

COMMUNICATIONS TODAY

MAY - JUNE 2023



5G SPECIAL EDITION

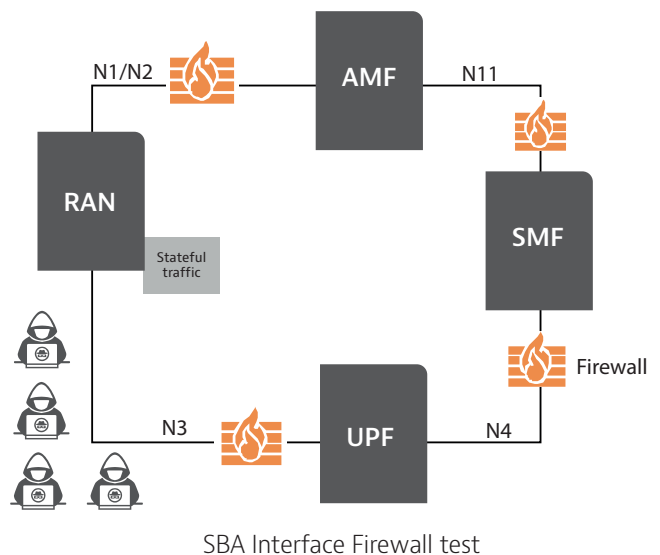
5G CORE SECURITY TEST

With 5G standalone Core Networks being deployed worldwide, new security concerns are emerging. Mobile Network Operators (MNO) are continuously looking at ways to protect their networks from being attacked and their customer data from being breached. One area being adopted by more and more MNOs is placing a Next Generation Firewall (NGFW) inside the 5G Core Network. This helps protect the network from unwanted traffic such as malware and cyberthreats and is vital in ensuring an uninterrupted experience to the end user.

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MOVEMENTS

APPOINTED

Gunjan Dave has been appointed as Member (Technology), Digital Communications Commission, reporting to Chairman DCC & Secretary (T), K Rajaraman. Dave succeeds Sanjeev Agrawal, who retired as adviser and had been entrusted with the additional charge of member.

Amit Malik has been appointed as vice president and sales leader for India, Ciena. Prior to this Malik was managing director strategic sales, global service provider segment, Asia Pacific & Japan region, Cisco Systems.

Dr Randhir Thakur has been appointed as chief executive officer & managing director, Tata Electronics Pvt. Ltd. Prior to this, Thakur was chief supply chain officer, Global Supply Management, Intel.

K. Krithivasan has been named the chief executive officer designate of Tata Consultancy Services (TCS) by the board. He succeeds Rajesh Gopinathan, who put in his papers. Gopinathan, to provide transition and support to his successor continues with the company till September 15, 2023.

Ravneet Kaur has been appointed as chairperson, Competition Commission of India. There has been no full-time chairperson for the competition regulator since Ashok Kumar Gupta demitted office in October 2022. CCI Member Sangeeta Verma has been acting as chairperson since October last year.

Nitin Gupta has been appointed as technical director, SRAM & MRAM Group, for its Odisha semiconductor project.

Rajesh Pathak has been appointed as the country managing director for India



AMIT MALIK



DR RANDHIR THAKUR



K. KRITHIVASAN



RAVNEET KAUR



RAJESH PATHAK



TERRY DALY

& SAARC, Spirent Communications plc. Pathak joins Spirent from Accedian, where he was the country director for India & SAARC. At BT, he was head – System Integration Sales & Partnership Alliances, India.

Vantage Towers, USA, has appointed **Christian Hillabrant** as chief executive officer. Hillabrant comes from Tillman Infrastructure, where he is chief operating officer.

Manoj Kohli joins Master's Union as chairperson. Kohli is now the chair of CII Unicorn Forum, which aims to attract new tech investments to India. Kohli has led mobile startup Escotel, was former CEO of Bharti Airtel, was a board member, SoftBank Group International, has served on the board of GSMA in 2008 and 2012, and was chairman of the CII Task Force on Ease of Doing Business.

Terry Daly has been appointed as semi-conductor advisor, Vedanta. Prior to this, Daly was an independent consultant in the microelectronics industry.

Margherita Della Valle has been appointed as group chief executive, Vodafone. She is also group chief financial officer until an external search for a new group chief financial officer is complete.

K. Guru Gowrappan has been appointed as president, Viasat. Prior to this Gowrappan was CEO, Verizon Media Group.

Anand Birje has been appointed as chief executive officer, Encora Inc. Prior to this, Birje spent almost 20 years at HCL Technologies Limited, where he was last president, digital business services.

Gabriela Styf Sjöman has been appointed as MD Research & Network



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MOVEMENTS

Strategy, BT Group. Prior to this, Sjöman was a board member at TDC Net.

Jean English has been appointed as senior vice president and chief marketing officer, Juniper Network. Prior to this English was SVP and CMO, NetApp.

Laurent Martinez has been appointed as chief financial officer, The Orange Group. Prior to this Martinez was chief financial officer, Alstom.

Bruno Zerbib has been appointed as chief technology & innovation officer, Orange, and a member of the Group's executive committee. Zerbib succeeds Trabbia who has been promoted as executive director and CEO, Orange.

Neil McRae has been appointed as chief network strategist, Juniper Networks. Prior to this, McRae was chief architect and managing director for architecture and technology strategy at BT.

Andrew Sotiropoulos has been appointed as senior vice president and general manager for APAC, NetApp. Sotiropoulos succeeds Sanjay Rohatgi, who is leaving the company to pursue opportunities outside of the company, after nearly four years of leading NetApp's sales teams in Asia-Pacific.

Karen Dykstra has been appointed as chief financial officer, VMware, in addition to her current role as a member of the VMware board of directors.

RESIGNED

Manish Chopra has resigned from his position as director and head of partnerships, Meta.

Wipro. In 2023, Wipro has so far seen the exits of chief operations officer



MARGHERITA DELLA VALLE



K. GURU GOWRAPPAN



SHIVNATH THUKRAL



PRAMOD BHASIN



ANANT MAHESHWARI



RAJAT MUKARJI

Sanjeev Singh, Americas 2 CFO Nithin V Jaganmohan, India head Satya Easwaran, iDEAS business head Rajan Kohli, and Americas 1 CFO Kamini Shah, the most recent being senior vice-president and head Healthcare and Medical Devices division Mohd Haque; SVP and head of the manufacturing and hi-tech business unit Ashish Saxena and Vice President Gurvinder Sahni.

ELECTED

Broadband India Forum (BIF) has appointed **Shivnath Thukral**, director and head of public policy at Meta, as its new vice president.

Pramod Bhasin has been elected as chairman, Data Security Council of India Bhasin was chairman, ICRIER.

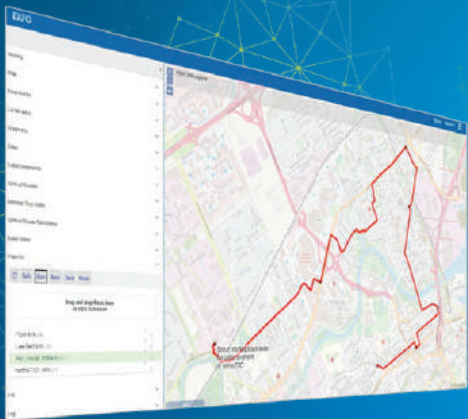
Nasscom. **Anant Maheshwari**, president, Microsoft India, has been elected as chairperson, Nasscom for 2023-24. Maheshwari takes over the reins from Krishnan Ramanujam, president – Business and Technology Services at Tata Consultancy Services, who served as chairperson for the year 2022-23. **Rajesh Nambiar**, chairman and managing director of Cognizant India, has been elected as vice chairperson, and its new executive council for 2023–2025 has also been announced.

Diego Scotti, chief marketing officer, Verizon has announced that he will step down after nearly nine years in the role. Chief strategy officer and executive vice president **Rima Qureshi** will lead Verizon's marketing team on an interim basis.

BEREAVED

Rajat Mukarji, director general, Broadband India Forum, has passed. Mukarji had spent almost 17 years at Vodafone Idea Limited. ■

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Email: CORP.Sales.India@exfo.com

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Editor

Anju Arora
Ph: +91-9811028914
anju@adi-media.com

Business Development

Neha Rathor
Ph: +91-9810422047
neha.rathor@adi-media.com

Content

Madhu Gupta
Ph: +91-9811128914
madhu@adi-media.com

Advertising

advertising@adi-media.com
ct.marcom@adi-media.com
Ph: +91-9667692502

Circulation

Firoz Khan
Ph: +91-9350590707
circulation@adi-media.com

Accounts & Administration

Anil K. Jha
Gaurav Sharma

Offices

- ◆ B-102, Queens Court, E Block Greater Kailash-II,
New Delhi-110048
- ◆ 18th Floor, Building A, DLF Cyber City,
DLF Phase 2, Sector 24, Gurugram-122002
- ◆ C-35, Sector-62,
Noida-201307

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EDITORIAL

India continues to go strong on 5G

K Rajaraman, Chairman, DCCI and Secretary, Telecom, DoT, has enough on his plate for the next four months. Scheduled to retire October 2023, the gold medalist from TKM College of Engineering, Kollam, typically with a 12-hour working day, is keen to see that the blueprint for the third phase of BharatNet project, optical fiber connectivity to the remaining 45,000 GPs and 400,000 villages, and mobile coverage to 45,000 villages by early 2024 via BSNL'S 4G saturation program, Aspirational Districts program and LWE areas projects is laid out. After having ensured availability of sufficient mid-band spectrum for 5G auctions and the allocation of E band, the chairman is working toward making adequate spectrum available for the next round of auctions. The commercial revival of BSNL, planning the execution of pending USOF projects, and streamlining RoW approvals are also high on his agenda. Before he retires, he would like to be assured that mobile services will be provided to all the villages in India, and that every nook and corner of this vast country will be connected by one or more of the three – mobile, fixed broadband, and satellite.

With BSNL poised for a turnaround, the three private telcos – Rjio, Bharti Airtel, and Vi – closed FY23 with combined gross revenues of `3.1 lakh crore, significantly higher than `2.6 lakh crore in FY22. AGR saw an increase from `2.06 lakh crore in FY22 to `2.36 lakh crore in FY23, as did the license fee collections for the government from `15,000 crore in FY22 to `16,700 crore in FY23. This revival is expected to be sustained over the coming years, as the Indian telcos continue to aggressively expand their network. However, their US counterparts, be it Verizon, AT&T or T-Mobile have a different story to tell, and with excess inventory in H1 FY24, they are expected to rein in the CapEx.

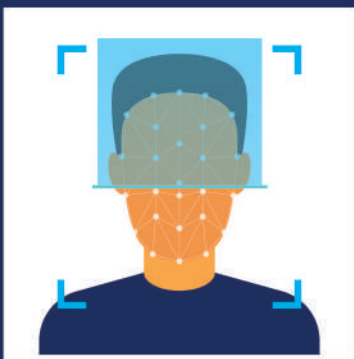
Shifting gears, the US government has officially kicked off USD 140.5 million as the first round of USD 1.5 billion Public Wireless Supply Chain Innovation Fund, to be administered by the National Telecommunications and Information Administration (NTIA). Specifically, the funding will go to support expansion of industry-accepted testing and evaluation, focusing on interoperability, performance, and security of open and interoperable, standards-based 5G radio access networks, and developing or improving the testing of those networks and their component parts. The testing and R&D industry is finally getting the attention it deserves.

Anju Arora

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Leverage technology for skilling on new and future digital technologies

In the rapidly evolving digital landscape, where technology is constantly advancing, the need to upskill and adapt to new digital technologies has become paramount. The Fourth Industrial Revolution has ushered in a wave of transformative technologies, such as artificial intelligence (IA), blockchain, and the Internet of Things (IoT), creating both challenges and opportunities. To remain competitive and thrive in this digital era, it is crucial to leverage technology as a powerful tool for upskilling, enabling individuals to acquire the necessary knowledge and skills to navigate the ever-changing digital landscape.

According to a report by the Telecom Sector Skills Council (TSSC), India requires a minimum of 22 million skilled professionals by 2025, in order to fully harness the advantages of 5G technology. However, the report highlights a significant demand-supply gap of 28 percent. The telecom council plans to train 1 lakh people in the next three years and open 10 new Centers of Excellence across the country. But the greater question lies in how effective the skilling and training programs are, and if the output from these would suffice the rapidly evolving requirements and expectations at the operational levels of the companies who are hiring.

The skilling ecosystem faces some major challenges at the grassroots level. The availability of both skilled and unskilled manpower is a key requirement in this ecosystem. While skilled manpower typically emerges from the urban areas, Tier-II/III cities, towns and rural areas provide the bulk of the unskilled resources. Training for these unskilled resources encompasses addressing a host of challenges.

Most of these candidates lack appropriate infrastructure for training and skilling, and a majority have to travel to different cities/towns to get the basic training. This geographical disconnect poses a grave hurdle at the beginning of the process itself. Moreover, lack of training modules and content in regional/vernacular dialect, even for teacher-student interactions, presents a severe handicap to comprehensive

and meaningful learning for the resources. It is also not feasible to provide physical training infrastructure/institutes in every location since the student distribution is pretty widespread.

The trainees from the non-urban locales are also not too aware or updated on the opportunities present in the industries, and the avenues to understand where and what skills need to be pursued for a successful career.

Presently, the connect between the industry and these trainees is not adequate, which leads to an overwhelming gap between the industry's skillset requirements, and the training being imparted to the students. The industry faces difficulties in allotting time and resources for the mapping and sourcing of skilled manpower, which leads to lack of clarity on how the on-ground needs of the industry can be met. The training institutes and trainers are, therefore, bereft of industry knowledge and clear-cut terms of requirements, which would greatly benefit the students. The quality control in terms of courses and content also cannot be monitored/evaluated fruitfully without the industry's active involvement. There is a serious dearth of learning and development (L&D) divisions in the industry for this purpose.

A collaborative approach with equitable involvement and contributions from both the industry and the academia is of critical importance for proper and productive training and skilling of resources. Measures like cross-movement between the academia and industry and joint labs for facilitating up-to-date operational-level training can help develop resources as per the actual evolving needs of the industry.

These students are not very well versed with IT and technology on a day-to-day basis either, which becomes a disadvantage in their adaptability to technical training. Most of the training centers lack modern facilities, and need to upgrade significantly. This is a fundamental requirement as the use of modern technology tools can very well address these preva-

lent problems mentioned above. Here is how we can better our learning and development programs so that the gap is lessened and the youth are able to get hired into their right domain of interest:

- The challenge of adequate training infrastructure and capacities can be overcome efficiently today, especially with the advent of 5G technology. Virtual classrooms and training facilities could meet this requirement with minimal physical infrastructure spends. Virtual use of resources through technology can deliver the best available content and teachers, both global and domestic, to the students in the neediest places. This would bring uniformity in the training imparted, thus minimizing the difference in quality of training and content for the trainees, irrespective of their locations.
- A learning management system (LMS) may be used that would facilitate access to educational content through various technologies, such as the web, smartphones, tablets, DTH (direct-to-home) with toll-free voice channel, social media, CBTs (computer-based training), and traditional textbooks. 5G will further offer real-time remote teaching or even high-quality simulations through the use of AR/VR and AI technologies. The creators of the LMS should possess the requisite expertise in application development and utilization.
- A hub-and-spoke model can ensure equitable access to high-quality content and teachers for all students, fostering a comprehensive and productive learning environment. In this system, a highly qualified teacher, based in an urban area, can teach through an LMS from a studio, supported by a local teacher in rural areas, facilitating self-learning. The master instructor, preferably from the industry, can teach in Hindi, English, or other languages for global experts, while the local facilitator translates into the regional dialect, eliminating the need for content translation into multiple dialects. Advancements in natural language processing, like the government's *Bhashini* initiative, coupled with AI utilization, are expected to enhance this aspect further. This approach offers growth opportunities for local teachers, bridges the gap between students and the industry, and aligns with Digital India and Make AI in India objectives.
- Upon the completion of the course, students will have to undergo online assessments based on outcomes and heuristics. Technology specialists are needed to create assessment platforms meeting quality assurance standards. An ecosystem of assessors, supported by local facilitators, will conduct assessments online. The models for internet-

connected and non-internet-connected locations can use web or Android-based tablets. Furthermore, on obtaining a skill or academic certification, trainees will have the option to enter either the job stream or the entrepreneur stream.

On the technology part, 5G will facilitate high bandwidth, faster speeds, 100 times more capacity for aggregation of consumers, without any degradation in quality and access to last-mile teaching facilities with increasing network proliferation. It will provide access to unlimited digital highways without congestion, with the capacity to connect all entities and facilities to a central location for uniform training. Edge computing, enabled by 5G, could facilitate a hierarchy-based computing network, which would benefit the local students – the local edge could cater to the needs of the specific area/district, while connecting to the entire world. High-data applications can be utilized via overlay on 5G apps for the convenience and benefit of the trainees as well as teachers. 5G can also enable customized learning, based on deep analytics and student assessment, to cater to the specific needs of different segments of students. Moreover, the industry will get the benefit of choosing from a country-wide pool of uniformly trained resources to mold and absorb in their operations, as per their requirements.

The industry is encountering significant challenges in finding the ideal candidates who possess the necessary knowledge, skillsets and mindset for the desired job profiles. Additionally, the intense competition within the industry makes it challenging to attract and retain top talent. The evolving work environment and adopting hybrid ecosystems present further hurdles when relying on traditional methods.

Embracing technology-driven approaches in the hiring process and providing potential employees with opportunities to grow alongside the industry are effective strategies to overcome these challenges. Leveraging technology for upskilling empowers individuals to stay ahead of the curve, adapt to changing digital landscapes, and unlock new career opportunities. Moreover, it enables organizations to build a future-ready workforce that can drive innovation and competitiveness in the digital era. With cohesive efforts, we can build a future that is driven by knowledge, innovation, and the limitless potential of technology.

This article is authored by Lt. Gen. Dr. SP Kochhar, Director General, Cellular Operators Association of India (COAI). Views expressed are personal. ■

Spillover benefits from digital communications infrastructure

The overflow is greater than the mainstream!

Recently, Union Minister Anurag Thakur shared an anecdote of his chat with Google CEO Sundar Pichai, who said that he had to carry a physical copy of his vaccine certificate everywhere when he travels but, in India, the citizens have their vaccine certificate on their phones itself! He praised India's digital initiatives, highlighting the convenience of vaccine certificates being available on smartphones, a feat unmatched by any other nation. India's achievements in the digital realm and its inclusive approach have enabled it to showcase many digital practices ahead of the rest of the world. These are powered by investments made at a fast pace in the digital communication infrastructure (DCI), which in turn are creating a multiplier effect on other sectors, society, economy, as well as other neighboring countries!

DCI is the bedrock for driving economic growth and societal benefits. As per International Telecommunications Union (ITU), *"Digital infrastructure is the key to enabling the benefits of the digital economy and society. Digital infrastructure is the physical hardware and associated software that enables end-to-end information and communications systems to operate."* India is a mobile-first nation, with mobile accounting for 98 percent of overall connectivity. While mobile will continue to be the primary pillar of our DCI, it has to be supported by many other pillars, else it would be a substandard level of connectivity. Systems of fixed/cable infrastructure, public Wi-Fi, E band, V band, and satellite communications (Satcom) are some of the other key elements of digital infrastructure. Another subset of great importance to the nation is the digital public infrastructure (DPI). The latter is a collection of technological systems, platforms, and services that enable the Indian government, businesses, and citizens to interact digitally. Often referred to as the *India Stack*, it includes a number of building blocks, such as Aadhaar (a biometric identification system),

e-KYC (electronic know-your-customer), UPI (unified payments interface), and DigiLocker (a cloud-based document storage system). For a geographically diverse nation that India is, the availability of more than one type of digital infrastructure is vital to ensure that there is no dependency on one type of infrastructure and switching traffic load is easier between available technologies, in case of emergencies or disasters.

We all understand and appreciate that when a highway is constructed, companies can locate along those highways and sell their products; employment in the region will benefit; small businesses can start restaurants; and so on. Bustling new townships suddenly appear. All these developments are well known to contribute to not only the socio-economic ecosystem of the region but also generate economic effects, called spillover effects, through various streams of revenue to the government exchequer through various taxes, duties, and levies. The highway would have been established primarily for logistics and connectivity purposes but these unplanned spillover effects actually soon assume far greater importance than the original intention itself!

Similar to the above example, the digital communications highway will create benefits not only for the communications sector but also for many other sectors, such as education, healthcare, banking, logistics, retail, energy, etc., to name just a few. In fact, the entire economy will reap benefits in terms of GDP impact and tax collections, and may even have positive rippling effects for other economies. The spillover effects due to DCI include, but are not limited to, decrease in the costs of transactions, enrich market information, accelerate knowledge diffusion, enhance quality of decision making, augment productivity, all eventually increasing economic growth.

Unfortunately, quite so often, policy-makers lose sight

of the large spillover effects in the anxiety to raise quick monies to bridge the immediate fiscal deficit through imposition of duties and levies and spectrum auctions based on high reserve prices. This causes much long-term harm to the aspect of intrinsic public interest. If we are to leave no one behind in digital transformation (“Sabka sath, Sabka vikas”), we need to forego the limiting short-term gains in favour of the larger and more sustainable Spillover Effects of DCI.

During the Covid-19 pandemic, education and health were the two worst-hit sectors, but these sectors were able to quickly rebound due to online shift of service availability in India. With the outbreak of Covid-19, many schools closed down and students were left with no choice but to study from home. Fortunately, ICT saved the day for teachers and students. It also helped in overcoming difficulties during the distressing public health crisis by enabling people to connect, work, shop, and learn while maintaining restraints such as *staying at home* and physical distancing. Big data was used by many governments for various pandemic-control measures and impact measurement related to contact tracing, mobility, and health analysis. India also set an example for the entire world by setting up the world’s biggest vaccine factory that is supplying the vaccine around the world.

Former ADBI Dean, the renowned economist, Dr Naoyuki Yoshino, has carried out remarkable studies and pioneer work on the spillover effect of infrastructure investments. Dr Naoyuki Yoshino (who is now Professor Emeritus at Keio University in Tokyo) has authored several ADBI working papers on the subject, and has emphasized the need for greater digital infrastructure investment in Asian countries, keeping in mind the economic spillover effects. A study covering the *Spillover Effects of Information and Communication Technology Infrastructure in India* by N Yoshino, et al., clearly highlights the importance of digital infrastructure for healthcare and education, especially in the post-Covid era. Another study quantifies the short-term spillover effects in terms of increased state tax revenues. The study shows that *on average, an increase in the number of GSM subscribers by 10 percent is expected to raise per capita regional state revenues by ₹134 or roughly 3 percent of the average state tax per capita in 2016.*

A 2018 BIF-ICRIER (Indian Council for Research on International Economic Relations) study quantifies the growth dividends of digital communications. A 10-percent increase in mobile penetration delivers

on average a 1.9-percent increase in the rate of state GDP growth. A 10-percent increase in India’s internet traffic leads to on an average a 3.1-percent increase in GDP per capita and a 10-percent increase in India’s mobile traffic leads to on an average a 1.6-percent increase in India’s GDP. Further, a 10-percent increase in India’s telecom investment can lead to, on an average, a 3.3-percent increase in India’s GDP. Thus, the USD 100-billion investment envisioned in the NDCP-2018 could cumulatively add a whopping USD 1.21 trillion to India’s GDP.

Beyond econometric estimations, the spillover effects are also visible simply by looking at the government initiatives. The triangulation of Aadhaar, Covid Vaccine Intelligence Network (CoWIN), and UPI not only made sectors, such as essential services, healthcare, and banking, accessible to the citizens but also helped to reduce the urban-rural divide that the citizens faced in terms of these facilities.

Job creation is also an important consequence of digital progress. Estimated broadband employment creation multiplier that provides an estimate of the potential employment gains from effective broadband development, is between 2.5 and 4.0 additional jobs for each broadband job.

Finally, the spillover effect from robust DCI of one nation rubs off on to the neighboring countries positively. A study by Kim (2020) broadly implies that increased access to the internet can benefit not only own country’s economic growth, but also other neighboring economies to a higher extent. The various digital initiatives that provide banking, health, and education are rapidly adapted by the neighboring countries. The successes of Aadhaar, Co-WIN, and UPI that flourish in India due to DCI are few exemplary initiatives that have led to cross-country spillover effect.

Adequate bandwidth is a fundamental enabler of growth in the modern information society, and also the demolisher of *imbalances and a great leveler* (Dr Abdul Kalam, 14.12.2006). This bandwidth highway has to be laid through creation of near-ubiquitous digital communications infrastructure with a clear recognition of the massive spillover effects, which surpass even the mainstream benefits.

The article is authored by TV Ramachandran, Fellow of IET (London) and President of Broadband India Forum. Views are personal. Research inputs by Garima Kapoor. ■

Healthcare 2.0: Unlocking opportunities with emerging technologies

The objective of this series of articles is to highlight how emerging technologies can be leveraged to meet various Sustainable Development Goals-SDGs 2030, while impacting various domains. Another objective of this series of articles is to highlight how leveraging all these technologies can help create business opportunities in various domains. This time, our focus is going to be on *Smart Health*.

Good health and wellbeing is one of the Sustainable Development Goals (SDGs) – SDG3. SDG3 of Sustainable Development Goals-SDGs 2030 states: “*Ensure healthy lives and promote wellbeing.*” The primary objective of SDG3 is to ensure healthy lives and wellbeing for everyone, regardless of age, gender or socioeconomic status. It aims to address various health challenges, reduce preventable deaths, and promote physical and mental well-being, and in the process envisages:

- #1 Reducing maternal mortality and ensuring access to quality maternal and reproductive healthcare services.
- #2 Ending preventable deaths of newborns and children under 5 years old, with a focus on tackling major diseases, malnutrition, and providing vaccinations.
- #3 Combating major communicable diseases, such as HIV/AIDS, malaria tuberculosis, as well as non-communicable diseases like cancer and cardiovascular diseases.
- #4 Ensuring universal access to healthcare services, including access to essential medicines and vaccines, and strengthening health systems.
- #5 Addressing substance abuse, promoting mental health, and providing access to affordable and quality healthcare services for all.

Emerging technologies like Artificial Intelligence, Extended Reality, Blockchain, Big Data Analytics, Quantum Computing, Internet of Medical Things, 3D Printing, Digital Twins, Drones etc., ensure that concepts like Digital Health can be implemented to leap frog the traditional approach, as there is an acute shortage of all resources, including trained health professionals at the global level.

Artificial Intelligence (AI) and data analytics

Healthcare data, including maternal health records can be analyzed to identify patterns and risk factors associated with maternal mortality and complications, since it varies from place to place. These technologies can help develop predictive models to identify high-risk pregnancies, provide personalized care plans and proactive intervention. (#1)

AI can help analyze disease patterns and environmental factors to detect outbreaks and anticipate disease trends. Early detection and response to outbreaks can prevent the spread of infectious diseases and enable targeted interventions to protect children’s health. (#2)

AI can also analyze, genetic information and molecular structures to accelerate drug discovery and development. It can also identify potential drug candidates, optimize treatment regimens, and predict drug responses. This can significantly impact the development of new therapies for communicable and non-communicable diseases, including HIV/AIDS, malaria, cancer, and cardiovascular diseases. (#3)

Data analytics and AI algorithms can also analyze large-scale healthcare data, providing insights for evidence-based decision-making and resource allocation. These technologies can help optimize healthcare delivery. It can also support clinical decision-making, risk stratification, and personalized treatment plans, improving health outcomes and efficiency of care. (#4)

Data from online assessments, surveys, and social media can be analyzed to identify individuals at risk of substance abuse or mental health disorders. It can

assist in the early identification of symptoms, prompt appropriate interventions and guide personalized treatment plans. It can also improve the efficiency of mental health screenings and support the scalability of services. (#5)

Telemedicine and telehealth

Prenatal care, postpartum care and advice on reproductive health can be enabled through telemedicine network in rural and remote areas as well. Video consultations and remote monitoring devices can be helpful in the process. (#1)

Telemedicine platforms can connect healthcare providers with patients in remote guidance, consultations and follow-up care for both communicable and non-communicable diseases. (#3)

Telemedicine facilitates access to healthcare services, including primary care, specialist consultations, and follow-up visits. It can reduce travel costs and time, overcome geographical barriers and improve healthcare access for marginalized populations. (#4)



Teletherapy and online counseling services enable individuals to receive therapy, counseling, and support for substance abuse, addiction and mental health issues. Teletherapy thus expands access to mental healthcare, especially for those in underserved areas or facing barriers to in-person services. (#5)

Electronic Health Records (EHRs)

EHRs can help improve the management of maternal healthcare information in terms of a comprehensive and centralized record of a woman’s medical history, facilitating continuity of care between different healthcare providers, thus leading to informed decision-making, reduced medical errors, and improved coordination during the course of this entire cycle. (#1)

EHRs for children can help in the comprehensive management of vaccination records, growth charts, and medical history, besides improving coordination of care and enable healthcare providers to identify trends, patterns and gaps in healthcare delivery. (#2)

EHRs and data analytics can facilitate comprehensive management of patient information, disease surveillance and research, besides enabling tracking of disease trends, identifying risk factors and developing targeted interventions for communicable and non-communicable diseases. Data-driven insights can help formulate public health strategies, personalized treatments and early interventions. (#3)

EHR systems can streamline healthcare delivery, improve coordination of care, enhanced patient safety, besides enabling healthcare providers to access patient information and medical history, reducing duplication of tests, improving medication management and supporting continuity of care. Also this process can contribute to data collection for health system monitoring, resource allocation and policy planning. (#4)

Internet of Medical Things (IoMT)

Wearable devices, such as smartwatches or patches, can monitor vital signs, fetal heart rate, and uterine contractions. These devices enable healthcare providers to remotely track the health status of pregnant women, identify potential complications early on, and provide timely interventions. (#1)

Telemedicine platforms and remote monitoring devices can facilitate remote consultations and monitoring of children’s health. Parents or caregivers can share vital signs and report any concerning symptoms to the healthcare providers. This can help in the management of chronic conditions, timely response to emergencies and continuous monitoring of children’s growth and development. (#2)

Wearable devices, such as smartwatches and fitness trackers, can collect real-time health data, monitor vital signs and track disease progression. These devices enable remote monitoring of patients with chronic conditions, allowing healthcare providers to intervene early in case of complications and optimize treatment plans. They can also promote preventive behaviors and encourage individuals to adopt healthier lifestyles. (#3)

Wearable devices with biosensors can monitor physiological and behavioral indicators associated with mental health and substance abuse. These devices can detect changes in heart rate, sleep patterns, physical activity and stress levels. Digital biomarkers derived from these data can aid in early detection, personalized interventions and tracking treatment progress. These can also be used for pain control, smart belt for protection of elderly people against falls and ingestible sensors for prevention of drug abuse. (#5)

Extended Reality

Extended Reality (ER), which includes Virtual Reality (VR) and Augmented Reality (AR), can be used to create immersive and interactive educational experiences for both healthcare providers and pregnant women. These technologies can simulate medical procedures, childbirth scenarios and complications, allowing for better training and increased awareness about maternal health. (#1)

ER can enhance health workforce training and capacity building. These can provide realistic training scenarios, allowing healthcare professionals to practice procedures, clinical decision-making and emergency responses. This technology reduces the need for physical resources and can reach a broader audience, improving the skills of healthcare providers globally. (#4)

Post trauma stress management, Parkinson's management, patient phobia management, rehabilitation process, special surgeries, robotic surgeries, precision biopsies, healthcare training and smart medical education can be effectively undertaken using Extended Reality.

