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INDEX

TELECOM SPECTRUM

Utilisation and need for adequate spectrum

The electromagnetic spectrum, comprising various frequency bands, is a critical resource in our digital age. Its significance spans across consumers, industries and governments, enabling services ranging from basic communications to advanced technological applications. The lack of adequate spectrum, particularly in densely populated regions, leads to severe consequences that affect every aspect of modern society. Here we delve into the impact of this scarcity, focusing on consumers, industries and governments, and attempt an analysis of India's current spectrum allocation, focusing on the requirements of 5G services.

How Consumers Utilize Spectrum

Spectrum underpins various services that consumers rely on daily, such as mobile communications, Wi-Fi connectivity, broadcasting and satellite-based services. Consumers engage with the spectrum through devices like smartphones, tablets and televisions. They rely on spectrum-based services for personal communications, entertainment, navigation and more.

Degradation of Services from Lack of Spectrum

- **Connectivity Issues:** Insufficient spectrum leads to overcrowded networks, resulting in slow internet speeds, dropped calls and overall poor quality of service. Simulations done by GSMA indicate that in regions with limited spectrum, consumers experience an average of 30% slower internet speeds compared to areas with ample spectrum availability.
- **Limited Access to New Technologies**: Emerging technologies like 5G depend on the available spectrum. Its scarcity can hinder adoption and limit consumer access to cutting-edge services. A study reveals that countries with extensive 5G spectrum allocations have witnessed an increase in the adoption of 5G-enabled devices compared to countries with limited allocations.
- **Increased Costs**: Limited spectrum may drive up costs for service providers, which may be passed on to consumers in the form of higher prices. Markets with spectrum scarcity tend to experience increase in data plan costs, affecting affordability and access.

Industry Utilization of Spectrum

Industries utilize spectrum across various sectors, including telecommunications, manufacturing, healthcare, transportation, and more.

- **Telecommunications**: Telecom operators rely on specific frequency bands to provide mobile and broadband services. In countries with spectrum shortage, telecom companies face significant reduction in network capacity, impacting service quality.
- **Manufacturing**: Automated manufacturing systems use spectrum-based communication for coordination and control. Spectrum scarcity results in a decrease in manufacturing productivity due to communication delays and system interruptions.
- **Healthcare**: Telemedicine and connected healthcare devices depend on spectrum for remote monitoring and care. Limited spectrum availability can lead to data transmission delays, affecting the quality of healthcare services in remote areas.

Impact of Spectrum Scarcity on Industry

- **Limited Growth and Innovation**: Inadequate spectrum hampers technological advancements, stifling growth and innovation within various industries.
- **Operational Challenges**: Limited spectrum availability can lead to interference and network congestion, affecting efficiency and productivity. Industries grappling with spectrum scarcity are found to have reported decrease in operational efficiency.
- **Regulatory and Compliance Issues**: Industries must navigate complex regulations related to spectrum usage, and scarcity can exacerbate these challenges, leading to potential legal hurdles. Industries operating in regions with spectrum shortages might spend more on compliance-related activities which could have been invested more efficiently in R&D activities.

Government's Utilization of Spectrum

Governments use spectrum for critical functions such as defense, public safety, meteorological services and governance.

- **Defense and Security**: The military leverages spectrum for secure communications, radar systems and intelligence. Spectrum scarcity can compromise the quality and security of military communications, posing national security risks.
- **Public Services**: Emergency services, public transportation and administrative functions depend on spectrum-based communication systems. Insufficient spectrum affects the quality of public services, leading to inefficiencies in transportation, emergency response and governance.

Consequences of Lack of Adequate Spectrum

- National Security Risks: Scarcity can compromise the quality and security of military communication, posing national security risks. Recent incidents in regions with spectrum shortages have led to communication vulnerabilities that could be exploited by adversaries.
- Degraded Public Services: Insufficient spectrum affects the quality of public services, leading to inefficiencies in transportation, emergency response and governance. Reports indicate a significant increase in emergency response times in areas with limited spectrum resources.
- Economic Impact: Lack of spectrum can hinder economic development by affecting industrial growth, technological innovation, and foreign investments. Some studies have found that in countries with advanced information and communication technologies, the use of spectrum enabled an increase in GDP of about 3.4%.

India's Spectrum Allocation: The Current State and Demand for 6 GHz Band

India's spectrum allocation scenario reflects a complex interplay of growing demand, regulatory frameworks and technological advancements. The burgeoning demand for mobile data, IoT applications and the anticipated rollout of 5G services has created a pressing need for additional spectrum.

Demand for 6 GHz Band

The 6 GHz band, considered vital for 5G services, can enable higher data rates, low latency and facilitate the proliferation of 5G services. Recent studies estimate that allocating the 6 GHz (mid-band) band for 5G in India could contribute to a 2% increase in GDP by 2030.

Identifying the 6 GHz band for IMT could catalyze the 5G revolution, spurring economic growth, technological innovation and societal benefits. India's regulatory bodies and policymakers must address these challenges promptly to meet the growing demand for spectrum and secure the nation's digital future.

Conclusion

The lack of adequate spectrum has far-reaching consequences, affecting consumers, industries and governments alike. From degradation of essential services to hindering technological advancements, the ripple effects of spectrum scarcity are profound. In the context of India, the pressing demand for additional spectrum, particularly in the 6 GHz band, underscores the need for thoughtful, forward-looking policies and robust regulatory frameworks. As the nation enters the 5G era, the intelligent and ethical management of this invaluable resource will shape its technological future, economic prosperity and social well-being. The path forward demands collaboration, innovation and a shared commitment to leverage spectrum for the greater good. India's ability to address this challenge will determine its position in the digital age and its role in the global technological landscape.

LT GEN DR S P KOCHHAR

MAKING ADVANCEMENTS IN INTERFERENCE-FREE SPECTRUM COEXISTENCE

The future of wireless communication will be a dynamic interplay of tech innovation, regulatory adaptation, security vigilance, and environmental considerations

Advanced wireless systems have revolutionised how people communicate with each other to the point where a majority of the earth's population now uses cellular mobile phones with other wireless devices. The realm of wireless communications is getting increasingly complex and congested, presenting significant challenges in terms of spectrum coexistence and interference.

Electromagnetic Compatibility (EMC) is crucial for devices to function effectively in their electromagnetic environment without negatively impacting other devices. This requires strong immunity to external signal interference and controlled electromagnetic emissions, often achieved through careful circuit design, filters and shielding. Challenges in EMC arise due to trends towards lower voltage, energy-efficient and compact designs,

> " Innovation in spectrum-sharing techniques will be key to addressing spectrum scarcity, with cognitive radio and dynamic spectrum access likely playing significant roles.

> The proliferation of wireless communication systems across a wider electromagnetic spectrum makes maintaining Electromagnetic Compatibility more challenging.

and cost-cutting measures, which can reduce resistance to Electromagnetic Interference (EMI). Adding radio transceivers and antennas to devices increases the risk of both internal and external interference.

The proliferation of wireless communication systems across a wider electromagnetic spectrum makes maintaining EMC more challenging, leading to coexistence issues. This is especially pertinent in areas with a high concentration of sensitive devices, such as healthcare facilities or using unlicensed or shared spectrum. In India, EMC of devices is not just a technical requirement, but a necessity for ensuring the seamless operation of a vast array of wireless communication systems across an ever-expanding spectrum. Ensuring EMC and coexistence is crucial for the reliability and performance of electronic systems, particularly in critical infrastructure sectors like defence, transportation, communication, healthcare, public safety and Smart Grid systems.

Adhering to EMC and coexistence standards, which realistically reflect the expected electromagnetic environments and usage scenarios, is vital for reliable operation. In radio frequency (RF) communication, interference from unwanted RF signals, either in-band or near-band, is a traditional concern. This is particularly relevant in licensed frequency bands, where all non-licensed signals are considered interference and in shared spectrums, where interference definitions are more complex.

In the case of Smart Grid systems, both interference and coexistence are significant concerns. Interference can be from intended or unintended RF emissions disrupting communications in Smart Grid wireless devices. This interference can vary in time and bandwidth, with different devices responding differently to various waveforms, such as amplitude-modulated or wideband direct sequence spread spectrum signals.

ADVANCEMENTS IN SPECTRUM TECHNOLOGIES

The evolution of technologies is playing a pivotal role in revolutionising wireless communication, addressing the growing demand for bandwidth in densely populated areas. Dynamic Shared Spectrum (DSS) dynamically allocates frequency bands in real time, catering to the ever-changing requirements of users. In synergy with DSS, Cognitive Radio (CR) intelligently detects and utilises available communication channels, avoiding interference and significantly enhancing spectrum efficiency. Similarly, the integration of Artificial Intelligence (AI) and Machine Learning (ML) into spectrum management has helped improve network performance.

Dynamic Shared Spectrum: This involves dynamically allocating frequency bands to users based on real-time usage and requirements. This approach is particularly beneficial in densely populated areas where the demand for spectrum is high. DSS operates by transmitting 4G Long Term Evolution (LTE) and 5G New Radio (NR) signals over a shared frequency. This technology dynamically assigns cellular resources between both networks depending on current demand.

Cognitive Radio Technology: It is a form of wireless communication in which a transceiver can intelligently detect which communication channels are in use and which are not. It instantly moves into vacant channels while avoiding occupied ones. It does not cause any interference to the licensed user. Given India's spectrum scarcity and the high demand for wireless services, CR technology can significantly enhance spectrum efficiency by dynamically identifying and utilising available channels.

Artificial Intelligence and Machine Learning: AI and ML are transforming network management by enhancing performance and managing interference in complex RF environments. They have made immense contributions, ranging from predictive analytics to automated optimisation, fault detections and self-healing, improvements in security and energy usage, and network slicing.

Predictive analytics, for instance, involves the examination of network data to predict traffic patterns,

6

> Predictive analytics involves the examination of network data to predict traffic patterns, facilitating optimal resource allocation and preventing congestion.

IN BRIEF

- Wireless communications face challenges in spectrum coexistence and interference due to increased complexity.

- Electromagnetic Compatibility (EMC) is vital for device functionality and is crucial in critical infrastructure sectors.

- Adhering to EMC standards is essential, especially in Smart Grid systems, to ensure reliable operations.

- Advancements include Dynamic Shared Spectrum, Cognitive Radio, and integration of AI/ML in spectrum management.

- Techniques like Beamforming, MIMO, RU scheduling, and spatial reuse enhance network performance.

- Challenges include spectrum scarcity, interference management, evolving regulations, and security concerns.

- The future involves 6G technology, spectrum-sharing innovations, and sustainable, energy-efficient communication.

facilitating optimal resource allocation and preventing congestion. Automated optimisation, driven by AI algorithms, dynamically adjusts network parameters in real time, reducing manual intervention and increasing operational efficiency. The fault detection and self-healing capabilities of AI swiftly identify and rectify network issues, often resolving problems before they impact users, thereby minimising downtime and enhancing reliability.

Furthermore, AI contributes significantly to security enhancements by efficiently detecting and responding to threats, identifying attack patterns, and taking pre-emptive actions to safeguard the network. In terms of energy efficiency, AI plays a crucial role in optimising the energy consumption of network infrastructure, which becomes increasingly vital as networks expand and energy costs rise.

In the context of 5G networks, AI and ML manage network slicing to allocate resources effectively for various services, ensuring each service receives the necessary resources without adversely affecting others. Additionally, AI enhances data processing at the network edge, resulting in reduced latency and improved response times, particularly beneficial for critical applications such as autonomous vehicles and industrial automation.

