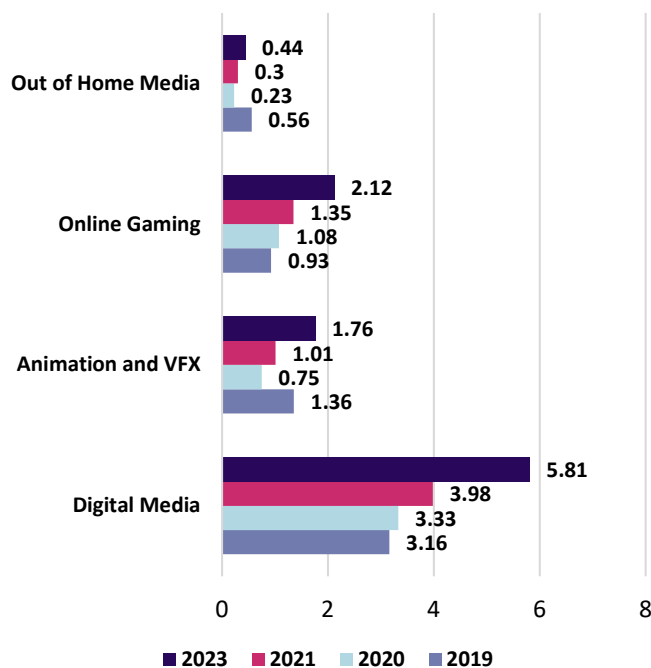
Despite economic headwinds, technological disruption, and rising geographic and sector-driven competition, the global Media & Entertainment (M&E) industry has continued to grow in 2023, with total revenues increasing by 5 percent in 2023 to US\$ 2.8 trillion, outperforming overall economic growth. The sector has witnessed an enormous transition in India, the market size was US\$ 27-29 billion in 2023. Similarly, the mobile gaming market of India shows significant growth and comprises 90% of the gaming industry, showing immense potential for the M-Gaming Industry. Next, there is a noticeable trend in users towards online video content in India's TV-dominated sector. Numerous domestic businesses and streaming services like Netflix and Prime Video, to name a few, have made significant efforts to produce local content in various languages. The enormous potential of the OTT Industry is demonstrated by the recent US\$ 8.5 billion merger of Reliance with Disney. Also, the Indian visual effects sector continues to flourish thanks to cutting-edge techniques and high-end equipment. India's industry workforce in VFX & Animation has grown 20 times from 2018 to 2023, thus showing phenomenal growth at a CAGR of 97.56% during the stated period, making this sector one of the most important job-creating ones.

Government measures such as increasing FDI limits and establishing an Animation, Visual Effects, Gaming, and Comic Centre for Excellence- make a more propitious environment for growth. Hence, India is well-positioned to be a global leader in the fast-moving and exciting industry as it continues to embrace mobile entertainment, mirroring these larger trends in digital consumption and innovation.

### Influencing Factors:

- ▲ Affordable plans and high demand for content
- ▲ Significant FDI inflows have bolstered growth and innovation in the sector
- ▲ Increasing Internet penetration and government push toward digital adoption
- ▼ Stringent data privacy regulations across geographies

## Industry Size of M&E Industry in India (US\$ billion)



## SOCIAL NETWORKING

Around the world, there are 5.07 billion social media users, which is 62.6% of the world's total population. The Global market size of social networking is US\$251.45 billion in 2024, and the CAGR is 14.8% YoY; it was US\$219.06 billion in 2023. 462.0 million social media users in India.

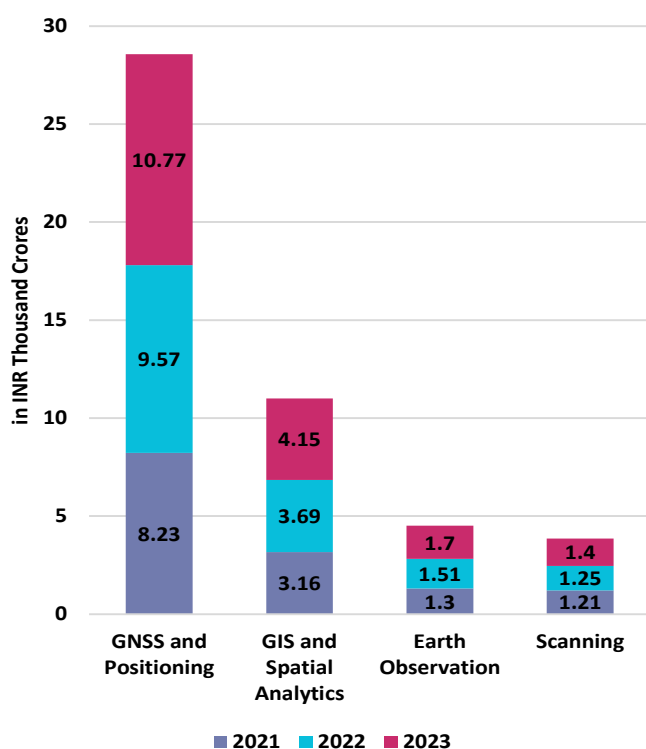
Facebook is the most used social network, and it has 3.06 billion active users in the world. The market cap of Facebook is currently US\$1.318 trillion. Facebook's average global revenue is US\$16.9 million, with US\$6.42 average revenue per user. Global stats of Facebook has 61.93%, Instagram has 11.79%, YouTube has 9.4%, Twitter has 7.14%, Pinterest has 6.65%, and Reddit has 2.32% as of July 2024. In India, Facebook's social media stats are 66.74%, Instagram 25.56%, YouTube 5.35%, and Twitter 0.92%. China ranked 1st with 1 billion social media users, India is 2nd with 467 million users, and the United States has 246 million users as of March 2024. Studies found that for students, especially in Africa, social networks are a distraction for them and a waste of time; addiction and cyber risks are some concerns that also arise. People are being protected by blocking such sites, and many believe that they are just depriving them of some important digital skills, which is counterproductive.

Social networking has transformed how people communicate with one another, how information is relayed, and how one interacts socially. It allows individuals to connect with and befriend other people regardless of their places of living. Just like its increasing usage, new applications of this technology are also under application these days.

**Influencing Factors:**

- ▲ Social media improves career development and improves business opportunities by enabling professionals to connect and share knowledge
- ▲ Social networks provide access to educational content, news, and support communities that improve personal development
- ▼ Social networking has the disadvantage of looser individual connections within larger, diverse networks that are wider in perspective
- ▼ Trust fosters sharing and interaction in social networks, with reciprocity strengthening social bonds further

**Indian Geospatial Market Size (In INR Thousand Crore)**



**LOCATION-BASED SERVICES**

In 2023, the Location Based Services (LBS) market was valued at US\$ 26.22 billion. The LBS market has shown significant growth, with a strong annual growth rate of 19.5% over the past 5 years. Key sectors leveraging LBS include retail, transportation, and healthcare.

North America leads the market due to technological advancements and a strong digital infrastructure, while the Asia Pacific region commands substantial growth in the location-based services (LBS) market for several key reasons - The region holds the world's largest population and contains the largest number of smartphone users. In addition, the process of urbanisation and smart city projects being rolled out in countries such as China and India further spur the demand for LBS in various industries like transportation and health. In May 2023, ISRO launched the NVS-01 satellite. This is expected to be India's next-generation GPS, which is available

to provide real-time positioning and timing services not only in India but also in neighboring regions. This would propel the market forward. In June 2023, Tatvic Analytics formed a partnership with Google Maps Platform, where Tatvic Analytics would help enterprises implement GMAPs, optimise spending, determine the right APIs to overcome a wide array of industry-specific problems, and realise total value from the Google Maps Platform Stack. Also, the government of India recently introduced a CORS (Continuously Operating Reference Stations) survey network across the nation to provide real-time location mapping positioning services. Increased integration of emerging technologies has contributed towards enhancing the accuracy and user experience of LBS systems thanks to the proliferation of mobile phones and IoT devices.

Location-based services stand on the verge of remarkable growth, impelled by technological development and a growing demand for personalized experiences. Innovations in GPS, mobile networks, and data analytics are refining LBS capabilities, granting businesses invaluable insights while offering customized services to consumers. As technology continues to progress, LBS will be integrated into many industries, changing customer interaction and operational approaches.

**Influencing Factors:**

- ▲ Demand for LBS is driven by an increasing number of smartphone users worldwide
- ▲ LBS-based businesses are being used increasingly to target advertisements and improve user engagement
- ▲ GPS technology and innovation in geolocation services are also driving growth
- ▼ A huge challenge to the growth of LBS arises from user data security and privacy issues
- ▼ The preliminary expenses associated with the establishment of location-based services may pose an obstacle for smaller businesses

**Expert Speaks**

*Summary of Insights: Currently, logistics and supply chains leverage real-time Location-Based Services (LBS) for efficiency, but high costs and complexity limit adoption. Affordable alternatives like smartphone-based data transmission democratize access to LBS, enabling businesses to customize delivery routes and track products in transit, reducing delays and gaining an edge. Platforms like India's ONDC expand LBS access for businesses with economic or geographical constraints. Technologies like blockchain and AI further enhance visibility and predictive capabilities, offering scalable, cost-effective solutions to meet diverse logistical needs.*

**Mr. Rahul Gadde**

Delivery Manager, Centiro

## SUPER APPS

In 2023, the global super app market was valued at US\$ 75.5 billion. In the year 2022, the market had a valuation of US\$ 61.30 billion. In India, the super apps market is experiencing significant growth as the overall app market of India was valued at US\$ 3.3 billion in 2023 when compared to US\$ 2.7 billion in 2022. It is estimated that globally, there will be 4.88 billion smartphone users in 2024, with 635 million new smartphone users over the past year alone. In terms of volume downloaded, the top 15 popular Super Apps were downloaded over 4.6 billion times worldwide.

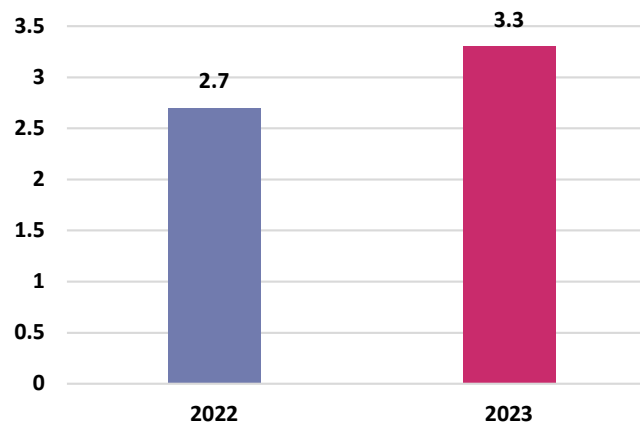
The implementation of emerging technologies is playing a pivotal role in the advancement of the super apps industry. Digital transformation technologies such as Artificial intelligence, Machine learning, and Blockchain are implemented to enhance user experiences by providing personalization, improved security, and seamless transactions for customers. Developers are able to integrate multiple services into a single platform due to the advancements in cloud computing. In terms of smartphone platforms, the Android segment is leading the market with more than 60% of the market share as the smartphones are priced lower, followed by the iOS segment smartphones. China leads the way in terms of downloads and users globally, as WeChat has over 1.3 billion users worldwide, followed by Alipay, which can support transactions in 18 foreign currencies. According to a recent survey in India, 90% of customers in India would prefer a single app platform to access all digital services, and 35% of customers struggle to navigate between platforms to access content. Tata Neu, MyJio, and AdaniOne are the biggest players in India, providing payment systems, e-commerce, hotel reservations, and travel bookings, to name a few services offered in the app.

The global super apps market is growing due to consumers' surging adoption of smartphones and telecom providers' affordable internet packs. The increasing digitisation of legacy services like financial payments, movie tickets, travel booking, and social media with the integration of the latest technologies like AI, blockchain, and 5G has accelerated the demand for a "one platform, all services" approach.

### Influencing Factors:

- ▲ Smartphone penetration and availability of high-speed wireless connectivity
- ▲ Increased adoption of digital payments
- ▲ Integration of advanced technologies
- ▼ Highly competitive market scenario
- ▼ Lack of Digital literacy

## App market in India (In US\$ billion)



## IN-VEHICLE INFOTAINMENT

The current In-Vehicle Infotainment market revenue stands at US\$ 25.5 billion as of 2024, compared to US\$ 23.1 billion in 2023. Europe has the highest growth rate among all regions. Meanwhile, North America accounts for the highest share of the In-Vehicle Infotainment market revenue.

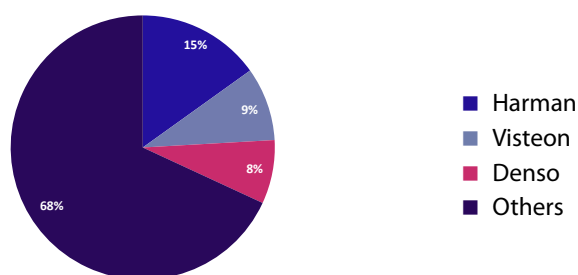
Advancements in technologies, such as driver assistance, smart navigation, and voice recognition, support growth in the market. Acceptance of cloud technology in the automobile industry is propelling in-vehicle infotainment system development, shaping the evolution of the industry. Innovations in in-vehicle infotainment will transform the automotive landscape with features such as touchscreens, AI, and augmented reality. Risk of driver distraction, data privacy, and other issues are a few of the significant hurdles to unlocking the full potential of these innovations and achieving a safer and more enjoyable experience for the driver. The growing electric and autonomous vehicle markets are providing a growth impetus for the in-vehicle infotainment market, whereas comfort and luxurious offerings driven by high-performance vehicles are at the same time creating demand. The in-vehicle infotainment market is driven by smart vehicles and safety features such as E-Call and fleet management. Leading vendors, such as ALPS, ALPINE, and Continental AG, are encashing on market opportunities through competitive and innovative flexible in-vehicle infotainment solutions compatible with various OS. In India, an increase in passenger vehicle sales is the driving force of market growth. Total sales rose from 3.07 million to 3.89 million units in FY 2022-23.

One key challenge for in-vehicle infotainment is the added cost of annual subscriptions for services like satellite radio, Wi-Fi, and real-time traffic, which start with free trials but become expensive over time. The 5G connectivity segment is set to dominate the in-vehicle infotainment market, enabling faster navigation, real-time data transfer, and enhanced multimedia features, driving the adoption of 5G technology among global automakers.

### Influencing Factors:

- ▲ Adoption of cloud technology, AI, and augmented reality
- ▲ Overcome driver distraction and data privacy enhancing driving experience
- ▲ Rise of electric and autonomous vehicles
- ▼ High cost for infotainment systems
- ▼ Ongoing operational expenditure in the form of subscription fees of network providers

### Market Share of Major Infotainment System Suppliers



### MOBILE APP STORE

CURRENT STATISTICS FOR FY 2023-24	PRÉVISION FORECAST FOR FY 2024-25
Global Revenue: <b>US\$ 171 billion</b>	Expected to reach: <b>US\$ 180.6734 billion*</b>

*\*Time-series Analysis*

Global consumer spending on Mobile Apps hit an all-time high, with iOS and Google Play crossing over US\$35 US\$ billion in Q1 2024. The year-over-year growth was 9.5 percent, while an increase from a previously set record for Q4 2023 was 3.4 percent.

The United States was once again the top market for consumer spending across iOS and Google Play, with US\$12.4 billion spent in Q1 2024. China Mainland ranked second with US\$6 billion in consumer spend on iOS alone, while India led with most mobile app downloads. The Indian mobile app market is gaining pace quite rapidly, and one such evidence is the Indus Appstore by PhonePe which was launched on 21 February 2024 and crossed 100,000 downloads in just three days, even going past Google Play and Apple App Store. This reflects the great demand for localized, developer-friendly platforms. AatmaNirbhar Bharat App Innovation Challenge by the Government of India is designed with high-quality localized application development that will help further strengthen the app ecosystem of India and cash awards and visibility for encouraging innovation among tech entrepreneurs by creating a competitive environment. Additionally, the Indian government has taken a proactive approach to controlling and managing the application market. Since 2020, over one hundred Chinese applications have

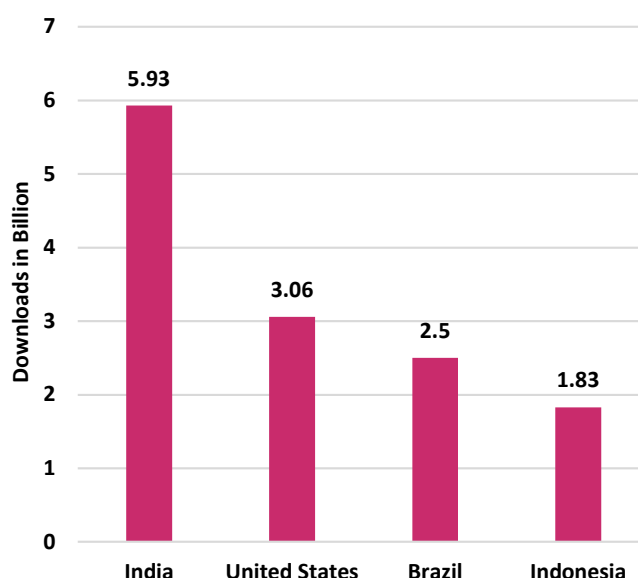
been blocked by India for national security reasons. This kind of policy towards the digital environment creates a risk-free digital zone while also promoting domestic invention.

The mobile app store industry is undergoing a transformation. In a world where Google and Apple rule the mobile app sector, 5G, AI, and regulatory shifts will lay the way to the next era. In India, the growth story is driven by affordable internet, government programs, and an increased focus on localisation.

### Influencing Factors:

- ▲ Smartphone Penetration & Affordable Data
- ▲ Localization & Government Programs
- ▼ Security and Privacy concerns
- ▼ Regulatory compliance challenges

### Top Markets by Downloads in Q1 2024



## DOMAIN 3: GOVERNANCE

### M-GOVERNANCE

In 2024, there are about 4.88 billion active smartphones worldwide, a significant 28.98% increase over the last five years, which is a growth of 14.9% YoY. As of January 2024, India had 751.5 million internet users, which is 52.4% of the country's population, and this number has increased by 2.6% from 2023 to 2024.

Global 5G adoption has touched 20%, M-Governance aims to make personalised and localised information services available anywhere. In 2024, MyGov will have more than three crore registered users in 22 states of India. In early 2024, India had 1.12 billion active cellular mobile connections, with this population percentage accounting for 78.0 % of the population. Low levels of literacy, lack of English knowledge (80% of Indians speak the local language and only 5% know English),



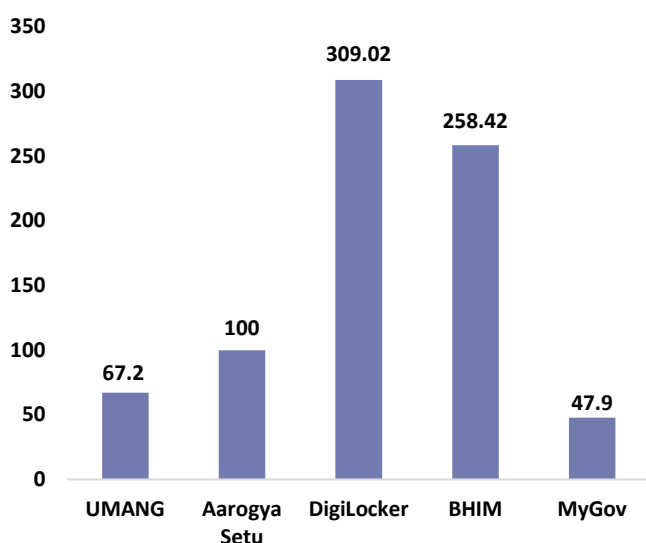
and digital illiteracy are the current challenges for m-governance in India.

M-governance rapidly spreads to remote areas, enhancing ICT's role in governance and poverty reduction. Governments will need to develop M-government strategies to leverage these technologies effectively. Building on past e-government efforts, this transition will take and face challenges, requiring careful planning and adaptation.

**Influencing Factors:**

- ▲ Demographics contains the components of gender, age, household income, poverty, education, and digital skills
- ▲ Cybersecurity technology will help the governance for better data privacy and secure payment
- ▼ Low level of literacy, lack of English knowledge, and digital illiteracy
- ▼ Legal and regulatory challenges can occur on cross-border connections with m-gov services

**M-Governance services registered users in million**



**BIOMETRIC TECHNOLOGY**

The biometric technology market has witnessed steady growth in the previous years, from US\$ 52.65 billion in 2023 to US\$ 59.76 billion in 2024, with a CAGR of 13.5%. North America has 32% of the biometric market share by region, followed by Europe, Asia Pacific, the Middle East & Africa, and Latin America, which amounts to 28%, 24%, 6%, and 10% respectively. Indian Biometric technology market size reached US\$ 214.41 billion in 2023, forecasted in 2024.

The U.S. biometrics market size was valued at US\$ 9.98 billion in 2023, and in 2024, it is US\$ 12.02 billion, with a CAGR of 20.50%. The top industries that implemented biometric attendance systems in 2024 are - 1. IT Sectors 2. Manufacturing 3. Healthcare 4. Education. The global

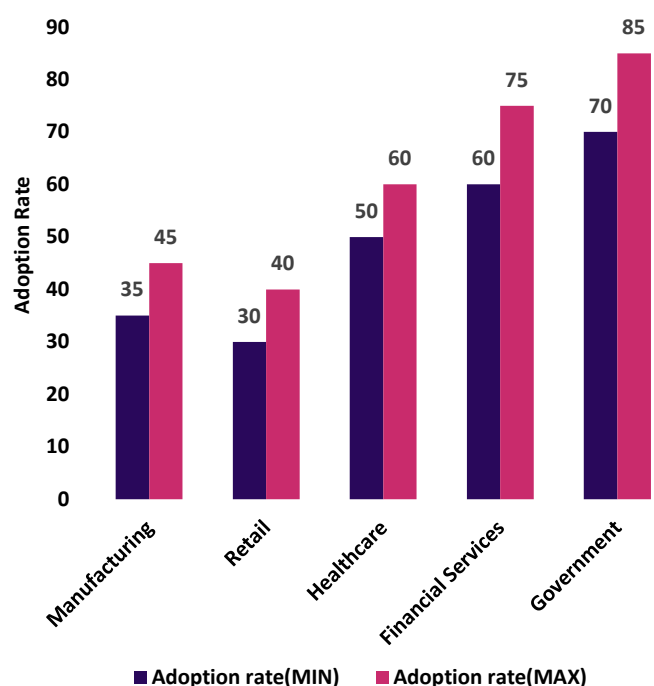
biometric time attendance market was valued at US\$ 1.1 billion in 2023. Segment by application are large enterprises and SMEs. Segments by type are the face, Iris, and fingerprint recognition. Biometric Attendance System (BAS) – Delhi Central in India As of 6 October 2024, BAS has 726 registered organizations, 322,717 registered employees, and the total registered devices is 71,771, which is 70764 from tablets and 1007 from desktops. Biometric technology faces several challenges, including Spoofing, Deepfakes, and Ethical concerns. The Canadian bank (TD Bank) pays US\$ 20 million to resolve treasury Spoofing cases amid wider U.S. (United America) probes. Deepfake cases worldwide detected a 245% YoY increase in this matter.

The biometric market is emerging and will account for more than US\$ 94.23 billion by 2028. Automated systems also offer enhanced security and fraud prevention. Despite spoofing, which does challenge the security of computerized systems, industries have begun adopting biometrics. HyperVerge is helping businesses utilize these innovation currents for future growth.

**Influencing Factors:**

- ▲ Very convenient since there is no need to remember or carry anything
- ▲ Biometric verification and authentication offer benefits in identity management
- ▼ Low-quality samples can lead to false acceptance or rejection
- ▼ Data Security: Strictly steps to protect personal information data

**Biometric Technology Adoption Rate By Industries (%)**



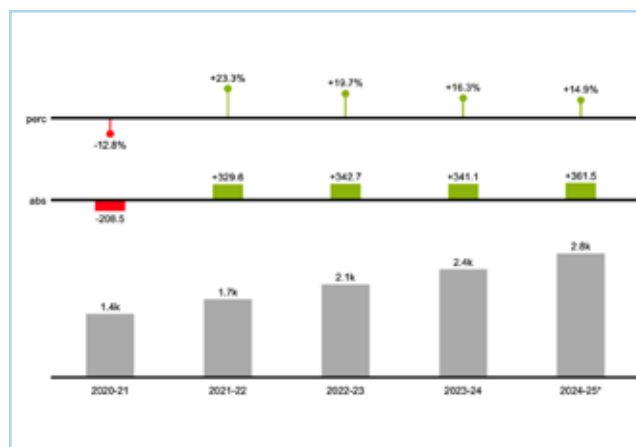
## PRÉVISION OUTLOOK

- The increasing demand for mobile-first banking models and tech-driven financial services anticipates a significant growth in blockchain applications in the finance sector
- Cross-border real-time payments are expected to connect financial services globally, as UPI will expand globally, which will contribute towards financial inclusion
- The rising adoption of Augmented Reality (AR) in the retail sector has enhanced shopping experiences and is driving omnichannel mobile shopping experience
- The recent advent of smart education devices, Artificial intelligence, VR, and enhanced connectivity capabilities has brought technology and knowledge closer to the users
- The introduction of CORS by the Government of India and 5G services across the country will help in surveying across the nation to provide live location map services
- The aim to localise and personalise information is giving rise to M-Governance and spreading to remote areas of India, transforming governance and security
- Mobile connectivity is being redefined with the adoption of 5G, rising eSIM adoption, and AI capabilities fostering growth in services linked to smartphones

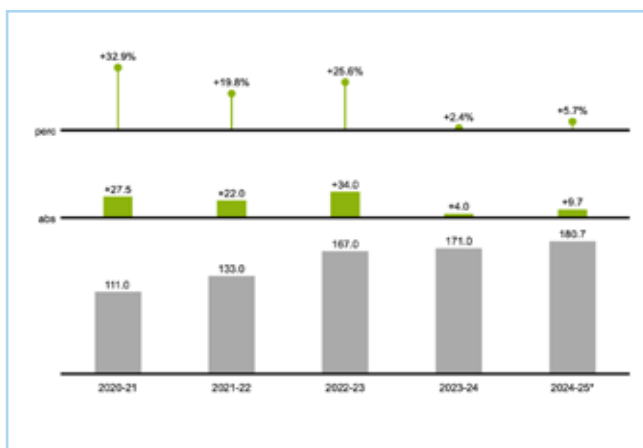
**Digital Payments (India)**  
**Volume of Transactions (in lakh crore)**



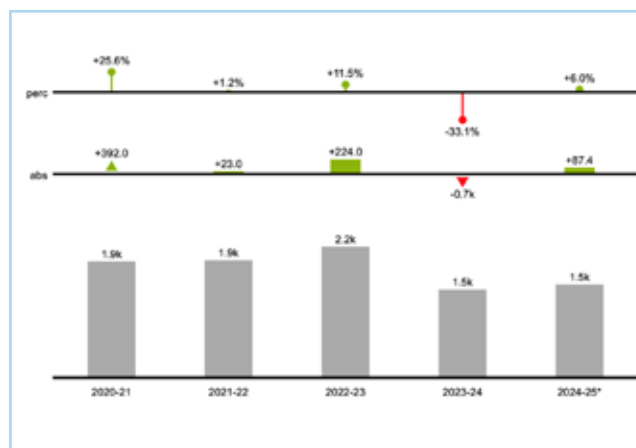
**Digital Payments (India)**  
**Value of Transactions (in lakh crore)**



**Mobile App Stores**  
**Global Consumer Spend (in US\$ billion)**



**M-Commerce Global Revenue**  
**(in US\$ billion)**



■ Increase  
■ Decrease

# CONSUMER ELECTRONICS



## Student Team

Keshava Sharma | Pritesh Gharat | Himani Dhiman | Yatharth Pandey

## SNAPSHOT

- ▶ India's smartphone market grew 1% YoY in Q2 2024, driven by improved inventory levels and new product launches; global shipments decreased 3.2% YoY in 2023 to 1.17 billion units, signaling consumer demand challenges
- ▶ Shipment of tablets rose from 30.6 to 30.8 million units from Q1 2023 to Q1 2024, indicating new interest. Shipments in India increased by 37% in Q1 2024 because of increased educational demands post-pandemic
- ▶ Worldwide TV shipments fell 3%, reaching 223 million units in 2023. Demand for premium TVs with advanced panel technology rose in India
- ▶ Technological advancement pushed the global STB market from US\$ 23.2 billion to US\$ 23.5 billion in 2023. Initiatives like "Made in India" promoted the Indian STB industry during increased competition
- ▶ Mirrorless camera shipments increased by 18.6% in 2023, while total market shipments fell to 7.72 million units in early 2023
- ▶ AR/VR shipments fell 23.5% YoY in 2023, continuing the 20.9% decline of 2022
- ▶ The gaming console market grew to US\$ 26.7 billion in 2023 as technology improved and consumers continued to spend more
- ▶ Approximately 504.1 million wearable devices shipped in 2023, a 2.4% YoY growth, mainly due to health consciousness

## DOMAIN 1: MOBILE DEVICES

This domain includes all the major mobile devices.

### SMARTPHONES (GLOBAL & INDIA)

CURRENT STATISTICS FOR CY 2023	PRÉVISION FORECAST FOR CY 2024
Global Smartphones Shipments: <b>1140 million units</b>	Expected to reach: <b>1164.40 million* units</b>
Indian Smartphones Shipments: <b>146 million units</b>	Expected to reach: <b>143.98 million* units</b>

\*Time-series Analysis

Global smartphone shipments in Q2 2024 climbed 6.5% year-on-year (YoY) to 285.4 million units, as the International Data Corporation (IDC) reported, and declined 4% YoY to 1140 million units in 2023, as per Canalis. According to the most recent Canalis study, the Indian smartphone market expanded by just 1% in Q2 2024, with 36.4 million units shipped. IDC estimates that 146 million smartphones were supplied in India in 2023, representing a 1% YoY rise.

In Q2 2024, the worldwide smartphone market had a 12% shipment increase, capping a third quarter of YoY growth. With 18.9% of shipments in 2024, Samsung

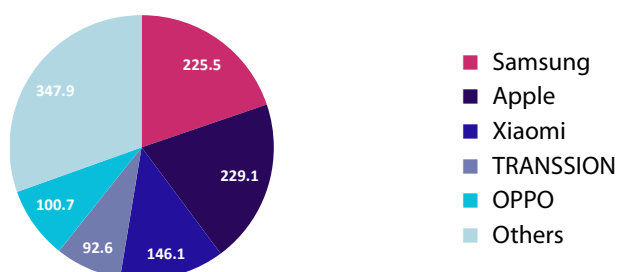
took the lead thanks to its powerful AI strategy and flagship product. With a 15.8% share, Apple concluded the quarter in second place. The two top businesses experienced only slight growth. With a share of 14.8%, Xiaomi ranked second YoY; Vivo and Oppo tied for fourth position with shares of 9.1% and 9.0%, respectively. India's smartphone market had a great start to 2024 because of the entry of new vendors with deep inventories, enabling channels to embrace several new products introduced during the quarter. Due to elections, sluggish seasonal demand, extreme weather in some regions, and other factors, the Indian smartphone market grew by just 1% in Q2. With an 18% market share, Xiaomi regained its top rank after six quarters, followed by Vivo and Samsung.

In the smartphone industry, optimism is still growing thanks to cutting-edge technology like generative AI and resurgent mass market demand. The second half of the year will likely see the release of more Gen AI smartphones, which might be the next primary growth driver after 5G and foldables. The Q2 is more akin to a prelude to these releases. Despite some parts' import tax reductions, price increases are anticipated to persist as operational pressures increase owing to rising component costs.

**Influencing Factors:**

- ▲ Increased vendor investments and recovery in consumer demand
- ▲ Improved inventory situation, which allowed channels to embrace new offerings
- ▲ Growth in value and Average Selling Prices (ASP)
- ▲ The evolution of on-device AI solutions for smartphones, with the potential to reshape the industry
- ▼ Increased component prices and reduced channel inventory levels
- ▼ Intermittent supply issues and low demand

**Global Mobile Vendor Market Share 2023 (Millions)**



**TABLETS (GLOBAL AND INDIAN)**

CURRENT STATISTICS FOR CY 2023	PRÉVISION FORECAST FOR CY 2024
Global Tablets Shipments: <b>128.5 million units</b>	Expected to reach: <b>100.7346 million* units</b>

\*Time-series Analysis

The global market faced a steady decline in their trends for a couple of decades, but the tablet shipments increased from 30.6 million to 30.8 million from Q1 2023 to Q1 2024, with year-over-year (YoY) growth of 0.5%. This growth was driven by the start of a fresh cycle, though long-term volumes are unlikely to match the surge seen during the pandemic.

The tablet market tycoon Apple, having witnessed a dull 2023 with a decline of 8.5%, has emerged on top with a 36% global market share and 12 million iPads shipped in Q1 2024. This is suspected due to the future scope and excitement for OLED screens for iPad Pro. The next in line is Samsung, which shipped 6.8 million units in Q1 2024. Chinese vendor Huawei has sustained its market share by shipping 2.7 million units satisfying demand in its home country and the Asia Pacific region. A massive 130% quarter-on-quarter (QoQ) increase in 5G tablet shipments has been reported due to a rise in 5G rollout and feature-rich tablets. It has significantly boosted India's tablet market in 2024, focusing on 5G-enabled devices. In Q1 2024, India's tablet shipments increased by 37%, with 1.3 million units shipped. One of the primary reasons for this growth is an increase in demand from the education sector. In India, Wi-Fi tablets dominate the market by 52%, and premium tablets witnessed a jump of 47% due to users' preference for high-end devices.

There's a storm taking the PC ecosystem towards innovation with new Snapdragon X Plus 8 Core Chips and the primary vendors are Acer, Asus, Dell, HP, Lenovo, and Samsung. This will prove a boon for customers seeking enhanced laptop performance with optimal consumption. Qualcomm has developed two ARM-based chips—Xelite and Xplus for the laptop market. For users prioritizing long battery life and seamless usage for everyday tasks, the Snapdragon X Plus 8-Core is the real deal. On the other hand, the Snapdragon X Elite chipset will cater to better A.I. processing by adding a Neural Processing Unit (NPU) to run Large Language Models (LLM) for Gen AI. Although Xplus might have low-performance issues compared to Xelite, the former is expected to suit mainstream laptops better.

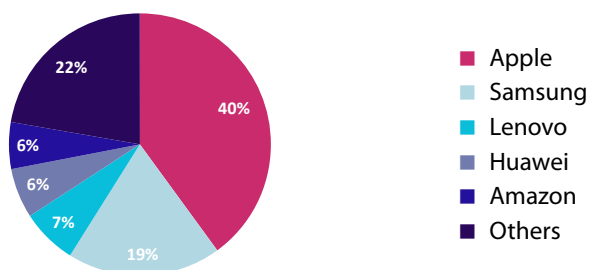
Even though the initial procurement cost of rugged tablets is high, their market is limited. With the manufacturers implementing innovations like A.I. and voice assistant integration, the lasting appeal of these devices for productivity, entertainment, and education will provide a new dimension to the tablet market and help recover the trajectory to pre-pandemic levels.

**Influencing Factors:**

- ▲ Interest in premium tablets
- ▲ Rollout and expansion of 5G network infrastructure
- ▲ Innovation in PC/laptop chip design leading to longer battery life

- ▲ Appealing for productivity, entertainment, and education purposes
- ▼ Rugged Tablet costs
- ▼ Competition with AI PCs and Smartphones

### Global Tablet Shipment Vendor Share CY-2023



## DOMAIN 2: HOME ENTERTAINMENT DEVICES

The trending and upcoming devices used for home entertainment are included in this domain.

### TELEVISION (GLOBAL & INDIA)

CURRENT STATISTICS FOR CY 2023	PRÉVISION FORECAST FOR CY 2024
Global Television Shipments: <b>223 million units</b>	Expected to reach: <b>247.12 million* units</b>

*\*Time-series Analysis*

The global television (TV) market shipments declined by 3% to 223 million units in 2023, according to Counterpoint Research. Smart televisions shipped in India declined by 16% year-on-year (YoY) as per the Counterpoint Research.

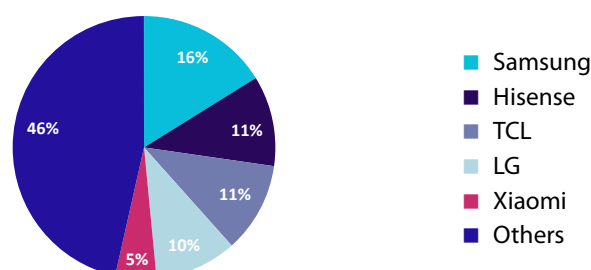
The total sales of premium TVs fell by 1% despite the growth in China. The shipment and revenues in China grew by 39% and 49% respectively. The US market's strength could not offset the downtrend in China and Europe. Samsung stood as the global market leader for 2023 with a market share of 16%, followed by Hisense at 11% and TCL also at 11%. The market was faced with a decline due to the high interest rate environment in Europe and the US and the real estate bubble in China. In India, Xiaomi stood as the market leader with 9.8% market share, followed by Samsung at 9.6% and TCL at 9.3%. The research indicated that the smart TV contributed to 91% of overall TV shipments in H1 2023, India. The consumer mindset was moving towards premium TVs with features like OLED, QLED, etc., and larger screens. TV companies are also focusing on newer panel technologies like Micro LED and Mini LED, holographic TVs, higher refresh rates, and sharper 8K displays. The decline in sales in India was due to the increased prices of panels and a fall in demand for small-screen TVs. Other reasons also include macroeconomic challenges and bloated inventory.

As the trend continues from 2022, 2023 has also seen a decline in the sales of TVs, both at a global level and Indian level. The global market faced a decline because of the high interest rates and the unwillingness of consumers to spend on non-essentials. On the other hand, premium TVs and TVs with larger screens have seen positive growth in India.

### Influencing Factors:

- ▲ Smart TV penetration in India peaked at 93%
- ▲ Consumers prefer premium and bigger TVs in India
- ▼ Saturation in the overall TV market
- ▼ Decrease in sales in India due to increased panel prices

### Television Market Share in 2023



### SET-TOP BOX

The worldwide market size of set-top boxes (STB) in the year 2023 was US\$ 23.5 billion, whereas in the year 2022, the market size of STBs was valued at US\$ 23.2 billion. In 2023, the contribution of the Indian market to the worldwide market share was valued at US\$ 2.8 billion.

The market for STBs is divided into various categories, such as cables, satellites, Internet Protocol Television (IPTV)/Over-the-Top (OTT), and hybrid. Of these, the cable and satellite sector holds the largest share in the market, with US\$ 7.68 billion in 2023. The most recent STB models use cutting-edge technologies to differentiate them from traditional STBs, like Full HD and 4K/8K resolution compatibility, voice-activated remotes, and Bluetooth Low Energy (BLE). This helps the STB industry grow. The leading companies in the worldwide STB industry are Commscope, Kaonmedia Company Limited, Huawei Technologies, etc. TRAI reports that in the first half of 2021, Tata Sky, a member of the Tata Group, held the largest share of the Indian DTH market, accounting for almost 33% of the total. The expansion of the Indian STB industry is being propelled by government initiatives like "Made in India" and the penetration of television sets in both urban and rural areas of the country. The frequent technological advancements, which lead to a shorter product cycle and increasing competition among companies, are a few challenges in the Indian STB business.

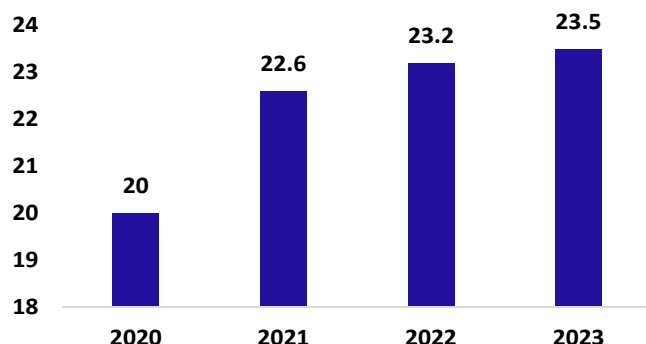
As digital technology develops quickly and the need for media material grows, the STB industry has witnessed a

significant surge in popularity, blending the worlds of entertainment and broadcasting seamlessly. Leading industry players are investing heavily in R&D to increase the range of products they offer, adding to the STB market's continued growth. As the market is expanding continuously and the competition is rising, the STB sector should provide affordable prices to beat the competition.

**Influencing Factors:**

- ▲ Raising adoption of internet and broadband services
- ▲ Individualized viewing experiences and usability
- ▲ Rising adoption of OTT services
- ▲ The increasing consumption of content on smartphones and laptops
- ▼ High costs and consumer price sensitivity
- ▼ Market saturation in developed regions

**Global Set Top Box Market Capitalisation (US\$ billions)**



**DIGITAL CAMERAS**

In 2022, the digital camera market globally faced a downturn, with shipments hitting 8.01 million units. Shipment units during early 2023 remain irregular; the total units shipped were 7.72 million. This is less than what was attained last year, which was 8.8 million. By the end of the first quarter of 2024, the shipment volume of units rose to 1.63 million, whereas that of the second quarter was at a higher level, reaching 2.08 million, according to the Camera and Imaging Products Association (CIPA) report.

The value of shipments for interchangeable-lens digital cameras saw a substantial increase in 2023. Last year, the growth of mirrorless cameras was recorded at an impressive 18.6%, accompanied by a notable 10.9% rise in value. This demonstrates the significant market strength of mirrorless cameras, prompting manufacturers to prioritize innovation to meet the evolving demands of consumers. The overall camera market value increased by 4.9% despite total units recording a drop of a slight 3.6%. Interchangeable lens shipments are about 1.25 times that of the digital still camera shipment, thus carrying forward an upward trend as was witnessed in the earlier years. Canon still held a dominant share of 46.5%, while other

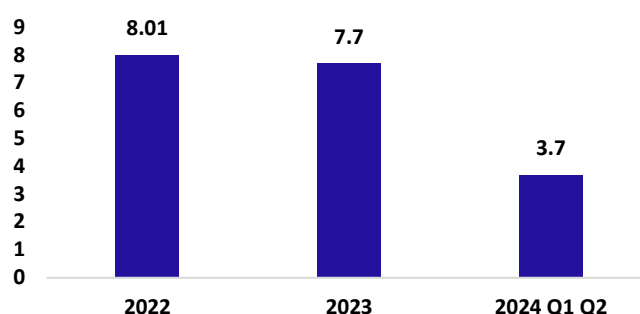
players, Sony and Nikon, benefited further from steady shipment growth.

The digital camera market is stabilizing after years of decline, with video emerging as a key growth driver, even among still photographers. Manufacturers recognize the importance of video for attracting and retaining customers, enhancing their offerings to meet expectations for high-quality content. AI has significantly improved cameras, particularly in subject identification and tracking, and manufacturers are exploring advanced functionalities, such as training cameras, to understand scene context for better subject prediction. Additionally, the industry acknowledges the need for improved smartphone integration, as customers find the multi-step process of sharing photos frustrating, presenting a vital opportunity for enhancement.

**Influencing Factors:**

- ▲ Rise of Mirrorless Cameras
- ▼ Slow down in Innovation
- ▼ Intense competition from Smartphone camera
- ▼ Declining Shipments

**Global Digital Camera Shipment Units (In millions)**



**AR/VR HEADSETS**

CURRENT STATISTICS FOR CY 2023	PRÉVISION FORECAST FOR CY 2024
Global AR/VR Headsets Shipments: <b>6.732 million units</b>	Expected to reach: <b>5.0692 million* units</b>

*\*Time-series Analysis*

The global shipments of AR/VR headsets declined by 23.5% in 2023 from 8.8 million units in 2022 by International Data Corporation (IDC), continuing the decline from the previous year, during which it fell by 20.9%. In the last quarter of 2023 (Q4 2023), the AR/VR market experienced 130.4% growth, while in the first quarter of 2024 (Q1 2024), it faced a sharp decline of 67.4%.

China's 2023 Virtual Reality (VR) market saw its most significant drop of 61% YoY in shipments in the last five years. Meta topped the market for Q4 2023 with a share of 62.2%, followed by Sony at 16% and ByteDance

at 6.4%, and for Q2 2024, Meta continued to top the shipments with a share of 60.5%, followed by Sony at 10.4% and Apple at 9.1%. Despite the launch of compelling products such as Sony's PSVR and Meta's Quest 3, sales declined due to economic pressures on households, slower spending in commercial segments, and a lack of compelling use cases. The decline in shipments was also due to macroeconomic uncertainty, and most companies also relied on legacy products launched a year ago. In light of the development of new products, the Consumer Electronics Show (CES) 2023 showcased new augmented reality (AR) glasses from TCL & Canon, while the Mixed Reality (MR) visor called MREAL from Canon was still in the research phase. The launch of Apple Vision Pro has also increased the average selling prices (ASPs) for MR headsets, but products from the likes of Meta & HTC have kept them from going much higher.

The downtrend continued from 2022, and in 2023, a decline in AR/VR headset sales was also seen due to economic pressures and legacy products. Q1 2024 faced a decline as the market transitioned to new MR and Extended Reality (XR) headsets. The influx of newer headsets with lower price points, roll-out and expansion of high-speed 5G network, and increasing economic stability could boost shipments.

#### Influencing Factors:

- ▲ Increasing adoption in healthcare, education, and industrial training industries
- ▲ Development of MR headsets that combine AR/VR coupled with expanding 5G network
- ▼ Steep prices of new AR/VR headsets
- ▼ Lack of compelling use cases for AR/VR headsets
- ▼ Influx of new generations of gaming devices

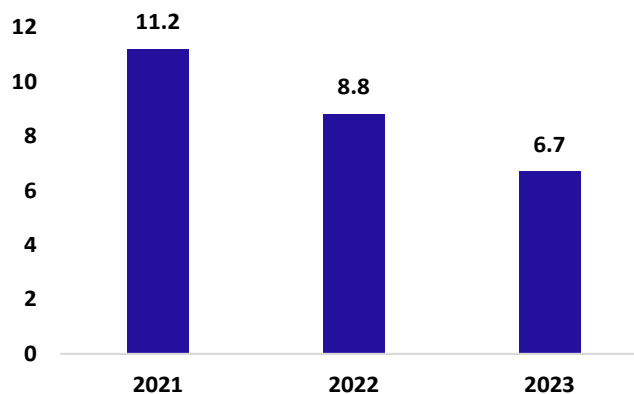
#### Expert Speaks

**Summary of Insights:** AR/VR industry trends show VR's expanding role in industrial applications, growing consumer affordability, and AR's rise through digital twins for workflow optimization, notably in data centers. A market rebound is anticipated through sports and tourism use cases, with future growth driven by OpenXR and AI-enhanced modeling. Regulatory measures are advised to prevent misuse, though current market adoption remains strong. Challenges like 3D content creation persist, but advances in AI integration and environment-sensitive VR content promise significant industry evolution. A market rebound is anticipated through sports and tourism use cases, with future growth driven by OpenXR and AI-enhanced modeling. Regulatory measures are advised to prevent misuse, though current market adoption remains strong. Challenges like 3D content creation persist, but advances in AI integration and environment-sensitive VR content promise significant industry evolution.