Drones

Drones can be used to transport essential medical supplies, such as blood products, medications, vaccines and emergency equipment like defibrillators in remote and inaccessible areas, thus overcoming

geographical barriers and ensure timely access to life-saving interventions for pregnant women, children or other patients in need of the same. Drones can also help transport critical patients from remote and inaccessible areas.

Quantum computing

Quantum computing aids speeding up of machine learning process, helps create antidotes for diseases like Alzheimer's and cancer, besides drug development, silico clinical trials, speeding up DNA sequencing and analysis.

Blockchain

Patient Data storage and protection, clinical trials, analysis of medical procedures, supply chain management and drug traceability can be ensured using Blockchain. Besides, it would help in improving transparency, traceability and accountability in the distribution process, reducing inefficiencies, stockouts and identification of counterfeit products.

Digital twins

Digital twins help evaluate surgery risk assessment, patient monitoring and development in drug therapy model.

3D printing

Prosthetics, dentistry, porous bone structures, bioprinting of bio parts including cartilages can be enabled leveraging 3D printing. This could be a big boon in the developing countries with a lot of citizens with physical challenges.

Mobile health (mHealth) applications

Mobile apps can provide valuable information on prenatal care, nutrition, childbirth and postnatal care in the form of reminders for important appointments and medication schedules. Besides this, the apps can enable women to track their own health indicators enabling them to report any abnormalities promptly. (#1)

Mobile apps can serve as valuable tools for health education, awareness and behavior change. They can provide information on proper nutrition, breastfeeding, immunizations, hygiene practices and early childhood development, besides sending reminders for vaccination schedules, growth monitoring, and nutrition interventions, ensuring that parents and caregivers stay informed and take necessary actions. (#2)

Mobile apps also enhance disease management and self-care for individuals with communicable and non-communicable diseases, besides providing educational resources, medication reminders, symptom tracking, and lifestyle interventions. For instance, mHealth apps can assist individuals with HIV/AIDS and non-communicable diseases in adhering to therapies, and monitoring their blood pressure, glucose levels or physical activity. (#3)

Mobile apps can provide access to healthcare information, health education and self-care tools. They can facilitate appointment scheduling, medication reminders, symptom tracking and remote monitoring. mHealth apps can also support supply chain management for essential medicines and vaccines, ensuring their availability and accessibility. (#4)

For developing nations, meeting these key objectives is quite a task, for various reasons, including limited resources, high poverty levels, limited access to education, food insecurities, lack of health infrastructure, limited access to clean water and sanitation, high rate of infectious diseases and finally being on the wrong side of the digital divide.

Emerging technologies facilitate the development of online healthcare marketplaces and telemedicine platforms that connect individuals with affordable and quality healthcare services. These platforms offer transparent pricing, facilitate access to healthcare providers, enable individuals to compare options and make informed decisions about their care. They can promote affordability, reduce barriers to access and increase healthcare choices.

Indian experience

Let us take the case of India, a developing nation with a population of 1.4 billion, with 70 percent of them (about a billion) living in 650,000 villages. So, for universal access to healthcare services we need minimum 650,000 well-equipped quality primary health centers, including healthcare professionals in the rural India alone. Considering the fact that some villages are several square kms in size, even one such health center is not any luxury. This is just the beginning of the challenge. The quality of healthcare professionals is the other facet of it. India is not alone. A large number of African nations and Asia and the Pacific islands have similar challenges. 46 Least Developed Countries (LDCs) are from these

regions. This is where technology can come to our rescue.

In 2008, the Government of India established a Pan-African e-Network platform, linking 53 nations of Africa to India, for education and health services. Over the next decade more than 5500 sessions of Continued Medical Education (CMEs) and also telemedicine (TM) sessions were conducted from AIIMS New Delhi, Apollo, Amrita, Fortis, SGPGI Lucknow, and other hospitals in India, for capacity building in Africa. This was a dream project of Dr. APJ Abdul Kalam, our former President. This was India's demonstration of how technology can be leveraged for capacity building in the domain of health, in a rare example of South-South cooperation. This was followed by another such program for the SAARC nations – Afghanistan, Bhutan, and Nepal. India also prepared a roadmap for an e-Network for the Pacific Small Island Nations in 2010.

Dr. Kalam also wanted the Pan-African experience to percolate down to the Indian villages, which have been getting a raw deal even after independence. So, with Telemedicine Society of India, we were able to establish a model for the Rural Telemedicine system. Let us hope that the same gets implemented on ground, across the country, so that the citizens living in the hinterland of the country do not have to move from pillar to post when they need medical attention.

Conclusions

Emerging technologies like Artificial Intelligence, Internet of Things, Quantum Computing, Extended Reality, Block Chain, Big Data Analytics etc., can play a significant role in taking healthcare to the hinterland of the developing nations. It would help in meeting all the five targets of SDG3, by 2030.

There is a tremendous scope for new businesses in the MSME segment also to flourish, while meeting the objectives of SDG3, leveraging these emerging technologies. A paradigm shift is expected to happen in the domain of healthcare in India and the other developing world as well, in the coming years!

This article is authored by Vimal Wakhlu, Former Chairman & Managing Director, TCIL. Views expressed are personal. ■

NextG: 6G

Let me get the déjà vu part behind us at the outset. 6G promises to revolutionize the way we live, work, and interact with our digital surroundings. As we adopt 5G in its complete glory, 6G offers the first tantalizing glimpse of its power. This focus on 6G may seem to be premature or predictable but it is, nevertheless, prominent at this juncture. While India has announced its 6G task force, the US has announced its Next-G alliance (I think the nomenclature itself ensures it continues to perpetuity!). It is noteworthy and interesting that the timelines are identical – 6G by 2030.

networks more efficient, reliable, and cost-effective, and also leveraging the mobile network to integrate the distributed computing resources for richer and more dynamic cloud services to applications, making them more powerful. The 6G WAC must provide a cloud framework that works in tandem with the 6G communication systems, enabling distributed applications to be deployed, using resources of multiple public, private, and hybrid clouds. I am aware that this is the bottom line here and now for 5G, but it is not true for 6G, ostensibly the next G, because it is set to evolve. Let us see how.

What will change?

Evolution across key parameters			
Issue	4G	5G	6G
Per device peak data rate	1 Gbps	10 Gbps	1 Tbps
End-to-end (E2E) latency	100 ms	10 ms	1 ms
Maximum spectral efficiency	15 bps/Hz	30 bps/Hz	100 bps/Hz
Mobility support	Up to 350 km/hr	Up to 500 km/hr	Up to 1000 km/hr
Satellite integration	No	No	Fully
AI	No	Partial	Fully
Autonomous vehicle	No	Partial	Fully
XR	No	Partial	Fully
Haptic communication	No	Partial	Fully
THz communication	No	Very limited	Widely
Service level	Video	VR, AR	Tactile
Architecture	MIMO	Massive MIMO	Intelligent surface
Maximum frequency	6 GHz	90 GHz	10 THz

Emanating from these parameters, the new-generation technology would bring forth several powerful changes and capabilities.

Let us discuss a couple of them. *Evolution to wide area cloud*

The journey of integrating communication and compute has begun with 5G, and as they say well begun is half done, but it is poised to go further and deeper with the concept of 6G wide-area cloud (WAC). WAC is the integration of cloud concepts into the 3GPP network so as to make the mobile

The convergence of mobile communications and cloud computing drove the definition of the service-based architecture (SBA) of the 5G Core (5GC), which in turn enabled network function virtualization (NFV) and cloud-native network function (CNF) as the cloudification of 5G mobile networks. This path of convergence is expected to continue to evolve in the 6G system (6GS), resulting in a 6G WAC. The 6G WAC is envisioned to be comprised of intelligent and ubiquitous computing, communication, and data services, spanning regional and metro area data centers, cell sites, on-premise equipment, and devices. Both the 6G system functions and applications can be supported as workloads by 6G WAC. In 4G and 5G, the network gained the ability to implement service chaining after the communication

tunnel anchor point (e.g., the 4G PGW or 5G user plane function, UPF), potentially introducing functionality that can better serve the needs of the user plane.

The transition of 5G to 6G will advance this evolution by making network programmability accessible to network operations as well as customizable services. This transition lays the foundation for creating cloud-native environments to adopt cloud computing technologies and further enable the flexibility to introduce new functions and services, dynamically orchestrate network resources, and steer traffic to the desired path.

Mostly, broad principles are being set now and details will have to be filled up gradually, so let us bear the pain of slow stacking up of concepts and principles. The following aspects need to be borne in mind while defining the next generation of mobile technology.

First, to manage the interdependencies between computing- and data-related aspects and the mobile system, it would be necessary to define the service requirements, exchanging and leveraging special capabilities, and requesting transport for advanced services (e.g., chaining and pipelining) in computing and data. The computing management functions will interact directly or indirectly with the core network, radio access network (RAN) nodes, devices, and applications to enable communication-aware computing services. The 6G architecture shall have to reflect these interactions by way of new functions, information interchange, joint control, and optimized functionalities.

Second, ubiquitous computing requires disaggregation of the services provided as well as the capability of allocating and orchestrating the distributed resources for services based on various requirements and business models. To enable efficient deployment of applications, the WAC architecture must permit easy reservation and activation of services across multiple domains. 6G scalability requirements need to address challenges, including defining the relationships, such as between controlling orchestration requests (e.g., intent-based) for compute, communication, and data resources, the orchestration of selected resources, and choices between central versus distributed control. The computing and data services are planned to be widely distributed in 6G; disaggregated components would be placed along a chain of computing nodes from user devices to network sites to data centers. The 5G-based mechanisms of service discovery, capability exposure, transport management, and traffic steering may face scalability and efficiency issues. For example, service discovery may require finer grained approaches to find a service instance in the 6GS compared to current domain name system (DNS) queries. Protocol enhancements may be needed to traditional mobile protocols to provide sufficient routing flexibility. Also, the integration of mobile devices for computing and data services further requires modifications to the existing air interface functions and protocol stack.

The 3G/4G/5G protocol stack is oriented toward point-to-point communication for a service, where the upper sublayers provide a bearer construct between fixed termination points. As applications evolve toward a

model requiring computing at different locations, this fixed-endpoint approach becomes more poorly matched to the needs of the underlying application. Although support for XR services in 5G is optimized from Release 18, these services are expected to develop significantly from 5G into 6G, becoming more widespread and more demanding in terms of the required network and compute capabilities. It is plausible for an XR service to have some computation performed at the local device (e.g., headset), some at a paired smartphone with better battery life, and more computational power than the form-constrained headset, some at the network edge, and some in an application server, accessed through the operator's core network – all as part of a single service from the user's perspective. Such multilocal distribution of computing should be expected as normal behavior from a service using the distributed cloud. The 6G protocol stack(s) should, therefore, naturally enable these use cases without increasing the complexity of the stack. Additional application classes can be expected to benefit from robust and native support of distributed computing, for example:

- AI/ML services involving multiple nodes, such as distributed federated learning, in which multiple peer nodes interact rather than relying on a single central server.
- Latency-sensitive transcoding of video formats to enable near-real-time display on a device that may have limited compute capability of its own.
- Secure multi-party computation, which may be important for 6G system security, and for applications that need to act on private data.

Tactile/haptic Internet

The tactile Internet is one of the most interesting advances that 6G promises to deliver and enable haptic interaction with visual feedback. Basically, human reaction time depends on the sensory stimulus and whether the human is prepared or unprepared for the situation. When reacting to a sudden, unforeseen incident, the time-lag for a human, sensing a stimulus and responding with a muscular reaction, is in the range of 1 second. Tactile/haptic Internet, thus, focusses upon way of transmission of information/feedback/interaction with the help of touch. The human auditory reaction time is about 100 milliseconds. To enable natural conversation, modern telephony is designed to ensure that voice is transmitted within 100 milliseconds. Higher latencies would disturb us. A typical human visual reaction time is in the range of 10 milliseconds. To allow for a seamless video experience, modern TV sets have a minimum picture-refresh rate of 100 Hertz,

translating into a maximum inter-picture latency of 10 milliseconds. But if a human is expecting speed, such as when manually controlling a visual scene and issuing commands that anticipate rapid response, 1-millisecond reaction time is required. Examples are moving a mouse pointer over a screen and viewing a smooth path of the pointer over the screen or moving our heads while wearing virtual-reality (VR) goggles and expecting an immediate response from the visual display. The most challenging latency requirement for technical systems arises in tactile or haptic interaction – our sense of touch and the movement of our limbs interacting with visual or auditory feedback. Human body interactions with machines demand a strict latency requirement in the order of 1 millisecond. If the time-lag between (say) the virtual picture and human movement is above 1 millisecond, cybersickness may occur, with users becoming disoriented in an experience similar to the motion sickness sometimes suffered at sea, in the air, or on the road.

ITU has defined the following possible use cases of haptic Internet:

- *Education and learning.* With haptic interactions, difference between class room teaching and virtual teaching would become non-existent, thus vastly improving effectiveness and accessibility
- *Healthcare.* The amalgamated expertise of medical doctors connected via the tactile Internet during remote diagnosis and treatment, as well as through the combination of experienced surgeons' tactile sense with the high spatial precision of robot-assisted operations, would make for a zero-error rendering of health services.
- *Personal safety zones.* A safe *bubble* can be created to interact with nearby objects, also connected to the tactile Internet. Applied to road traffic, in the long term, this safety zone will be able to protect drivers, passengers, and pedestrians. Vehicles will detect safety-critical situations and react instantly to avoid traffic accidents and warn other objects of impending danger. In production environments, occupational safety levels will improve as production machines or robots will detect and avoid the risk of harm to people in their vicinity.
- *Traffic in a smart city* will be optimized by heeding local safety constraints as well as parameters, such as the overall traffic density in a smart city. Guided autonomous driving or platoon driving will allow for a continuous traffic flow in which safety and energy efficiency will be significantly improved as compared to today's situation.
- *Energy.* In decentralized electrical energy generation

and distribution networks, the tactile Internet enables dynamic activation and deactivation of local power generation and consumption, potentially even considering the AC phase information to minimize the generation of unusable reactive power.

Haptic Internet would have the most significant impact on the *virtual reality* space. Haptic feedback is a prerequisite for high-fidelity interaction, allowing the user to perceive the objects in the VR not only audio-visually but also via the sense of touch. This allows for sensitive object manipulations as required in tele-surgery, micro-assembly, or related applications, demanding high levels of sensitivity and precision. When two users interact with the same object, a direct force coupling is brought into existence by the VR, and the users can feel one another's actions. High-fidelity interaction is only possible if the communication latency between the users and the VR is in the order of a few milliseconds. During these few milliseconds, the movements of the users need to be transmitted to the VR server, where the physical simulation is computed and the result is returned to the users in the form of object status updates and haptic feedback. So, 6G would have to be designed to cater to these expectations.

The haptic Internet would be a big step toward inclusive society for people with disabilities. The tactile Internet would become their extended world, providing the sensory inputs, and taking them to the other side of the communication chain. Also, the support and assistance provided to people with disabilities by exoskeleton-based artificial limbs and power amplifiers will improve their mobility, ensuring them the ability to lead a self-determined life.

In the ever-evolving landscape of wireless communication, technological advancements continue to push the boundaries of what we once deemed possible. As we adapt to the rapid growth of smart devices and the Internet of Things (IoT), the world eagerly awaits the dawn of the next generation of wireless connectivity – 6G. In summary, the transition from 5G to 6G will bring faster speeds, reduced latency, seamless connectivity, advanced AI integration, and transformative applications across various sectors. Common people will experience a new level of convenience, efficiency, and connectivity, transforming the way they live, work, and interact with technology.

This article is authored by Alka Selot Asthana, Executive Director - Telecommunications Consultants India Ltd. Views expressed are personal. ■

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Unleashing the digital growth

Developing a framework for digital infrastructure expansion

Quick and reliable data access is one of the critical requirements for economic growth, innovation, and social progress as our world becomes more and more reliant on digital technologies. Thus, governments and private sector organizations worldwide invest heavily in developing and maintaining digital connectivity infrastructure to improve the quality of life and drive economic growth. This makes digital connectivity infrastructure an essential ingredient for businesses, governments, and individuals as our world becomes more dependent on digital technologies.

Especially in India, for escalating the economic growth of the country, the government has set the vision of developing digital infrastructure as a core utility for every citizen, and the *Digital India* program has been launched. The government has focused on digital services to enhance the last-mile deliveries and bring better transparency and accountability in the governance system. The role of digital infrastructure has assumed an increased importance. Even this year's economic survey states that in the coming years, availability and spread of digital infrastructure will contribute significantly to economic growth.

Telecom sector has witnessed exponential growth in the past decades. There exists a robust licensing/registration framework, which has evolved over the years, under which various stakeholders operate across various layers of connectivity, including infrastructure creation, network deployment, service provisioning, and application delivery.

The NTP 1999 is a significant milestone in the history of Indian telecommunications, as it recognizes the vital role that telecom infrastructure plays in the growth of the sector and in meeting the growing demand for telecom services. In 2000, the infrastructure provider (IP) category was introduced to promote the growth

of telecom infrastructure. The IP model has two categories: IP-I and IP-II, with IP-I limited to providing passive infrastructure, such as towers, ducts, and dark fiber on lease/rent/sale basis to telecom service providers. By enabling infrastructure sharing among different service providers, the IP model promotes cost efficiency, reduces duplication, and facilitates rapid expansion of telecom services to underserved areas.

IP-II could establish digital network, provide transmission capacity, and could lease/rent out/sell end-to-end bandwidth to the other licensees of telecom services. IP-II were required to pay license fee. But IP-II licenses were discontinued effective December 2005.

The advent of Machine-to-Machine (M2M) communication and Internet of Things (IoT) services is paving way for the Fourth Industrial Revolution (Industry 4.0). New-generation mobile technologies like 5G are providing broadband highways with very low latency capabilities, generating enormous use cases across verticals. All this will be requiring existing networks to be upgraded and developing advanced infrastructure with enhanced technologies.

Also as per National Digital Communications Policy (NDCP) – 2018, lot of emphasis is laid on digital infrastructure stating that "Digital infrastructure and services are increasingly emerging as key enablers and critical determinants of a country's growth and well-being." The *Connect India Mission* advocates for creating robust digital communications infrastructure.

The *Propel India* mission, which states that "There is an imperative need to review the existing licensing, regulatory, and resource-allocation frameworks to incentivize investments and innovation to optimize new technology deployments and harness their

and transmission system only. This is appropriate as allowing the sharing of core network nodes is not advisable due to the inherent complexities and challenges involved. The complexity of the core routing and services would make it difficult for a single node to manage multiple PLMN traffic, and implementing different or separate charging mechanisms and lawful interception (LI) provisions would be extremely challenging.

UL licensees may be concerned about the quality of DCIP's infrastructure and its impact on customer services. To safeguard this, DCIP licensees with the new UL authorization must comply with guidelines on security, data privacy, and quality of service. These requirements on DCIP will ensure better network availability for end-users.

DCIPs should not be permitted to obtain MWB spectrum allocation under their license to avoid conflicts of interest with TSPs. DCIPs should be permitted to purchase equipment only for bands in which they have tie-ups with UL licensees. The Authority must also find ways to encourage purchase of equipment to the extent possible from the domestic manufacturers under the *Make in India* program and to promote *Atmanirbhar Bharat*.

Some stakeholders have suggested to maintain a level playing field, and not to impose regulatory levies twice, and pass-through should be allowed. It is suggested that no license fee (LF) on DCIP licensees should be levied to avoid cost increases that would negate the benefits of sharing. Hence, the proposal of TRAI to not levy any license fees on DCIPs is supported; this will encourage and incentivize them and attract more players/investment in the sector.

Also National Digital Communications Policy (NDCP) – 2018, under the *Connect India* mission with a goal to "*Ensure connectivity to all uncovered areas*" is set to be achieved by 2022. Also a goal "*To provide 1 Gbps connectivity to all Gram Panchayats of India by 2020 and 10 Gbps by 2022*" has been set.

Ground reality reveals startling facts. As per TRAI data, Rural tele-density stands at 57.79 percent as on Feb 28, 2023. Because of pure business priorities and lack of wherewithal, TSPs are not able to penetrate further in the remaining unconnected area and contributing enough to enhance the rural tele-density further and extend broadband penetration. While urban internet subscriber density stands at 104.77 percent, in the rural

it stands at 38.33 percent. At this pace, one can imagine how long it will take to connect rural India. Because of the reasons, there is apprehension that with lack of investment and priorities of 5G roll out for rural area, this will potentially further widen the digital divide.

It is envisaged that with advent of DCIP, sharing of active infrastructure will reduce the cost for the service providers, which will help them make the rural business case much more doable with affordable tariff for the rural masses.

Also, it is important that digital infrastructure providers are permitted and are made eligible to participate in the USOF tenders. This will not only have significant impact on the viability of rural connectivity in unconnected areas but will also provide sharing of infrastructure, which can be used by multiple service providers at additional delta cost. This will also ensure competitive service offering for the rural communities from multiple service providers.

As an additional significant player, this new category of infrastructure providers will not only bring fresh huge capital, which is critical for the exponential growth of the digital infrastructure in the country but will also encourage lot of innovation in the country for development of innovative and sustainable technological solutions for sharing of BTS/RAN solutions for ensuring continuous reduction of active infrastructure sharing cost.

A new category that creates advanced digital infrastructure, as required, with evolving enhanced technologies including 5G/6G, M2M, IOT and Industry 4.0 so as to speed up connectivity penetration in the country.

Specialized service providers can use this infrastructure, promoting efficient resource utilization by allowing it to be shared among all types of licensees.

In summary, the consultation process should focus on simplifying the licensing/authorization process for the new category of *Digital Connectivity Infrastructure Provider*. This will create a level playing field and a conducive environment for rapid growth of digital infrastructure in the country, while defining a proper framework for this category.

The article is authored by Sanjeev Kakkar, a Telecom Expert. He has held various CXO level positions in technology companies. Views expressed are personal. ■

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Vijaywada | Patna | Jaipur | Raipur

Intelligent connectivity for the digital industry

Every year, May 17 is celebrated as the World Telecom Day and I must state that I am absolutely proud to have been associated with the telecom industry for almost 24 years by virtue of my past association with AT&T India and Telstra India, donning multiple roles. We have all seen the massive strides made by the telecommunications industry over the last few decades and the profound impact it has had on the world. In our increasingly interconnected global society, the telecom industry stands as the backbone of modern communication, linking individuals, communities, and nations like never before. Its influence is felt across all facets of our lives, transcending geographical boundaries and time zones. The telecom industry continues to serve as a catalyst for economic growth, driving innovation, productivity, and efficiency across various sectors. By providing the infrastructure and platforms that enable businesses to collaborate, operate, and reach customers globally, telecom networks are a driving force behind economic expansion and job creation.

Impact of the telecom industry during the Covid situation

One can never forget how the telecommunications industry played such an important and critical role during the Covid pandemic. Thanks to the high-speed cellular and broadband networks, serving both the Enterprise and the Consumer segments, businesses continued to run and the wheels of the economy were moving when lockdowns and social distancing measures were the norm. Platforms, such as Zoom, Cisco Webex, Microsoft Teams, etc., ensured seamless collaboration as people were using these platforms to connect with colleagues, clients, and classmates as schools and businesses were shut down. With increased adoption of Cloud during the pandemic as enterprises moved many of their critical applications to cloud platforms, the need for ensuring reliable connectivity was an imperative, and one must compliment the telecom service providers for having risen to the occasion by ensuring uninterrupted and reliable connectivity so as to ensure business continuity.

Evolution of connectivity

If I look back at the past, every upgrade in connectivity has driven social development. During the early days of the industrial era, telegraphs and telephones transformed long-distance communication. In the information era that succeeded the industrial era, cellular mobile, fiber, and data communications have enabled the explosive growth of the internet and rapid development of the global economy. When I started my career in the mid-nineties, during my stint with a company that manufactured statistical multiplexers at that time that were used for mainframe to terminals connectivity using 9.6 kbps/14.4 kbps leased lines. Indian Railways were a big user of these multiplexers for connecting the mainframe computers in metropolitan cities to remote computer terminals across multiple cities and towns for the passenger reservation application. During my stint with Telstra V-Comm (a JV between Telstra Australia and VSNL) from 1996 onwards, I have vivid memories of installing large 3.8-meter diameter VSATs on rooftop buildings for organizations across India, wanting to connect their offices using satellite communications links. A 128-kbps satellite link during those days was billed at a whopping Rs 20 lakh per annum. With the privatization of the telecom sector, and with the cost of terrestrial communication links coming down, we have seen the transition from low-speed X.25 packet-switched networks and high-cost frame relay networks to high-speed networks – from kbps to Mbps and now to Gbps. From an enterprise standpoint, we have seen how network architectures evolved from using leased lines to private MPLS-based VPNs, and we now are seeing growth of SD-WANs that are providing application aware, low-cost, and secure connectivity.

Now, we are entering the intelligent era, and this requires intelligent connectivity. Individuals, homes, and enterprises require more from connectivity, which is increasingly embedded with technologies, such as AI and cloud. With the advent of 5G, IoT, AI/ML, AR/VR, 3D printing, and metaverse, we stand on the cusp

of a digital revolution that will reshape industries and economies in the years ahead. Intelligent connectivity will become a critical enabler for businesses across various sectors, from manufacturing and retail to healthcare and finance. With the Covid-19 pandemic accelerating the adoption of digital technologies, intelligent connectivity has become even more crucial for enterprises to stay competitive and agile.

The connectivity industry is experiencing a few major changes. The first change is moving from plain vanilla IoT to connected intelligent twins. In the current era, where people and homes are the key focus, connectivity is the main goal – specifically, the connectivity of every physical asset. As we start to see the integration of intelligence in our day-to-day lives, thanks to AI-powered consumer applications and intelligent chatbots, and the fusion of AI into enterprises accelerates, we need to connect more things, more intelligently. The second change is for the telecom service providers to move from providing best effort to differentiated, deterministic, and predictable services. Connectivity requirements vary with industries and different service scenarios. For example, smart city applications require massive connections, while smart factory use cases require predictable latency. Providing differentiated services is table stakes, and deterministic assurance is mandatory. Only after the telecom service providers develop these two capabilities can they gain a foothold in vertical markets. The third change is moving from manual operations and management (O&M) to a state of hyper-automation. 5G, AI, and cloud significantly enhance network capabilities, but also bring challenges to operating and managing networks. As compared with 4G networks, 5G networks increase connection density significantly and the number of network configuration parameters by a factor more than 10,000. As current network complexity increases, manual O&M is just not good enough. Big data analytics and AI must be deeply integrated to simplify decision-making, implement hyper-automation, and free people from unnecessary complexity. These changes highlighted above clearly imply that the value of the connections depends not only on the quantity of connections, but also on quality, bandwidth, and latency of these connections.

For the telecom service providers, intelligent connectivity solutions present a great opportunity to add additional value over the basic layer of connectivity and offer end-to-end solutions that

create business impact for enterprises, and thus drive additional revenue streams. The need for telcos to morph themselves into techcos is an absolute must, if they have to show differentiation and compete in a hyper competitive marketplace. For the enterprises, intelligent connectivity can address a number of challenges that they face in the day-to-day running of their businesses, for example for a manufacturer use cases around predictive maintenance, asset optimization, robotic motion control, monitoring of AGVs, AI-powered computer vision for quality will see huge traction, connected supply chain will drive a number of use cases around track and trace, etc., and for discrete manufacturers the ability to now fuse IoT and AI into products and make them smart, intelligent, and connected will be a game changer. Intelligent connectivity can also drive more use cases, which can impact employee and customer experience, and this gives an opportunity for enterprises to innovate around their business models, leveraging the power of IoT, AI, etc., to drive new revenue streams.

Conclusion

As the industry becomes more digital, current industrial connectivity has to keep pace and hence evolving toward advanced and intelligent connectivity is essential for realizing the digital industry. Intelligent connectivity is characterized by agility, flexibility, performance, security, energy efficiency, ease of installation, cost effectiveness, location accuracy, and the need to support diverse industrial applications with specific latency, speed, and power requirements. 5G connectivity addresses most of them and hence becomes a strong contender to adopt, along with current technologies, during this evolution toward intelligent connectivity. In the future, the sixth generation of connectivity technologies (6G) will continue to develop in various aspects, such as scale, time, and space. 6G will provide significant bandwidth improvements, much lower latency, and widen coverage to evolve an intelligent society into a futuristic society. Any assumptions about the future of connectivity may be significant underestimates and hence the best way to predict the future is to create the future. Let us advance toward the intelligent connectivity era together as it requires the entire ecosystem to collaborate to make this happen.

This article is authored by Sunil David, Digital Technology Consultant; Ex-Regional Director (IoT)-AT&T; Co-Chair of Digital Comm. Group of IET Future Tech Panel; and CII National AI Forum Member. Views expressed are personal. ■



FACE-TO-FACE

Dr Satya N Gupta in a series of exclusive interviews with business leaders inviting their comments on blockchain technology and its impact on business

Interview with Anurag Agrawal and Kamlesh Nagware



Anurag Agrawal

Co-Founder & Director
DataBloc Technologies

Dr. Satya N. Gupta

Chairman - Bharat IPv6 Forum &
Chairman - Blockchain for
Productivity Forum

Kamlesh Nagware

CTO Blockchain
Snapper Future Tech

Having been an early starter in Blockchain technology, how do you see development of Blockchain ecosystem in India?