CHANGING TECHNOLOGIES AND TECHNIQUES
The evolution of wireless communication technologies has been instrumental in meeting the burgeoning demands of modern communication networks. Among these, several key techniques stand out for their impact on enhancing network performance, reducing interference, and optimising resource utilisation.

Beamforming: This signal processing technique, used in antenna arrays, directs transmission power specifically towards receivers, improving signal quality and reducing interference.

> With wireless networks increasingly underpinning critical infrastructure and services, safeguarding against cyber threats and ensuring communication integrity are paramount.

MIMO technology: Multiple Input Multiple Output (MIMO) uses multiple antennas at both transmitter and receiver ends, enabling communication with multiple users over the same frequency band, thereby boosting network efficiency and capacity.

RU scheduling in 5G networks: Resource Unit or RU scheduling allocates the smallest units of time and frequency among users, optimising network throughput and ensuring fair resource distribution.

Spatial reuse: This involves reusing frequency bands in different spatial locations or by different users within the same area to maximise throughput while managing interference, especially in dense networks.

Channel bonding: It combines adjacent frequency channels into a single, wider channel, increasing bandwidth and data throughput, often used in Wi-Fi technologies. However, it requires careful management to avoid increased interference in crowded spectrum areas.

CHALLENGES AND FUTURE DIRECTIONS

As we delve into the future of wireless communications, we face a multifaceted landscape of challenges and opportunities. One of the primary hurdles is managing the increasing scarcity of the spectrum in the face of burgeoning device numbers and data demands. Efficiently allocating and utilising this limited resource is crucial. Concurrently, interference management remains a persistent technical challenge, especially in densely populated areas where multiple wireless technologies coexist. The growing complexity of networks, particularly with the advent of 5G and the anticipated arrival of 6G, adds another layer of complexity, necessitating seamless integration and compatibility among diverse devices and technologies.

On the regulatory front, the evolving spectrum of regulations and the need for international coordination present their own set of challenges. Aligning global spectrum management strategies is essential but often complicated by differing national interests and regulatory frameworks.

Additionally, security concerns are more prominent than ever. With wireless networks increasingly underpinning critical infrastructure and services, safeguarding against cyber threats and ensuring communication integrity are paramount.

Looking ahead, the emergence of 6G promises even faster speeds and more reliable connections, potentially exploring new spectrum bands and incorporating cutting-edge technologies like AI and quantum communication. Innovation in spectrum-sharing techniques will be key to addressing spectrum scarcity, with cognitive radio and dynamic spectrum access likely playing significant roles. The integration of AI and ML will further advance, streamlining network management and optimisation. Moreover, there's a growing emphasis on developing sustainable and energy-efficient communication technologies, aligning with global environmental consciousness and the need for greener network infrastructures.

The future of wireless communication is set to be a dynamic interplay of technological innovation, regulatory adaptation, security vigilance, and environmental consideration. Navigating these challenges and opportunities will require continuous innovation, strategic planning, and international collaboration. ♣

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8

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[TELECOM TALK]
INFRASTRUCTURE

LT GEN DR S P KOCHHAR

SPECTRUM SYMPHONY: ORCHESTRATING THE MELODY OF FINITE RESOURCES

Efficient spectrum management is essential for India's digital growth and security amidst rising wireless demand and technological advances

The electromagnetic spectrum serves as the lifeblood of modern communications infrastructure. The spectrum underpins virtually every aspect of modern life, from enabling ubiquitous mobile connectivity to powering innovative Internet of Things (IoT) applications. However, as the digital landscape evolves rapidly, managing finite-spectrum resources becomes increasingly complex.

In a country where millions rely on wireless technologies for essential services, education, commerce, and communications, efficient spectrum management emerges as a paramount concern for sustaining its digital momentum and propelling socioeconomic development. Currently, India stands at a pivotal juncture where strategic actions in spectrum management are imperative to drive the country's digital ambitions to the next level and foster sustainable development across various sectors.

> The intricate balance between meeting current technological needs and planning for future advancements is at the heart of effective spectrum management.

9

In India, RF spectrum management and regulation are crucial due to the country's vast and diverse needs for wireless communication.
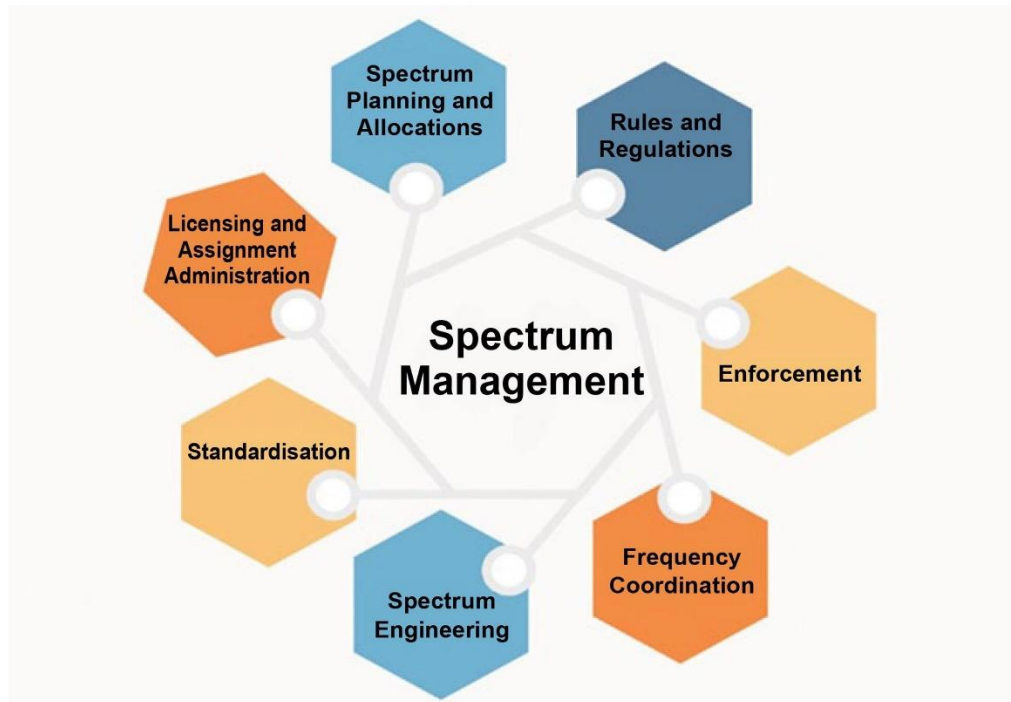
IMPORTANCE OF SPECTRUM MANAGEMENT

Spectrum management and regulation are essential for organising and coordinating the use of the radio frequency (RF) spectrum to prevent interference between different users. The radio spectrum is a finite resource that supports various services, including telecommunications, broadcasting, navigation, and national defence. Without effective management and regulation, the increasing demand for wireless technologies could lead to spectrum congestion, where too many signals interfere with each other, degrading service quality or making specific applications unusable.

Regulation ensures that the spectrum is used efficiently and fairly, allocating specific bands for particular uses and implementing technical standards to maximise compatibility and minimise interference. This promotes innovation and investment in new technologies and safeguards critical communications, especially in emergencies and public safety operations.

THE INDIA CONTEXT

In India, RF spectrum management and regulation are crucial due to the country's vast and diverse needs for wireless communication, spanning urban to remote rural areas. The Department of Telecommunications, under the Ministry of Communications, oversees spectrum management and regulation, ensuring that the radio frequency spectrum is used efficiently to meet the growing demands for digital communications.

With India's rapid technological growth and the digital revolution, efficient spectrum management supports a wide range of services, including cellular telephony, broadband wireless access, and direct-to-home broadcasting.

10

> Border regions face the challenges of overlapping spectrums that can cause interference, security breaches, and disruptions in communications.
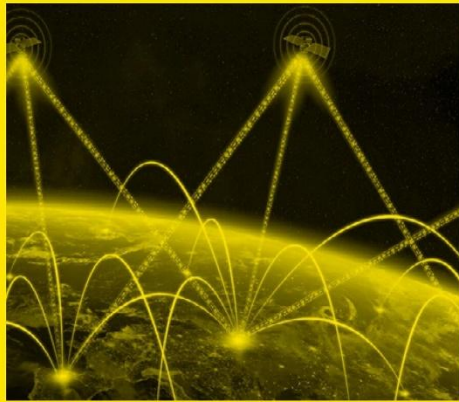
IN BRIEF

- Poor spectrum management can lead to interference, disrupting critical communications and posing security risks.

- India's diverse needs demand robust regulation and coordination to ensure smooth wireless communication.

- Strategic actions in spectrum management are crucial to drive India's digital ambitions and foster sustainable development.

- International collaboration and harmonisation are vital to optimise spectrum use and promote global connectivity.

- Collaborative efforts and bilateral agreements are essential to manage spectrum use effectively, especially in border regions prone to interference and security risks.

The regulatory framework in India also focuses on auctioning spectrum bands to telecom operators, a method that efficiently allocates spectrum and generates significant revenue for the government. This process, along with setting technical and operational standards, ensures that interference is minimised and spectrum is used to promote competition, innovation, and access to digital services for all Indians.

REGULATORY FRAMEWORKS AND NATIONAL STRATEGIES

A robust regulatory framework is the cornerstone of effective spectrum management. Continuous monitoring and enforcement are essential to maintaining order and integrity when using the spectrum. Monitoring involves tracking frequency usage across the spectrum to detect unauthorised or inefficient use.

Regulatory agencies employ advanced monitoring equipment and software to monitor spectrum activities. When irregularities are detected, enforcement actions are taken, which may involve fines, license revocations, or other corrective measures. This vigilance is crucial for preventing interference and maximising the utility of the spectrum.

In addition to allocation and monitoring, countries develop National Frequency Allocation Plans (NFAPs). These strategic plans outline how frequency bands are allocated domestically, taking into account national security, public safety and economic interests. The NFAP is a dynamic document that evolves to accommodate technological advancements and changing societal needs. It serves as a blueprint for managing the spectrum within a country's borders and ensures its use aligns with national priorities.

Moreover, technical standards play a pivotal role in spectrum management. These standards define the rules and protocols governing how different wireless devices and services communicate. They enable interoperability, allowing devices from various manufacturers and services to work together seamlessly. In a world where an array of wireless technologies coexist, standards are the pivots that facilitate harmonious interaction. They

> When spectrum allocations are aligned globally, manufacturers can produce standardised devices at a lower cost, benefiting consumers worldwide.

are crucial in integrating emerging technologies like 5G and the Internet of Things, where diverse devices must communicate seamlessly to deliver their full potential.

SPECTRUM MANAGEMENT FOR DEFENCE

Effective spectrum management at national borders and for defence purposes is a critical aspect that cannot be overstated. Border regions often face unique challenges due to the overlap of different countries' spectrum allocations. Without meticulous management, this overlap can lead to interference, disrupt critical communication channels, and potentially lead to security breaches.

The spectrum is an invaluable asset for national defence. Military operations rely heavily on secure and reliable communication channels, which can be compromised by interference from civilian networks, especially in border areas. Ensuring a clear and interference-free spectrum for defence purposes is a matter of operational efficiency and national security.

To mitigate these risks, countries often enter bilateral or multilateral agreements, especially with neighbouring nations, to coordinate spectrum use along their borders. These agreements are crucial for establishing protocols and guidelines for managing the spectrum in ways that respect each country's needs and minimise interference.

Additionally, defence departments work closely with national spectrum regulatory bodies to carve out dedicated frequency bands for military use. These bands are often shielded from civilian use, ensuring that defence communications remain precise and secure. This separation is vital in times of crisis or military exercises, where the demand for reliable communications is at its peak.