**Mr. Sushanth Jambu**

Senior AR/VR developer, Imagine

#### Global AR/VR headset Shipment units (in millions)



#### GAMING CONSOLES (GLOBAL)

As of 2023, the worldwide market for the gaming console has grown to US\$ 26.7 billion. Whereas in 2022, the market size of the gaming console was US\$ 24.36 billion. Asia Pacific turned out to be the largest global market for the gaming console, accounting for a 39.7% market revenue share in 2023.

The application segment is further divided into non-gaming and gaming. The gaming segment held the largest share of the market at around 59% in 2023. Further, the product type segment has been bifurcated into Xbox, PlayStation, Nintendo, and others. The PlayStation segment led to a market share of approximately 34% in 2023. Microsoft Corporation and Nintendo Corporation Limited are a few of the well-known companies in the game console market. Among many others, they are NVIDIA Corporation and Sony Group Corporation. Among many factors, shifting consumer preferences, technological improvements, and emphasizing gaming as entertainment has driven this sizable market expansion. Another trend in rising global demand is consoles with limited editions and exclusive game releases, which show people's readiness to pay for top-notch gaming experiences. In contrast, the high cost of the devices, global logistical challenges, labor shortage, disruption of shipping, rising freight costs, etc., have made it difficult for the gaming console market to thrive. The non-gaming applications are not games but are used in retail, services, finance, or entertainment sectors to enable users to have a personalized phy-digital experience.

The popularity of gaming as a stress-relieving and entertainment medium has raised the demand for gaming consoles. Major players in the market spend a significant amount on R&D, increasing their product lines and focusing on creating video gaming consoles designed on blockchain and cloud computing. Furthermore, increasing internet usage, automation of homes, and 5G adoption are anticipated to grow the industry by offering opportunities. Therefore, competitors in the industry must provide affordable products to develop and endure in a market that is becoming increasingly competitive.



### Influencing Factors:

- ▲ Technological advancements
- ▲ Raising the number of gaming influencers and e-sports
- ▲ Entertainment Features Fuel Console Market Growth
- ▲ Widespread adoption of cross-platform games
- ▼ Global logistical issues due to geo-political tensions driving prices up

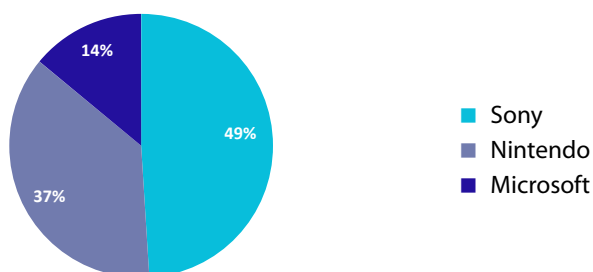
#### Expert Speaks

**Summary of Insights:** The evolution of gaming culture reflects technological shifts and increased accessibility in consumer choices. Early experiences with games like Microsoft Flight Simulator show how interest in gaming has varied across time and region. Glazer Games explores blockchain for innovation, receiving industry validation when Microsoft acquired Activision. The pandemic broadened gaming demographics, attracting older players. Technologies like AR/VR, AI, and blockchain enhance gaming but remain costly. Looking ahead, mobile gaming is expected to rise significantly, while consoles are likely to remain, benefiting from improved affordability and accessibility.

**Ms. Kripashree Rajkhwa**

Founder & Head of Technology, Glazer Games Inc.

### Global Gaming Console Vendor Market Share CY2023



### DOMAIN 3: IoT DEVICES

This domain comprises smart devices based on the Internet of Things (IoT) concept.

### WEARABLE DEVICES (GLOBAL & INDIA)

CURRENT STATISTICS FOR CY 2023	PRÉVISION FORECAST FOR CY 2024
Global Wearable Devices Shipments: <b>504.10 million units</b>	Expected to reach: <b>591.62 million* units</b>

\*Time-series Analysis

The global wearables devices market at the start of the year 2024 shipped approximately 113.1 million units, marking an 8.8% year-over-year (YoY) increase for 2023. The market shipped around 504.1 million units, reflecting a 2.4% YoY growth from 2022. The key trend

observed in the latest quarter is the rising demand for health and fitness tracking devices, driven by increased consumer health consciousness. In India, the wearable devices market grew significantly, with shipments reaching 25.6 million units in Q1 2024, showcasing a 2.1% YoY growth as per International Data Corporation (IDC).

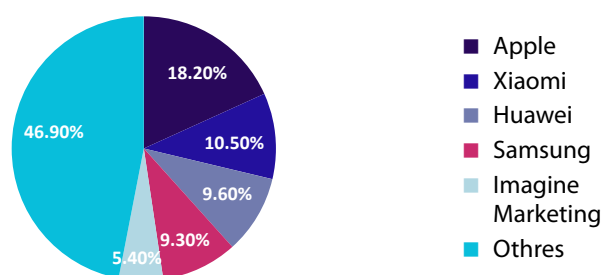
Apple led the wearable market globally in Q1 2024 by shipping 20.6 million units, securing an 18.2% share. It maintained its top position even though it was constrained by poor macroeconomic conditions, a temporary ban on some watch models, and Imagine Marketing (boAt), with 6.1 million units, and the volume for boAt went up 17.5% because of extreme competition within the home country. Xiaomi was driven by its value-oriented products and success in re-entering the Wear OS market, becoming the third-largest vendor within Google's ecosystem. Huawei took third place, surpassing Samsung, driven by the recovery of its smartphone business and bundling strategies. Despite success in lower-priced wearables, Samsung saw a decline in smartwatch volumes as its core offerings struggled, and other brands collectively held 46.4%, reflecting a fragmented market. In India, local brands introduced affordable devices, boosting the wearable market. The demand for wearables in healthcare and fitness is expected to grow, enabling remote health monitoring.

The global wearable devices market is expected to sustain its growth trajectory, driven by ongoing technological advancements and heightened health awareness. In India, the market is poised for rapid expansion as affordable wearables gain traction. However, economic uncertainties and infrastructural challenges may impact short-term growth. Improving digital literacy and healthcare access will be crucial for unlocking the market's full potential.

### Influencing Factors:

- ▲ Innovations in sensors and connectivity enhance user experiences
- ▲ Local Indian brands offer affordable wearables, boosting market demand
- ▼ Economic uncertainties and market saturation.
- ▼ Limited Consumer Awareness

### Market Share of Wearables Global Q1-2024



## SMART HOME APPLIANCES

The global shipment of smart home appliances declined by 1.8% in 2023 compared to the previous year, bringing the total to 857.1 million units from 871.8 million units in 2022, according to the International Data Corporation (IDC). In 2023, the market capitalization of smart home devices was US\$ 37.73 billion. The factors driving product demand include the growing adoption and penetration of smart home technologies and a surge in the rapid advancement of I.T. infrastructure and wireless communication technologies.

During the first quarter of 2024, the overall market saw a slowdown, particularly in regions with economic headwinds. In contrast, the Asia Pacific region has been one of the major contributors to surging demand for smart home appliances, driven mainly by rapid urbanization, rise in disposable incomes, and technological advancements. For instance, in the leading market of China, companies like Xiaomi, with its Mi Smart Home Hub, and Haier, with its smart refrigerators, are some of the firms making massive adoptions of these smart appliances to the tech-savvy customers who desire connected living solutions. Moreover, from singular to multi-functionality is a new trend in smart appliances. Manufacturers have been prompted to combine multi-functionality in a single appliance to help consumers save space and add cost. The major smart home appliance market players include Panasonic Corporation, Haier Electronics Group Co. Ltd., Miele & Cie. K.G., and General Electric.

Growth in the market is hindered by relatively higher upfront costs associated with deploying comprehensive security systems. For most technology-aware consumers, primarily in price-sensitive markets, it remains a very significant barrier. The lower cost of acquiring and installing high-end security devices, along with subscription fees for monitoring services, is likely to drive budget-sensitive individuals toward adopting such solutions. In addition, market players will have to work on affordable product development, innovative pricing strategies, and long-term value creation for consumers concerning smart homes.

### Influencing Factors:

- ▲ Increased adoption of AI and IoT
- ▲ Growing consumer demand for energy efficiency
- ▲ Rising disposable incomes in developing economies
- ▼ High Initial Costs and Affordability Issues
- ▼ Supply chain distortions including component shortages

### Expert Speaks

**Summary of Insights:** In the evolving smart home appliances industry, IoT and AI are at the forefront, driving innovation in connected devices. The introduction of the Matter protocol is pivotal for improving device interoperability. However, the industry faces challenges such as data privacy concerns, supply chain disruptions, and price sensitivity in markets like India. The future looks promising with advancements in energy-efficient appliances, augmented reality, and modular designs, all poised to revolutionize the way consumers interact with technology in their homes. These developments demand a heightened focus on R&D for further market growth and adaptation.

### Mr. Chetan Kandpal

Head- FAE & Technical Sales | Home Appliance BG, CVTE  
(Guangzhou Shiyuan Electronics Co. Ltd.)

## SECURITY APPLIANCES

The global security appliance market performed admirably in 2023, with total market sales estimated to be close to US\$ 17.6 billion, up 5.2% year-on-year (YoY) from 2022. Of those, shipments in the fourth quarter were roughly US\$ 4.96 billion, indicating a negligible YoY gain of 0.8%. Firewall and Unified Threat Management (UTM) security appliances helped drive growth in 2023, when revenue growth climbed by 9.7% YoY. According to International Data Corporation (IDC), 1.2 million security appliances were shipped in the fourth quarter, demonstrating a stable demand for hardware-based security solutions. IDC reports that the Intrusion Prevention System (IPS) market expanded 2.3% YoY throughout the quarter, while the markets for VPN security appliances and content management showed a single-digit YoY decline.

Undoubtedly, new technologies are challenging this security appliance market. Enhanced AI and higher firewall throughput are the key trends that enable organizations to optimize cybersecurity spending. Reports also highlight industry trends toward offering subscription-based models to go with software services and hardware. Nevertheless, there are solid regional variances as well. America, Europe, the Middle East, and Africa (EMEA) grew by 5.1% and 15.1% YoY, respectively, and Asia/Pacific declined by 4% during that time. The ongoing growth of this market will likely carry on and, at times, come from improvements in supply chains, specifically with hardware becoming a significant component of people's overall cybersecurity strategy.

The market is expected to grow as there is an increase in cyber threats and the need to be well-guarded against an attack. In India, this market has been increasing because organizations are taking cybersecurity seriously as a part of their operations. Even regional economic changes and different regulatory aspects can restrain the market. The security appliance market was

looking optimistic due to high technological innovation and market demand.

**Influencing Factors:**

- ▲ Increasing cybersecurity awareness and regulatory compliance
- ▲ Technological advancements in AI and throughput
- ▼ Regional economic instability due to geo-political tensions

**Expert Speaks**

***Summary of Insights:** Recent shift toward a subscription-based model reflects broader industry trends, enhancing predictable revenue and positively impacting shareholder expectations. Already at a 45% subscription base, Cisco's acquisition of Splunk further solidifies this approach, adding significant recurring revenue. While advancing in subscriptions, Cisco remains committed to its hardware, offering integrated, end-to-end security solutions that set it apart from competitors like Fortinet. Programs like Cisco Partner 360 in the APJC region support partner-driven implementations, aligning with Cisco's "partner-first" philosophy and facilitating seamless adoption of comprehensive cybersecurity solutions across diverse markets.*

**Mr. Nisarg Patel**

Business Development Manager, APJC Partner Sales, Cisco

**CONNECTED VEHICLES**

In 2023, the global connected vehicles market was valued at an impressive US\$ 80.87 billion, highlighting the significant growth and impact of connected automotive technology. Worldwide, global battery electric vehicle (BEV) sales have grown by 9% in Q2 2024. The primary contributor to the above growth is China, which holds a 50% share of global BEV sales. With a high revamp in production and strategic partnerships of production processes with various battery manufacturers to lower manufacturing costs, we can witness the numbers growing.

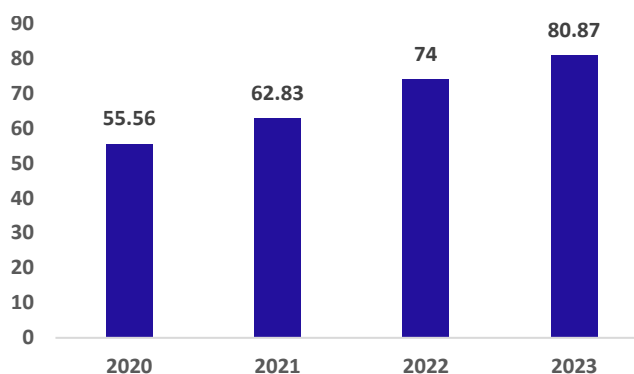
Tesla, the front-runner in the connected car market, faced a decline of 5% year-on-year (YoY) sales, but it has recouped as the best-selling BEV brand for Q1 2024. This is due to its competitive pricing, brand-new models like Cybertrucks, and affordable Model 2 for its large customer base. BYD Auto comes in second in the customer acquisition for connected vehicles, with a 21% YoY growth in Q2 2024. Major B.Y.D.'s sales are pulled from models like Yuan/Atto3 and Seagull with Blade Battery technology that provides E.V. safety. A study on India's connected vehicle market depicts a 54% YoY growth in Q1 2024. The launch of new models and increased customer demand for feature-laden digital cars support the numbers. Top features like Hinglish voice commands, remote AC, and engine start/stop that smoothly integrate with the human lifestyle have made Kia the show stealer by selling around 400,000 vehicles.

While the rise of connected vehicles raises significant data privacy concerns, implementing stricter regulations within the automotive industry and technological advancements such as enhanced anti-theft systems can ultimately provide valuable benefits and improve consumer trust. With the Indian government taking the initiative to mandate connected technologies in passenger cars (under AIS-140), it is anticipated to play a vital role in integrating connected technologies within connected vehicles.

**Influencing Factors:**

- ▲ Enhanced high-speed 4G/5G connectivity
- ▲ Demand for advanced features cars driving new model rollouts
- ▲ Conducive Government regulations
- ▼ Lack of Fast Charging infrastructure
- ▼ High initial Cost
- ▼ Data Privacy issues

**Global Connected Vehicles Market Capitalisation (In Billions)**



**Expert Speaks**

***Summary of Insights:** The market for connected cars and autonomous vehicles is evolving transportation by emphasizing the industry's pursuit of connectivity, data security, and real-time analytics. There are four key stages involved in vehicle autonomy - localization, perception, decision-making, and operation which are incredibly vital. There is a need for a great emphasis on cybersecurity, especially with data privacy acts like D.P.A. and GDPR, to protect against potential hacks. Not only this, but the solutions are centered around sustainable practices, B2B collaborations, and robust infrastructure to support connected vehicle technology. Finally, a balanced approach to innovation highlights addressing customer expectations and regulatory challenges. There is a need for a great emphasis on cybersecurity, especially with data privacy acts like D.P.A. and GDPR, to protect against potential hacks. Not only this, but the solutions are centered around sustainable practices, B2B collaborations, and robust infrastructure to support connected vehicle technology. Finally, a balanced approach to innovation highlights addressing customer expectations and regulatory challenges.*

**Mr. Vinit Jhavar**

Co-founder & CEO, CarsDaily

# CASE STUDY '25

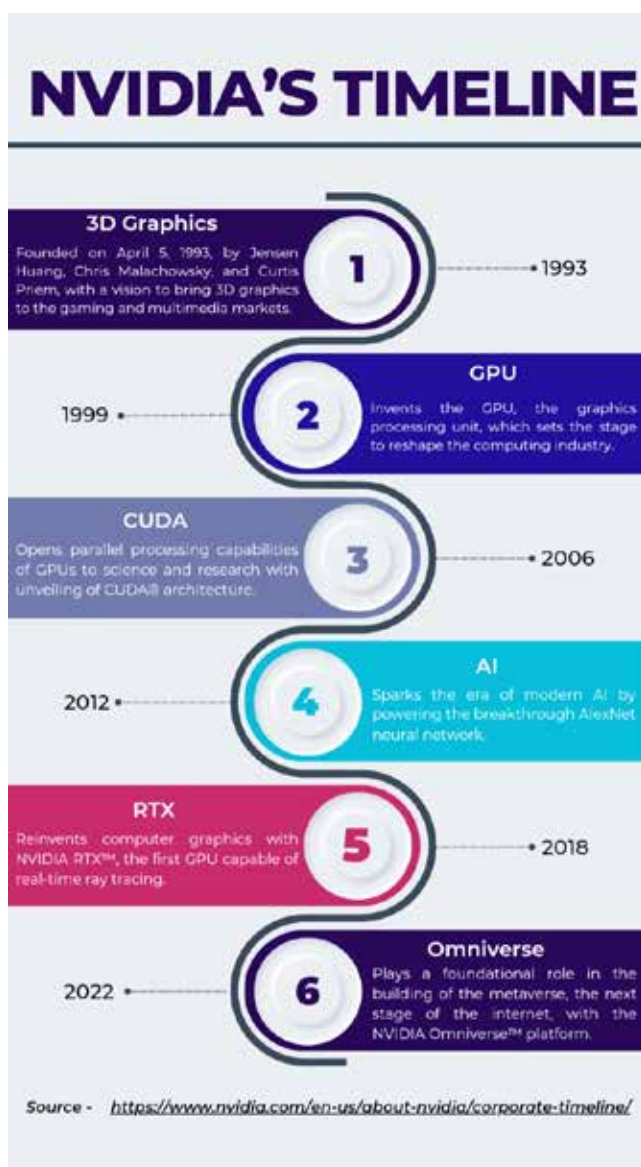


**From Graphics to AI :  
Transformational journey**

## FROM GRAPHICS PIONEER TO AI POWERHOUSE: NVIDIA'S EVOLUTION

Founded in 1993 by Jensen Huang, Chris Malachowsky, and Curtis Priem under the name NVIDIA, it was embarked upon to revolutionize the whole gaming and visual computing industry. It set a difference in 1997 with its RIVA 128 GPU, positioning it as one of the leaders in high-performance graphics technology. In 1999, Nvidia marked the release of the world's first GPU, known as the GeForce 256, which brought transform and lighting capabilities to hardware-based perspectives with revolutionary gaming and entertainment. This was to mark a critical turning point through which Nvidia began to dominate markets in both gaming and visual computing. By the 2000s, Nvidia had started to move its limits beyond gaming to include professional visualization and high-performance computing. This structural change was found in a string of strategic steps that comprised the production of Compute Unified Device Architecture (CUDA), which was the development of 2007 that enabled parallel processing

on GPUs and proved to be a pillar in the advancement of AI. It was during this period, approximately in the mid-2010s, that Nvidia began to transition from graphics to Artificial Intelligence by leveraging its GPU architecture for applications beyond gaming in parallel processing. It eventually began to target AI and data centers primarily as under-addressed markets in areas such as machine learning and deep learning, along with high-performance computing. Nvidia entered AI and data centers with a purpose; it was the growing demand for high-performance computations in machine learning that ensured this entry. The GPUs developed by the company for the primary purpose of playing games proved to be very efficient for AI tasks due to their parallel processing ability, making Nvidia the leader in AI hardware and software. Another significant landmark event in Nvidia's history was its acquisition of Mellanox Technologies at US\$ 6.9 billion back in 2020. A part of the vision set by Jensen Huang, the erstwhile CEO, to eventually transform Nvidia into a full-stack computing leader for AI, cloud, and autonomous vehicle technologies, these acquisitions have shaped the organization into what it is today. With this, under Huang's leadership, Nvidia grew from a small graphics chipmaker into a multi-billion-dollar AI powerhouse that managed to reach a revenue of US\$ 26 billion in Q1 FY2025.



## ARCHITECTING THE FUTURE: CUDA AND NVIDIA'S TECHNOLOGY STACK

Humans today desire speed and efficiency. With no minute to waste, we persistently look for technologies to complete tasks in the blink of an eye. Nvidia's revolutionary invention, Compute Unified Device Architecture (CUDA), is a software framework aimed at enhancing the acceleration of the Graphics Processing Unit (GPU). A hype among developers and IT professionals who prefer high data throughput, CUDA GPU provides much faster data processing than traditional CPUs, as the spotlight is on achieving high efficiency and parallel processing. The AI community has taken CUDA as the backend for deploying deep neural networks. It is becoming a hit among developers, allowing them to use multiple languages like C, C++, Python, FORTRAN, and MATLAB. The CUDA toolkit is versatile as it provides a Pandora of options for developing applications based on GPU acceleration. But it didn't happen overnight; Nvidia upgraded its previously used Pascal (GP104) to Turing (TU104) to Ampere (GA104) architecture to boost its GPU performance and provide phenomenal acceleration. Even though this architecture brought innovative precisions to boost and ease AI adoption, NVIDIA decided to scale up its power. Hopper was launched to stimulate the training of AI models and handle workload variety at the highest speed possible using advanced TensorCore technology. One of the significant advantages that NVIDIA's GPU

provides is the integration of Python packages like PyTorch and TensorFlow. The flexible architecture of GPU gives the data scientist/developers the freedom to deploy computation to one or more CPUs or GPUs in a desktop, server, or mobile device without rewriting code in tensorflow. NVIDIA's GPU supports PyTorch by providing strong acceleration, Deep Neural Networks, and the ability to reuse popular Python packages like Scipy and Cython. However, let's see the other side of CUDA. Its C/C++ syntax rules and proprietary nature are among the significant drawbacks, as it will only support Nvidia hardware, and compatibility with other GPU brands is limited. Updated versions of CUDA do not have emulators or fallback support for its previous versions. OpenGL, a transferor language, can access CUDA-registered memory, but vice versa, it is impossible.

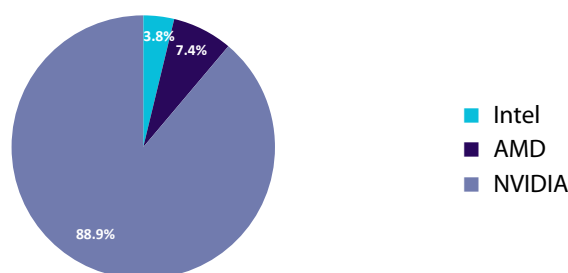
### EXPANDING HORIZONS: AI, DATA CENTERS, AND THIRD-PARTY CHIP PROVIDERS

NVIDIA is broadening its influence from AI to data centers and as an external chip manufacturer, solidifying its position in the AI market. NVIDIA's shares have risen by 240%, making it the third most valuable company in the U.S. stock market after only Microsoft and Apple. NVIDIA had explosive shipments of graphics cards for the data center, at about 3.76 million units in 2023. NVIDIA's shipments of GPUs grew over a million units, where NVIDIA reported 2.64 million shipments of data-center GPUs from 2022. In 2023, NVIDIA enjoyed dominant market shares, with 98% in data-center GPU shipments, similar to market share numbers in 2022. NVIDIA has retained a 98% revenue share of the data-center GPU revenue market with US\$ 36.2 billion, which is more than three times the growth from US\$ 10.9 billion in 2022. NVIDIA has also dominated deep learning research advances by creating specialized hardware and software solutions. Deep-learning-intensive workloads, such as its specially designed NVIDIA A100 Tensor Core GPUs, are optimized for maximum performance and efficiency. NVIDIA, which is a dominant global designer and supplier of AI chips, aims to capture a portion of an exploding market for custom AI chips and shield itself from the growing number of companies pursuing alternatives to its products. Nvidia said major customers, including Amazon, Alphabet's Google, Microsoft, OpenAI, and Oracle, are expected to use the new chip, B200, in cloud-computing services they sell and also for their own AI offerings.

The latest wave of tech companies includes AWS, IBM, SAP, Accenture, Snowflake, and Lenovo, which announced collaborations at NVIDIA's global conference, GTC AI, in San Jose, California. IBM Consulting is partnering with NVIDIA to help clients solve complex business issues and accelerate their

transformation journeys with AI in an open ecosystem. AWS also announced their collaboration with NVIDIA to advance Generative A.I. innovation with the new NVIDIA Blackwell GPU platform. Accenture also announced it will pioneer how advanced GenAI and real-time graphics capabilities are brought to life in the modern client experience, using NVIDIA's Omniverse platform and NVIDIA Edify-powered models. SAP and NVIDIA also said that they are expanding their partnership to accelerate the transformative power of data and GenAI across SAP's cloud solutions and applications portfolio for enterprise customers.

**Market capitalization of top 3 AI companies**



### CHALLENGES AND CRITICISMS: SUSTAINABILITY AND POWER CONSUMPTION

With the growing demand for computing power, NVIDIA uses direct-to-chip liquid cooling instead of traditional cooling solutions for its data centers, which not only cuts down energy consumption but also gives higher computing densities, reducing the data center footprint as a whole. The company also believes that AI is the best tool for achieving sustainability and sustaining it.

Nvidia's sustainability strategy is centered on using accelerated computing, which, unlike traditional CPU-only systems, combines GPUs and CPUs to handle complex computations, being up to 20 times more energy efficient. NVIDIA also announced the most powerful AI supercomputer – Earth-2, which is designed for meteorological research. It aims to continuously predict climate and weather events at regional and global levels. The company highlighted that its data center, with the latest H100 GPU, has performance comparable to that of its A100 GPU while consuming 3.5 times less energy. The H100 is also 86 times more efficient when compared to CPUs at AI inference. Nvidia further commits to match 100% of its global electricity usage with renewable energy sources by January 26, 2025, either by purchasing or generating it, thereby reducing its carbon footprint. NVIDIA also assesses Corporate Social Responsibility (CSR) to identify key social and environmental impacts, leveraging stakeholder expectations, risks, and opportunities. NVIDIA has taken initiatives & implemented frameworks such as the Global Reporting Initiative (GRI), the Sustainability

Accounting Standards Board (SASB), the Task Force for Climate-Related Financial Disclosures (TCFD), and the United Nations Sustainable Development Goals (UN SDG). In 2022, NVIDIA powered 23 of the top 30 supercomputers in the Green500 list, including the No. 1 system. More than five terawatt-hours of energy per year, i.e., US\$ 750 million worth of energy, was required to power those 500 systems, but NVIDIA's systems could cut the consumption by more than 80%, resulting in just US\$ 150 million if all systems were as efficient as the 30 greenest systems offered by NVIDIA.

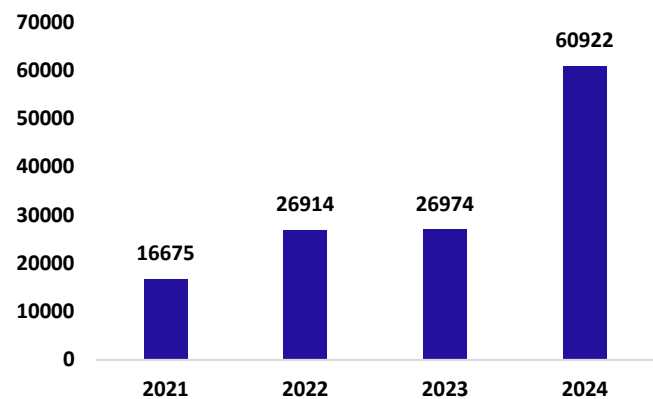
A growing concern that is common about Nvidia is that NVIDIA offers limited visibility in its product roadmap, leading to uncertainty in the minds of its customers regarding long-term technology upgrade plans. Despite NVIDIA's dominance in the AI chip market, it faces another significant challenge. A major concern is the possible saturation of the AI training market, after which it will pitted against the likes of Intel and AMD. Looking Ahead: NVIDIA's Strategic Vision and Future Challenges.

As generative AI rapidly transforms industries, NVIDIA specifically needs to focus on AI hardware. The firm has continued to monopolize the AI market by guaranteeing that its GPUs and software are crucial to deploying AI across the world. Leveraging the official CUDA software framework, NVIDIA has led the developments in GPUs, establishing itself as a necessary element in the AI landscape as industries continue to ramp up their AI adoption. NVIDIA's CEO Jensen Huang, with the aim of enabling 3.5 million developers, represents the company's vision for the future of AI.

The tension in the market of AI chips is getting intense given that Nvidia, AMD, and Intel are all vying for ownership of the market. At the moment, Nvidia has an 80% market share, primarily due to superior GPU technologies that are specifically for AI use. Although AMD is slowly but surely increasing its market share and taking advantage of the increasing demand growth. In response, NVIDIA is diversifying and venturing into areas such as metaverse through Omniverse, autonomous driving through NVIDIA Drive, and AI healthcare solutions. Not only does this widespread approach enhance NVIDIA's positions in high-growth segments, but it also guarantees further growth after computer gaming and AI. So, by entering these niche markets, NVIDIA is covering its back in several lucrative industries of the future. Looking forward, NVIDIA's CEO, Jensen Huang, proclaims AI language models as a service as a significant software growth area in the future. The rapid advancement of AI technology makes NVIDIA well-placed to meet emerging trends of adoption of scalable AI solutions across industries. NVIDIA is experiencing key issues when it comes to the diverse but pressing issues that affect the company as it moves to a future

of increased competition, a complicated supply chain, and possible revenue stagnation. Therefore, for NVIDIA to solidify its AI leadership position, more innovations and better partnerships need to be achieved due to the evolving semiconductor industry. Therefore, Organizational growth and development can only be sustained in its capacity to meet these emerging challenges.

**NVIDIA's Revenue (In US\$ million)**



## CONCLUSION

Through the above research, we saw how Nvidia earned fame as the leader in the software and hardware industry. In the mid-2010s, Nvidia began to transition from graphics to AI by leveraging its GPU architecture for applications beyond gaming in parallel processing, such as AI training and inference. It eventually began to target AI and data centers in areas such as machine learning and deep learning, along with high-performance computing. To complement its goals, NVIDIA launched CUDA, a revolutionary invention that enhances GPU acceleration. The company navigated through various architectures, improving the performance with each. Its latest framework, Hopper, aimed to train AI models and handle larger workloads. Not only this, but it also attracted developers and data scientists through the integration of popular libraries like PyTorch and TensorFlow. Although with some drawbacks like limited flexibility and use of C syntax, NVIDIA has earned AI dominance. With this, it has also grabbed a strong position in the advances of deep learning research by creating specialized hardware and software solutions. Deep-learning-intensive workloads, such as its specially designed NVIDIA A100 Tensor Core GPUs, are optimized for maximum performance and efficiency. The B200 "Blackwell" chip is 30 times faster at functions such as providing answers from chatbots. These innovations have raised NVIDIA's share by 240%, making it the third most valuable company in the U.S. stock market after only Microsoft and Apple. AI-driven investments in sustainability and elaborate cooling systems contributed to lowering NVIDIA's carbon footprint and raising the efficiencies of data center computing.

With high competition, there are various AI chip developments going from AMD and Intel, as well as other chip producers developing AI hardware. Furthermore, newcomers continue to challenge the market for AI chips. However, geopolitical risk and trade barriers, especially related to semiconductor products, create problems for Nvidia's supply chain,

making it more complicated. However, staying ahead of the curve in the Age of Disruptive Innovation and competitors can be achieved with a focused dedication to environmentally-friendly business practices such as energy conservation and optimal use of resources like renewable energy.

## PRÉVISION OUTLOOK

### GLOBAL MARKET OUTLOOK

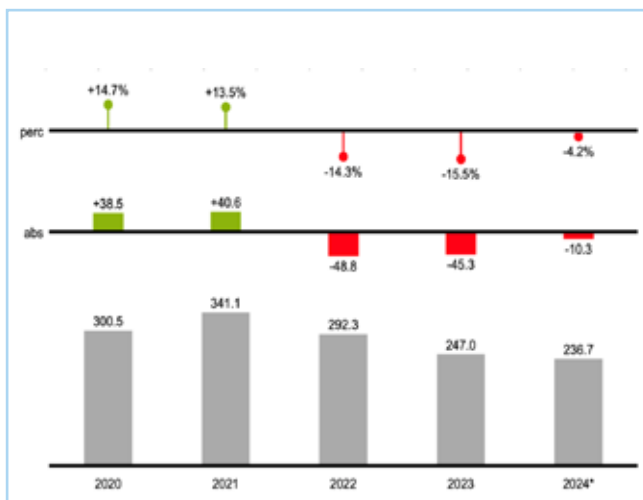
- **Mobile Devices:** Smartphones and feature phones will register growth as generative AI advances reach the mass markets despite macroeconomic pressures
- **Home Entertainment:** Premium television and AR/VR headsets will grow through technological innovations, as well as 5G rollouts, despite the global economic headwinds
- **IoT Devices:** Wearables, home appliances, and connected vehicles will accelerate growth as the adoption of global wireless and improvement in operational efficiency gain strength

### INDIAN MARKET OUTLOOK

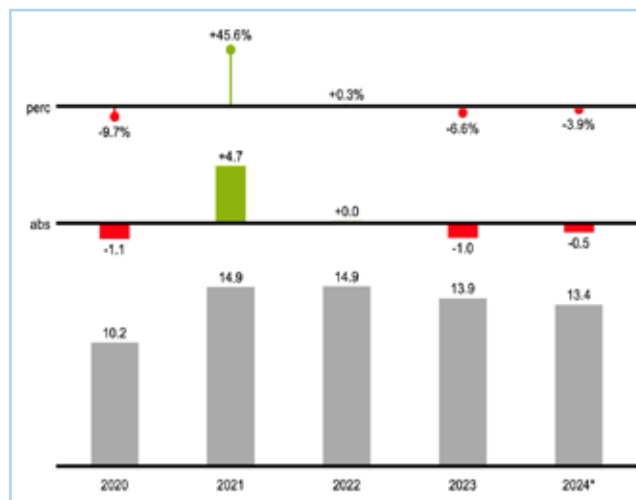
- **Mobile Devices:** The growth is expected with low-cost smartphones and telecom infrastructure expansion, thus touching Indian consumers
- **Home Entertainment:** The growth is expected from smart televisions and other high-end products, where the disposable income has gone up and access to high-speed internet has also increased
- **IoT Devices:** Good growth is expected because of the increased interest in IoT-enabled solutions across various industries. It indicates the rapid pace of technological adoption in India and innovation in consumer electronics



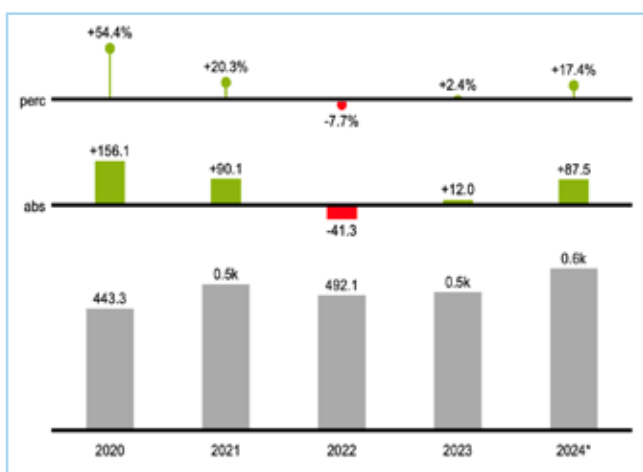
### Global PC Shipments (in millions)



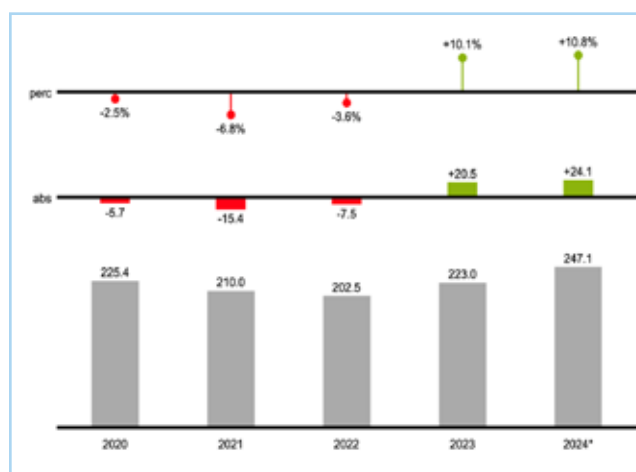
### Indian PC Shipments (in millions)



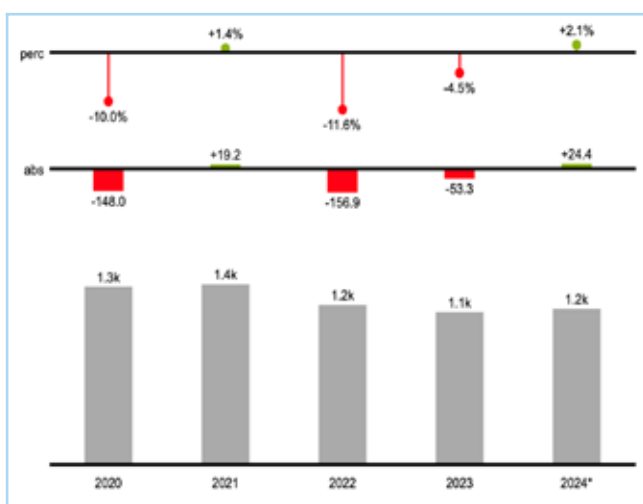
### Global Wearable Devices Shipments (in millions)



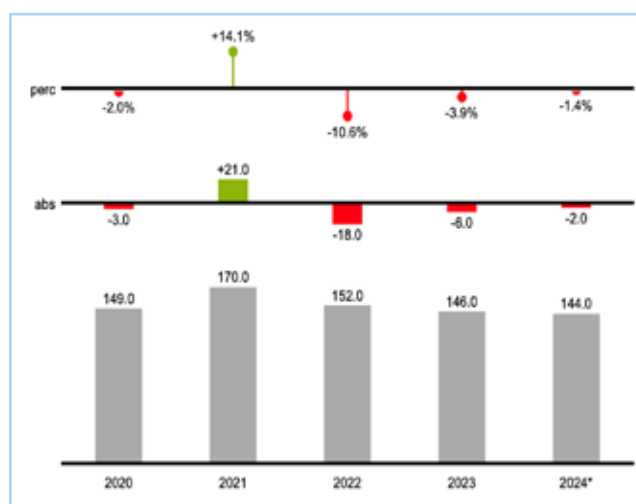
### Global Television Shipments (in millions)



### Global Smartphone Shipments (in millions)



### India Smartphone Shipments (in millions)



■ Increase  
■ Decrease

# TELECOM TECHNOLOGIES



## Student Team

Amudala Sai Durga | Devanshu Dhapwal | Shrishti Bajpai | Ritam Chatterjee | Rashmi Sinha

## SNAPSHOT

- In 2023, the market for mobile data offloading reached a valuation of US\$ 6.9 billion
- As of the first quarter of 2024, India reported 165,147 public Wi-Fi hotspots, accompanied by a 10.48% drop in user engagement
- The global market for MPLS was valued at US\$ 64.98 billion in 2023
- Currently, over 1.2 million kilometres of submarine cables are operational worldwide
- IoT global market size valued at US\$ 300.3 billion in 2023
- By 2023, 15.7 billion connections have been established to IoT systems
- Indian IoT Market size valued at US\$ 1.2 billion in 2023
- Global Spending on the IoT Enterprise sector increased to US\$ 268 billion in 2023, up 15% from 2022
- Global Massive MIMO market valued at US\$ 6.58 billion in 2023
- In 2023, Global 5G Market size valued at US\$ 98.3 billion
- Global Metro Ethernet market valued at US\$ 29.91 billion in 2023
- The 5G connections worldwide surpassed 1.5 billion by the end of 2023
- The number of 5G subscribers in India reached 130 million in 2023, increasing from 10 million in 2022
- India's international ranking has improved in mobile broadband speed from 118 to 15
- The global IP Multimedia subsystem market has reached US\$ 3.14 billion in 2024
- The global Rich Communication Services Market will reach US\$ 2.29 billion by 2024
- In 2023, the Indian Public Cloud market, encompassing IaaS, PaaS, and SaaS offerings, achieved a total revenue of US\$8.3 billion
- The market for Open RAN is rapidly growing, with revenues reaching US\$ 1.64 billion in 2022 and US\$ 2.7 billion in 2023
- In 2023, the SDN market has been valued at US\$ 26.8 billion and the NFV market has been valued at US\$ 27.3 billion
- In 2023, IPv6 had a market size of US\$ 39.18 billion in 2023
- India's IPv6 capable rate is 81.06% as per APNIC

## DOMAIN 1: ACCESS NETWORK

This domain includes parameters that form part of the access network.

### OPEN RAN

The telecommunications industry is on the brink of a transformation with Open Radio.

Access Network (O-RAN) is poised to be at the center of this revolution. The market for Open RAN is rapidly growing, with revenues reaching US\$ 1.64 billion in 2022 and US\$ 2.7 billion in 2023. Open RAN went through several technological innovations, such as advanced narrowband Massive Multiple Input Multiple Output (MIMO) and multi-user MIMO beamforming, increasing the density of the network. The Open RAN Alliance also launched the Non-Real-Time RAN Intelligent Controller (R1) interface to improve compatibility in multi-vendor networks. Network management improvement was achieved with the Service-Based Architecture optimisation of the integration with Service Management and Orchestration (SMO). Open RAN is driven by the transformation towards virtualisation and cloud solutions, but it faces issues such as the complexity of integration and the involvement of multiple vendors. North America is already dominating the Open RAN space thanks to large-scale 5G deployments and backing from the government. Asia-Pacific was quick to embrace the system widely and make valuable contributions globally. Europe is gathering speed, stressing the compliance of critical segments with the open-standards approach and the minimisation of costs as its market position improves.

The outlook for Open RAN continues to surge upward; impetus will be provided by the global drive toward 5G deployment and, mainly, a rising requirement for network flexibility and cost efficiency. Open RAN, globally, is anticipated to capture a significant part of the total RAN market in the upcoming years, with large contributions from North America and Asia-Pacific. Increased demand from virtualisation, automation, and multi-vendor networks will accelerate this growth. However, challenges such as integration complexity and high up-front costs will remain.

#### Influencing Factors:

- ▲ 5G demands boost Open RAN investments
- ▲ Open RAN deployment on 2G, 3G, and 4G networks expands rapidly
- ▼ Integrating and managing complex multi-vendor components presents challenges
- ▼ Ensuring interoperability between different RAN vendors poses a difficulty
- ▼ Open RAN's architecture remains vulnerable to data breaches

## 5G

The 5G connections worldwide surpassed 1.5 billion by the end of 2023, making it the fastest-growing mobile broadband technology. The global market size of 5G services is valued at US\$ 98.9 billion in 2023. India is among the fastest-growing 5G networks in the world. The number of 5G subscribers in India reached 130 million in 2023, increasing from 10 million in 2022. The rapid expansion of 5G networks across the country by telecom operators has improved India's international ranking in mobile broadband speed from 118 to 15.

The rapid growth of 5G technology has been made possible by the large-scale expansion of IoT, the growing demand for enhanced connectivity and the increased use of 5G-enabled mobile devices. Enhanced Mobile Broadband (eMBB) segment dominated the market in 2023 with a share of more than 40% by providing high data speeds. For instance, Charter Communications and Nokia collaborated in June 2023 to implement eMBB to enable users to access high-quality content consumption with accelerated speed and improved mobile service. Global IoT devices reached 16.1 billion in 2023, contributing to the growth of 5G Massive Machine-Type Communications (mMTC) technologies such as Narrow Internet of Things (NB-IoT) and Long Term Evolution for Machines (LTE-M) targeting uninterrupted connectivity for high connection density applications. The increased availability of 5G in India can be attributed to the notable proliferation of 5G-capable smartphones. As of 2023, India's share of 5G smartphone shipments has exceeded 52%, with a growth of 66% YoY.

Despite the rapid expansion of 5G adoption globally, it remains an evolutionary process. Lack of use cases that exploit 5G capabilities, unwillingness of subscribers to pay premiums, and high capex requirements are a few of the key constraints for 5G adoption. The increasing demand for extended reality (XR) solutions with ultra-low latency and high-performing connectivity makes the capabilities of 5G networks essential. 5G can play an important role in achieving India's digital inclusion goals to bridge the digital divide by enabling access to high-speed broadband through Fixed Wireless Access (FWA) in rural and remote areas.

**Expert Speaks**

**Summary of Insights:** 5G technology is set to transform telecommunications with unprecedented speeds, ultra-low latency, and extensive machine-type communication capabilities. It utilises three key spectrums: low-band for extensive coverage, mid-band for a balance between coverage and capacity, and millimetre wave for ultra-high speeds in dense urban settings. Through network slicing, operators can deploy multiple virtual networks on a single physical infrastructure, enabling customised service delivery and efficient resource utilisation. Key features like non-standalone architecture and dynamic spectrum sharing ensure 4G compatibility, while network disaggregation separates hardware and software, moving beyond traditional "black-box" solutions. Additionally, NFV integration brings data processing closer to the source, enhancing management efficiency.

**Mr. Buland Khan**

Chief Technologist, Wipro Limited

**Influencing Factors:**

- ▲ Increased penetration of 5G-enabled smartphones and devices
- ▲ Incorporation of massive MIMO enabling high data speeds with low latency
- ▼ High investment, lack of 5G use case, inability to monetise, and limited availability of the 5G spectrum
- ▼ Demand for more intricate network architecture increased the complexity of building and upgrading 5G infrastructure

**MASSIVE MIMO**

Massive MIMO (Multiple-Input Multiple-Output) wireless communication technology represented a global value of US\$ 9.05 billion in 2024, up 17.28% year over year from US\$ 6.58 billion in 2023 and US\$ 5.61 billion in 2022. The Market size of the Massive MIMO technology in the Asia-Pacific is recorded at US\$ 7.5 billion in 2024.

The throughput gains, high speed, the capability of carrying more data, and efficient spectrum use in Massive MIMO will fuel the progress of digital technologies. It is further evolving with innovations in graphene and metamaterials that will help reduce system size and corresponding costs. The technology enhances data integrity and efficiency, and future 6G networks will likely benefit from AI (Artificial Intelligence) and communication integrations. High cost and complex interference management are the major bottlenecks to the widespread deployment of Massive MIMO, especially in emerging markets. However, more antennas translate into increased latency and more power consumption, constraining large-scale adoption of MIMO by operators. Therefore,

the growth of 5G is both a challenge to the massive MIMO market in the Asia Pacific and a huge opportunity for its development. Innovation has been the emphasis of more prominent companies like ZTE (Zhongxing Telecommunication Equipment). Massive MIMO greatly improves spectral efficiency, coverage, and energy use for wireless networks to carry more users with less interference for a better user experience. Though massive MIMO is currently being impelled majorly by the upcoming implementation of 5G and other projects like "Digital India," high infrastructure costs and limited spectrum are the essential concerns.