Anurag

I have been working in Blockchain technology since 2016. Having understood the revolutionary potential of this technology, with its key features of decentralization, provenance, security, and immutability, I decided to start my own company in Blockchain space in 2018. Of course, having an experience of more than 2 decades in the industry at that time helped me in initial stages of this journey.

In the last 5 years, there has been a substantial interest in Blockchain and allied areas like Web 3, metaverse, and non-fungible tokens (NFTs) in the country. The industry, the public sector, as well as the academia have come to better appreciate the power of Blockchain technology, and how it can be used in their digital transformation journey. Recently, we conducted a three-day training program on Blockchain at the National Academy of Indian Railways (NAIR), Vadodra, for top railway officials, and the response was overwhelming. Blockchain is still in an early stage, as compared to other new-age technologies like artificial intelligence (AI), data analytics, cyber security, etc. Adoption of Blockchain is on an exponential path in India, and there is no doubt its adoption will catch up even more as we see real benefits coming out.

Kamlesh

My Blockchain journey started when I was a part of IBM India during 2016–2018, and currently as the CTO of a Blockchain startup Snapper Future Tech. The Blockchain community is rapidly growing in India, with an increasing number of people interested in the potential of decentralized technologies and the internet of value. Polygon is an India-homegrown Web3 infrastructure company, focusing on a Layer-2 scaling solution for Ethereum that aims to provide faster and cheaper transactions with a higher degree of scalability. Every Blockchain protocol is looking at India to set up a Blockchain community. In recent times, Algorand, Polkadot, and Layer1X have started India-centric approach.

In India, state governments are piloting various e-governance use cases; for one of the state governments (Telangana), we did a pilot in 2018 with land registry department and a similar trial has been done in other states like Andhra Pradesh, Kerala, Maharashtra, Madhya Pradesh, and Tamil Nadu. As per the government statistics, more than 20+ state governments are trying e-governance implantations. There are many initiatives

by the Indian government. NITI Aayog, which is the Indian government's Planning Commission, NISG (National Institute of Smart Governance) and recently the Indian government issued their national Blockchain strategy and Center of Excellence for Blockchain (Apiary by Meity & STPI) startups to help startups and government to adopt Blockchain technology for smart governance. We are also a part of Apiary to work with e-governance projects. E-rupee CBDC by RBI, NIC building national Blockchain infrastructure, Tamil Nadu e-Governance Blockchain infrastructure, CBSE issuing certificates on Blockchain, NPCI and other FinTech having Blockchain practice and building innovative solutions for country.

Whenever there is any discussion on Blockchain, the topics of bitcoin and cryptocurrencies invariably come in. How do we get around this noise and set the wheat apart from the chaff?

Anurag

This is a question which I'm frequently asked and I'm glad you brought it up. We need to understand that Blockchain is the underlying technology and bitcoin and all other cryptocurrencies are applications built on top of it. Apart from cryptocurrencies, Blockchain has hundreds of other use cases in all industries – from retail to healthcare and supply chain to the public sector. Blockchain is being used to store patient medical records, tracking and tracing of products through the entire supply chains, creation and administration of carbon credits to tackle climate change - to name just a few. Somehow, bitcoin is in the news because people think of it as an easy and fast way to make money without understanding the underlying Blockchain technology.

Government of India (GoI) has come up with regulations to safeguard the interest of investors, but more needs to be done at a global level because bitcoin and cryptocurrencies are decentralized peer-to-peer payment networks without any central authority issuing or managing them. India's G20 Presidency is the right opportunity to work on this with all stakeholders worldwide. I would also like to add here, regulations should be made in a way that it doesn't hinder the development and adoption of technology and it's important to have industry experts on board for this.

Kamlesh

It's true that when discussing Blockchain technology, bitcoin and cryptocurrencies often become part of the conversation due to their historical significance and their role in popularizing Blockchain. However, it is essential to separate the underlying technology of Blockchain from its applications, such as cryptocurrencies like bitcoin. To distinguish the core

BLOCKCHAIN

principles and potential of Blockchain technology from the noise surrounding cryptocurrencies like Bitcoin, it's important to adopt a balanced and informed approach with education, awareness, and identifying right use cases solving the real-world problems. Having a balanced and informed regulatory framework is important, which is very important for mass adoption. Also, Blockchain influencers, leaders, and authorities should talk about Blockchain beyond bitcoin. You can listen to my Ted Talk on the same subject – “Cutting through the noise around Blockchain” – <https://youtu.be/FUZDdIYF6bw>.

How do you think the Blockchain industry is going to impact IT and the telecom industry?

Anurag

The impact of Blockchain technology on telecommunications industry is extensive and far reaching. We know Blockchain technology is being used in the telecom industry to automate processes, such as billing, roaming, and supply chain management. Also, due to its unique properties of transparency and data immutability, it is being used by communication service providers (CSPs) for fraud prevention and identity and data management.

But here I would very briefly touch upon a futuristic use case of Blockchain technology in telecom, which we are working on:

Blockchain technology can be used to ensure secure and error-free peer-to-peer connectivity for hundreds of Internet of Things (IoT) devices with cost-efficient self-managed networks. We know IoT sensors usually carry sensitive information about core assets or information pertaining to customers of the company, which makes data and network security an essential and costly pillar of IoT connectivity. In this case, Blockchain allows for highly secure peer-to-peer self-managed mesh networks using a sufficiently large

number of nodes. To start with, these networks can be introduced into a private environment, based in mid-range cell-towers, which need low investment requirements. By establishing such a network in a public Blockchain (like Ethereum), further expansion or evolution into a public Blockchain enables seamless connectivity and security. CSPs could then provide private/public key security to enable such a public Blockchain network with a global reach. provide private/public key security to enable such a public Blockchain network with a global reach.

In fact, some of the well-known companies in telecom space like British Telecom, Huawei, Samsung, and Verizon have secured patents in Blockchain for telecom solutions.

Kamlesh

The Blockchain industry is set to have a profound impact on the IT and telecom sectors. It will enhance data security and privacy, streamline supply chain management, automate processes through smart contracts, revolutionize identity management and authentication, enable decentralized communication networks, and foster new business models through tokenization. These advancements will bring increased efficiency, transparency, and cost savings to the IT and telecom industry, paving the way for innovative applications and disrupting traditional paradigms.

India has always been the pioneer in software development in the world for at least 25 years. Keeping this leadership stature in mind, what would be your advice to the young talent pool in India to look at Blockchain and decentralized ledger technologies (DLT) as a career/entrepreneur option and what is the way forward?



Anurag

The real boom and mass hiring in Indian IT sector came during late 1990s when Y2K or *millennium bug*, as it was called, created a scenario of potential disruption in computer systems around the world. After that, India has been at the forefront of tech innovation, research, and product development. Technology has been a critical driver of India's rapid economic growth, and it continues to transform the country's IT landscape at an unprecedented pace. Apart from all global companies ramping up India operations, India has witnessed a burgeoning startup ecosystem with supportive government policies, increased access to venture capital funding, and a culture of innovation and entrepreneurship.

Blockchain technology is still in its early stages of development, which means there is significant potential for growth and advancement. The demand for Blockchain talent is growing rapidly as more and more industries begin to explore the potential of the decentralized ledger technologies. Things like the decentralized Web, popularly called Web 3, are coming up to make people-powered internet a reality. The continuous growth of Blockchain as one of the revolutionary technologies in recent times has spurred a wide range of job roles like Blockchain developer, solution architect, UX designer, quality engineer – to name just a few. These roles have a very high demand in the market, offering one of the best salaries to youngsters apart from a great path of career progression.

India also has a very vibrant Blockchain startup ecosystem. It is estimated there are over 200 Blockchain startups in the country offering innovative solutions across numerous industries, including finance, healthcare, supply chain, and more.

Kamlesh

As a leader in software development and IT services, India's young talent pool has a tremendous opportunity to explore careers and entrepreneurial ventures in Blockchain and decentralized

ledger technologies (DLT). As per the Nasscom report, India is home to 450+ Web3 startups with a USD 1.3 billion of investment in the last 2 years. Between 2021 and 2022 alone, India registered more than 170 new Web3 startups, yielding over 50-percent CAGR growth since 2015, according to the study. 11 percent of the Web3 talent is in India, making India the third biggest talent pool in the web3. This pool is growing at the fastest rate worldwide, at 120 percent likely in the next 1–2 years.

Here are some ways to encourage the growth of the Web3 community in India:

- *Education and awareness.* Educating people about Web3 technologies, their benefits, and how they work is critical to the growth of the community. Companies, organizations, and individuals can offer educational resources, such as online courses, workshops, and meetups, to help people understand the potential of Web3 technology.
- *Community building.* Building a strong and supportive community is essential to the growth of the Web3 community in India. This can be achieved through social media groups, online forums, and in-person meetups, where people can share ideas, collaborate, and network with like-minded individuals.
- *Supporting local projects.* Supporting local Web3 projects can help showcase the potential of the technology and encourage adoption. Local projects can be anything from developing decentralized applications (dApps) to creating Blockchain-based solutions for local problems.
- *Collaboration.* Collaboration is essential for the growth of the Web3 community in India. Companies, organizations, and individuals can work together to develop innovative solutions and drive adoption of Web3 technology.

Regulatory clarity. Providing clear and supportive regulatory frameworks for Web3 technologies can encourage investment in the industry and drive innovation. This can provide certainty and encourage businesses to develop and invest in Web3 projects. ■



A portrait of Jürgen Hatheier, a man with short brown hair and glasses, wearing a blue shirt and a grey blazer. He is smiling slightly. The background is a light blue gradient.

Enabling Indian MSMEs to break new ground with 5G

Jürgen Hatheier,
Chief Technology Officer-International,
Ciena

Service providers in India are already looking at the limitless opportunities that 5G can offer enterprises keen on digital transformation. It is not uncommon to see service providers encouraging enterprises to tap onto their 5G networks, leveraging services such as real-time network slicing and the ability to run cloud applications on-demand. For instance, Airtel announced a strategic partnership with Vultr, a privately held cloud computing

company, to offer cloud solutions to Indian enterprises earlier this year.

Such examples mean that enterprise customers would not need to worry about how to adopt 5G or build their own 5G infrastructure – and can use 5G as-a-service in real-time. In a digital-first future, such all-encompassing, open and cloud-ready solutions may be the cornerstone

of every enterprise's operations.

What about Micro, Small, and Medium Enterprises (MSMEs)? How does 5G apply to this select group, and what is the opportunity for service providers?

With around 630.5 lakh micro-enterprises, 3.3 lakh small businesses and 0.05 medium businesses, India has one of the largest pools of Micro, Small, and Medium Enterprises (MSMEs) in the world, contributing significantly to the country's economy. As the 5G ecosystem continues to grow in India, it promises to transform how MSMEs compete in India by enabling new use cases like remote surgery, Industry 4.0, and smart cities. This will enable MSMEs to maximise profit by improving both productivity and efficiency.

Most MSMEs rely extensively on mobile phones and public wireless networks to run their business. This is hardly surprising, considering a significant percentage of people in India access the Internet for the first time via mobile.

The Covid-19 pandemic also accelerated the adoption of mobile enterprises from all segments, including MSMEs. A recent survey, MSME Digital Index 2023, conducted by PayNearby, reveals that 66 percent of MSMEs use smartphones for business activities consuming 2GB-5GB of data each day. Interestingly, 55 percent of surveyed MSMEs used mobile hotspots to connect to the Internet at work and 73 percent used mobile Internet to connect to the Internet at home. On the other hand, only 30 percent of the surveyed MSMEs used Wi-Fi routers, and the use of ethernet cables and dongles was just 10 percent and 5 percent.

Gaining new capabilities and efficiencies

All this makes 5G extremely relevant to small and medium enterprises in the country. The promise of ubiquitous coverage providing ultra-high speed and extremely low latency of less than one millisecond will provide more reliable connectivity to small businesses, helping them to focus on their core competencies to grow their business. Furthermore, the 5G network increases mobile network capacity over 4G, allowing more users to connect to the network without any impact on network performance than ever before.

The growing aspirations of new-age India demand improved connectivity and 5G will play a crucial role in ensuring this. Since its launch in India in October 2022, 5G has already helped the country improve download speeds by 115 percent, from 13.87 Mbps in September 2022 to 29.85 Mbps in January 2023, as per the recent Ookla report.

5G will open up a world of new opportunities for Indian MSMEs by providing a robust connection to cloud

applications. For MSMEs dependent on network-related tasks, such as online sales or sharing of documents and files across the cloud, having access to faster speeds means these businesses will be able to get tasks done quicker and more efficiently. This, in turn, will help enhance the workforce's productivity, leading to improved bottom lines. Cloud computing has already become a crucial component of any digital transformation, whatever the size of the organisation. More reliable connectivity will help in the wider adoption of cloud-based applications and, in turn, will fast-track the digital transformation of MSMEs.

The promised low latency provided by 5G will allow people to communicate more effectively and efficiently, which is especially relevant to MSMEs working in logistics, healthcare, and manufacturing. Low latency also drives improved customer experiences, where every sale is crucial to commercial success.

5G levels the playing field by empowering MSMEs to be as agile digitally as they are operationally. It also enables them to be more innovative by providing opportunities to explore new business models and technologies, like the Internet of Things (IoT). 5G's growing ecosystem will allow MSMEs to leverage the capabilities of the IoT to grow their revenue by improved management of operations.


Furthermore, they will also be able to use other 5G-connected technologies, like Virtual Reality (AR) and Augmented Reality (AR), to better train their employees and to showcase their competencies to prospective customers.

The MSME opportunity for service providers

As per the latest data released by the Indian Government, MSMEs contributed 26.83 percent in Gross Value Added to the country's GDP in 2020-21. By 2025, the Ministry of MSME aims to increase the sector's contribution to up to 50 percent of the country's economy. The potential for MSME growth is limitless.

For instance, Fixed Wireless Access (FWA) is a key use case of 5G and can allow service providers to provide high-speed connectivity to MSMEs in remote and difficult-to-reach areas. Typically, these areas have remained unconnected because it could be expensive to lay and maintain fibre. 5G FWA changes this and will play a crucial role in bridging the digital divide and in empowering small businesses in rural and remote areas to participate actively in the global digital economy.

For 5G to truly help MSMEs, it is important to have available a robust network that is designed, built, and managed to provide ubiquitous coverage with the high speed and low latency that mobile MSMEs need. Only then will MSMEs be able to leverage the vast potential of 5G technology to enhance productivity and efficiency to grow their business and revenue. ■

A portrait of Paul Atkinson, CEO of Optical Networking at STL. He is a middle-aged man with short, dark hair, wearing glasses, a dark blue pinstriped suit jacket, a white shirt, and a red tie with blue polka dots. He is smiling slightly and looking towards the camera. The background is a solid light blue color.

“ Telecommunication at the forefront of digital transformation: The role of optical fibre ”

Paul Atkinson,
CEO-Optical Networking,
STL

In December 2022, India's total subscriber base reached 1170.38 mn with a tele-density of 57.69 percent for rural subscribers. The overall wireless internet data usage has increased almost 7 times from around 4,200 petabytes in 2018 to 32,397 petabytes in 2021, making India one of the biggest consumers of data worldwide. According to TRAI, the average wireless data usage per wireless data subscriber was 16.40 GB per month in June 2022,

a significant increase from 61.66 MB in March 2014.

The Department of Telecommunications was allocated USD 11.92 billion in the Union Budget 2023-24, out of which USD 48.88 million is for Research and Development and USD 611.1 million is for BharatNet. Additionally, the FDI inflow in the telecom sector between April 2000-December 2022 stood at USD 39.02 billion.

These numbers indicate that the telecom sector in India is poised for continued growth and development.

Affordable high-speed internet has been key to India's digital transformation, thanks to the growth of 4G and 5G networks. Telecoms have also driven financial inclusion through mobile banking and digital payments. Telemedicine has made healthcare more accessible, while online education has opened up new opportunities.

OFC: Enabling the present & future of telecom

As the telecom industry rapidly advances, digital transformation is driving it to new heights, with emerging technologies such as 5G networks and the IoT revolutionizing the way people communicate and do business. At the forefront of this transformation is optical fibre. Its role has become increasingly important in creating a robust digital network. The development of a deep fibre backbone is key to the creation of a ubiquitous network. In this regard, government support through initiatives such as BharatNet aims to develop around 10,000 km of OFC infrastructure across India by fiscal year 2024-25. The National Highways Authority of India (NHAI) has unveiled its intentions to establish an integrated network spanning approximately 10,000 kilometers of OFC infrastructure throughout India by the fiscal year 2025. NHAI's subsidiary, National Highways Logistics Management Limited (NHLML), will spearhead the project, constructing utility corridors along national highways to facilitate the development of the OFC infrastructure. This extensive OFC network will extend internet connectivity to remote regions in India and support the country's transition to advanced telecommunication technologies like 5G and 6G.

With digital transformation accelerating, the telecom industry is relying on optical fibre to provide the necessary infrastructure for many of the latest telecommunication technologies. Connecting smart city devices, such as sensors, cameras, and traffic lights, connecting hospitals and clinics enabling them to share data and images in real time, connecting schools and universities, enabling them to deliver online courses and collaborate with other institutions, etc, the benefits are far too many.

Optical fibre has emerged as a game-changer in the deployment of 5G networks, given the high bandwidth and low latency requirements of this next-generation technology. The use of optical fibre as a backbone for the 5G network infrastructure enables seamless interconnectivity among its various components. Moreover, its superior transmission capabilities, especially over long distances, contribute significantly to lowering the cost of 5G network deployment.

It is a critical component for the IoT which involves connecting a massive number of devices and sensors that require high-speed data transfer and low latency.

For instance, in smart cities, thousands of sensors are used to monitor traffic, weather, pollution levels, and other critical data. Optical fibre provides a high-speed backbone network that can handle the massive data traffic generated by these sensors, enabling real-time monitoring and analysis for improved decision-making.

Cloud computing is one of the fastest-growing sectors in the tech industry, and OFC is playing a big role in enabling its growth. Businesses that are migrating to cloud services require fast and reliable data transfer rates with low latency to ensure a smooth transition. For instance, a company can use OFC to connect to a cloud service provider and transmit large amounts of data quickly and securely. This is essential for businesses that rely on cloud services for tasks such as data storage, software applications, and virtual machines, among others.

Charting the path forward

India's telecom market has seen explosive growth over the past few years, making it the world's second-largest telecom market. Its worth noting that the wireless segment accounts for 95.4 percent of the total telephone subscriptions, highlighting the importance of mobile devices in the country.

Looking ahead, the rise in mobile-phone penetration and declining data costs are expected to further increase internet usage in India, with an estimated 500 million new internet users set to come online over the next five years. The falling cost of data has made it possible for people and businesses to use data in ways that were not possible just a few years ago. For example, people can now stream movies and music, play online games, and work from home without having to worry about data costs. Businesses can now use data to collect customer information, track inventory, and automate processes. This presents significant opportunities for businesses, especially those operating in the digital space.

To support this growth, the Indian government has made significant investments in telecom infrastructure, with approximately USD 78 billion spent on laying 5,84,747 km of OFC as of July 2022, connecting 1,87,245 Gram Panchayats (according to IBF). Moreover, service is already available on fiber and satellite in 1,81,888 Gram Panchayats. This infrastructure will be essential in providing high-quality connectivity to new internet users in India, and the growth in infrastructure is expected to continue to meet the demands of the expanding market.

As a result, the telecom industry in India is poised for significant growth, and businesses that can capitalize on this opportunity stand to benefit greatly. The stage is set for innovative companies to develop cutting-edge technologies that can help meet the evolving demands of the market and take advantage of the new wave of internet users. ■

A portrait of Sameh Yamany, Chief Technology Officer at VIAVI Solutions. He is a middle-aged man with dark hair, wearing a dark suit, white shirt, and a patterned tie. He is smiling slightly and has his arms crossed. The background is a light blue gradient.

Hyperscale and 5G

Sameh Yamany,
Chief Technology Officer,
VIAVI Solutions

By 2025, the digital universe is expected to reach 175 zettabytes. The numbers are staggering, but the hyperscale ecosystem is rising to the challenges in meeting the insatiable demand for memory, bandwidth, computing power, storage, and speed. At the same time, cloudification is blurring the proverbial lines between networks and applications, while 5G technologies are pushing more intelligence to the edge of the network. The

hyperscale ecosystem and the breakthrough technologies accompanying it are turning these unprecedented challenges into opportunities for operators worldwide.

Hyperscale use cases

The primary 5G use case categories of Ultra Reliable Low Latency Communication (URLLC), Enhanced Mobile Broadband (eMBB), and Massive Machine

Type Communication (mMTC) frame a variety of new verticals with unique requirements and performance expectations for latency, densification, bandwidth, speed, and other essential characteristics. Despite the requisite cloudification and redistribution of intelligence from the core to the edge, hyperscale data centers will continue to play a pivotal role in the scalability, SLA conformance, and network efficiency that supports these verticals.

• Factory Automation

The manufacturing sector has recognized the potential of private edge cloud computing to provide a responsive central nervous system connecting breakthrough robotics, material handling and predictive maintenance applications. This market has expanded as 4G transitions to 5G and private companies leverage URLLC to enable next-generation factory automation or “Industry 4.0”. High bandwidth is required to support smart factory data rates from 1-20 Gb/sec. Densification of real-time IoT sensors can number in the millions for a single deployment. Hand tools as elemental as screwdrivers are now being converted into intelligent devices, continuously streaming torque, position, and calibration data back through the network. Data center software plays a pivotal role in coordinating and analyzing IoT sensor data and optimizing predictive maintenance trigger points.

• Connected Health

The healthcare industry presents an equally multi-faceted set of verticals encompassing online consultations, remote surgeries, AR/VR training for nurses, telemetry and data management applications, each with disparate latency, bandwidth, privacy and mobility requirements. While routine health check-ups and record transfers may be more forgiving with respect to latency and reliability, cutting edge remote surgical procedures underscore the need for end-to-end network monitoring and assurance. The coordinated data analytics, AI, and machine learning (ML) capabilities of the hyperscale data center and edge computing locations must flawlessly address these flexible requirements to ensure patient safety and mitigate healthcare provider’s liability.

• Unmanned Data Centers

The next generation of data centers, particularly at the edge, will be overwhelmingly lights out (unmanned). This new reality has accelerated the development of the data center IoT vertical with its own unique and dedicated network slice. The data-center-as-use-case leverages the same real time 5G IoT sensing and remote automation that is redefining manufacturing plants, smart ports, retail centers, and stadium venues. Robots or drones can effectively perform important surveyance tasks within the center, while URLLC can be used to queue automatic links to service dispatch. Much like smart



Data centers are moving to a ‘lights out’ and proprietary IoT model

port sensors within shipping containers, strategically deployed temperature and humidity sensors can feed back important environmental data to automate and expedite hardware and HVAC adjustments.

Disaggregated 5G networks

Use cases like these are poised to reshape industries for the better, allowing businesses to dive more granularly into data and chart new paths for efficiency. However, with costs and complexities only set to rise, some of the biggest challenges for hyperscalers will be driven by the intricacies of distributed, disaggregated, cloud-native 5G networks.

With technologies like virtualized RAN, massive multiple input – multiple output (MIMO), and antenna beamforming further complicating radio frequency (RF) and network performance testing, new challenges will likely emerge around spectrum analysis, demodulation, and service-level agreement (SLA) conformance. This end-to-end network complexity is a challenge in a world where operators have to meet higher customer demands for performance, efficiency and reliability, while also managing their own stack.

Network stress testing prevents failures, lowers costs and boosts performance

To overcome this and fully realize the power of 5G and Open RAN, infrastructure must be equipped with seamless end-to-end network slicing orchestrated for the needs of each unique vertical it serves. This requires a departure from legacy methods of data center and network testing and assurance because critical 5G IoT use cases leave no margin for error around reliability and SLA conformance.

New developments in network stress testing can assist in safeguarding or even preventing potential real-world failures. In contrast, pre-deployment testing for 5G verticals could be broadened into RF testing and certification, RAN transport or Xhaul connection calibration and verification, and application, slicing analytics, and emulation. By emphasizing upstream testing and validation, network operators can reduce unplanned outages, troubleshooting or the need for updates after deployment while also boosting performance. ■



RedCap: The Advanced IoT for 5G network



Prashanth Kaithamana

Senior Director – Sales & Marketing
Anritsu India Private Limited



RedCap stands for *reduced capability*. RedCap is the 3GPP IoT wireless specification designed to address several generic and specific use cases for 5G NR. The current state of RedCap can be traced back to several requirements in the industry that culminated due to multiple and overlapping requirements from use cases and IoT verticals.

There are several reasons why RedCap is needed from

an infrastructure and operator's point of view. It is important to note that while 5G networks are being deployed globally, they are not all the same 5G network types. There are two distinct 5G network types – stand alone (SA) and non-stand alone (NSA). The SA networks rely completely on 3GPP 5G specifications for all device and infrastructure equipment. NSA networks rely on both 3GPP 4G and 5G specifications. This means that SA-

only devices are specifically designed for 5G networks, and do not support 4G technologies, such as LTE-M and NB-IoT. This can be a problem for operators of pure green-field 5G networks (no legacy 4G installations) and regional mandates for devices to support SA, if they want to satisfy IoT requirements.

RedCap offers a migration path from 4G to 5G as spectrum is migrated to new bands. The number of 5G NR bands is expected to grow just as they did between legacy technologies 2G→3G and 3G→4G. In fact, RedCap can operate in the FR2 bands offering entirely new spectrum that would otherwise not be available for 4G devices.

RedCap bridges the gap between 4G IoT and 5G NR technologies. Finally, IoT service providers will eventually need to sunset legacy technologies and need a migration path forward. Many 2G/3G devices and services are nearing end of life as it makes economic sense to move to more efficient technologies. RedCap will offer the most longevity of them all as 5G technologies are expected to be around even further than 4G by taking us into the next 1–2 decades.

The primary benefit of RedCap is the new use cases that RedCap addresses by enabling cost-effective devices. There are three initial IoT 3GPP Rel-17 use case requirements by the industry needed to be solved – industrial wireless sensors, video surveillance, and wearables. Each of them has slightly different requirements across data rate, latency, reliability, and battery life.

Lower-complexity wireless hardware in the devices means simpler modem and RF front-end architectures. Lower number of antennas and less MIMO allow for lower device costs. No or less duplexers (depending on the band), less amplifiers, and filters can greatly simplify the components of RedCap devices, so the form factor can be designed around specific use cases. This reduction of hardware also directly benefits the costs of the devices. In addition, RedCap devices are not required to support as many frequency bands as 5G smart phones, further lowering costs typically seen in 5G smart phones. These hardware reductions will also allow for smaller devices, which are critical in the wearables RedCap use cases. Due to these hardware and cost reductions, we should expect to see many new 5G devices and use cases develop in the coming years. We may even see much lower-cost 5G smart phones based on RedCap. Additionally, we would expect the number of use cases to grow as 3GPP continues further development of RedCap specifications.

RedCap specifications were included in 3GPP Rel-17 and finalized in June of 2022. It will take around a year for modems and RF front ends to arrive. Eventually modules

and end-devices will take another year or less. So, we should expect to see some of the first RedCap devices to appear around the end of 2023 on to middle of 2024, depending on the level of complexity and integration of the RedCap devices. This will be the appropriate time as global operators will continually be deploying 5G SA networks over the next several years.

NR and RedCap devices especially need the RRC_Inactive state for reduced latency and to send small amounts of data while not requiring the extra overhead of RRC connection establishment from RRC_Idle state. RRC_Inactive is not available in 5G NSA. Measurements are still performed for the serving cell, intra-frequency, inter-frequency as well as interRat for e-Utran cells. This means all the robustness of NR mobility allows device engineers to re-use much of the core NR software. In addition, a RedCap device can have the ability to move to LTE networks, if desired. Of course, the LTE capability must be designed into devices, but it is an option. Link recovery functionality is also specified for RedCap just as NR.

Rel-17 RedCap has only begun the reduction of complexity to lower cost and increase battery life. There is still much to be done for RedCap. 3GPP has already been working on RedCap Rel-18 (NR Advanced) items for study. This RedCap Phase-2 is planned for initial release in early 2024. Some of the features under study include:

- Sidelink – direct 5G device to device communication
- Positioning – better location for accuracy applications
- Unlicensed band – availability of shared spectrum
- Multicast and broadcast (MBS) – point to multi-point services
- RedCap device types – classification of RedCap devices.

We can expect additional use cases to be defined that will address challenges in the world, such as drones, power grids, robotics, industrial, transportation, asset tracking, AGV, wearables (e.g. smart watches, wearable medical devices, AR/VR goggles, etc.), industrial wireless sensors, and video surveillance etc. Therefore, RedCap technology will change industrial and consumer arena totally which leads to energy conservation and reducing carbon footprint.

Anritsu provides cutting-edge solutions for upcoming telecommunications technologies, ranging including RedCap from indoor coverage mapping in small wireless systems to over-the-air testing in large wireless networks. Our complete solutions are designed to meet your ever-changing market needs. Anritsu has accumulated key strengths in various technologies and know-how, including signaling, protocol, conformance, and RF measurement. Anritsu uses these strengths built over many years to offer customers optimized 5G measurement solutions, supporting the fastest time to market (TTM). ■

A portrait of Purushothaman KG, a man with dark hair and glasses, wearing a dark pinstriped suit jacket, a white shirt, and a purple patterned tie. He is looking directly at the camera with a neutral expression. The background is a light blue gradient.

Key trends in telecom sector: India 2023 and beyond

Purushothaman KG,
Partner and Head, Digital Solutions &
Telecommunications Industry Leader,
KPMG in India

The year 2022 was a revolutionary year for the Indian telecom industry with some high-decibel, stand-out developments and regulatory initiatives taken to boost the digital economy. The launch of 5G services was a big turning point, ushering the era of technological advancements and connected ecosystem. It was also encouraging to see multifaceted telecom reforms and announcements made in Union Budget 2023 that shows

positive outlook and growth potential of the telecom industry and become a defining sector of the decade.

GSMA's 'Government Leadership Award 2023' to India is a testimony showing global confidence in India telecom industry's growth backed by strong regulatory reforms and initiatives driven by the telecom ministry around spectrum auctions, digital inclusion, sustainability,

next generation technology innovations, and enhanced consumer welfare.

Defining trends in 2023 that contributed to this global recognition

Ease of setting up digital infrastructure. Advancements in “GatiShakti Sanchar” portal eased the Right of Way (RoW) approvals for efficient deployments of network infrastructure, resulted in faster mobile tower clearances for more than 85 percent of applications. More than 200,000 5G sites are deployed over the last eight months across cities due to efficient and faster approval processes.