SPECTRUM HARMONISATION AND COLLABORATION

The radio spectrum knows no borders, making international coordination and harmonisation imperative. Without global cooperation, radio frequency interference would be rampant, disrupting wireless communication across national boundaries. Organisations like the International Telecommunication Union (ITU) are the top brass for these efforts, pivotal in setting global standards and managing international spectrum allocation.

Global conferences and agreements, such as the World Radiocommunication Conference, are platforms where countries negotiate and agree upon allocating frequency bands for different services worldwide. These conferences are a testament to the importance of international collaboration, as they ensure efficient global communication and facilitate economies of scale in equipment production. When spectrum allocations are aligned globally, manufacturers can produce standardised devices at a lower cost, benefiting consumers worldwide through reduced prices and enhanced interoperability.

The intricate balance between meeting current technological needs and planning for future advancements is at the heart of effective spectrum management, an essential endeavour for the seamless functioning of modern wireless communication technologies. From establishing national regulatory frameworks to international coordination through organisations like the ITU, spectrum management ensures the optimal use of the spectrum, paving the way for technological innovations and enhanced global connectivity, benefiting societies, economies and individuals alike.

As wireless technologies evolve rapidly, spectrum management will remain a dynamic field, requiring ongoing adaptation and collaboration to meet the ever-growing demands for wireless connectivity. In this digital era, the responsible and efficient management of airwaves is more critical than ever, serving as the foundation upon which our interconnected world is built. ♣

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12
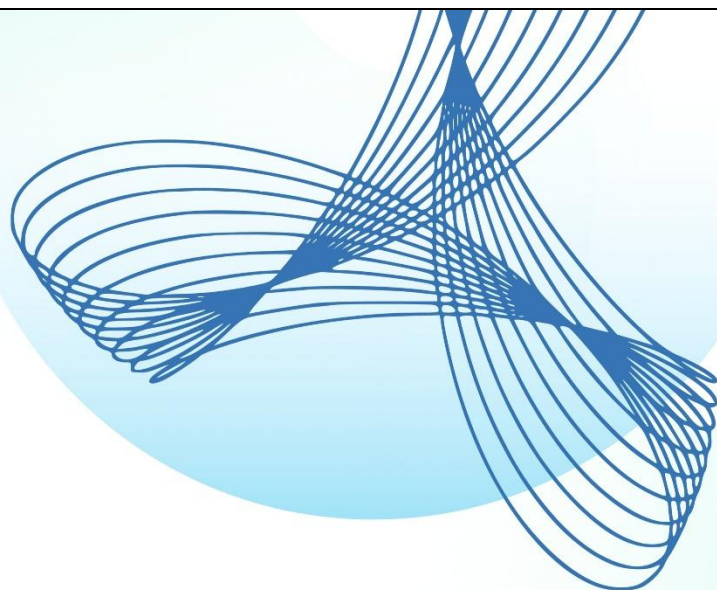
THE EVOLVING
TELECOM LANDSCAPE

Navigating the Indian telecom landscape in 2024

As India's digital fabric unfolds, the telecom sector remains essential, carrying information, connecting people, and driving progress. In 2024, we anticipate ongoing changes in this dynamic field and the Indian telecom industry is ready to work together, creating an environment that encourages innovation and inclusivity. Reiterating our push for a supportive regulatory framework, we stay positive about the sector's possibilities. The 5G rollout, a key part of our designs for a tech-savvy India, is picking up speed. We see faster progress in infrastructure developments and accelerated adoption of advanced applications in areas like health, education, and agriculture.

2024 outlook for India

Looking ahead in 2024, the outlook for the Indian telecom sector remains promising, driven by a combination of factors, such as increased smartphone penetration, the rollout of 5G technology, government initiatives, and changing consumer behaviors.

Accelerated 5G deployment

One of the most significant developments in the Indian telecom sector in 2024 will be the accelerated deployment of 5G networks. Telecom operators in India have been gearing up for the 5G revolution, with spectrum auctions and massive infrastructure investments taking place. The Indian government has also shown its commitment to 5G technology by facilitating spectrum allocation and streamlining regulatory processes. The implementation of 5G is expected to open new opportunities for businesses, improve the quality of mobile services, and drive innovation across various industries.

Internet of Things (IoT) expansion

The adoption of IoT technology is expected to gain significant momentum in 2024, thanks to the rollout of 5G networks and the increasing availability of affordable IoT devices. IoT has the potential to transform various sectors, including healthcare, agriculture, smart cities, and manufacturing. In agriculture, for example, IoT sensors can help farmers monitor soil conditions, weather patterns, and crop health, leading to more efficient farming practices and increased yields.

Smart cities initiatives are also expected to benefit from IoT, with improved traffic management, waste disposal, and energy conservation. As IoT becomes more accessible and affordable, businesses and government agencies in India are likely to invest in IoT solutions to enhance efficiency and productivity.

Emergence of edge computing

Edge computing, which involves processing data closer to the source or device rather than relying solely on centralized cloud servers, is poised to gain prominence in the Indian telecom sector in 2024. This technology is particularly relevant in applications that require low latency, such as autonomous vehicles, industrial automation, and remote healthcare monitoring.

With the deployment of 5G networks, edge computing capabilities will be enhanced, enabling real-time processing of data for critical applications. Investments in edge computing infrastructure are expected to increase, creating new opportunities for businesses and developers to leverage this technology for innovative solutions.

Enhanced digital payments and financial inclusion

The Indian government's push for digital payments and financial inclusion is set to continue in 2024. Initiatives, such as the Pradhan Mantri Jan Dhan Yojana (PMJDY) and the Unified Payments Interface (UPI) have already made significant strides in increasing financial access and promoting cashless transactions.

In 2024, we can expect further innovation and expansion in digital payment services, with the integration of technologies like blockchain and artificial intelligence (AI) to enhance security and convenience. As more Indians gain access to smartphones and the internet, digital payments are likely to become the preferred mode of financial transactions, contributing to financial inclusion and economic growth.

Increasing smartphone penetration

With smartphones becoming an essential tool for communication, entertainment, and accessing online services, businesses are likely to invest in mobile app development and digital marketing to reach a wider audience. Falling smartphone prices, coupled with affordable data plans, have made smartphones accessible to a broader section of the population, including those in rural areas. This trend will further fuel the growth of the digital economy in India.

Focus on rural connectivity

In 2024, the Indian government and telecom operators are expected to place a strong focus on expanding network coverage in rural and remote areas. This effort will not only bridge the digital divide but also unlock new markets for telecom services and digital initiatives.

Data privacy and security

As the Indian telecom sector continues to evolve, data privacy and security will remain paramount areas of focus. With the increasing volume of personal data being generated and shared online, there is a growing need for robust data protection measures and regulatory frameworks.

In 2024, we can expect stricter regulations governing data privacy and cyber security. User awareness about data privacy rights and protection measures is likely to increase, leading to greater demand for secure and privacy-conscious services.

Sustainable practices and *green* telecom

Sustainability and environmental concerns are becoming increasingly important in the telecom sector. In 2024, we can expect a greater emphasis on green telecom practices, including energy-efficient network infrastructure, reduced carbon emissions, and responsible e-waste management.

Regulatory changes

The regulatory landscape in the Indian telecom sector is subject to continuous evolution. In 2024, we can expect regulatory changes aimed at fostering a conducive environment for growth, innovation, and consumer protection. These changes may include spectrum pricing adjustments, licensing reforms, and the introduction of new rules to address emerging technologies and challenges, as indicated in the Telecom Bill 2023. The industry will need to adapt to these regulatory changes while continuing to focus on delivering quality services to the customers.

Enabling innovation through light-touch regulation

As we venture into the exciting territories of emerging technologies like artificial intelligence, blockchain, and the Internet of Things (IoT), a supportive regulatory environment is paramount. COAI has consistently advocated for a light-touch, technology-agnostic approach to regulation, one that fosters innovation while addressing legitimate concerns around data privacy and security.

Building a digitally inclusive future

Connecting the unconnected remains a core mission for the Indian telecom sector. The industry is committed to bridging the digital divide, ensuring that the benefits of connectivity reach every corner of the nation. To achieve this, we need continued collaboration with the government on progressive initiatives, while promoting affordability, and simplifying regulatory processes can remove barriers to access for underprivileged communities.

In conclusion, the Indian telecom sector is poised for continued growth and transformation in 2024. The rollout of 5G technology, expansion of IoT, increased smartphone penetration, and a focus on rural connectivity are among the key trends that will shape the industry. With the right investments and strategies, the Indian telecom sector can play a pivotal role in driving digitization, economic development, and improved quality of life for millions of Indians. As technology continues to advance, it is essential for all stakeholders, including government authorities, telecom operators, and consumers to work together to ensure that the sector continues to thrive and benefit the nation.

In the dynamic landscape of India's telecommunications sector, the year 2023 marked a momentous period characterised by transformative initiatives, particularly the nationwide roll-out of 5G. Lauded as the fastest in the world, this strategic deployment, coupled with progressive government policies, has firmly positioned India as a global leader in the ongoing 5G revolution.

As of October 2023, the subscriber base for telecom services in India reached an impressive 1.182 billion, making it the second largest in the world. This substantial expansion underscores the growing significance of information and communication technology. Notably, the average data usage per subscriber surged to 18.4 GB in June 2023, reflecting the increasing reliance on telecom services in the country.

Progressions towards a sustainable telecom ecosystem

The telecom landscape in India witnessed a significant stride forward with the Telecommunications Act, 2023 receiving the assent of the President in December 2023. This comprehensive legislative measure places strong emphasis on fostering robust telecom networks, as evidenced by the well-defined chapter on right of way (RoW). The act ensures the granting of RoW in a non-discriminatory manner, coupled with a clear directive that exempts this network from tax, levy, cess, fees or duties on the associated property. A notable provision is the prevention of coercive actions, such as sealing or shutdowns without due permission from the central government. These positive measures are poised to enhance the connectivity of Indians, ensuring a resilient digital network that spans the entire country. The act also demonstrates a commendable focus on clarifications and penalties. By introducing proportionality and nexus with the nature of the offence, it establishes a considered and rational approach to penalties. This progressive step not only enhances industry confidence but also contributes to the ease of doing business.

A significant regulatory shift is the replacement of the term "licence" with "authorisation" in the legislation. This modification aims to simplify the overall regulatory landscape for telecom services, bringing clarity to the authorisation requirements for providing telecommunication services. Furthermore, it also incorporates stringent provisions to address the unlawful interception of messages or unauthorised access, thereby bolstering national security. Notably, it places the authority to authorise internet shutdowns exclusively in the hands of the central government. This approach ensures continued, uninterrupted and seamless telecom connectivity for all, aligning with the broader goal of building a robust and inclusive digital infrastructure across the nation.

In 2023, the Telecom Regulatory Authority of India (TRAI) took proactive

measures to bridge the digital divide, proposing specific measures to enhance telecom infrastructure in the underserved northeastern states. Simultaneously, the Ministry of Defence introduced progressive RoW Rules, further streamlining the deployment process for telecommunication networks.

A significant milestone in the industry was the advent of 6G technology. Although still in the research phase, India aims to complete the 6G roll-out by 2030. Prime Minister Narendra Modi's release of the 6G vision document and establishment of 6G labs in India underscores a collective effort in shaping the future of telecom, contributing significantly to global 6G research.

Efforts to bridge the broadband gap include the launch of the fixed wireless access system in the country, particularly in areas with less than 10 per cent home broadband penetration. This innovative system, offering fibre-like bandwidth through wireless means, accelerates deployment in densely populated areas where laying optical fibre cables may not be feasible. Further, the rapid pace of innovation in the telecom sector necessitates a multifaceted approach to cybersecurity. While technologies such as edge computing, blockchain, artificial intelligence (AI), internet of things (IoT), and digital tokens offer opportunities, they also pose security challenges, necessitating robust protocols and secure architectures for a resilient digital future.