The market for Massive MIMO is anticipated to grow fast globally, mainly due to the deployment of 5G and technological innovation. This includes AI integration and advanced antenna design. However, the challenges of high infrastructure costs and signal processing complexity will also be felt more in emerging economies. In India, Massive MIMO will be hastened by government initiatives, such as the present 5G rollout. Also, high upfront infrastructure costs and limited spectrum availability are propositions expected to give impetus to adoption.

**Influencing Factors:**

- ▲ High data demand drives Massive MIMO wireless communication technology
- ▲ 5G rollout boosts adoption of MIMO technology
- ▲ Spectrum efficiency is a key driver for Massive MIMO
- ▼ Deployment complexity issue while technology setup
- ▼ Interference Challenges such as hard-to-manage signals
- ▼ Due to High Power Consumption, implementation costs increased

**DOMAIN 2:  
CORE TECHNOLOGICAL ADVANCEMENTS**

The latest developments happening in Core Networks are mapped into this domain.

**CLOUD COMPUTING**

CURRENT STATISTICS FOR CY 2023	PRÉVISION FORECAST FOR CY 2024
Global Market Size: <b>US\$ 602.31 billion</b>	Expected to reach: <b>US\$ 628.13* billion</b>

*\*Time-Series Analysis*

Cloud computing has changed the face of global landscape technology in almost all aspects, increasing adoption in existing sectors, adoption across new sectors, and revenue growth. In the year 2023, the global revenue of the service was equal to US\$ 669.2 billion. The revenue of cloud computing services in the

first quarter of 2024 was US\$ 76 billion, which was a 21% increase from the same period of the previous year. In 2023, the Indian Public Cloud market, encompassing Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS) offerings, achieved a total revenue of US\$ 8.3 billion.

Many Organizations are increasingly adopting hybrid cloud models, combining private and public clouds for flexibility, security, and cost-efficiency, avoiding monopolies and high prices. This multi-cloud approach mitigates reliability issues. In Telecom, cloud computing enhances virtualisation, centralised data storage, software-defined networking, network function virtualisation, automation, and scalability. Despite the growth of personal cloud storage, challenges like data leakage and cyber threats hinder market progress. In the Asia Pacific (APAC) region, major players include Amazon Web Services (AWS), Microsoft Azure, and Google Cloud. The APAC cloud market is expanding rapidly due to high demand and governmental push for digitalisation, and the increased number of data centers is driving significant growth in this sector.

The market size of cloud computing is expected to witness remarkable growth globally, propelled by parameters such as Digital transformation, Artificial Intelligence, Machine learning integration, and Multi-Cloud. Cyber-attacks are a significant challenge to address. In response, cloud providers had to spend US\$ 4.5 billion on cloud security in 2022, increasing to US\$ 5.6 billion in 2023, reflecting a 25.2% growth to gain customers' trust globally. Despite obstacles, APAC's cloud market is thriving, fueled by rising cloud adoption among small and medium businesses (SMBs) and the pivotal role of channel partners in overcoming barriers.

### Expert Speaks

**Summary of Insights:** Cloud computing propels industry innovation with scalable, cost-effective solutions across AWS, Azure, and Google Cloud, while AWS Spot Instances and Azure Reserved Instances manage demand surges in sectors like finance and healthcare. Public, private, and hybrid cloud models assure security and compliance, and multi-cloud setups leverage unique platform capabilities supported by Kubernetes for interoperability. While edge computing and hybrid adoption meet low-latency needs, Digital transformation accelerates through DevOps, containerisation, and AI tools like AWS SageMaker. Quantum tools such as AWS Bracket expand capabilities, and though NFV adds complexity, it enhances agility in virtual network management, supporting seamless scaling.

**Ms. Pratima Upadhyay**  
Senior Software Engineer, Airbnb

### Influencing Factors:

- ▲ Heavy investments in security boost, data protection, and trust
- ▲ Integration of Big Data, Artificial Intelligence (AI), & Machine Learning (ML) with the cloud to boost market growth
- ▲ Increased number of data centers in the APAC region
- ▼ A concern for the vendor lock-in period
- ▼ Data sovereign regulations

### MULTIPROTOCOL LABEL SWITCHING (MPLS)

The worldwide growth in business enterprises has increased the demand for efficient and secure information management. In 2023, the global MPLS (Multiprotocol Label Switching) market size was at 64.98 US\$ billion.

One of the significant trends in the managed MPLS market includes the integration of SD-WAN technology into the network, thus optimising the flow of traffic and transforming network management, which is critical as business networks need to move towards complexity. The need for secure, scalable, and efficient networking solutions has boosted the adoption of MPLS services across various domains, such as healthcare, telecommunication, BFSI Sector (Banking, Financial Services, and Insurance), retail, and government. There has been an increase in demand for MPLS solutions in the BFSI sector because of the surge of cyberattacks. As MPLS is built on a private link, no outsider can access it, making it secure even if the data transmitted is unencrypted, giving greater security to businesses. Additionally, a very important driver for the growth of the industry has been the rising level of remote working via VPN; a lot of hybrid workers prefer to work from home over the office. Also, there has been a tremendous increase in the number of Internet of Things (IoT) devices, which also require stable and high-speed networks. These devices can have their data demands supported efficiently for optimum functionality with managed MPLS services.

Market Growth for MPLS Demand for robust data transfer solutions, especially in support of cloud and VoIP (Voice over Internet Protocol) and other services requiring significant bandwidth, has further fueled market growth for MPLS. As businesses are demanding and adapting to changes really fast, the need for MPLS services is to remain strong and continue to drive the market in upcoming years.

### Influencing Factors:

- ▲ Need for enhanced network performance and reliability
- ▲ Improved security features over existing technology

- ▲ The growing number of IoT devices requires secure and stable connections
- ▼ The operating and maintenance costs with the need for trained personnel

## INTERNET PROTOCOL VERSION 6 (IPv6)

The exhaustion of IPv4 addresses globally and its inherent limitations have necessitated the introduction of IPv6. As a result, the Global IPv6 Market was valued at US\$ 1.3 billion in 2022 and has since expanded to a total market size of US\$ 39.18 billion in 2023.

Cloudflare observed that roughly 36% of the HTTP/HTTPS traffic was IPv6 across the internet, and 25.3% of all the websites were using IPv6. As per the Asia Pacific Network Information Centre (APNIC), For India, the proportion of IPv6 capable devices/networks stands at 81.06%. In IPv6, more summary and hierarchical routes are available. The sender and receiver manage packet fragmentation and reassembly. Devices can also configure their addresses automatically using Stateless Address Autoconfiguration (SLAAC) without needing a specific protocol. Additionally, IPv6 has included Internet Protocol Security (IPsec) as a standard to enhance security, providing privacy extensions and supporting routing protocols such as Open Shortest Path First Version 3 (OSPFv3). The ability to use extensions allows for greater IPsec deployment over IPv6, thus increasing IPv6 security. India has the opportunity to accelerate internet and related technology innovation and advancement by quickly and effectively implementing IPv6. The global transition to IPv6 is inevitable, and the current adoption rate is around 40% globally.

IPv6 represents a revolution in Internet technology, and it provides a solution to the limitations of IPv4 and supports the growth of the digital economy in the future. The transition to IPv6 poses challenges such as high initial costs, new infrastructure, software upgrades, increased risk of security breaches, and the need for employee training. However, the benefits outweigh the costs. By taking the appropriate steps involved in deploying IPv6, organisations can increase the security and strength of their networks.

### Influencing Factors:

- ▲ Depletion of IPv4 addresses and the expanding demand for IoT, 5G and cloud computing
- ▲ Government policies are advocating for adopting IPv6
- ▲ The cost of ownership of IPv6 is becoming lower than IPv4
- ▼ High initial costs and increased risk of security breach

## IP MULTIMEDIA SUBSYSTEM (IMS)

The global IP (Internet Protocol ) Multimedia subsystem market has reached US\$ 14 billion in 2024. The emergence of edge computing and the deployment of 5G networks has increased the IMS (IP Multimedia Subsystem) market by decentralising data processing and reducing latency. This is crucial to ensure seamless integration of multiple communication services and networks such as 4G, 5G, and WiFi.

The emergence of 5G and the surge in LTE (Long-Term Evolution) and VoLTE (Voice over Long-Term Evolution) technologies has accelerated the implementation of IMS services globally. IMS solutions play a crucial role in the 5G ecosystem by providing cutting-edge multimedia services with low latency communication to accommodate the rapid growth of various rich multimedia applications like OTT streaming, gaming, AR(Augmented Reality), and VR (Virtual Reality). The shift towards remote and hybrid work and the need for effective collaboration tools have enabled the demand for IMS. The standardisation and user-friendly nature of IP multimedia subsystems made it an ideal solution for a wide range of businesses, and its cost efficiency compared to other systems has benefited both large and small businesses. Hence, mobile network operators across the globe have leveraged IMS significantly to modernise their existing services. For instance, Virgin Media O2 migrated its mobile subscribers to their virtualised IMS solution, which provides VoLTE and VoWiFi (Voice over Wireless fidelity). However, data security and privacy concerns in virtualisation were significantly challenging, and implementation of IMS technology in legacy systems faces several complexities like high maintenance cost, software and compatibility issues.

The well-established telecommunication infrastructure and the high adoption rate of advanced technologies have made the North American region a dominant player with the largest revenue share in the global IMS market. The exponential pace of adaptation of virtualisation fuels the market expansion in the Asia Pacific region. Government initiatives like the Digital India program, PM-WANI scheme across diverse sectors and heavy 5G investment with a large customer base make India a key player in the IMS technology market.

### Influencing factors:

- ▲ The 5G Network rollout is accompanied by a need for Wi-Fi offloading
- ▲ Government initiatives supporting increased adoption of Wi-Fi
- ▼ Network security concerns in virtualisation.
- ▼ High initial costs and complexity of implementation

## METRO ETHERNET

The Global Metro Ethernet Market is estimated to be US\$ 32.03 billion in 2024, showing a growth of 7% YoY from US\$ 29.91 billion in 2023 to US\$ 28.86 billion in 2022. Multi-mode Ethernet modules provide high-speed, scalable solutions and account for 70% of the global market share. Growing internet traffic and demand for scalable and customised bandwidth, providing an alternative to the TDM-based core-network technologies. North America is the regional market leader, accounting for more than 33% of the global value contribution, primarily through a stronghold in capital investments within network infrastructure.

100G Metro Ethernet offers high capacity, low latency data transport in optimised architectures for 5G, IoT, and cloud services by using Dense wavelength-division multiplexing (DWDM) along with coherent optical transmission. It enhances bandwidth efficiency, reduces power consumption, and offers scalable networks from the telco and the data center. High-speed networks from streaming, cloud services, and VoIP market demand, in addition to the upgradation of telecom infrastructure, are increasing the growth of the Metro Ethernet market. The region that leads is Asia-Pacific, with a growth rate of 14%. China, Japan, and Korea are regional market leaders primarily because of the efficiency of deployments and aggressive pricing. Ciena's 8700 Packetwave Platform brings 10GbE/100GbE aggregation combined with 100G WaveLogic optics directly into high-performance metro networks and data centers, thus providing high aggregation efficiency. Alcatel-Lucent Enterprise recently unveiled the MEF-certified Metro Ethernet switches that support up to 100G. Comcast has rolled out its newest Metro Ethernet service on the back of Ciena technology, offering scalable, high-speed, low-latency connectivity ideal for all applications in the cloud and the world of remote work supplied by organisations.

Metro Ethernet is crucial for Metropolitan Area Networks, as they are more characterised by flexibility, scalability, and cost-effectiveness. This offers high-speed data connectivity with seamless video, audio, and internet integration over a single Ethernet cable. These trends concerning rising data traffic and cloud adoption with the development of technologies point towards the future's exponential growth of the Metro Ethernet market.

### Influencing Factors:

- ▲ Rising Need for High-Quality Networks Driving Market Growth
- ▲ Metro Ethernet services offer a reliable and simple plug-and-play solution
- ▼ Infrastructure involves a significant initial investment in network components

- ▼ Rising Levels of Competitiveness to Hinder Market Advancement

## DOMAIN 3: INTELLIGENT NETWORK AUTOMATION

Technologies that reduce the complexities of traditional or legacy systems by centralising the network management operations are listed in this domain.

### SELF-ORGANISING NETWORK (SON)

The Self-Organizing Network concept was proposed in conjunction with the physical layer for Long Term Evolution (LTE) and was standardised by the 3rd Generation Partnership Project (3GPP) in Release 8. Global market size in 2022 was US\$ 5.3 billion, and now it has been estimated to be US\$ 5.9 billion in 2023, which is a growth of 11.3%. It is designed to raise the network's capacity by as much as 25%.

SON has not been globally adopted even after 15 years primarily because network management is a very complex issue, and networks come in different configurations. Multi-vendor systems and their interfaces are not strictly standardised. SON plays an important role in addressing the complexities of optimising legacy, current, and future network performance, plans, and spending. The adoption of SON is essential for operators to maintain competitive advantages and to match customers' high expectations. The Service Management and Orchestration (SMO) framework of O-RANs (Open RAN Alliance) has been implemented by Ericsson through the Intelligent Automation Platform, which is designed to operate not only the 3GPP standardised SON applications but also the custom applications. Nokia and STC Group have offered AI-powered MantaRay Cognitive SON solutions in Saudi Arabia, which allow networks to operate autonomously and efficiently, minimising human error. In conclusion, it can be restated that each of the described SON functions is implementation-dependent. They are not given in any of the professional standards or guidelines. The steps required to perform the SON functions, such as the measurement done by the mobile stations, are determined, but not the way the measurements are used. Thus, the effectiveness of the implementation of SON will lead to greater network performance.

### Influencing Factors:

- ▲ Collaborative efforts among OEMs and Telcos to accelerate enterprise adoption of private 5G networks
- ▲ Increasing urbanisation drives demand for advanced systems to manage network complexities
- ▼ Complexities arising out of multiple vendor installations and lack of interface standardisation

## SDN/NFV

CURRENT STATISTICS FOR CY 2023	PRÉVISION FORECAST FOR CY 2024
SDN Global Revenue: <b>US\$ 28.2 billion</b>	Expected to reach: <b>US\$ 33.16* billion</b>

*\*Time-Series Analysis*

In the contemporary landscape of networking technologies, Software Defined Networking (SDN) and Network Functions Virtualization (NFV) stand out as pivotal advancements, offering significant benefits to service providers. These technologies, rooted in virtualisation, revolutionise the management and deployment of network services. As of 2023, the SDN market has burgeoned to a valuation of over US\$ 26.8 billion. Concurrently, the NFV market has also witnessed substantial growth, with its size reaching US\$ 27.3 billion in the same year.

SDN and NFV have transformed the network architecture, which enables applications to have real-time visibility into the network; with this combination, you get automated provisioning along with centralised command and control. SDN allows the network to function and run off-shelf hardware, which reduces the CapEx. Through improved network element programmability, NFV facilitates automation and algorithm control, making it easier to design, implement, scale, and manage networks, which lowers OpEx. When SDN is paired with network virtualisation and virtual machines, service providers can implement control and user plane separation (CUPS) architecture. Network automation and virtualisation are becoming more and more necessary as the network gets more complicated and demands more cloud-based services, IoT devices, security agility, and cloud migration. High capital expenditures, maintenance and support, and end-of-life events for hardware networking devices are all resolved by NFV. The key constraints for SDN include the introduction of complexity to network design and management, increased risk of security and cost of legacy network integration with SDN.

With the growing number of data centers being built for network data storage, NFV and SDN are necessary. Thus, these business shifts across vertical divisions are what power the adoption of NFV technologies. In recent 5G deployments, the use of NFV and SDN contributes greatly to the commercialisation of 5G wireless communication. Due to significant digital transformation, especially in emerging countries and the rise of FinTech start-ups, BFSI is becoming a more alluring sector for players in the SDN and NFV industry.

### Influencing Factors:

- ▲ The high penetration of wireless network infrastructure is driving growth in the market
- ▲ The rising adoption of bring-your-own-device (BYOD) is a driving factor for the use of NFV

- ▲ The need for advanced network management is a key driving factor
- ▲ The demand for cloud-based services has increased the use of network virtualisation and automation
- ▲ The NFV industry is expanding due in large part to the demand for sophisticated network management systems
- ▼ Complexity of network design and management, increased risk of security and cost of legacy network integration

## SD-WAN

CURRENT STATISTICS FOR CY 2023	PRÉVISION FORECAST FOR CY 2024
Global Revenue: <b>US\$ 5.6 billion</b>	Expected to reach: <b>US\$ 6.51* billion</b>

*\*Time-Series Analysis*

SD-WAN (Software-defined Wide Area Network) is on the cusp of an important change in the landscape of networking. Flexible managed, cloud-centric architecture, with a lower cost of ownership coupled with seamless enterprise-level SD-WAN, is revising the way enterprises manage and then optimise their networks. In 2022, SD-WAN had a revenue of US\$ 2.5 billion. Growth continued to accelerate into 2023, generating a total of US\$ 4.2 billion.

AI (Artificial Intelligence) and ML (Machine learning) have more recent advances for SD-WAN, specifically in intelligent traffic management and automated optimisation. Predictive maintenance is improved using AI-based solutions, while 5G and multimode cloud connectivity enable scaling with greater ease.

Advanced security techniques, such as Zero Trust architectures and quantum-resistant encryption, have proven so effective in fighting off emerging cyber threats from adversaries.

### Expert Speaks

**Summary of Insights:** SD-WAN is a transformative technology that enables centralised by leveraging software-defined networking principles to manage and optimise wide area networks. SD-WAN supports multiple transport protocols, reducing reliance on costly MPLS connections while providing secure, reliable internet-based connectivity. Key benefits include real-time traffic control, automated failover, and application-aware routing, which improve network resilience and efficiency. SD-WAN incorporates features like Secure Access Service Edge (SASE), enabling secure access to applications and supporting network segmentation and zero-trust architectures. Though integration with legacy systems can be challenging, SD-WAN offers significant advantages in cost reduction, cybersecurity, and optimised connectivity across distributed networks.

**Mr. Balkrishna Dubey**

MS Network Engineer,  
NTT Global Data Centers and Cloud Infrastructure



The SDWAN as a service offering is gaining traction as it makes the task of enterprises deploying SD-WAN extremely flexible, consequently reducing their CAPEX burden. Most organisations use SD-WAN to realise the high performance associated with the internet, cloud, and unified communications. However, factors such as bandwidth network congestion or server overload may hinder user experience, mostly occurring at Local Loop customer Edge Router, which is prone to congestion. North America, led by the US and Canada, is at the forefront of the global SD-WAN market. Strong infrastructure and continuous technological innovations support its position. Leading players in SD-WAN, like Cisco, Oracle, and VMware, position themselves with strategies like product launches and partnerships with the aim of strengthening their market position.

This global trend toward network efficiency and adaptability sustains an extremely positive outlook for SD-WAN. SD-WAN will capture a huge share of the networking market in North America and Asia-Pacific as remote work and cloud adoption increase. More particularly, factors related to the increasing need for the real-time management of data and seamless performance applications are expected to factor in and speed up the growth of SD-WAN. However, integration complexity, along with pressure on legacy infrastructure, might pose a challenge in mass deployment.

**Influencing Factors:**

- ▲ Digital transformation drives SD-WAN evolution.
- ▲ Increased cloud-based software boosts SD-WAN adoption
- ▼ Need for optimisation of SD-WAN with legacy network infrastructure

**MOBILE DATA TRAFFIC AND DATA OFFLOADING**

CCURRENT STATISTICS FOR CY 2023	PRÉVISION FORECAST FOR CY 2024
Global Mobile Traffic (in Exabytes/month): <b>136.6</b>	Expected to reach: <b>164.5921*</b>

*\*Time-series Analysis*

In the last decade, there has been an upsurge in mobile data usage worldwide. Given that 5G suffers from coverage issues due to higher frequencies used, there is a need for mobile data offloading. This exponential growth has boosted the demand for mobile data offloading solutions. The market for mobile data offload was estimated to be worth US\$ 6.9 billion in 2023.

The primary factors behind this development are technological advances, such as small cell networks,

the availability of WiFi access points connected via fiber connectivity, and the deployment of an IP multimedia subsystem (IMS), enabling seamless integration with mobile networks. Wi-Fi offloading is one of the most common techniques as it works on existing Wi-fi infrastructure, reducing the load on mobile cellular networks, especially in high-density areas. As of Quarter 1, 2024, there were 1,65,147 public Wi-Fi hotspots in India. There has been a decrease of 0.01% in the number of public Wi-Fi hotspots; moreover, the number of unique Wi-Fi users has declined by 10.48% compared to the previous financial quarter. The decrease suggests that the government needs to develop a better strategy and reflect more on its efforts to push public Wi-Fi.

The market for mobile data offloading has the potential to grow significantly because of technological advancements; offloading techniques keep improving with innovations. However, several challenges must be resolved and addressed first, including social and economic ones coupled with technological and capital limitations. The existing infrastructure will have to take on greater network traffic from mobile data offloading; supporting this infrastructure requires strategic planning and investment. Data security is also one major issue, as connecting to a network involves security threats; the framework for employing offloading has to be thoroughly evaluated. India has to solve its Wi-Fi infrastructure issues to take full advantage of these prospects.

**Influencing Factors:**

- ▲ Substitution for the limited coverage of 5G mobile networks in indoor buildings
- ▲ Growing demand for online video streaming
- ▲ Increased deployment of IMS by telcos
- ▲ Increasing roll-out of 5G and Government push for public Wi-Fi
- ▼ Slow development of Wi-Fi infrastructure

**DOMAIN 4: MOBILE, BROADBAND AND OTHER SERVICES**

Trending technologies that create different revenue streams for telecom operators are included in this domain.

**INTERNET OF THINGS (IOT)**

CCURRENT STATISTICS FOR CY 2023	PRÉVISION FORECAST FOR CY 2024
No. of IoT Connected Devices (Worldwide): <b>15.9 billion</b>	Expected to reach: <b>17.35* billion</b>

*\*Time-Series Analysis*

Worldwide IoT industry revenue generated about US\$ 969.6 billion in 2023. The global IoT market size was around US\$ 300.3 billion in 2021 and US\$ 318.8 billion in 2022, following US\$ 380.6 billion in 2023. In 2023, the IoT market size in India was reported to be about US\$ 1.2 billion. Integrating artificial intelligence and machine learning with the Internet of Things (IoT) helped build applications like Predictive maintenance, energy management, and smart facility management. The use of IoT systems increased due to the use of 5G's ultra-reliable low-latency communication (URLLC) capability and Time Sensitive Networking (TSN) standards. IoT Technologies like NB-IoT and Cat-M have wide-scale applications, which include less complexity, longer battery life with low cost, and low to medium throughput. As of 2023, global IoT system connections are 15.7 billion, which consists of 3.6 billion wide-area IoT, cellular IoT 3.4 billion, and 12.1 billion connections of short-range IoT systems. We see an increasing demand despite the shortage of semiconductors across the globe. The United States leads the market with US\$ 141 billion in Market revenue generation, following China as the largest IoT device manufacturer. In 2023, Global spending on the IoT enterprise sector was US\$ 268 billion, showing significant sectorial growth of 15% YoY. In India, the lack of comprehensive data protection laws raises concerns about data breaches and misuse, while unreliable internet connectivity and power supply in many regions hinder IoT implementation. Govt. initiatives like Digital India and the Smart Cities Mission are providing a boost to the adoption of IoT in India.

With smart technology and energy insights, IoT is expected to reduce costs and reduce energy consumption efficiently across the globe. The rise of IoT adoption can be slower in India than in others, considering the inadequate infrastructure and low levels of digital awareness. However, IoT is anticipated to keep advancing sustainability, effectiveness, system connectivity, security, and AI data utilisation.

#### **Influencing Factors:**

- ▲ Push for increased Operational efficiency in telecom operations driven by IoT
- ▲ Increasing consumer demand for connected devices is a for IoT adoption in telecom
- ▲ Growing investments in advanced network architectures like vRAN
- ▼ Telecom operators face high CAPEX and OPEX in upgrading networks for IoT
- ▼ Challenges with integrating IoT systems into existing telecom infrastructures
- ▼ Growing security concerns related to the vast increase in connected devices

## **SUBMARINE CABLE SYSTEM**

Submarine cables are the most important contributor to high-speed internet and data over a large distance. This industry segment has seen an increased demand worldwide because of the continued expansion of communication networks. Despite some fluctuations, new submarine cable investment has been US\$ 2 billion per year on average for the past eight years and with the increased demand, the value of new submarine cables entering service in the coming two years is expected to cross US\$ 10 billion. Submarine cables market was US\$ 27.61 billion in 2023.

Cloud and Content companies such as Amazon, Google, Meta and Microsoft have generated a huge amount of internet traffic, and their share of international subsea capacity usage has increased from 10 percent to 71 percent over the past decade. This has prompted them to take greater control of the delivery of their services by investing in subsea cables. Together, these companies have invested in nearly 60 cables by 2024 and are expected to own or part-own at least 40 by the end of 2026.

This explosive growth has been brought up by an unprecedented demand for high-speed internet, for which submarine cables come into play as they enable such vast volumes of data transfer with extremely low latencies. More than 1.2 million kilometers of submarine cables are currently active worldwide, covering about 99% of international data traffic. This requirement is increasingly being multiplied by growing cloud-based services and the advent of undersea data centers, requiring more robust communication infrastructure. Other emerging technologies include 5G, AI, and IoT. These technologies require a network that supports high capacity with real-time processing and connectivity. Such technologies need high-capacity networks that support real-time data processing and connectivity. Thus, submarine cables need to cope with the volume of data traffic associated with such technologies. Technology advancements in optical amplifiers and repeaters have allowed submarine cables to span greater distances without signal degradation. This, coupled with the development of stronger and more durable cable materials, has significantly enhanced the longevity and efficiency of undersea networks. A new trend that can be observed is the increasing interest in renewable energy solutions, which is affecting the growth of the submarine cable market. Governments around the world are investing in connecting offshore wind farms to onshore grids. Governments are cornered by pressure to ensure that clean energy is transmitted efficiently while reducing carbon emissions.

Submarine cables are essential in digital transformation, high-speed internet connection, and digital connectivity

in numerous industries. It is set to expand rapidly due to technological advancements, rising internet usage, and the growing emphasis on renewable energy solutions. As organisations and businesses need to adapt to changes in demands and technology, the submarine cable market will further facilitate global communication and connectivity.

**Influencing Factors:**

- ▲ Increased demand for reliable and high-capacity communication networks
- ▲ Increased demand for bandwidth and investments from Hyperscalers.
- ▲ The increasing consumption of mobile data worldwide
- ▼ High installation and maintenance costs

**RICH COMMUNICATION SERVICES - ENHANCED (RCS-E)**

The global Rich Communication Services Market will reach US\$ 2.29 billion by 2024. RCS-e is modernising traditional SMS messaging by introducing features like Instant messaging, voice over Wi-Fi and IP, video sharing and calling, and WebRTC (Web Real-Time Communication) to provide users with a more interactive and engaging messaging experience.

Increased number of advertising and marketing companies, enabling RCS (Rich Communication Services) to bring new interactivity to Application-to-Person (A2P) and Person-to-Person (P2P) messaging domains. It is transforming digital marketing and advertising by allowing companies to brand their messages visually, use corporate branding, and provide more authentic and personalised engagement for rapidly growing hyperconnected consumers. Development and

adoption of mobility services with voice-over long-term evolution (VO-LTE) technology enabling the use of calls and web surfing while sending messages with images simultaneously. The increasing investments in the long-term evaluation (LTE) and IP multimedia subsystem (IMS) are enabling the growth of RCS-e to facilitate the next generation of broadband mobile services. For instance, in February 2023, Vodafone collaborated with Google across the European market for mobile messaging services, pixel devices and the Vodafone TV platform. This enhanced Vodafone customers' messaging experiences through Google Jibe Cloud, which empowered Vodafone's implementation of RCS. Nevertheless, RCS is not categorised as an end-to-end encrypted messaging channel since it enables the RCS providers to see customers' messages, which places it at a disadvantage against other competing chat apps such as iMessage, WhatsApp and Signal, with strong message encryption features.

Partnerships by mobile engagement and communications providers with various telecom operators to provide rich, personalised multimedia content to their customers were the key drivers for RCS-e in the APAC (Asia-Pacific) region. Increasing smartphone penetration and strict regulation for OTT (Over The Top) messaging services were boosting the adoption of RCS-e in India.

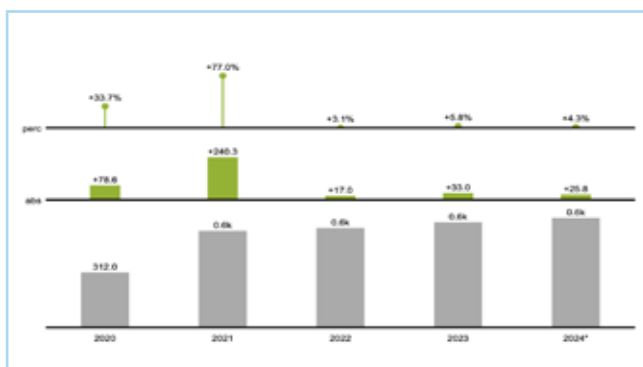
**Influencing Factors:**

- ▲ The increasing number of advertising and marketing companies
- ▲ Increase investments in LTE, IMS, and the development and adoption of mobility services with VO-LTE technology
- ▼ Limited capability to offer end-to-end encryption and lack of compatibility with some mobile platforms

## PRÉVISION OUTLOOK

- The market for MPLS is expected to keep on growing because of the heightened demand for hybrid models of operation and the continued growth of IoT devices
- AI and 5G take the advancement of IoT yet further into innovative, better solutions, such as predictive maintenance
- The growth of Massive MIMO is driven by deployments of 5G technologies, innovations in AI, graphene, and metamaterials
- 100G Metro Ethernet and DWDM technology significantly improve the efficiency and scalability of data transport for 5G, IoT, and cloud services
- The expansion of IoT and the demand for extended reality(XR) solutions have increased the penetration of 5G-enabled smartphones and devices
- Incorporation of massive MIMO enabling high data speeds with low latency
- The shift towards remote and hybrid work and the need for effective collaboration tools have increased the demand for IMS solutions
- Recent SD-WAN updates use AI for smarter traffic management and predictive maintenance, with 5G and multi-cloud enhancing scalability
- The depletion of IPv4 addresses and the expanding demand for IoT, 5G, and cloud computing have given a boost to IPv6
- The rise of data centers drives demand for NFV and SDN, supporting business transformation and growth across various sectors

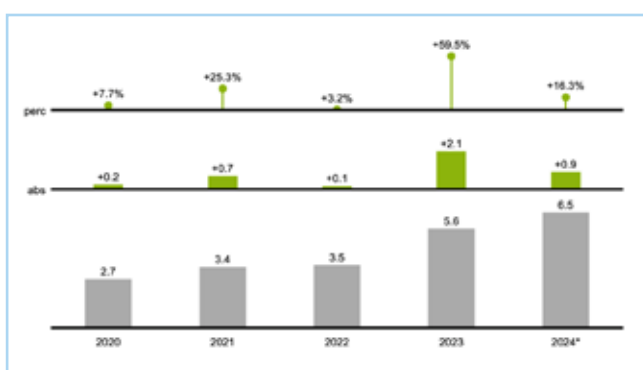
**Cloud Computing - Global Market Size  
(In US\$ billion)**



**SDN\_NFV - Global Revenue  
(In US\$ billion)**



**SDWAN Global Revenue  
(In US\$ billion)**



**Global Mobile Traffic  
(in Exabytes/month)**



**No. of IOT Connected Devices Worldwide  
(In billions)**



■ Increase  
■ Decrease

# INDIAN TELECOM

## Student Team

Vaibhav Kosode | Yatharth Goli | Shruti Jaiswal | Sidharth Sahoo | Sai Praneeth Garudadri

## SNAPSHOT

- ▶ Indian telecom subscriber base saw growth of 2.44% in April 2024 from 1172.52 in April 2023, by crossing 1200 million subscriber base in April 2024
- ▶ The ARPU for voice increased marginally by 0.94 percent to Rs 14.97 in Q4 of 2024; the industry also saw an increase in wireless services ARPU to ₹153.54
- ▶ The gross revenue for ILD varied from ₹ 3653.23 crores in Q1 FY24 to ₹ 3454.94 crores in Q4 FY24, while the revenues for NLD grew from ₹ 7875.86 crores to ₹ 8041.44 crores over the same period
- ▶ In FY 2024, the total MNP requests rose from 819.70 million to 962.53 million by the end of March 24, making a net total of 142.83 million requests
- ▶ The FDI in the telecom sector fell by 57.6% year on year in FY 2023–2024
- ▶ Total number of wireless subscribers in India as of March 2024 is 1165.49 million
- ▶ NDCP achieved a 9.15% growth in broadband subscribers, rising from 846.57 million to 924.07 million in FY 2023-24

## DOMAIN 1: KEY TELECOM METRICS

This domain includes major key telecom metrics.

### SUBSCRIBER BASE

Indian telecom subscriber base saw growth of 2.44% in April 2024 from 1172.52 in April 2023. Indian telecom also crossed 1200 million subscriber base in April 2024, which is an increase of 0.16% from 1199.28 million in Mar 2024 to 1201.22 million at the end of April, making it the world's second-largest telecom market. Wireless subscribers dominate the subscriber base with 1166.96 million, and wireline had 34.26 million subscribers at the end of April 2024. Wireless subscribers in urban areas decreased from 634.47 million at the end of March 24 to 633.53 million at the end of April 2024.

However, wireless subscriptions in rural areas increased from 531.02 million to 533.42 million during the same period. The overall Tele-density in India increased from 85.69% at the end of Mar 2024 to 85.76% at the end of April 2024.

Reliance Jio leads the subscribers' market share of 40.48%, followed by Airtel and Vodafone Idea, who hold 33.12 % and 18.77% respectively. On the other hand, BSNL registered a maximum loss in both segments, of around 1.23 million in wireless and 36,940 in wireline. A significant increase in wireless subscribers and Jio's vision to provide internet-enabled feature phones to existing 250 million feature phone users helped it to gain subscribers significantly. It was seen that BSNL could not retain its subscriber base due to a decline in

investments and due to delays in rolling out its high-speed 4G and 5G networks. BSNL is likely to invest in network upgradation infrastructure in the coming year and roll-out of high-speed 4G and 5G upgraded networks for the customers to retain them on BSNL.

India's nationwide availability of 5G surged from 28% by the start of 2023 to 52.0% by the financial year-end, highlighting an impressive 23.9 percentage point increase within a year. Reliance Jio's 5G availability contributed to 68.8%, while Airtel contributed 30.4%. However, reports indicate low capacity utilization and delayed monetisation have slowed the rollout of 5G. This, coupled with the primary aim of transitioning feature phone users to smartphones, has prompted both Jio and Airtel to upgrade their 4G networks.

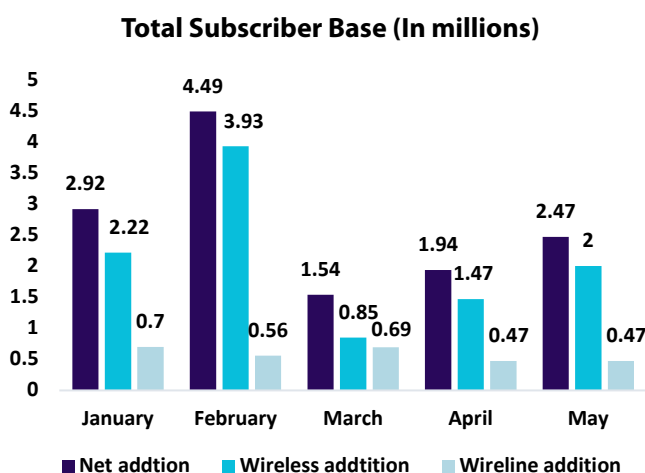
India has 51.92 million M2M cellular mobile connections, with Airtel leading with a market share of 55.69%, followed by Vodafone Idea Limited, Reliance Jio Infocom Limited, and BSNL with a market share of 28.32%, 11.41%, and 5.58% respectively.

CURRENT STATISTICS FOR FY 2023-2024	PREVISION FORECAST FOR FY 2024-2025
Total Subscriber base (million): <b>1186.16</b>	Total Subscriber base (million): <b>1207.28*</b>
Total Teledensity (%): <b>85.03</b>	Total Teledensity (%): <b>85.92*</b>
Urban teledensity (%): <b>133.55</b>	Urban Teledensity (%): <b>133.7*</b>
Rural Teledensity (%): <b>58.41</b>	Rural Teledensity (%): <b>59.57*</b>
Total Telecom Revenue (₹ cr): <b>3,36,066</b>	Total Telecom Revenue (₹ cr): <b>3,59,460*</b>

\*Time-series Analysis

**Influencing factors:**

- ▲ 2G to 4G transition of wireless subscribers
- ▲ Rollout of 4G towers in rural areas
- ▲ Significant increase in M2M cellular subscribers
- ▼ A decline in 5G investments due to low-capacity utilisation and delayed monetisation



**VOICE & DATA ARPU**

CURRENT STATISTICS FOR FY 2023-2024	PREVISION FORECAST FOR FY 2024-2025
Voice ARPU (Rs): <b>15.15</b>	Voice ARPU (Rs): <b>14.91*</b>
Data ARPU (Rs): <b>135</b>	Data ARPU (Rs): <b>148.13*</b>

\*Time-series Analysis

The Average Revenue Per User (ARPU) for voice increased marginally by 0.94 percent to ₹ 14.97 in Q4 2024. It increased compared to the previous quarters, where the voice ARPU declined from ₹ 15.44 in Q1 2024 to Rs 14.83 in Q3 2024. There was also a rise in Data ARPU of 1.02 percent from ₹ 137.34 in Q3 2024 to ₹ 138.75 in Q4 2024. The rise in ARPU reflects a stabilizing market after periods of decline.

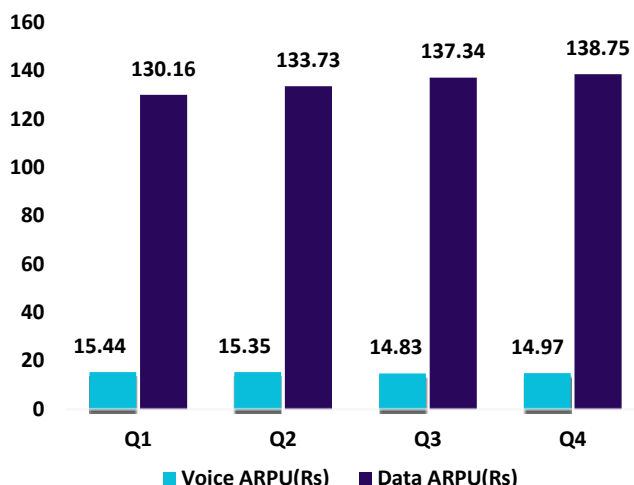
The increase in voice and data ARPU can be attributed to a combined effect of an increase in the number of data subscribers from 89.66 crores at the end of Q4 2024 to 91.33 crores at the end of Q1 2025 and an increase in tariffs of all telcos from July 2024. This has led to an increase in the monthly ARPU of prepaid services, which crossed the Rs 150 mark for the first time in Q4 2024. We saw an increase in wireless data usage in India, which went from 49,543 PB (Petabytes) in Q4 2023 to 52,636 PB in Q1 2024. Although there was a marginal decrease in voice minutes for Reliance Jio from 1.34 lakh crore minutes to 1.33 lakh crore minutes in Q2 2024 compared to the previous quarter, the ARPU still increased due to the increase in subscriber base, which grew from 44.85 crores in Q1 to 45.97 crores in Q2. Talking about other telcos, Airtel showed continuous growth in ARPU from Q1 2024, which stood at Rs 200 to Rs 208 in Q3 2024.

The factors that have led to the increase in voice and data ARPU in the Indian Telecom Industry include the growth in data traffic, tariff hikes for both voice and data and an ever-growing subscriber base. Although there were a few hikes in tariffs, the industry has witnessed constant growth in subscribers triggered by trends of increased 5G services and 4G network enhancements. Such trends indicate that the industry has entered a positive growth phase, with further ARPU increases expected.

**Influencing factors:**

- ▲ Increase in Data Subscribers
- ▲ Increase in wireless data usage
- ▲ Augmentation of 4G networks
- ▼ Decline in voice tariff due to shift from 2G to 4G

### Voice and Data ARPU for FY 2023-24



### NLD/ILD

CURRENT STATISTICS FOR FY 2023-2024	PREVISION FORECAST FOR FY 2024-2025
NLD Revenue: <b>30920.23 crores</b>	NLD Revenue: <b>31782.69* crores</b>
ILD Revenue: <b>14314.01 crores</b>	ILD Revenue: <b>13842.25* crores</b>

\* Time-series Analysis

The gross revenue for ILD (International Long Distance) varied from ₹ 3653.23 crores in Q1 FY24 to ₹ 3454.94 crores in Q4 FY24, while the revenues for NLD (National Long Distance) grew from ₹ 7875.86 crores to ₹ 8041.44 crores over the same period. One of the underlying trends was the growth in the average minutes of usage (MoU) per wireless subscriber, which was up by 4.21% to 995 minutes in Q4.

India has attracted a total FDI inflow of US\$ 70.9 billion in the financial year 2023-24, this, coupled with a 17.5% growth in domestic private capital investments, accounted for ₹ 5.51 lakh crore of planned investments. These investments are driving business expansion that, in turn, needs digital communications services. These trends have fuelled a growing demand for high-speed and smooth connectivity worldwide, enabling connectivity and virtual collaboration, thus positively impacting the NLD and ILD Telecom Service Providers.

Technological developments such as 5G are fast-tracking the growth of the NLD and ILD markets. 5G is being adopted at a very fast pace with the help of large events such as the Indian Premier League and continuous expansion by players such as Airtel and Jio. In Q2, Airtel and Jio added 0.48 crore new subscribers, and the total wireless subscriber population had risen to 116.55 crores by Q4. The industry also saw an increase in wireless services ARPU to ₹ 153.54., a year-on-year increase of 7.88%. These trends, coupled with

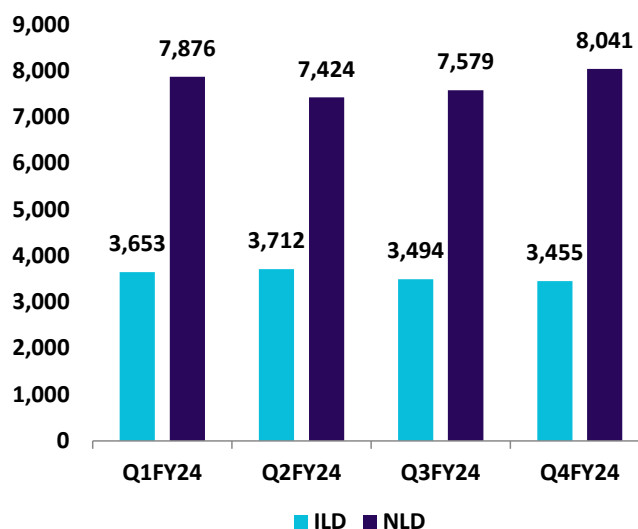
the growing consumer base of broadband subscribers, standing at 92.41 crores as of Q4, demonstrate the stable growth of the sector. However, regulations and stiff competition will remain key factors affecting the market.

The NLD segment is expected to expand further because of the rising digitization and the full implementation of 5G. The ILD segment is also experiencing some regulation issues, but it will grow with the increasing traffic in global data. These are the increasing number of wireless subscribers and the increasing need for broadband internet services. The Indian telecom industry is on the path of growth and development in the future because of the technological factor and the strategic investments in infrastructure.

### Influencing Factors:

- ▲ 5G adoption Across India
- ▲ Continuous expansion by Airtel and Jio
- ▲ Business expansion fuelling the need for NLD/ILD services
- ▼ Regulations and stiff competition

### NLD and ILD (FY24) in ₹ Crore



### MOBILE NUMBER PORTABILITY

In FY 2024, Total Mobile Number Portability (MNP) requests rose from 819.70 million to 962.53 million by the end of March 24, making a net total of 142.83 million requests. As of May 2024, 12 million subscribers placed a request for porting, and the cumulative MNP requests rose to 985.60 million in May'24 from 830.65 million at the end of April'23.

With the ongoing rollout and implementation of 5G services by key players like Reliance Jio and Bharti Airtel, MNP requests are to stay high, partly on VIL users porting out to 5G services available on Jio/Airtel platforms. The states under the MNP Zone-I, spanning



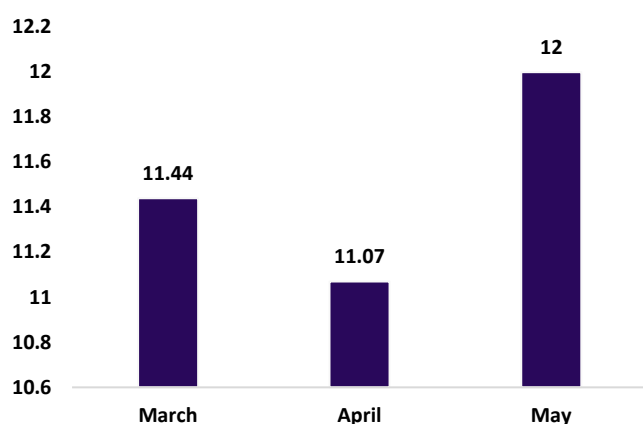
across Northern and Western India, recorded the highest number of MNP requests, primarily in Uttar Pradesh-East with around 93.42 million requests, closely backed by Maharashtra at approximately 80.77 million. In MNP Zone-II, spanning across Southern and Eastern India, the state of Madhya Pradesh received the highest number of requests, approximately 76.35 million, followed by Karnataka with about 67.80 million. To foster healthy competition among telecom operators and to reduce the negative impacts of MNP, the Telecom Regulatory Authority of India (TRAI) has amended MNP Regulations from time to time. TRAI, in its ninth amendment in regulations, which came into effect on July 1st, 2024, introduced a seven-day waiting period for the issuance of a Unique Porting Code (UPC), which implied that UPC allocation won't be possible after a SIM swap. This change is intended to address fraudulent SIM port activities and can lead to a pivot in the MNP landscape.