Announcements for future readiness – Union Budget 2023 has announced setting up 100 test labs for developing applications for 5G services, focus on upskilling the youth on emerging technologies and creation of COEs for AI with a vision of “Make AI work for India”.

Focus on climate and sustainability – Green solution initiatives have been taken with a focus on cost reductions, power saving, energy efficiency, reducing associated carbon emissions, and utilizing hybrid power sources with solar and wind energy.

Strengthen data protection and governance – Initiation of the data governance policy in draft to drive growth initiatives of startups to monetize non-personal data in a secured and legal manner. The benefits that are derived from access to anonymized data will enable data models in machine learning and AI to be tested across industries in conjunction with Data Protection Bill 2022.

Cybersecurity - Initiatives taken to enhance the cybersecurity and privacy posture across the entire digital ecosystem adopting enhanced security technologies and capabilities such as EDR/ XDR, Zero Trust Architecture, Cloud Security, IoT Security.

Developing India as an investment destination – Investments of around ₹4,115 crores are committed by more than 40 companies under PLI scheme including 28 MSMEs to expedite production for telecom and networking products focusing to enable 5G roll-outs and device compatibility.

With remarkable breakthroughs reforms in 2022, new propositions through the Telecom Bill (expected to be tabled in the monsoon session) and significant focus to expand digital ecosystem, India is all set to leapfrog and lead the world with forward looking momentum to continue through to 2023 and beyond.

Roadmap 2023 and beyond – India ahead with setting forth the 6G vision for India

Bharat 6G vision document aims to facilitate finance R&D, design, and development of 6G technologies

by Indian startups, research bodies, and universities to enable India to become a leading global supplier of IP, products, and solutions for affordable 6G telecom solutions. Phase 1 (2023 to 2025) is expected to explore ideas, risky pathways, and proof-of-concept tests. Phase 2 (2026 to 2030) is expected to develop ideas, establish use cases and benefits, create IP, and set up test beds for commercialization.

5G widespread implementation of proofs of concepts, use-cases across sectors is set to take the industry forward in its journey to realize the full 5G potential. As per KPMG’s 5G enterprise survey, more than 85 per cent of enterprises across multiple sectors are expecting up to 20 per cent ROI on various 5G/industry 4.0 use-cases. For 21 percent of the 5G/industry 4.0 use cases, the median gestation period (period between conceptualization, solution building, to launch) will take 6-12 months.

Deployment of open-source solutions like Open RAN, open Wi-Fi, open digital architectures will be significantly mainstreamed this year and will find greater acceptability as key drivers of innovation and cost competitiveness.

Investments to digital infrastructure – With 5G services being available PAN India, proper indoor coverage is still likely to push beyond 2023 and enterprises adoption also may face some pushback to navigate a downturn in the macroeconomic scenario. Towers fiberization, and small cell deployments will continue to be deployed on wider scale.

New Telecom Bill and Data Governance policy – The government is scheduled to release the second draft of the Telecom Bill 2022 sometime in 2023. The bill expects to address the legacy and current issues facing the telecom sector but also proposes to provide a future-ready framework.

Data governance policy is quintessential to effectively drive growth initiatives of startups to monetize non-personal data in a secured and legal manner. The benefits that will be derived from access to anonymized data will enable data models in machine learning and AI to be tested across industries. The policy will also be reviewed in conjunction with the initiative of the government on the Data Protection Bill, 2022.

Satellite based communication services – TRAI has released a consultation paper on Assignment of Spectrum for Space-based Communication Services and we may possibly see satellite communication and internet services launch in India possibly by end 2023. Satellite internet will be key to delivering internet services to remote areas which are difficult to cater via broadband or mobile network. ■

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Telecom, IT, and Internet revolution in India – Government initiatives, manufacturing, 5G, role in economy and exports

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Dhanendra Kumar,

Chairman, Competition Advisory Services (I) LLP;
Formerly Executive Director for India, Bangladesh, Sri Lanka and Bhutan, The World Bank;
Secretary to Government of India, Ministry of Defence; &
Chairman, Committee on National Competition Policy;
www.Compad.in



India has witnessed a remarkable revolution in the telecom and IT sectors over the past few decades. The bright Indian entrepreneurs, advent of new technologies, and support of the government initiatives have transformed India into a global powerhouse in telecommunications and digital economy. This article explores the government initiatives supporting the sector, significant contributions of the industry to the

Indian economy and exports, manufacturing of telecom equipment, the rollout of 5G technology, and the emerging challenges.

India is now rapidly emerging as a global leader in the Internet economy, duly supported by the government initiatives, contributing significantly to the economic growth and exports. According to a joint report by Google-

Temasek-Bain, released recently, India's Internet economy is expected to register a six-fold surge during the decade, reaching USD 1 trillion by 2030.

India has emerged as a prominent hub for telecom equipment manufacturing, attracting both domestic and international players. The government's Make in India initiative has played a pivotal role in encouraging local manufacturing, reducing dependency on imports, and boosting jobs. Several leading companies like Nokia, Ericsson, Samsung, and Apple have established manufacturing facilities in the country, for the production of a wide range of telecom equipment.

The government had last year extended the PLI scheme for telecom and networking products to 42 beneficiaries, with a total committed outlay of ₹4115 crore. Out of these, 17 companies had applied for additional incentive of 1 percent, as per the stipulated criteria under designed manufacturing, aimed to build a strong eco-system for 5G. To boost it further, the government has just announced a modified version *PLI Scheme 2.0* for IT hardware – covering laptops, tablets, all-in-one PCs, servers, and ultra-small form factor devices – with a budgeted investment of ₹17,000 crore. It is expected to generate 17,000 direct and 2 lakh indirect jobs, and a likely production of USD 24 billion by 2025-26 and exports of USD 12–17 billion.

The rollout of 5G technology in India is poised to be a game changer for the telecom industry. 5G promises higher data speeds, lower latency, and enhanced connectivity, opening up possibilities for innovative applications across sectors, such as healthcare, education, transportation, and manufacturing. The government has actively pushed the adoption of 5G technology, manufacturing of equipment, and spectrum auctions to enable its commercial deployment. The rollout of 5G is expected to accelerate digital transformation, fuel innovation, and provide a boost to the overall economy.

The Prime Minister launched the 5G services in October 2022, and within 8 months, these services rolled out in all 28 states and 8 UTs, making it the fastest 5G rollout in the world. During this period, 200,000 sites covering 700 districts have been covered with 5G mobile spread having fiber connectivity, even to the hilly and remote areas. Such fiber connectivity supports extremely high Internet bandwidth for seamless access at various locations providing much superior voice and video call quality.

The government has introduced several initiatives to promote the growth of the telecom and IT sectors. The *Digital India* campaign aims to transform India into a digitally empowered nation and knowledge economy. It focuses on improving digital infrastructure, expanding broadband connectivity, and increasing digital literacy. The National Digital Communications Policy 2018 aimed

to attract investments, promote ease of doing business, and ensure universal broadband access. These initiatives have created an enabling environment for telecom and IT companies, fostering innovation, entrepreneurship, and job opportunities.

The telecom and IT sectors have emerged as key contributors to the Indian economy. The rapid expansion of mobile and Internet penetration has connected millions of people, bridging the digital divide and enabling access to various services. Telecom and IT companies have been significant contributors to the country's GDP, employment generation, and tax revenues. The sector has stimulated economic growth, attracting investments, and fostering technological advancements. Additionally, the increased adoption of digital services has facilitated financial inclusion, e-commerce growth, and digital payments, further driving the economy forward. During the pandemic, digital economy received a big boost, with e-commerce in goods and services carrying the daily life and businesses on its shoulders, be it trade, education, healthcare, or delivery of government services, etc.

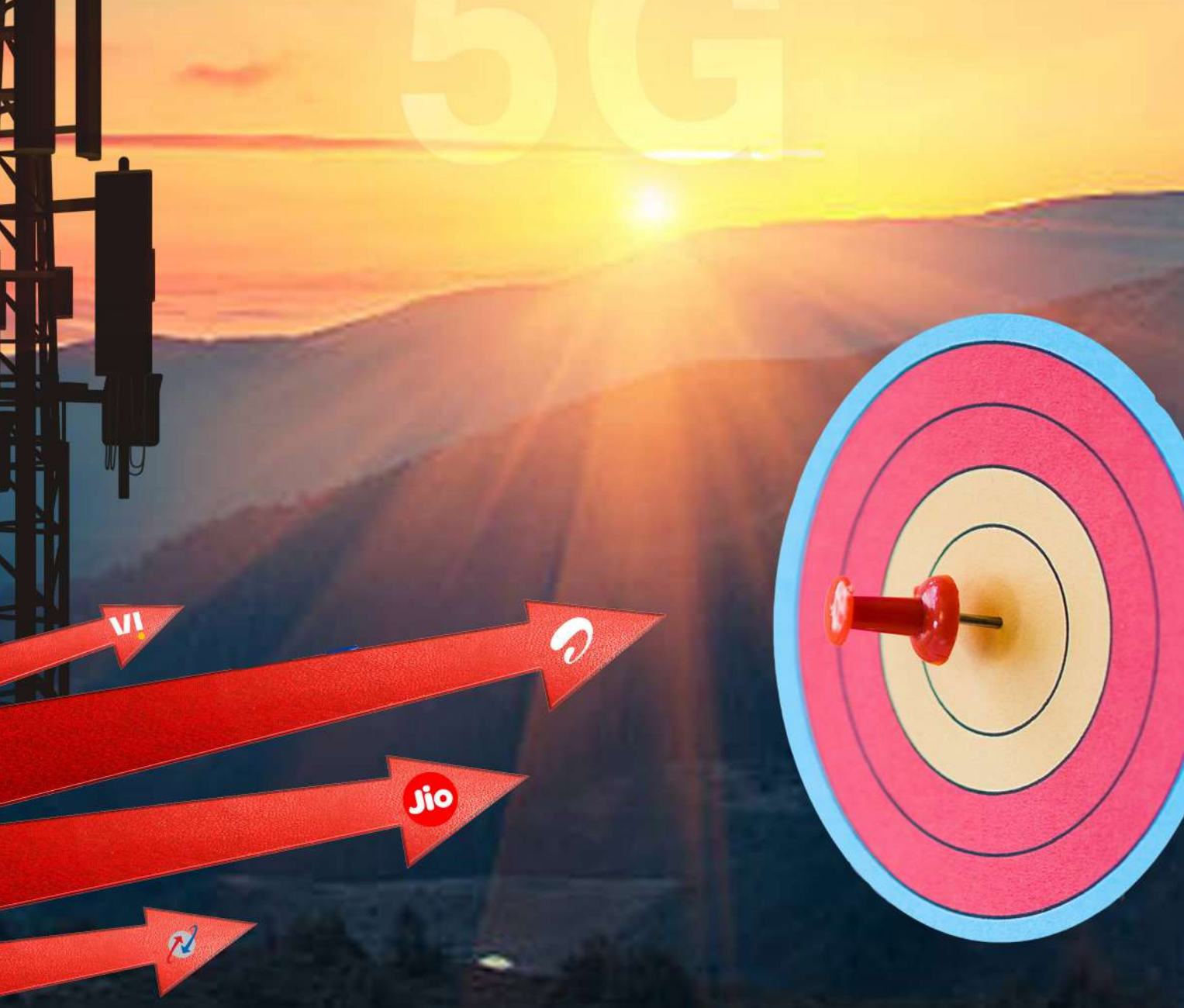
India's telecom and IT industry has gained global recognition for its capabilities and competitiveness. The country has become a leading exporter of IT and IT-enabled services, offering a wide range of services, including software development, business process outsourcing, and engineering services. Indian companies have established their presence in international markets, providing cutting-edge solutions and generating export revenues. Moreover, Indian telecom equipment manufacturers have also been exporting their products to various countries, contributing to the country's export earnings. The government's recent schemes under PLI 2.0 are expected to contribute significantly in this regard.

Competition is good for the growth, quality, and service in the sector. The government envisions state-owned BSNL to be in the league of the few major players, providing better competition and resultant benefits to people, and has announced the third revival package for BSNL with a total outlay of ₹89,047 crore, extending the total financial support to BSNL to ₹3.22 lakh crore. The package includes allotment of 4G and 5G spectrum for BSNL with equity infusion.

The telecom and IT revolution in India has propelled the country into the digital age big time, with significant contributions to economy and exports. Government initiatives such as *Make in India* and *Digital India* have fostered a conducive environment for growth, attracting investments and creating job opportunities. The rollout of 5G technology, along with frontier technologies like AI, ChatGPT, etc., hold tremendous potential for innovation and economic development. It is essential to sustain the momentum through policy support and collaboration between industry players, academia, and the government. ■

5G SPECIAL





TELECOM SERVICES

5G – The India story

With the recent capital infusion in BSNL, and the three telcos having seen higher revenues and ARPUs in FY23, Indian telecom sector seems to be on the cusp of a turnaround.

India has implemented one of the fastest rollouts of 5G services in the world. Within 8 months of the launch, Reliance Jio and Bharti Airtel have provided coverage in 700 districts, with 200,000 sites installed, with one site installed per minute. 5G network has been rolled out in all 28 states and 8 UTs now. No mean feat indeed!

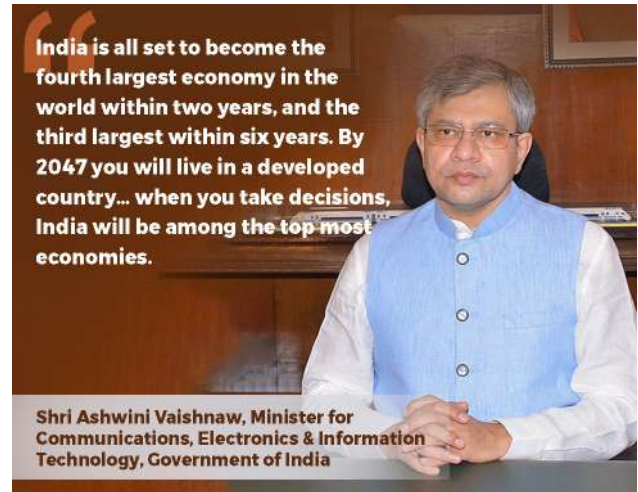
A *Telecom Kranti* in the words of Union Minister for Communications, Railways and Electronics & IT, Ashwini Vaishnaw. Developed countries like USA are showing interest in Indian 4G/5G technology stack. The minister, while launching the 200000th 5G site at Gangotri in May 2023, also said that to lead in the 6G technology development, India has over 100 patents in 6G technology, which shows the prowess of the talented engineers and innovators of the country.

This received international acclaim too. “India, when it comes to 5G technology, is moving at absolute warp speed. I think India has experienced some of the fastest large-scale deployment of 5G infrastructure anywhere in the world and continues to do so. That’s an amazing representation of India’s inventiveness and ability to adapt and adopt new technologies rapidly. The speed, with which India is adopting and rolling out 5G technology, I think augurs very well, for India being able to unlock tremendous economic and technology benefit from it,” said Robert Le Busque, regional vice president of Asia-Pacific, Verizon Global Enterprise.

“India is likely to overtake America in 5G rollout by the year-end,” said Börje Ekholm, CEO, Ericsson. The US ambassador to India, Eric Garcetti, expressed confidence and added, “India, with its vast population, its thriving digital economy, the use of technology that in some ways is leapfrogging other nations around the world, is poised to leverage the transformative power of 5G and 6G... to catapult itself to the forefront of the digital revolution.” Accolades abound.

The two telcos seem to be in a frenzy. Jio plans to provide all-India 5G coverage by December, with Airtel aiming for blanket availability by March next year.

Bharti Airtel is rolling out non-standalone 5G (NSA-5G), wherein the company will use 3500MHz band for downlink and L-1800 for uplink. The uplink on L-1800 band helps Bharti coverage by additional 100–300mts, which will improve experience versus otherwise only 3500MHz-



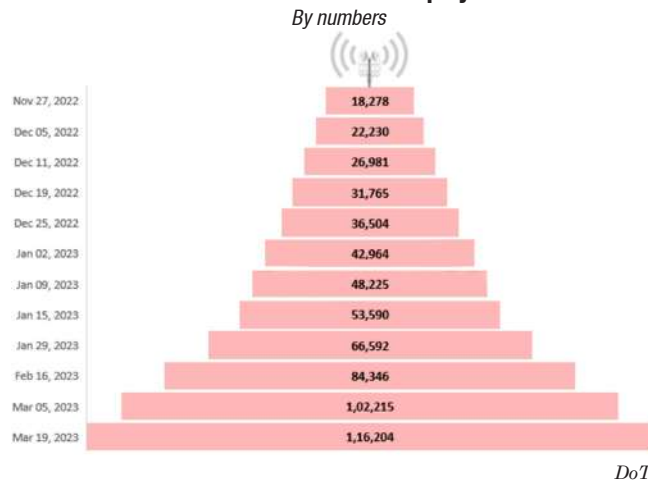
based 5G network. Bharti will be mounting largely integrated radio (radio and antenna), while 4G BTS will be used with additional 5G slot. NSA-5G will use the core of 4G. For backhaul, Bharti will require to strengthen its fiber footprint, but it will be less pressed due to E-band (71–76/81–86GHz) allocation. E-band can provide a microwave throughput of up to 10 Gbps, which can help maintain reasonable quality of 5G services with one-hope fiberization.

RJio is rolling out standalone 5G (SA-5G), wherein RJio will use a combination of 3500MHz/700MHz with carrier aggregation. This will help RJio provide superior experience deep into the market due to sub-GHz spectrum. RJio will also need to invest in separate core for 5G. RJio is relatively better placed with strong fiber network for backhaul versus Bharti.

Bharti Airtel and RJio have committed large CapEx outflow for 5G rollout over the next few years. Bharti has guided for total India CapEx of ₹750 billion for the next three years, wherein in FY23 and FY24, CapEx will be relatively high, and it will start tapering FY25 onwards. RJio has announced total 5G investments of ₹2000 billion, which includes ₹900 billion toward spectrum, ₹600–700 billion toward network rollout and the remaining for ecosystem development.

Vodafone Idea and BSNL have yet to deploy their respective 5G networks. While Vi has been trying to raise funds from the market for more than two years

5G base transceiver stations deployed in India





without success, BSNL has recently been sanctioned a revival package of ₹89,047 crore, its third; its first was in October 2019, when it was awarded ₹69,000 crore and the second in July 2022 was a bigger package of ₹1.64 lakh crore. It is expected that both the telcos are putting their house in order, and India may well continue to have four service providers. How these two will manage to keep their heads above water, only time will tell.

While India is expected to have pan-India 5G coverage by March 2024, “right now the telecom industry is ahead of the rest of the ecosystem,” says Gopal Vittal, Chief Executive Officer of Bharti Airtel and South Asia. He elaborates, “The rest of the ecosystem across devices, across applications, content, all of that needs to change and we hope that over the next coming years, this ecosystem will flourish. 5G is a spy around which more application need to come.”

Many unresolved issues threaten to create havoc with the telcos that already have over-stretched balance sheets, stressed with huge debts, poor realizations because of low prices, and low ARPUs. The decision to auction or not to auction satellite spectrum is yet to be taken. While the millimeter-wave (mmWave) spectrum has been auctioned, and is already with telcos, it has yet to see application around home and enterprise usage in India. Right-of-way continues to be a challenge in most states.

While tech companies want spectrum directly from the government for setting up captive networks, the stakes are as high as ₹75,000–₹90,000

crore for the telcos, for that is what they expect to generate once private networks deployment starts fully in the next few years and India is able to find its use cases for enterprise.

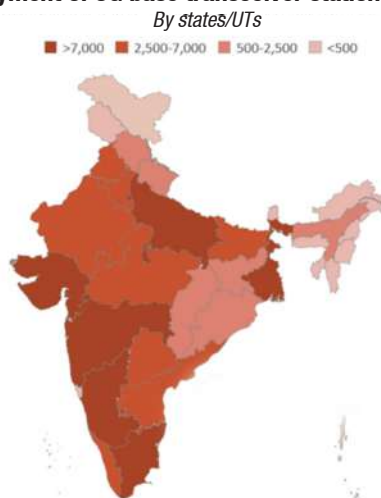
To add to this, the timeline for 6G in the nation is set for 2030. **Bharat 6G vision** document aims to facilitate finance R&D, design, and development of 6G technologies by Indian startups, research bodies, and universities to enable India to become a leading global supplier of IP, products, and solutions for affordable 6G telecom solutions. Phase 1 (2023 to 2025) is expected to explore ideas, risky pathways, and proof-of-concept tests. Phase 2 (2026 to 2030) is expected to develop ideas, establish use cases and benefits, create IP, and set up test beds for commercialization.

This new technology, however, will truly be a step up. 6G will likely support data rates of 1 terabit in a second, meaning that the use cases will expand to ideas such as holograms and AR products, which is truly revolutionary.

Not only this, but the technology is also the first to allow for connection between terrestrial and non-terrestrial networking elements, which will enable a device to work between multiple technologies, bringing with it a revolutionary change and connecting millions, if not billions, of machines.

With the current global economy best described as slow, uncertain, challenging, difficult, volatile, and unpredictable, the Indian telecom industry is cautiously optimistic of where it is headed. ■

Deployment of 5G base transceiver stations in India



DoT

Operator investment in 5G



GLOBAL SCENARIO

Lighting up with 5G

5G has made its way around the globe over the last several years, but its journey is far from over. 2023 is expected to close at 1.9 billion 5G connections.

The fifth generation of wireless cellular networks, 5G, marked another year of astonishing growth. Global 5G wireless connections, after adding 455 million connections, increased by 76 percent from 2021 to 2022, reaching up to 1.05 billion, are poised to touch a mark of 5.9 billion by the end of 2027.

The Asia-Pacific region has been leading the 5G race, with South Korea and China being the first countries to launch commercial 5G services in 2019. According to a report by the Global System for Mobile Communications Association (GSMA), the Asia-Pacific region will have the largest number of 5G users by 2025. It will account for almost two-thirds of the global 5G network.

In China, the three major operators recently revealed that by the end of March 2023, the number of 5G package users on the entire network exceeded 1.2 billion. Among them, the number of China Mobile 5G package users hit 689.235 million, China Telecom users is 283.21 million, and China Unicom 5G package users hit 223.81 million. There are another 8.7 million 5G users that use China Radio and Television, the fourth largest operator in China.

South Korea, by the end of 2022, had over 28 million 5G users. The country's three major carriers – SK Telecom, KT, and LG Uplus – have expanded their 5G networks to cover most major cities.

Japan launched its 5G services in March 2020, with NTT Docomo, SoftBank, and KDDI being the major carriers. The country has been slow to adopt 5G, with the tech facing several issues with the rollout. By 2022, it had over 53 million users. There are reports that Japan will have over 100 million users by the end of this year.

India has two service providers that have launched 5G services. Bharti Airtel's 5G service by March 2023 is available in 500 cities and the telco is adding 30 to 40 cities every single day. The telco is adding 30 to 40 cities every single day, and by September 2023 expects to expand our 5G footprint to all of urban India. Reliance Jio had by March 2023 launched its True 5G services in 365 cities. Jio is on track to cover all cities by December 2023. The other two telcos, Vodafone Idea and BSNL have yet to order the equipment.

North America is expected to have the second-largest number of 5G users by 2025, according to the GSMA. It will account for around 20 percent of global 5G users. As of 2022, there are about 150 million 5G users in North America. Verizon, T-Mobile and AT&T are the major carriers.

Canada has been slow to adopt 5G, with limited coverage in most major cities. It has over 3 million 5G subscribers now, with the major carriers being Bell, Rogers, and Telus.

Europe. Several EU nations, including the UK, Germany, and Spain, have launched 5G services, with the rollout accelerating in 2020. According to the GSMA, Europe is expected to have the third-largest number of 5G users by 2025. As of 2021, there are over 25 million 5G subscribers in Europe, but this figure in April 2023 is over 80 million.

The United Kingdom launched its 5G services in May 2019, with EE being the first carrier to offer the service. Other major carriers, including Vodafone and O2, followed suit later in the year. As of February 2022, the UK had over 3 million 5G subscribers. Germany launched its 5G services in mid-2019, with Deutsche Telekom, Vodafone, and Telefonica being the major carriers. The country has been slow to adopt 5G, with limited coverage in most major cities. As of February 2022, Germany had over 5 million 5G subscribers.

The Middle-East and Africa region is also starting to see 5G deployments, with countries, such as the UAE and Saudi Arabia launching commercial 5G services in 2019. According to the GSMA, the region is expected to have over 70 million 5G connections by 2025. The United Arab Emirates launched its 5G services in 2019, with Etisalat and Du being the major carriers. Saudi Arabia also launched its 5G services in 2019, with Saudi Telecom Company and Mobily being the major carriers. In Africa, nations like South Africa, Botswana, Seychelles, Zimbabwe, Madagascar, Lesotho, and Egypt all have 5G service.

Latin America. 5G is still in the early stages of adoption in Latin America, with several countries, including Brazil and Mexico launching pilot projects in 2020. According to the GSMA, the region is expected to have over 60 million 5G connections by 2025. As of 2022, the number of 5G subscribers in Latin America was relatively small.

Brazil launched its 5G services in July 2021, with Claro being the first carrier to offer the service. Other major carriers, including Vivo and TIM, followed suit later in the year.

Mexico launched its 5G services in late 2020, with Telcel and AT&T being the major carriers. As of September 2022.

Opening up in emerging markets

Moving ahead, growth will come from key markets within APAC and LATAM, such as Brazil and India. Many of the new 5G markets scheduled to launch networks in 2023 are in developing regions across Africa – including Ethiopia and Ghana – and Asia. Today, 5G adoption in the sub-Saharan region sits below 1 percent but will reach over 4 percent by 2025 and 16 percent in 2030, largely thanks to a concerted effort from the industry and government organizations to provide connectivity to citizens.

“Until now, 5G adoption has been driven by relatively

mature markets and consumer use cases like enhanced mobile broadband, but that is changing. We are now entering a second wave for 5G that will see the technology engage a diverse set of new markets and audiences,” says Peter Jarich, Head of GSMA Intelligence. “The extension to new use cases and markets will challenge the mobile ecosystem to prove that 5G truly is flexible enough to meet these diverse demands in a way that is both inclusive and innovative.”

The rise of 5G FWA

As of January 2023, more than 90 fixed broadband service providers (the vast majority of which are mobile operators) had launched commercial 5G-based fixed wireless services across over 48 countries. This means around 40 percent of 5G commercial mobile launches worldwide currently include an FWA offering.

With T-Mobile, USA expecting to have eight million FWA subscribers, Verizon is targeting five million by 2025, and RJio announcing ambitions to connect as many as 100 million homes across India to its 5G FWA network, the number of FWA users looks likely to grow substantially over the next few years.

While the majority of current 5G FWA deployments focus on the 3.5–3.8GHz bands, several operators around the world are already using 5G mmWave spectrum as a capacity and performance booster to complement coverage provided by lower bands.

Only 7 percent of 5G launches have been in 5G mmWave spectrum so far, but this looks set to change given 27 percent of spectrum allocations and 35 percent of trials are already using 5G mmWave bands. Furthermore, in 2023 alone, the industry will see ten more countries assigned 5G mmWave spectrum for use – a significant increase from the 22 countries that have been assigned it to date. Spain received the first European 5G mmWave spectrum allocation this year, resulting in Telefónica, Ericsson, and Qualcomm launching their first commercial 5G mmWave networks at MWC Barcelona 2023.

Enterprise IoT driving growth

The figures from GSMA Intelligence also suggest that, for operators, the enterprise market will be the main driver of 5G revenue growth over the next decade. Revenues from

business customers already represent around 30 percent of total revenues on average for major operators, with further potential as enterprise digitization scales. Edge computing and IoT technology presents further opportunities for 5G, with 12 percent of operators having already launched private wireless solutions – a figure that will grow with a wider range of expected IoT deployments in 2023.

Another major development for the enterprise will be the commercial availability of 5G Advanced in 2025. Focusing on uplink technology, 5G Advanced will improve speed, coverage, mobility, and power efficiency – and support a new wave of business opportunities. GSMA’s Network Transformation survey showed half of the operators expect to support 5G Advanced commercial networks within two years of its launch. While this is likely optimistic, it presents the ecosystem with a clear opportunity to execute on.

5G spectrum dynamics

The realization of 5G use cases rests on the timely allocation of spectrum to operators and industry verticals. Spectrum for 5G ranges across different bands that can be grouped into three – low-band (below 1GHz), mid-band (between 1GHz and 6GHz) and high-band or millimeter wave (above 24GHz).

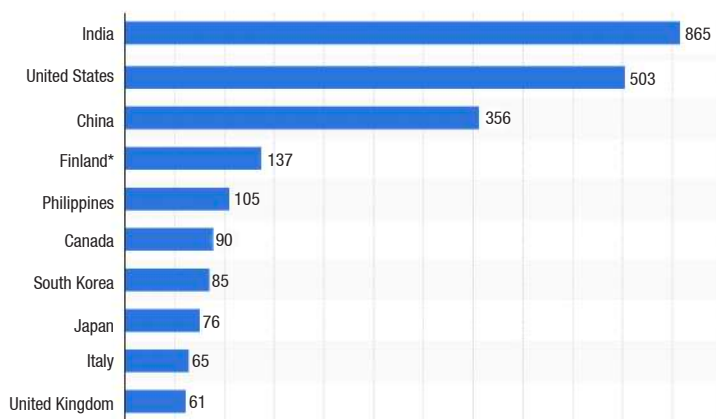
Low-band and mid-band spectrums are adjacent to existing spectrum allocations of 4G and earlier

technologies, which makes them easy to be repurposed for 5G. Mid-band, specifically 3.5GHz to 3.7GHz, has emerged as the most popular spectrum for 5G, with at least 180 operators using it for their commercial 5G network.

Due to their adjacency to existing spectrum for earlier mobile technologies, low-band and mid-band spectrum 5G best serves enhanced mobile broadband, or eMBB use cases. Ultra-reliable low-latency communications, or URLLC, and massive machine-type communications, or mMTC use cases are better served by millimeter wave 5G due to the high-capacity characteristics of higher frequencies.

As most 5G networks worldwide are based on mid-band spectrum, eMBB use cases are currently the most popular offerings of many operators. But to an average consumer, eMBB 5G is indistinguishable from the current 4G. In

Number of cities in which 5G is available 2023 by country



Statista

fact, some demonstrations of 4G LTE-A breach 1 Gbps speed – almost as fast as current 5G speeds. For some, 5G is just faster 4G, and these consumers do not see the need to jump to the new technology when 4G can already serve their needs.