Challenges in India's telecom landscape

Despite these advancements, challenges persist, including the allocation of the 6 GHz spectrum, which is crucial for maintaining network quality. The recent decision by the World Radiocommunication Conference to open up the 100 MHz spectrum in the 6 GHz band for mobility services globally underscores the importance of allocating this spectrum for international mobile telecommunications services in India. Additionally, addressing the burden placed on telecom service providers by large traffic-generating (LTG) digital platforms is imperative for sustainable growth and financial viability.

Another major challenge is the LTG digital platforms' contribution to network costs. Telecom service providers (TSPs) have been demanding a fair and equitable contribution from LTGs to ensure quality telecom and digital connectivity services for Indian citizens, without putting the burden on end-users, start-ups, and micro, small and medium enterprises to recover these high costs. LTGs have been burdening telcos' network infrastructure with disproportionate traffic, all the while earning significantly from both subscription fees and advertising revenues. This situation places an undue burden on TSPs, hindering their financial sustainability and business viability. Thus, it is imperative that LTGs contribute to this rising infrastructure cost, especially as we look forward to an era of increasing convergence of services and verticals, with more bandwidth-heavy applications expected to emerge.

The introduction of the proposed Lowering Broadband Costs for Consumers Act of 2023 in the US was another pivotal development, which clearly establishes the need for various "edge service providers" that generate disproportionately large traffic, that is, LTGs, to contribute towards infrastructure costs in order to make digital connectivity affordable for end-users. This is a global acknowledgement of the need for LTGs to contribute to network costs and vindicates the position of the Indian telecom sector.

As per a recent TRAI report, the high cost of electricity constitutes nearly 25 per cent of operational expenses for TSPs. This translates to billions of dollars diverted from network upgrades and expansion, ultimately impacting millions of users and hindering India's digital ambitions. This makes it all the more necessary for LTGs to share revenue with TSPs. Government intervention, through targeted policy initiatives and collaborative efforts with the industry, is crucial for overcoming this roadblock and unleashing the transformative potential of telecom.

With this lightning-fast rate of innovation, the need for a multifaceted approach to cybersecurity is more significant than ever. Technologies such as edge computing, blockchain, AI, IoT, and digital tokens offer opportunities but also pose challenges to security. Protocols, firmware updates, and secure architectures are essential to ensure a safe digital future.

In conclusion, as India cements its 5G dominance, the telecom industry buzzes with the anticipation of a transformative wave of use cases. From revolutionising industries to empowering individuals, 5G promises to be the fuel propelling India towards a digitally empowered future. Industry stakeholders are also anticipating a collaborative effort with LTGs to develop high quality networks and a responsible fair-sharing model, ensuring sustainable growth for the entire digital ecosystem. Regulations will also play a major role in addressing challenges, providing a supportive framework for innovation while ensuring free and fair competition. ▲

18

Our best bet in balancing progress and preservation lies in technology and intelligent communications networks. This is easy to see. Take India's telecom sector, for instance. As the world's second-largest, it plays a pivotal role in fuelling the country's GDP growth, creating millions of jobs, and driving a multiplier effect across society and businesses.

India's telecom industry has been at the forefront of remote work, a necessity during the Covid years that has persisted post-pandemic. The success of India's telecom sector is reflected not only in its impressive performance metrics—strong subscriber growth, high usage, and low tariffs—but also in its transformative impact on lives and livelihoods. With a subscriber base exceeding 1.2 billion today and some of the world's lowest tariffs driving service affordability, India stands among the largest data consumers globally.

GREEN DEVELOPMENT THROUGH TECHNOLOGY

The true transformative power of telecommunications lies in its ability to accelerate economic, social, and

> The true transformative power of telecom lies in its ability to accelerate economic, social, and environmental progress, and sustainable development.

| Telcos are using green energy sources and adopting eco-friendly procurement practices, such as sourcing SIM cards made from recycled plastic materials.

environmental progress, offering the promise of sustainable development. Reducing carbon footprints is a boardroom agenda for both the telecom sector and other industries. Telecom service providers in India are proactively embedding sustainability into their operations, extensively using green energy at network sites and data centres.

Committed to achieving the Net Zero objective by 2050, telecom companies are taking active steps to reduce their carbon footprint through initiatives like energy-efficient green data centres, energy optimisation, and the adoption of renewable energy sources.

Beyond working within a robust ESG framework and adopting responsible business practices, telecom companies are also aligning partners and suppliers with their green objectives. Telecom infrastructure companies are also developing decarbonisation roadmaps and exploring alternative energy solutions like solar, wind, and hydropower.

In combating climate change, telecom companies are also solarising network sites and opting for eco-friendly procurement practices, such as sourcing SIM cards made from recycled plastic materials. Their Environmental, Social, and Governance (ESG) efforts are directly overseen, reviewed, and monitored by board-level committees.

ROLE OF 5G IN ADVANCING SUSTAINABILITY

5G technology is crucial in advancing sustainability efforts across various sectors. It is revolutionising business operations and contributing significantly to the ESG journey. Studies suggest that 5G networks are up to 90% more energy-efficient than legacy wireless technologies. This remarkable efficiency is complemented by the digital technologies powered by 5G networks, which support industries on their decarbonisation paths.

One of the key advantages of 5G is its ability to enable real-time analytics, drive energy efficiency, facilitate smarter warehouse and inventory management, and help large fleets save time, consume less fuel, and produce fewer emissions by optimising routes to destinations.

SUPPORTING SUSTAINABLE DEVELOPMENT GOALS

As the world navigates unprecedented challenges and disruptions, advanced telecom networks provide solutions that align with multiple dimensions of the UN's 17 Sustainable Development Goals (SDGs). From ending poverty to ensuring food security and inclusive and equitable education to reducing inequalities, telecom technology is significantly impacting these areas globally today.

Intelligent networks and smart devices have already demonstrated their potential to enhance financial services and extend them to unserved and underserved communities. In India, the powerful combination of Jan Dhan, Aadhaar, and Mobile (JAM Trinity) has fuelled financial inclusion and reduced leakages in subsidy transfers, making it a shining example of how technology and telecom connectivity can improve lives.

In education, robust communications networks and reliable connectivity bring quality educators into virtual classrooms previously inaccessible due to geographic or socio-economic barriers. Digital connectivity is also the building block for smart and sustainable cities, leveraging data networks and automation to manage resources, reduce wastage, and improve public safety optimally.

Moreover, strong digital connectivity enabled video conferencing and collaboration tools to work seamlessly as the world came to a standstill. The long-term benefits to productivity and efficiency have been widely recognised. The advent of 5G, with its superfast speed and low latency, will undoubtedly further optimise remote work capabilities, reducing corporates' need for global travel.

This progress improves not only the ease of living for communities, with intelligent transport systems, smart grids, next-gen building management solutions, and reduced traffic congestion, but also lowers carbon

20

> Telecom infrastructure companies are developing decarbonisation roadmaps and exploring alternative energy solutions like solar, wind, and hydropower.

IN BRIEF

- Telecom is driving India's economic growth with over 1.2 billion subscribers and strong demand for data consumption.

- Telecom companies are embedding sustainability through green data centres, energy optimisation, and eco-friendly practices to achieve Net Zero by 2050.

- 5G networks, up to 90% more energy-efficient, are pivotal in transforming industries by enabling real-time analytics and optimising energy and resource use.

- Telecom innovations support SDGs by enhancing financial inclusion, access to education, and building smart cities with intelligent transport and energy systems.

- Digital technologies, including 5G and IoT, could help achieve global emission reductions, contributing significantly to India's economic growth and sustainability goals.

emissions through smart planning of infrastructure, buildings, and mobility systems.

According to estimates, Information and Communication Technology (ICT) has the potential to reduce global greenhouse gas emissions by up to 15%. Technologies such as Artificial Intelligence (AI), Internet of Things (IoT)-based smart metering systems, sensors, and live data analytics are revolutionising utility operations, providing urban planners with valuable insights for more efficient energy management and sustainable development.

ENABLING ECONOMIC GROWTH

The World Economic Forum has suggested that digital technologies could deliver up to one-fifth of the emission reductions needed to achieve the 2050 net-zero energy, materials, and mobility goals. It is well established that an average 10% increase in mobile broadband adoption can lead to an approximate 1% increase in GDP growth. With a GDP of over USD 3.4 trillion, India is currently the fifth-largest economy globally and is on track to become the third-largest economy by FY28. India has also set its sights on becoming a fully developed economy of USD 35 trillion by 2047.

As the world moves towards a future characterised by both growth and sustainability, technology stands at the forefront of this transition. With its ability to drive economic development, enhance social inclusion, and support environmental stewardship, the sector is a vital enabler of progress. By leveraging innovations such as 5G, embracing sustainability practices, and contributing to achieving global sustainability goals, the industry will continue to play a central role in shaping a brighter, greener future for all. 🐝

The author is a decorated military veteran who retired as Signal Officer-in-Chief, the head of the Indian Army's ICT. He was also the first CEO of the Telecom Sector Skill Council (TSSC) and is the Director General of the Cellular Operators Association of India (COAI).

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[TELECOM TALK]
NETWORK OPERATIONS

LT GEN DR SP KOCHHAR

BUILDING SMARTER HIGHWAYS IN TELECOM'S NEW DIGITAL FRONTIER

Autonomous networks enable telcos to streamline operations, enhance services, and reduce costs, driving efficiency in a data-driven, hyperconnected world

The role of telecom networks has transformed significantly over the past few years, especially since the onset of the COVID-19 pandemic. As people increasingly turned to digital applications to perform everyday tasks, telecom networks evolved to provide the necessary digital infrastructure to address these requirements; be it education, entertainment, job, shopping, banking, healthcare needs, agriculture or others.

To address the evolving connectivity demands, Telecom Service Providers (TSPs) have integrated additional platform-based services powered by modern technologies such as the Internet of Things (IoT), blockchain and edge computing. While these efforts have significantly improved customer experience, they have turned network management into a complex, costly and time-consuming process. This is where the role of network automation comes in.

> " AI and ML have made network automation smarter, enabling advanced analysis through historical and real-time data while enhancing network discovery.

> To address the evolving connectivity demands, TSPs have integrated additional platform-based services powered by IoT, blockchain and edge computing.

Today, autonomous networks powered by Artificial Intelligence (AI) and Machine Learning (ML) are revolutionising telecom services delivery worldwide. They simplify every operation, from policy implementation to network testing, from predictive maintenance to problem resolution, and more.

BENEFIT FOR INDIAN TELCOS

India has witnessed a staggering growth in Internet subscriptions over the past few years. With an overall Internet penetration of 85.85%, India is home to the second-largest telecom industry in the world. While the growth has provided TSPs in India with ample opportunities for revenue generation, the challenges associated with infrastructure build-out and management have outpaced those benefits. According to a report by Cisco, the cost of managing today's complex networks is two to three times more than the cost of the network itself. Thus, network automation has emerged as the way forward to reduce network management costs.

Network automation reduces or completely eliminates human intervention in network operations. With improved responsiveness and predictive maintenance capabilities, autonomous networks can resolve common network issues as they happen, without human involvement, significantly reducing the chances of network downtime while also saving associated labour costs.

Automation also simplifies application deployment, a key process in network management and also a major cause of network downtime for telcos. With automation, TSPs can gain complete control of the process by speeding up the application deployment and reducing human errors, thereby eliminating network outages.