Mobile subscribers will continue to switch network operators and migrate towards those who provide better network reachability and higher data rates. It is expected that such a scenario will intensify the competition between the two major key players – Reliance Jio and Airtel. However, TRAI will have to ensure that it does not lead to a duopoly, which could hamper the Quality of Service (QoS) in terms of data rate and connectivity for the subscribers.

**Influencing factors:**

- ▲ 5G network expansion in India
- ▲ Value Added Services being bundled into 5G packages
- ▲ TRAI's 7-day waiting period regulation for UPC issuance will instill confidence in the MNP process

**MNP (in millions)**



**DOMAIN 2:  
GOVERNMENT AND REGULATORY ASPECTS**

**FDI**

The foreign direct investments (FDI) in the telecom sector fell by 57.6% year on year in FY 2023–2024 (₹ 5469 crores in FY 2022 – 2023 to ₹ 2318 crores in FY 2023 – 2024). Quarter-wise, Q3 received the least investments (4 crores); the largest inflows were in Q1 (₹ 1933 crores).

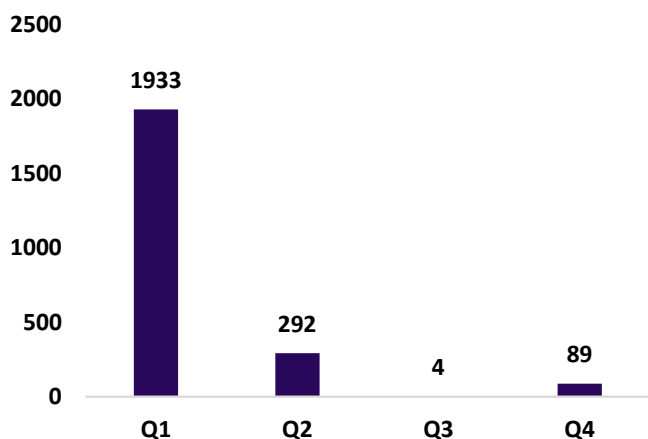
The global economic uncertainties, along with bureaucratic delays, difficulties in contract reinforcement, increase in repatriation, and disinvestment, have resulted in an overall decrease in FDI inflows. In the service sector, which includes telecom, the rising interest rates, geopolitical tensions, and perceived protectionism that support domestic sourcing have all contributed to a decline in FDI inflows to merely 0.69% of the GDP compared to 0.87% in FY 2020. However, prospective FDI in the industry could look better. FDI in the sector has been found to have a non-linear path and is more commonly in the form of waves with peaks whenever new technologies emerge. With the new Telecommunications Act of 2023 and the opening up of satellite communications, it intends to be more attractive. The new act facilitates the creation of regulatory sandboxes to encourage and facilitate innovation and technological development. Department of Telecommunications has launched the Bharat 6G alliance (B6GA) on similar lines. A grant of 240.51 crores under the Telecom Technology Development Fund has been allotted to research and development in B6GA. The government of India also plans to treat satellite broadband as a telecom service. Such a policy allows 100% FDI through an automatic route.

The present situation in the telecom sector consists of fewer players than earlier, and the domestic funding sources are much more willing to invest, reducing the dependence on foreign investments. However, policy reforms in the regulatory and technological aspects are expected to raise the FDI inflows and potentially reverse the downtrend that has been happening in recent years.

**Influencing Factors:**

- ▲ Government initiatives to drive technological innovations along with policy reforms
- ▲ Opening up of satellite communications
- ▼ Global economic uncertainties
- ▼ Perceived protectionism in the form of domestic funding and sourcing

### FDI in Telecom for FY 2024 (in ₹ Crore)



### Wi-Fi CALLING

Since its inception in 2019, WI-FI calling has gained momentum. Widespread 4G adoption, schemes like the Prime Minister’s Wi-Fi Access Network Interface, and rapid expansion of fiber optic networks contributed to uptake in WI-FI calling. Total number of wireless subscribers in India as of March 2024 is 1165.49 million. In FY 2023-24, rural India has shown continuous growth in wireless subscribers, having an average quarterly increase of 0.86%. As a result, there are 531.02 million rural wireless subscribers (March 2024) in India. However, urban areas have exhibited a decline in adoption rates. With an average quarterly growth rate of 0.44%, urban wireless subscribers stand at 634.47 million (March 2024). The introduction of 5G networks has propelled the usage of WI-FI calling. Vi has recently met minimum roll-out obligations for the 5G network. Reliance Jio and Bharti Airtel have almost a countrywide 5G coverage. Telcos are developing innovative technologies to provide broadband-like services without a wired connection (Fixed Wireless Access – FWA, popular as AirFiber). Airtel Xstream AirFiber & Jio AirFiber were introduced in August & September of 2023, respectively. Vi successfully tested the technology in March 2024. This would further enhance the coverage of wireless services where infrastructure development is not feasible. Reliance Jio has gone a step ahead by announcing successful testing of Jio SpaceFiber in remote areas of Gujarat, Chhattisgarh, Odisha, and Assam. With this ever-increasing availability of wireless networks, subscribers are more prone to use WI-FI calling, which has become cheaper and more widely accessible than calling over traditional cellular networks.

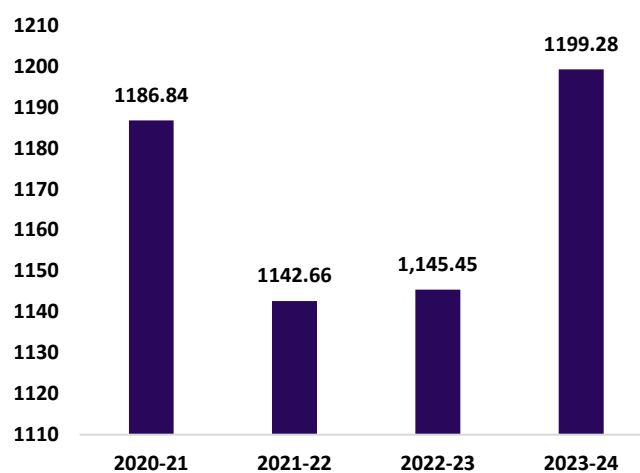
However, the availability and security of public hotspots is a persistent issue. On the user side, inconsistent network quality, restricted mobility, and device compatibility limit Wi-Fi calling. Whether in remote rural areas or dense urban clusters, communication is essential. To satisfy this need, WI-FI calling can be

seen as an emerging solution. With an increase in 5G adoption, emerging technologies like FWA and SpaceFiber are expected to make WI-FI calling more popular, accessible, and affordable.

### Influencing factors:

- ▲ Increasing coverage of 5G networks
- ▲ Emerging technologies – FWA, SpaceFiber
- ▼ Insecure public hotspots
- ▼ Restricted mobility of the user
- ▼ Inconsistent quality of service

### Wireless Subscribers (in Millions)



### TELECOM INDEX

CURRENT STATISTICS FOR FY 2023-2024	PREVISION FORECAST FOR FY 2024-2025
AGR (₹ in Cr): <b>270504</b>	AGR (₹ in Cr): <b>298722.83*</b>

\* Time-series Analysis

The Telecom service’s Adjusted Gross Revenue (AGR) for Q4 FY 2023-24 stood at ₹ 70,462 crores. At the end of March 2024, Private operators’ contribution to the telecom subscribers market share was 91.70%, and the same for Public Sector Undertakings was 8.30%. The private operators hold a 92.26% share of wireless subscribers, while the P.S.U. Operators command a 7.74% share. The growth of total wireline subscribers was slow at 2.19% in the Q2 2023 compared to the previous quarter.

The wireline subscribers increased by 6.12% in March 2024 over December 2023 and much more if matched with the % increase in the previous quarter. AGR stood at a rise of 9.25% in March 2024 on a YoY basis. This surge in AGR can be attributed to an overall increase in subscriber base, both individual and corporate, as well as a hike in tariff by all telcos. As part of the P.L.I. scheme, by the end of October 2023, the Centre had approved approximately Rs 4,014 as a total commitment by

42 companies that sent in investments worth Rs 2,725 crore to the Government of India. Since this scheme incentivizes domestic production, it reduces dependence on imports under the PLI scheme. The wireless subscriber base is 97.18% of the total subscriber base. Reliance Jio Infocom Ltd stood at 40.30% by the end of March 2024, with the top market share of the wireless subscriber base. Second is Bharti Airtel Ltd, with 33.10%. Except for these two, all other companies showed negative growth quarterly by the end of March 2024. However, what has doused the spirits for ARPU's revitalization is its slow growth, still pegged at 7.88% YoY in March 2024.

Companies can leverage tariff hikes to improve revenue growth. Indian telecom operators have adequate headroom for hiking tariffs distinctively throughout a couple of years to upgrade the revenue growth of the concerned telecom companies.

### Influencing Factors:

- ▲ Implementation of PLI scheme
- ▲ Good Headroom for tariff hikes
- ▼ Slow growth of ARPU

## NATIONAL DIGITAL AND COMMUNICATION POLICY

The National Digital Communications Policy (NDCP), with its primary mission to provide broadband, witnessed a 9.15% growth in broadband subscribers during FY 2023-24, increasing from 846.57 million to 924.07 million. Among this, the number of wireline and wireless broadband subscribers rose to 40.06 and 884.01 million, from 33.49 and 813.08 million in 2022-23, with an individual growth rate of 19.61% and 8.72%, respectively.

India has been largely utilizing digital technologies such as Cloud services and IoT to run its various initiatives, like the National Broadband Mission and Bharat-Net, to expand broadband connectivity and telecom infrastructure installation across the far-fetched rural areas. The Government launched the PM Gati-Shakti Sanchar portal to channel Right of Way (RoW) permissions and remove clearances. With the 'Secure India' mission of NDCP, to address the security of data communications of Indians from spam calls and avoid cyber frauds, the Government has recently asked the telecom operators to initiate trial runs for Calling Name Presentation (CNAP), such that names of the callers would be displayed as they dial, on behalf of unknown numbers. The Number of Gram Panchayats (GPs) connected under the BharatNet Project increased to 2,13,570, and the total optical fiber laid spanned up to 6,85,095 by mid-July-2024. On 31 July 2024, the Government introduced a "5G Intelligent

Village" proposal focused on uplifting rural areas with technological advancements in 5G. Proposals are to enable Massive Machine-type communication (MMTC) and Ultra-Reliable Low-Latency Communication (URLLC) aspects of 5G in planned village locations spanning the states of Gujarat, Haryana, Madhya Pradesh, Rajasthan, Maharashtra, Assam, Andhra Pradesh, Uttar Pradesh.

After the reach of digital payment initiatives in different parts of the country, with such proposals, it is expected that there will be further growth in broadband connectivity in rural regions of India. In addition, the Department of Telecom (DoT) needs to promote the Data Economy by further establishing Data Centres and Content Delivery Networks in India. The Government needs to ensure that 5G, in integration with advanced technologies like AI, makes its initiatives reach the last mile of connectivity.

### Influencing Factors:

- ▲ 5G Services implementation in India
- ▲ Facilitation of Right of Way (RoW) permissions and removing regulatory hurdles
- ▲ Government Initiatives for 5G Expansion
- ▼ Unavailability of Advanced Telecom Infrastructure in Rural India

## IMPACT OF TELECOM BILL

The 2023 Telecommunications Bill represents one major step toward modernizing India's telecommunications sector. Replacing two archaic laws—the Indian Telegraph Act of 1885 and the Wireless Telegraphy Act of 1933—this Bill has been born with the expectation to reshape telecom regulations to be in tune with the changing digital landscape. Indeed, with India being ranked as the world's second-largest telecommunications market by TRAI and a teledensity of 85.69%, this reform comes in time with the country's use moving into the 5G era and in terms of digital infrastructure.

The Bill is a measure to modernize India's infrastructure regarding spectrum allocation and licensing processes, reducing bureaucratic delays and encouraging innovation. It may further foster participation in initiatives like the Bharatnet project and the Prime Minister's Wi-Fi Access Network Interface to bridge rural India's digital divide. On the other hand, the Bill raises concerns regarding privacy and surveillance in light of the fact that it grants the government power for interception of communications and suspension of internet services without procedural safeguards. Given incredibly stringent provisions for user authentications, including biometric identification, misuse of personal data, and privacy threats are the concerns the Bill raises. From an economic point of view, rationalizing regulatory processes and spectrum allocation may

make India a more competitive player in the global scene by attracting more efficient telecommunication operations. However, an enhancement of surveillance powers and frequent internet shutdowns may cost the government and telecom service providers dearly in terms of losing public trust.

As is envisaged in the Telecommunications Act of 2023, the Government has reiterated that the spectrum used for satellite internet services will not be auctioned but allocated administratively, which is in line with global trends.

The Telecom bill is a sea change in India's modernization of the telecom framework, which is at par with global standards. While this has provided opportunities for

modernization and spectrum efficiency, operational growth cannot circumvent the concerns it raises regarding privacy, surveillance, and shutting down the internet. While building its digital future, there has to be a balancing of innovation and preservation of civil liberties, ensuring that steps toward progress do not come at the cost of fundamental rights.

**Influencing Factors:**

- ▲ Administrative allocation of satellite spectrum
- ▲ Regulatory support for network modernization
- ▲ Simplified Licensing Process
- ▼ Expansion of Surveillance Powers
- ▼ Increased Risk of Internet Shutdowns

# CASE STUDY '25

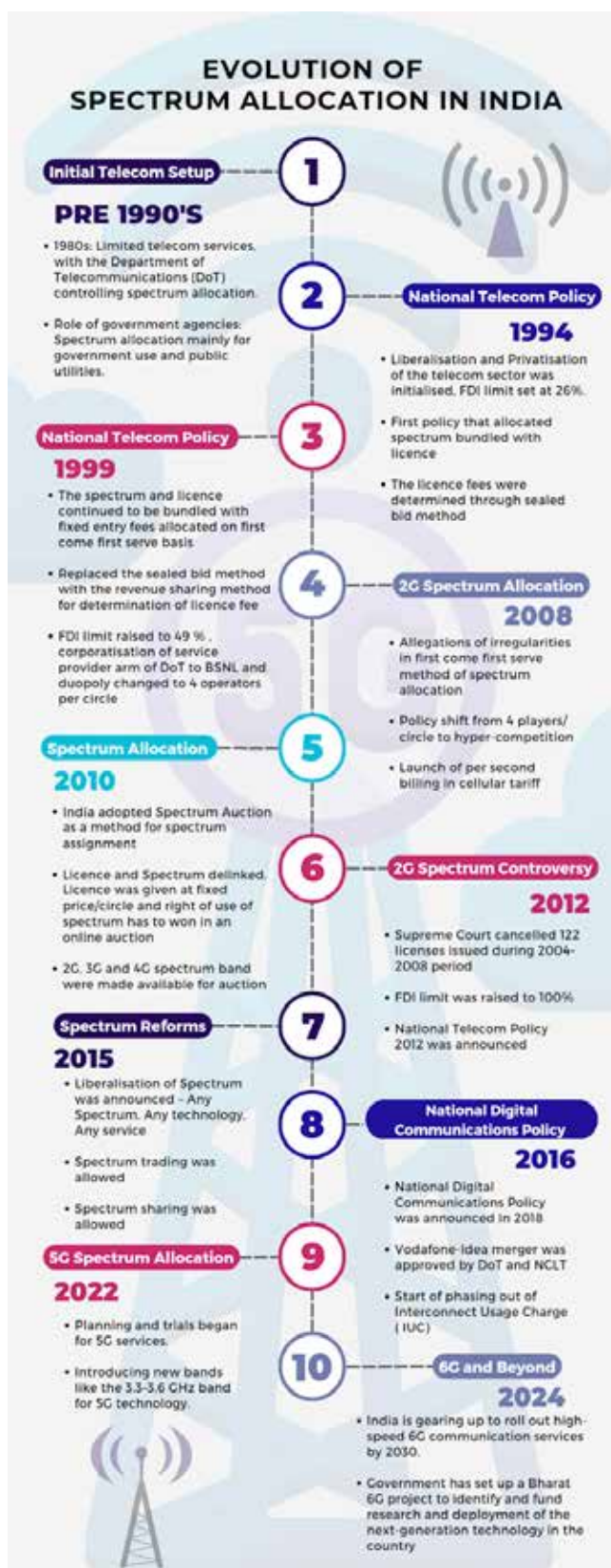


**The Spectrum Blueprint:  
Navigating India's Telecom Evolution**

## INTRODUCTION

The Indian Telecom sector has evolved rapidly from being state-owned before the 1990s to now being dominated by private companies. The liberalization of the sector after the 1990s allowed private players to enter the market, which also led to the flow of foreign investments and transformed the market landscape.

The introduction of GSM technology made mobile phones accessible to the masses, driving subscriber growth. To provide voice and data services to mobile phone users, telecom companies use spectrums of frequencies, which are limited resources. The demand for spectrum is such that in the previous 5G auction, the Indian government finalised bids worth ₹1.5 lakh crore for the rights of use of spectrum by Telcos. As cellular technologies evolve from 2G to 5G, the demand for spectrum increases due to its finite nature. Moving forward, technologies like 5G and IOT will only drive up the demand for spectrum.



## HISTORICAL SPECTRUM ALLOCATION METHOD (1991-2000)

Significant structural reforms in telecommunications began in developing countries in the 1990s, forming complex structures through commercialization, competition, and private sector participation. Before these changes, low tele density, poor infrastructure, limited services, and high prices marred Indian telecommunication. Users of telecom services were limited to the government sector and non-commercial deployments. The Indian Telegraph Act (1885) and the Indian Wireless Telegraph Act (1933) governed spectrum management, and the Wireless Planning & Coordination Wing (WPC) of the Department of Telecommunications (DoT) was in charge of radio regulation - responsible for radio frequency management, coordination, and licensing. WPC had taken a command-and-control approach (application-based mechanism) of fixed charges and license fees.

First, Given the changing global circumstances, the need for private players in the sector was realized and introduced in the National Telecom Policy (1994). The DoT adopted a process in which applicants were shortlisted on the basis of financial eligibility set on certain net worth conditions as well as the condition of having a foreign company as a partner. The shortlisted applicants were then allocated spectrum (2G spectrum mostly in the 900 MHz band) bundled with the licence through a sealed bid method auction. For administrative reasons the country was divided into 22 circles further divided into 4 metros, A, B and C circles. Two licences were awarded in each circle in order to avoid the monopoly of service providers in a circle. DoT continued with this policy from 1995 to 1998 as the government granted licenses and spectrum bundled together for a sealed bid-determined license fee. The scenario within a year or two turned sour for the operators as they were unable to recover the investments made thanks to the unaffordably high tariffs but still had to pay the license fees. However, since the license conditions specified a lock-in period of 5 years, telcos and their foreign JV partners could not exit the market. The New National Telecom Policy (1999) attempted to address these

issues. An effort was made to make the process more transparent, avoid monopolies, and make larger bands available to cater to the increasing demands.

## **TRANSITION TO AUCTIONS (2000-2010)**

Until 2000, the spectrum allocation had been largely administratively driven, and the spectrum in the 900MHz band was allotted to licensees for providing 2G GSM Service. The 2001 spectrum allocation auction was a step in the right direction as it replaced the sealed bid method with the revenue sharing method for the determination of licence fees. The spectrum and licence continued to be bundled with fixed entry fees allocated on a first come first serve basis. The FDI limit was raised to 49 %, followed by the corporatisation of the service provider arm of DoT to BSNL, and the duopoly changed to 4 operators per circle. To bridge the lacuna in issuing separate licenses for different telecom services in regulatory policy, the government of India unified the licenses for fixed and cellular services into a Unified Access License in 2003. In 2005, TRAI determined that GSM and CDMA operators held a lesser spectrum than the world average . Through the spectrum allocations from FY 2002-03 to FY 2005-06, the AGR rose by 108.33% from 40800 to 85000 (crores), respectively. In 2006 TRAI suggested that the government treat 3G spectrum allocation differently from 2G, and the government came out with the 3G mobile services policy in 2008. Post 2008, there was a boom in the telecom sector, which promoted competition among the operators to provide better quality with more value-added services at lower tariffs . By 31 March 2009, apart from BSNL and MTNL, the Basic Services sector had five licensed private operators in the different telecom circles. 2010 was a landmark year as India held its first spectrum auction . Licence and spectrum were delinked , the licence was given at a fixed price per circle, and the right of use of spectrum had to win in an online auction.

The 2010 Spectrum auction was highly competitive with key players such as – Bharti Airtel, Vodafone India, RCom, Tata Docomo, Idea Cellular, and Aircel. The 3G spectrum auction combined with the bid values for broadband wireless access licenses yielded more than Rs 100,000 crore, contributing to 1% of GDP in 2010 to the Government of India.

## **2G SPECTRUM CONTROVERSY AND ITS CONSEQUENCES**

The perceived underpriced telecom license allotment by the Indian government in 2008 is estimated to have caused a presumptive loss of almost ₹1.76 lakh crore to the national exchequer, as was pointed out by Comptroller and Auditor General in his audit report . The whole episode is marred by charges of inefficient governance, corruption, and favouritism. It prompted

the Central Bureau of Investigation (CBI) and the Enforcement Directorate investigations into the matter culminating in the arrest of 18 high-profile individuals, including former Telecom Minister A. Raja. In 2012, the Supreme Court canceled 122 telecom licenses and ordered fresh auctions to make the process fair. Scrutiny of the debate over the contentious first-come-first-served (FCFS) spectrum allocation policy by the Delhi High Court and Supreme Court led to its abolition and adoption of a "competitive auction" approach, which not only doubled the number of telecom operators but also triggered a price war, reducing tariff by over 50%. However, while this expansion opened the market to new entrants, it came at a significant cost. Foreign companies like Etisalat and Telenor incurred huge losses. They booked impairments of ₹3,782 crore and ₹3,297 crore, respectively. This financial crunch further strained the banking industry that gave loans worth ₹30,000 crore to these companies. The controversy revealed deep governance issues, resulting in financial losses and sector disruptions. The Supreme Court's intervention brought reforms but also triggered consolidation in the telecom industry.

## **SPECTRUM ALLOCATION IN THE 4G ERA (2010-2020)**

Defining moments for India's 4G profile were the 2010, 2012, and 2015 spectrum auctions. Competitive bidding for the 2100MHz and 2300MHz bands in 2010 triggered ₹ 1,06,262 crore. The 2012 auction underperformed, with most of the spectrum sold at reserve prices and only ₹ 9,407 crores raised. India's largest auction ever by volume was the 2015 auction, pushing competitive bidding across the 800 MHz, 900 MHz, 1800 MHz, and 2100 MHz bands to a ₹ 1,09,875 crores mark.

Indian smartphone sales increased by more than 50% post-2010, making telecom operators increase their capacity to meet the rising demand. The government's Digital India Campaign in 2015, for building digital infrastructure with digitized services, further increased requirements for larger networking and high availability of spectrum, which increased demand for 4G technology.

The government allowed spectrum trading, sharing, and liberalisation to ensure optimal use of the spectrum. The Spectrum sharing guidelines were released by DOT on 24th September 2015, while the Spectrum trading guidelines were issued on 13th October 2015. In 2016 Reliance Jio was one of the first Telecom operators to leverage this opportunity and partnered up with RCom to trade and share the spectrum of 800 MHz band along with its 2300 MHz band to ensure seamless 4G services. During the period from April to September 2016, around 197 MHz of the additional spectrum was reformed for auction by harmonization of spectrum in 800 MHz and

1800 MHz bands. The Telecom Regulatory Authority of India (TRAI) also favoured spectrum refarming. Between 2014 and 2021, it recommended that the 900 MHz band the government had allotted to operators in the 1990s should be reused for more efficient technologies such as 4G.

Market leaders used the 4G spectrum to develop a competitive advantage. Reliance Jio entered the market in 2016 by launching an all-IP network with reasonably priced 4G data on plans, as a market penetration strategy. Bharti Airtel has also taken steps to reform its 2G and 3G spectrum, particularly the 900 MHz band, to strengthen its position in a competitive 4G ecosystem against competition from Jio.

## **CURRENT SPECTRUM ALLOCATION METHODS (2020-2024)**

Between 2020 and 2024, the Indian telecom sector has seen development with regard to spectrum allocation, especially in its roll-out into 5G. India 5G Spectrum Auction 2022 concluded after a total of 40 clock rounds on August 1, 2022 with a total bid amount of ₹ 1,50,173 crore. 600 MHz and 3300 MHz bands were being auctioned for the first time. 10 MHz of spectrum in 600 MHz was reserved for BSNL/MTNL for 5G Services, while other telcos are bidding aggressively for the 3300 MHz 5G band. Jio was the only telco that acquired 10 MHz of spectrum in the 700 MHz band.

The 2024 spectrum auction bagged only ₹11,340 crore, though responses have been less compared to the 2022 auction that raised ₹1.5 lakh crore, thus capturing just 12% of the reserved price. Some of the major players during the auction included Bharti Airtel acquiring spectrum worth ₹6,857 crore, Vodafone Idea securing the value of ₹3,510 crore of spectrum and Reliance Jio played a minor role as its bids would amount to ₹974 crore. Harmonization of bands increased efficiency, and the advancement of network performance was achieved. Now, it has brought an opportunity for telecom operators to fully utilize low- as well as high-frequency bands in diverse urban and rural deployments. Captive 5G networks have become important as they are used in manufacturing and logistics, whereas private 5G networks come into play with a dedicated spectrum for secure communications, IoT systems, and automation in that environment. As those operations start to become data-oriented, the demand for that spectrum to support those private networks will be substantial. The high reserve prices presented in 2024, have been a major factor in the auction outcomes. Some experts criticize the government policy of setting high reserve prices as it raises the cost of spectrum acquisition, leaving telcos with fewer funds for network rollout. However, given the transparency that auctions bring, they are here to stay.

## **CHALLENGES IN SPECTRUM ALLOCATION IN INDIA**

Mismanaged spectrum allocations have impacted market competition, quality of service, and the digital divide. For smaller players, high reserve prices are a big challenge. Due to this, bands remain unsold and limit the competition in the market, as smaller players cannot afford the spectrum needed for expansion, often leading to underutilization of the available spectrum. India has relatively more spectrum scarcity and less than 40% and 50% of the spectrum available in Europe and China, respectively. Such low availability limits the telcos from fulfilling the demands for high-speed data services and creates competition for limited resources. This results in impetuous bidding and inflated prices leading to delays in new technology deployments by discouraging long-term investment. The high cost of spectrum acquisition also leads to fragmented spectrum allocation in higher frequency bands, limiting the operators' ability to upgrade networks and making integrating newer technologies more difficult. A digital divide also exists between urban and rural India, as the bands suitable for rural transmission (e.g., 700 MHz) are highly-priced. This is problematic since operators are more drawn to resourced urban markets than rural ones, resulting in a lack of quality service delivery for India's remote and impoverished circles.

## **CONCLUSION**

As India marches towards the 6G era, enough focus is being given to the additional spectrum required to support the next-gen technologies. According to estimates by the DoT, it may require ₹5.45 lakh crore worth of spectrum unlocked through refarming and repurposing frequency bands already in use, especially mid-band (3-6 GHz range) by 2030 for a shift to 6G. The 7-15 GHz band is likely to form an essential part of the country's 6G landscape. Bands around 7.125-8.5 GHz, 10.7-13.25 GHz, and 14-15.35 GHz are emphasized by industry participants like Nokia as critical for a balance between coverage and capacity. As such, it will prove particularly critical in a country like India, where quite a large and diversified geographical landscape must be served efficiently. India would need an estimated 500-750 MHz of additional spectrum per network in these bands to meet future demand. While the world is currently working on research in the sub-terahertz sub-THz spectrum, India has yet to explore the same. Applications associated with this spectrum include high-precision sensing and positioning requirements, which will not replace the mid-band spectrum but supplement it. Due to their limited propagation capabilities, sub-THz may not fit too well into large area networks, but it will be an important enabler of specific 6G use cases in India. India's telecom sector evolution epitomizes how the management of spectrum plays



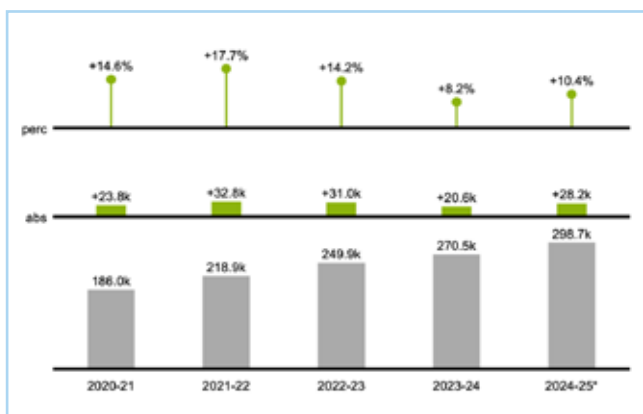
a significant role in driving technological progress. As future technologies like 5G and 6G continue to evolve, strategic and adaptable approaches to the allocation

of spectrum will only remain as important to ensure connectivity, innovation, and sustainable growth in this fast-moving and dynamic telecom landscape.

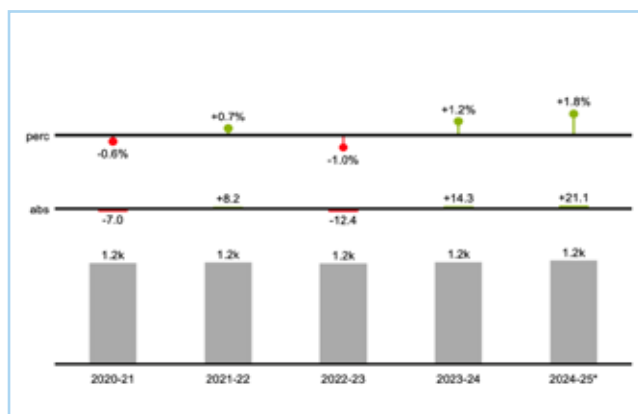
## PRÉVISION OUTLOOK

- Subscriber growth remained strong, driven by enhancements in 4G services and the expansion of 5G networks that portend well for future growth in that space and increased ARPU
- The trend of high MNP requests influenced competitive strategies. With over 65 million users switching networks, companies focused on improving service quality and 5G offerings to retain and attract customers
- The DoT has launched the B6GA, which is positioned to further research and development while creating regulatory sandboxes that will help to foster innovation in future telecom technologies
- Wi-Fi calling has become more accessible and affordable, driven by increased network coverage, improvements in 5G infrastructure, and the possibility of new technologies like FWA
- The introduction of the Telecommunications Bill 2023 modernised regulatory frameworks, promoting innovation and efficiency in service delivery. This reform also prioritized rural connectivity, supporting initiatives aimed at bridging the digital divide
- The launch of the PM Gati Shakti Sanchar portal facilitates streamlined ROW permissions, aiming to eliminate clearance bottlenecks and expedite infrastructure development in the telecom industry

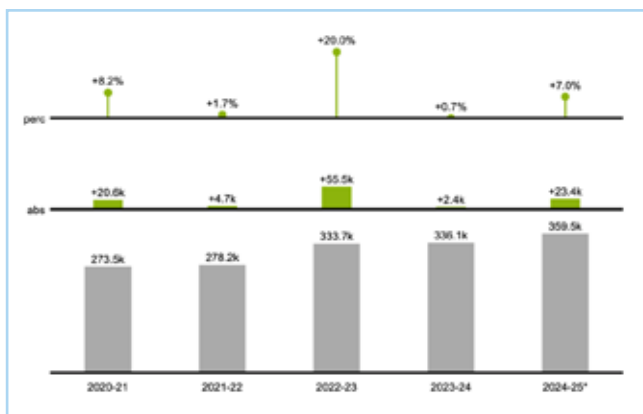
### Adjusted Gross Revenue (In INR Cr.)



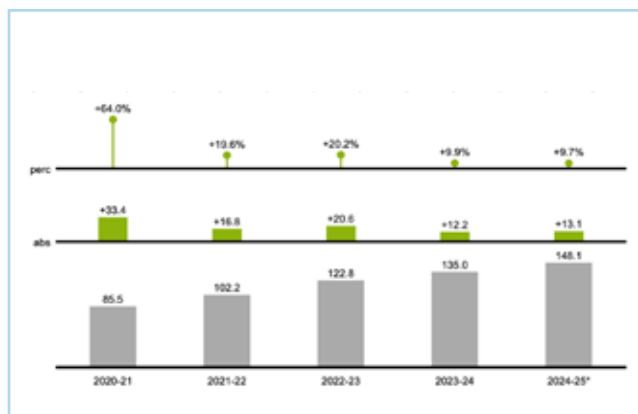
### Total Subscriber Base (In millions)



### Total Telecom Revenue (In INR Cr.)



### Data ARPU (INR)



■ Increase  
■ Decrease

# TELECOM SOFTWARE



## Student Team

Adrija Bose | Miti Jain | Atri Mazumdar | Parv Bajaj | Vishruth Bhat

## SNAPSHOT

- ▶ The cloud-native 5G core market surged from US\$ 2.76 billion in 2022 to US\$ 12.5 billion in 2023 due to increasing mobile subscriptions and the deployment of cutting-edge 5G technologies
- ▶ Global CRM market grew 11.77% YoY, reaching US\$ 91.43 billion in 2023 with North America holding a 59.6% market share
- ▶ Real-time data analytics market reached US\$ 28 billion in 2023, with telecom analytics contributing US\$ 4.91 billion
- ▶ The Service Delivery Platform (SDP) market grew to US\$ 2.98 billion in 2023 and is now valued at US\$ 6.43 billion in 2024 due to a global trend for Health System Strengthening
- ▶ The global service assurance market expanded from US\$ 6.5 billion in 2020 to US\$ 7.66 billion by 2023, driven by the need for Communication Service Providers (CSPs) to detect and remediate network issues
- ▶ Global BI market reached US\$ 29.38 billion in 2023, with North America as the leading region
- ▶ Global OSS/BSS market hit US\$ 67.7 billion in 2023, growing by 11.9% with the market in North America and Europe growing significantly
- ▶ Network Management System (NMS) market valued at US\$ 10.02 billion in 2023, with a CAGR of 10.03% due to rise in cloud-based services, security and 5G network deployment
- ▶ Cloud billing market valued at US\$ 4.79 billion in 2023, growing at a 15.2% CAGR due to the rise of cloud and Internet of Things (IoT)

## DOMAIN 1: CONTROL SOFTWARE

This domain includes software and systems that form part of control software in telecom.

### NETWORK MANAGEMENT SYSTEMS

CURRENT STATISTICS FOR CY 2023	PRÉVISION FORECAST FOR CY 2024
Global Market Revenue NMS: US\$ 11.04 billion	Expected to reach: US\$ 9.91 billion*

\* Time-series Analysis

The Network Management System (NMS) has seen a significant increase in its market value and is expanding at a CAGR of 10.03%. The NMS market is valued at US\$ 10.02 billion 2024 compared to US\$ 9.9 billion in 2023. The reliance on NMS is rising due to an increased requirement for cloud-based services, security, and 5G network deployment.

According Ericsson Mobility Report, the number of 5G connections globally reached 1.76 billion in 2023, which is a 66% increase from the previous year. This swift expansion highlights the worldwide move toward

advanced connectivity for the next generation. Nearly 82% of businesses adopting hybrid cloud solutions recognise a need for NMS. Organizations understand the significance of real-time network performance monitoring, NMS allows administrators to track network traffic, identify bottlenecks, and promptly address issues. In 2023, there was a significant surge in cyberattacks, affecting over 343 million individuals. Moreover, data breaches have increased by 72% in 2023 compared to 2021. These alarming statistics highlight the growing need for heightened cybersecurity measures to protect individuals and organizations from such threats, showing the need for NMS whose solutions integrate security features such as intrusion detection, firewall management, and threat analysis, which will likely act as a catalyst for the NMS market expansion. The IT and telecom sector dominates the NMS market, accounting for around 25% in 2022, and the solutions component made up over 72% of the market, which is anticipated to exceed US\$ 14.4 billion by 2032. The need for network complexity and visibility is driving the NMS. However, the shortage of skilled professionals and the complexity of modern networks limit NMS adoption.

The focus on network security, SD-WAN, and Network Function Virtualization with a rise in technological advancements playing a crucial role led by industry leaders like Cisco and IBM, and the growing 5G networks and increasing internet speeds are a catalyst for the boost in NMS growth.

### Influencing Factors:

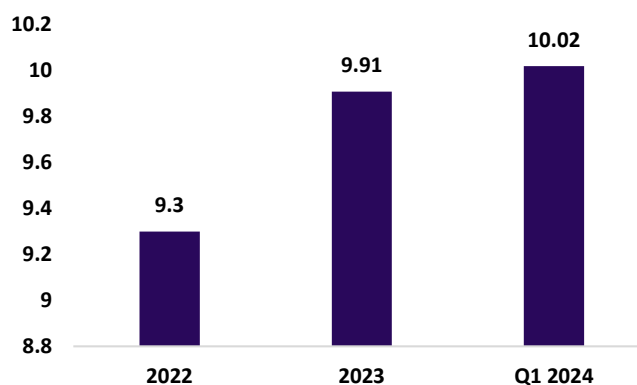
- ▲ Increasing reliance on networks
- ▲ Rising trend of mobile and remote access
- ▲ Increase in demand for IOT (Internet of Things) linked devices
- ▼ High cost of implementing the solution
- ▼ Lack of skilled professional

### Expert Speaks

**Summary of Insights:** Network management systems have advanced significantly in scalability through distributed master-slave architectures and dynamic autoscaling on cloud platforms like AWS and GCP. AI now enables a proactive approach, analysing traffic patterns and detecting anomalies to prevent issues before they occur. Protocols like SNMP, TCP, and UDP allow tailored monitoring for diverse devices, including IoT. Each IoT device—whether a drone or smart appliance—utilizes specific Management Information Bases (MIBs) for efficient diagnostics and effective management within interconnected networks.

**Mr. Piyush Tiwari**  
Engineering Leader, Zipy

### Market Revenue (In US\$ Billion)



### CLOUD-NATIVE 5G CORE

The cloud-native 5G core market has increased from US\$ 2.76 billion in 2022 to US\$ 12.5 billion in 2023. This is due to increasing mobile subscriptions and the growing deployment of cutting-edge 5G technologies across many sectors, including healthcare, manufacturing, and retail.

As high-speed, low-latency communication is necessary for driving 5G innovation, cloud-native solutions increase flexibility, scalability, and cost efficiency by minimizing the need for hardware. They can enable network slicing and edge computing and facilitate new models such as Network-as-a-Service, which has led to an increasing shift towards virtualization and automation in network management with some of the major vendors in the 5G core market like Nokia, Huawei, Ericsson, and Samsung. However, full-fledged cloud-native migration is costly and time-consuming and has huge investments attached. Moreover, different technology standards may make it challenging to integrate and deploy cloud-native 5G technologies due to issues like data privacy, security, and interoperability, which are significant limiting factors for adopting cloud-native 5G core technologies. The 5G core incorporates cloud-native architectures that feature a componentized control plane, a programmable user plane, and a disaggregated information plane. Such an architecture built on cloud-native principles and microservices, eliminates costly hardware and long upgrades, allowing a quick transition to standalone 5G supports.

Cloud-native 5G core is an extreme departure from all previous mobile core architectures because it completely adopts cloud techniques. However, the challenge would be protecting businesses against cyber threats and disruptions. Nonetheless, this change will alter the environment to drive new kinds of collaboration and creativity. Intel supports this transformation with technology enabling cloud-native, distributed 5G core networks to help Communications Service Providers realize their Service Level Agreements while driving innovation for 5G.

**Influencing Factors:**

- ▲ Increasing mobile subscriptions and the growing deployment of cutting-edge 5G technologies
- ▲ Increasing shift towards virtualization and automation in network management
- ▲ High elasticity in throughput and operational automation
- ▼ Full-fledged cloud-native migration is costly
- ▼ Protecting business against the risk of cyber threats and disruptions

**DOMAIN 2: FUNCTION AND COMMUNICATION SUPPORT**

This domain includes the systems and software that form a part of the function and communication support.

**OSS/BSS**

CURRENT STATISTICS FOR CY 2023	PRÉVISION FORECAST FOR CY 2024
Global Market Revenue OSS/BSS: <b>US\$ 61.17 billion</b>	Expected to reach: <b>US\$ 57 billion*</b>

*\*Time-series Analysis*

Reaching a landmark of US\$ 67.7 billion, the global market for business system support (BSS) and operating system support (OSS) expanded by 11.9% in 2023. Regional Growth Rates of OSS/BSS have been impressive in North America and Europe due to developments in telecom and IT services.

As mobile users roll out 5G networks worldwide, the need for OSS/BSS systems to maintain high performance and low latency is also increasing. This growth is driven by the increasing complexity of communication networks, the advent of 5G, and the need for technology integration. Major players such as Huawei, Nokia, Ericsson, and Netcracker Technologies Corporation (NEC Corporation) have played a significant role in this development by providing solutions that meet the needs of mobile users. This development emphasizes how crucial OSS/BSS systems are to manage mobile communications, boosting customer satisfaction, and enhance network performance, and shortening the bill to cash cycle. At the Mobile World Congress (MWC) in Barcelona in February 2024, Ericsson and Indosat Ooredoo Hutchison (IOH) announced the signing of a MoU as a part of which they will work towards boosting customer satisfaction and aid Indonesia's upcoming digitalization initiatives. Ericsson and Indosat have also partnered to grow the company's operations on the Ericsson Business Support System (BSS) platforms. This will allow the company to offer a cutting-edge, faster-to-market solution to the prepaid customers.

The continuous expansion of telecom networks is the driving force for growth in the telecommunications industry. OSS and BSS are critical for managing these complex network functions and enhancing customer relationships. To keep ahead of the competition, the top OSS and BSS market players continue to investing in the telecommunications industry, thus enhancing the growth of OSS and BSS. The future of the OSS/BSS market is promising as it continues to add value to the telecom industry as it gears up to meet the demands for quality services to its customers.

**Expert Speaks**

*Summary of Insights: Operational Support System (OSS) and Business Support Systems (BSS) are integral in telecom industry, with OSS handling the network infrastructure and BSS handling the operations which are customer facing. AI and ML integration is transforming OSS/BSS by automating processes of order management, issue resolution which there by reduces manual intervention. Due advancements in virtualization and 5G the service delivery has become fast. TM Forum's standards and open digital architecture have ensured that there is an interoperability between the systems. This enables a seamless multi-operator ecosystem.*

**Mr. Aravind Mishra**

Senior Business Development Consultant

**Influencing Factors:**

- ▲ Increased Adoption of 5G drove investments and growth in the market
- ▲ The increasing complexity of telecom networks
- ▲ Rising demand for integrated and automated systems
- ▼ Unwillingness to switch from outdated technologies
- ▼ Integration and customization demand a significant investment

**AI & BI**

CURRENT STATISTICS FOR CY 2023	PRÉVISION FORECAST FOR CY 2024
Global Market Revenue AI: <b>US\$ 158.77 billion</b>	Expected to reach: <b>US\$ 150.20 billion*</b>
Global Market Revenue BI: <b>US\$ 29.42 billion</b>	Expected to reach: <b>US\$ 31.05 billion*</b>

*\*Time-series Analysis*

In 2023, the global Business Intelligence market was valued at US\$ 29.38 billion, and North America is anticipated to hold the largest share of the global business intelligence market. Increasing enterprise tech spending drives technology service providers to expand Artificial Intelligence services beyond traditional IT, including AI and GenAI platforms, automation tools, data analytics, and industry-specific applications.

The rising demand from small and medium-sized enterprises for cloud-based business solutions is boosting the BI industry. Growing need for data scalability and KPI-based tracking functionality enable organizations to enhance user experience through BI applications. The BI market is hugely impacted by the North American continent. Notable investments have caused healthcare and retail industries to experience substantial transformation, leading to complete digitalization. BI solutions assist companies in transforming their data into valuable insights that enhance decision-making and provide a competitive benefit. Power BI by Microsoft market leader is being used by over 2,34,200 companies. It holds a 17% market share, while Tableau follows closely behind with 13%. The increasing adoption of deep learning and machine learning technologies is fuelling the rapid expansion of the AI market. Improvements in AI-driven content creation offer a considerable chance for growth in the AI industry. Innovative technologies like GPT-4 and DALL-E can generate top-notch texts, images, and videos, transforming fields like marketing, entertainment, and content creation. Dealing with bias and inaccuracies in AI output is a major obstacle for the industry.

Many consumers have raised concerns pertaining to data breach about businesses using artificial intelligence in their day-to-day applications. It is essential to balance and address these apprehensions and highlight the significance of implementing strong ethical guidelines and transparent algorithms to address these hurdles effectively.

**Influencing Factors:**

- ▲ The rising demand from SMEs for cloud-based business solutions
- ▲ BI solutions help companies turn their data into actionable insights
- ▼ Concerns related to bias and inaccurately generated outputs
- ▼ AI market will require robust ethical standards and transparent algorithms

**REAL-TIME DATA ANALYTICS**

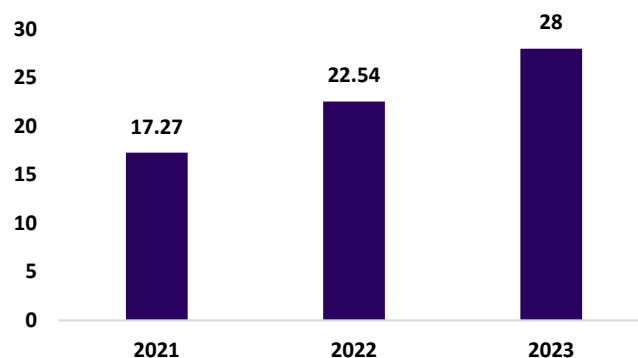
According to recent data, in the year 2023, the real-time data analytics market was valued at US\$ 28 billion. With the growing need for precise decision-making, rising data streaming, booming finance sector, and collaboration between various sectors, the demand for real-time data analytics has been growing dramatically. In 2023, information analytics in the telecom industry contributed US\$ 4.91 billion.

With the need for data monetisation, telecom firms have seen exceptional growth in the volume of information. As the world becomes more customer-oriented, the primary asset remains in understanding customers

and applying that knowledge to develop products and solutions. Enterprises that use technologies such as stream processing engines, machine learning algorithms, cloud computing, and IoT devices driving real-time analytics achieve sales growth of 85% and a gross margin of over 25% more than their competitors. According to data, 42% of organizations that use real-time data analytics to deliver consistently have seen positive impact on their revenues. It leads to increased productivity, operational efficiency, and greater customer satisfaction. Besides this, organizations adapting to the changes based on data analytics can expect a rise in sales margin by 8% to 25%. In most cases, 2% of the increase in revenue comes from just implementing real-time CRM analytic software. With the adoption of 5G and IoT technology, businesses are generating a massive chunk of data. As these IoT devices generate vast amounts of data, it's essential to analyse them in real time and take preventive action to ensure safety of machinery.