Operators wanting to offer URLLC and mMTC use cases face several hurdles. Spectrum availability is at the top of the list, with regulators in many markets not yet releasing millimeter-wave spectrum. While the US has been the most prominent advocate of millimeter-wave, or mmWave, most of Europe and Asia-Pacific are sticking to mid-band spectrum. Second, the lack of demand for consumer eMBB 5G has caused some operators hold back on their 5G investments, which makes the expansion to URLLC and mMTC use cases even a harder business case to defend. Lastly, the use of mmWave spectrum requires building dense networks, which ultimately drives up cost for operators.

These headwinds might explain why several auctions for mmWave spectrum received little interest from operators in several markets, such as Brazil, Chile, Cyprus, Hong Kong, Poland, and Russia. While South Korea successfully auctioned 28 GHz in June 2018, operators waited until December 2020 before turning on their mmWave 5G due to concerns with the cost of power. China, despite multiple announcements of interest, has not even allocated mmWave spectrum to operators.

At the moment, 5G is in a somewhat quiet period in terms of new services and applications. The industry is stuck on the rhetoric of private networks, the metaverse, and a myriad of low-latency applications as it waits for the widespread arrival of stand-alone 5G.

The spectrum pipeline in the US looks bleak, especially since the US Senate failed to renew the FCC’s auction authority.

In the US, T-Mobile is in a superior position with 5G. It has both a plethora of mid-band spectrum, and has deployed a stand-alone network. Mid-band spectrum (1GHz to 6GHz) has emerged as a critical and globally harmonized component of 5G networks as it offers

optimal speed and coverage needed for more advanced wireless capabilities. However, T-Mobile does not have an ecosystem behind it, namely, devices, thanks to the fact that the world’s operators have been slow to move to stand-alone 5G.

As of March 2023, there are no bands in the spectrum pipeline in the US. And, T-Mobile, which built its 5G network leadership largely on the 2.5 GHz spectrum it got with Sprint, is still waiting to get the 2.5 GHz spectrum it won in last summer’s 2.5GHz auction.

T-Mobile won over 90 percent of the licenses in that auction, but FCC Chairwoman Jessica Rosenworcel has said that the agency cannot issue 2.5GHz band licenses until Congress reauthorizes the FCC auction authority.

Analysts at New Street Research (NSR) have their doubts about the FCC’s legal analysis in saying it cannot issue the

licenses at the present time, but they do not think T-Mobile will be able to get a court to force the FCC to issue the licenses prior to the auction authority being re-established, which may not be until the back half of this year.

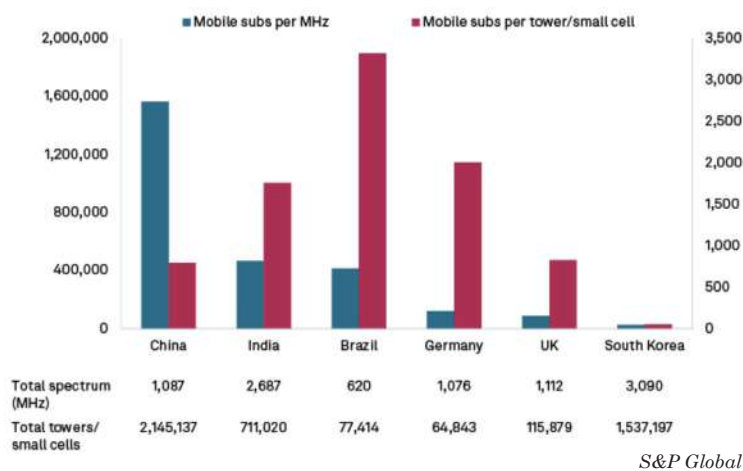
The 2.5GHz (n41) band, CBRS (n48) band, 3.7–3.98 C-band and 3.45–3.55GHz bands have been allocated in the US. But the identification, allocation, and repurposing of the spectrum is a multi-

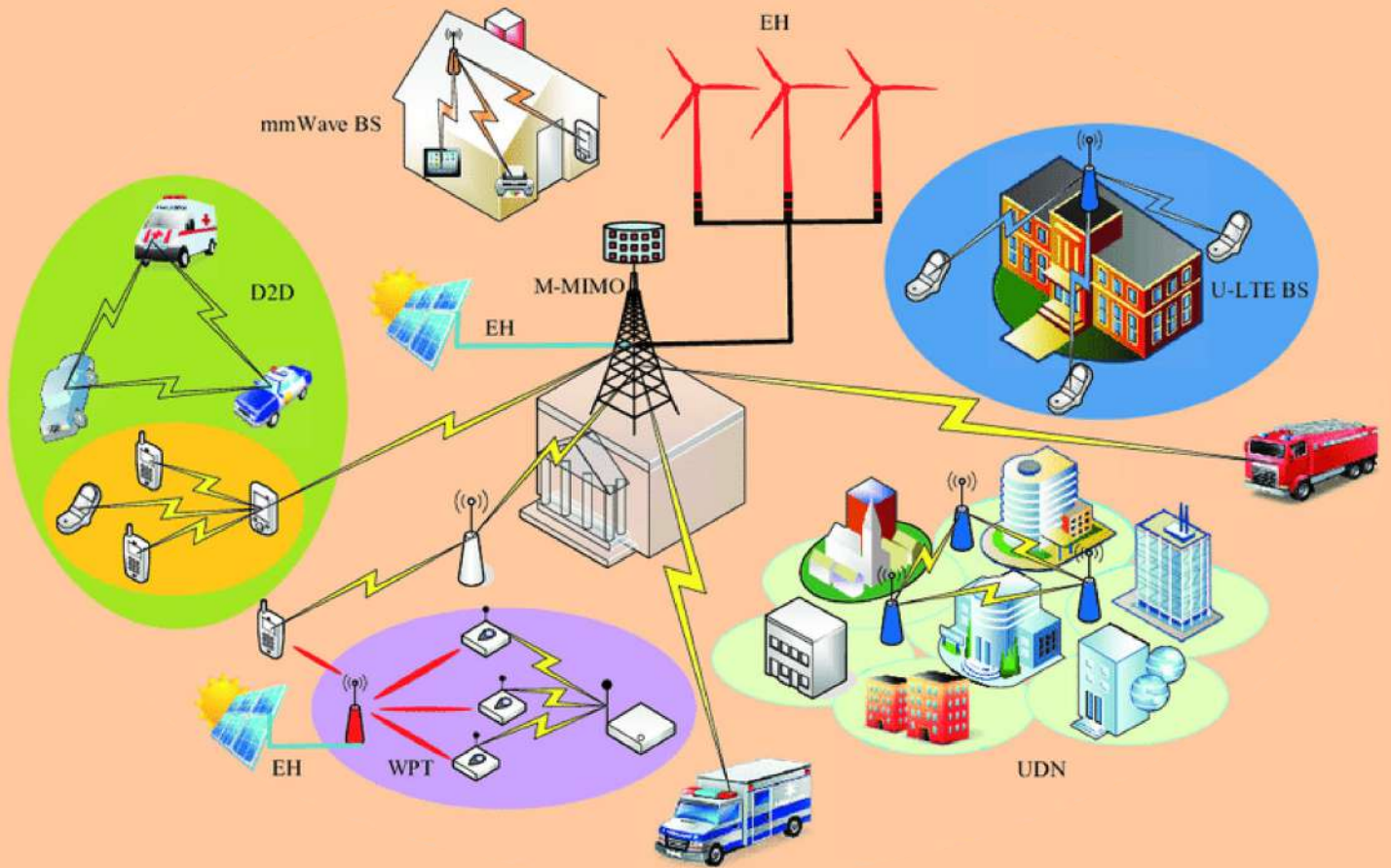
year process and the lack of spectrum in the pipeline is of critical concern.

It is a difficult endeavor, given that many networks will rely on challenging new deployments, such as edge compute and virtualized RAN, and more expensive capital expenditure requirements.

While non-stand-alone 5G has enabled carriers to get to the market quicker, this deployment is supposed to be temporary. However, the number of carriers planning to deploy stand-alone 5G services has dropped, from 21 percent in 2021 to 18 percent in 2022, finds an S&P Global survey. And the operators that have deployed a stand-alone network, as T-Mobile in the US, do not have an ecosystem behind it, namely devices, thanks to the fact that the world’s operators have been slow to move to the stand-alone 5G. ■

Select mobile market stats, 2022





5G ECOSYSTEM

Telcos are defining their role in the wider ecosystem

The telecom service providers will need to abandon their walled-garden mindset, and make giant strides toward cross-sector convergence, spearheading digital transformation across industries.

5G is no longer a journey reserved for the privileged. It has rolled out in 2497 cities globally across 92 countries serving more than 1.2 billion people.

5G is more than a new generation of technologies; it denotes a new era in which connectivity will become increasingly fluid and flexible. 5G networks will adapt to applications and performance will be tailored precisely to the needs of the user.

Service providers are coping with a volume and velocity of challenges they have not previously seen. Will my multi-vendor system work? Can my network functions perform in the cloud? Does edge deliver on its promised value? Is my new network secure? Will my processes and network scale to meet new demands?

For all the progress made, 5G remains in its infancy with plenty of roadway ahead. Less than 35 percent of service providers have deployed any flavor of 5G. Less than 5 percent have deployed on a true 5G core network. 5G is harder, more expansive, and has more riding on it – literally and figuratively – than any previous-generation network. It is no surprise then that even with today’s macro-economic headwinds, more than USD 175 billion will be spent globally on infrastructure between 2023 and 2025 to support everything these deployments comprise – from cloud and core to private wireless networks, Open RAN, and beyond. Investments will be made to counter inflationary and energy pressures with heightened focus on solutions and technologies to improve productivity, capital efficiency, and power management. The 5G opportunity is not solely left to traditional players. It is attracting investment and competition from tech leaders outside of telecom, leading to a much larger field of vendors.

Diverse vendors

The disaggregated 5G core and cloudification of the network have opened the door to the first real opportunity for vendor diversification in the heart of the network. Now, vendors can choose to deploy only a piece of the core network. This has potential cost benefits for service providers, who have more choices and, therefore, more financial leverage as hardware becomes commoditized.

Meanwhile, hyperscalers with expertise in IT, cloud, virtualization, and scale are heavily engaged and bring capabilities that have not yet been in the service provider mainstream. The enthusiasm around Open

RAN is bringing the multi-vendor, plug-and-play model to the radio network as well. In space, the non-terrestrial networks are getting a boost from 5G NTN connectivity standards, and a host of LEO satellite providers are in play. This growing coral vendors is great news for the industry, and service providers are working with multiple providers to move quickly and take advantage of existing capabilities. They recognize that they cannot be experts in everything, especially vertical markets, such as automotive or private networks. Where they lack expertise, or for functions outside primary domains, they are outsourcing to managed services companies. This diverse set of players does bring new challenges – security, standards interpretation, and feature parity, among them.

Telcos and ecosystem

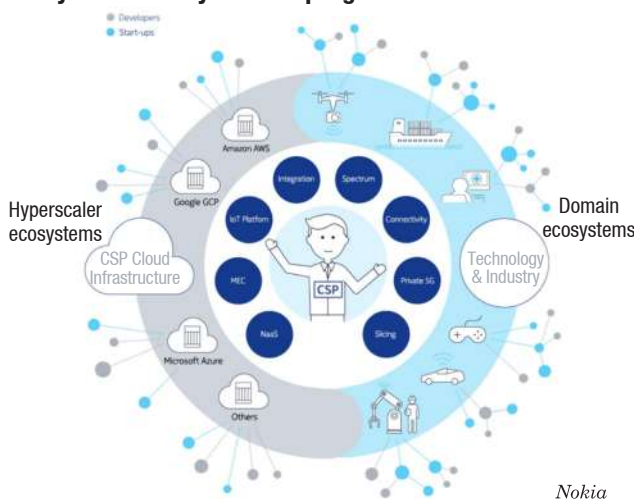
The telcos are on a generational shift from presenting a solution and being in front of the customer to understanding that they are actually part of an ecosystem. They are focusing beyond connectivity toward collaboration across the telecom value chain and cross-sector, leading to the creation of new business models and innovation. India is making giant strides toward cross-sector convergence, spearheading digital transformation across industries. They are teaming up with developers, systems integrators, hyperscalers, and over time maybe even other telcos. Only by working together can these variously skilled parties enable the full value of 5G to be realized.

The 5G ecosystem is a constellation of mutually beneficial relationships aimed at addressing a specific business objective. And the enterprise is where the biggest 5G opportunities lie – opportunities that will amount to USD 4.5 trillion by 2030.

An ecosystem approach to the enterprise 5G opportunity is vital, because business goals like digital transformation and intelligent automation require complex solutions that exceed the capabilities of any one supplier. To move up the value chain, telcos need to enable innovation to occur elsewhere. Then they need to recognize when that innovation has value, and bring their commercial capabilities to bear to ensure that the value is maximized.

Some of the most successful ecosystems of the digital era are those created by hyperscalers and SaaS giants like Amazon and Salesforce. Both have built global platforms (AWS and AppExchange, respectively), where developers can access resources, experiment,

Ecosystems are key to developong new 5G-enabled services



build, and commercialize the results – with a portion of any revenue going to the ecosystem orchestrator.

Telcos can, and should play in these hyperscaler-led ecosystems and can do so in a number of ways. The most basic model is by monetizing network APIs – providing 5G network functions as a service in the hyperscalers’ public clouds and charging developers either for bulk utilization or per API call.

While the returns from simply providing open APIs will be minimal, the plug-and-play aspect of the model is something telcos should aim for. The way to extract more value from it is to join forces with the developers who make use of the APIs, and help them bring their solutions to market.

5G is a new technology for enterprises, so the telcos can help them understand the technology and how it can be used to address their business needs. They do not need an ecosystem of 50 partners to do that – they can do it with a handful. It may not, however, be the same handful of partners for every business need. The needs of manufacturing companies are very different from those of healthcare providers, and organizations in those sectors will look for relevant vertical experience in the suppliers they engage.

Whichever approach they take, telcos will need to abandon their walled-garden mindset and make it easy for as many developers as possible to work with them. They will need to open up, because the size of an ecosystem to a large extent determines its impact.

The other critical mindset shift will be from one of ownership and control to one based on loose partnerships and a fail-fast culture. With more workloads moving to the hyperscalers, telcos will need to focus on what they can offer

that is unique – whether that is connectivity expertise, local points of presence, mobile security, or other capabilities.

Defining the 5G ecosystem

Given the scale of the global efforts involved in developing the concepts, the technologies, the infrastructure, and the use cases, when all pooled together, make up the phenomenon, the 5G ecosystem, the intricate web of relationships which connects all the players involved.

In its own analysis of 5G, the World Economic Forum (WEF) has offered a very useful and coherent explanation of this 5G ecosystem, setting out what it calls the 5G Ecosystem Cycle. According to the WEF’s model, the various parts that make up 5G fit together something like this:

Spectrum. The WEF refers to radio spectrum as the *oil of the 5G ecosystem*, the fuel which powers the machine. Radio spectrum is not quite a finite resource as it can be reused, but there is a finite capacity as to how much of it can be used at once, with only the bandwidths sitting in the 3-kHz to 300-GHz frequency range currently being suitable for communications.

Infrastructure. Mobile infrastructure is what makes radio spectrum available for use in wireless communications and data services. Infrastructure includes the network – base stations, mobile backhaul, edge clouds, and core networks.

Devices. Devices are an essential cog in the mobile machine, providing the interface via which end users can enjoy the benefits of mobile connectivity. To date, one type of device above all others – the mobile phone – has dominated the mobile landscape, and phone manufacturers and vendors have, therefore, been key players in the ecosystem. But one of the most significant changes anticipated with 5G



Each 3GPP release delivers new features that enable or enhance support for new revenue-generating applications and services. This roadmap highlights the key contributions of current and planned 3GPP releases for a set of promising new 5G revenue streams. After a release is finalized, equipment typically becomes available within 18-24 months. Initial network deployments begin 6-12 months after equipment availability and may continue for several years.

Spirent Communications

is that it will open the door to new use cases for mobile, meaning a much broader range of devices will be built, ready to connect. From industrial machines to home appliances, vehicles to medical equipment, OEMs from across a huge swathe of verticals will suddenly find themselves with a stake in the 5G ecosystem. And just as network operators are leaning on network tech specialists to build out their 5G assets, so device OEMs will rely on chipset manufacturers to provide the essential technology that will allow their devices to connect.

The service segment of the 5G ecosystem cannot be undermined, the commercial relationships which link customers to network capabilities. Network carriers and virtual operators will continue to hold a key stake in 5G services, particularly in the consumer segment, where buying airtime off a mobile company is likely to remain the standard commercial model. But as use cases for mobile diversify, so will the market for 5G services. From ISPs delivering mobile broadband to software specialists building advanced mobile-first applications, from systems integrators helping businesses migrate their connectivity to wireless to cybersecurity specialists, helping enterprises protect vast new IoT deployments, 5G will likely create brand new opportunities for brand new mobile services.

Security sits in the center of the 5G ecosystem cycle, which the WEF argues will be a critical consideration for consumers, enterprises, and public bodies in deciding whether to switch to 5G (and, therefore, in making all the investment by all the various stakeholders worthwhile). Elsewhere, the WEF also outlines various potential security concerns around 5G which stakeholders must overcome – the increased vulnerabilities that come with increased dependence on networks as more and more devices connect, the corresponding multiplication in target points for

cybercriminals and other hostile forces, the huge hike in complexity in data and privacy protection as we move from the World Wide Web to multiple interconnected webs of networked services (sometimes referred to as the Internet of Everything). Some of these security concerns have already become high-profile news, such as the geopolitical wrangle over Huawei’s involvement in infrastructure build-out and its alleged relationship with the Chinese government.

Other issues rest on the fact that 5G will continue to operate alongside, and indeed on the same networks as, previous generations of mobile technology, in some regions stretching back all the way to 2G. In the context of contemporary cyber threats, several signaling protocols used for 2G, 3G, and 4G have security flaws, which could undermine 5G signaling security through proximity. How to work backwards and resolve the signaling security shortcomings of 30 years of mobile technology in time for 5G remains a major challenge.

The technology leaders, namely, the network technology vendors – the hardware and software companies; the network operators with each country with its set of service providers; and the chipset manufacturers comprise the balance ecosystem.

Driven by the rapid pace of technology innovation, the need to fill skill gaps, and the disaggregated 5G network, a hesitancy to embrace outsiders has turned into a true desire to team for success – increasingly, this is not a choice but a reality.

The intersecting trends of an expanding set of vendors and the need for neutral, collaboration environments are stimulating the creation of ecosystems. A growing realization that validation costs will surge without tighter ecosystem coordination is adding even more urgency to this push. ■



Spirent Communications



5G AND ENTERPRISE

Reimagining Industry Futures

Enterprise participation in 5G investment has seen a rapid uptick, energy and consumer companies are leading the way, with manufacturing organizations lagging behind other industries, says an EY study.

Enterprises' 5G and IoT strategies are increasingly oriented toward growth. Among organizational priorities, IoT's contribution to revenue growth is now on par with the operational efficiency benefits it offers. And 5G-IoT use cases such as virtual reality (VR), augmented reality (AR) and remote working now score ahead of others – such as infrastructure control – as focus areas for applications.

Sustainability and broader environmental, social and governance (ESG) goals are very much at the heart of enterprises' relationship with technology. Emerging technologies can play a critical role in reducing the organization's carbon emissions, and most enterprise will prioritize vendors who can articulate the environmental impact of new technologies.

Looking ahead, organizations cite capabilities and credentials around sustainability as the number one attribute they will be seeking in their suppliers in the future, ranking ahead of competitive pricing or end-to-end solution capabilities. Businesses also expect to leverage their ecosystem positions to explore circular business models with other organizations.

From technology deployments and partnerships to security, execution challenges are mounting. Successful activation of 5G requires businesses to

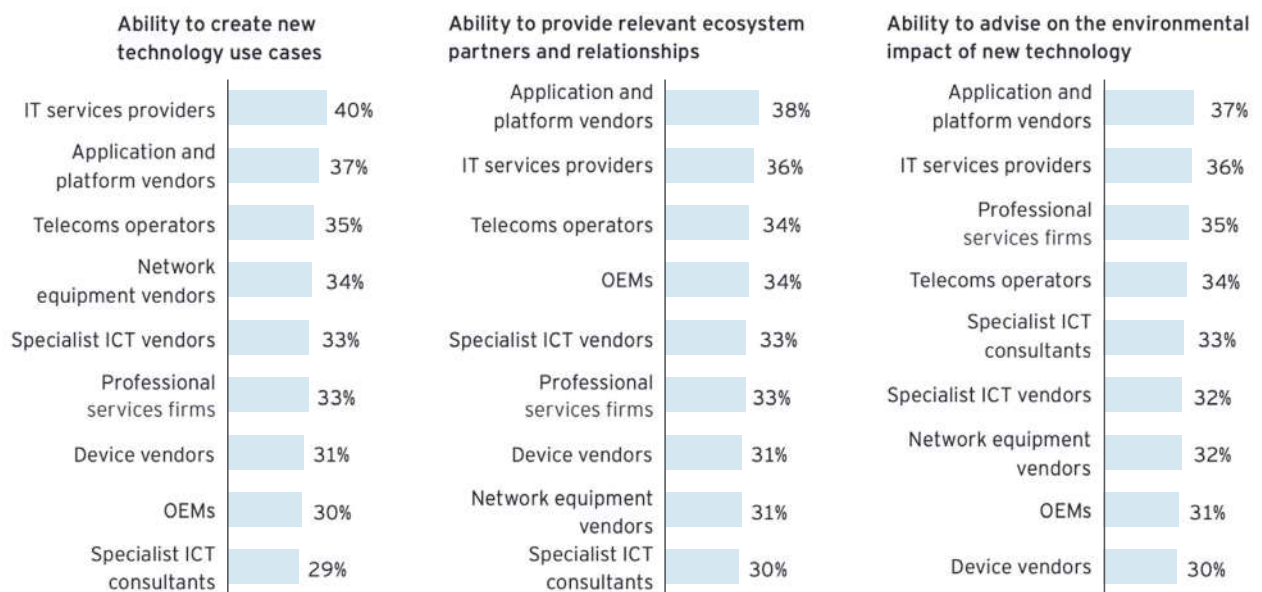
make new choices in how they purchase it and whom they purchase it from, which generates uncertainties. Although the wide range of 5G purchasing models on offer brings new procurement options and service benefits, uncertainty over deployment scenarios and timings now ranks second as an internal 5G challenge at a time when return on investment (ROI) anxieties are rising. Execution challenges also extend into organizations' ecosystem strategies, with more businesses than ever finding multi-sided partnerships difficult to execute in practice, and limited resources for collaboration also presenting more problems than before. Finally, security concerns remain firmly on the corporate radar: Cyber risks lead this year's external challenges associated with 5G.

Knowledge gaps undermine efforts to exploit 5G alongside other technologies, such as edge computing. Knowledge gaps continue to pose problems: While businesses are keen to explore 5G's relationship to other emerging technologies, many do not think that they understand the ideal points of intersection between them. Poor understanding of 5G's relationship with other technologies tops the list of internal challenges organizations face this year, while four in 10 cite exploring these relationships further as a top priority. Meanwhile, three in four organizations believe they need a better understanding of edge computing use cases. These findings highlight that knowledge gaps have different origins and

Enterprise perceptions of supplier competencies

Response to survey conducted by EY to the question posed to all

Which types of ICT supplier are viewed as the most capable of providing the following competencies by your organization?



EY

dimensions, suggesting more than a quick fix is needed.

These are the main conclusions that Tom Loozen, global telecommunications leader at EY, draws from the consultancy’s latest annual study of enterprise perceptions surrounding 5G and IoT.

The “EY Reimagining Industry Futures Study 2023” is based on an online survey of 1,325 enterprises worldwide. Conducted in November 2022, the survey suggests that many industry verticals are still furtively weighing up their 5G investment options, despite the technology being on their radar for five or six years.

Enterprises have mixed views on supplier competencies – but rank IT services providers and application vendors ahead of the rest. Enterprises’ perspectives on which types of ICT suppliers are most capable of providing various competencies are instructive. There are no dominant leaders when it comes to the perceived ability of different suppliers to create use cases, provide ecosystem relationships or advise on the environmental impact of new technology.

That said, respondents tend to favor IT services providers and application providers above others. There is more

variation in sentiment between industries. For example, specialist technology vendors score top for environmental advice among energy companies and rank second as use case creators among consumer industry respondents. Encouragingly for telcos, government respondents see them as best placed to provide relevant ecosystem partners and relationships.

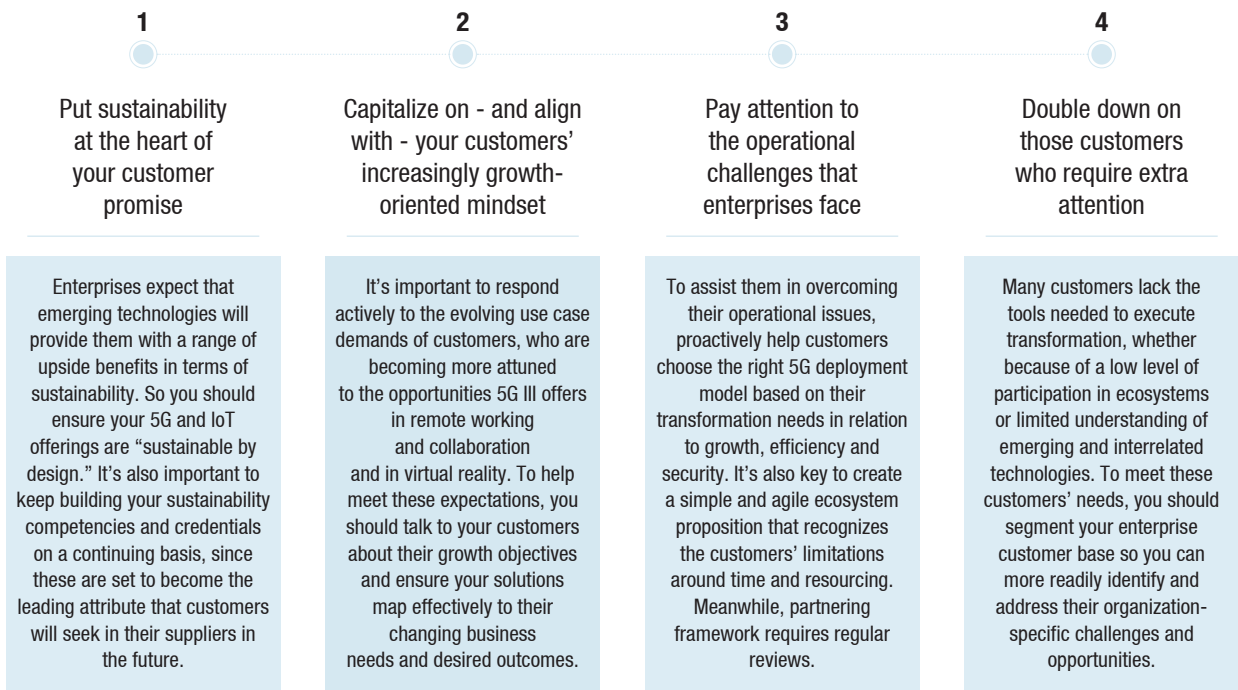
Given its promise of being the “G for enterprise,” enterprise adoption of 5G has fallen below expectations.

One major barrier to 5G adoption, finds the survey, is complexity of integration with existing technologies. But EY takes it one step further. Telco management has not shown enough digital ambition when it comes to serving the enterprise market by allowing the technology integration challenge to largely go unaddressed.

While organizations’ views on specific supplier competencies are fairly evenly spread, their perceptions of overall expertise in technology and advisory capabilities are both more clear-cut and also broadly consistent year-on-year. Telcos rank first as perceived IoT experts, meanwhile, they continue to lag as digital transformation experts, with only one in five respondents selecting them as their most trusted supplier. ■

Next steps for 5G service providers

EY has identified four key actions that 5G providers could take to help enterprises realize their ambitions





CT'S TAKE

The telcos see revival in FY23

The FY23 results of the telcos suggest a revival that is expected to be sustained over the coming years.

With BSNL poised for a turnaround, the three private telcos closed FY23 with combined gross revenues of ₹3.1 lakh crore, significantly higher than ₹2.6 lakh crore in FY22. This had a similar impact on the adjusted gross revenue (AGR) that was ₹2.36 lakh crore in FY23, up from ₹2.06 lakh crore in FY 22; and on the license fee collections for the government,

₹16,700 crore in FY23 against ₹15,000 crore in FY22.

Industry AGR (incl. NLD) rose 1.4 percent QoQ / 9.1 percent YoY to ₹56,000 crore. Top-3 operators' combined AGR (incl. NLD) rose 1 percent QoQ / 8.7 percent YoY during Q4 FY23. Industry AGR (incl. NLD) grew at a high

TELECOM

single digit despite no tariff hike in the past 12 months, while QoQ revenue growth was lower due to two less days in the quarter. The growth was driven by subscriber addition and premiumisation (2G to 4G). FY23 AGR (incl. NLD) stood at ₹2,18,800 crore vs ₹1,90,200 crore in FY22, up 15.1 percent. Industry gross revenue was up 1.3 percent QoQ (7.1 percent YoY) to ₹62,800 crore.

Bharti Airtel Limited

Airtel delivered strong revenues and operating margins across the portfolio during FY23 and the overall cash flow, i.e., Ebitda minus CapEx is ₹23,000 crore. This was despite heightened CapEx, rural expansion, and no meaningful tariff hikes.

The company has reported total income of ₹1.39 lakh crore during FY23 as compared to ₹1.17 lakh crore during FY22, a 19.38-percent increase. The company posted net profit of ₹8345.9 crore for FY23 as against ₹4255 crore in FY22, an increase of 47.94 percent. The telco's net debt is ₹226,020 crore as of March 31, 2023.

The EPS was ₹14.57 for FY23 as compared to ₹7.63 for FY22. The results were in line with estimates as a higher-than-expected performance in India was offset by slower growth in Africa. Growth in homes and enterprise business remains strong.