With AI and ML, network automation has become even more intelligent. It provides advanced network analysis leveraging historical and real-time data and facilitates network discovery. With these insights, TSPs can identify possible issues associated with each network element and proactively address them to avoid performance issues. Furthermore, insights into customer intent can

help operators provide more targeted and personalised services.

Software-defined network (SDN), a programmable network management system in automated networks, is also gaining popularity among telcos. With SDN, TSPs can track network changes in real time and deploy new configurations, like adjusting routing paths based on real-time traffic conditions, ensuring efficient data delivery and minimising congestion. Automatic configuration of security controls also eliminates the risks associated with manual misconfigurations. With such insights and automated controls, networks become more agile and secure.

NETWORK OPTIMISATION AND SUSTAINABILITY

Operators around the globe are striving to reduce greenhouse gas emissions and cut down electricity consumption in order to save costs and achieve the UN Sustainable Development Goals (SDGs). Automated networks are the answer to this, as they help optimise network resources.

With AI integration, network provisioning becomes even more intelligent, significantly saving resources. AI automation can improve the energy efficiency of networks by maximising network utilisation without impacting the performance of energy-saving features. As per Nokia estimates, it can reduce energy consumption by up to 30%, cutting CO_2 emissions and cooling costs by 70%.

NETWORK AUTOMATION BY INDIAN TSPS

TSPs in India have realised the value of automating their networks to drive operational efficiency and cost savings. The four major operators have invested heavily and collaborated with leading tech companies to bolster their networks with advanced AI/ML technologies.

Reliance Jio has partnered with Guavus to leverage their AI-based solutions to provide real-time consumer experience and predictive analytics that would enable the telco to automate network troubleshooting and garner

23

> With network management costs two to three times higher than the networks themselves, automation stands out as the essential path to cutting expenses.

IN BRIEF

- **Telecom's digital evolution:** As daily tasks go digital, telcos provide crucial infrastructure, yet face challenges in complex, costly network management.

- **AI-driven network automation:** AI and ML-powered autonomous networks simplify operations, improve policy management, predictive maintenance, and problem resolution.

- **Boosting efficiency for Indian telcos:** With high internet penetration, India's telcos find automation essential to handle rising demands and cut operational costs.

- **Intelligent insights with SDN:** Software-defined networking enables real-time control, agility, and security, tracking traffic and adjusting configurations as needed.

- **Driving sustainability goals:** Automated networks cut emissions and improve energy efficiency, aiding global telecom operators in meeting UN SDG targets.

- **Automation for growth:** Indian TSPs adopt automation to enhance service, stay competitive, and support innovative business models in a rapidly evolving market.

key marketing insights. Similarly, Bharti Airtel has deployed Avanseus's predictive maintenance (PdM) solution across its operations. It has also partnered with IBM, Red Hat, Cisco, and Ericsson to enhance its networks through automation.

Vodafone Idea also has partnered with Cisco and Red Hat. Its strategic partnership with Red Hat to automate its IT infrastructure has helped reduce costs and improve operational efficiency. It has also partnered with Nokia to deploy the massive MIMO solution for network flexibility. State-owned BSNL, too, has partnered with Nokia for industrial automation solutions. It also signed a Memorandum of Understanding with Ciena for its 5G network solutions.

As network automation stays at the heart of innovative business models for telecom operators in India, its implementation requires a strategic and step-by-step approach. First, a thorough network analysis is required to identify key areas for automation and then select the right tools based on the requirements. As networks evolve to address the new demands, automation efforts will also have to undergo innovations to stay agile and responsive to market requirements. By adopting appropriate network automation strategies, TSPs can stay on top of the digital innovation curve and drive efficiency across the entire value chain. 🔽

The author is a decorated military veteran who retired as Signal Officer-in-Chief, the head of the Indian Army's ICT. He was also the first CEO of the Telecom Sector Skill Council (TSSC) and is the Director General of the Cellular Operators Association of India (COAI).

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24

5G AND
BEYOND

5G monetization in India - Future insights and outlook

Communications Today - 5ᵗʰ May 2024

Blazing-fast speeds, lower latency, higher bandwidth - 5G has arrived in India promising to revolutionize various sectors, elevate experiences, propel societies forward, and unravel new opportunities for businesses. For the telecom industry, in particular, the transition to 5G is pegged to unlock a new wave of opportunities, viz. opening new use cases and revenue streams through innovative business models and cross-sectoral collaborations.

In a resounding feat, India has spearheaded the fastest rollout of 5G in the world, deploying over 435,000 5G BTSs nationwide. However, despite the evident potential the technology offers and the plethora of innovative use cases envisaged across industries, not much headway has been made in terms of its uptake for enterprise use, which is expected to consist of the majority of 5G's revenue opportunities. The anticipation for ground-breaking killer apps to drive the use cases and business has gone unmet. Monetizing 5G is expected to unfold gradually over the next few years, relying on a myriad of applications rather than one killer app.

Another observation worth considering is the historical pattern w.r.t. the new technology generations. It can be seen that all the odd Gs 1G, 3G, and now 5G - have been grounds for new technologies, new applications, and exploration of new monetization opportunities. However, true monetization has eluded the odd Gs and rather materialized with the even Gs. Following this trend, I feel that 5G could be a precursor to 6G, which may usher in monetization opportunities once the technology and the market-reach mature sufficiently.

As we envision a future brimming with possibilities, certain discernible trends are poised to shape the structure and operations of the telecom ecosystem. This evolution aligns with the dynamic shifts of this vibrant sector and the growing convergence across industries. It is anticipated that some clear strategic business units will emerge in telecom, viz., networks, platforms, applications, and devices, where networks will provide the backbone for the sector, platforms will facilitate seamless integration between networks and applications, applications will adapt to user behavior, and devices will evolve to become more user friendly lighter, with enhanced battery life.

The rise of platforms

Platforms are the new kids on the block, acting as intermediaries bridging the gap between the networks and applications. These could be owned by either the telecom operators themselves or by technology companies, both possessing requisite expertise in the digital domain.

Platforms, perhaps, hold the highest potential to monetize their services through various business models and aggregation of different verticals. Operating massive cloud/virtual ecosystems, platforms offer edge computing and storage services locally, and can integrate with 5G networks to facilitate digital services and applications, catering to the requirements of the varied user base. Besides, platforms would also have the option to monetize the services by hosting applications or providing the interface to the users, as is already underway.

Platforms would offer tailored APIs allowing developers to integrate various functionalities into their applications. This flexibility can be leveraged to offer specialized services, which can be monetized through developer charges, based on API usage or by offering premium API packages with advanced features.

Another emerging monetization avenue would be X-as-a-service (XaaS), which involves virtualization of functionalities to offer different important services through a software-driven ecosystem. This would be akin to network-as-a-service, aka NaaS, whereby telcos can lease network functionalities and infrastructure to platforms on a subscription basis, encompassing services like VPNs, SDNs, etc. The SLA requirements of the user/consumer would determine the monetization offer in this regard, besides the scale/size of the operation/business being catered to.

Sandboxes for testing of applications/products is another burgeoning area, which holds promise for platforms to leverage. These sandboxes can be provided to startups/developers seeking industrial-level facilities to test and assess their offerings efficiently against real network conditions within a controlled environment, before market launch. Platforms could provide subscription/fee-based access to such developer sandboxes with customized configurations, network settings, and test scenarios.

Performance of platforms

While the future of platforms looks promising enough, their success would depend largely on the robustness of the underlying telecom networks on which they will ride to offer their services - both in terms of strong capacity and expansive availability across the market. For services like cloud computing and storage, content streaming, e- commerce and search, flawless user experience is paramount. Moreover, these platforms would handle enormous amounts of data daily, necessitating a well-equipped telecom network, capable of handling such massive data traffic efficiently. Even for content delivery services, buffering and streaming interruptions can mar experiences if networks are unable to perform. Hence, networks would continue to play a pivotal role even in this evolved ecosystem.

Role and importance of networks

The foundational role of telecom networks is thus evident, as the basic tenets of providing the required quality of service lies majorly on the shoulders of this CapEx-heavy and critical vertical. While it is expected to deliver technically efficient and futuristic networks, leveraging ever- evolving technologies like 5G and 6G to provide the best possible user experience, they obviously need to evolve continuously themselves, to be able to perform as expected. Telecom networks have to be efficient, flexible, and agile to adapt to emerging, innovative trends, such as AI, IoT, etc. This adaptability is crucial to address fluctuations in network conditions and traffic patterns in real time by employing adaptive routing algorithms, dynamic resource allocation mechanisms, and software-defined networking (SDN) principles. Besides, increased adoption of cloud and edge computing plays a pivotal role in making network operations more agile, automated, and capable of meeting diverse demands.

Essentials for a high-performance telecom network

While superior networks are imperative for delivering excellent network coverage and performance to platforms for meeting their varied data requirements, building, maintaining, and upgrading such high-performance telecom networks entail significant capital investments to ensure the network's reliability, capacity, and performance. Adequate spectrum allocation across different frequency bands is also crucial for providing the necessary bandwidth to support high-speed data transmission and communication

services. Besides, to ensure nationwide coverage, telcos require adequate permissions from state/local authorities to set up the requisite infrastructure and deploy networks, a process often complicated by authorities seeking unreasonable charges. Additionally, continuous investments are required for technology refresh and upgrade, to ensure that the networks can support the latest technologies and deliver desired outcomes. For example, with the advent of AI, investing in specialized components and technologies like graphics processing units (GPUs) has become a necessity, although it involves high costs for the telcos to implement in the networks as these are made-to-order equipment, with long waiting period and advance payments made for procurement.

Challenges for networks

Networks by themselves have limited possibilities for monetization, as their coverage across the country will eventually reach saturation. Further, the resulting revenue from network services (ARPU) depends largely on the subscriber base or user population, which cannot grow exponentially. However, the high costs associated with creating, operating, maintaining, and upgrading networks continue to move northwards as demand for bandwidth and the data traffic increases.

Overcoming network setbacks

In such a situation, it becomes imperative for stakeholders benefitting most from telecom networks to contribute responsibly and equitably toward their costs, ensuring sustainability. Large traffic generators (LTGs), which generate disproportionate volumes of traffic and enjoy a free ride over the networks, should especially contribute to this purpose. This will help ease the burden on Telecom Service Providers (TSPs), allowing them to invest in future upgrades and ensure the viability of the telecom sector.

Deploying 5G in remote areas is also an expensive and business-wise unviable proposition as the scarce population and resulting low RoI do not justify the deployment costs. The government can play a crucial role here by incentivizing telecom networks through tax incentives and subsidies. Further, local bodies should consider the larger benefits of telecom connectivity for overall socio-economic development of the region rather than treating this as a money-minting opportunity. This approach will foster digital inclusion and equitable access to high- speed connectivity across the nation.

Conclusion

5G has been the mobile broadband technology with the fastest uptake in India and is pegged to be the catalyst to propel the vision of Digital India forward. While that is something to rejoice in, monetization of 5G is the need of the hour. The biggest value proposition of 5G lies in ushering innovative use cases across industries. Concerted efforts from government bodies, local authorities, and industry stakeholders are essential to overcome challenges, promote digital inclusion, and harness the full potential of 5G for the benefit of all.

World Telecom Day 2024: Achieving sustainability goals in India with 5G, futuristic technologies

ET Telecom - 17th May 2024

Digital technology acts as the cornerstone of sustainable development across economies. This is especially true for India, a country with complex socio-economic patterns, yet abundant in technology talent, especially among the young generation. Thanks to the digital strategies adopted by the Government with a focus on fostering innovation and inclusivity, India has ascended to become the third largest digitalised country in the world, only behind the USA and China. The visionaries in India have also embarked on diverse projects with ICT as the foundation, holding the potential to build a sustainable economy and elevate India's status as the third largest economy by 2027.