As the Internet has become the center of business and individuals' lives, telecom operators are expected to provide high QoS and network services. This is possible only through real-time data analytics, which helps predict network failures and optimize the utilization of the network.

**Real Time Data Analytics Market Revenue (in US\$ Billions)**



**Expert Speaks**

*Summary of Insights: AI and machine learning have revolutionized real-time data analytics over time by redefining work, making it more predictable while results are made more efficient. Tools like Power BI, Python, and VBA Macros are essential for efficient real-time data visualization. Data security is ensured through the segregation of data engineers from analysts so that the data is protected. Key issues in managing high data volume are the lack of innovation and scalability in advanced AI models that, although they advance analytical capability, are resource-intensive and demand expertise.*

**Mr. R Kumar**  
Senior Data Analyst, EY

**Influencing Factors:**

- ▲ Adoption of IoT and 5G
- ▲ Increasing rivalry and market saturation
- ▲ Demand for personalized services
- ▲ The emergence of edge computing
- ▼ Overcoming the "Traditional Reports, Traditional Job" mindset
- ▼ Data quality concerns
- ▼ Uncertainty about what, exactly, to do with all the data available

**CLOUD BILLING SYSTEM**

The cloud billing market, valued at around US\$ 4.79 Billion in 2023, is growing globally at a compound annual growth rate (CAGR) of 15.2%. The surge in cloud and Internet of Things (IoT) technologies, along with the increasing shift towards paperless billing coupled with need for reduction of costs are driving substantial growth in the cloud billing market. To stay ahead in the competitive landscape, businesses are increasingly embracing cost-effective strategies to restructure their operations.

The growth of the global cloud billing market is driven further by the rise of virtualized work environments, need for efficient operations, and improved performance. In 2020, Zuora and GoCardless (UK) launched a joint subscription payment solution. Zuora's Subscription Economy Index shows that subscription revenue has grown eight times faster than sales revenue over the past eight years. From a business standpoint, cloud billing solutions (CBS) offer substantial financial benefits by minimizing the need for extensive IT resources, expensive hardware, and complex integrations while reducing the risk of vendor lock-in. Key players in the cloud billing market include Amazon Web Services, Inc., IBM Corporation, Oracle Corporation, SAP SE, and Amdocs Inc. Despite the rapid expansion of the market, challenges persist. Implementing a full CBS involves a considerable upfront cost, unlike on-premise models. Transitioning from a manual to an automated manufacturing line incurs high costs. Additionally, because CBS handles sensitive data, data breaches could negatively impact a company's brand, and business strategy, making the increase in cyberattacks a significant challenge for the growth of the cloud billing market.

Despite some challenges, the cloud billing market is anticipated to grow remarkably due to the rapid adoption of IoT integration across industries. Moreover, CBS offers significant advantages, including the ability to manage pricing complexities, track third-party billing, and reduce licensing and service costs, which are expected to drive market growth further.

**Influencing Factors:**

- ▲ Streamlined operations and enhanced performance
- ▲ Growing need among enterprises to leverage BI
- ▲ Need for lower OPEX and CAPEX across industries
- ▼ Increasing cyberattacks and data theft activities
- ▼ The high initial cost of installation and maintenance

**DOMAIN 3: B2C**

This domain includes the software and systems that support B2C, i.e., Business-to-consumer communication.

**CUSTOMER RELATIONSHIP MANAGEMENT**

CURRENT STATISTICS FOR CY 2023	PRÉVISION FORECAST FOR CY 2024
Global Market Revenue CRM: US\$ 112.33 billion	Expected to reach: US\$ 91.43 billion*

*\*Time-series Analysis*

The global customer relationship management (CRM) market size has recorded a growth of 11.77% Year-on-Year (YoY) from US\$ 81.80 billion in 2022 to US\$ 91.43 billion in 2023. North America holds the largest CRM market share, accounting for 59.6% and valued at US\$ 61.42 billion in 2022. In India, the CRM market is also experiencing significant growth, with a Compound Annual Growth Rate (CAGR) of 18.14%. This rapid growth of the CRM software market is predominantly driven by the increasing adoption of cloud-based CRM solutions.

Ongoing trends such as hyper-personalization of customer service, automation, and robust social media customer service implementation increase the adoption of CRM platforms across industries. The BFSI, retail, Government, technology services sectors are the largest spenders in the CRM market, representing 61.2% of total expenditure. Growing demand for 360° customer view to manage and analyse customer interactions and data throughout the customer lifecycle is one of the primary drivers for the demand for Financial CRM. In the retail sector, online shopping is increasing by leaps and bounds. Worldwide e-commerce sales increased from US\$ 5.3 trillion in 2022 to US\$ 5.8 trillion in 2023. Major companies operating in the CRM software market are SAP AG, Salesforce.com, Microsoft Corporation, and Oracle (NetSuite Inc.) Corporation, Adobe Inc., Genesys Telecommunication Laboratories Inc., Zendesk Inc., and Zoho Corporation. Although the CRM software market is growing rapidly, the growing number of data breach incidents through CRM concerns software providers.

The CRM market is expected to grow exponentially in the upcoming years. The market is characterized by innovation driving substantial advancements in

omnichannel marketing, customer data management solutions, and big data analytics. Moreover, expanding cloud platforms and varied CRM solutions presented by market players are expected to create robust opportunities for CRM market growth.

**Expert Speaks**

**Summary of Insights:** Highlighting the transformative impact of cloud-based CRM systems on efficiency and scalability, enabling global data management and rapid processing. Cloud solutions in the context of global organisations where teams are not co-located help establish robust governance model at the systemic level to respect GDPR and Privacy laws and do guarded outreach. For SMEs and large enterprises, CRM needs vary, with customization focusing on specific workflows, campaign management, and customer engagement. AI and ML are pivotal in creating class act deliverables to perfection while exponentially empowering reach and relevance programs of an organization with iterative data/behavioural intelligence around customers.

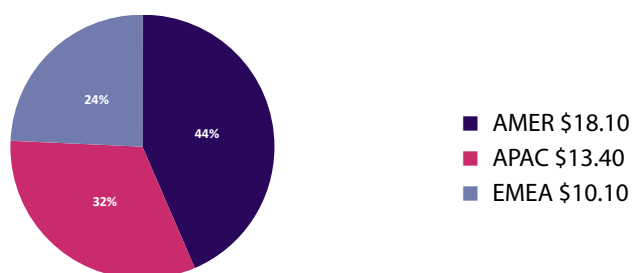
**Mr. Satwik Bakshi**

Manager-CRM Specialist, McKinsey & Co.

**Influencing Factors:**

- ▲ The demand of businesses seeking real-time insights into customer behaviour
- ▲ The incorporation of AI and ML allows features like hyper-personalization
- ▲ Cloud technology assisting SMEs in growth
- ▼ Security concerns pose challenges for CRM software market growth

**Total spend Of CRM Solutions By Region FY 2023**



**SERVICE ASSURANCE AND FULFILMENT**

CURRENT STATISTICS FOR CY 2023	PRÉVISION FORECAST FOR CY 2024
Global Market Revenue service assurance: <b>US\$ 7.5 billion</b>	Expected to reach: <b>US\$ 7.87 billion*</b>

\*Time-series Analysis

Service assurance and fulfillment have become critical in the telecom industry as networks evolve towards more complex infrastructures like 5G and the Internet of Things (IoT). Globally, the service assurance market has grown significantly from US\$ 6.5 billion in 2020 to US\$ 7.66 billion by 2023. This growth is driven by the need for Communication Service Providers (CSP) to detect and remediate network or performance issues.

Integrating more recent and developed Artificial Intelligence (AI) and Machine Learning (ML) technologies into their offerings is the primary focus of major telecom service assurance providers. Currently involved in this invention are companies such as Accenture, Cisco Systems, Inc., Broadcom Incorporated (CA Technologies Inc.), Tata Consultancy Services Limited, and Nokia Corporation. These organizations are creating solutions for turning on service assurance across the business that improves the networks' quality and availability and accompanies it with operational excellence and customer satisfaction. In September 2023, CloudFabrix unveiled an AI-based 'Telco Service Assurance and Automation Solution' and a GSI Partner Program. Reporting also became unified from different data sources, and auto-ML, data automation, and service automation were improved. It focused on large telecommunications environments and offered solutions for high-level service agreements. Information privacy issues remain a significant threat to the growth of global demand for communication services. The need to protect personal data given the exponential increase in the number of connected devices.

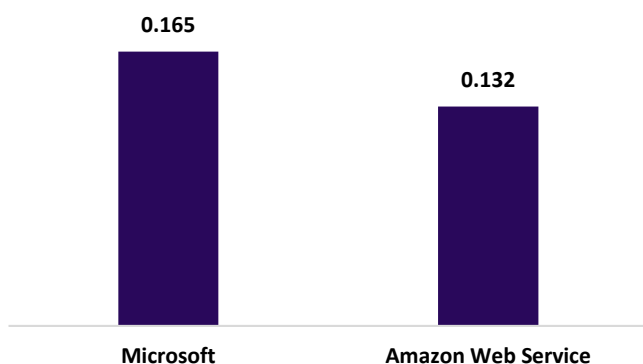
Ongoing roll-out of 5G networks in countries like China, India, Japan, and others has increased the need to enhance service assurance, and the market is expected to grow at a rate of 8.4%. The growing heterogeneous customer base also pushes for effective, high-quality voice and data communications services. This is due to favourable government policies and enhanced investment in telecom facilities in the Asia-Pacific market.

**Influencing Factors:**

- ▲ Increased use of technologies such as 5G, IoT, and edge computing
- ▲ Increasing adoption of AI/ML and automation in SA service offerings
- ▲ Growing dependence on communication services for personal and professional needs
- ▲ Advanced security services are necessary for cloud and virtual networks
- ▼ Coordination between different service assurance systems is a significant challenge
- ▼ Analysing large amounts of data is quite challenging



### Revenue Assurance Market (in US\$ Billion)



### SERVICE DELIVERY PLATFORM

The Service Delivery Platform (SDP) was valued at US\$ 2977 million in 2023. It is currently valued at US\$ 6.43 billion in 2024. The increasing demand and a global trend for Health System Strengthening are boosting the service delivery market.

SDPs enable telecom operators in designing, implementing, and managing Digital services based on Web 2.0, mobile multimedia services, and mobile multimedia devices. As SDPs embrace cloud-based delivery models to deliver a range of Digital Services, they are now called Digital SDPs. As for the present SDP market, North America is leading because of the intense focus and demand for businesses to become more agile and the need for digital transformation. The need for digitalization technologies, such as Travel-as-a-Service proposed by the Spontana-CWT joint venture and the TIMWETECH digital service delivery platform, increases their attractiveness, especially in partnership with the OTT service providers. Availability of a range of applications, increasing adoption of mobile devices, the popularity of cloud and 4G & 5G network expansion are fuelling the SDP market while helping operators cut down on operational expenses. However, data security and data breaches are prominent issues that may slow the industry's growth.

The global DSDP market is anticipated to grow as cloud adoption continues to rise across various industries, presenting new and diverse opportunities for expansion. Continuous technological advancements are driving this growth, with industry leaders such as Amdocs, IBM, and Ericsson playing a crucial role in shaping the market landscape. As companies increasingly embrace cloud-based solutions, the demand for robust and innovative DSDP is expected to surge, creating a competitive yet promising environment for market players to thrive and innovate.

#### Influencing Factors:

- ▲ Growing demand for lowering operational costs
- ▲ Increased adoption of cloud-based delivery models

- ▲ Increase in demand for IOT (Internet of Things) Technology across industries
- ▼ Data Breaches and security concerns
- ▼ Complexity and integration challenges
- ▼ Vendor lock-in

### DOMAIN 4: MIDDLEWARE

This domain includes the systems and software that enable middleware integration.

### APPLICATION INFRASTRUCTURE AND MIDDLEWARE

CURRENT STATISTICS FOR CY 2023	PRÉVISION FORECAST FOR CY 2024
Global Market Revenue AIM: US\$ 57 billion	Expected to reach: US\$ 61.18 billion*

\*Time-series Analysis

In 2022, the Application Infrastructure Middleware (AIM) market stood at US\$ 52.1 Billion. However, with the upgradation of the applications and the growing need for security, reliability, and real-time processing this market soared high to US\$ 57 billion in 2023.

The transformation of manufacturing organizations to operate in Industry 4.0 has led to a growing emphasis on automation, interconnectivity, and real-time data utilization, which is expected to have a positive impact on the AIM software market. Modern technologies like Internet of Things, machine learning, and cloud computing have become essential for computer systems. Automated tools like robotics are required to interface with these platforms and technologies, which is done through AIM software. The subsequent advancements in AIM have been extended to forming the Robotics Operating System (ROS), the robotics middleware on which robotics systems can be built. With the increasing IoT adoption as the number of IoT devices are likely to grow, there will be a need for middleware to manage the exchange of data. According to a report published by Ericsson, 4G and 5G networks will provide cellular connectivity to 4 billion IoT devices by the end of 2024. In addition, multi-tenancy in cloud-based AIM solutions enables businesses to integrate this architecture. It helps them to reduce infrastructural and administrative expenses. However, market development is limited in cloud-based AIM due to outsourcing middleware services to third-party vendors, which might lead to data breaches and security vulnerabilities.

Despite these challenges, with the growing technology trends like 5G, IoT, and Robotic Process Automation, the need for AIM is expected to continue to rise. This shows the importance of AIM in helping organizations survive the technologically evolving business landscape.

### Expert Speaks

**Summary of Insights:** *Sharing his deep insights into cloud-native infrastructure, focusing on its scalability, cost efficiency, and security, especially in the context of cloud providers like AWS. He explained how cloud computing eliminates the overhead of managing physical data centres by offering flexible, on-demand services. For startups, it reduces upfront costs with a pay-per-use model, enabling rapid application development. Emphasized the importance of security and compliance, particularly with regional data privacy laws, like the EU's regulations for financial institutions. Additionally, how cloud solutions dynamically scale based on business needs, with cost optimization features, and discussed the future impact of AI and machine learning on cloud infrastructure optimization.*

**Mr. Anurag Bhandarkar**  
Infrastructure Architect AWS,  
Cognizant

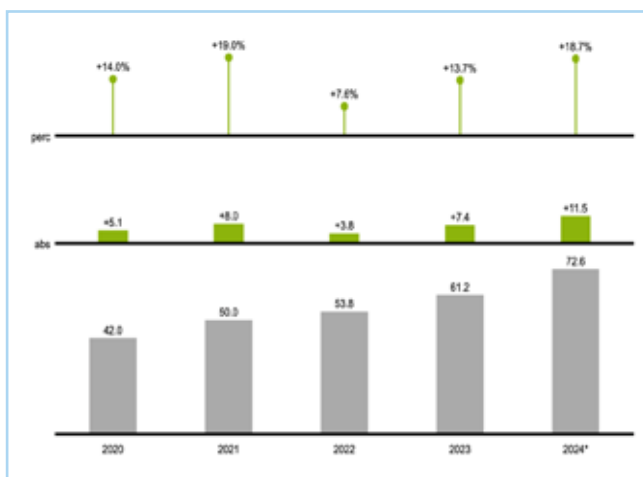
### Influencing Factors:

- ▲ Adoption of cloud computing services
- ▲ Growing need for improved scalability and flexibility
- ▲ Growing demand for real-time data analytics
- ▲ Increasing adoption of artificial intelligence and machine learning technologies
- ▲ Deployment of wireless 5G networks
- ▲ IoT-enabled devices
- ▼ High cost associated with implementing and maintaining solutions
- ▼ Data breaches and security vulnerabilities
- ▼ Requires specialized expertise to deploy and manage it

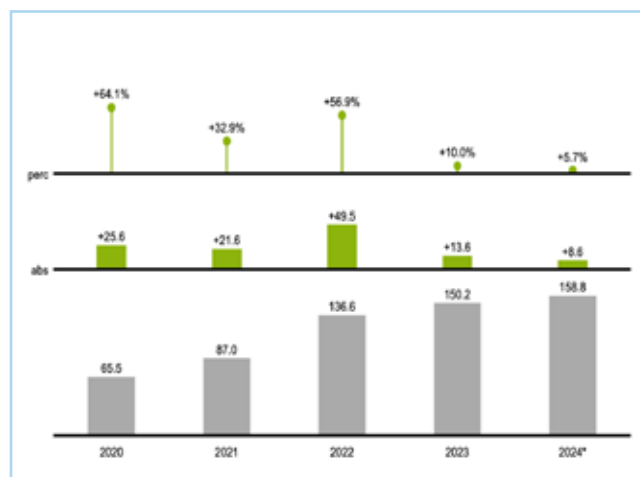
## PRÉVISION OUTLOOK

- Cloud-native adoption is driven by the need to build elastic, significantly cheaper mobile network services like Network as a Service (NaaS), virtualization, and automation of network services
- The adoption of CRM will raise hyper-personalization to serve customer life cycle management functions and should show greater developments in omnichannel marketing
- The ability to understand customer behaviour and forecast future trends from the data gathered by IoT devices and 5G networks will improve the usage of Real-time data analysis for business effectiveness.
- Development and popularity of Web 2.0. multimedia services through mobiles and a rise in utilization of IoT-related services will create the need for SDPs
- The integration of AI and machine learning into service assurance processes will detect and prevent network failures in real time to increase operational excellence and customer satisfaction
- The AIM market is expected to grow as organizations adopt cloud-based solutions and Industry 4.0 technologies
- There will be a continued increase in the use of generative AI and BI as organizations seek to leverage analytics and business decisions across industries for competitive advantage
- The global OSS/BSS market is set for strong growth driven by 5G deployment and complex communication infrastructures. Integrating automation and AI will streamline operations and enhance service quality.
- The global network management system is expected to record high growth because of the greater reliance on features such as 5G, cloud computing, and IoT
- Cloud billing adoption is expected to grow in the future as Businesses remain committed to improving processes and reducing costs, the integration of IoT across industries will boost demand for these solutions

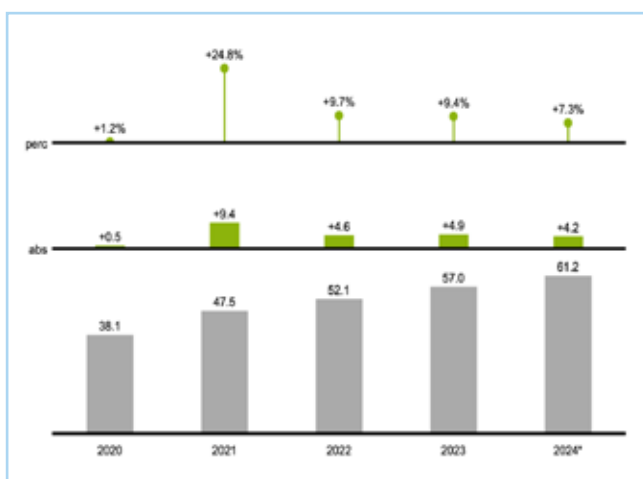
**Global OSS/BSS Market Revenue (US\$ billion)**



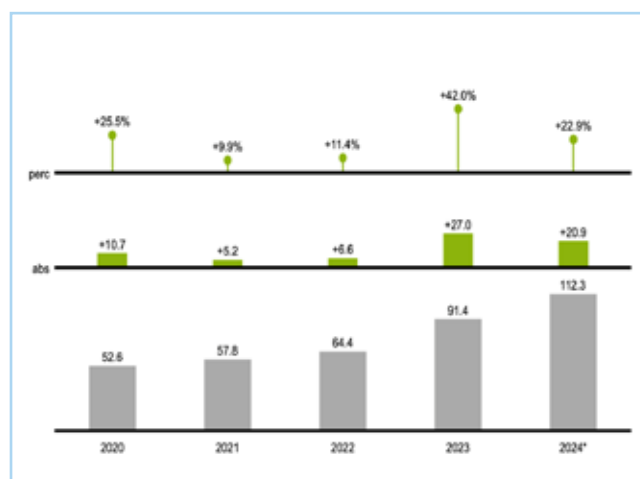
**Global AI Market Revenue (US\$ billion)**



**Global AIM Market Revenue (US\$ billion)**



**Global CRM Market Revenue (US\$ billion)**



■ Increase  
■ Decrease

# COMMUNICATION INFRASTRUCTURE



## Student Team

Hrishikesh Mohan | Mudit Shrivastava | Sriharsha Kolluru | Soumali Pal | Aina Sharma

## SNAPSHOT

- ▶ The DAS market expanded to US\$ 10.28 billion in 2024, with growth driven by Radio over Fiber (RoF) for better indoor connectivity
- ▶ Under PM-WANI, India aims to install 41,160 DAS towers in rural areas to support 4G expansion
- ▶ The LPWAN market reached US\$ 14.31 billion in 2023, with IoT connections nearly doubling due to Industry 4.0
- ▶ India's LoRaWAN adoption in LPWAN is being led by Tata Communications, while NB-IoT dominates in China
- ▶ The RAN market reached US\$ 12.58 billion in 2023, with APAC holding 37% of the 5G RAN share
- ▶ Bharat 6G in India partnered with NextG to advance 5G/6G and Open RAN research
- ▶ The global smart pole market grew to US\$ 16.65 billion in 2023, with the UK's pilot enhancing urban connectivity
- ▶ Active infrastructure innovations like SDN and NFV are critical for scaling 5G and lowering telecom costs
- ▶ India's data center market grew 21% in early 2024, fueled by IoT and 5G
- ▶ Indus Towers focuses on rural expansion, allocating over 60% of its FY24 budget to connectivity projects
- ▶ The market for VSAT reached US\$ 2.88 billion in 2023, which is driven by high demand for remote connectivity that's growing at 10.1 % CAGR year-on-year
- ▶ The telcom government budget grew 14% in 2024 with major funds spent on Bharatnet and BSNL/MTNL
- ▶ Optical fiber demand surged, with the market at US\$ 3.2 billion in 2024, primarily led by 5G needs in North America

## DOMAIN 1: INFRASTRUCTURE

This domain includes parameters that form Telecom Infrastructure.

### ACTIVE INFRASTRUCTURE

With the growing complexities in digital networks, Active Infrastructure is acting like a beating heart that actively monitors, adjusts, and optimizes network operations in real-time. Global data traffic is rising, reaching 59 exabytes in 2023, a whopping 23% increase

from last year, which shows the increasing need for active infrastructure sharing to reduce costs.

Since advanced antennas like Massive MIMO (Multiple-Input Multiple-Output) are driving the infrastructure expansion, service providers can share active infrastructure such as antennas, Radio Access Network (RAN), and Wi-Fi equipment, subject to mutual agreements. Backhaul sharing is also allowed, provided there is no impairment in the Quality of Service. The Licensee can also share his infrastructure to provide other authorized services under different telecom

licenses. The satellite provider could also share an authorized Gateway Hub with a bandwidth seeker. Such regulations ensure effective resource utilization and cost-cutting in the telecommunication industry. However, Infrastructure sharing has limitations, such as conflict between sharing companies, compatibility issues, etc. There are also administrative hurdles, including spectrum allocation, zoning laws, and environmental assessments. Moreover, any technical fault in the shared infrastructure might become a single point of failure and thus would affect the services of all TSPs that share it.

However, innovations such as software-defined networking, network function virtualization, and AI for network optimization enhance efficiency and reduce operational expenditure. Since the capex for 5G is rising, the modern telecom network needs active infrastructure as its lifeblood. The requirement for robust, scalable, and efficient active infrastructure, if not a need now, cannot be overemphasized when the industry moves to more advanced technologies soon. Investment in this area is imperative if the telecom sector is to meet future growth and success.

**Influencing Factors:**

- ▲ Advanced antennas like Massive MIMO drive infrastructure expansion
- ▲ Rising data traffic due to mobile internet, streaming, and IoT demands efficient infrastructure
- ▲ Innovations like NFV, SDN, and AI-driven network management
- ▼ Significant capital expenditure for deploying and upgrading infrastructure, especially for 5G
- ▼ Hurdles such as spectrum allocation, zoning laws, and environmental assessments

**PASSIVE INFRASTRUCTURE**

CURRENT STATISTICS FOR FY 2023-24	PRÉVISION FORECAST FOR FY 2024-25
Towers (In Numbers): 780000	Expected to reach: 815108.10*
Average Tenancy: 2.1	Expected to reach: 2.19*

*\*Time-Series Analysis*

As of February 28, 2024, India has 33.10 million wire-line phone services and 39.46 million wire-line broadband subscribers. According to the Body of European Regulators for Electronic Communications (BEREC), the sharing of passive infrastructure reduces the CAPEX and OPEX of telecom operators in the range of 16% to 35%. In support of the vision of the Government of India to wipe out the Digital Divide and to provide the rural community with a powerful and connected environment, Indus Towers Limited, the largest provider

of passive telecom infrastructure in India, secured in FY 24 over 60% of its additions for rural India.

ATC India- an indirectly owned subsidiary of American Tower Corporation – has been India's leading independent Passive Telecom Infrastructure Provider since 2007 and currently owns and operates more than 75,000 telecom towers in India, catering to all major telecom operators across the country. In India, the Telecommunications Regulatory Authority of India (TRAI) mandates that universal service providers who operate the Universal Service Obligation Fund (USOF) projects share infrastructure with at least two other operators, which will improve telecom coverage in underserved areas, reduce costs of operation and particularly improve the quality of service to consumers. RailTel and CloudExtel have come together to offer the first-of-its-kind Shared Radio Access Network (RAN) service to better the telecom user experience in high-density locales. The first trial was completed at Mumbai Central railway station with the support of Bharti Airtel, Vodafone Idea, Nokia, and Telecom Infra Project. The pilot increased the average mobile data speeds by five times—from 3 Mbps to 15 Mbps—while the data usage was up by 20%. Indus Towers’ portfolio of nearly 220,000 telecom towers across all 22 telecom circles has made it one of the biggest tower infrastructure providers in the country, and it has seen it actively contributing toward India's digital transformation.

Passive infrastructure sharing is quickly becoming popular in the telecom industry as more firms start sharing the other elements of the infrastructure that are not electronic, such as towers, dark fiber, and duct space. Passive infrastructure sharing can bring up to 35 % of capital expenditure savings and up to 25 % of operating expenses.

**Influencing Factors:**

- ▲ Shared passive infrastructure saves costs and optimizes investments
- ▲ Fewer active components improve energy efficiency and reduce environmental impact
- ▼ Incentives to invest in new infrastructure are reduced by shared resources
- ▼ Coordination challenges and competitive neutrality shifts due to shared infrastructure

**DATA CENTERS**

The global data center market was valued at approximately US\$ 229.23 billion in 2023, with the United States capturing a 40% market share. In Q1 2024, India's data center market added 71 Mega Watt (MW) of Information Technology (I.T.) capacity, reaching a total of 942 MW, a 21% increase from the previous period. The market saw transactions of around 200 MW,

I.T. capacity, driven by various sectors. This rapid growth highlights that companies are boosting their digital infrastructure to meet the growing demands of the Internet of Things (IoT), Artificial Intelligence (AI), and 5G, driving the market forward.

Global companies like Microsoft and BlackRock, through the Global AI Infrastructure Partnership (GAIIP), are collaborating to raise up to US\$ 100 billion for AI data centers and energy infrastructure. These investments are expanding global data center presence and driving the industry towards sustainable energy sources such as green hydrogen, microgrids, and renewable energy credits to manage the increasing power demand of data-intensive technologies. India, ranked 14th globally with 151 data centers, is seeing rapid growth driven by its 880 million internet subscribers. Mumbai accounts for 49% of the total capacity due to its strategic submarine cable connectivity. The gradual shift from the Central Processing Unit (CPU) to the Artificial Intelligence-run Graphics Processing Unit (GPU), cloud and edge computing play an equally important role in the future of data storage. Notable investors in the regional data center sector, like RailTel, have already set up data centers in Gurgaon and Hyderabad, providing cloud and security services to various government organizations, and plan a 30 MW data center at its Noida plot. Similarly, telecom and IT companies like Reliance and Amazon are significantly expanding their data center capacities to support emerging technologies like 5G, IoT, and AI. Notably, AWS is set to invest a substantial US\$ 12.7 billion in bolstering its data center infrastructure in India.

In 2024, several prominent companies, such as Adani-Connex, Reliance, Sify, Atlassian, Yotta, and AWS, have revealed significant plans to invest in expanding data centers across India, making a pivotal year for data center expansion. The data center sector is growing significantly due to technology breakthroughs, increasing investments, and a rising focus on future technologies like AI and sustainable energy solutions.

#### **Influencing Factors:**

- ▲ Rising demand and expansion of Data Centre Infrastructure
- ▲ Adoption of AI and Advanced Technologies
- ▼ Concerns Over Data Security and Privacy
- ▼ Increasing Power Consumption and Environmental Impact

### **ENTERPRISE NETWORK EQUIPMENT**

The global Enterprise Network Equipment market is US\$ 56.8 billion in 2024. Meanwhile, India's networking market size was valued at US\$ 114.07 million in 2023. The North American region leads the international market with a share of over 40%, which is US\$ 22.72

billion in 2024. The European region occupies over 30% of the worldwide market, US\$ 17.04 billion. Asia Pacific's market share is around 23%, a size of US\$ 13.06 billion. The Information Technology and Telecom sector is the most significant segment in the enterprise network equipment market.

The need for enterprise networking solutions that afford the right connectivity for numerous devices is quickly arising due to the prevalence of wireless devices, such as smartphones and laptops. The policy of Bring Your Own Device (BYOD), wireless, cloud, and edge computing contribute to this need for network functionality. IoT and virtualisation technologies require a robust and agile networking infrastructure for unhampered yet safe operations. This is a massive challenge for small and medium-sized enterprises because of the high upfront investment and running operations costs. In June 2023, Nokia Corporation, in partnership with DXC Technology, declared the global availability of the managed secure private wireless network and digitalization platform DXC Signal Private LTE and 5G. ZTE Corporation demonstrated a suite of FTTx and connected home broadband solutions at Networks X in Amsterdam in October 2022, including a 50 Gigabit Passive Optical Network (50G-PON) & 0 Gigabit Passive Optical Network (10G-PON) Combo, Light Optical Distribution Network (ODN) solution and business optical gateway. For the company, simplicity of deployment and maintenance are keys to optical networks. In July of the year 2022, Alcatel-Lucent Enterprise engaged the services of SBP Digital Service in developing the management system of standards-based network hardware in this case SBC and Routers. ZTE's innovations include the development of 50G-PON and 10G-PON, which take broadband speed and deployment efficiency to a higher level. Collaboration between DXC Technology and Nokia brings private, secure wireless networks to raise operational efficiencies for businesses.

In the future, investments in high-performance equipment to sustain competitive advantage shall continue as service providers seek more secure, efficient, and elastic network architectures. Those firms that have sought to improve their networking capacities to address these trends of connectivity will not just address today's connectivity requirements but will stand ready to embrace future technological changes and progressive urban initiatives.

#### **Influencing Factors:**

- ▲ Faster data transfer and high traffic are handled efficiently
- ▲ Seamless accommodation of growing needs for network expansion
- ▲ Protection of sensitive data by firewalls and encryption
- ▼ High upfront costs faced by smaller organizations

## DOMAIN 2: TOWERS

This domain includes parameters for different types of towers and antenna systems.

### DISTRIBUTED ANTENNA SYSTEM

Distributed Antenna System (DAS) market size has increased to US\$ 10.28 billion in 2024 from US\$ 9.69 billion in 2023, growing at a CAGR of 6.03%. This increase in demand for DAS has given rise to new technologies like Radio over Fiber (RoF) for the deployment of indoor DAS systems to address network issues like low internet speed, poor connectivity, and higher latency issues.

The factors contributing to the increase in demand for DAS are its compatibility across different generations of communication. The increase in wireless data (mostly 5G networks, connectivity across everyday devices, and the emergence of satellite-based internet. The drawback of 5G connectivity is that the 2-millimeter Wave frequency range (FR2 mm) cannot penetrate through obstacles, creating problems like low internet speed, hampering connectivity and high latency problems. East African Community (EAC) collectively has decided to launch satellites for communication to partner with international tech companies, fueling the growth of the satellite communication market supported by North America as the biggest manufacturer. India, being the second largest telecom market, faces the issue of having a chunk of its subscribers still relying on 2G and 3G services. Under the PM-WANI Yojana, the Government of India (GOI) plans to deploy 41,160 towers based on DAS technology in rural parts of India for better 4G connectivity. The demand for satellite-based communication for combat scenarios worldwide has extended the demand in remote and war-affected areas. The Internet of Things market has grown annually by a two-digit percentage, reaching a market capitalization of US\$ 64.8 billion, fueled by a strong demand for DAS from retailers and businesses.

As demand for access to the internet and connectivity continues, the pressure for global connectivity will continue and technologies like distributed antenna systems will play a key role in connectivity through cost-efficient solutions.

#### Influencing Factors:

- ▲ Growing demand for connectivity
- ▲ Upgradation of current communication infrastructure
- ▲ Flexibility to support and integrate various communication technologies
- ▲ Government support for the expansion of DAS-based connectivity
- ▼ High initial cost of implementation

## SMART POLES

The smart pole market expanded significantly, with a year-on-year growth of 16.82 % from US\$ 14.24 Billion in 2022 to US\$ 16.65 Billion in 2023, of which North America contributed US\$ 5.49 Billion or 33%, making it one of the key players. Countries like China and India are leading the regional market expansion in the Asia Pacific and are growing exponentially as they witness the continuous deployment of smart poles.

The governments of the UK, Germany and France are investing in digital infrastructure, which enhances public internet connectivity, boosts economic productivity and addresses the digital divide in growing towns and cities, aiming to improve the delivery of public services. Virgin Media O2 embarked on a pilot project integrating smart poles into the existing fiber infrastructure to augment mobile connectivity throughout the UK. This has enhanced coverage, brought deployment flexibility and cost savings, and has supported other smart city projects, future network requirements, and customer experience, leading to an uptick in its market share in the UK. Major governmental bodies in countries like Seoul, Los Angeles, Munich, and Leuven have also adopted smart pole technology deployment, revolutionizing urban infrastructure. The Humble Lamppost Project is among the most prominent rollouts in Europe; it has turned lamp posts into smart posts that provide energy-efficient light, surveillance, monitoring environmental conditions, and even economic opportunities across European smart cities. In India, the City of Srinagar plans to introduce 50 smart electricity poles following the significant success and popularity received for the pilot scheme at Zero Bridge, witnessing daily 4,000 exclusive network connections. The Smartpole enables features such as integrated Wi-Fi hubs, electric vehicle charging points, and advertising displays. In Chennai, the malfunctioning of a dozen installed smart poles prompted the Greater Chennai Corporation to initiate urgent repairs as part of the 150-crore integrated command and control center project, ensuring the efficiency and reliability of poles.

The smart pole market is registering dramatic growth based on the adoption of groundbreaking technologies into public infrastructure and the support of smart city initiatives. Transforming traditional streetlights with an intelligent system enables real-time responses and automatic brightness adjustment according to ambient light conditions. Smart poles support telecom services, smart lighting, and environmental sensors enhancing operational efficiency, safety, and revenue streams for smart city infrastructure.

#### Influencing Factors:

- ▲ Reduce traffic jams and prevent accidents

- ▲ Integration of IoT, 5G, and AI technologies
- ▼ Higher upfront costs compared to traditional poles
- ▼ Inability to withstand harsh weather conditions

## VSAT & SATELLITES

CURRENT STATISTICS FOR FY 2023-24	PRÉVISION FORECAST FOR FY 2024-25
Total Connections (In Numbers): <b>253530</b>	Expected to reach (In Numbers): <b>236728.6*</b>

*\*Time-Series Analysis*

The market size of Very Small Aperture Terminal (VSAT) was US\$ 2.88 billion in 2023, growing at a Compound Annual Growth Rate (CAGR) of 10.1 % year-on-year. VSAT is available in many ranges of bandwidths and data transfer speed may go up to 150 Mbps of download speed and up to 50 Mbps of upload speed in the remotest location.

VSAT communication technology solely relies on geostationary satellites positioned at a distance of 36,000 kilometers from the Earth, due to which the average latency is as high as 250 milliseconds (ms). The protocol processing further adds another 300 to 500 milliseconds of delay. There are different frequency bands under which VSAT operates. C band (6 GHz) is the frequency band that was used in the first commercial VSAT; Ku band, HTS (high-throughput satellite) band, and L band are among others, they operate under 12-18 GHz, 26-40 GHz, and 1-2 GHz respectively. Due to the variety of bands used in VSAT, the adoption of technologies has increased, mainly by companies in mining oil and gas and offshore vessels. The idea of HTS technology is to increase the capacity and efficiency of satellite links as a result of improvements in satellite design and ground equipment. Recently, Nelco Ltd. was awarded a contract worth US\$ 400 million by the Oil and Natural Gas Corporation to provide satellite communication to offshore sites. HTS is important at present and in the future in the global demand for data and connectivity, particularly in locations where towered infrastructure is not financially feasible. Low Earth Orbiting (LEO) satellites form mega-constellations and unleashed mega-capacities, proving that VSAT remains critically vital for the development of telecommunication worldwide. While North America dominates the market for VSAT technology due to the rapid adoption of satellite technology and the recent advancement in reducing the antenna size, India is also making progressive steps by planning to increase the maximum transmission data speed from 512 Kbps to 2 Mbps while keeping the license fee at 10% of the adjusted gross revenue for the commercial VSAT service providers.

While high latency remains a challenge due to reliance on geostationary satellites, ongoing advancements

in frequency bands and reduced antenna sizes are accelerating adoption, we can state that VSAT technology is of great importance in the expansion of communication networks.

### Influencing Factors:

- ▲ Surge in reliable communication in remote and mobile environments
- ▲ Demand for real-time data transmission in maritime, military, and energy industries
- ▼ High cost of installation and maintenance of VSAT terminals
- ▼ High latency in the network due to the distance between the satellite and the receiving terminal

## DOMAIN 3: COMMUNICATION MEDIA

It consists of the parameters that form the communication channel.

### OPTICAL FIBRE

CURRENT STATISTICS FOR FY 2023-24	PRÉVISION FORECAST FOR FY 2024-25
Total Fiber rollout: <b>3857865 Kms</b>	Expected rollout: <b>4227731 Kms</b>

*\*Time-Series Analysis*

The optical fiber market has grown to US\$ 3.2 billion (bn) in 2024, from US\$ 2.8 billion in 2023, with a CAGR of 16.4%. This growth is due to the rising need for quick data transfer across the globe and rising sectors that heavily utilize communication technologies. North America leads globally, accounting for 35% of the market share by the end of 2023 because of the increasing demand for 5G networks and Internet of things devices.

Several key technologies are driving this growth, like hollow core fiber, which increases the data transfer speeds by up to 30% by reducing the latency from 5 microseconds per kilometer to 3.46 microseconds per kilometer with data transfers reaching a distance of 340 kilometers when tested by the Optoelectronics Research Centre at the University of Southampton. Similarly, Dense Wavelength Division Multiplexing (DWDM) improves network efficiency by transmitting as many as 192 data channels simultaneously, with every channel carrying up to 100 Gbps. This is equivalent to a total capacity of 19.2 terabits per second per fiber per pair. Advanced technologies such as bend-insensitive fiber are designed to maintain the integrity of the signal even if the fiber is bent or twisted. Government initiatives towards enhancing broadband deployment, particularly in underserved regions, have further boosted growth. For instance, the US government has allocated US\$ 65 billion through the Bipartisan



Infrastructure Law, with plans to lay more than 12,000 miles of optical fiber infrastructure to improve broadband access and capability. Meanwhile, in India, through the BharatNet project, the government aims to connect 2,50,000 gram panchayats and 6,40,000 villages, for which 690,259 km of optical fiber cable have already been laid nationally. Emerging applications such as quantum communication networks also benefit from advancing fiber optics. QuNET, a German research initiative with a budget of €125 million, is currently working on a secure quantum communication network with the help of optical fiber, to support future technologies that require faster, more secure, and more efficient data transmission.

In conclusion, optical fiber is poised to change global connectivity, mainly supported by significant financial investments, quick technological evolution, and an increasing requirement for fast data transmission technology. The ongoing significant advancements will likely define global connectivity's future, paving the way for better communication infrastructure.

#### **Influencing Factors:**

- ▲ Lossless transmission of data over long distances
- ▲ Advancements in telecommunication technologies like 5G
- ▲ Government initiatives towards connecting rural parts of a country
- ▼ The cost of installation and maintenance of optical fiber cables is too high
- ▼ Retail adoption of satellite communication hampers the demand for optical fiber

### **DOMAIN 4: NETWORKS**

This domain includes parameters that form communication networks.

#### **LPWAN**

The global market for LPWAN (Low Power Wide Area Networks) is around US\$ 14.31 Billion for the year 2023, where the connectivity in IoT (Internet of Things) has almost doubled to 1.33 billion in 2023 from 698 million in 2022, which is around 8% of the overall IoT industry. The surge in LPWAN is due to the adoption of Industry 4.0, smart agriculture, smart metering and monitoring, and smart bin practices for its low power consumption all over the globe, leading telecom operators to commercialize LPWAN.

Among the LPWANs, LoRaWAN (Low Range WAN) dominates the Indian market because of the initiatives of Tata Communications and SenRa, which implemented LoRaWAN in multiple cities in support of the Government's mission of expanding IoT

connectivity. LPWAN consumes low power through narrowband modulation, infrequent data transmission, and low-duty cycles, which minimize energy usage during communication. However, it has low data throughput due to its focus on long-range, low-power communication with narrowband modulation and small data packets. Unlike the rest of the world, China led a massive adoption of NB-IoT (Narrowband IoT) across multiple use cases as part of its 'Big Connectivity' strategy. However, some industries are exploring collaboration and cooperation within LPWANs to create a competitive edge. Somtech and Unabiz companies integrated Sigfox and LoRa platforms to provide end-to-end connectivity. Moreover, the IoT connections through Low Earth Orbit (LEO) have been explored and implemented by Spain-based agency Telefonica and DT.

Though the LPWAN ecosystem is maturing, wherein power consumption and data-rate trade-offs still exist, rapid innovations such as edge computing, dynamic data-rate adoption, and improved security features make LPWANs versatile, dynamic, and robust. Integrating LPWANs with satellite and hybrid-connectivity models can proliferate advancements and research. It possesses the potential to revolutionize the IoT industry, which is continuously growing. As LPWANs evolve, industries will rely more on LPWANs tapping their hidden potential by solving security concerns, standardization, and dynamic needs.

#### **Influencing Factor:**

- ▲ IoT expansion leads to further proliferation of LPWAN
- ▲ Low power is consumed for data transmission
- ▲ Smart monitoring of assets is possible, leading to increased efficiency
- ▲ Edge compute, and hybrid connectivity options will help further the adoption
- ▼ Low data throughput and information security concerns
- ▼ The LPWAN ecosystem is still in a maturing stage
- ▼ Power Consumption-data rate trade-off exists

### **RADIO ACCESS NETWORK**

The market size for Radio Access Network (RAN) increased from US\$ 12.46 billion in 2022 to US\$ 12.58 billion in 2023, with the emergence of the Open RAN presenting a significant market opportunity. The largest global market share of 5G RAN is held by the Asia Pacific region, with the highest share of 37% due to the aggressive rollout of 5G infrastructure by the plethora of service providers in the region.

The ongoing large-scale deployment of 5G calls for the industry to consider widening the 5G OEM ecosystem. The number of RAN providers is increasing globally

with the continuous implementation of Open RAN. Nippon Electric Company (NEC) has developed a RAN autonomous optimization technology, which is based on UEI status to effectively manage 5G Radio Access Networks and enhances the QoS for applications such as remote robots and vehicle control. In 2023, Bharat 6G of India allied with US-based NextG as a part of the Telecommunications Industry Solutions alliance that stimulated further collaboration in Open RAN and research related to 5G and 6G technologies between these two countries. However, the overall revenue in the RAN market has declined notably starting from the first quarter of 2023, mainly due to the unfavorable macroeconomic environment in the major countries and resistance from the telcos to shift to new network architectures. Regarding constraints for Open RAN, most operators believe that integration and complexity are the main threats. Vendors such as Ericsson, claim that Open RAN is more expensive than conventional RAN equipment.

The future development of RAN is closely aligned with the overall expansion in the telecommunications industry. As the 5G rollout and transition to 6G continues, RAN will continue to be important not only from an innovation perspective but also from an investment perspective. Initiatives led by the government, such as the release of C-DOT's Open RAN testbed, are directing innovation towards the growth of a vibrant Open RAN ecosystem within India.

#### **Influencing Factors:**

- ▲ Adoption of Open RAN
- ▲ Ascent of 5G and transition to 6G
- ▲ Government initiatives such as the release of C-DOT's Open RAN
- ▼ Unfavorable macroeconomic conditions in major economies
- ▼ Integration and complexity of infrastructure

### **DOMAIN 5: GOVERNMENT INITIATIVES**

#### **GOVERNMENT INCENTIVES**

The government has allocated ₹ 1,11,915 crore for the telecom sector in the recent budget, which is 14% more than the previous budget, which was around ₹ 97,579 crore. Out of the allocated budget, 79% has been allocated to revive Bharat Sanchar Nigam Limited (BSNL) and Mahanagar Telephone Nigam Limited (MTNL) to enhance the telecom infrastructure. Other important schemes launched by the government are Production Linked Incentives and Bharatnet, which the rural people of India can avail.

The Department of Telecom (DoT) had designated ₹ 82,916 crore for capital infusion into BSNL in the year

2024-25, which had gone up by about 28% from ₹ 64,787 crore for the last fiscal. PLI scheme had attracted investment of ₹ 3,401 crore in domestic manufacturing, with the central government taking steps to cut down the import of critical components such as chips. To drive the innovations in 6G, the Indian government allies with 6G IA of Europe and Oulu University, Finland. The government has also introduced the Centralized International Out Roamer (CIOR) system. CIOR system is the centralized international out-roamer to curb spoofed incoming international calls. Moreover, the Bharatnet project focused on rural broadband connectivity has seen a rise in its budget by up to 70%, increasing up to ₹ 8,500 crore. The government has proposed using AI and face recognition models for the verification of SIMs. The budget also proposed to increase the Customs duty on Printed Circuit Board Assembly (PCBA) of specified telecom equipment from 10% to 15% for promoting domestic manufacturing. It further reduced the Basic Custom Duty on mobile phones, mobile PCBA, and mobile chargers to 15%.

Three years ago, the government announced the Telecom PLI scheme, and the scheme attracted an investment of ₹ 3,400 crore. This has led to the telecom equipment production has exceeded in excess of ₹ 50,000 crore with exports totaling approximately ₹ 10,500 crore, creating more than 17,800 direct jobs and many more indirect jobs. This initiative aims to enhance the competitiveness of India's telecom manufacturing industry, promoting local production and reducing import dependency.