Bharti's AGR (incl. NLD) increased 1.3 percent QoQ / 10.8 percent YoY to ₹20,400 crore. Bharti's AGR (incl. NLD) market share rose to 36.5 percent (flattish QoQ, up 60bps YoY). Its incremental AGR YoY was ₹2,000 crore vs ₹2,400 crore for RJio. Circle-wise analysis shows Bharti grew faster in C' circles (2.3 percent QoQ), A (+1 percent) and B circles (+1.1 percent) while in the metros AGR was stable QoQ. The circles that underperformed are: Mumbai (-2.7 percent QoQ), Tamil Nadu (-2.8 percent), UP East (-2.7 percent) and Punjab (-1.6 percent). Bharti's market share improvement was driven by Delhi (+80bps QoQ), Maharashtra (+70bps), Andhra Pradesh (+65bps) and Karnataka (+90bps). In FY23, Bharti's AGR (incl. NLD) was up 18.5 percent YoY at ₹79,300 crore.

The total subscriber base stood at 335.4 million as of March 2023, on a total of 275,069 network towers. Its total number of 4G customers now stands at over 224 million and they account for 67 percent of its India customer base. The average data usage per customer per month remained flat sequentially at 20.3 GB but was 20.2 percent higher on a YoY basis.

The telco's prospects are bright, underlining positives like a strong addition in 4G subscriber base and

improving data consumption. Tariff hikes, if any, will boost the company's ARPU, that remained flat sequentially and grew 8.4 percent on a YoY basis to ₹193. A year ago, that figure stood at ₹178.

Airtel continues to report decent performance on Indian wireless business front with resilient and industry-leading KPIs in terms of India post-paid/4G subscribers, margins, and cash flow generation (despite elevated CapEx).

FY24 CapEx in India will be largely similar to FY23 (₹28,000 crore). Bharti Airtel has stopped adding any 4G capacity BTS, and 5G CapEx beyond urban locations will depend on handset penetration. It will continue to invest in transport network and enterprise business. It expects CapEx from FY25 onwards to moderate from highs of FY23 and FY24. Analysts expect it to decline to 17 percent of revenue by FY25, from 27 percent in FY23.

Bharti Airtel has added 37,492 sites and 33,650 km of fiber in a year. And is adding 1.6 million home passes in FTTH per quarter. The telco is leveraging FTTH to wide up the towers and this has been a huge game-changer in terms of wiring up the towers on a very, very smart and efficient basis. The telco is re-engineering its towers wherein it plans to relocate 66.5k towers from high-cost locations.

Bharti Airtel's 5G services are now live in 3500 census towns (out of 7000) and the telco is adding 35-40 towns daily with the target of covering the urban and key rural areas by end FY24. Rural rollout is based on handset penetration, which has slowed down. 5G handset penetration has not picked pace as was anticipated.

Reliance Jio Infocomm Limited

RJio reported revenues of ₹90,786 crore for FY23, up 17.9 percent from ₹76,977 crore in FY22. RJio's net profit rose 22.87 percent over the year-ago period to ₹24,429 crore.

Ebitda growth of 24.2 percent YoY from ₹37,857 crore in FY22 to ₹47,034 crore in FY23 was led by higher revenues and ~260 bps increase in margins.

Jio's net subscriber addition was 29.2 million during FY23, and a customer base of 439.3 million as the fiscal came to a close, with monthly churn remaining stable at ~2 percent. ARPU increased 6-7 percent YoY to ₹178.8 per month, due to the impact of tariff hike, better subscriber mix, and data add-ons within the select customer cohorts. An RJio user consumes 23.1 GB per month versus 13.3 GB per month two years ago.

Bharti Airtel Limited

Results (₹ crore)

Financials	FY23	FY22	% Change
Total Income	140081.4	117081.2	19.64
Net profit	8345.9	4254.9	96.15
EPS	14.57	7.63	90.96

Reliance Jio Infocomm Limited

Results (₹ crore)

Financials	FY23	FY22	% Change
Total Income	90786	76977	17.9
Net profit	24429	(28245.4)	22.87
Ebitda	47034	38757	24.2

RJio's AGR (incl. NLD) rose 1.7 percent QoQ / 11.3 percent YoY to ₹23,300 crore. RJio's AGR (incl. NLD) market share was 41.7 percent, up 13bps QoQ. AGR growth has been relatively higher in B and C circles – 2.2 percent and 2.3 percent QoQ respectively; A circle AGR grew 1.4 percent while metro AGR was flattish. Circle-wise analysis shows RJio lost market share in six circles, including Delhi (-115bps QoQ), Karnataka (-6bps QoQ), UP West (-198bps) and Odisha (-95bps). RJio showed significant pick-up in AGR in Mumbai and Kolkata circles, up 3.9 percent and 2 percent QoQ respectively. In FY23, RJio's AGR (incl. NLD) rose 17.5 percent YoY to ₹90,500 crore.

Jio Platforms (JPL), holding company of the telecom and digital services business of Reliance Industries Limited, reported a 23.5-percent YoY growth in net profit to ₹19,124 crore for FY23. Revenue from operations stood at ₹98,099 crore, up 20.2 percent. However, the stellar revenues of ₹25,465 crore in the March 2023 quarter meant that JPL's annualized revenue rate (ARR) stood over ₹1 lakh crore.

RJio is expected to incur a capital expenditure of ₹38,000 crore in FY24 and ₹31,000 crore in FY25. "Despite the aggressive 5G CapEx cycle, it is notable that the network operating expenses at RJio remained flat for Q4 FY23 at ₹72,000 crore," said Swarnendu Bhushan and Aliasgar Shakir, research analysts at Motilal Oswal Financial Services Ltd. "Growth will continue to soften due to a higher base and a lack of tariff hikes amid heightened competition, along with intensifying 5G spending."

Net debt (excluding CapEx creditors and lease liabilities) increased from ₹78,503 crore in FY22 to ₹151,500 crore in FY23, largely led by 5G spectrum and launch-led CapEx. The large CapEx has created significant operating leverage, which should drive earnings in FY25, according to JPMorgan analysts, Pinakin Parekh and Sarfraz Bhimani. Still, Reliance Jio's free cash flow – at ₹6700 crore in FY23 – was a positive surprise, as it was the highest-ever for a fiscal, despite the CapEx.

Pan-India 5G rollout target of December 2023 is on track with RJio having launched 5G during Q3, and 5G coverage has expanded to 2300+ towns and cities till date. The company indicated that 60,000+ sites have been deployed across 700 MHz and 3500 MHz bands with six sectors.

Moving forward, for Jio, the best way to ride out this tide of debt would be to increase ARPU by way of tariff hikes, and improve the subscriber mix with more high-paying postpaid subscribers. Among the three private

telecom operators in India, RJio continues to have the least number of postpaid users. But analysts do not expect any material change in the postpaid user base. "Postpaid users are an extremely sticky lot," says Mayuresh Joshi, head of equity research at William O'Neil & Co. in India. "For a postpaid user, it becomes very difficult to switch operators, and the telecom companies know that. There's very little churn in terms of postpaid, and they do not get swayed by offers."

The company continues to see 5G as a medium to long-term enabler of higher data usage and ARPU driver along with its dedicated efforts to catch up on postpaid offerings (through new plans) where it currently lags incumbents.

Furthermore, it has declared intent to aggressively expand broadband coverage (targeting 100 million customers in two to three years versus the current base of ~9 million) both through new plans and fixed wireless access (likely to be launched when 5G reaches critical mass). RJio's fiber-to-home service, accounts for 60 percent of all wired broadband connections in India. In Q4 FY23, Jio Fiber added a net 700,000 users – its subscriber base is now 34 percent higher than that of Airtel. But its contribution to RJio's revenue remains miniscule at 6 percent.

It also continues to build on enterprise use case, both for large enterprises and small and medium businesses. Thus, with no tariff hike in sight, 5G users' data usage trend will drive the ARPU in the near and medium term.

Superior spectrum portfolio, along with superior digital ecosystem offering, lends Jio a competitive advantage even in 5G (as seen in the 4G foray)

Vodafone Idea Limited

The annual revenue of Vi, for the first time since merger, improved compared to last year. Revenue for FY23 grew by 9.5 percent from ₹38,520 crore to ₹42,180 crore supported by tariff hikes, improving subscriber mix and 4G subscriber additions. As a result, EBITDA for the year increased from ₹6680 crore to ₹8300 crore, registering a strong growth of 24.1 percent. EBITDA margin at 19.7 percent is the highest post merger.

CapEx spend for FY23 stood at ₹3360 crore.

The total gross debt (excluding lease liabilities and including interest accrued but not due) as of March 31, 2023 stood at ₹209,260 crore versus ₹222,890 crore as of December 31, 2022, due to the conversion of debt representing NPV of

Vodafone Idea Limited Results (₹crore)

Financials	FY23	FY22	% Change
Total Income	42488.5	38644.9	9.9
Net profit	(29301.1)	(28245.4)	(3.7)
EPS	(8.43)	(9.83)	1.4

Bharat Sanchar Nigam Limited Results (₹crore)

Financials	FY23	FY22	% Change
Revenue from operations	19130	16811	14%
Net profit	8161	6982	16.8%

TELECOM

interest arising due to deferment of spectrum instalments and AGR dues into equity issued to Government of India. It comprises of deferred spectrum payment obligations of ₹130,710 crore and AGR liability of ₹65,550 crore that are due to the government, debt from banks and financial institutions of ₹11,390 crore and Optionally Convertible Debentures amounting to ₹1610 crore. With cash and cash equivalents of ₹230 crore, the net debt stood at ₹209,030 crore.

The company continues to have a negative net worth of ₹74,360 crore.

Vi's AGR (incl. NLD) market share fell to 16.6 percent (down 40bps QoQ). Vi's AGR (incl. NLD) dipped 1.1 percent (both QoQ and YoY) to ₹9,300 crore. Dip in its leaders hip circles was at 1 percent QoQ due to fall in QoQ revenue in Andhra Pradesh (down 3 percent QoQ) and UP East (down 6.2 percent). AGR decline in the established circles was 0.6 percent QoQ while decline in others was at 6.5 percent. Mumbai AGR grew 8.2 percent QoQ and UP West was up 3.7 percent. In FY23, Vi's AGR (incl. NLD) rose 6.6 percent YoY to ₹37,700 crore.

Vodafone Idea had 225.9 million subscribers as on March 31, 2023. And while its active user base shrunk by 1.7 million to 207.9 million, the high-paying 4G user base grew by a million to 122.6 million. The blended churn stood at 3.8 percent in Q 4FY23 as against 4.4 percent in Q3 FY23.

The January–March 2023 period was notable for Vi as the government agreed to convert into equity the interest accrued on the company's dues. Vi is now proposing a significant equity infusion of ₹14,000 crore as part of its business revival plan. The plan includes contributions from the company's existing promoters, Aditya Birla Group (ABG) and Vodafone Group Plc. The two promoters will invest ₹2,000 crore as fresh equity, with them already having invested ₹5,000 crore since the government's telecom revival package in September 2021. They will collaborate with the company to raise an additional ₹7,000 crore from external investors, either through direct equity or convertible structures.

The company is also yet to launch its 5G operations.

Bharat Sanchar Nigam Limited

In FY23, BSNL's revenue from operations was at ₹19,130 crore, compared to ₹16,811 crore in FY22, a 14-percent growth. The telco's revenue target based on its MoU with DoT was ₹17,161 crore,

The growth in revenue was driven largely by BSNL's FTTH, leased line businesses, and other operating income that grew 30 percent to ₹2071 crore. Mobile services, which contribute 29 percent to BSNL's revenue from operations, witnessed a 7-percent YoY increase at ₹5638 crore in FY23.

The government has set the revenue target of the company

at ₹20,008 crore for FY24, ₹24,428 crore for FY25, and ₹28,476 crore for FY26.

In FY23, BSNL's loss widened to ₹8161 crore, compared to ₹6982 crore in FY22. The increase in consolidated losses is due to the provision for AGR dues to the government worth ₹17,688 crore; it received the viability gap funding of ₹16,189 crore. Owing to this adjustment, the company showed an exceptional loss of ₹1499 crore, which increased its total net losses.

BSNL's total expenses rose 5.1 percent to ₹27,364 crore. Of ₹27,364 crore, employee cost, which includes salaries, wages, allowances, and other benefits, was at ₹7952 crore, an increase of 11 percent from FY22.

As of March 2023, BSNL's wireless subscriber base was at 103.6 million, which is the lowest among all four operational telecom operators. In the last 15 months till March-end, the company lost nearly 11 million subscribers.

The government is making all efforts to turnaround the PSU.

The recent merger of BBNL with BSNL gives it access to nearly 6.11 lakh kilometers of freshly laid optical fiber cable network. This is between the block HQ and the gram panchayat. BSNL has a total optical fiber network of more than 7.78 lakh route kms, which is the highest by any telco in India; most of this fiber is between the district HQ and the block HQ, and a substantial portion of this fiber has been laid in the NLD (intercity) backbone of the country. The merger with BBNL has boosted its capacity to handle heavy data traffic and meet much of the requirements of rural India from the 2.23 lakh GPs which are already connected to the BBNL's broadband network.

BSNL has placed an advance purchase order of over ₹19,000 crore with Tata Consultancy Services and ITI Limited for the deployment of a 4G network, comprising more than 1.23 lakh sites. BSNL would be deploying a completely home-grown telecom network, which has all its components designed and developed indigenously, and in complete consonance with global standards. The 4G Core was designed and developed by C-DoT, and the Tata Group company, TCS, has taken the lead in providing the radio access network (RAN) The network would be jointly rolled out by the engineers of TCS and BSNL.

BSNL has started rolling out of 4G network with 200 sites, and after a three-month trial will launch an average of 200 sites per day. It is aiming to capture 100 million 4G customers in 2 years, i.e., effectively, an average of 1000 4G subscribers per tower now being set up.

Plans are that 4G network of BSNL will be upgraded to 5G by December 2023.

While the market forces decide the fate of the telcos, a ₹256–₹285 ARPU would not hurt! ■



OPINION

Insights from thought leaders, business thinkers and practitioners – strategists, executives, and entrepreneurs to create a better future.

Preparing for November 2023 session at WRC 23, Dubai

VJ Christopher,
Wireless Adviser,
WPC Wing,
Department of Telecommunications



World Radio Conference (WRC), previously known as World Administrative Radio Conference (WARC), is the apex body in the radio sector of ITU, which are held once in four years. The WRC-23 is scheduled to be held in Dubai in November, 2023. In WRC-19, the different spectrum bands were identified for the IMT-2020, popularly known as 5G spectrum bands. It is the peculiarity of WRC that such identifications are arrived at through consultations and consensus and multilateral agreements. The saga for this years' WRC is going to be thrilling and challenging at the same time because of the plethora of the different agenda the WRC-23 is going to consider.

The Conference Preparatory Meetings (CPMs) are important meetings of the ITU-Radiocommunication (ITU-R) sector that help in the consensus-building process internationally for the World Radiocommunication Conferences (WRCs). Each WRC finalizes and approves a list of agenda items for the next WRC. The agenda items are generally proposals regarding introduction of a new application in the candidate frequency band(s) under a specific kind of service or it can be about allocating a frequency band to a new service. The general rule for the introduction of such new applications and services is that the existing services and applications must be protected from harmful and unacceptable interference. This calls for sharing and compatibility studies between the existing use and the incoming application, which are often complex in nature and are carried out over a 4-year study period between two consecutive WRCs.

Conference Preparatory Meetings are held twice in a WRC study cycle. The first CPM is held immediately and the second CPM is held before the WRC meeting to harmonize the views of different ITU regions and individual administrations.

WRC-19 had established 19 specific agenda items for

WRC-23. In addition, there are a few standing agenda items that will also be considered by WRC-23. The 19 agenda items are grouped into five broad categories, namely, fixed, mobile and broadcasting issues; aeronautical and maritime issues; science issues; satellite issues; and general issues. The WRC-23 cycle has carried out the studies and held several meetings, many of which were held remotely (online) due to Covid-19. The Draft Conference Preparatory Meeting Report was published by ITU-R on November 25, 2022, which contains the result of the studies for each agenda item and various methods to incorporate changes to the radio regulation to satisfy the agenda items. The draft CPM report was examined by various member states (administrations) and discussions were held at the second meeting of the draft CPM text, held at Geneva from March 27 to April 6, 2023.

CPM23-2 was able to achieve consensus on many agenda items. However, in a few agenda items, there are open and unresolved issues due to which agreement could not be provided. In one of the agenda items on the 6 GHz spectrum for IMT, a common ground could not be reached between the proponents of IMT and broadband. The agenda items on in-flight and maritime connectivity (IFMC) – which makes broadband internet availability in airplanes and ships possible – agreement could not be reached on the regulatory mechanism to deal with interference case, sufficiency of the power flux density limits to protect terrestrial services, reporting mechanism for the notifying/authorizing administrations, interference resolution mechanism of the systems, etc. These issues, among others, would be discussed and resolved at the meetings at regional level (APG 23-6) and WRC-23. Based on the discussions held during the CPM23-2 meeting, draft CPM report has been updated/modified and the outcome is the final CPM report, which will help the governments of the member countries to finalize their views for WRC 23 to be held in November and December 2023 in Dubai. ■

Six macro factors reshaping business this decade

Mark Raskino,
Managing Vice President,
Gartner



Executives will continue to grapple with a host of challenges during the 2020s, but from the maelstrom new business opportunities will arise.

A decade-long boom, generated substantially from inexpensive finance and lower-cost energy, led to structural stresses such as highly leveraged debt, crumbling international alliances, and bubble-like asset prices. We were overdue for a reckoning.

Executive leaders must acknowledge these six changes to reconsider how business will get done.

The threat of recession

Although Covid-19 was the visible impetus for the economic volatility we have seen in the last several years, the reality is that the markets were already fragile and precarious.

What we have found, though, is that actions you take now are critical to your success during a downturn and beyond. Success requires early, decisive action by every function in the organization to manage spend, secure talent and accelerate digital.

Systemic mistrust

Even before the events of 2020, global consumer and citizen trust was at an all-time low. Now, the ripple effects, such as supply chain and talent shortages, and overall brand mistrust demand a relentless focus on customer value. Often building a more tailored and personalized connection to the individual's needs can help overcome consumer distrust and frustration.

Poor economic productivity

The digitalization of work, coupled with the adoption of hybrid and remote work practices, has created a renewed focus on the fundamentals of workplace productivity. Once detached executives are starting to peer down

through delegation layers and into the details to find out-of-date technologies, bureaucratized practices and process inefficiencies.

You must rethink how work gets done and who does it to enable responses to disruptions and change. Failure to re-evaluate these fundamentals will exhaust already taxed employees and make them less willing and able to stay engaged, while being productive.

Sustainability

Now that it's not overshadowed by the pandemic, sustainability is once again a mainstream concern for CEOs.

Customers, investors, regulators and employees now expect business leaders to focus more on environmental sustainability, and a sustainable business is seen as an opportunity to grow efficiency and revenue.

A talent shortage

Organizations find themselves with a unique challenge – keeping the in-demand talent they have and finding the competitive talent they need, especially when staff budgets are contracting or staying flat.

To combat the tricky combination of an economic slowdown and the talent market squeeze, the best leaders will enact creative methods to acquire new skills and capabilities without hiring new full-time employees.

Emerging technologies

Emerging technologies will have a large, disruptive effect in the coming decade. Adaptive AI, the metaverse, platform engineering, sustainable technology and super apps will change how organizations and societies operate. To capture the opportunities, it is critical to understand what, when and how key technologies will impact your strategic ambitions in the coming years. ■

Enterprise 5G opportunity in India – is it the steppingstone for revenue acceleration?

Prashant Singhal,
Emerging Markets TMT Leader,
EY



The telecoms sector in India is witnessing renewed growth riding on accelerated 5G rollout. To start with, 5G would improve enterprise connectivity manifold. Depending on the requirement, topology and feasibility, 5G can offer improved quality of service, quick set-up, and customization. 5G is expected to play a crucial role in the proliferation of SD-WAN, which is one of the fastest growing enterprise networking segments. 5G's ability to offer high-speed and low latency networks in places where fixed line is not available, makes it a viable option for enterprise connectivity.

Globally, private 5G network deployment is on the rise and opens-up several new use cases. Manufacturing and automotive are the early adopters, with smart manufacturing, industrial automation and auto manufacturing emerging as top use cases. Access to licensed spectrum and expertise in technical aspects of network deployment positions telecom operators well, where they can offer significant value for end customers. An integrated telecom operator in Taiwan aimed to double the number of private networks deployed for enterprise customers in 2022. Whereas two leading operators in Germany have launched 5G private network solutions for enterprises.

On the other hand, partnerships are crucial to cover myriad aspects of a private network. Telecom operators are reassessing their position in the wireless private network supply chain and considering strategic partnerships with system integrators and equipment vendors. A leading operator in the US partnered with a network OEM to combine their respective capabilities and enable customers to build 5G private network.

In India, telecom operators are well placed to capitalize on the 5G private network opportunity. The specific business model to be adopted – developing end-to-end capabilities or partner network OEMs/System

Integrators – remains to be seen. Telecom operators can proactively educate enterprise customers and look to co-develop the solution together. At the same time, building necessary capabilities around 5G private networks should be a key focus.

Capitalizing on the enterprise 5G opportunity will require telecom operators to reposition themselves from pure connectivity/network providers to a solution driven approach. Globally, telecom operators have formed strategic partnerships with leading players across industry verticals and network OEMs to trial enterprise 5G use cases. Successfully delivering the proof-of-concept will help to strengthen the commercial proposition and open-up further monetization opportunities.

Success in the 5G era may require an altogether different approach. For instance, setting-up a separate 5G Business Unit (BU) to focus on differentiated service offerings. One of the Nordic telcos has formed a separate division to provide private networks, especially for 5G. The new division can be more agile and free of any legacy baggage.

Globally, telecom operators are taking up differentiated positions through a platform-centric approach for 5G. A leading Japanese technology major has developed a private 5G Network-as-a-Service platform, with end-to-end management capabilities to help drive business value and support innovative business models.

Telecom operators in India are uniquely positioned to learn from the plethora of enterprise 5G use case trials currently undergoing globally. It is important to identify incremental enterprise revenue benefits through 5G services, rather than relegating 5G to a replacement technology. The basic building blocks need to be in place – skills building, strategic partnerships, end-to-end solution provisioning, and innovative delivery mechanisms. ■

Effective change in the telecoms industry – A priority for CEOs

Quah Mei Lee,
Director,
Frost & Sullivan



The uncertainty in the future economic viability of the telecoms business is making change an immediate necessity. As mobile operators struggle with an identity crisis, their vendors have been acquiring new strengths to tackle the potential with digital through M&A, e.g., Ericsson acquired Vonage, and IT players have been encroaching into the network space, e.g., Microsoft acquired Metaswitch, for network capabilities to further tap on the enterprise opportunity. Only a handful of mobile operators, e.g., Singtel, Vodafone, and T-Mobile, are leading the way with 5G solutions for enterprises. 5G solutions are coming out of boxes to make it easy for enterprises to adopt, but more success with 5G is needed.

The industry cites cost and monetization as challenges faced with 5G. However, the business case could still make sense at high cost, if monetization was not an issue. Therefore, monetization may be the bigger problem, not cost, but cost still needs to be managed. New innovative business models need to be crafted to re-engineer cost and reduce risk. A 2022 Frost & Sullivan survey found that 60 percent of respondents cited that they do not believe the *build it and they will come* approach will be sustainable from 5G onwards. Mobile operators and their regulators need to consider new approaches to improve future prospects.

If there is need, 5G will be embraced. Indeed, 5G is finding a place in some of the most automated industries, e.g., in existing semiconductor factories in Taiwan, driven by use of augmented reality and artificial intelligence. The reality is such that some companies and some parts of the industry are moving faster with 5G because there is an exact fit for the need being addressed, but others require some development for there to be fit. The success of a few companies that are taking a different approach and achieving better outcomes, e.g., Rakuten Mobile, signals time for a review of the relevance and effectiveness of global alignment. Competing global IT

players can craft and execute monetization strategies faster than the global associations that bring together the more than 750 mobile operators.

Beyond connectivity, the need for end-to-end integrated services cannot be met without greater collaboration. The legacy mentality of control needs to give way to trust as future growth of the telecoms industry depends on how well companies can collaborate. Of the many partnerships that have been announced, many are collaborations with companies that do not compete. Part of the reason for this could be attributed to collaboration skills being rare amongst the telecoms industry workforce, where a large majority of workers still comprise of men and the industry struggles with discrimination. Another reason is that tapping on the opportunity requires companies to be more open, which is still not something that is intuitive for companies, especially in the telecoms industry.

The telecoms industry faces a skillset shortage that hampers the adoption of new emerging technology and new practices. Attracting top talent is a challenge as the industry is no longer a high-growth industry. The incorporation of automation in parallel further adds complexity as mobile operators need to find the right balance between human touch and automation. Finding the way forward with culture and talent needs to fall back on a clear strategy for business transformation.

The industry is well aware that change is necessary but achieving change is an uphill challenge. Up until recently, decisions have been for the short term. The business transformation that is necessary at this juncture is meant for long term, where clarity is elusive and success is not guaranteed. This increases the difficulty in getting everyone on board – investors and customers alike. However, the future of the telecoms industry is at stake should effective change not be made an immediate strategic imperative on mobile operator CEO agendas. ■

5G priorities, challenges, and impact in transforming lives and unlocking new opportunities in India

Naman Agrawal,
Specialist (S&T),
NITI Aayog



It has been over 6 months since 5G was launched in India, and while there has been a lot of buzz around it, users – both individual and institutional – are yet to see its impact. This impact will only be visible in its transformational sense when the full potential of 5G is achieved.

The 5G potential can be unlocked, provided all stakeholders across industries adopt a collaborative approach. For instance, by enabling smart manufacturing, immersive content – AR/VR, immersive/cloud gaming – 5G can transform several industries. 5G is expected to create several new job opportunities in manufacturing, transport, ICT, healthcare, and retail, but upskilling and reskilling the workforce will be critical. Surveys indicate that 70 percent of enterprises are expected to make the highest investment in 5G in the next 3 years, compared to other emerging technologies.

5G priorities and challenges for Indian enterprises

As 5G adoption increases the number of endpoints and use cases, the risks of cyber-attacks and data breaches are paramount for enterprises in India. At the same time, 45 percent of Indian enterprises would like to explore 5G's relationship with other emerging technologies (e.g., AI). This highlights that 5G priorities underline the need for a holistic approach to emerging technology adoption. However, the real challenge lies in creating financially viable and market-ready use cases. With 39 percent of enterprises seeking to explore 5G's impact on future business models, the industry's attention is shifting beyond just technology convergence to adoption of new applications enabled by technology.

Cross-industry collaboration is the key to unlocking the value of 5G

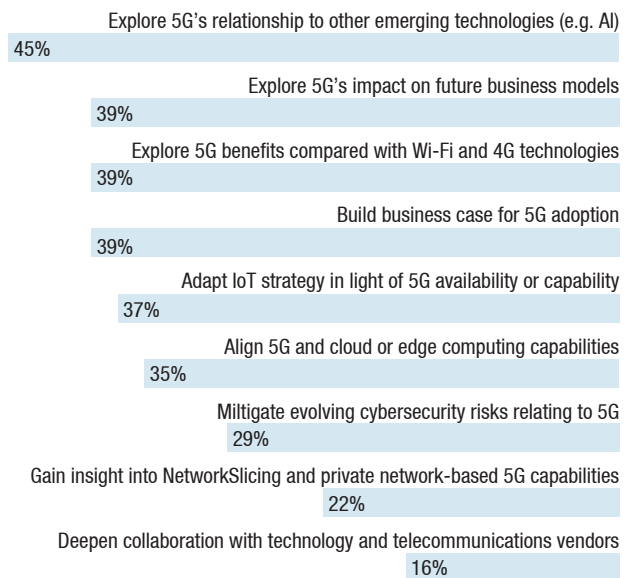
For India to seize the 5G opportunity, all stakeholders must act immediately through a collaborative approach, supported by an enabling ecosystem and the proper regulatory support. Since 5G impacts a wide range of in-

dustries, close coordination between various government departments and sector regulators is necessary for the success of 5G in India. A collaborative approach involving all stakeholders – the government, sector regulator, telecom operators, network equipment vendors, technology players and companies across various industries – will help develop India's 5G ecosystem roadmap.

5G has the potential to change the socioeconomic fabric in India and transform society at large. Providing pan-India connectivity through fixed wireless access (FWA)

Most important 50 priorities for Indian enterprises

% of respondents, N = 49 (Indian enterprises currently investing or planning to invest in 5G)



70 percent of the enterprises in India intend to make the highest investment in 5G as compared to other emerging technologies, such as quantum computing, edge computing, analytics and AI, and blockchain in the next three years, (EY survey).

Functional areas	Use cases
Advanced manufacturing	<ul style="list-style-type: none"> Automation and control - assembly line, remote assistance, robot control, collaborative robots Maintenance - AR assistance Autonomous factory transport
Automotive	<ul style="list-style-type: none"> Infotainment - immersive content and applications, UHD/4K video Navigation - HD maps, hyper-precise location services Autonomous vehicles - V2V communications, driver assistance, platooning Port management - real-time monitoring and analysis, control of traffic, automation of service equipment
Education	<ul style="list-style-type: none"> Smart classrooms with immersive lessons and training with AR and VR Holographic telepresence - a teacher can be virtually beamed to a classroom in a remote location
High-speed broadband	<ul style="list-style-type: none"> 5G Fixed Wireless Access (FWA) in rural areas to open-up new avenues of economic growth
Life sciences and healthcare	<ul style="list-style-type: none"> Remote monitoring of health data Remote consultation and diagnostics - 5G-based video conferencing, smart ambulance Digital hospitals - faster data transmission withing departments, immersive training Pharma manufacturing - automation and control, remote maintenance
Media and entertainment	<ul style="list-style-type: none"> Immersive content - AR/VR UHD/4K/8K - superior TV viewing experience Gaming - Immersive and cloud gaming In-stadium immersive experience Broadcasting - live broadcasting and streaming
Smart infrastructure	<ul style="list-style-type: none"> Safety and security - HD surveillance cameras, emergency response (VR assistance) Smart utility services Citizen engagement and e-services High-speed connectivity in public places Immersive tourism

services could be a game changer, especially in rural areas. 5G FWA is expected to spawn new avenues of economic growth through high-speed internet connectivity in households, improving fixed broadband penetration significantly. 5G has the potential to address some of the primary challenges owing to the lack of optimum infrastructure in sectors, such as healthcare and education. 5G is likely to improve access to education and the quality of virtual learning.

5G – Potential to transform a host of industries in India

The transition to 5G will unlock new use cases and revenue streams through innovative business models. It will bolster the startup ecosystem and enable India to be an R&D hub for 5G technology and use cases. Developing 5G applications is likely to have a significant impact across industries.