Achieving Sustainable Development Goals with Mobile Internet

The United Nations has stated that affordable Internet access is a basic human right and a key component of achieving its 2030 Sustainability Development Goals (SDGs). GSMA's 2023 Mobile Industry Impact Report further validates that countries with higher levels of mobile connectivity have achieved greater progress towards meeting the SDGs, and they are also leading in SDG implementation. With India's mobile Internet adoption growing at tremendous speed, we are getting closer to achieving the SDGs.

Mobile data traffic in India reached 17.4 EB per month in 2023 with a CAGR of 26% over the last five years. Now, 5G is set to introduce a new-age digital revolution, driven by the increasing data consumption pattern and the evolving use cases. As per the latest Nokia MBiT Index, in 2023, 5G users in India used 3.6 times more data on average as compared to 4G users, and average monthly mobile data traffic per user grew 24% year-on-year in 2023 to 24.1 GB.

While the digital journey looks highly prospective for India, challenges still persist. While expansive and ubiquitous mobile connectivity for all citizens across the country is desirable and relentless efforts are being made by the industry to facilitate the same, it cannot happen without cooperation and collaborative efforts at the ground level. Adequate spectrum at reasonable rates across different frequency bands, such as the potent 6 GHz band, is crucial for providing the necessary bandwidth to support high-speed data transmission and communication services across the vast expanse of India. Besides, in addition to the exponential prices paid for spectrum, deploying telecom networks and their maintenance, upgrade, regular technology refresh, etc. lead to heavy investments for the telcos, aggravated further by the continuously and disproportionately increasing data traffic generated especially by the Large Traffic Generators (LTGs). Therefore, it becomes imperative that stakeholders benefitting most from telecom networks, like the LTGs, contribute responsibly and equitably towards their costs, ensuring sustainability and viability of the telecom sector.

Moreover, to ensure nationwide coverage, telcos require adequate permissions from state/local authorities to set up the requisite infrastructure and deploy networks, a process often complicated by authorities seeking unreasonable charges. It is imperative that local bodies bear in mind the larger benefits of telecom connectivity for overall socio-economic development of their region, rather than treating this as a money-making opportunity. This approach will foster digital inclusion and equitable access to high-speed connectivity across the nation.

To bridge the digital divide and make high-speed mobile internet accessible to all is the priority for India. With ubiquitous mobile connectivity, mobile-enabled services will become accessible to the needy. Advanced technologies like AI and Internet of Things (IoT) can catalyse the progress across sectors and help the country achieve the SDGs faster.

5G and Emerging Technologies for a Greener World

With telecom acting as the central nervous system enabling communications and connectivity, telecommunications infrastructure gains relevance as a sustainable investment. As per a World Bank and ITU study, it is estimated that telecom operators generated 133 $MtCO_2e$ of operational emissions in 2022, accounting for only 0.4 percent of total global GHG emissions from energy. With the imminent proliferation of the present 5G and future 6G technologies and their diverse applications, this figure is poised to surge. However, while the overall power consumption of 5G base stations is estimated to be at least twice that of 4G, and higher in sites which operate in multiple frequencies, 5G networks would use less energy to transmit the same amount of data compared to 4G. Ericsson estimates that a 5G system can carry 10 times the volume of data traffic than a 4G system with no net increase in energy consumption.

With energy accounting for approximately 20% of the telcos' opex, the concept of sustainable next-generation network technologies gains further relevance for them. Enter green telecom networks, a transformative concept that places energy efficiency, carbon emissions reduction and long-term sustainability at the forefront of its operations. Fundamentally, such networks focus on using energy-efficient hardware, optimizing network infrastructure and implementing power-saving features. They also rely on renewable energy sources to reduce reliance on fossil fuels. The industry is also working on intent-driven automated network architecture that is able to orchestrate existing and new functionality. These software-defined smart and intelligent power solutions can dynamically adjust network resources and reduce energy consumption.

The latest generation telecom networks also indirectly contribute to SDGs by introducing innovative solutions to foster green operations across other sectors. For example, 5G, with its higher speed, lower latency and enhanced capacity, enables a range of sustainability-focused applications, such as smart grids for energy optimization, connected sensors for precision agriculture and IoT-based solutions for energy-efficient buildings.

Cellular-connected production management systems and IoT tracking powered by 5G have the potential to enhance efficiency in factories and warehouses. Furthermore, initiatives like connected cars and smart buildings powered by 5G introduce new avenues for reducing carbon emissions and combatting climate change. More importantly, 5G has the ability to power AI solutions with far higher energy efficiency compared to 4G. To cite a global scenario, Ericsson estimates that by 2030, connectivity could lead to reducing EU emissions by approximately 550 $MtCO_2e$, equivalent to 15 percent of the EU's total emissions in 2017; and a further 55–170$MtCO_2e$ of emissions savings per annum would be possible with the implementation of 5G technology.

With climate change taking centre stage in industry discussions over and over again, it's time to invest in pragmatic solutions that help address this global crisis. 5G, in tandem with advanced technologies like AI and IoT, can lead to diverse applications that can directly impact sustainability metrics. Meanwhile, operators need to continue to invest in innovative and automated solutions that can optimize their network investments and reduce energy consumption and thereby, cost.

[TELECOM TALK]
SKILL DEVELOPMENT

LT GEN DR SP KOCHHAR

PREPARING INDIA'S WORKFORCE FOR 5G AND THE LEAP TO 6G ERA

India's GDP powerhouse telecom sector faces a 2.5 M talent shortfall. Rapid 5G and upcoming 6G require heavy investments in upskilling to stay ahead

In the last decade, India has established itself as a hub of technological innovation, spearheading the digital revolution globally. With the fastest 5G rollout in the world and the launch of 6G technologies aimed at 2030, there is a subsequent growth in the demand for a skilled labour force in the country.

India's telecom industry is a vital engine of the nation's economy, powering roughly 6.5% of the country's GDP. It ranks among the top sectors for job creation, making it a significant driver of employment. However, the industry is undergoing a dynamic transformation fuelled by the arrival of 5G-centric, next-generation technologies like data science, Artificial Intelligence (AI), Internet of Things (IoT), Blockchain, Robotics and Cloud Computing. These advancements generate a high demand for a well-skilled workforce equipped to handle these cutting-edge developments.

OPPORTUNITIES FOR TALENT GROWTH IN THE 5G ERA

A recent report by TeamLease highlights an important opportunity for the telecom sector in India: the need for a skilled workforce. The telecom industry is poised to address a shortfall of 2.5 million skilled workers, and this demand is expected to grow significantly by 2030. This trend coincides with a moderated pace of workforce growth in FY23-24 compared to the previous year.

This scenario underscores a pivotal point: as a key driver of India's economic growth, the telecom industry has a unique chance to attract and develop talent. The

The focus is shifting towards competencies in embedding AI within networks and creating software development kits for 6G functionalities.

> The industry will require talent to navigate connectivity and application layers as these elements become increasingly interconnected in the 6G era.

rapid technological advancements in 5G demand a highly trained workforce essential for efficient network operations. Mastering 5G will pave the way for 6G innovation, enabling India to unlock the full potential of next-generation technologies. By investing in skill development now, the industry can ensure sustained growth and technological leadership in the future.

NURTURING TELECOM TALENT FOR ECONOMIC GROWTH

The leading telecom players are investing heavily in training programmes to upskill their workforce on emerging technologies to address the current shortfall in telecom talent. They also collaborate with universities and technological institutes to set up centres of excellence and research labs, ensuring job-ready graduates acquire the necessary skill sets. Several online platforms also offer telecom-related courses and certifications, providing flexibility for working professionals to upskill or reskill at their own pace.

The government is also working actively on skilling new entrants, upskilling existing workers and reskilling those with outdated skills. One such initiative is the Pradhan Mantri Kaushal Vikas Yojana, which provides financial assistance to individuals and training providers for courses relevant to the telecom sector, making them more accessible. The government's 'Skill India Mission' is another national initiative that provides vocational training to millions of youths across various sectors, including telecom, with skill development programmes in network engineering, mobile communications and fibre optic technology.

By addressing the talent gap through strategic workforce development and collaboration, the telecom sector can navigate the current economic climate while maintaining its long-term trajectory of innovation and growth. While major players are nearing completion of their 5G deployments in urban centres, a significant opportunity remains in rural India, where many villages still lack basic mobile connectivity. This creates a broader need for a robust mobile network foundation to support 5G expansion.

Expanding mobile and 5G coverage to rural India presents a significant opportunity for job creation. Skilled engineers, technicians and project managers will be crucial for building and maintaining the necessary infrastructure. Staffing firm Quess Corp. estimates this rural 5G push will generate an additional 50,000 jobs over the next two to three years.

Achieving pan-India 5G coverage is crucial for successfully launching and adopting 6G technology. A widespread 5G infrastructure will act as the foundation upon which 6G advancements will flourish, creating more jobs and opportunities for the youth. Thus, the 6G race hinges on a skilled 5G workforce.

SKILLING FOR A 6G-READY WORKFORCE

6G's arrival promises a revolution. It is expected to create a surge in IoT, mind-blowing Augmented and Virtual Reality experiences and sophisticated AI automation. To navigate this new landscape, employees will need to undergo a metamorphosis. Mastery of 6G principles, novel networking protocols, advanced cybersecurity measures and sophisticated data analytics will become essential skills for managing and securing the future of connectivity.

With 6G clearly on the horizon, India has a unique opportunity to establish itself as a global leader and a key player in shaping global standards. The Department of Telecom (DoT) spearheads this initiative through the Technology Innovation Group on 6G (TIG6) and the visionary 'Bharat 6G Vision' document. This strategic initiative fosters collaboration between domestic companies, agile Indian startups, esteemed academic institutions and R&D powerhouses, aiming to develop cutting-edge 6G technology and cultivate a future-proof workforce adept at leveraging its full potential.

The introduction of 6G offers telecommunications companies a unique chance to disrupt the existing landscape. Thoughtful development of 6G technology could attract substantial cross-sector investment, foster innovation, boost adoption and ignite future waves of disruptive technologies. As new network technologies

> A widespread 5G infrastructure will act as the foundation upon which 6G advancements will flourish, creating more jobs and opportunities for the youth.

IN BRIEF

- India leads the global digital revolution with rapid 5G rollout and aims for 6G by 2030.

- The telecom sector powers 6.5% of India's GDP and is a top job creator.

- 5G advancements drive demand for skilled workforce in data science, AI, IoT, and more.

- According to a TeamLease report, the sector needs 2.5 million skilled workers by 2030.

- Government and telecom players invest heavily in upskilling and reskilling initiatives.

- Rural 5G expansion will generate 50,000 jobs, crucial for future 6G development.

emerge, there will be a corresponding need for new competencies and skills. Developing the necessary talent for 6G will allow operators to leverage new value-creation opportunities effectively.

Beyond enhancing wireless capabilities, the 6G era will be integral to a larger connectivity ecosystem influenced by advancements in AI, Edge Computing and autonomous driving. Mobile Network Operators must adapt their talent mix and upskilling strategies to develop a new range of technical skills.

According to a recent report by McKinsey, the focus is shifting towards competencies in embedding AI within networks and creating software development kits for 6G functionalities. Additionally, the industry will require talent to navigate connectivity and application layers as these elements become increasingly interconnected in the 6G era.

FUTURE-READY WORKFORCE: ADAPTING TO 6G DEMANDS

The government's initiatives and the industry's recognition of the critical need for a skilled workforce are fuelling positive growth in the telecom industry. The sector is projected to employ a staggering 6.79 million individuals in the current fiscal year. This surge is driven by a shift in required skills, with companies actively recruiting field personnel like sales executives, customer relationship specialists and network infrastructure technicians.