Despite the initiatives introduced by the government, the sector still needs some reforms. The Foreign Direct Investment (FDI) has dipped to US\$ 282 million from US\$ 713 million last year. At the same time, BSNL's asset monetization has added up only to ₹ 189 crore against a target of ₹ 20,200 crore. In this regard, the government has focused on infrastructure development, increasing domestic manufacturing, and technology innovation, thus keeping the telecom sector well-positioned towards a significant contribution to India's economic growth.

#### **Influencing Factors:**

- ▲ Increased government investment in the telecom sector - 14% more than the year 2023
- ▲ Focus on boosting domestic manufacturing capabilities - Schemes like PLI
- ▲ Strengthened efforts to improve rural connectivity - Bharatnet
- ▲ Higher capital infusion to support telecom infrastructure. - Investment in BSNL and MTNL
- ▼ Subdued FDI inflows due to geo-political tensions and global economic downturn

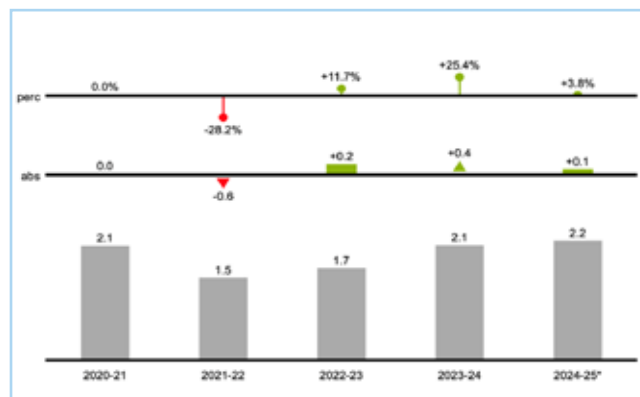
## PRÉVISION OUTLOOK

- The DAS market is on the rise because of the increasing demand for 5G and satellite technology, which are working together to improve connectivity
- India is broadening digital access in rural areas with more networks and government initiatives, giving a boost to IoT
- LPWAN tech is advancing as China focuses on NB-IoT and satellites, while LoRaWAN strengthens IoT in India
- The RAN market is growing with 5G expansion, supported by India and the US collaborating on future technology
- Smart poles are spreading quickly across Asia, with exciting projects like Virgin Media O2's pilot in the UK
- The VSAT market is expanding as new satellite tech offers faster, more robust internet for remote areas
- Telecom providers are sharing infrastructure more often, cutting costs and helping improve mobile speeds
- India's data centers are expanding fast, drawing global investment because of AI advancements and new data cables
- Fiber optics are making data faster, and BharatNet is pushing for wider connectivity across India
- The Indian government is increasing its telecom infrastructure investments, even as foreign direct investment has recently slowed

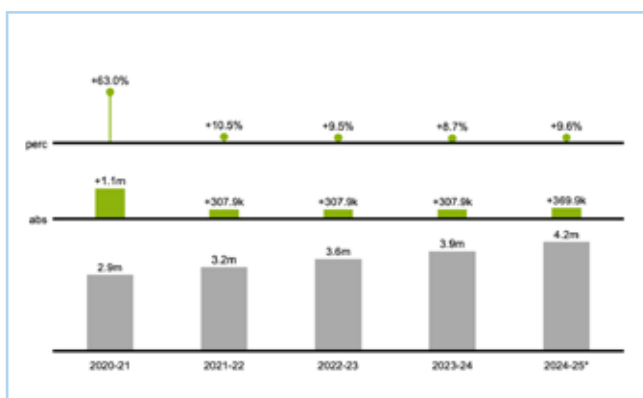
### Number of Towers (India)



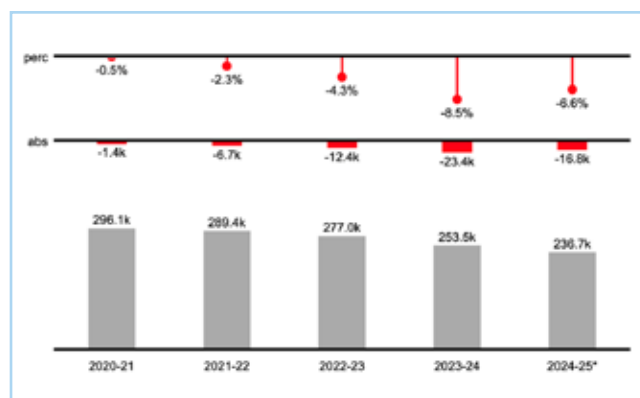
### Average Tenancy (India)



### Optical Fiber Cable Route Kilometer (India)



### VSAT Subscribers (India)



■ Increase  
■ Decrease

# BROADBAND

## Student Team

Lisha Purbey | Soniya Mansukh | Varun Ganjoo | Skanda Kesarkar | Ankush Sen | Hitesh Raiwal

## SNAPSHOT

- ▶ The total number of broadband subscribers in India saw a significant rise, from 861.74 million in 2023 to 935.13 million in 2024, an annual increase of approximately 8.55%
- ▶ In Q1 2024, global spending on cloud infrastructure reached US\$ 76.5 billion, marking a 21% year-on-year increase and leading to a gain of US\$ 13.5 billion compared to 2023
- ▶ The mobile broadband market witnessed a CAGR of 6.3%, growing from US\$ 649.26 billion in 2023 to US\$ 689.72 billion in 2024
- ▶ India's fiber subscriber base increased by more than 23%, from 28.56 million in March 2023 to 35.1 million in March 2024
- ▶ The worldwide 5G-FWA market grew at a robust 39.92% CAGR, from US\$ 32.74 billion in 2023 to US\$ 45.81 billion in 2024
- ▶ To combat spam and telecom-related fraud, TRAI held discussions with the Ministry of Home Affairs, DoT, and JCoR to combat spam and telecom-related fraud with an emphasis on improving the DCA system and preventing bad links
- ▶ The worldwide market for satellite broadband, valued at US\$ 4.0 billion in 2023, has grown to US\$ 5.3 billion by 2024
- ▶ In 2023, the global market for unified communications was valued at US\$ 69.16 billion, and by 2024, it had grown to US\$ 77.044 billion

## DOMAIN 1: CLOUD TECHNOLOGIES

This domain includes parameters for Cloud services.

### CLOUD SERVICES

Cloud infrastructure's global spending increased by 21% year on year (YoY) in Q1 2024 to US\$ 76.5 billion, representing a US\$ 13.5 billion gain. Total revenue of US\$ 3.8 billion has been generated for the Indian public cloud services (PCS) market, comprising Platform-

as-a-service (PaaS), Software-as-a-service (SaaS), and Infrastructure-as-a-service (IaaS) for the 1st half of 2023.

According to the Cloud Security Alliance report, 98% of organizations globally rely on cloud services, encompassing everything from SaaS solutions to fully cloud-native infrastructures. India has started adopting new technologies such as blockchain and artificial intelligence-powered chatbots. The adoption of Cloud-based Data analytics, machine learning, and the Internet of Things (IoT) presents cloud providers with new

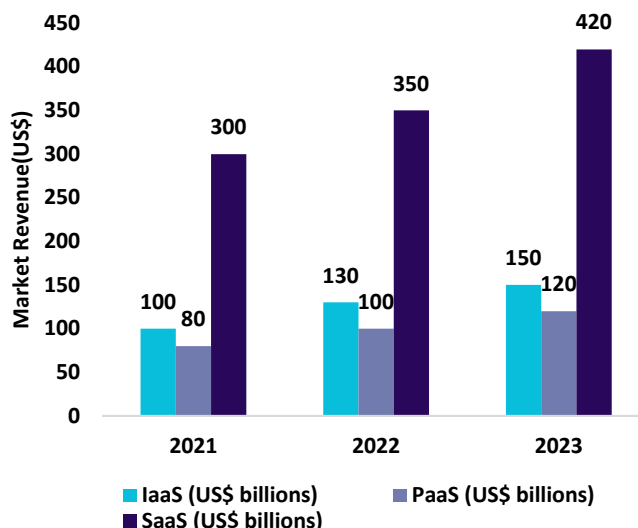
growth opportunities in the Indian cloud-computing industry. In spite of the fact that India generates 20% of global data, its contribution to data center capacity stands at a meager 3%. The integration of technologies such as 5G, IoT, and AI is expected to drive a substantial surge in data demand, potentially leading to a threefold increase in data consumption across India. Driven by technology adoption, India's data center sector is witnessing significant growth. The sector is projected to see an investment influx of approximately ₹ 50,000 crore over the next three years, aiming to double the network capacity to nearly 2,000 MW. Some of the most popular cloud Computing Trends to be followed in 2024 are PaaS, The Rise of Hybrid and Multi-Cloud Strategies, Serverless Databases, and Green Cloud Computing. Due to diffusion and subsequent sales of IoT devices, there has been a corresponding hike in the demand for Everything-as-a-Service (XaaS) solutions to administer the data they generate. In India, the XaaS economy is looking to shift the customer from a high capex model to a more predictable opex model. Microsoft Azure, Amazon Web Services (AWS), and Google Cloud (GCP), the top three cloud service providers, increased by 24% in total and accounted for 66% of all spending. AWS has become a prominent cloud service provider in India. It provides strong infrastructure and a wide range of services, and thus, AWS has become the best choice for companies. In 2023, Amazon Web Services (AWS) revealed its plan to invest ₹ 1,05,600 crores (equivalent to US\$12.7 billion) into India's cloud infrastructure by 2030 to support the increasing demand for cloud services in the country.

As organisations continue to realise the benefits of cloud computing, the market is growing by providing advanced features like flexibility, efficiency, and Strategic value and driving innovation across industries. High availability and reliability are major issues in cloud ecosystems. Businesses must seek extra resources to meet the demands, and sensitive data of the cloud users is compromised due to hacks.

**Influencing Factors:**

- ▲ Shift by companies from Capex to Opex model
- ▲ Edge Computing integration driven by increased investments in Data centers
- ▲ Increasing adoption of AI/ML across sectors
- ▼ Data Security and Privacy Concerns
- ▼ Unstable internet connectivity in underdeveloped areas

**Worldwide Public Cloud Services Revenue**



Note: SaaS revenue includes both SaaS Application and SaaS System Infrastructure Software

**UNIFIED COMMUNICATIONS**

The Global Unified Communications (UC) market was at US\$ 69.16 billion in 2023. UC unifies real-time and non-real-time features like chat, audio, video, and email into a single interface, allowing for seamless communication across devices. This improves communication and encourages flexible cooperation, enabling organisations in the digital age.

The market of Unified Communication as a service (UCaaS) size was US\$ 32.01 billion worldwide in 2023. Moreover, the Indian UCaaS market generated a revenue of US\$ 2,250.8. Major industry players are actively engaged in the UCaaS market in creating advanced API-driven solutions, aiming to streamline communication. Recently, Avaya announced an association with Zoom's upcoming Artificial Intelligence(AI)-powered Zoom Workplace, integrating it with Avaya's Communication and Collaboration Suite to offer customers a streamlined approach to managing communications environments. Additionally, RingCentral announced new variations for its AI-powered contact center solution, RingCX, including real-time AI assistants, AI-based training insights, and a customizable framework for integrating Intelligent Virtual Agents. Furthermore, key players like 8x8 Inc. and Twilio are expanding their capabilities by including Contact Centre as a Service(CCaaS) and Communication Platform as a Service(CPaaS). Adopting Unified Communications streamlines communication but poses challenges when integrating with existing systems. During this year's Enterprise Connect event in the United States of America (USA), the UC security panel, which featured companies such as SecureLogix, Ribbon Communication, and Oracle, highlighted the challenges organizations are encountering due to AI, toll fraud, and the misuse of messaging platforms

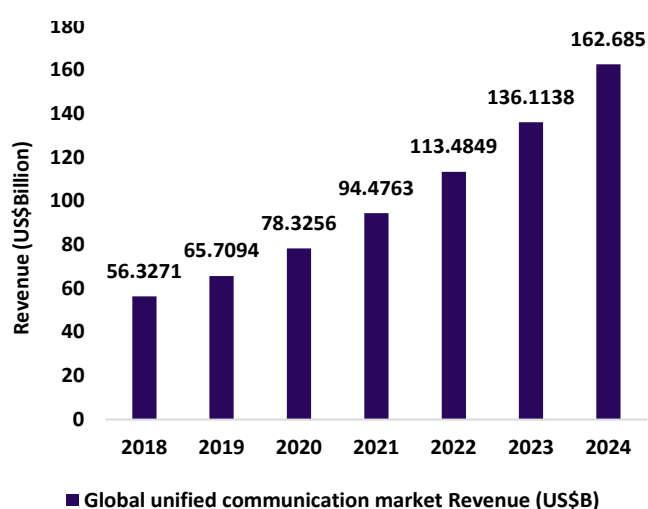
in unified communication systems. To address such challenges, firms like Cisco are adding AI to enhance security, user experience, and seamless integration with existing systems.

UC platforms have championed real-time collaboration, making interactions seamless and instantaneous, and there's a growing trend for asynchronous communication. The landscape of UC is continuously evolving, and the scope for technological advancements like Internet of Things (IoT) integration, 5G-rollout, edge-computing, etc, in UC will shape the future of workplace communication.

### Influencing Factors:

- ▲ Integration of revolutionary technologies like AI, cloud computation, IoT, etc
- ▲ The UC markets are growing rapidly, driving investments
- ▲ Industry collaboration to create advanced API-driven solutions aiming to streamline communication
- ▼ Vulnerability to threats like AI- misuse, toll fraud, etc
- ▼ Integrating UC systems with existing IT infrastructure can be complex and costly

### Global unified communication market revenue



## DOMAIN 2: WIRELESS TECHNOLOGIES

This domain includes parameters for different types of wireless technologies.

### MOBILE BROADBAND

CURRENT STATISTICS FOR CY 2023	PRÉVISION FORECAST FOR CY 2024
Mobile Broadband Subscribers: <b>855.27 million</b>	Expected to reach: <b>928.07 million*</b>

\*Time-Series Analysis

The mobile broadband market is steadily rising, from US\$ 649.26 billion in 2023 to US\$ 689.72 billion in 2024, with growing consumer demand for mobile internet with a compound annual growth rate (CAGR) of 6.3%. In March 2024, the Telecom Regulatory Authority of India (TRAI) reported 914 million mobile broadband subscribers, exceeding the 40 million wired-line subscribers.

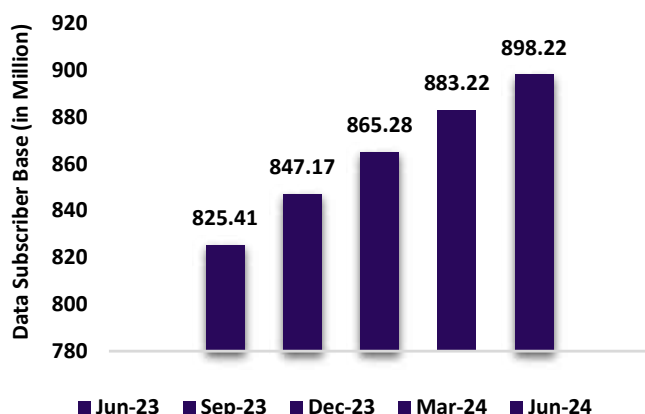
As the mobile-broadband industry continues to evolve, focus on 5G, Internet of Things (IoT), and Fixed Wireless Access (FWA) integration will shape the future of connectivity. As per the chief marketing officer of Huawei, 5G Advanced boasts significant advances in performance and capabilities. Qualcomm is producing chipsets like the Snapdragon X80 that offer peak data rates in download and upload speeds of 10Gbps and 3.5Gbps, respectively, thanks to an advanced Carrier Aggregation mechanism. These innovations enable telcos to offer 5G Advanced compatibility from the get-go to make untested use cases viable to assess. The total number of cellular IoT connections reached 3.4 billion in 2023. According to studies, data flow from cellular IoT connections is expected to increase in the coming years, driven by the growing need for data analysis for operational efficiency and development of new revenue. In 2024, 241 out of 310 communications service providers offer FWA services, a 29% increase from 2023. An Ericsson Report highlights the crescendo of FWA and the need for more 5G Standalone technology deployment.

In India, technological advancements in this industry are developing rapidly but face unique challenges. Initially, with high 5G download speeds, it gradually declined with increased data consumption. Indian telcos have started investing in scaling networks to increase 5G base transceiver stations. Additionally, Airtel focuses on 5G capacity, ceasing 4G investments. 5G-FWA's deployment faces spectrum & infrastructure investment limitations. Moreover, Reliance Jio is scaling FWA services by leveraging its mobile subscriber base, offering 5G standalone access. Ultimately, the mobile broadband industry is poised for significant growth, driven by these technologies despite challenges.

### Influencing Factors:

- ▲ Increased adoption of mobile internet
- ▲ Integration of IoT devices
- ▲ Increased scaling in 5G networks
- ▲ Increased roll-out and availability of 5G-based FWA
- ▼ Increasing adoption of FTTH driven by fibre-roll-out
- ▼ Significant capital investment to maintain infrastructure

### Mobile Broadband Subscriber Base in India



### SATELLITE BROADBAND

The Global market of Satellite Broadband valued at US\$ 4.0 billion in 2023. The key driver is the increased use of satellite services by firefighters, police, and other agencies in developing countries. Additionally, governments of many countries are subsidizing businesses to offer broadband services to rural communities throughout emerging nations, fostering market expansion. The market size of Indian Satellite communication is expected to grow, and satellite broadband will soon be commercially available in India. The lower latency of low earth orbit (LEO) satellites increases the opportunity given by the Indian Government to provide connectivity to unconnected and remote areas. The Indian Government has decided to allocate spectrum through an administrative process for satellite broadband. Post this, the TRAI is expected to provide additional recommendations on the pricing of the spectrum to be given administratively. The Luxembourg-based SES and the Indian-based Reliance Industries Jio platform have teamed to run satellites that provide high-speed satellite internet connectivity. With this joint venture, The Orbit Connect India, they will be competing against businesses such as Amazon and Starlink, that are keen to venture into the Indian market space. Bharti Airtel too has partnered with UK's OneWeb to offer satellite internet services in India. The Indian Government had approved the amendment in the Foreign Direct Investment (FDI) policy for the liberalization of the Indian space sector, and many investors are showing interest in investments made for satellites.

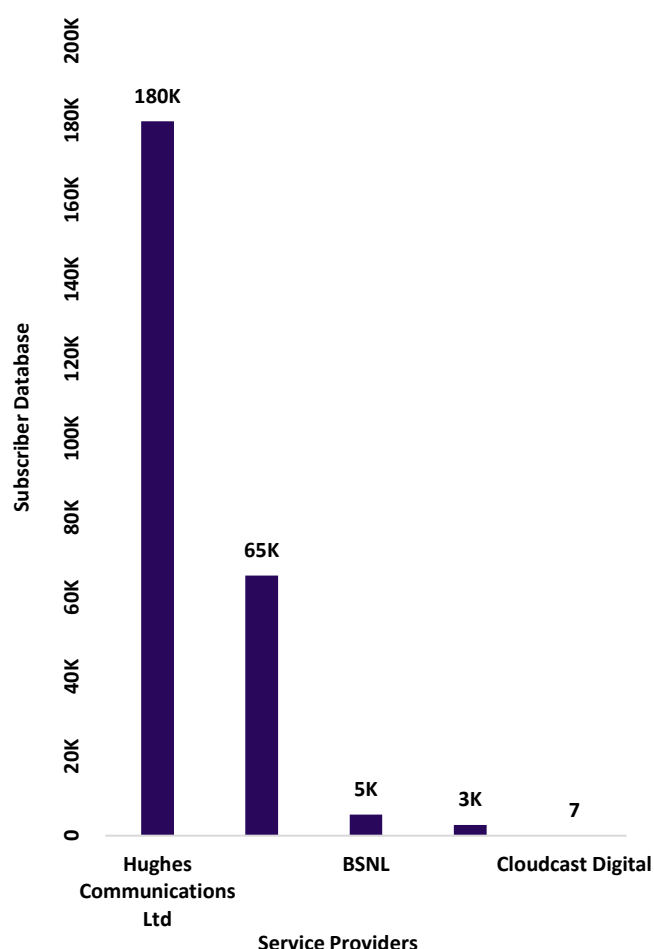
The low height of satellites provides less signal coverage, which results in tracking difficulty and poses a threat to satellite internet expansion in the country. However, Satellite Broadband will be a new dawn for digital India. The preparation for launching satellite internet services by companies like Jio would provide entry to many international and regional operators, triggering innovation and increased customer growth. With the digital revolution taking place, India has the

potential to completely change the environment and establish new standards for the rest of the world.

### Influencing Factors:

- ▲ Allocation of Satellite Airways by the Indian Telecom Bill of 2023
- ▲ Increased use of satellite services by fire, police, and other agencies
- ▲ Lower latency of Low Earth orbit satellites
- ▲ Increased competition driven by the cost of spectrum acquisition
- ▼ Low signal coverage and tracking difficulty

### VSAT Service Providers Subscriber base as on Mar 2024



### FIXED WIRELESS ACCESS

The worldwide 5G fixed wireless access (FWA) market was US\$ 32.74 billion in 2023 with a 39.92% compound annual growth rate (CAGR). Despite India's 82.5% penetration of mobile connections, there is a digital divide. 5G-FWA services for broadband will bridge it, especially in areas that are not covered by FTTH.

The market for FWA is rising globally owing to technological advancements such as Zhong Xing Telecommunication Equipment Corporation's (ZTE)'s



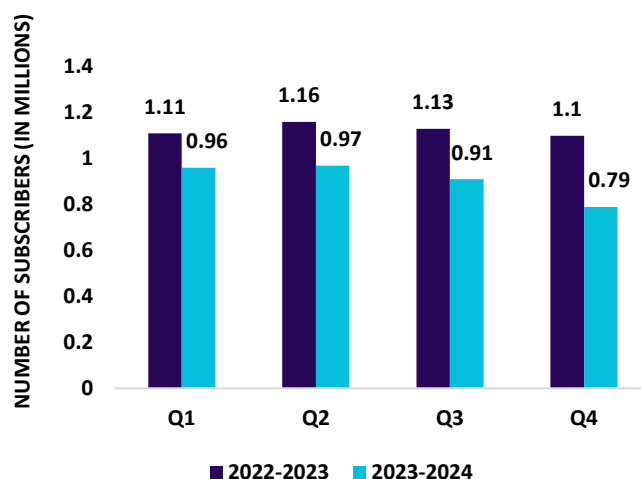
AI-powered customer premise equipment(CPE), improving bandwidth efficiency and reducing congestion, thus driving adoption. Moreover, the Global Mobile Suppliers Association (GSA) report shows that 467 operators in 188 countries worldwide have announced FWA services using Evolution (LTE) or 5G, with 407 operators launching services in 176 countries. India's low broadband penetration offers telcos a chance to expand FWA coverage, enabling cost-effective deployment, service bundling, and Average Revenue Per User (ARPU) growth. With an aim to monetise 5G airwaves and boost data usage, both Bharti Airtel and Reliance Jio have enhanced their efforts to expand their fixed wireless access (FWA) offerings to provide home broadband services. Fibre rollouts are expensive and time-consuming, especially in metros such as Mumbai where RoW (right of way) permissions are awarded at a cost in excess of ₹ 1 crore per kilometer, resulting in longer time to generate returns. A recent press release from Ericsson highlighted a demonstration of 5G-FWA in collaboration with Airtel. The test, conducted using mmWave technology, achieved peak speeds of 4.7 Gbps, showcasing mmWave's potential to meet high network capacity demands. Furthermore, Jio's 5G Standalone Access (SA) with dedicated network-slicing efficiently manages congestion despite AirFiber users consuming 400GB monthly. Airtel is also upgrading to 5G-Standalone for nationwide FWA services without extra costs, as its radio and network infrastructure is already prepared for 5G-SA deployment. In contrast, Himachal Futuristic Communications Limited(HFCL) introduced India's first 5G-FWA CPE solution supporting both SA and Non-SA technologies across multiple frequency bands.

Despite significant development in India, 5G-FWA remains a niche technology, with household penetration at 0.5% by 2024. In 2024, Jio and Airtel continue to have a stronghold on market share while Vi and BSNL face critical revival efforts. In conclusion, 5G-FWA will become crucial for closing the digital-divide and making Internet access more accessible. It can also complement the existing FTTH deployments in areas which are non-viable for FTTH roll-out.

**Influencing Factors:**

- ▲ Telcos are upgrading to 5G-SA, thanks to availability CPE for both SA & Non-SA tech
- ▲ Can complement the existing FTTH in areas which are non-viable for FTTH roll-out
- ▼ High frequency bands used in 5G, pose challenges for indoor signal penetration
- ▼ High initial expenditure in deploying the 5G-FWA infrastructure

**FWA Subscribers per Quarter in India (in millions)**



**WI-FI**

As of June 2024, the wireless subscribers base reached 898.92 million from 826.37 million in June 2023, of which the proportion of active users is about 90.65 percent of the total base. The Wireless technology Wi-Fi (Wireless Fidelity) has continued gaining popularity by aiding digital initiatives in domains like education, healthcare, and smart homes with the advent of Internet of Things (IoT) devices etc. Advancements like Wi-fi 6, which is rolling out with 802.11ac, Wi-Fi 7, and Wi-Fi 8 on the horizon, are contributing significantly to this expansion. The public Wi-Fi landscape has grown substantially, with PM-WANI steadily contributing, with 2,07,642 public Wi-Fi hotspots as of June 2024, along with 199 PDOAs and 111 app providers. Additionally, the Bharat Net Project Scheme aims to provide connectivity and Internet access to almost 3.84 lakh villages and about 1.5 crore households, which plays a crucial role in bridging the digital divide. The global enterprise Wireless Local Area Network (WLAN) market has also increased from US\$ 5.19 billion in 2018 to US\$ 7.05 billion by 2023, at a CAGR of 6.4%. Also, Wi-Fi 7 connectivity is standardized, which would function with 320MHz channel bandwidths for highly accelerated Wi-Fi.

The Bharat 6G Vision's goal is also likely to increase 50 million public Wi-Fi hotspots by 2030. Furthermore, BharatNet Phase III also aims to focus on the expansion and strengthening of the present infrastructure built in Phases I and II, in which the Gram Panchayats (GPs) are to be linked based on a ring network of 8 to 10 GP's in the Internet Protocol Multi-Protocol Label Switching (IP-MPLS) network, ensuring robust and resilient network connectivity supporting the digital transformation of India.

**Influencing Factors:**

- ▲ Technological advancements in next-gen Wi-Fi standards (Wi-Fi 6, 7, 8)

- ▲ Rising adoption of network devices
- ▲ Government initiatives like the PM-WANI scheme, Digital India campaign, and BharatNet
- ▼ High cost of backhaul internet connectivity under PM-WANI

### LI-FI

According to the International Market Analysis Research and Consulting (IMARC) Group, the Light Fidelity (Li-Fi) global market is valued at US\$ 686.9 million in 2023. Li-Fi is coming out as a secure communication solution for governments, preventing any eavesdropping and cyber-attacks from radio-based systems like WiFi.

Li-Fi keeps improving as the need for wireless communication grows. At the Mobile World Congress in February 2024, pureLiFi unveiled its Li-Fi product, LINXC Bridge™, enhancing indoor 5G mmWave signal connectivity. This innovation bridges the gap between Li-Fi and 5G, enabling faster, seamless communication. Velmenni, an Indian telecom startup, has been funded by the Ministry of Defence under its Innovations for Defence Excellence (iDEX) initiative to upgrade Li-Fi technology. The funding was done so as to boost wireless communication in the Indian Navy, transmitting data securely with increased speed and decreased latency. Velmenni's Li-Fi technology uses patented modulation and optical design but still requires a direct line of sight to connect. Further research is being done into non-line-of-sight, which could improve the system's reliability and flexibility and allow for signals to work around obstacles. An Ahmedabad-based startup, Nav Wireless Technologies Pvt Ltd, showcased innovative Li-Fi solutions at the India Mobile Congress 2024. These solutions support the BharatNet Phase 3 Project. Apart from this, Nav Wireless Technologies leverages optical wireless technology - Free Space Optical Communication (FSOC) to enhance connectivity in areas where infrastructure is limited.

Li-Fi technology is meeting the growing demand for wireless communication in industries like automobile, aerospace, and banking. However, the big limitation lies in requiring line-of-sight and network coverage through walls. Nonetheless, it offers great potential for secure communication at high speeds.

#### Influencing Factors:

- ▲ Li-Fi enhances data security using visible light, minimising unauthorised access
- ▲ It supports high-speed, low-latency data transfer that boosts performance
- ▲ Investment of Indian Startups in research and development to enhance Li-Fi connectivity
- ▼ Requires line of sight, limiting use when blocked
- ▼ Li-Fi's range is limited as light waves cannot pass through opaque obstacles like walls

## DOMAIN 3: WIRED COMMUNICATION

This domain includes parameters for different wired communications.

### CABLE MODEM

CURRENT STATISTICS FOR CY 2023	PRÉVISION FORECAST FOR CY 2024
Cable TV subscribers: <b>0.685 million</b>	Expected to reach: <b>0.580 million*</b>

*\*Time-Series Analysis*

The global market volume of Cable Modem is valued at US\$ 5.5 billion in 2023. This is due to the surge in the investment in Data-over-Cable Service Interface Specifications (DOCSIS) 4.0, which augmented the Cable Modem Termination System. The use of data-intensive applications like Internet Protocol Television (IPTV), Video on Demand (VoD), and online gaming have also led to a global market volume surge. Meanwhile, the volume of cable modems in the Indian market decreased from 0.68 million in Q4 2023 to 0.66 million in Q1 2024.

The decrease in market volume of Cable Modem during Q1 2024 might be due to the shift to Fiber to the Home (FTTH) and broadband connections. Additionally, the increase in the price of Cable Television tariffs has further contributed to the decline in cable modem subscribers in India. Due to competition from Over-the-top (OTT) platforms and service offerings like Prasar Bharati's free DTH service, Cable TV operators affiliated to the All India Digital Cable Federation have been reluctant to enter into upwardly revised tariff contracts with the broadcasters. As these new tariff plans become operational, both the direct-to-home and Cable TV segments are struggling from customer churn. However, broadcasters are worried that the new Telecom Regulatory Authority of India (TRAI) order on free dish channels can hurt their business. The combined impact of the amendment of TRAI and the draft broadcast regulation bill can potentially be a risk as it might impact the operation which might lead to an increase in the demand for cable modems in India.

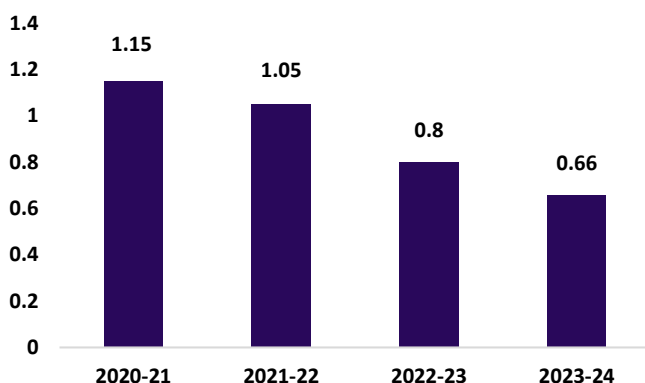
According to market research, the global cable modem market is growing, while it's the opposite for the Indian cable modem market. Factors like the rising demand for FTTH connections and OTT platforms might be the reason for this.

#### Influencing Factors:

- ▲ New TRAI order on free dish channels
- ▲ Cable operators teaming up with OEMs to provide high-speed broadband services
- ▼ Increase in the adoption of mobile broadband

- ▼ Resistance from cable TV subscribers to TRAI's new tariff order
- ▼ Increased competition from OTT Platforms

**Cable Modem Subscribers in India (in millions)**



**DSL**

In India, Digital Subscriber Line (DSL) subscribers have significantly declined from 2.58 million in Q2 2022 to 1.06 million in Q2 2023. Evidently, demand for FTTH (Fiber to the home) connections is on the rise while that of DSL connections is nose-diving. There is a downward trend in Q3 2023; Q3 2023 saw a decline to 1.06 million DSL subscribers.

DSL is declining in North America and Europe. However, the usage of DSL continues to be a dominant force in Asia-Pacific with growing infrastructure and remains a vital technology in Latin America and Africa because of deployment complexities. Providers are working on advancements in DSL technology, including DSL bonding, vectoring, and G.fast, which have significantly improved speed and reliability, achieving near fiber-like performance over copper lines. In India, 86% of fixed-line internet users mainly use fiber, broadband, or DSL lines from their homes. It was reported that 34% of the users with fiber, DSL, fixed-line, or broadband had experienced more than two issues with their connection every month.

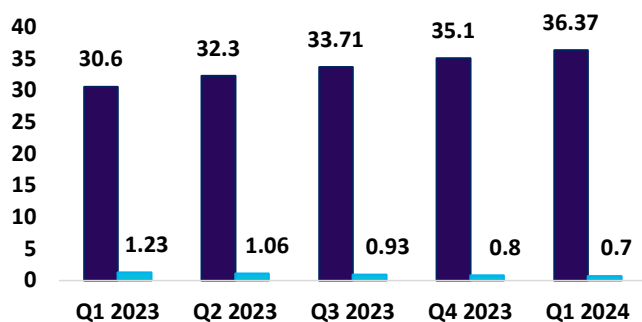
The global DSL chipsets market size from 2022 was estimated at US\$ 343.7 million. One of the major declines for DSL is the BharatNet Project, connecting Gram Panchayats with OFC. While DSL speeds reach 100 Mbps, cable and fiber attain a speed higher than 1 Gbps and above 1 Gbps, respectively. Fiber has more reliability with lower latency than DSL or Cable, hitting performance in high-demand activities. Fiber Optic Networks, 5G Wireless Networks, Cable Internet Connectivity and Broadband Satellite Connectivity are predicted to take over DSL in future.

**Influencing Factors:**

- ▲ Cost-efficient option in areas that retain PSTN telephones

- ▲ Cost-efficient option in areas that are currently not covered by FTTX
- ▼ Shift towards fiber optic and wireless broadband.
- ▼ Connection disruptions and speeds lower than promised
- ▼ Advanced connections, such as cables and fiber, replace legacy broadband technologies like DSL

**DSL and Fiber Subscribers in India (in millions)**



■ Fiber Subscribers (In millions) ■ DSL Subscribers (In millions)

**DOMAIN 4: FIBRE NETWORK**

This domain includes parameters for different Fibre networks.

**FTTX**

CURRENT STATISTICS FOR CY 2023	PRÉVISION FORECAST FOR CY 2024
Fiber subscribers: 32.92 million	Expected to reach: 38.08 million*

*\*Time-Series Analysis*

India's Fiber subscriber base grew by over 23%, from 28.56 million in March 2023 to 35.1 million in March 2024. There is a need for higher bandwidth thanks to the increased use of data-intensive applications. The Department of Telecommunication (DoT) introduced a recognition program for Internet service providers to increase digital inclusion and last-mile connectivity to rural areas.

Fiber-to-the-X (FTTx) adoption is being driven by the growing use of Platform-as-a-Service (PaaS) and Software-as-a-Service (SaaS), but high costs and long deployment times have hindered widespread FTTx rollouts. For this, operators can explore alternative business models like build-your-own-infrastructure, and build-operate-transfer (BOT) or services like Fiber-to-the-node (FTTN). Indian Cabinet has approved ₹ 1.39 lakh crore spending under the project BharatNet for last-mile connectivity to 6.4 lakh villages across the country. By April 2024, Bharat Sanchar Nigam Limited (BSNL) delivered 38.93 lakh Fiber-to-the-Home

(FTTH) connections, also extending services to Gram Panchayats through the involvement of nearly 6,000 BharatNet Udhaymi (BNUs). RailTel's optical fiber cable network spans over 21,000 km, connecting over 6,108 stations for local cable operators to offer FTTH services to home broadband networks.

India stands 13th in the world in terms of total number of data centers, with 138 currently in operation. 45 more are on the way, according to the Indian Ministry of Electronic & Information Technology (MeitY). The need for more data centers coupled with the need for data localisation is expected to drive further expansion of the fibre network to tier-2 and 3 cities and towns. Another driver for adoption of FTTH is the rapid expansion of the e-commerce industry and increased spending and viewership of OTT platforms.

As per Point Topic, India's fiber broadband subscriber base is set to grow rapidly as the country aims to become a leading digital society. Even though India is currently ranked 60th out of 134 economies in the Network Readiness Index 2022, the growth potential is significant, improving its global competitiveness and creating a more connected and prosperous society. Businesses such as Bharti Airtel, Jio, and BSNL are expanding their fixed and mobile broadband networks, with fiber subscriber growth in India expected to reach a peak in 2025.

**Influencing Factors:**

- ▲ Government initiatives such as BharatNet for rural OFC connectivity
- ▲ Expansion of data centers to tier-2 and 3 cities
- ▲ Increased adoption of FTTH thanks to the adoption of e-commerce and OTT
- ▲ Higher bandwidth requirement: increasing trends of smart cities, SaaS, and PaaS
- ▼ Scaling up of alternate technologies and Fixed Wireless Access (FWA)

**INTERNET TELEPHONY**

CURRENT STATISTICS FOR CY 2023	PRÉVISION FORECAST FOR CY 2024
VOIP minutes of usage: <b>312.74 million</b>	Expected to reach: <b>337.68 million*</b>

*\*Time-Series Analysis*

The global market size of Internet Telephony is valued at US\$ 2.8596 billion in 2023. The total outgoing minutes of usage for Internet Telephony in India reached 93.47 million in Q3 2023, compared to 78.08 million in Q4 2022. Increasing remote work at the global corporate level is opening up new market opportunities in VoIP (Voice over Internet Protocol) services, particularly for international calls.

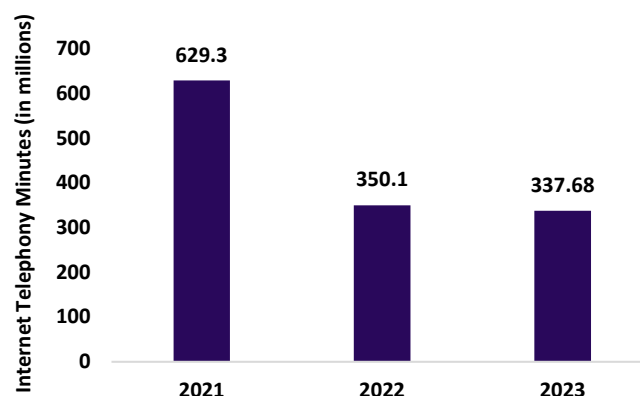
Recent VoIP trends integrate AI Powered tools such as Dialpad GPT (Generative Pre-trained Transformer) to streamline a more communicative task and deliver more real-time insights to a call. UCaaS (Unified Communications as a Service) platforms like Vonage and RingCentral enhance collaboration via instant messaging and video conferencing. The most effective Internet Telephony solutions are cloud-hosted. RingCentral has been able to utilize VoIP integration that enables cloud-based PBX (Private Branch Exchange) technology, providing the ability to provide flexible internet-based call management through mobile and desktop apps for the streamlining of communications. Ooma has evolved to help VoIP become better with innovations such as virtual receptionists, mobile apps, and CRM integrations using integration of cloud-based systems for home offices and small businesses. Verizon's 5G VoIP supports both network slicing and adaptive EVS codecs to facilitate optimal resource allocation and real-time dynamic voice adjustments which enhance call reliability, reduce latency, and guarantee good communication quality even at the periods of highest usage on the network.

Advancements in VoIP enhance cost efficiency, significantly reduce communications costs, improve mobility through remote work, and provide strengthening security with increased encryption of business operations and IT infrastructure. With the progressive liberalisation of the telecom sector, it would not be far off to think about VoIP to be the basic modality in voice and data communication.

**Influencing Factors:**

- ▲ Rapid shift from plain old telephone service to VoIP services
- ▲ Rising penetration of 5G
- ▲ Increasing popularity of video calling and conferencing
- ▼ Customer reluctance to switch providers

**Internet Telephony Minutes (in millions)**



## VPN

The global Virtual Private Networks (VPN) market is valued at 50.9 billion US\$ in 2023, comprising 5.3 billion internet users. Out of this, 1.6 billion people use VPNs, representing 31% of all internet users.

Recently, India, with a VPN user base of 45 million, surpassed Indonesia, with the highest VPN user base of 42 million. The rapid increase of internet users in India has given way to an increased usage of VPNs and factors like the adoption of zero-trust security models, advocacy for privacy rights, and the sustained prevalence of hybrid work arrangements. Around 50% of VPN users use VPN only to access restricted entertainment channels. In a 2023 survey by Zscaler, 45% of those surveyed said their organisation had experienced at least one VPN attack. Certified Information System Auditor (CISA) released several advisories about VPN vendors from mid-January to mid-March 2024 after hackers targeted 1700 organisations. All this gave rise to Zero Trust Network Access (ZTNA) solutions service. Google One discontinues its VPN service within the Google one due to low usage. NordVPN removed its India servers after the Computer Emergency Response Team (CERT) law, which requires them to store user information for up to five years. It now offers virtual servers in India.

The availability and usage of VPNs continue to rise; this depends entirely on consumers' online activity, the restriction by the country's governing body, and the geopolitical tensions that may spike and ban VPN services. About half of all users prefer using free VPNs over paid options. VPNs are now more commonly used for personal reasons rather than business purposes. 77% of VPN users utilise VPNs for personal use, while 50% use them for business purposes.

### Influencing Factors:

- ▲ Rise in cyberattacks, increasing demand for better privacy tools
- ▲ More free and low-cost VPN options
- ▼ Government regulations, restrictions on the use of VPNs, and geopolitical situations
- ▼ Prompting a shift towards alternative security solutions like ZTNA

## TRAI REGULATIONS

To combat spam calls and messages rampant throughout the country, The Authority of India that regulates Telecom (TRAI) conducted a meeting between the Joint Committee of Regulators (JCoR), The Ministry of Home Affairs (MHA), and The Department of Telecom (DoT) at its headquarters. The new regulation plans to address key issues like fraudulent activities that happen

through malicious links, leveraging the DCA system established by the Telecom Service Provider (TSP), and enhancing information exchange among regulators to control frauds using telecom sources.

Earlier this year the TRAI notified about the Registration of Consumer Organizations (Amendment) Regulations of 2024. In this act, according to the comments of the stakeholders, the authority has decided to register consumer organisations in Multiple states/Union territories without disturbing the current ecosystem. This would provide more exposure to the consumer organisations which are having a presence in different segments of society and would help them operate even at the national level. The Indian Government plans to authorise spectrum in the 95 GHz to 3 THz band range. This would support experimentation, indoor-outdoor testing, Research and Development, and the introduction of next-generation wireless technology. The TRAI has granted a one-month extension to operators who provide access, ensuring that the data containing URLs and links of OTT and APKs, that are not on the allowlist will no longer be permitted as of October 1, 2024. This step will help reduce the misuse of title and content templates, resulting in a more secure telecom environment. In April 2024, the TRAI recommended a Framework recommended for encouraging innovative technologies, services, use cases, and business models through a regulatory sandbox (RS) in the digital communication sector. This was envisaged in the Telecommunication Law 2023 and aims to facilitate a live testing environment where new products, services, processes, and business models. Another significant policy initiative of the DoT was to accept the TRAI recommendation of allocating satellite spectrum through the administrative process and not through auction.

A tariff order of 2024 (70th Amendment) was released by the TRAI under which the authority has highlighted the necessity to justify the cost of broadband connectivity to PDOs to speed up the expansion of the PM-WANI scheme.

### Influencing Factors:

- ▲ Regulations would help in exchanging information while decreasing fraudulent activities
- ▲ Reduce the misuse of templates resulting in a more secure telecom environment
- ▲ Need for the facilitative environment for testing new technologies, business models, etc
- ▲ New Exposure to consumer organisations, which would provide them with more exposure
- ▲ Need for support for the introduction of satellite-based internet services

## RURAL BROADBAND

According to the report released at the India Digital Summit 2024 by the Internet and Mobile Association of India (IMAI) in partnership with Kantar, a digital and analytics company, internet penetration in India grew by a modest 8% yearly. Rural India is predominant, constituting over 53% or 442 million of the total user base. India's overall teledensity is 85.64%, with the rural market currently at 58.92%, showcasing significant growth potential.

Broadband subscribers grew by 9.15% over the last year by adding 7.70 million new subscribers, further segregating rural broadband growth, which is the highest at 12.5%, while urban broadband growth is 6.8%. This resulted from dedicated digital initiatives in rural areas through government schemes like BharatNet, Digital Bharat Nidhi, Centre for Broadband Proliferation in Rural Areas (CBBPiR), etc. According to the Ministry of Communication, 95.15% of villages have 3G/4G mobile connectivity. The revised BharatNet Program is set to connect fiber connections to 42,000 uncovered Gram Panchayats and 1.5 crore rural homes. Rural Indian users constitute over 50% of the user base for digital entertainment services like social media, OTT, audio/video streaming, online shopping, etc. MoU signed among Open Network for Digital Commerce (ONDC), Universal Service Obligation Fund (USOF), and Prasar Bharati: Advancing digital empowerment for rural India by combining broadband services with OTT and e-commerce platforms. India aims to boost home broadband penetration from 13% to 80%, focusing on rural areas, with an investment of over Rs 4.2 trillion through public-private partnerships (PPP).

The new network planning tool by IIT Bombay has helped the BharatNet Scheme seamlessly integrate wireless and satellite links to connect rural areas in India. The satellite internet connectivity project in rural India is a transformative step seeking to bridge the digital divide in the country. This digital transformation is actively reshaping rural India and playing a significant role in the country's overall digital ecosystem.

### Influencing Factors:

- ▲ Government schemes like BharatNet, Digital Bharat Nidhi significantly boost rural broadband growth
- ▲ Evolution of satellite internet solutions
- ▲ Digital entertainment services have experienced an increase in user base
- ▼ Need for enhancing infrastructure in remote areas to ensure consistent connectivity

## SUBSCRIBER BASE

CURRENT STATISTICS FOR CY 2023	PRÉVISION FORECAST FOR CY 2024
Fixed Line Broadband subscribers: <b>37.87 million</b>	Expected to reach: <b>44.41 million*</b>

*\*Time-Series Analysis*

There is a substantial change in the total number of broadband subscribers, which increased from 861.74 million in 2023 to 935.13 million by the end of May 2024, growing approximately 8.55% yearly. This accounts for about 64.93% of India's population of 1.44 billion.