India’s engineering/advanced manufacturing segment offers the most significant 5G/IoT opportunity. Multiple use cases exist in this segment with the benefits of increased efficiency, productivity, better safety standards, and highly efficient production. In healthcare, 5G’s benefits can immediately be realized in home-based care and connected hospital devices, as 5G facilitates real-time data transfer. For instance, an intelligent ambulance, equipped with the latest medical instruments, including an HD video camera and portable MRI scanners, can help to transfer real-time data to the hospital. 5G also has the potential to open up remote patient monitoring and diagnosis opportunities

in healthcare in rural areas.

The Indian media and entertainment sector is transitioning from passive to participative consumption, fuelled by the popularity of immersive technologies, such as AR and VR, networked gaming, and interactive game shows. 5G may help accelerate this trend and completely transform the consumer experience. Also, there will be an innovation in using 5G to distribute live HD broadcasts in significant events, bringing alive the next-generation stadium experience through in-stadium AR. With the rise in online gaming as its own market segment, 5G can enable massive multiplayer games with immersive worldbuilding.

Further, the advent of 5G may significantly enhance connected-car features, and usher in the age of autonomous vehicles (AV) in India. It will connect vehicles-to-vehicles, roadside infrastructure, road users, and cloud services to improve transportation experience and quality of life. On the other hand, 5G’s ability to support many sensors and real-time dissemination of information and analysis makes it suitable for several smart city functionalities, ranging from intelligent utility services to automated traffic management. 5G significantly enhances safety and security by supporting high-throughput real-time video surveillance.

The industry and users have spent enough time dreaming of the 5G painting. All that remains is to wake up and finish painting the 5G dream.

The article is co-authored by, Siddhey G Shinde, NITI Aayog ■

Envisioning sustainable digital transformation

Rishu Sharma,
Director & Digital Evangelist,
Birlasoft



“*What’s next in Digital?*” I was asked in a conversation with a CXO, recently.

Enterprises leading with a digital-first mindset find themselves, now, at the crossroads of making the next progression – the next that entails the triple-P impact – people, planet, and profit, ensuring environmental, social, and economic viability.

Digital and sustainability, though deeply interconnected, are often viewed independently and in silos. In practical terms, digital promotes and advances enterprises’ sustainability efforts. The convergence of sustainability and digital is pivotal for building a sustainable and resilient future. Both boost each other mutually, specifically in areas of:

- *Driving innovation in products and services.* Digital technologies foster products and services that are not only pioneering but also meet the sustainability quotient.
- *Data, the backbone of sustainability.* Enterprises are dealing with a data deluge (compounded further with digital) that can enable them to meet sustainable goals, if used optimally.
- *Enabling the future of work.* The hybrid world that we live in operates amongst hybrid work models, clouds, and ecosystems. While digital enables these core components of the hybrid world, it also simultaneously helps in promoting sustainability.
- *Transitioning to clean and green energy sources.* Digital promotes combining green sources and the shift thereof to the sustainable systems.
- *Enhancing operational efficiencies.* Varied digital technologies bring together the benefits of improved efficiencies and utilization of resources and operations alike, through tech like Cloud, AI, IoT, and analytics, to name a few.

But then the next imperative remains on how to progress on this journey. What are the best practices that enter-

prises should keep in mind? How do organizations ensure that the digital and sustainability efforts complement each other, while being mutually inclusive? All to accelerate sustainable transformation and innovation! Some key steps below are crucial for future-ready enterprises:

- *A clearly articulated and well-established vision.* Usually the first step, most organizations fall in the trap of multiple characterizations of what sustainable digital programs mean for them. A clear vision of digital sustainability that entails what it means for the ecosystem and the ESG goals leads to the next step, mostly of associated infrastructure needs.
- *Getting the infrastructure ready.* While most businesses are digitally-first driven, are they really leveraging technology for sustainability? Investing in technological infrastructure that is sustainable is non-negotiable to all things green. Think of consolidating digital tools that promote data-driven sustainability. Think of IT/OT/ET integrations. Think renewable, think recyclable, think green.
- *Responsibility and contribution.* Readiness of vision and infrastructure alone is not enough. Organizations must promote participation across the levels of internal and external ecosystems for deep-rooted sustainable digital transformation. Additionally, enterprises must also account for responsible use of resources, specifically in response to emerging technologies and their impact.
- *Tracking and measuring success.* It is crucial to define the metrics for the success of sustainable transformation programs.

Sustainable digital transformation warrants bringing in ESG priorities on the same page as the organizational goals while keeping in mind the triple-P impact. Enterprises of tomorrow accelerate innovation and develop resiliency, by imbibing sustainability as part of their long-term digital vision.

My answer to the CXO’s question, naturally was, “The shift toward sustainable digital transformation.” ■

The impact of AI on businesses – A revolutionary tool to navigate through the global recession in 2023

Mandar Mungee,
Chief Revenue Officer,
Grene Robotics



As we move further into 2023, there are growing concerns about the potential risk of a global recession. While the world economy has not yet fully recovered from the recession of 2022, several reports indicate that the recovery may not even happen and would not be sustainable in the long term. Businesses are still uncertain about the future. How can companies safeguard themselves? One definite answer to this is the adoption of artificial intelligence (AI) and autonomy. But first, let's understand the recession and dive deeper into the impact of AI.

So what exactly is a recession?

A recession is commonly defined as a period of economic decline marked by two consecutive quarters of negative growth in the gross domestic product (GDP). However, some experts argue that a true recession also involves a significant increase in the unemployment rate alongside negative GDP figures. This inflationary environment often precedes recessions and further reduces consumer spending.

The term "recession" was officially coined by the National Bureau of Economic Research (NBER) Business Cycle Dating Committee. According to the committee, a recession is characterized by "a substantial decline in economic activity that spreads across the economy and lasts for several months." While the committee does not follow strict rules to determine a recession, it places significant emphasis on personal income as a key indicator.

Why do recessions occur?

Understanding the causes of recessions has been a continuous focus of economic research, as several factors contribute to their occurrence. One major trigger is sudden changes in input prices, such as a surge in oil prices or a country's decision to implement contractionary policies to address inflation. Additionally, issues in financial markets, such as significant increases in asset prices and

excessive credit expansion, can also lead to recessions.

Predicting recessions is challenging due to their multiple potential causes. While certain indicators like asset prices, the unemployment rate, and consumer confidence can provide some predictive value, accurately forecasting recessions remains a formidable task for economists.

Digital transformation is the best strategy

It is no longer news that the right adoption of technology can save a company from going down in difficult times. We saw this happening during the Great Recession of 2007–2009, and then even during the Covid-19 pandemic. Companies that were quick to adapt to technology were the ones who managed to stay afloat and accelerate their profitability, both during and after the downturn. They were able to prioritize early cost restructuring, based on their adoption of emerging digital solutions. Since then, it has been established that to stay ahead of the curve and be future-ready, digital transformation is the best strategy.

Digital transformation can redefine the way businesses operate, leveraging technology to streamline operations, enhance efficiency, and drive innovation. In a survey conducted by CNBC's Technology Executive Council, AI, machine learning, robotics, and software-defined security are identified as the key priorities in 2023. By embracing these technologies, companies can position themselves for sustainable success, and build the resilience necessary to navigate future economic uncertainties.

Impact of global recession on India

As per RBI, unlike the global economy, India is not likely to experience a slowdown and will continue maintaining its growth rate achieved in 2022-23. The Indian economy is intrinsically better positioned than many parts of the world, while heading into a challenging year ahead. It is also mainly because of its resilience and reliance on domestic drivers.

OPINION

However, there is a chance that India may still be affected by the global economic downturn to some extent. According to Moody's analytics report titled *APAC Outlook: A Coming Downshift*, India may experience slower growth in 2023.

Role of AI

AI has created a special space for itself across industries, and already impacts the world in many ways.

Post-pandemic, companies have become predictive and dynamic in their decision-making to achieve operational resilience. Therefore, to become flexible, many businesses started to conserve cash, slowing their growth plans and preparing for survival, given that the future could be challenging.

In such scenarios, AI can make a meaningful impact by reducing hidden costs, improving productivity, and finding new revenue streams. Let us understand the two primary aspects of AI for businesses that can support growth during an economic downturn.

Automate workflows and processes

One of the key strategies to navigate a recession is to manage resources efficiently and handle costs effectively. However, many companies need help managing time-consuming tasks that can impede the normal flow of business operations, such as document review, invoice reconciliation, and payment processing.

To address this issue, automating repetitive and mundane tasks, such as data entry and document processing, can lead to significant cost savings for a business. It includes reducing overhead costs and minimizing costly human errors caused by repetitive manual work.

For instance, in the manufacturing and automobile industries, quality and inspection-related issues become a central focus during times of recession. It becomes difficult to allocate resources to manage every aspect of the manufacturing process. Hence, smart solutions, such as engine defect detection, using visual inspection, AI comes into play. They can help to remedy quality issues with maximum accuracy.

By leveraging AI and predictive maintenance, anomaly detection, can also be integrated into the process. Furthermore, warehouse inventory count automation can be implemented to accelerate operations, while reducing the risk of human error.

Allows businesses to protect their competitive advantage

As stated by Reid Hoffman, the co-founder of LinkedIn, in today's competitive landscape, businesses must incorporate AI into their strategies to secure a competitive advantage, either presently or in the future.

Rather than being a cost centre, technology is now a business driver—and AI tools can be a sustainable differentiator that sets companies apart. Why? Rather than replacing the work of humans, it enhances them. Knowledge workers spend 30 percent of their time searching for the right information. When data is complex, unstructured, and large in scale, this search process is resource-intensive and time-consuming. This makes it hard for organizations to scale since additional resources need to be added to earn additional income.

With tools like AI, employees can free up time for more high-value work, improving the output and quality of the business overall.

Increase revenue efficiency

AI will eventually be recognized as an essential technology for any industry to stay competitive, even during an economic downturn. According to Accenture, AI can potentially increase profitability rates by an average of 38 percent by 2035 and generate an additional USD 14 trillion in economic growth across 16 industries and 12 economies.

If businesses are experiencing decreased revenue and profitability due to reduced demand for their products or services during a recession, AI can potentially help increase revenue efficiency. This is possible by automating certain tasks and processes in an organization. AI has the ability to comb through multiple data points from customers, the company, and competitors to provide valuable insight into patterns and vulnerabilities within a customer base, identifying customers who are likely to leave, and improving overall customer retention. For example, the tech giant Amazon uses AI to drive dynamic pricing – reducing prices to elicit more sales when needed and increasing prices when demand is high.

Algorithms can also reveal patterns in buyer behaviour, sales performance, and external conditions, which increase sales revenue, while eliminating uncertainty in the sales process. This assists the sales leader in determining which tactics work best at each touchpoint.

AI to help thrive, not just survive

Several reports indicate a potential risk of a global recession in 2023. While it is impossible to predict the future with certainty, it is essential to be aware of these risks and take measures to mitigate them. With AI, businesses can navigate closely any market environment by increasing accuracy, productivity, and growth at a lower cost. It reduces customer issues and improves expense management.

As a result, investing in new technology during a downturn may seem daunting, but the medium to long-term benefits far outweigh one-time costs. ■



Data Centers

Waiting with bated breath

The data center industry continues to see massive investment, albeit riddled with challenges.

ENTERPRISE NETWORKS

2023 has yet to see large acquisition deals in the data center industry.

2022 saw USD 48 billion worth of data center deals transacted, including the closure of the USD 15-billion CyrusOne acquisition announced in 2021. 2021 saw a flurry of 10- and 11-figure deals, those broke records for the industry. 2020 was a then-record-breaking year for M&A in the industry, with more than USD 31 billion spent across more than 110 deals, doubling the figures of 2019.

While multi-billion-dollar acquisition deals are common occurrences in the world of technology, such giant buyouts are relatively rare in the field of data centers.

“Hyperscale operators continue to aggressively expand their operations, while both enterprise and consumer-oriented cloud markets keep on growing rapidly. This is driving an ever-increasing need for data center capacity,” John Dinsdale, a chief analyst at Synergy Research Group, had said in the wake of the CoreSite/CyrusOne deals in 2021.

“The level of data center investment required is too much for even the biggest data center operators, causing an influx of new money from external investors. In quick succession, ownership of four of the top six US data center operators has changed hands, while the two biggest names in the industry – Equinix and Digital Realty – are increasingly turning to joint ventures to help fund their growth. Over the last 18 months, there has been a very notable shift in buyers with private equity investors becoming a lot more active than data center operators,” Dinsdale added.

With greater innovation and industry transformation, particularly in 5G and the metaverse, the data center owners and operators in 2023 are seeking infrastructure solutions partners that are able to advise them on the best practices and technologies to help them meet their *net-zero* goals.

While the commitments toward net-zero carbon emissions from most operators in India are encouraging, there are still many challenges on the path ahead. Similar to data center operators, the end customers of data centers may also have net-zero commitments. These customers

may demand requirements in terms of MEP equipment, sourcing of raw materials, etc., based on their net-zero commitments. Such requirements can directly impact the CapEx and operating costs for operators.

India, for instance, has ~1.5 GW of new supply in the pipeline, and the landbank with operators can potentially add another 3 GW of supply. While India is focused on increasing renewable energy generation, the capacity addition may not keep pace with data center deployments, thereby delaying the net-zero targets. In the face of increasing data demands and the environmental impact of technology, data center operators are prioritizing sustainability to ensure that their data centers are green and carbon-neutral.

Data centers are continuing to experience increased regulation and third-party oversight as the world continues to grapple with the industry’s rising energy and water consumption against the backdrop of ongoing climate change.

Increased regulation leads to important innovations. The process may not always be easy or linear, but it can be navigated with the help of expert data center partners and innovative solutions that can anticipate the changes while meeting the always-increasing requirements of data center applications.

It is happening in some places already. Dublin, Ireland, and Singapore have taken steps to control data center energy use, and data center water consumption – especially in areas prone to drought – is likely to trigger similar scrutiny.

Prefabricated, modular data center designs will be a part of their future data center strategy, concludes a recent Omdia survey. A continuing shift in the same direction among hyperscalers is being observed as they seek the speed and efficiencies standardization delivers.

This is a newer concept for the world’s leading cloud providers, and they are turning to colocation providers – who have been standardizing for years – to make it happen. Specifically, those cloud providers are outsourcing their new builds to colos to leverage their in-market



expertise, proven repeatability, and speed of deployment. In short order, standardization – ranging from modular components, such as power and cooling modules and skids, to full-fledged prefabricated facilities – will become the default approach, not just for the enterprise but also for hyperscale and the edge of the network.

Increased reliance on batteries for longer load support with minimal generator capacity, increasing rack densities, and creating thermal profiles that require liquid cooling and thereby addition of direct-to-chip cooling to new Open Core Protocol (OCP) and Open19 standards are accelerating trends.

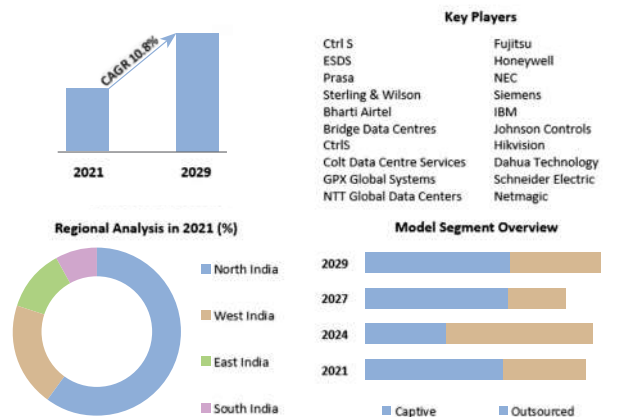
An industry grappling with higher costs, and a slowing global economy, sets the stage for a challenging landscape for delivering new data center capacity. After several years of powerful growth, the digital infrastructure sector faces a challenging environment for building new data centers at internet speed. Key markets are facing power constraints, and new deployment timelines may be slowed by supply chain issues and community resistance. On the demand side, enterprise IT shops will likely face budget constraints, while the hyperscale sector must absorb the massive amount of capacity leased in 2022.

The hype about generative AI became reality in 2023. For the data center sector, this means more demand for specialized high-performance computing (HPC) platforms. The large cloud providers will be the key players here, but forward-leaning enterprises may want to use these tools to unlock business value in proprietary datasets that may not be cloud candidates.

That creates opportunities for high-density colocation, offerings optimized around new processors and software frameworks for generative AI. Larger colo and wholesale data center providers may accelerate plans to create high-density zones in their facility.

Community resistance to data center development is a growing challenge in some of the most important data center markets, as they devour vital community resources like water and electricity. Extreme heat and drought are raising the bar for fast-growing cloud computing platforms and data center developers.

Indian data center market



Maximize Market Research

In many regions, data centers are now using air-cooled chillers that recirculate water in a closed loop, drastically reducing their water use. But in other regions, they continue to rely on evaporative cooling systems that are highly efficient but require lots of water.

According to the US Department of Energy, the water-usage effectiveness (WUE) of an average data center, using evaporative cooling systems, is 1.8 L per kWh. That type of data center can consume 3–5 million gallons of water per day – similar to the capacity used by a city of 30,000–50,000 people. The industry will continue to take steps to self-monitor and moderate – including an increasing preference for environmentally-friendly thermal designs – but this year will see increases in regulatory oversight.

We have reached a tipping point. The existing data center ecosystem has an upper limit when it comes to the amount and density of infrastructure it can cool, with average data center physically unable to cool racks with a density greater than 20 kW. Conventional air cooling ceases to be an economical or effective solution when rack densities are higher than 20–25 kW. This was not perceived as an especially pressing issue even a couple of years ago, when the industry sat comfortably in the 10–19 kW range.

More heat means more power consumed to cool server



Comparison of the best data center service providers

Company	Headquarters	Founded In	# of data centers	Market served	Services
Equinix	Redwood City, CA, US	1998	202 (12 more to come)	24 countries	5
Digital Realty	San Francisco, CA, US	2004	214	14 countries	3
China Telecom	Beijing, China	2002	456	>10 countries	6
NIIT Communications	Tokyo, Japan	1999	48	17 countries	9
Telehouse/KDDI	London, UK /Tokyo, Japan	1988/1953	40	12 countries	4

Software Testing Help

racks, more carbon emissions, more wear and tear on hardware, and fewer opportunities for enterprises to capitalize on the power of AI/HPC. Customers are already consuming AI/HPC resources on a regular basis to solve the most pressing and immediate problems. AI/HPC in the enterprise space has become normalized, accepted, and expected. Moving forward, a new breed of facility that is capable of accommodating the hardware powering this revolution is needed.

When rack densities grow to the point we are starting to see in dedicated AI/HPC facilities, air ceases to be a viable medium for cooling those servers. Liquids, on the other hand, can absorb a lot of heat very quickly and carry it away, making water or dielectric cooling fluid much more effective than air as a cooling agent. Cooling a server using a dielectric cooling fluid is 1500 times more efficient than traditional HVAC cooling. The data center industry is waking up to the fact that immersion cooling is no longer a niche solution, but rather the enabler that will make AI/HPC accessible to a rapidly expanding user market; that is where collocated HPC or HPC-as-a-service comes into play.

With the generative AI industry alone predicted to reach USD 103.74 billion by 2030, at a CAGR of 33.7 percent from 2023 to 2030, a shift toward higher-density digital infrastructure is imminent. The chips that are being released right now — the ones that will support the transition of generative AI, advanced GPU processing, and all the other technologies are producing twice as much heat as the previous generation. There is little to suggest the leap to the generation after that will be any less exponential.

Indian scenario

India’s data center industry doubled to 722 MW in 2022 from 350 MW in 2019, registering a robust CAGR of 27 percent. In 2022, the industry saw an all-time high absorption of 160 MW, which is 32 percent higher than the previous year. Mumbai leads the absorption pie, accounting for a 43-percent share, with a substantial hyperscale precommitment being delivered in Delhi NCR.

India has been and will be the preferred market for data

center providers. The rising demand for on-demand video, mobile gaming, and online content will be a stronger force for data center procurement in the country.

This growth shows no signs of slowing down, thanks to the high pace of India’s digital transformation, migration of IT infrastructure to third-party providers, and growing usage of data from new and existing channels. Hyperscalers’ public cloud services have been scaling up their requirements and are expected to grow further.

With a strong precommitment pipeline, it is expected to result in 678 MW being added over the next three years, taking the industry’s capacity to 1400 MW by end-2025. This will create demand for 9.1 million sq. ft. of real estate space, which will need an investment of USD 4.8 billion, some from global investors or alliances to fund the additions, in both data center infrastructure and data center sector real estate, according to a JLL report. The highest capacity addition is expected in Mumbai, including Navi Mumbai, requiring 4.7 million sq. ft. of real estate, followed by Chennai at 2.3 million sq. ft. and Delhi NCR at 1 million sq. ft.

Strong data localisation policies of the government encouraged setting up of a robust data center ecosystem in India as they mandated processing of data generated in the country within its boundaries. Initiatives, such as Digital India, Make in India, Atmanirbhar Bharat, and the Digital Personal Data Protection Bill 2022 are providing the requisite impetus.

It is not just India that is seeing huge sums of money going into data centers. One good example is NTT Ltd. Following the Jakarta 3 Data Center (JKT3) in Indonesia, completed in April 2022, and the Cyberjaya 6Data Center (CBJ6) in Malaysia, scheduled for completion around the middle of 2023, the company has announced an investment of USD 90 million for the development of its newest and largest data center in Thailand.

Despite cloud-based alternatives to on-site servers becoming more popular, the various large companies across the world are continuing to build data centers and the growth momentum is expected to continue. ■



T&M

A shot in the arm for the wireless testing industry

NTIA's allocation of USD 140.5 million as the first funding round gives a powerful signal of the relevance of testing in 5G and next-gen wireless technology.

The first funding opportunity for the USD 1.5-billion Public Wireless Supply Chain Innovation Fund, which is part of the CHIPS and Science Act passed last year, and focuses on federal government's efforts to promote a secure supply chain and open approaches to network infrastructure, has been officially kicked off by the US government. National Telecommunications and Information Administration (NTIA) is administering the fund.

127 applications requesting USD 1.39 billion to support testing and research and development activities related to open and interoperable wireless networks have been received.

This first round consists of up to USD 140.5 million. It focuses on expanding and improving testing and R&D that will demonstrate the viability of new approaches to wireless like open radio access networks (O-RAN) and remove barriers to adoption.

Specifically, the funding will go to support expansion of industry-accepted testing and evaluation, focusing on interoperability, performance, and security of open and interoperable, standards-based 5G RAN and developing or improving the testing of those networks and their component parts.

Later, funding opportunities will build upon the foundational work of this first NOFO, creating an ecosystem for wireless innovation, built by the US and its global allies.

"The overwhelming interest in this first round of funding shows the private sector is stepping up to meet that need. These are the important first steps in this critical project to help us drive competition, strengthen our supply chain, and provide our allies additional trusted, innovative choices," said Alan Davidson, US Assistant Secretary of Commerce, US Department of Commerce.

Telecom networks are facing a slew of simultaneous changes that are increasing complexity, from the deployment of 5G and the addition of new, higher frequency spectrum bands to the cloudification of the network and the exploration of O-RAN. This has huge implications on how those networks are tested, assured, and optimized.

The emergence of ubiquitous cloud-based networks is one such huge change for the telcos. The shift to cloud-native and disaggregated networks brings a software-centric environment and such an agile environment means a high volume of changes to the network – and all of these changes have the possibility of affecting service reliability and service continuity in a negative way. Testing is essential to ensure that the network changes do not impact the end-customer experience.

To meet this requirement, tests are evolving. Cloudification of network test is taking place, so that testing benefits from the cloud in the same ways that the network itself does, through increased availability, scalability, and agility through centralizing the management of network testing.

At the same time, telcos are increasingly adopting DevOps practices with a focus on continuous integration, continuous delivery, and continuous testing (CI/CD/CT) to enable them to constantly improve existing services and launch new ones to remain competitively differentiated. Of course, each iteration or new service chain will need to be rigorously tested and validated before launch and in-service to ensure the upmost QoS.

Of course, this brings challenges. Ensuring high quality of service (QoS) and QoE requires pre-launch test and validation as well as in-service real-time, end-to-end monitoring of application performance visibility across multiple domains throughout the entire lifecycle of the service.

Service providers use two tried and tested service assurance approaches – passive monitoring and active assurance. Passive monitoring offers in-depth, post-event analysis of network behavior and performance, based on real traffic. Conversely, active assurance requires emulated/simulated test traffic to be injected into the network – either in live networks or in test labs using containerized or virtualized test agents – to validate SLAs before and after service activation and guarantee superior QoS.

Such a repetitive approach to producing and testing software in short cycles allows organizations to reliably improve and release software on a *continuous basis*, reducing the cost, time, and risk of delivering incremental software changes and launching new services. In turn, this requires the automated testing and validation of new



"Fiscal Q3 2023 revenue and non-GAAP operating margin came in within our revised guidance range. Lower than expected NEMs and semiconductor R&D spend during the March quarter adversely impacted our initial NSE revenue expectations.

On a positive side, we saw the beginning of stabilization of demand for our field instruments during the March quarter. In the current quarter, we are seeing the signs of recovery in our field instruments and stabilization in the lab and production business. We expect the stabilization and recovery momentum to continue into the second half of calendar 2023."

Oleg Khaykin, President and Chief Executive Officer, VIAVI Solutions

software code at every stage of the software development lifecycle. The 5G mantra is simple – “Test early. Test often. Test everywhere. Automate.”

Leaders in the T&M sector continue to engage in M&A activity

Emerson Electric Co. has agreed to buy National Instruments Corp for USD 8.2 billion, capping a nearly year-long pursuit of the measurement equipment maker. Emerson estimated that the NI transaction will result in USD 165 million in cost synergies over five years.

The acquisition is expected to bolster Emerson’s efforts to reshape itself as a major global player in the automation industry. The deal will strengthen a key pillar of Emerson’s strategy to build out its capabilities in the high-growth area of testing and measurement and allow it to tap National Instruments’ software-connected automated systems as part of its profitability push. The acquisition is expected to close in the first half of Emerson’s fiscal 2024, or by March 2024.

March 2023, NI announced the acquisition of SET GmbH (SET), long-standing experts in aerospace and defense test system development and recent innovators in power semiconductor reliability test. Together, the companies will reduce time to market for critical, highly differentiated solutions and accelerate semiconductor-to-transportation supply-chain convergence with power electronic materials, such as silicon carbide (SiC) and gallium nitride (GaN). By combining capabilities, NI and SET can offer more differentiated solutions to customers and grow together by leveraging NI’s global scale.

February 2023, Keysight acquired Cliosoft, thereby adding its line of hardware design data and intellectual property (IP) management software tools to its portfolio of electronic design automation (EDA) solutions. By bringing Cliosoft into its EDA business, Keysight boosts its intelligent automation software offerings with PDM as an essential component in building the foundation for more productive workflows. Keysight is extending Cliosoft’s capabilities to include test data in a fabric that provides customers with a much stronger link between design and test.

Manufacturers teamed up too. Spirent Communications and NI have teamed up on what they say is the first and only comprehensive test solution for the O-RAN

radio unit (RU). A bevy of partners, including Spirent Communications and the 5G Open Innovation Lab, worked together to spotlight a new private network solution that is aimed at making easier to deploy enterprise private mobile networks and assure their performance.

The T&M vendors recently announced results. They indicate that in the field of information and communication, which is the main field of test and measurement business, 5G smartphone penetration is slow despite that operators in each country have already initiated 5G services. This is because a killer application has yet to emerge, as well as some of the technical challenges in 5G via mmWave.

Meanwhile, the completion of the Release 17 standardization is increasing the utilization of 5G. Research and development for 5G utilization in the automotive field has begun, as well as research and demonstration experiments for building 5G networks in private domains, such as private 5G. In IoT field, the demand for customer-premises equipment (CPE), which is laid in the last mile, is increasing. In response, demand for developing 5G wireless module and Wi-Fi 6E has emerged. Furthermore, research and development for the next-generation communication standard, 6G, has begun.

In 5G networks, the O-RAN Alliance has been working to open up wireless access networks so that operators can build wireless networks more flexibly. By applying the O-RAN standard specifications to base station equipment that was previously configured with the manufacturer’s proprietary interface, it has become easier to build multi-vendor radio access networks. As a result, operators around the world are introducing O-RAN.

Since the data traffic is expanding rapidly due to sophisticated cloud computing services and the progress of 5G services, the network infrastructure is under strain. To solve this issue, service providers that are pursuing higher-speed networks are concentrating on the promotion of 100Gbps services, and network equipment manufacturers are developing 400Gbps and 800Gbps network equipment. In addition, research and development of innovative optical and wireless network (IOWN) is underway.

Rising prices and interest rates, increased geopolitical risks, and a prolonged global semiconductor shortage can



“In the T&M business, we captured the development and production-related demand for high-speed network transmission in data centers, as well as the demand for general purpose test instruments. However, due to slowdown of mobile market growth, soaring raw material prices, as well as the increased fixed costs and sales promotion expenses caused by global inflation, rising labor costs, etc., revenue decreased by 1 percent YoY to 72.8 billion yen and operating profit decreased by 28 percent to 10.9 billion yen, with operating margin of 14.9 percent (in fiscal year ended March 2023).”

Akifumi Kubota Director, Executive Vice President, CFO, Anritsu Corporation



“Keysight delivered a strong quarter with record second quarter revenue, record gross margin, record free cash flow, and above-guidance earnings per share, demonstrating the resilience of our increasingly diversified business.

While navigating near-term macro dynamics, we continue to capitalize on growth opportunities and customer investments across multiple markets.”

Satish Dhanasekaran, President, and CEO, Keysight

have an important impact on our business performance. Amid such environment, we work to improve profitability by passing on cost increases due to inflation and other factors to our prices. We take measures against parts procurement risk like semiconductor shortage, such as securing inventory in an organized way, creating structure like strong relationship with business partners in order to get information quickly. Furthermore, we attempt to change high risk parts to alternative items for minimizing the risk.

VIAMI Solutions

VIAMI reported results for its third fiscal quarter ended April 1, 2023. The third quarter of fiscal 2023 net revenue was USD 247.8 million. GAAP net loss was USD (15.4) million, or USD (0.07) per share. Non-GAAP net income was USD 18.0 million, or USD 0.08 per share. Second quarter of fiscal 2023 net revenue was USD 284.5 million. GAAP net income was USD 8.4 million or USD 0.04 per share. Non-GAAP net income was USD 31.5 million, or USD 0.14 per share. Third quarter of fiscal 2022 net revenue was USD 315.5 million. GAAP net income was USD 19.2 million, or USD 0.08 per share. Non-GAAP net income was USD 52.0 million, or USD 0.22 per share.