However, the evolution does not stop there. As we move towards 6G technology, the demand for specific skill sets will continue to shift, highlighting the need for upskilling and reskilling initiatives. The concept of 'survival of the fittest' is particularly relevant here. Those who can adapt and acquire the skills relevant to the industry's evolving landscape will remain valuable assets.

It is interesting to note that as automation and AI become more prominent, human-centric skills like creativity, critical thinking and emotional intelligence will become increasingly indispensable. ♣

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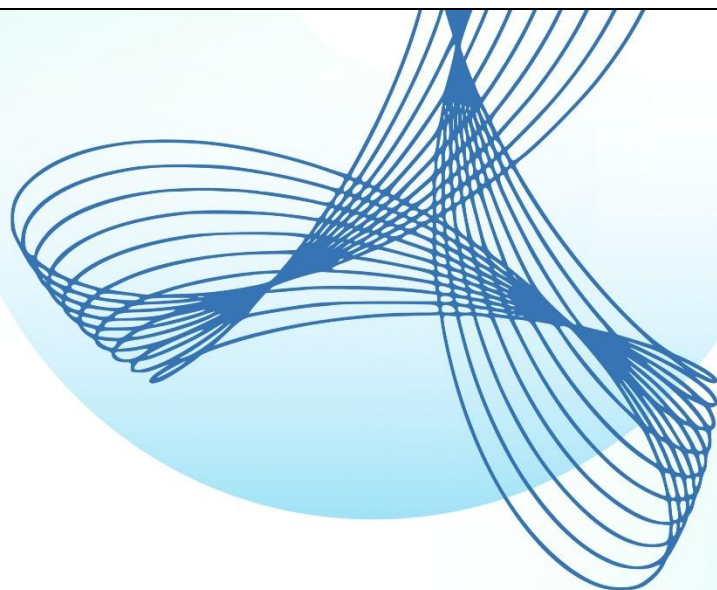
NEXT GEN TECH
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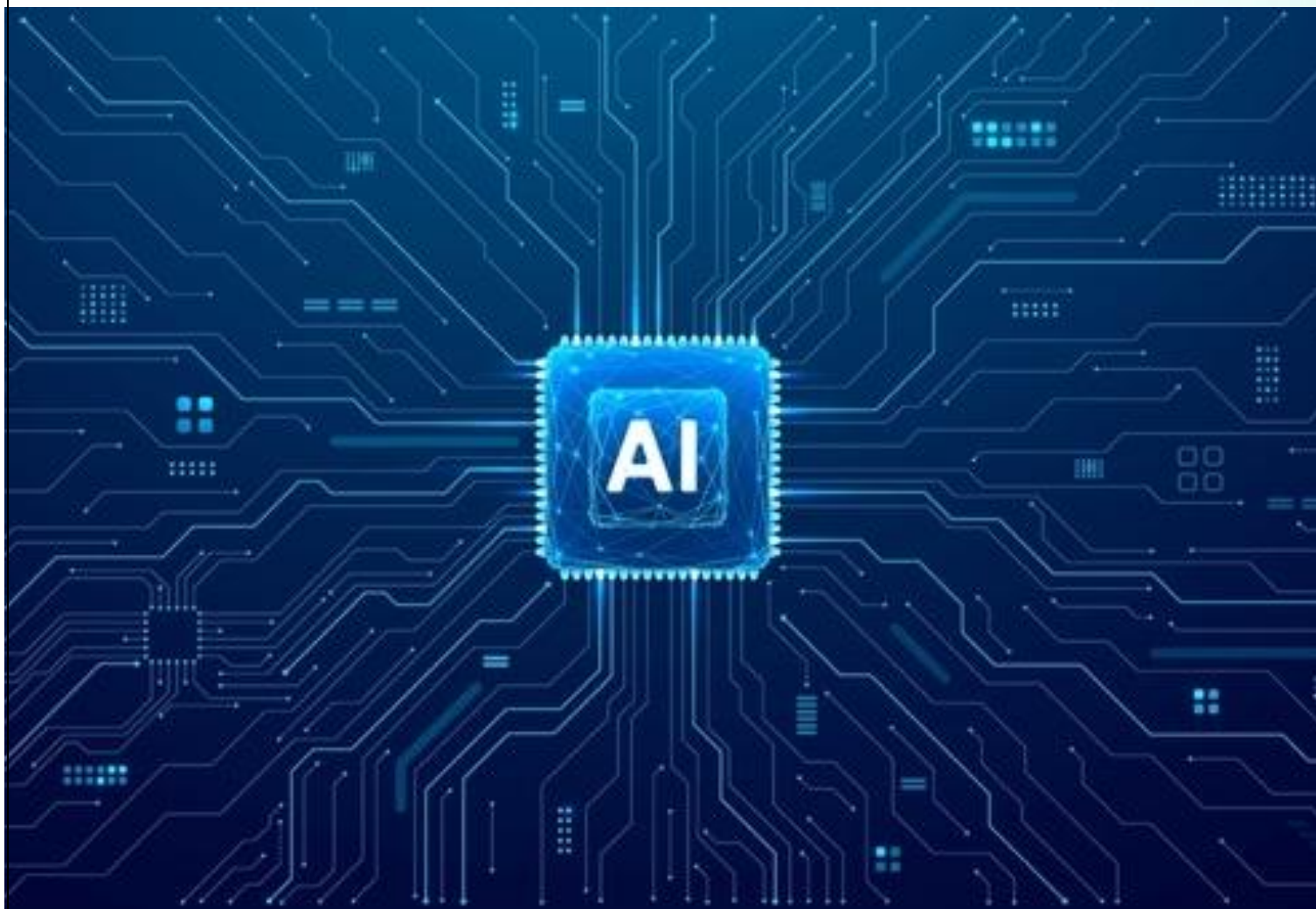
Essentials for an effective AI mould for India

SP KOCHHAR

Director-general, COAI (Cellular Operators Association of India). *Views are personal*

The 'knowledge' of embedded artificial intelligence and GenAI's 'wisdom' need to work efficiently together to produce fruitful results

ARTIFICIAL INTELLIGENCE, OR AI, is dominating discussions today in both tech and non-tech forums alike. The customer-facing application, generative AI (GenAI), has especially become a buzzword, drawing attention and leading to policy discussions and regulatory actions across the world. While these are progressive developments and definitely required to propel India's aspirations for leadership in yet another technology vertical, there are other integral parts to this AI ecosystem which seem to be missing in conversations but need to be focused upon.

While GenAI seems to be the area of focus for all today, its efficacy is contingent upon the entirety of the ecosystem that facilitates its operations. The crux of GenAI lies in its ability to parse through data, organised in specific templates within data bins, to generate meaningful outputs. The collection of data based on criteria and sorting them into specific bins is what I mean by a 'templated' approach in this regard. Without such a structured input process, these data repositories risk becoming mere data dumps, significantly diminishing the quality of AI-generated responses. This underscores the critical role of embedded AI systems in preprocessing data to ensure its utility.

Understanding an AI system's workings elucidates the importance of templated data management. Data, in its raw form, is akin to unmined gold — valuable but not immediately useful. The various sectors/sources produce large data sets, which essentially is 'raw data'. The embedded AI systems take the requirements from the GenAI system at one end and sift through raw data to make templatised trend-based data sets, which are then used as inputs for GenAI to produce the required results. This is akin to producing intelligible information or 'knowledge' by embedded AI systems. Thereafter, the GenAI system absorbs this data, analysing it to read the trends and inferring from these trends to produce results, or what can be termed as 'wisdom', which cater to the requirements of the users.

The template is a critical part of this process, and needs to be formulated by the government to ensure uniformity of the data being collected. It would also help provide a semblance of sanity and sanitation checks on the diverse data being collected from across multiple sectors and from multiple sources. Unless a specified template is implemented for the purpose, owing to the diversity of sources, the data collected may be fragmented or cluttered, which would constrain the production of fruitful outcomes from the eventual GenAI application used.

It is equally important to understand that the analysis and subsequent outcomes produced by the GenAI depend fundamentally on the nature of the data present in the system. Relying on data sets tailored to the nuances of the Indian environment is crucial for AI systems to generate accurate and relevant outcomes. The diversity of India's geography, languages, consumer behaviour and industrial landscape demands a localised approach to data compilation. This necessitates governmental oversight to ensure the representation of India's unique attributes in AI anonymised data sets, a cornerstone in leveraging AI technology for national advancement by making these data sets available for experiment and utilisation without impinging on privacy and data security.

For example, consider the scenario of implementing a national digital education initiative designed to cater to the diverse needs of India's student population, aiming to address various educational requirements across regions, accounting for local languages, varying curricula and access to resources. For the initiative to be effective, it is crucial to gather and organise detailed information about these variables and feed them into an embedded AI system. The system then analyses the data, identifies patterns, and passes them on to GenAI, thus allowing the latter to tailor educational content and delivery methods to meet the specific needs of different student groups. If the system were to rely solely on global education models/data, it might not fully capture the unique educational landscapes of India's regions, potentially leading to less effective or irrelevant content. Localised data ensures the AI system can generate more accurate and impactful solutions, showcasing the importance of tailored AI applications in national development projects.

India's ambition to become a digital economy leader necessitates a robust foundation in AI technologies. As we race forward on the digital highway, it's crucial to not just celebrate the milestones but also lay down the tracks — by focusing on the underlying AI ecosystem's components. Ensuring the comprehensive development of AI technologies, backed by localised, structured data sets, is paramount for India's journey towards technological pre-eminence. This strategic focus will not only fortify our position in the global tech arena but also ensure the sustainable and inclusive growth of our nation in the digital age.

> India's ambition to become a digital economy leader necessitates a robust foundation in AI technologies. It's crucial to not just celebrate the milestones but also lay down the tracks

Telecommunications: The cornerstone for AI for Good, responsible regulations & cybersecurity

ET Government - 9th October 2024

As the world gains more intelligence 'artificially', there is nothing impossible 'virtually'. Artificial Intelligence (AI) and Machine Learning (ML) have become integral parts of almost all sectors worldwide, India being no exception.

IDC anticipates that AI spending in India will surpass $512 billion by 2027. While AI/ML technologies have immense potential to drive innovation and growth, the United Nations Resolution on Artificial Intelligence has recognised that unethical and improper use of AI systems would impede the achievement of the 2030 Sustainable Development Goals (SDGs).

Since the telecommunication industry has played and continues to play a crucial role in the development of the AI technologies, it is also at the vanguard of ensuring the ethical use of these technologies, facilitating AI for good. Worldwide, the telecommunications industry is developing AI-driven solutions, including AI-powered threat detection and automated response systems, while also spearheading the formulation of regulations aimed at creating a sustainable AI ecosystem.

AI: Boon or Bane?

Cybercriminals are increasingly using AI to launch sophisticated masquerading techniques, capable of deceiving even the most discerning brains. For example, in phishing attacks, they create fake emails perfectly mimicking the communications style of the target institution, with all personalized details harvested from social media and other sources.

The communication looks so authentic that even the employees of the same organization fail to recognize it and fall victim to the deceptive messages. Scammers are also leveraging deepfakes to dupe people and organizations in order to exhort money and do other harms. The exploding popularity of AI applications has thus created a sense of urgency among authorities to devise necessary policies to prevent their misuse.

Considering the fact that AI-powered threats will remain a major challenge into the foreseeable future, industry experts advise that defenders focus on preparing for a world where threats are unique and are coming faster than ever before.