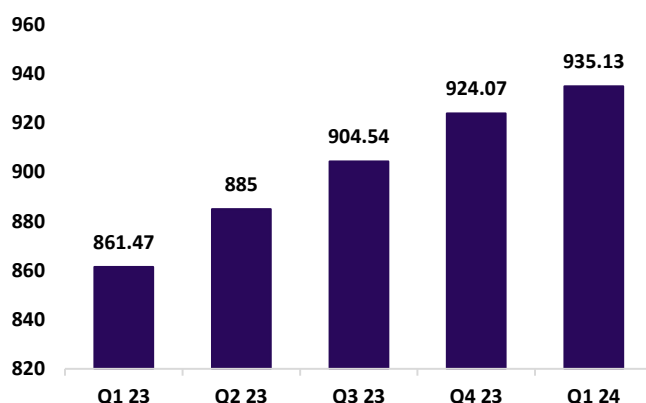
As per the report by Mobile India Tariff Bit Index (MBiT), the compounded annual growth rate of mobile data traffic in India saw a rise of 26% in the past five years, reaching 17.4 exabytes per month in 2023. Over the same period, the mobile broadband subscriber base has doubled from 345 million to 765 million, which is enhanced by the availability, affordability, and value-adding capabilities of fiber-to-the-home (FTTH) connections. Additionally, the fast growth of technologies like the Internet of Things (IoT), Over-the-Top (OTT) services, Artificial Intelligence (AI), etc. are set to expand the subscriber base further. In Q1 FY 2024, the Indian Telecom market bought 34 million smartphones, exhibiting a year-on-year (YoY) growth of 11.5%. Reliance Jio continues to dominate the wireless market, with a net increase of 2.68 million new subscribers, expanding its global customer base to a total of 472.42 million. Bharti Airtel also added 752,000 customers, with a total number of 267.57 million subscribers. However, Vodafone Idea and BSNL saw a decline in the subscriptions.

The government's involvement in digital infrastructure is contributing to addressing the urban-rural access and user experience difference through measures like BharatNet, and National Digital Communications Policy, thereby augmenting the subscriber base. Subscriber base demand gets further fuelled due to the integration of new technologies available, such as Fiber to the Premises (FTTP), instead of the traditional old Digital Subscriber Line (DSL). However, challenges such as the high costs of maintaining and deploying infrastructure at larger scales need to be considered in order to keep the technological boom.

### Influencing Factors:

- ▲ Digital Transformation Acceleration (reliance on Internet services)
- ▲ Digital Policies and Initiatives introduced by Government
- ▲ Increase in Fiber optic infrastructure
- ▲ Increase in internet and smartphone penetration
- ▼ Inadequate infrastructure in rural areas hampers service expansion

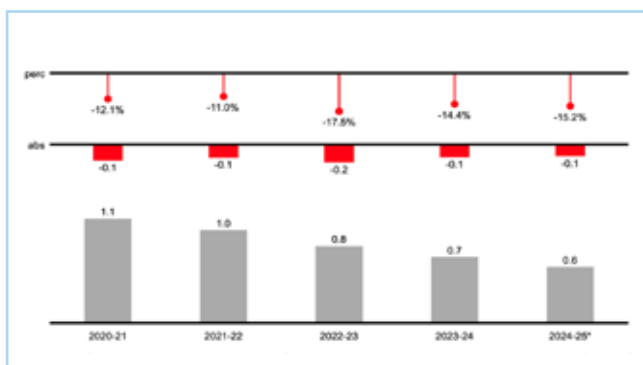
**Total Broadband Subscribers in India  
(in millions)**



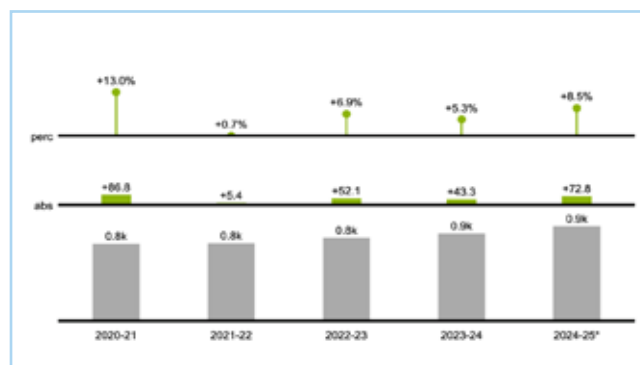
**PRÉVISION OUTLOOK**

- With The PM-WANI and The Bharat-Net Project Scheme, the public Wifi landscape of the country will change substantially, bringing connectivity to remote areas
- With advanced 5G, it is expected that the data flow through cellular IoT connections is expected to increase in the upcoming years
- With the introduction of new tariff plans and with competition from Over-the-top (OTT) platforms and service offerings like Prasar Bharati’s DTH services, the market of cable TV segments is facing a severe customer churn in India
- With the increase in sales of IoT devices, there is a demand in the increase of Everything as Service (XaaS) solutions to customers
- With the increase of Fiber optic, 5G, and Satcom services, DSL technology is decreasing, though there are a few advancements, DSL connectivity to its subscribers does not look promising
- Government Schemes like BharatNet, Digital Bharat Nidhi, Centre for Broadband Proliferation in Rural Areas (CBBPiR), etc, with a target to increase penetration, are providing a boost to the broadband subscribers in the rural sector of the country
- As the global Unified Communications market (UCaaS) grows, many new technological advancements will shape the future of workplace communication

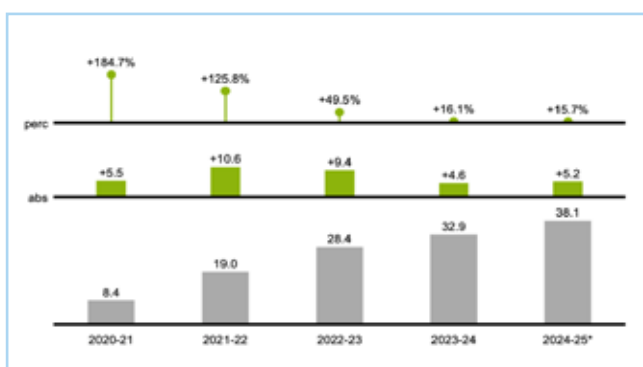
### Cable Modem Subscribers (In millions)



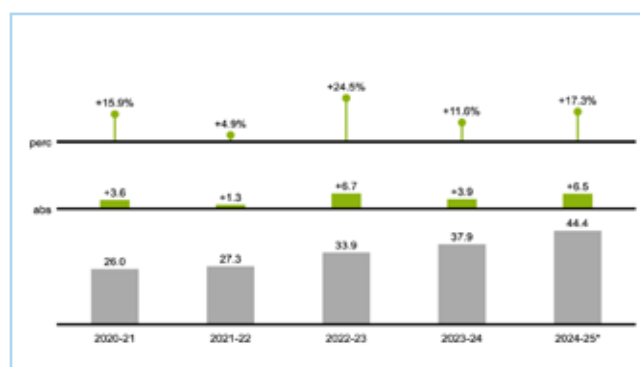
### Mobile Broadband Subscribers (In millions)



### Fibre Subscribers (In millions)



### Fixed Line Broadband Subscribers (In millions)



■ Increase  
■ Decrease



## Student Team

Mansha Bhatia | Krishna Patel | Pushpesh Kumar | Radhika Gupta | Susmit Baidya | Rohan Deshmukh

## SNAPSHOT

- ▶ Australia's telecom industry has been defined and influenced by the NBN project that has supported the growth of broadband connectivity throughout the country, including the regions that are hard to reach
- ▶ France managed to experience a great post-pandemic revenue restoration of retail telecom revenues and remains the leader in Europe's telecom market, with 87% of the population using the internet
- ▶ The Indonesian government and its Bakti Foundation initiative are actively working to improve connectivity in remote regions of Indonesia. They plan to construct 630 base transceiver stations (BTS) in challenging areas by the end of 2024, indicating a commitment to expanding communication networks in underserved regions
- ▶ The Singapore telecom market shows one of the highest penetration rates in the world, indicating a very tech-savvy population with a growing demand for high-speed internet and seamless connectivity
- ▶ The South Korean government has been proactive in ensuring the country's telecom infrastructure remains robust, as a result, South Korea has one of the highest internet speeds globally, coupled with exceptional 4G and 5G coverage
- ▶ Both Etisalat and du, supported by government initiatives like Dubai 10X, are deploying 5G to boost customer connectivity and unlock transformative applications such as IoT, AR, and VR for businesses
- ▶ The U.S. telecom market has expanded rapidly, driven by technological advancements in 5G, cloud-based models, partnerships with streaming services, increased IoT adoption, and rising demand for smart solutions, with notable growth in wireless and broadband subscriptions
- ▶ Switzerland's telecom market, valued at US\$ 5 billion in 2024, is marked by high mobile and broadband penetration, strong 5G and fiber-optic network expansions, and a focus on smart city and digital innovation despite a decline in fixed-line users amid a competitive market
- ▶ Russia's telecom sector, valued at US\$ 21.6 billion, is highly mature, with major players driving high mobile (219.8 million subscribers) and internet penetration (90.4%), significant fiber-optic expansion, and government-backed 5G rollouts set for 2026 to boost digital services across the country
- ▶ Kenya's US\$ 3.2 billion telecom market, led by Safaricom, is marked by high mobile penetration (124.4%), a rise in mobile revenue (up 7.7%), and a preference for prepaid plans, while voice traffic is shifting towards OTT-based alternatives amid a growing ICT investment landscape
- ▶ China's telecom sector, led by state-owned giants, is a global leader with extensive 5G coverage (over 90% of villages), rapid growth in cloud and big data revenues, and widespread 5G integration across industries, supported by millions of 5G base stations and thousands of "5G plus industrial internet" projects

- ▶ Argentina's telecom sector, led by key players Movistar, Claro, and Telecom Argentina, is experiencing growth with high internet penetration (89%), expanding broadband and 5G initiatives, and rising demand for OTT services, though economic challenges impact consumer spending on telecom services

## DOMAIN 1: APAC

The APAC region domain includes countries located in or near the Western Pacific Ocean.

### AUSTRALIA

The nominal GDP of Australia stands at US\$ 1.675 trillion, with a population of 26.2 million. The Australian telecommunications market is a dynamic sector, continuously evolving to meet the demands of a growing, digitally connected society. The telecom market's estimated value is US\$ 22.13 Billion in 2024. With the continuous increase of wireless users due to 5G and National Broadband Network (NBN) networks, Australia is keen on improving the network.

Australian wireless subscriptions totaled 25.31 million by 2023. Australia's telecom industry has been defined and influenced by the NBN project that has supported the growth of broadband connectivity throughout the country, including the regions that are hard to reach. Leading operators such as Telstra, Optus, and Vodafone's deployment of 5G networks has been a key to incubating innovation across services, which serve as the foundation for superior services such as IoT, automation, and smart cities. Daily usage of mobile devices to provide communication and internet services caused the fixed lines to have subscribers of 6.4 million. A survey indicates 96.2% of people using the Internet in 2023, indicating a strong digital environment in the country. However, the decline in fixed-line subscriptions suggests a clear consumer shift toward mobile devices and wireless services for everyday connectivity needs.

Despite these rapid changes the telecom market has been experiencing certain issues in providing an equal service for all regions of the country. The Australian population's extent and distribution highlight the need for resilient, high-performance telecom infrastructure. The government, along with telecom operators, is responsible for reducing the gap between urban and regional areas concerning digital connectivity. Therefore, today, telecommunications in Australia has a high potential to transform and develop along with innovative technologies like 5G, NBN projects and IoT solutions. Hence, the sustained investment in digital infrastructure, together with new service offerings, shall enable the sector to deliver not only to the increasing demand from the consumer but to the consumers in rural and urban areas.

### Influencing Factors:

- ▲ Boosting demand for faster internet and better connectivity services
- ▲ New entrants and consolidation reshaping market dynamics
- ▼ Ongoing Australian Competition and Consumer Commission (ACCC) reviews to ensure regulations are in line with technology advancement
- ▼ Major breaches like the 2022 Optus incident leading to customer dissatisfaction

### CHINA

CURRENT STATISTICS FOR FY 2022-23	PRÉVISION FORECAST FOR FY 2023-24
Wireless Subscribers: <b>1,810,000,000</b>	Expected to reach: <b>1,824,020,000*</b>
Teledensity	Expected to reach: <b>126.9*</b>
Broadband Subscribers: <b>636,306,000</b>	Expected to reach: <b>676,917,800*</b>

*\*Time-series Analysis*

With a population of 1.425 billion and a nominal GDP of US\$ 17.963 trillion, China is the second largest economy of the world. It is also one of the leading players in the telecom industry at the global level. As of 2023, China has 77.5% of internet penetration as a percentage of population. Revenue from the telecom services summed up to US\$ 167.6 billion in the January-August period, rising 2.7% Year-on-Year (YOY). Revenue from domains like Cloud computing and Big data has increased by 12.3% and 61.6%, respectively, compared to 2023.

China's telecom industry grew constantly in the first half of 2024. The Chinese telecom market is dominated by three state-owned companies: China Mobile, China Telecom, and China Unicom. As of 2022, China has built the largest 5G network, and the number of 5G supporting infrastructure like base stations in the country accounted for three-fifths of the global total. China's 5G network covers every city, town, and more than 90% of its villages. 5G technology has been integrated into various sectors, such as power, mining, healthcare, and education, with large-level applications. China has also built a few hundred 5G factories and launched over ten thousand projects to implement "5G plus industrial internet" and more than 3 million 5G base stations.

China is expected to continue 5G development and expansion in cultural and tourism sites, healthcare facilities, universities, transportation hubs, and subway systems. China's role in global trade remains significant, with its vast market attracting foreign investment despite trade frictions with Western nations. The country also focuses on high-quality growth through advancements in technology and green energy sectors, aiming to transition from rapid expansion to sustainable development.

**Influencing Factors:**

- ▲ Promotion in digital transformation of businesses
- ▲ 5G infrastructure support and initiatives
- ▼ High capital investment for setting up infrastructure and projects
- ▼ Isolation and pulling out of investments due to geo-political tensions
- ▼ Rejection of Chinese equipment imports due to national security concerns
- ▼ Telecom growth is hindered by the replacement of foreign chips with domestic alternatives

**INDONESIA**

Indonesia is the world's fourth most populous country and tenth largest economy with a nominal GDP of US\$ 1.319 trillion. There has been rapid growth in the country's telecom sectors over time. As of 2022, the mobile teledensity is at 115 with the mobile subscriber base reaching 352 million in 2023. Broadband subscribers are also rising steadily, with more than 13 million broadband users as of 2023, reflecting a growing demand for high-speed connectivity.

The key players in the country's telecom market are Telkom Indonesia, Indosat Ooredoo, XL Axiata, Smartfren Telecom, and Tri Indonesia. Operators are investing in new services, more 5G deployments, and broadband infrastructure with increasing demand for speed and reliability in internet services. The Indonesian government and its Bakti Foundation initiative is actively working to improve connectivity in remote regions of Indonesia. They plan to construct 630 base transceiver stations (BTS) in challenging areas by the end of 2024, indicating a commitment to expanding communication networks in underserved regions. The broadband network, known as Palapa Ring, has already been completed and is ready to spur more growth in connectivity throughout the country. Operators such as PT XL Axiata Tbk continue increasing coverage through expanding their 4G networks in rural areas in Central Sulawesi. The Over-the-Top (OTT) services, which have mushroomed enormously after COVID-19, are still transforming the telecom landscape. According to Mordor Intelligence, OTT consumption will be over 3.5 billion hours per month in 2025 due to affordable smartphones and enhanced internet access. This shift

towards digital content, entertainment, and services is creating a hard competition between mobile operators and OTT providers and, hence, a vibrant digital ecosystem.

Demand for enterprise digitization and high-speed Internet, however, is expected to fuel further investments in broadband services that are likely to expand the telecom sector over the long run. Overall, Indonesia's telecom market is going to witness steady growth up to 2025 as service providers and the government continue to build infrastructures and connect more of the archipelago.

**Influencing Factors:**

- ▲ Rising enterprise digitization and the need for high-speed connectivity
- ▲ Government initiatives providing a boost to telecom infrastructure
- ▼ Inadequate infrastructure and high costs limit fixed internet access in remote areas
- ▼ Expanding mobile and broadband networks position Indonesia's telecom sector for steady growth in Southeast Asia

**JAPAN**

With a population of approximately 125 million and a nominal GDP of 4.231 trillion, in 2023, Japan's mobile subscriber base grew by approximately 3.8%, increasing from 211 million in 2022 to 219 million. An internet penetration rate of 93.2% indicates a mature and highly connected market. The telecom market was valued at US\$ 130 billion, with major players such as NTT Docomo, KDDI, SoftBank, and the emerging Rakuten Mobile leading industry dynamics.

Following the COVID-19 pandemic, Japan witnessed a steady increase in demand for mobile and internet services, fueling the growth of OTT platforms and cloud services. Significant Capex investments by top providers are underway, with the government planning additional incentives to enhance the 5G ecosystem and further expand connectivity across rural areas by fiscal year 2030. The Ministry of Internal Affairs and Communications (MIC) promotes various initiatives like ICT policy partnerships with the US and Germany on the Internet economy to provide an environment in which the Internet can be used more safely and securely and also move forward in promoting radio waves through R&D in LTE and LTE - Advanced systems, for Intelligent Transport System and mobile services for safe driving and public services in case of a disaster. Although the average annual mobile revenue growth was lower than mobile service subscriptions growth highlighting the structural challenges faced by mobile operators, additionally, efforts were taken to reduce churn through bundling discounts.

Japan's initiative has improved broadband infrastructure, boosting mobile broadband usage and accessibility. Fixed-line subscriptions have declined as the market gravitates toward mobile and wireless solutions. Overall, Japan is well-positioned to maintain its status as a global leader in telecommunications, paving the way for innovations in safe driving, disaster response, and the broader Internet economy.

### Influencing Factors:

- ▲ Recent 5G spectrum grant fostering investment from big players
- ▲ Post-COVID, the surge in mobile and internet use has accelerated growth in OTT platforms and cloud services
- ▲ Cutting-edge innovation integral part of the sector
- ▼ Declining Voice and SMS revenues will result in lower ARPUs
- ▼ A decline in fixed-line subscriptions reflects a market preference for mobile and wireless connectivity options

## SINGAPORE

Singapore has a population of 5.65 million and a nominal GDP of US\$ 467 billion. The telecom industry in Singapore is one of the most mature and competitive markets in the world, building a progressive regulatory environment and a highly competitive market for the nation's residents. Broadband subscribers in Singapore have also shown a slight increase, growing from 1.56 million in 2022 to 1.57 million in 2023, showing the continued demand for faster internet services and IOT applications amid the growing demand for digital services by the masses. Singapore's GDP reached US\$ 501.43 billion in 2023, with 5.7% contributed by the information and communications industry. Economic data also indicates a per capita income of US\$ 84,734, down from US\$ 88,428 in 2022.

This drop can be attributed to rising inflation and lower workforce participation, affecting revenue generated in the sector with consumers electing to tighten their budgets, which in turn has affected the investment by telcos in newer network infrastructure. The Singapore telecom market shows one of the highest penetration rates in the world, indicating a very tech-savvy population with a growing demand for high-speed internet and seamless connectivity. Demand for digital services like streaming platforms, e-commerce, and cloud services has also contributed to the steady growth.

The telecom market in Singapore is dominated by companies like SingTel, Starhub Limited, and M1 Limited, whose investment in robust 5G networks and high internet speeds of over 200 Mbps has led

to wider impact in the economy, supporting various industries like e-commerce, fintech, and digital media. The Singapore government has continued to support the sector's growth with initiatives like the Infocomm Media Development Authority (IMDA) and Singapore Smart Nation initiatives.

### Influencing Factors:

- ▲ Increased demand for broadband due to rising IoT adoption by businesses
- ▲ Rising demand for e-commerce and digital media
- ▼ High levels of inflation
- ▼ Highly competitive sector in a highly regulated landscape

## SOUTH KOREA

South Korea has a nominal GDP of US\$ 1.665 trillion and its population stands at 51.8 million. The South Korean telecommunications market is the third-largest market in the world in terms of revenue, and the three largest fixed and mobile network operators have invested heavily in towers and fiber infrastructure over the past two decades. As of 2023, the country's telecom market, driven by significant investments in 5G and broadband infrastructure, plays a pivotal role in its digital economy. South Korea's telecom sector demonstrates remarkable dynamism, driven by the rapid deployment of advanced mobile networks and a consistent decline in traditional fixed-line services. In 2023, the country's wireless subscriber base reached 83.9 million, reflecting a strong penetration rate and the public's reliance on mobile communication. The South Korean government has been proactive in ensuring the country's telecom infrastructure remains robust, as a result, South Korea has one of the highest internet speeds globally, coupled with exceptional 4G and 5G coverage. Despite its advancements, the South Korean telecom sector faces challenges, including increasing competition among operators, regulatory constraints, and the growing need for cybersecurity.

The launch of 5G services has propelled South Korea to the forefront of the global telecom market. In 2023, the 5G network covered over 97% of the population, providing the foundation for innovation in smart cities, IoT, and high-performance services like augmented and virtual reality. However, challenges such as balancing urban-rural connectivity, addressing cybersecurity risks, and fostering competition in the M2M/IoT space must be managed. With continued investment and innovation, the telecom sector will further support South Korea's ambitions as a global tech leader, ensuring inclusive and high-performance digital access for all citizens.

### Influencing Factors:

- ▲ Heavy 5G and fiber investments boost South Korea's global telecom leadership
- ▲ High broadband penetration drives smart city and IoT advancements
- ▼ Regulatory constraints hinder market growth
- ▼ Cybersecurity risks challenge infrastructure resilience

## DOMAIN 2: AMER

This domain includes countries that are in the AMER region i.e., North, Central, and South American Countries.

### ARGENTINA

CURRENT STATISTICS FOR FY 2022-23	PRÉVISION FORECAST FOR FY 2023-24
Wireless Subscriber: <b>62,700,000</b>	Expected to reach: <b>64,883,220*</b>
Teledensity	Expected to reach: <b>136.30*</b>
Broadband Subscribers: <b>11,500,000</b>	Expected to reach: <b>12,858,692*</b>

*\*Time-series Analysis*

Argentina has a nominal GDP of US\$ 632.8 billion with a population of 45.4 million. The Argentina telecom sector has shown steady growth in recent years. Argentina has one of the highest internet penetrations in Latin America, with over 83 % of its population using the internet. Wireless subscribers had reached 62.7 million in the year 2023. Teledensity stood at 132, with most of the country accessing services. The broadband market experienced growth, with 11 million new subscribers driving a 3.2% increase in annual revenues. Internet penetration was also high: more than 89% of the people used the internet in a country where the sector has come to symbolize importance in Argentina's digital space.

With the changes in the global telecom industry, it will be interesting to see how Argentina adopts 5G. The new 5G technology will be marked by a new path toward connecting with broader coverage, especially in rural areas. The country has also seen the adoption of all digital innovations such as cloud computing, artificial intelligence, and network function virtualization. Argentina's fiber-optic infrastructure build-out - spurred, as this is across much of Latin America, by rising demand for internet access - follows a similar pattern for most of the Latin America region. The growing demand for Over-The-Top (OTT) services and increased data usage is driving the need for better mobile and broadband services. The market is dominated by three major players: Telefonica Argentina (Movistar), America Movil (Claro), and Telecom Argentina. However, the

fluctuating economy affects consumer purchasing power and can lead to reduced spending on telecom services, particularly in lower-income households.

While growth could slow down due to market saturation, 5G will be one of the key drivers and enablers for better mobile internet services and broader connectivity across sectors. Argentina is one of Latin America's smaller but fastest-growing OTT markets. It has the highest internet penetration in Latin America, even while regulatory shifts and market competition demand strategic adaptation for sustained momentum. The market is expected to grow in the coming years, driven by the increasing demand for mobile and broadband services and the convergence of services.

### Influencing Factors:

- ▲ 5G rollout Will expand rural coverage and connectivity
- ▲ Argentina has 88% high internet penetration
- ▼ Teledensity at 132% limits subscriber growth
- ▼ Rising inflation and cost of living can constraint consumer spending on telecom
- ▼ Complex regulations could slow telecom expansion

## UNITED STATES OF AMERICA

CURRENT STATISTICS FOR FY 2022-23	PRÉVISION FORECAST FOR FY 2023-24
Wireless Subscriber: <b>386,000,000</b>	Expected to reach: <b>389,000,000*</b>
Teledensity: <b>116.2</b>	Expected to reach: <b>119.54*</b>
Broadband Subscribers: <b>131,000,000</b>	Expected to reach: <b>129,000,000</b>

*\*Time-series Analysis*

With a population of about 340 million, and USA is the world's largest economy, with a nominal GDP of US\$ 25.463 trillion. The US telecom market has grown manifold in the last few years, both in revenue and subscriber volume. In 2022, the number of wireless subscribers was 372.7 million, for which teledensity stood at 110%, and the number of broadband subscribers was 131 million. Per capita income skyrocketed to US\$ 81,695.2 in 2023. Year over year, there was a mobile cellular subscription growth from 373 million in the year 2022 to 386 million in the year 2023, and fixed broadband subscriptions gradually went up from 128 million to 131 million. All this shows the further expansion of the telecom industry in the U.S. because of increased digital demand and infrastructure development.

Technological advancements have been one of the crucial shaping factors of the U.S. telecom sector. Probably, in the recent past, every other shift that

occurred in the industry was related either to 5G or to the cloud-based business models or, more specifically, to the partnerships between telecom companies and streaming services. The push for 5G services during this period witnessed the sunset of 3G from the markets in 2022, indicating the approach of a significant moment for operators in the telecom space. Added to that, the rising use of IoT and the integration of these technologies across sectors markets accelerated growth. Increasing demand for smart solutions across various sectors like health and manufacturing further prompted investment in the telecom sector.

Hence, growth going forward is majorly propelled by a high smartphone adoption rate, the progress of 5G services, and increasing demand for IoT-based solutions. On the other side, high capital costs and stringent regulation shall continue to pose challenges. The industry, however, is expected to grow steadily as companies in the telco domain adapt themselves to new technologies and extend further service offerings in an increasingly competitive field.

**Influencing Factors:**

- ▲ Increased demand for wireless and broadband connectivity
- ▲ Mutually beneficial partnerships between telcos and streaming companies
- ▼ Expensive 5G and IoT infrastructure investments.
- ▼ Post-COVID rules and restrictions on foreign sourced equipment

**DOMAIN 3: EMEA**

EMEA is the shorthand designation meaning Europe, the Middle East, and Africa. This domain includes countries from the continents of Africa and Europe, as well as the countries that make up the Middle East.

**FRANCE**

CURRENT STATISTICS FOR FY 2022-23	PRÉVISION FORECAST FOR FY 2023-24
Wireless Subscribers: <b>774,000,000</b>	Expected to reach: <b>77,800,000*</b>
Teledensity	Expected to reach: <b>124.79*</b>
Broadband Subscribers: <b>32,300,000</b>	Expected to reach: <b>32,659,484*</b>

*\*Time-series Analysis*

The nominal GDP of France is US\$ 2.783 trillion, and its population stands at 66.28 million. The telecommunications market of France shows growth, which was evident in 2023, with 77.4 million wireless subscribers representing high demand for mobile services in the country. Moreover, the number of

fixed broadband subscribers increased to 32.3 million, which supports France's commitment to extending the internet connection. However, the country's per capita income increased only moderately to US\$ 44,460.8, allowing telecom operators to increase the ARPU.

France's telecom market is growing at a constant rate due to increased demand for broadband, expansion of Fiber to the Home (FTTH), and great government support for 5G. Government initiatives for rural broadband connectivity and smart city projects are driving telecom growth. France managed to experience a great post-pandemic revenue restoration of retail telecom revenues and remains the leader in Europe's telecom market, with 87% of the population using the internet. However, there are some challenges as well, the regulatory control on tariff, spectrum allocation, and data protection can stifle growth and innovation, not to mention highly competitive market conditions.

The French telecom sector is expected to grow higher because of the huge demand for mobile as well as broadband services. The possible threats to point out are the high costs of infrastructure and the market saturation that exists today; however, the potential to increase ARPU with further ongoing investments made to develop, modernize, and bring the market greater adaptability seems a prime motivator for continued growth. The major focus on technology development and service quality should keep France as one of the leaders in the European telecommunication market.

**Influencing Factors:**

- ▲ High demand for mobile and broadband services
- ▲ Strong government support for 5G and FTTH expansion
- ▲ Post-pandemic recovery in retail telecom revenues
- ▼ Stringent regulations concerning tariff, spectrum, and data privacy
- ▼ Environmental concerns requiring sustainable practices

**KENYA**

CURRENT STATISTICS FOR FY 2022-23	PRÉVISION FORECAST FOR FY 2023-24
Wireless Subscribers: <b>66,745,709</b>	Expected to reach: <b>67,214,600*</b>
Teledensity: <b>118</b>	Expected to reach: <b>115.436*</b>
Broadband Subscribers: <b>1,320,000</b>	Expected to reach: <b>1,331,558*</b>

*\*Time-series Analysis*

Kenya has a nominal GDP of US\$ 113 billion and a population of 54.25 million. Kenya's telecom market is worth US\$ 3.2 billion. Mobile revenue and investment in the ICT sector improved by 7.7% to raise US\$ 2.63 billion

and 14 % to realize US\$ 4.56 billion, respectively, as of 2023. In the year 2023, mobile voice traffic increased by 4.1%. Active mobile (SIM) subscriptions increased by 0.6%, from 64.7 million to 66.4 million, compared to the previous year. This resulted in an increase in mobile (SIM) penetration rate by 0.4 percentage points. The total mobile phone devices connected to mobile networks was 62.9 million, penetration rate of 124.4%. 63.5 % and 60.9% are the penetration rates for feature phones and smartphones, respectively.

Prepaid services accounted for the majority share of total mobile subscriptions in 2024, and it is expected to be the dominant service category. In Kenya, there are five large players in the telecom segment, which are Safaricom, Airtel, TelkomKenya, Finserve, and Jamii Telecommunications, where the market leader is Safaricom. It is driven by MNOs offering prepaid plans with value-added benefits at competitive prices, as Kenya is a price-sensitive market. Average monthly mobile voice usage in Kenya is expected to decline in the next few years as there is a growing subscriber preference for OTT-based voice communication alternatives.

There is high competition in the telecom segment with few players, and the market leaders are expected to enjoy higher market share as there is an increasing demand for high business end connectivity and entertainment services through the internet. Despite COVID-19 challenges, Kenya's telecom sector has demonstrated resilience and innovation. Obstacles like the digital divide, affordability issues, regulation, and competition exist, but the industry has also embraced opportunities to diversify into Digital services for fuelling the growth of the telecom sector in the country.

#### **Influencing Factors:**

- ▲ Kenya's strategic plan to provide high quality and reliable service to its citizens
- ▲ Increasing urban population and their demand for 4G and 5G services
- ▼ Practical difficulties in laying telecom infrastructure in rural areas with rugged terrains
- ▼ Slow adaptation of regulatory frameworks to keep pace with technological development

### **NIGERIA**

Nigeria has a nominal GDP of US\$ 477 billion and a population of 223 million. The Nigerian telecommunications market expanded in 2023, with wireless subscribers increasing to 224 million from 222.2 million in 2022. Alongside this growth, Internet penetration also reached 55.4%, showing progress in adopting mobile and internet services. Although the per capita income fell by 25.0%, declining from US\$ 2,162.6 in 2022 to US\$ 1,621.1 in 2023.

Technological progress like the expansion of 4G and the rollout of 5G have notably enhanced Nigeria's telecommunications landscape. This shift enhances connectivity and network capacity, addressing the growing demand for high-speed services needed for IoT and smart cities. The growth of satellite-based broadband services, increased mobile usage, and bonus talk time significantly drove this progress, enhancing connectivity and user engagement across the country. The decline in income can be attributed to several factors, including the depreciation of the naira and rising transportation costs, which increased by 27.2% compared to 25.7%, driven by fuel price hikes. However, declining foreign investments, rising energy costs, inflation, and currency depreciation have slowed the sector's momentum. Additionally, vandalism has led to financial setbacks, diverting resources that could have been used for further telecom expansion. Despite these obstacles, the sector shows resilience and continued potential for growth.

The telecommunication market for Nigeria is expecting a large growth, due to government support towards strengthening the internet and the IoT solution, increasing adoption of smartphones and other digital services that are changing the face of consumers' experiences. Regardless of the challenges faced during the COVID-19 pandemic, RoI On capital expenditure, and market forces shift, the sector has proved remarkably resilient, key in enhancing Nigeria's digital change and economic growth. The telecom sector remains crucial, with opportunities to improve connectivity through evolving technology and growing internet usage.

#### **Influencing Factors:**

- ▲ 5G deployment enhances network performance
- ▲ Expansion of satellite-based broadband and increased mobile usage
- ▲ Increased government investment in telecom infrastructure supports market growth
- ▼ Currency depreciation and rising transportation costs
- ▼ Lower per capita income restricts ARPU growth opportunities for telecom operators

### **RUSSIA**

With a nominal GDP of US\$ 2.240 trillion, The telecom sector in Russia is one of the most mature and competitive markets in the world, serving a total population of 145.45 million, with a total revenue of US\$ 21.6 billion in 2022. Boasting a teledensity of 168.98 in 2021, the percentage of individuals using the Internet has gone up to 90.4% in 2024. The market's stronghold is in the urban cities of Moscow and St. Petersburg, the primary cities and economic hubs, leading the charge, with the major players in the sector being MTS, MegaFon, and Rostelecom – serving 130.4 million internet users overall.

Mobile services have emerged as a frontrunner in the market, with a total subscriber base of 219.8 million. The government has also put efforts in this field, as understood from the announcement by the Russian Ministry of Digital Development of the rollout of 5G networks at domestic base stations commencing in major Russian cities in 2026. The industry has invested heavily in the deployment of fiber-optic lines, which is significantly enhancing broadband penetration. This has enabled the availability of high-speed internet and also paved the way for advanced digital services like cloud storage, IoT-enabled industry processes and smart home surveillance systems. The government's initiative to extend the reach of broadband in outlying areas has given results, with considerable growth in the broadband sector.

The development of 5G services has been hastened by the lack of spectrum. The spectrum range of 3.4 GHz, most commonly used in Europe, has been restricted only for use by the military and intelligence agencies. Despite these limitations, the industry leaders have put forward a joint venture, New Digital Solutions, aimed at developing strategies to deploy 5G using shared networks and assets. Another complication for the market is the exit of network infrastructure vendors like Nokia and Ericsson due to geopolitical constraints. The Vodafone Group has also ended its partnership with MTS, dealing a big blow to the industry.

#### **Influencing Factors:**

- ▲ Increased demand for digital services by the technology-savvy population
- ▲ Technological innovations in smart cities and IoT solutions
- ▼ Recent geopolitical turbulence and sanctions
- ▼ A highly regulated sector with great government scrutiny

### **SWITZERLAND**

With a nominal GDP of US\$ 808 billion and a population of 8.8 million. Switzerland's telecom market, estimated to reach US\$ 5 billion in 2024, stands as a testament to the nation's commitment to innovation and connectivity. With one of the highest mobile and broadband penetration rates in Europe, the Swiss telecom landscape is evolving rapidly, driven by cutting-edge 5G deployments and expanding fiber-optic networks.

Switzerland has a high level of wireless penetration, with over 10.60 million wireless subscribers in 2023. Although there was a slight decline from previous years due to market saturation, the country remains well-connected in terms of mobile services. This can be deciphered by the mobile teledensity rate, which stands at around 120%. But like many other advanced telecom markets, Switzerland has seen a steady decline in fixed-

line subscribers, with numbers dropping to 3 million in 2022. Switzerland has made significant investments in expanding its broadband infrastructure, with 98.4% of the population reported as active internet users as of 2023. The Swiss telecom market is highly competitive, with several operators like Swisscom, Sunrise, and Salt offering a range of services, from mobile and broadband to pay-tv. The country's telecom operators are not just providing connectivity but shaping the future of smart cities and digital innovation.

However, this progress comes at the expense of slower services like DSL and 4G, which are becoming less relevant as 5G takes center stage. While bundled service offerings have bolstered growth in recent years, the market must now embrace OTT services to drive future average revenue per user growth. Switzerland's telecom operators are not only connecting the nation but also leading innovations in IoT, M2M, and smart city initiatives, which will help Switzerland maintain its position as a global digital leader, with 5G, OTT services, and broadband expansion powering the next phase of growth.

#### **Influencing Factors:**

- ▲ Rapid 5G deployment supports IoT, M2M, and smart cities
- ▲ Need for incorporating OTT services to drive ARPU growth
- ▼ Fixed-line subscribers fell, reflecting a shift away from traditional services
- ▼ DSL and 4G are becoming less relevant as 5G dominates

### **UNITED ARAB EMIRATES**

The UAE has a nominal GDP of US\$ 508 billion and a population of 10.3 million. The United Arab Emirates (UAE) telecommunications market maintained its impressive momentum of growth rate in the year 2023, reaching 21.2 million wireless subscribers. The country also had 3.9 million Fixed Broadband Subscribers, which showed a growth of 5.4% compared with the previous year. The percentage of individuals using the Internet in the year 2023 is at 100%. The per capita income of the UAE also reached US\$ 52,976 in 2023. This gives the telecom operators a chance to grow their Average Revenue per User (ARPU) as mobile penetration advances.

The telecommunication sector has grown tremendously by adapting to advanced technologies such as 5G. By the end of the year 2023, 97% of the populated areas have been provided with 5G, offering a good impact on the capacity and speed of the networks. Both Etisalat and du, supported by government initiatives like Dubai 10X, are deploying 5G to boost customer connectivity and unlock transformative applications such as IoT, AR, and VR for businesses. Alongside 5G,



the UAE is investing heavily in fiber-optic networks, enhancing broadband infrastructure to support the digital needs of households and businesses, crucial for smart city developments and digital services across sectors like healthcare and education. The National Broadband Plan further promotes fiber-optic growth, reinforcing the UAE's ambition to establish itself as a regional technology and innovation hub. However, the constant accession of laws, particularly the stringent UAE regulations which control the market by partially restricting VoIP services, overpowers the market dynamism.

The migration to 5G has enhanced network capability to meet the rising demand from the population growth. The UAE remains a global leader in optical fiber communications with 97% fiber optic penetration, proving that the country is well prepared for future-focused communication systems and creating a technical landscape that promotes improved connection.

#### **Influencing Factors:**

- ▲ 100% mobile coverage for diverse various services
- ▲ Wireless subscribers reached 21.2 million, indicating strong demand for telecom services
- ▼ A high penetration rate restrains subscriber addition to certain degrees
- ▼ Coverage exceeding 100% in many areas may hinder revenue growth opportunities

### **UNITED KINGDOM**

The UK has a nominal GDP of US\$ 3.071 trillion and a population of 68.2 million. The United Kingdom (UK) telecom industry continues to be a highly dynamic sector, with advancements in communication services for the nation's 67.96 million residents. The industry is seeing robust growth, especially in wireless subscribers, with a jump from 81.5 million in 2022 to 89.2 million by the end of 2023. Broadband subscribers in the UK have also shown an increase, growing to 28.5 million in 2023,

showing the continued demand for faster internet services amid the rise of remote work post the COVID pandemic. The GDP of the UK currently stands at US\$ 3.34 trillion. Economic data from 2023 also highlights a per capita income of US\$ 48,866, which has risen from US\$ 45,564 in 2022.

The percentage of individuals using the internet reached 98% by 2023, which coincides with an increase of 23% in traffic over the year. This increase can be attributed to the joint ventures Project Gigabit and the Wireless Infrastructure Strategy. Despite this, there is much room for improvement amidst rising inflation and geopolitical turbulence. The telecom operators have no option but to implement price rises to foot the bill for rising costs for infrastructure and labour, which affect the consumers greatly with a high cost of living already squeezing household budgets.

The UK is one of the largest telecommunication markets in the world, and it continues to show steady growth. Considerable investment in the sector from public and private players ensures the demand for more data and bandwidth is met. Although there have been price increases by operators amidst rising operational costs, the long-term trend for telecom services has followed a downward trend. And yet, the UK lags behind other markets in its digital infrastructure, especially in areas like download speeds and network coverage. The government has to ensure that its plans to provide standalone 5G in all populated areas by 2030 are a resounding success and that its plans to invest in future telecom technologies is fruitful so that the country continues to thrive in an ever-changing global landscape.

#### **Influencing Factors:**

- ▲ Increased demand for broadband due to rising IOT adoption
- ▲ Rise of 23% in overall network traffic over the year
- ▲ The joint ventures Project Gigabit and the Wireless Infrastructure Strategy
- ▼ Rising levels of inflation and geopolitical tensions

## **PRÉVISION OUTLOOK**

- ▶ The French telecom sector shows strong growth potential, with ongoing investments in technology and service quality poised to boost ARPU and sustain market leadership in Europe
- ▶ Technological progress like the expansion of 4G and the rollout of 5G have notably enhanced Nigeria's telecommunications landscape
- ▶ China focuses on high-quality growth through advancements in technology and green energy sectors, aiming to transition from rapid expansion to sustainable development
- ▶ In UAE, Government initiatives like Dubai 10X are deploying 5G to boost customer connectivity and unlock transformative applications such as IoT, AR, and VR for businesses, also promoting fiber-optic growth, reinforcing the UAE's ambition to establish itself as a regional technology and innovation hub
- ▶ In Russia, the Telecom industry has invested heavily in the deployment of fiber-optic lines, which is significantly enhancing broadband penetration

# SPECIAL FEATURE '25



**AI TRISM :**  
AI Trust, Risk and Security  
Management

# SPECIAL FEATURE AI TRISM



## Student Team

Sanak Majumdar | Krishnaveni Konar | Prashant Pajiyar | Aakshi Gera | Rushikesh Bhandari

## SNAPSHOT

- ▶ The Global Artificial Intelligence Market was assessed at US\$ 196.63 billion in 2023
- ▶ In 2023, approximately 35 billion records were exposed due to data breaches, highlighting escalating cybersecurity risks
- ▶ AI-based cyber threats surged globally, resulting in over 800 million attacks in 2023
- ▶ The projected US\$ 215 billion spent on AI cybersecurity solutions in 2024 represents growing concern over the mitigation of issues related to AI technologies
- ▶ Cyberattacks using AI have risen by 30% year over year
- ▶ Tools such as LIME and SHAP are being developed to explain AI model predictions.
- ▶ The AI TRiSM model developed by Gartner offers a structured way of managing Trust, Risk, and Security in AI
- ▶ The juxtaposition of key Pillars of the AI TRiSM model, XAI and Model Ops not only helps to ensure transparency but also helps to optimize the AI lifecycle

## INTRODUCTION

### CURRENT LANDSCAPE OF RISK AND PRIVACY IN AI

The global Artificial Intelligence Market was assessed at US\$ 196.63 billion in 2023, and year-on-year growth stands at a compound annual growth rate of 36.6% from 2024 to 2030. Adopting Artificial Intelligence technology has been critical for companies to provide better customer experiences and improve their presence in the Artificial Intelligence industry 4.0.

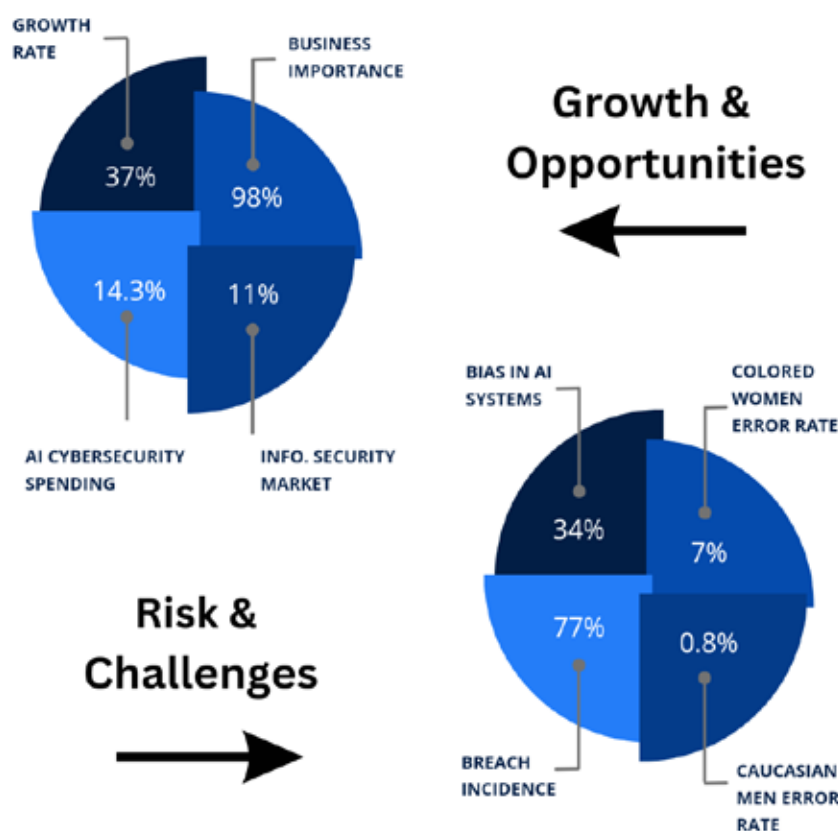
With AI's swift evolution, we are also witnessing a transformation in the dynamics of risk and privacy, forging a new digital paradigm. 98% of surveyed companies consider their AI models crucial for business

success, yet 77% have faced breaches in their AI systems within the past year. As noted, several threats relate to the large-scale implementation of AI in organizations. The most common is AML attacks, wherein the AI algorithm is targeted to alter AI's behaviour, evade AI-based detection, or steal the underlying technology. There are Generative AI system attacks as well, which threaten the AI's filters and restrictions, intending to generate content deemed harmful/illegal.

Furthermore, the issue of hallucinations or biases that exist in an AI system presents significant challenges to the functionality and fairness of the artificial intelligence system. Bias can infiltrate AI systems, leading to facial recognition error rates as high as 34%. Darker-skinned women experience a 7% error rate, compared to just 0.8% for lighter-skinned men. Additionally, the

increasing number of Internet of Things (IoT) devices incorporating AI greatly increases the potential for cyberattack incidents. Each device serves as a potential access point for breaches. There are also concerns about audio-visual deepfakes, user data privacy, and algorithmic opacity. These concerns underscore the need for regulatory frameworks to address consumer apprehensions. Following suit, the Information Security and Risk Management market will reach US\$ 287 billion in 2027, with a CAGR of 11.0% from 2022 to 2027. Spending on AI cybersecurity solutions is projected to reach US\$ 215 billion in 2024, an increase of 14.3% from 2023, reflecting growing concern about mitigating AI-related security risks.

New AI advancements heighten risks to data privacy, bias, ethics, and legality. Addressing these challenges demands a robust risk management strategy integrating technology, ethical principles, and legal frameworks to protect business interests, organizational integrity, and consumer data.