Highlights

- Americas, Asia-Pacific, and EMEA customers represented 40.5 percent, 30.5 percent, and 29.0 percent, respectively, of total net revenue for the quarter ended April 1, 2023.
- As of April 1, 2023, the company held USD 586.6 million in total cash, short-term restricted cash, and short-term investments.
- As of April 1, 2023, the company had USD 96.4 million aggregate principal amount of 1.0 percent senior convertible notes, USD 68.1 million aggregate principal amount of 1.75 percent senior convertible notes, USD 250 million aggregate principal amount of 1.625 percent senior convertible notes, and USD 400 million aggregate principal amount of 3.75 percent senior convertible notes, with a total net carrying value of USD 792.1 million.
- During the fiscal quarter ended April 1, 2023, the company generated USD 17.8 million of cash flows from operations.

For the fourth quarter of fiscal 2023 ending July 1, 2023, the company expects net revenue to be between USD 242

million and USD 262 million and non-GAAP earnings per share to be between USD 0.07 to USD 0.09.

Anritsu Corporation

Anritsu group’s operating results for the fiscal year ended March 31, 2023, were as follows:

Orders decreased 0.5 percent YoY to 110,107 million yen, and revenue increased 5.2 percent to 110,919 million yen. Operating profit decreased 28.8 percent to 11,746 million yen, profit before tax decreased 27.5 percent to 12,438 million yen. Profit decreased 27.9 percent to 9256 million yen, and profit attributable to owners of the parent decreased 27.5 percent to 9272 million yen.

The test and measurement segment group develops, manufactures, and sells measuring instruments and systems for a variety of communication applications, and service assurance. The group delivers them to service providers, network equipment manufacturers, and maintenance and installation companies. During the fiscal year ended March 31, 2023, the vendor captured the development and production-related demand for high-speed network transmission in data centers, as well as the demand for general purpose test instruments. However, due to slowdown of mobile market growth, soaring raw material prices, as well as increased fixed costs and sales promotion expenses caused by global inflation, rising labor costs, etc., both revenue and operating profit decreased YoY. Consequently, the segment revenue decreased 0.8 percent YoY to 72,753 million yen and operating profit decreased 28.5 percent to 10,874 million yen.”

Business Forecast. It is estimated that demand for development will continue not only for the spread of 5G services in Europe, but also for the use of 5G in other fields. We also estimate that demand will grow for the expansion of network infrastructure in data centers and other facilities. With the above outlook, Anritsu group aims to be a 5G/IoT industry leader. To establish a competitive advantage, we work to provide solutions in a timely manner that accurately meet 5G-related demand, development demand for utilizing 5G, and demand for faster network. Furthermore, we have identified the following four priority new growth areas – EV and battery measurement, local 5G, optical sensing, and medical and pharmaceuticals. The company will accelerate growth in each of these areas through external collaboration and M&A.

Keysight Technologies

Keysight Technologies, Inc. reported financial results for the second fiscal quarter ended April 30, 2023.

Highlights

- Revenue grew 3 percent to reach USD 1.39 billion, compared with USD 1.35 billion last year, or 5 percent on a core basis, which excludes the impact of foreign currency changes and revenue associated with businesses acquired or divested within the last twelve months.
- GAAP net income was USD 283 million, or USD 1.58 per share, compared with USD 258 million, or USD 1.41 per share, in the second quarter of 2022.
- Non-GAAP net income was USD 380 million, or USD 2.12 per share, compared with USD 334 million, or USD 1.83 per share in the second quarter of 2022.
- As of April 30, 2023, cash and cash equivalents totaled USD 2.50 billion.

By segment, Communications Solutions Group (CSG) reported a revenue of USD 937 million in the second quarter, down 3 percent over last year, reflecting a 7-percent decline in commercial communications, while aerospace, defense, and government increased 7 percent driven by radar, spectrum operations, space and satellite, and research in 5G and 6G technologies.

Keysight's third fiscal quarter of 2023 revenue is expected to be in the range of USD 1.37 billion to USD 1.39 billion.

National Instruments Corporation

NI recently announced Q1 2023 revenue of USD 437 million, up 13 percent YoY, a record for a first quarter. For Q1 2023, the value of the company's total orders was down 10 percent YoY, compared to a very strong Q1 2022.

GAAP net income for Q1 was USD 47 million, with diluted earnings per share (EPS) of USD 0.35, and non-GAAP net income was USD 83 million, with non-GAAP diluted EPS of USD 0.62.

For Q1, YoY orders in the Americas region were down 12 percent, in EMEA orders were flat, and in APAC orders were down 15 percent.

With supply chain constraints beginning to ease, the vendor continued reducing its delinquent backlog as

planned to support revenue growth despite a challenging economic environment. This dynamic also supported its continued gross margin expansion. GAAP and non-GAAP EPS were in the upper half of our guidance range, driven primarily by operational execution, as well as a lower-than-expected tax rate.

The acquisition of NI by Emerson Electric Co. is still pending.

Spirent Communications plc.

In 2022, Spirent delivered another year of robust revenue growth and a material increase in earnings.

Order book was up 7 percent to USD 288.1 million, with 30 percent for delivery beyond the next 12 months, which is a record and adds to future revenue visibility. Revenue was up 5.5 percent, driven by renewed strength in high-speed Ethernet from market demand and new product launches, offsetting some customer timing impacts in *lifecycle service assurance*. Adjusted operating profit increased by 9 percent to USD 129.5 million, with adjusted operating margin improving to 21.3 percent, up from 20.6 percent in 2021.

Spirent has worked with Reliance Jio's R&D team and its dedicated quality assurance labs for many years. In 2022, its balance sheet shows USD 1.6 million (as compared to nil in 2021) of earnings from its India subsidiary.

For RJio, Spirent provided a hybrid managed solution that delivers the customer's detailed test requirements and can be rapidly delivered and scaled as required. The telco utilized Spirent's test-as-a-service managed solution to deliver automated validation and security testing of its new 5G standalone core network and cloud infrastructure. Focused on 5G SA core, cloud infrastructure and security, the solution is further enabled by Spirent's extensive automation, reinforcing the strong collaboration between the two companies.

German test and measurement company Rohde & Schwarz said that it ended its fiscal year with increased revenue and strong order intake.

Rohde & Schwarz

R&S is privately held, but the company nonetheless reports a few of its financial and operating highlights



"We delivered strong results with EPS and revenue above the midpoint of our guidance. Revenue for the first quarter was up 13 percent YoY and a record for a first quarter. For Q1, GAAP operating margin was up over 500 bps and non-GAAP operating margin was up over 600 bps as compared to the same quarter last year.

We believe these results are a testament to the initiatives that we've executed since 2017 to transform NI into a company with higher growth, better profitability, and lower cyclicality. I'm proud of the performance of our team in a dynamic environment."

Eric Starkloff, President and CEO, NI



“Once again, we grew our order book, improving our visibility and reducing technical cyclicality in our business. We successfully implemented our engineering site strategy to transfer resource to lower-cost regions, which contributed to the flat operating cost base, compared to 2021. This was delivered despite industry-wide cost inflation, and provides us with an efficient operating structure as we look forward. We have a strong balance sheet, which affords us a high degree of flexibility in growing our business, allows us to continue to innovate, invest in R&D and go-to-market channels whilst also focusing on inorganic opportunities that position us for continued growth.

Since the fourth quarter of 2022, we have seen delays to some of our customers’ decision making, and whilst we expect a more challenging first half of 2023, our business drivers remain intact, and we are very well placed to deliver for our customers as they invest in technologies, such as 5G, in order to maintain their own competitive advantages.”

Eric Updyke, Chief Executive Officer, Spirent Communications plc

each year. For its fiscal 2021-22 year, the company said that revenues were up to 2.53 billion euros (about USD 2.5 billion), or about, compared to 2.28 billion (about USD 2.26 billion) in its previous fiscal year. The company said that each of its three divisions achieved double-digit growth, but converting orders to billable sales was impeded by the tight supply chain situation. Having vertically integrated plants in Germany, Czech Republic, Singapore, and Malaysia helped the company stay stable, however.

R&S saw strong demand for high-performance wireless testers, signal generators, spectrum analyzers, and oscilloscopes in the wireless communications and automotive technologies sectors, and its businesses providing security scanners, military communications systems, and air traffic control systems also were on a solid footing.

R&S closed out June 2022 with around 13,000 employees, holding steady from last year’s number.

Indian market dynamics

India is a hotbed for test and measurement equipment, given the major tech overhaul the country is going through in every sector, including start-ups or traditional industries. Led by changes and demand of emerging trends like green mobility, rapid urbanization that is ushering in demand for 5G-led telecom industry, coupled with government focus on smart transition to green energy, hi-tech manufacturing processes, health industry, communication tools and smart appliances, smart transportation, the testing and measurement market is expected to experience an unprecedented growth in India.

The Indian market for general-purpose electronic T&M instruments alone has touched USD 300 million by 2022, according to Frost & Sullivan. It is poised to experience a CAGR of 5.1 percent during the period 2023 to 2032. The valuation of the worldwide test and measurement equipment market is expected to touch USD 28 billion by 2023.

The enhanced adoption of electronic devices and the increased penetration of modular instrumentation in

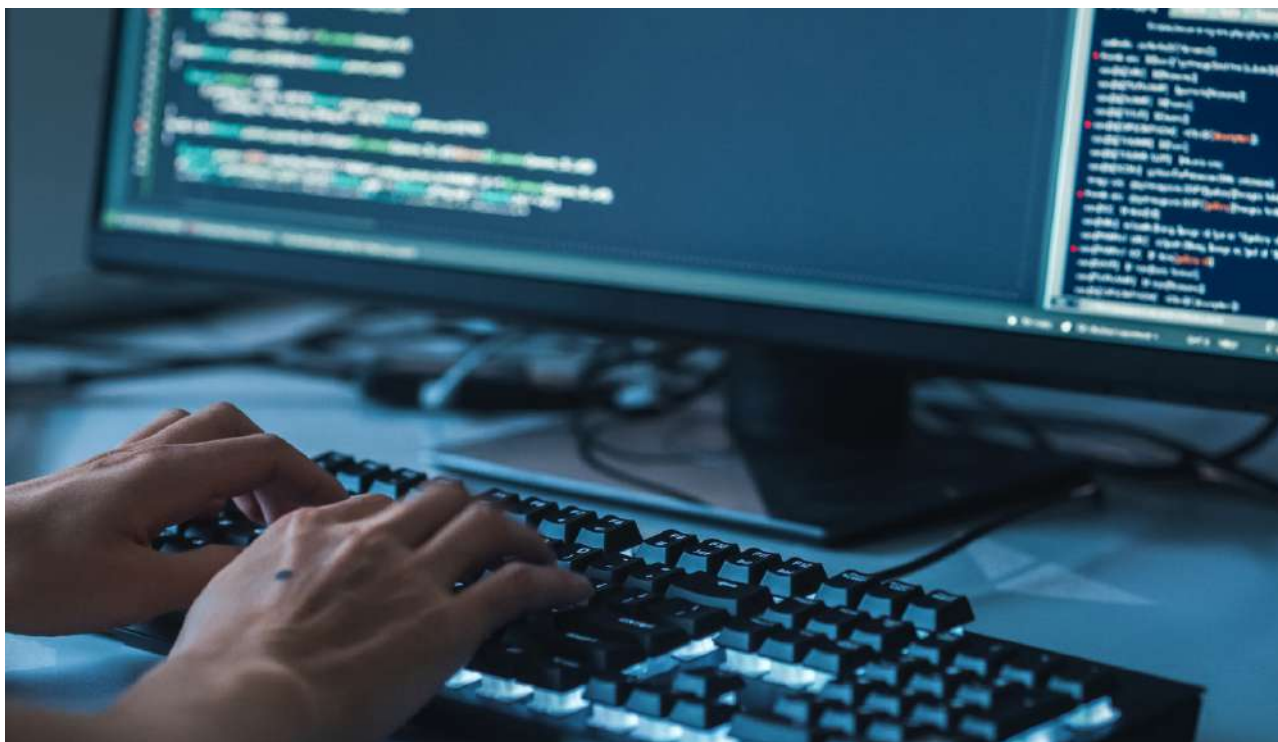
every appliance used today depend on precision test and measurement tools. As the growth of the segment is registered by key end-user segments like telecom, automotive, aerospace and defense, electronics design and in a demand-driven scenario, the market is expected to boost forward in the near future.

Smart homes and uber lifestyle today demand that the rooms will reach the right temperature, be it air-conditioning or heating, before the person actually gets to the door. A smartwatch or a smartphone can perfectly satisfy the requirement. But what the remote control needs is to be perfectly synchronized through 5G networks. These networks need good-quality, highly reliable T&M instruments to create, design, deploy, and maintain them. With wireless applications increasing in range, the need for precision engineering is more in demand. Millimeter (mm) wave is the newest buzzword in the telecom industry and it has created demand for a new type of T&M instrumentation.

The government’s push for BharatNet, Digital India, smart cities, information highways, e-governance, India Stack are a few key projects which require extensive use of T&M as the crucial enablers, for each of these are connectivity and precision data. Further demand is created by the steps taken for pan-India optical fiber cable installation and maintenance in the community antenna television (CATV) segment.

The government has mandated testing of many consumer goods, and a number of labs, the mandatory testing and certification of telecom equipment (MTCTE) labs, have been established under this program.

The drive for environmental sustainability and the carbon-neutral approach to value add will further drive the demand up for the test and measurement sector. The downside of such a huge demand is that the quality of products available in the market may not be up to the standard in remote areas. While the test and measurement market is expected to see an unprecedented, demand-led growth, it is important that there is enough awareness on quality products, regular maintenance, and the right fitment according to requirements. ■



Report

Remaining steady through turbulence

Near-term turbulence aside, Indian SaaS remains in its early stages and has proven that it is building world-leading companies across categories.

The Indian Software-as-a-Service (SaaS) ecosystem continues to gather momentum despite prevailing market headwinds and has become a global leader behind only the US in scale and maturity. Whether measured in total annual recurring revenue (ARR) of \$12 billion–\$13 billion in 2022, up four times over the past 5 years; or investment (~\$5 billion in 2022, up six times), Indian SaaS progress is irrefutable and its future trajectory promising. This momentum is driven by a mutually reinforcing flywheel of SaaS companies and investors, with a proliferation of new SaaS companies with proven growth models, supported by investors who are allocating increased capital to Indian SaaS across stages.

Indian SaaS companies are being founded in record numbers and are proving they have a right to win in the global market. Of the 1,600 Indian SaaS companies that have now been funded over the past five years, around 14 of them exceed \$100 million in ARR (vs. around 5 in 2020) and are reaching this growth milestone as quickly as their US counterparts. Indian SaaS companies win using a variety of approaches, including product leadership, attractive pricing, and service quality—and emerge as globally best-in-class across numerous categories. While software buyer sentiment has softened in the second

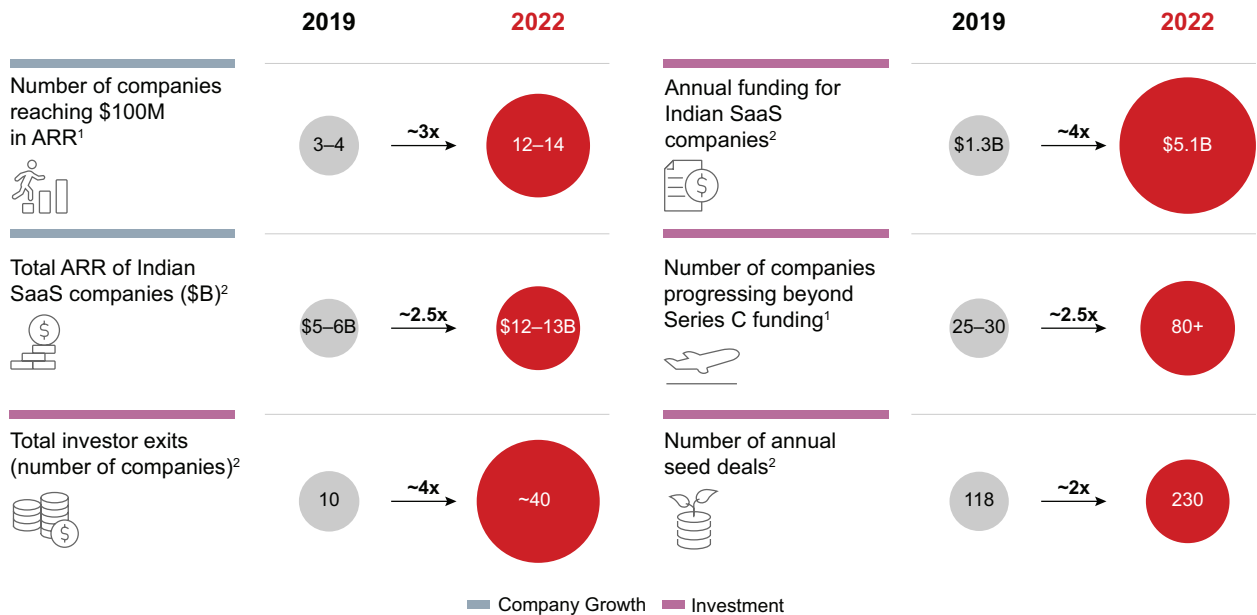
half of 2022, Indian SaaS companies play in categories that benefit from long-term, secular-demand tailwinds.

Encouraged by this growth, investment in Indian SaaS reached an all-time high of ~\$5 billion in 2022, bolstered by a record \$1 billion investment in Securonix. However, 2022 has been a game of two halves. While 2021's funding momentum carried over into a record first quarter, there has been a subsequent 40% year-on-year decline in investment across quarters two through four as global sentiment has softened. Behind this has been a decline in large deals as investor sentiment meets with scaled Indian SaaS companies that previously raised capital, benefit from supportive economics, and choose to stay out of the capital markets for now.

Despite this market slowdown, proven revenue growth combined with attractive margins has made SaaS a comparative bulwark for investors, with Indian SaaS venture capital (VC) investment up 10% over quarters one through three in 2022—while overall VC investments are down ~22% vs. 2021. Investors in Indian SaaS benefit from an opportunity to back a wide array of companies across sub-categories and have a clear path to realisation, with ~40 SaaS exits in 2022 (almost doubling year-on-

REPORT

The Indian SaaS ecosystem has come a long way over the past three years



Notes: [1] 2022 figure refers to cumulative number of companies till October 2022; [2] Attribute annualised for 2022; ARR: Annual recurring revenue
Sources: Bain PE-VC deals database; Tracxn; Crunchbase; Pitchbook; VCCEdge; Public filings; Venture Intelligence; Secondary research; Industry participant interviews; Bain analysis

year) across a variety of modes. As a result, more than 70% of investors expect to increase their investment in Indian SaaS going forward.

Growth remains at the top of the agenda for Indian SaaS companies, with new market entry enabled by effective enterprise go-to-market (GTM), a key priority. Selling into scaled SaaS markets such as the US (close to \$150 billion in SaaS spending) is a strategic imperative, and today just around 20% of revenues for Indian SaaS companies are generated from India. Going global necessitates effective enterprise GTM playbooks that Indian SaaS companies are increasingly refining. However, Indian SaaS companies are also being confronted with a new economic reality that emphasises efficiency, and cost and liquidity management now need to be part of any management team’s toolkit.

Near-term turbulence aside, Indian SaaS remains in its early stages and has proven that it is building world-leading companies across categories. We expect that over the next 5 years, Indian SaaS companies will collectively reach ~\$35 billion in ARR and capture ~8% of the global SaaS market.

Indian SaaS investment overview

2022 was another record year for Indian SaaS investments, with investments reaching ~\$5.1 billion in 2022, up ~20% vs. in 2021.

- Growth has primarily been driven by increased interest in earlier-stage deals; there are more seed

deals happening (+65% vs. 2021) that are larger (\$1.7 million vs. \$1.3 million average in 2021), while the number of Series A investments have nearly doubled (+90% vs. 2021) as a greater supply of companies meets more early-stage capital across existing and new investors.

- Later-stage deals have become smaller (~\$75 million average vs. ~\$100 million in 2021) as some of the largest Indian SaaS companies choose not to raise in prevailing market conditions.

Investment growth was primarily driven by a record \$2.2 billion in investment in the first quarter of 2022 (~55% of the total year-to-date, excluding Securionix); from the second quarter onwards, there has been a substantial decline (-40%) in investments vs. 2021 as global investor sentiment has softened.

Indian SaaS has seen a large increase in the breadth of investible companies, with funding concentration reduced in recent years. The top 15 deals for Indian SaaS accounted for just ~50% of deal value in 2022, down from 60% to 70% in prior years and below the ~70% observed in Indian tech.

In an environment of softening investor sentiment, SaaS has emerged as a comparative bulwark for India-focused venture investors given proven revenue growth and attractive operating economics, becoming among the fastest-growing venture investment sectors and accounting for ~17% of total investments in the first 3 quarters of 2022, up from ~12% in the first three quarters of 2021.

Indian SaaS is beginning to provide realised returns to investors, and the number of exits almost doubled in 2022, reaching ~40 exits across a variety of modes, including large-scale secondary transactions, strategic acquisitions, and public market exits/initial public offerings (IPOs).

Public markets offer a meaningful path to exit, and many Indian SaaS companies are already 'IPO Ready' based on their scale; however, deteriorating market conditions have led to muted IPO activity throughout 2022.

Key SaaS themes

Indian investors continue to back a range of companies across horizontal business, horizontal infrastructure, and vertical SaaS. When we look at investments in these sectors, excluding the Securonix deal:

- **Horizontal business:** Largest investment category (nearly 70% of 2022 investments), driven by large end-markets (more than \$140 billion for top-5 horizontal categories) and numerous proof-points of >\$100 million ARR companies (~70% of top-20 Indian SaaS companies are horizontal business).
- **Horizontal infrastructure:** Around 15% of 2022 investments, with numerous global leaders emerging out of India in DevTools in particular (e.g., Postman, BrowserStack) given India's extensive developer base (~10% of global total) and rapid, product-led growth.
- **Vertical:** Around 15% of 2022 investments, with smaller end-markets (~\$30 billion) compared to horizontal business. Vertical SaaS is typically high-retention, with India's notable healthcare and wellness and logistics companies seeing rapid growth.

An increasingly mature Indian SaaS ecosystem provides investors with an opportunity to back companies across a variety of sub-sectors within horizontal and vertical SaaS:

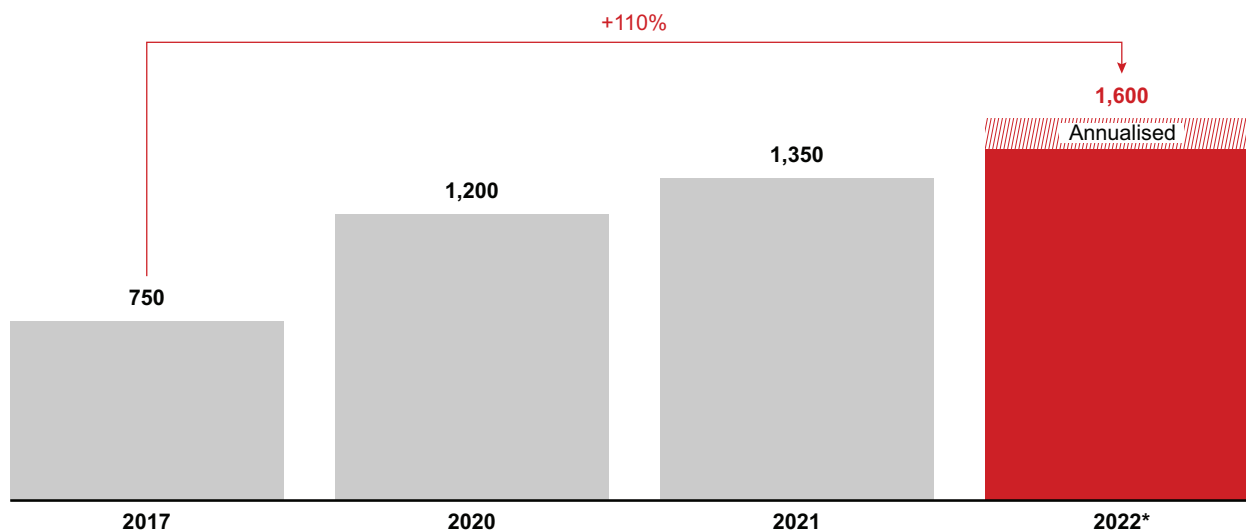
- Indian SaaS companies often bring a unique approach to these sub-sectors (e.g., mobile-first solutions in MarTech and underserved geographies/verticals/employment models in human capital management).
- While select categories are comparatively mature, there are clear white-space opportunities for existing and new Indian SaaS companies (e.g., pricing management, workflow automation, identity and access management).

Indian SaaS investors consistently back companies in larger and more mature sub-sectors such as Customer Relationship Management & Sales and Enterprise Resource Planning. An increased diversity of companies has enabled Indian SaaS investors to begin developing sub-sector specialisation for the first time (e.g., Nexus in DevTools).

The outlook for Indian SaaS investment remains broadly positive over the next 12 months, with ~90% expecting to increase or maintain their capital allocation to SaaS driven by strong business economics, path to scale, and successful exit trends.

Investors count dev tools, CRM, and logistics tech among the most exciting sub-sectors, while portfolio priorities are product market fit and GTM for early-stage companies, and talent management/acquisition and overseas GTM for late-stage companies.

The number of SaaS companies being funded in India has doubled compared to five years ago

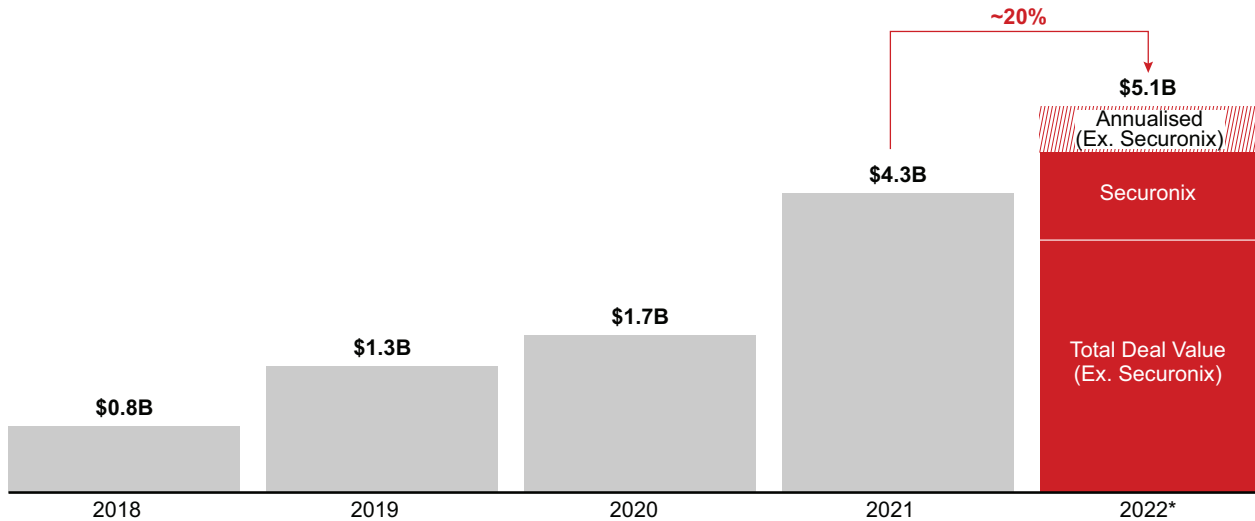


Notes: * Total SaaS companies in 2022 annualised based on H1'22; Companies that have raised funding have been considered for above analysis; number of companies listed above are directional

Sources: Tracxn; Crunchbase; Venture Intelligence; Pitchbook; Bain PE-VC deals database; Bain analysis

REPORT

Indian SaaS investments increased by ~20% in 2022 vs 2021, boosted by a record ~\$1 billion investment in Securonix



Notes: Investment data based on deals with known funding amount; * 2022 data annualised basis addition of H1 2022 data and linear projection for H2 2022 using July–October 2022 data, excludes \$1B Securonix deal, considering it as a one-time, high-value deal
Sources: Bain PE-VC deals database; Tracxn; Crunchbase; Pitchbook; Venture Intelligence; Bain analysis

Focus areas for Indian SaaS companies

Bain's experience shows that focus areas for Indian SaaS companies vary by scale but centre on several key themes:

- **Smaller companies** (less than 1,000 FTEs) are primarily focused on entry into new markets, managing downturns, and talent acquisition and retention as they look to scale.
- **Larger companies** (more than 1,000 FTEs) additionally focus on enhancing their GTM model and are maintaining a long-term view towards IPO readiness.

Global markets are a key step for Indian SaaS companies looking to achieve substantial scale (more than \$100 million ARR). Developing a clear overseas market growth playbook is a strategic imperative for most companies that involves:

- **Market opportunity:** India remains a comparatively smaller market opportunity (~\$2–3 billion) when compared to the US (~\$150 billion). The majority of Indian SaaS companies looking to achieve meaningful scale build an overseas focus, with the US alone comprising ~50% of top-20 Indian SaaS company revenues.
- **Growth model:** The US SaaS market is highly competitive, and Indian companies that succeed do so through a combination of product excellence, competitive pricing, and a focus on distinct/underserved market segments combined with a clear GTM playbook.

Downturn management is becoming increasingly critical

for Indian SaaS companies. Cost and liquidity management are essential toolkits for management teams, while downturns are an opportunity for well-capitalised companies to “play offense” and engage in tactical mergers and acquisitions.

Building winning talent models is critical to maintain growth and a competitive edge.

- **High demand and long-term attrition:** Talent demand from Indian SaaS companies is increasing rapidly (more than 80% headcount growth over 2020–2022), and Indian SaaS companies compete for talent from similar sources.
- **Winning talent models:** Talent outperformers have more than 10 percentage points lower annual attrition. Building winning talent strategies involves focusing on key interventions across priority areas for employees, namely culture and values, compensation and benefits, and leadership engagement.

Numerous Indian SaaS companies are at an IPO-ready scale (more than \$100 million ARR). Going forward, as capital markets recover, going public will require a well-defined pre- and post-IPO strategy, a compelling equity story, thoughtful timing, and technical readiness.

Complete report, <https://www.communicationstoday.co.in/india-saas-report-2022-bain-company/>

Based on Bain & Company report, *India SaaS Report 2022*



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