Credits: SIDTM Students

## INTRODUCTION: INTERNATIONAL REGULATORY LANDSCAPE







In today's swiftly advancing digital world, safeguarding data and privacy regulations have become more critical than ever. In 2023 alone, around 35 billion records were exposed due to repeated data breaches and cyber threats. The average price of a data breach has risen to US\$ 4.45 million, an all-time high with a gradual increase of 15.3% every year. Looking at these stakes, the requirement of commanding regulatory frameworks for conserving such data and maintaining trust from the consumer end was necessary. With digitization, many businesses have started moving towards digital operations; ventures must know how these regulatory laws help minimize the risks in terms of the compliance perspective.

Several data protection regulations have emerged globally in recent years:

- **GDPR (General Data Protection Regulation):** It was implemented in May 2018; this is an EU regulation that helps individuals have control over their data; if not followed in the right way, it can result in operational non-compliance penalties of up to US\$ 22 million or 4% of the company's global turnover.
- **CCPA (California Consumer Privacy Act):** Starting from the 1st of January 2020, this act awards privacy rights to California residents, allowing the state to impose fines on noncompliant organizations up to US\$ 7500 per violation.
- **DPDP Act (Digital Personal Data Protection Act):** This law was started in India and helps in data privacy and protection in the digital domain, reflecting the growing global emphasis on data security.

There are some attributes that are similar to the data protection regulation, such as data minimization, transparency and accountability principles and a few consumer rights which help the consumer to manage their data. However, some firms try to implement them differently, and it costs somewhere between US\$ 1 million and US\$ 5 million to get consent from them. Moreover, when there is a cross-border flow of data, it leads to some challenges in compliance with different laws in different countries, and the fact these laws are dynamic in nature makes it even more challenging. The visibility of data and the increased protection rights create huge problems for firms in balancing the need for strong security measures with the rights, thus probably underlining the need to establish good strategies for compliance and protection of personal data.

# GDPR VS DPDP VS CCPA

<p><b>WHO HAS TO COMPLY</b></p> <p><b>GDPR</b> All the Companies which are processing personal data of EU residents.</p> <p><b>DPDP</b> Indian and foreign organizations processing data of Indian citizens.</p> <p><b>CCPA</b> All the Companies, handling data of California residents</p> 	<p><b>PROTECTS</b></p> <p>GDPR   DPDP   CCPA EU Residents   Indian Residents   California Residents</p>
<p><b>TRANSPERANCY</b></p> <p><b>GDPR</b> Transparency about data usage is mandatory</p> <p><b>DPDP</b> Mirrors GDPR in terms of transparency</p> <p><b>CCPA</b> Clear disclosure about data collection, selling practices.</p> 	<p><b>SCOPE</b></p> <p><b>GDPR</b> All personal data, online and offline</p> <p><b>DPDP</b> Only digital personal data</p> <p><b>CCPA</b> Personal information of California residents</p> 
<p><b>PENALTIES</b></p> <p><b>GDPR</b> EUR 20 million (USD 22 million) or 4% of global revenue</p> <p><b>DPDP</b> INR 250 crore (USD 30 million)</p> <p><b>CCPA</b> USD 7,500 per violation, plus damages</p> 	<p><b>DATA STORAGE</b></p> <p><b>GDPR</b> Data minimization, encryption, retention limits</p> <p><b>DPDP</b> Data localization, purpose limitation, security measures</p> <p><b>CCPA</b> Access and deletion rights, data segmentation</p> 
<p><b>CONSUMERS' RIGHTS</b></p> <p><b>GDPR</b> The right to: be informed   access   rectification   erasure/to be forgotten   data portability   object to automated processing</p> <p><b>DPDP</b> The right to: access   correction and erasure   appoint a nominee   grievance redressal</p>	<p><b>DATA PROTECTION OFFICERS</b></p> <p><b>GDPR</b> A DPO must be appointed under certain circumstances; some countries mandate a DPO for all companies</p> <p><b>DPDP</b> A DPO based in India must be appointed for significant data fiduciaries</p> <p><b>CCPA</b> CCPA does not require a data protection officer</p> 

Credits: SIDTM Students

## NAVIGATING SECURITY CHALLENGES IN AI

AI-based cyber threats have increased worldwide; attacks have increased YoY by 30%, resulting in over 800 million attacks in 2023. Such threats are getting more complex since adversaries use AI technology to smooth attacks, infiltrate security measures, and perform precision operations. Another significant global phenomenon of artificial intelligence is using AI for ransomware, phishing, and malware to enhance cybersecurity measures. India also has one of the highest increases in AI-driven threats, contributing 15 percent towards the global impact. This growing threat

explains why international and national approaches are essential to effectively combating artificial intelligence security risks.

Technology has grown exponentially, especially with artificially intelligent systems coming up with business opportunities and more formidably developed systems to conduct cyberattacks. Threat actors leverage AI to improve performance, and conventional protection tools are no longer helpful. They utilise features such as ML algorithms to perform several AI-aided attacks. In poisoning attacks, the attacker receives a malicious data set intending to change the AI systems to make decisions with wrong information. This doesn't seem right, and it discredits the AI models, especially in sensitive fields such as health and finance. Inference attacks work on patterns in the output of the AI, and a hacker gets to know about much secret information without directly getting into the data. This is a worrying trend, especially for industries dealing with large volumes of sensitive information, including telecommunications and banking.

Another type of attack is evasion, which incorporates inputs built to bypass AI models and cause those models to classify them as harmless or benign, allowing the hacker to sneak past a security system. Examples of evasion attacks have been identified in facial recognition systems where the modification of images is done in a way that makes it difficult for them to be detected, posing a high risk to identity verification systems. Extraction attacks target acquiring confidential data that is coded in the AI algorithms. These attacks are particularly devastating in organizations that use advanced algorithms or formulas because the attackers can determine the algorithms through reverse engineering, depriving the organizations of their competitive advantages.

One of the trends at the global level is AI hacking automation, which means cyberattacks intensification. Even though ransomware attacks have happened before, today, most of these attacks are controlled by Artificial Intelligence, whose algorithms can look out for weaknesses and plan and launch an attack themselves. This has been seen more so in North America and the European market, where AI-led cyber-attacks are increasingly reported. However, the threat lies in the growth of AI governance and ethical standards that regulate or ban some AI-based resources.

In India, however, the challenges are a little more defined. Since many business fields, such as banking, telecommunication, and healthcare, have begun integrating AI technology into their operations, they have become more exposed to these complex heists. There are not enough regulatory measures to counter the problem as it continues. Still, there is significant progress in India from the side of critical vendors that present AI solutions that detect breaches and potential threats. Some examples include Indian financial institutions spending on AI-based security to prevent inference or extraction attacks.

Such factors include the enhanced partnership of private and public sectors globally and in India to counter AI-related threats. External factors like the EU's AI Act changes frame the direction artificial intelligence will take. Some of these challenges are expected to be halted by the Data Protection Bill in India, which proposes stringent data management and AI measures.

### MOST CONCERNING CYBERATTACKS



Credits: MIT Technology Review Insights

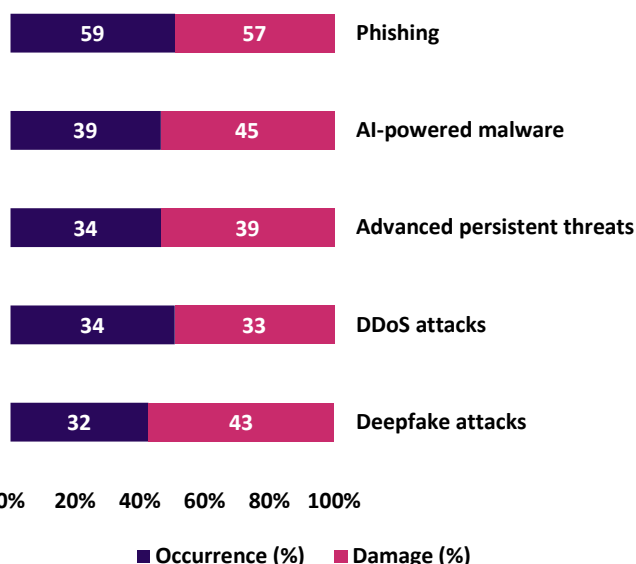
### Expert Speaks

**Summary of Insights:** Responsible AI governance is crucial for organizations to ensure compliance with legal and ethical standards, protect data privacy, and build trust. Best practices include integrating privacy into product design and fostering cross-department collaboration to implement AI governance frameworks. The most significant challenges in governance involve simplifying technical concepts for non-technical stakeholders. Emerging AI technologies will enhance security and compliance, while ethical considerations such as data minimization are often overlooked. Effective communication of AI risks involves using relatable, non-technical examples to convey biases and outcomes, ensuring stakeholders understand the importance of responsible AI development.

#### Mr. Amal Nair

Privacy Program Manager,  
Microsoft

### AI CYBER THREAT



Credits: 2023 Beyond Identity Survey

### AI TRISM (AI TRUST, RISK AND SECURITY MANAGEMENT)

The AI TRISM model, as proposed by Gartner, represents Trust, Risk, and Security Management. It was designed as organizations increasingly require effective management of the complexities and risks associated with AI technologies, especially during its increasing incorporation into business activities. With the acceptance of AI, the burden on businesses increased not only on the ethical, data privacy, and regulatory compliance levels but also on the risk and security levels in the AI systems. The AI TRISM model gives us a structured framework for building trust with stakeholders, mitigating risks, and ensuring security in AI systems.

**Key Entities of the AI TRiSM Model are:**

- Trust: Introduces trust between AI system users and all stakeholders
- Risk: Expose, assess, and mitigate the risks associated with the deployment of AI
- Security: Integrity and confidentiality of AI systems and supporting data

Though other AI ethics and governance frameworks are also available, such as the EU's Ethical Guidelines for Trustworthy AI or the IEEE's Ethically Aligned Design, AI TRiSM

Differs from the others by being more explicitly business-oriented. Most of the models have been more ethics-based and have failed to focus more directly on risk management and security issues related to business operation and compliance.

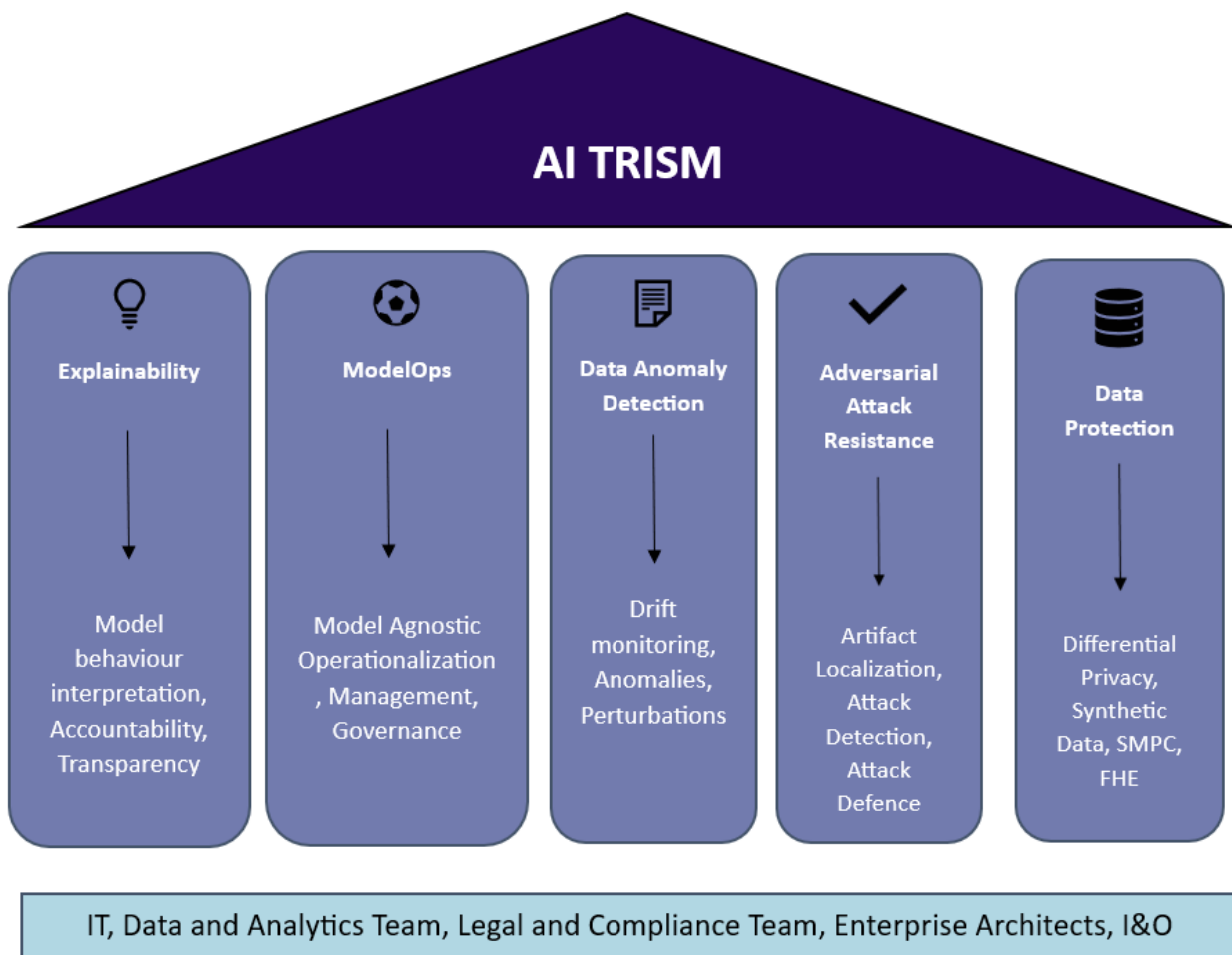
From a business point of view, the AI TRiSM model equips an organization with responsible AI strategies that resonate with their general governance and risk management policies. Doing this minimizes risks both legally and in terms of reputation and encourages innovation because any implementation of AI is considered ethical, secure, and trusted by its users. This puts a business firm on top rung regarding ethical AI usage and enhances its competitiveness in the market.

The AI TRiSM model summarizes leading requirements regarding navigating the intricate landscape of AI governance, thus providing both the ethical and business perspectives with a comprehensive framework.

**Expert Speaks**

***Summary of Insights:** Communicating AI risks to non-technical stakeholders requires translating complex ideas into relatable terms, especially around protecting personal data when interacting with AI. Safeguarding personal identifiable information (PII) is crucial. In Cloud FinOps, AI has transformed the sector by offering real-time insights, anomaly detection, resource optimization, cost forecasting, and automated policy enforcement. Centralized solutions are vital for scaling FinOps effectively, improving inventory accuracy and cost management. AI's role in cloud utilization includes optimizing resources, reducing overprovisioning, and enabling accurate budgeting through FinOps platforms like IBM Aptio Cloudability or Flexera One.*

**Mr. Akash Kanojia**  
Product Manager, HCL Tech



Credits: SIDTM Students

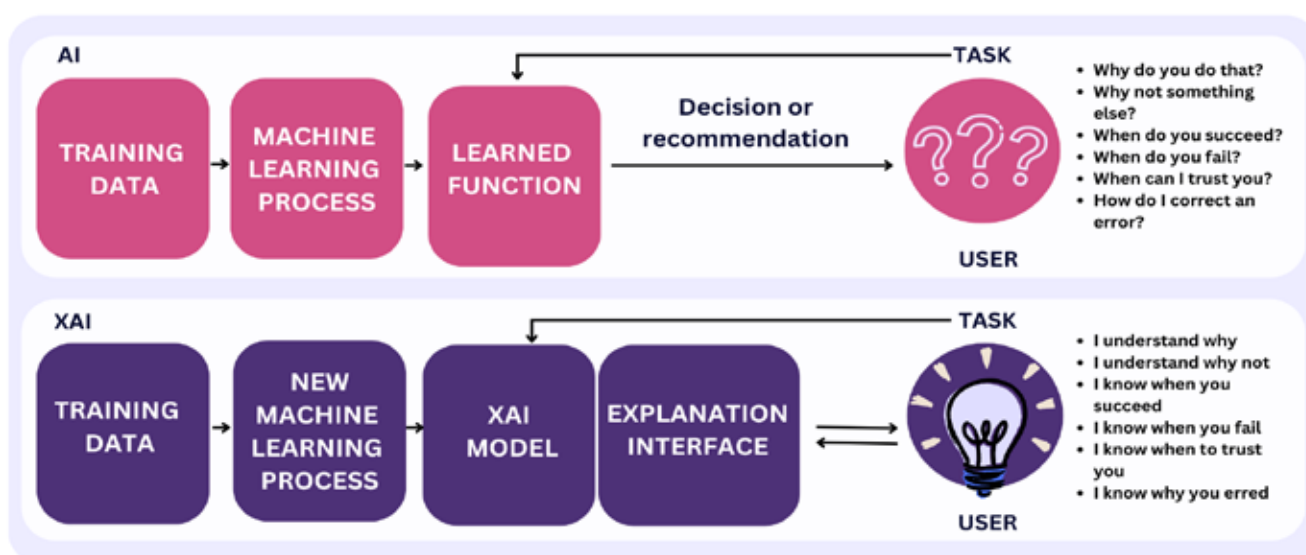
## THE FOUR PILLARS OF AI TRISM EXPLAINABLE AI (XAI)

One of the rising concerns about artificially intelligent systems is that they tend to be opaque or black boxes. In recent years, researchers have looked for ways to develop algorithms that are more reflective of human decision-making processes. However, the need for reliable AI models is critical in deploying AI in sectors that greatly affect one's quality of life, like agriculture, climate change, healthcare, and many others. It's becoming increasingly important due to regulations requiring interpretability, transparency, and traceability in data-sensitive sectors like healthcare. Explainable AI (XAI) addresses a gap in the application of AI by reducing predictions in sectors like healthcare, finance, and law, where mistakes can be extremely costly. XAI will identify who made a particular decision, thus increasing accountability and Confidence in the system. It will also enhance conformity with the laws.

In banking services, fraud detection or personalized pricing is much more effective, thereby increasing customer satisfaction. In healthcare, XAI permits very powerful insights into complicated molecular interactions that happen during drug development and reasonable interpretation of them. XAI facilitates trust and governance in high-risk sectors which leads to better AI consumption by clients and patients.

It is forming part of Explainable AI with tools like LIME (Local Interpretable Model-agnostic Explanations) and SHAP (Shapley Additive explanations). LIME explains an individual prediction from black-box models with an ideal fundamental model by constructing highly interpretable surrogate explanations (i.e., local linear approximation which sufficiently mimics complex behavior of the underlying global one, based on perturbed instances).

### AI vs Explainable AI



Credits: SIDTM Students

## MODEL OPERATIONS (MODEL OPS)

One of Forbes Advisor's recent surveys has shown that companies use AI at a high rate to enhance and optimize their operations. According to the study, businesses are using AI for various services. Some of the most used applications are cybersecurity and fraud management, used by 51% of firms, and customer service, used by 56% of businesses.

Model Operations (ModelOps) are crucial in optimising the managing procedures of AI models while implementing such services. ModelOps is a key element of Gartner's AI TRISM (AI Trust, Risk, and Security Management) paradigm proposed by Gartner.

This pillar is driven by the management of AI models at every stage of their lifecycle, from creation and implementation to continuing upkeep with regulations and improvement. Also, by automating the repetitive processes during the software lifecycle, businesses can efficiently save operational costs on model training, testing, and deployment.

Furthermore, ModelOps can help define precise model monitoring and assessment procedures to promote improved governance and compliance. Routine check-ups on AI performance are thus meant to enable organizations to prevent such errors by adjusting in advance. Such functionality enhances the reliability of the AI systems and encourages trust between the stakeholders who might need to make decisions based on these tools.



**Expert Speaks**

**Summary of Insights:** The rise of AI since 2005 has brought significant advancements and raised ethical concerns, particularly around data privacy, transparency, and accountability. Responsible AI, focusing on privacy protection and ethical governance, is vital to maintaining trust in AI systems. Explainability and transparency are critical in high-stakes industries like healthcare and finance. Emerging technologies such as AI auditing tools, explainable AI, and privacy-preserving methods like federated learning are key to improving AI security and ensuring responsible, ethical, and fair practices in future AI development.

**Mr. Souva Majumder**

Director cum Technical Consultant of AI Governance,  
Apollonius Computational Business Solutions OPC Pvt. Ltd

Along with the AI TRiSM framework in which they exist, JPMorgan Chase and Goldman Sachs are applying ModelOps throughout organizations to provide transparency and help manage activity. They will ensure that their models of AI are as efficient as possible and that best practices are industrialised.

Businesses globally are rapidly using AI while optimizing their services, and while doing so, they are using the ModelOps strategy given by the AI TRiSM framework to reduce the implementation. Businesses must utilize this advanced management strategy to encourage innovation and maintain a competitive edge over competitors.

**AI APPLICATION SECURITY**

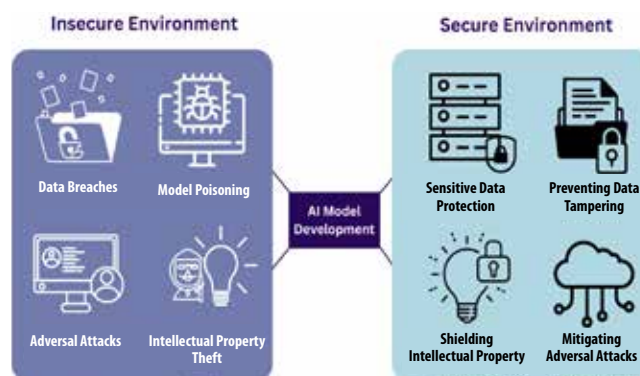
AI Application Security is the major security function of Gartner's AI Trust, Risk, and Security Management (AI TRiSM) before which AI attacks, for example, adversarial disturbances and inappropriate use receive AI threats and systems are protected from data breaches. This field of study deals with AI technology's security issues; traditional security solutions are often insufficient due to the complex nature and extensive data required by AI models.

The three most significant risks are model leakage, adversarial attacks, and model inversion. In a model inversion attack, threat actors can reconstruct susceptible training data, and privacy is breached. With slight modifications in the input data leading to an incorrect output, adversarial attacks could become severe threats in such aspects as autonomous vehicles and wrong financial predictions. In 2023, a quarter of the Artificial Intelligence businesses experienced threats to the data by adversarial attacks that resulted in monetary losses, degeneration of the business and privacy breaches. The human cost of an information

breach went up to US\$ 4.45 million in the same period. AI Application Security is thus the most relevant thing in ensuring that only secure and trustworthy AI functions are deployed.

AI Application Security ranges through all industries. In the medical environment, it protects patient information and facilitates accurate identification, where the costs reach US\$10 million per breach. FinTech firms develop new fraud detection systems with the help of AI security measurements, which resulted in an average annual loss of US\$5.4 million decrease. These measures also help defense systems to use AI security to avoid the agency of the enemy and protect the national interest.

One of the recent developments in the AI application security sector is differential privacy techniques and secure multi-party computation, which provide data privacy or model security. Changes in legislation, such as the EU's AI Act, need to be introduced to strengthen security requirements and reduce the level of risk of AI application implementation.



Credits: SIDTM Students

**PRIVACY**

The privacy of the AI TRiSM framework ensures that sensitive information is well protected and adheres to data protection regulations. It focuses on protecting personal data from unauthorized access and breaches, which is important as AI systems depend heavily on large amounts of data for training and operations.

**Challenges Addressed by Privacy Measures:**

- Data Breaches: With the continuous evolution of cyber threats, AI systems face a high risk of data breaches that would result in grave legal and reputational damage to organizations
- Regulatory Compliance: Organizations need to put extra efforts into such challenging regulations as GDPR, which obligates strict guidelines in matters of data handling and privacy
- Public Trust: The user's trust in an AI application is critical to the widespread adoption of AI.

In AI TRiSM, privacy protection plays a crucial role across various industries. In healthcare, AI systems use patient data for diagnostics but use encryption and anonymization to ensure that sensitive information is not compromised. In finance, financial institutions use AI to detect fraud, ensuring customer data is encrypted and access only restricted to authorized personnel. And in retail, companies like Amazon use AI for personalized recommendations while ensuring customer privacy through robust data protection practices.

In some recent developments, the landscape for AI privacy has been shifted. It also includes, without invading personal data, model federated learning that could learn from various sources in the world while reducing some risks from exposure but permitting the

achievement of successful training for the AI. Lately, organizations have begun taking up the AI TRiSM framework to deploy AI.

The AI TRiSM framework is a business-related, fully realized approach to AI governance that addresses trust, risk, and security. It is a mechanism for building responsibility and transparency, operating well in critical areas like health care, finance, and self-driving cars. With the deployment of AI TRiSM, known for the suitability of correct abductive logic that incorporates interpretability, efficient production of secure AI applications, and data privacy, organizations can safely use AI technology to get their desired benefits like responsible innovation and compliance with regulatory standards.

## PRÉVISION OUTLOOK

- ▶ The global market for artificial intelligence is anticipated to expand rapidly over the next several years, experiencing robust growth through 2030
- ▶ The market for information security and risk management is expected to grow steadily, reaching a substantial value by 2027
- ▶ The average cost of a data breach is increasing significantly each year, resulting in an increasing financial burden
- ▶ There will be a growing need for explainable AI, especially in high-stakes industries like healthcare and finance where transparency and accountability in AI decision-making are critical for regulatory compliance
- ▶ The focus on securing AI applications is expected to sharpen, leading to the development of specialized security solutions tailored for AI systems

## GENERATIVE AI REVISITING PRÉVISION'24

Prevision'24 topic for special feature was Generative AI a swiftly advancing range of artificial intelligence where GenAI has emerged rapidly using deep learning models such as GPT for text and GANs for images to produce almost human-like content across multiple sectors. From early statistical models, GenAI transformed with deep learning innovations into a highly invested sector: in Q1 2023, it stood at US\$ 11 billion, and most of this investment occurred in India. It has the potential but also throws up serious privacy and security concerns: data privacy risk, misinformation, and inbuilt bias. These factors have thrown a spotlight on Responsible AI, which

focuses on the ethics of development: transparency, bias minimization, and accountability. The survey reflects that 73% of employees are concerned about the security risks linked to GenAI, while 54% of IT leaders are calling for stronger safeguards. Organizations such as Google, Meta, and OpenAI embrace RAI principles and the practice of AI TRiSM to protect user data. In the near future, GenAI will add another US\$ 4.4 trillion to the world economy but it needs sustained ethics and regulative frameworks in the area of responsible AI innovation.

# REFERENCES

- 5G Americas
- 8x8, Inc
- Aarogya Setu
- ABI Research
- Accenture
- ACL Digital by Alten
- ACM
- ACMA
- Acumen Research and Consulting
- Acute Market Reports
- Allied Market Research
- Altius
- Amazon Press Release
- Analysys
- Analytics India Magazine
- APNIC
- Appinventiv
- AppsFlyer
- Astute Analytica
- Attendance.Gov.In
- Aureon
- Automotive-Technology
- Avaya
- Backlinko
- Bain & Company
- Bennett University
- Bharat Exhibitions
- Bharat Net
- Bhim
- BigID
- Birlasoft
- BIS (U.S.A.)
- Blockchain-Council.Org
- Bloomberg
- BuddeComm
- Business Newswire
- Business Research Insights
- Business Standard
- Business Today
- Business of Apps
- CableLabs
- Camera and Imaging Products Association
- Canalys
- Carrierbid
- Cato Networks
- CCS Insight
- CDW
- Ceic Data
- Ceoworld.Biz
- Check Point
- Chevron
- China Government
- China Internet Network Information Center
- Ciena
- Cisco
- Cision
- Clifford
- Cloudwards
- CNBC
- Cogent Infotech
- Cognitive Market Research
- Coherent Market Insights
- Communications Authority of Kenya
- Communications Today
- Companies Market Cap
- Competition Commission of India
- Coresight Research
- Counterpoint Research
- Crocker Communications
- CSI
- Custom Market Insights
- CXOToday
- Cybermedia Research Insights
- Data Bridge
- Data Fortune
- Data Reportal
- DD News
- Deccan Chronicle
- Deloitte
- DemandSage
- Department for Promotion of Industries and Internal Trade
- Department for Science, Innovation and Technology (U.K.)
- Department of Telecommunications Device Authority
- Digilocker
- Digital Information World
- Digital Infra Network
- Digital Photography Review
- Dolph microwave
- Economic Times
- Edge Delta
- Einpresswire
- Emarketer
- Embedded Computing
- Emergen Research
- Emossy
- Enisa Europa
- Enterprise Apps Today
- Equity Master
- Ericsson Reports
- European Association for Signal Processing
- European Commission
- Evertiq
- Expereo
- Expertmarket
- EY
- FCST Communications
- Federal Communications Commission (Switzerland)
- Fieldengineer
- Fierce Network
- Financesonline
- Financial Express
- Fit Small Business
- Fitch Solutions
- Forbes
- Fortune Business Insights
- Fortune India
- Fraunhofer IOF
- FS Community
- Future Market Insights
- Future Networks
- Gallerio
- Gartner
- Gil Global Information
- Giz China
- Global Information, Inc. Research
- Global Market Insights
- Global Mobile Suppliers Association
- Global Monitor
- Globaldata
- Globalknowledge
- Globe Newswire
- GMI Research
- Grand View Research
- Gs.Statcounter
- GSMA
- Hackaday
- HCL Technologies
- Help Net Security
- HFCL
- HG Insights
- Horizon Grand view research
- Hyperverge.Co
- Iberdrola
- IBM
- IDC
- Idem Est Research & Advisory
- IEC Telecom
- IEEE
- Igi-Global
- IMARC Group
- Inc42
- IBEF
- Indian Embassy
- Indian Express
- Indian Television
- Indo-Asian News Service
- IndustryArc
- Informa
- Inkwood Research
- Inside Telecom
- Insights Active Learning
- Intel
- International Data Corporation
- IJARCEE
- International Market Analysis Research and Consulting Group
- IRJMERS
- Invest India
- IoT Analytics
- IPv4.Global
- ISRO
- IT Brief Asia
- IT Governance
- ITU
- Jedem
- Jio Platforms Ltd.
- Kigen
- Kings Research
- Knowledge Based Value Research
- KPMG
- KSG India
- LiFi Group
- Light Reading
- Live Mint
- Macrotrends
- Market Research
- Market Wide Research
- Markets And Markets
- Market Standards
- MarMore
- Matellio
- Maximize Market Research
- McKinsey and Company
- MediaNama
- Medium
- Ministry of Commerce & Industry
- Ministry of Communications
- Ministry of Electronics & IT
- Ministry of Internal Affairs and Communication (Japan)
- Ministry of Law and Justice - eGazette
- Mirrorless Rumors
- MIT Technology Review
- Mobility Foresights
- Mordor Intelligence
- Mygov
- Nairametrics
- Nasscom Community
- National Center for Communication Security
- NCBI
- NDTV
- NEC
- Network18 Group
- NextDC
- NFON
- NIC
- Nokia
- NPCI
- NRSC
- Oberlo
- Obkio
- Observer Research Foundation
- Offshore Technology
- Omdia
- Open Signal
- OpenVPN
- OrbitalToday
- Outlook Business
- Ovic.Vic.Gov.Au
- Paloaltonetworks
- Pew Research
- Photonics Spectra
- PIB
- Polaris Market Research
- Portulans Institute
- Powergistics
- PR Newswire
- Precedence Research
- Prescient Market Research
- Press Information Bureau
- PressReader
- Privacy Affairs
- PRS Legislative Research
- P&S Intelligence
- PwC
- Razorpay
- RBI
- RCR Wireless News
- Reliance Industries reports
- Reports Valuates
- Research and Markets
- Researchgate.Net
- Research Nester
- Research Support Society
- Ribbon Communications
- RingCentral
- RingOffice
- Roland Berger
- Root Analysis
- Route Mobile
- Salesforce
- Science And Engineering
- Science Direct
- SDXCentral
- Security.org
- SES S.A
- Shard Secure
- Shifte Learning
- Sky Quest
- Software Strategies Blog
- Spherical Insights
- Splunk
- Springer Nature Link
- Statusbrew
- Stellarix
- Straits Research
- Sumsub
- Syniverse
- Syrma and SGS
- Tata Tele Business
- Tatvic
- Taylor and Francis
- TDRA (U.A.E.)
- Tech Digest
- Tech Target
- Tech Xplore
- Tech Business News
- Technavio
- TechNexus
- Technology Magazine
- Techopedia
- Techpoint.Africa
- Techradar
- TechSci Research
- TechTarget
- TELCOMA Global
- Tele.net
- Telecom Economic Times
- TRAI
- Telecom Review
- TelecomLead
- Telecommunications Carriers Association
- Telecoms Tech
- TelecomTalk
- TelecomTV
- Telefonica
- The Brainy Insights
- The Business Research Company
- The Business Times
- The Channel Company
- The Global Market Insights
- The Hindu Group
- The Indian Express
- The Insight Partners
- The Tech Report
- The Times Group
- The White House
- Times of India
- Tiny Blog
- TMforum
- Today Digital
- Transparency Market Research
- Travancore Analytics
- Twilio
- Umang
- Valnet
- Value Market Research
- Vantiva
- Verified Market Research
- Verizon
- Viasat
- VMware
- Voice&Data
- W3techs
- WICZ TV
- Wifitalents
- Wipro
- World Bank
- World Economic Forum
- Worldometer
- Worldpay Global
- Xenonstack
- Yaguara.com
- Ziff Davis
- Zion Market Research
- Zscaler
- ZTE Corporation

# ABBREVIATIONS

- € - Euro
- ₹ - Indian Rupee
- 100GbE- 100 Gigabit Ethernet
- 3GPP -
- 3rd Generation Partnership Project
- 4G - Fourth Generation
- 5G - 5th Generation
- 5G - Fifth Generation (mobile network technology)
- 5G-FWA -
- 5th Generation Fixed Wireless Access
- 6G - 6th Generation of Communication
- A2P - Application-to-Person
- ACCC - Australian Competition and Consumer Commission
- ADSL- Asymmetric Digital Subscriber line
- AGR - Adjusted Gross Revenue
- AI - Artificial Intelligence
- AI - Active Infrastructure
- AI TRISM - Artificial Intelligence Trust, Risk and Security Management
- AIM - Application Infrastructure Middleware
- AIS 140 - Automotive Industry Standard 140
- AML - Anti-Money Laundering
- APAC-Asia Pacific Accreditation Cooperation
- API - Application Programming Interface
- APK - Android Application Package
- APNIC - Asia Pacific Network Information Centre
- AR - Augmented Reality
- ARPU - Average Revenue Per User
- ASP - Average Selling Prices
- ATC - American Tower Corporation
- AWS - Amazon Web Services
- B6GA - Bharat 6G Alliance
- BAS - Biometric Attendance System
- BBNL - Bharat Broadband Network Limited
- BEREC - Body of European Regulators for Electronic Communications
- BEV - Battery Electric Vehicles
- BFSI - Banking, Financial Services, and Insurance
- BI - Business Intelligence
- BLE - Blue Low Energy
- bn - Billion
- BNPL - Buy Now Pay Later
- BNU - BharatNet Udhaymi
- BOT - Build Operate Transfer
- BSNL - Bharat Sanchar Nigam Limited
- BSS - Business System Support
- BTS - Base Transceiver Stations
- BYD - Build Your Dreams
- BYOD - Bring Your Own Device
- C band - Frequency band (6 GHz)
- CAGR - Compound Annual Growth Rate
- CapEx - Capital Expenditure
- Cat-M- Category M low-power wide-area technology
- CBBPiR - Centre for Broadband Proliferation in Rural Areas
- CBDC - Central Bank Digital Currency
- CBS - Cloud Billing Solutions
- CCaaS - Contact Centre as a Service
- CCPA - California Consumer Privacy Act
- C-DOT - Centre for Development of Telematics
- CERT - Computer Emergency Response Team
- CES - Consumer Electronics Show
- CIOR - Centralized International Out Roamer
- CIPA - Camera and Imaging Products Association
- CISA - Certified Information System Auditor
- CNAP - Caller Name Presentation
- CORS - Continuously Operating Reference Stations
- CPaaS - Communication Platform as a Service
- CPE - Customer Premise Equipment
- CPU - Central Processing Unit
- CRM - Customer Relationship Management
- CRM - Customer Relationship Management
- CSP - Communication Service Providers
- D2D - device-to-device
- DAS - Distributed Antenna System
- DCA - Digital Consent Acquisition
- DCI - Digital Connectivity Infrastructure
- DISHA - District Development Coordination and Monitoring Committees
- DLT - Distributed Ledger Technology
- DOCSIS - Data-over-Cable Service Interface Specifications
- DoT - Department of Telecommunication
- DPDP - Digital Personal Data Protection Act
- DSL - Digital Subscriber Line
- DSL - Digital Subscriber Line
- DTH - Direct-to-Home
- DWDM - Dense Wavelength Division Multiplexing
- EAC - East African Community
- E-Call - Emergency Call
- emBB - Enhanced Mobile Broadband
- EMEA - Europe, Middle East, and Africa
- eNB - Evolved Node B (base station in LTE networks)
- E-SIM - Embedded Subscriber Identity Module
- ETF - Exchange Traded Funds
- EU - European Union
- EV - Electric Vehicle
- EVS - Environmental Science
- FDI - Foreign Direct Investments
- FR2 mm - Frequency Range 2
- Millimeter Wave
- FSOC - Free Space Optical Communication
- FTTH - Fibre-to-the-Home
- FTTN - Fiber-to-the-node
- FTTP - Fiber to the Premises
- FTTx - Fiber to the x (where x can be home, building, etc.)
- FWA - Fixed Wireless Access
- FY - Fiscal Year
- GAIIIP - Global AI Infrastructure Investment Partnership
- GCP - Google Cloud
- GDP - Gross Domestic Product
- GDPR - General Data Protection Regulation
- Gen AI - Generative Artificial Intelligence
- GMAPS - Google Maps
- GOI - Government of India
- GP - Gram Panchayats
- GPON - Gigabit Passive Optical Network
- GPS - Global Positioning System
- GPT - Generative Pre-trained Transformer
- GPU - Graphics Processing Unit
- GSA - Global mobile Suppliers Association
- GSMA - Global System for Mobile Communications Association
- HD - High Definition
- HFCL - Himachal Futuristic Communications Limited
- HTS - High-Throughput Satellite
- HTS band - High-Throughput Satellite band (26-40 GHz)
- HTTP - Hypertext Transfer Protocol
- HTTPS - Hypertext Transfer Protocol Secure
- I.T. - Information Technology
- IaaS - Infrastructure-as-a-service
- IaaS-Infrastructure As a Service
- ICT - Information and Communications Technology
- IDC - International Data Corporation
- iDEX - Innovations for Defence Excellence
- IEEE - Institute of Electrical and Electronics Engineers
- IIT - Indian Institute of Technology
- ILD - International Long Distance
- IMAI - Internet and Mobile Association of India
- IMARC - International Market Analysis Research and Consulting
- IMDA - Infocomm Media Development Authority
- IOH - Indosat Ooredoo Hutchison
- iOS - iPhone Operating System
- IoT - Internet of Thing
- IP-MPLS - Internet Protocol Multi-Protocol Label Switching
- IPS - Intrusion Prevention System
- IPsec - Internet Protocol Security

- IPTV - Internet Protocol Television
- IPv4 - Internet Protocol version 4
- IPv6 - Internet Protocol version 6
- ISRO - Indian Space Research Organization
- IT - Information Technology
- JCOR - Joint Committee of Regulators
- Kbps - Kilobits per second
- km - Kilometer
- KPI - Key Performance Indicator
- Ku band - Frequency band (12-18 GHz)
- KYC - Know Your Customer
- L band - Frequency band (1-2 GHz)
- LBS - Location Based Services
- LEO - Low Earth Orbit
- Li-Fi - Light Fidelity
- LIME - Local Interpretable Model-agnostic Explanations
- LLM - Large Language Models
- LoRaWAN - Low Range Wide Area Network
- LPSS - Lightweight Payment and Settlement System
- LPWAN - Low Power Wide Area Network
- LTE - Long-Term Evolution (a standard for wireless broadband)
- LTE-M - Long Term Evolution for Machines
- M&E - Media & Entertainment
- M2M - Machine to Machine communication
- M-Banking - Mobile Banking
- MBit - Mobile India Tariff Bit Index
- M-Blockchain - Mobile Blockchain
- Mbps - Megabits per second
- M-Commerce - Mobile-Commerce
- M-Education - Mobile-Education
- MEF - Metro Ethernet Forum
- M-Entertainment - Mobile Entertainment
- M-Gaming - Mobile Gaming
- M-Governance - Mobile Governance
- MHA - Ministry of Home Affairs
- M-Health - Mobile Health
- MIC - Ministry of Internal Affairs and Communications
- MIMO - Multiple Input Multiple Output
- ML - Machine Learning
- mMTC - Massive Machine-Type Communications
- MNO - Mobile Network Operator
- MNP - Mobile Number Portability
- ModelOps - Model Operations
- M-PESA - Mobile Pesa
- MPLS - Multiprotocol Label Switching
- MR - Mixed Reality
- MTNL - Mahanagar Telephone Nigam Limited
- MU-MIMO - Multi-user Multiple Input Multiple Output
- MW - Mega Watt
- MWC - Mobile World Congress
- NACH - National Automated Clearing House
- NB-IoT - Narrow Band-Internet of Things
- NBN - National Broadband Network networks
- NDCP - National Digital Communications Policy
- NEC - Nippon Electric Company
- NETC - National Electronic Toll Collection
- NFV - Network Functions Virtualization
- NLD - National Long Distance
- NLP - Natural Language Processing
- NMS - Network Management System
- NOFN - National Optical Fiber Network
- NPCI - National Payments Corporation of India
- NPU - Neural Processing Unit
- NSE - National Stock Exchange of India
- OEM - Original Equipment Manufacturer
- OFC - Optical Fiber Cable
- OLED - Organic Light Emitting Diode
- ONDC - Open Network for Digital Commerce
- OPEX - Operating Expenses
- O-RAN - Open Radio Access Network
- OSPFv3 - Open Shortest Path First Version 3
- OSS - Operating System Support
- OTP - One-time-password
- OTT - Over-the-top
- P2P - Person-to-Person
- PaaS - Platform-as-a-service
- PB - Petabytes
- PBX - Private Branch Exchange
- PCS - Public Cloud Service
- PDO - Public Data Office Aggregator
- PDOA - Public Data Office Aggregator
- PLI - Production Linked Incentives
- PM-WANI - Prime Minister's Wi-fi Access Network Interface
- Poe - Operational Expenditure
- PON - Passive Optical Network
- POS - Point of Sale
- PPP - Public-Private Partnerships
- PSU - Public Sector Undertaking
- QoQ - Quarter on Quarter
- QoS - Quality of Service
- QuNET - Quantum Network
- R&D - Research and Development
- RAN - Radio Access Network
- RBI - Reserve Bank of India
- RCS-e - Rich Communication Services enhanced
- RF - Radio Frequency
- RoF - Radio over Fiber
- ROS - Robotics Operating System
- ROW - Right of Way
- SA - Standalone Access
- SaaS - Software-as-a-service
- SDN - Software Defined Networking
- SDN - Software-Defined Networking
- SDP - Service Delivery Platform
- SD-WAN - Software Defined Wide Area Network
- SEC - Securities and Exchange Commissions
- SHAP - SHapley Additive exPlanations
- SIM - Subscriber Identity Module
- SLAAC - Stateless Address Autoconfiguration
- SMB - Small and Medium Business
- SME - Small and Medium Enterprises
- SMO - Service Management and Orchestration
- SMS - Short Message Service
- SON - Self-Organizing Network
- STB - Set-Top Box
- THz - Terahertz communication
- TRAI - Telecommunications Regulatory Authority of India
- TSN - Time Sensitive Networking
- TSP - Telecom Service Provider
- TSPs - Telecom Service Providers
- TV - Television
- TWh - Terawatt-hours
- UC - Unified Communications
- UCaaS - Unified Communication-as-a-Service
- UK - United Kingdom
- UPC - Unique Porting Code
- UPI - Unified Payments Interface
- URL - Uniform Resource Locator
- URLLC - Ultra Reliable Low Latency Communication
- US - United States
- USA - United States of America
- USOF - Universal Service Obligation Fund
- UTM - Unified Threat Management
- VFX - Visual Effects
- VIL - Vodafone Idea Limited
- VoD - Video on Demand
- VoIP - Voice over Internet Protocol
- VoLTE - Voice Over Long-Term Evolution
- VoWiFi - Voice over Wi-Fi
- VPN - Virtual Private Network
- VPN - Virtual Private Networks
- VR - Virtual Reality
- vRAN - Virtualized radio access networks
- VSAT - Very Small Aperture Terminal
- WAP - Wireless Access Protocol
- WebRTC - Web Real-Time Communication
- WiFi - Wireless Fidelity
- WLAN - Wireless Local Area Network
- XaaS - Everything-as-a-Service
- XAI - Explainable AI
- XR - Extended Reality
- YoY - Year on Year
- ZTE - Zhong Xing Telecommunication Equipment Corporation
- ZTNA - Zero Trust Network Access

# TEAM PRÉVISION 2025



**SENIOR TEAM**



**JUNIOR TEAM**





Prévision, SIDTM's Annual Telecom Forecast, stands as a beacon illuminating the intricate landscape of the Telecom and Digital Technology sector. Celebrating its 22nd year, the research report is a collaborative effort by the analytical and creative minds of SIDTM students under the guidance of esteemed faculty, alumni, and industry experts. The 1500+ man-hours invested by the Prévision team reflect a commitment to forecasting market trends and showcasing the application of knowledge in statistics, technology, and experiential learning.

The year's special feature is AI TRiSM: AI Trust, Risk, and Security Management. It is a strategic framework to enhance the governance of AI systems with trust, risk mitigation, and security. The fundamental role of AI TRiSM is to provide a foundation to create trust and ensure the responsible usage of AI in business operations, thus making all of its business operations compliant with regulatory standards while reaping maximum benefits from AI technologies.

Prévision is not merely a publication; it is a testament to SIDTM's dedication, enriching academia and industry alike. The Expert Interaction Program, expansion across verticals, and meticulous forecasting processes make the research report an invaluable resource, reaffirming the institution's commitment to shaping the future of the telecom industry. Explore the depths of telecom trends and embark on a journey of knowledge and foresight.

## TEAM P'25



**SYMBIOSIS INSTITUTE OF DIGITAL AND TELECOM MANAGEMENT**

CONSTITUENT OF SYMBIOSIS INTERNATIONAL (DEEMED UNIVERSITY)

(Established under section 3 of the UGC Act, 1956) | Re-accredited by NAAC with 'A ++' grade | Awarded Category - I by UGC