The silver lining is that AI itself provides solutions to counter these challenges and humanity strives to harness its potential faster than the foes.

Telecommunications Sector Driving Responsible AI Regulation

As the providers of digital communications infrastructure, telecommunications service providers (TSPs) are at the forefront in devising responsible AI regulations.

The Global System for Mobile Communications Association (GSMA), which represents the interests of mobile network operators worldwide, has recently launched the first industry-wide Responsible AI (RAI) Maturity Roadmap to provide telecom operators with the tools and guidance to test and assess their responsible use of the technology. Previously, GSMA launched the AI for Impact initiative wherein it

collaborated with partners across the public and private sectors to commercially scale responsible AI for a better future.

Major consultations are going on to set up a regulatory framework for AI globally, with some of them already enacted into law. For example, on August 1, 2024, the European Union's AI Act came into force, setting comprehensive regulations for AI systems across the EU.

In India, The Telecom Regulatory Authority of India (TRAI) last year recommended that the Artificial Intelligence and Data Authority of India (AIDAI) be set up as an independent statutory authority supported by a multi-stakeholder advisory body. TRAI also proposed a risk-based regulatory framework to categorize and regulate AI use cases, especially those with direct human impact.

In an attempt to tackle the growing menace of deep fake content on social media, the Ministry of Electronics and Information Technology (MeitY) released a draft of an upcoming law which decrees social media platforms such as Facebook, Instagram, YouTube and X to include watermarks and labels on AI-generated content.

On the occasion of the first foundation day of the Indian Cybercrime Coordination Centre, the Hon'ble Home Minister Shri Amit Shah launched the Cyber Fraud Mitigation Centre (CFMC), a consortium formed by the representatives of major banks, financial intermediaries, payment aggregators, TSPs, IT intermediaries and States/UTs' Law Enforcement Agencies (LEAs), to curb cyber crimes using AI.

AI for Sustainability: the Greater Good

Apart from effectively managing cyber threats, AI is being used for building sustainable telecom networks. The telecom industry in India has adopted the greener networks strategy in order to save costs and achieve UN SDGs. A Nokia report states that approximately 85% of the energy for networks is not used productively.

With AI, network provisioning can become more intelligent, leading to significant savings on resources. As per Nokia estimates, AI powered networks can reduce energy consumption by up to 30%, cutting CO_2 emissions and cooling costs by 70%. With these insights, TSPs in India are collaborating with tech giants to take advantage of these technologies.

Building a Promising Future with AI

While the telecommunications industry is rapidly evolving by integrating next-generation technologies like AI and ML to combat cybercrime and develop sustainable networks, its initial goal was to improve customer experience.

Now that there is conscious understanding of the potential AI/ML technologies possess, more such use cases will evolve and the telecommunications industry will continue to propel that course of innovation, setting standards and regulations wherever required.

Edge AI and its impact on network infrastructure

The incredible advancements in communication technologies and rapid proliferation of smartphones, IoT devices, 5G networks, and real-time data processing have led to an unprecedented surge in data generation. Trillions of data bytes generated at the edge of networks has put massive pressure on traditional cloud-based infrastructure, resulting in network congestion, latency, bandwidth, and security concerns. To address these challenges, a groundbreaking computation paradigm edge computing has emerged. By steering away data processing from centralized and cloud-based systems toward the peripheries of the network, edge computing ushers in a seminal shift, aiding faster data processing and transmission, as well as operational efficiency. With artificial intelligence (AI) systems evolving rapidly, and dramatically improving processing speeds, the convergence of AI and edge computing or edge AI presents unprecedented opportunities.

The rise of edge computing

The present advanced Internet-abled gadgets like surveillance, virtual reality, and real-time traffic tracking require quick processing and fast responsive gadgets. Edge computing satisfies these demands through strategic deployment of data processing capabilities in close proximity to the source of data generation, such as local edge servers or IoT devices, rather than relying on centralized data processing warehouses or cloud data centers. By reducing the need for extensive data transfers to centralized cloud environments, edge computing offers a multitude of business benefits, including faster data processing and insights generation, reduced latency, better response times, and enhanced bandwidth availability.

With so much data to handle on a daily basis, a major question arises how does edge computing work? Edge computing uses small, low-power devices called edge devices to extend the cloud capabilities to the edge of networks to execute computationally rigorous errands, and stock large quantities of data in closer proximity to the data handlers. It is like having mini data centers right where the action is happening. They intercept streams of data and act upon them in situ, either returning results directly to users, sending commands to machinery, or relaying refined insights to cloud central servers for further processing. This reduces strain on the network and allows for quicker analysis and response times.

The dance between edge computing and cloud computing

Here an important question arises will edge computing replace cloud computing? Well, to be fair, edge computing complements cloud computing by addressing the inherent limitations of relying solely on centralized cloud servers. This proximity is critical especially for applications that require instant analysis and feedback, such as autonomous vehicle navigation systems, real-time surveillance, and on-site industrial process controls.

However, in many cases, the two have a symbiotic relationship. For instance, services, such as web hosting and IoT, benefit greatly from edge computing when it comes to performance and initial processing of data, but still require a robust cloud backend for things like centralized storage and data analysis. The cloud continues to provide powerful, centralized resources for heavy lifting, such as big data analytics, long-term storage, and complex computations that do not require immediate response times. This dual approach ensures that applications can leverage the right kind of computing power at the right time, optimizing both efficiency and performance.

Transition of AI to leverage edge computing

The evolution of AI technologies has ushered in a new era of computational paradigms, transforming various sectors, including telecommunications. As technology advances and demand for low-latency and high-bandwidth applications continue to surge, traditional cloud-centric AI architecture faces inherent limitations in meeting these requirements, especially with the global deployment of 5G.

As per Gartner, by 2025, the creation and processing of 75 percent data owned by enterprises will take place outside data centers or cloud. As a result, AI technologies are moving to the edge, processing datasets much closer to the devices, applications, and users, where data is generated. AI, together with edge computing, can handle these tasks, converting raw data into actionable insights in an efficient and cost-effective manner.

AI at the edge - A game changer

Edge AI combines two pivotal technologies in today's digital transformation era edge computing and artificial intelligence. In this paradigm, AI algorithms are deployed either directly on edge devices or on the servers closer to the devices, enabling real-time data processing, without relying on cloud connectivity. This represents an efficient alternative to traditional AI frameworks that rely heavily on central cloud computing environments.

Edge AI harnesses machine learning (ML) models capable of operating independently or in tandem with cloud resources. These models are trained using vast datasets in the cloud and then subsequently deployed to edge devices, where they analyze and infer data in real time. For example, when a user communicates something to Alexa or Google, voice recordings are processed within the edge network, using AI to convert speech to text, and responses are generated accordingly.

This convergence of edge computing and AI will be enhanced by advancements in hardware in future, through specialized AI chips and neural processing units (NPUs), which will empower edge devices to perform complex computations faster and in an efficient manner. This capability enables faster decision making, enhancing the efficiency of various network applications.

Edge AI revolutionizing computing

Edge AI represents a transformative leap in computing by significantly enhancing decision making and responsiveness through local data analysis, thereby reducing response times. This low-latency processing is crucial for applications, such as autonomous vehicles, where split-second decisions can be life-saving, and in industrial settings where AI-powered edge devices predict equipment failures to minimize downtime and maintenance costs. Moreover, processing data at the edge alleviates network bandwidth strain by transmitting only essential insights instead of large amounts of raw data to the cloud, reducing transfer costs and congestion, and ensuring network scalability as IoT devices proliferate.

Edge AI also enhances privacy and security by keeping sensitive data closer to its source, reducing risks of breaches in healthcare, banking, and smart home applications. It addresses data privacy concerns by minimizing data transmission to the cloud. The deployment of AI models on edge devices allows for greater scalability and flexibility in network infrastructure, enabling localized processing, and adaptation to changing demands by adding more devices as needed. This decentralized approach prevents the need for overhauling entire infrastructures. Further, edge AI is energy-efficient, optimizing power consumption

and extending battery life for remote IoT devices, making it suitable for various applications and environments.

Future of edge AI

The future of edge AI promises transformative impacts across industries, driven by increased adoption, advanced hardware, and robust frameworks. According to Fortune Business Insights, the global edge AI market is poised for significant growth, with a valuation of USD 24.2 billion in 2024 and projected to reach USD 54.7 billion by 2029, growing at a CAGR of 17.7 percent during the forecast period. The rapid growth of IoT devices across various industries, including smart homes, industrial automation, healthcare, agriculture, and transportation, has been a significant driver for edge AI hardware.

In healthcare, edge AI will enable real-time patient monitoring and diagnostics, thereby enhancing treatment outcomes, while in agriculture, it will optimize resource allocation and crop management. Smart cities are poised to benefit from edge AI through improved traffic management, enhanced public safety measures, and greater energy efficiency. The future will also see closer collaboration between edge and cloud environments, with edge devices managing real-time processing and cloud handling AI model training, updates, and large dataset storage. This hybrid approach ensures optimal performance and scalability.

As edge AI matures, we can expect the evolution of its frameworks that will simplify AI model deployment and management, accelerating adoption across sectors. Besides, improved interoperability and standardization will facilitate seamless integration of AI capabilities into existing edge solutions. As edge AI continues to evolve, its impact on network infrastructure will be profound. Networks will need to support increased demand for low-latency, high-bandwidth connections, driving the development of more resilient architectures with improved connectivity options, including 5G and beyond.

Despite such progressive technological advancements, challenges, such as ensuring data security and privacy, establishing standardized protocols, and managing the lifecycle of AI models, need to be addressed. Organizations have to implement robust security measures to protect edge devices from cyber threats and develop efficient mechanisms for model updates and monitoring. Additionally, regular updates and retraining of AI models deployed at the edge will be essential for maintaining accuracy and relevance over time, necessitating efficient deployment, monitoring, and updating mechanisms by organizations.

The way forward

Edge AI marks a notable advancement in computing evolution. By embedding AI capabilities into edge devices, organizations can unlock new possibilities for real-time data processing, enhanced decision-making and improved user experiences. The impact on network infrastructure will be profound with reduced latency, increased efficiency, and greater scalability. As technology continues to advance, the potential of edge AI will expand further, revolutionizing industries and reshaping the future of computing.

Recipe for AI: Regulation & benchmarking

SP KOCHHAR

Director general, Cellular Operators Association of India

Beyond regulation, standardisation of artificial intelligence practices and technologies ensure safety, interoperability, and trust

ARTIFICIAL INTELLIGENCE (AI) STANDS at the crossroads of innovation and ethics, presenting both transformative benefits and profound challenges. This dual nature of AI necessitates comprehensive regulation and responsible deployment, as we prepare to integrate it into every facet of society — from healthcare and education to security and finance. AI's potential to enhance our lives is undoubtedly immense. It improves industry efficiency, optimises business operations, and contributes to environmental conservation by monitoring biodiversity and predicting climate change impacts. By processing vast data sets quickly, AI unlocks new knowledge and drives innovations previously beyond our reach. However, this data also poses significant risks, from breaches of confidentiality to identity theft and beyond.

The advent of deepfakes and AI-based impersonation illustrates these dangers vividly. These technologies, which manipulate audio and visual content with disturbing accuracy, can be used to commit fraud, spread misinformation, and manipulate public opinion, threatening individual privacy and societal trust by undermining the fabric of factual consensus. Furthermore, AI's role in perpetuating societal biases, due to algorithmic prejudices, poses a stark challenge to fairness and equity.

Governments worldwide are increasingly recognising the need to address AI challenges and are implementing a range of strategies and regulations. The European Union (EU) leads with comprehensive AI regulations focusing on high-risk applications, transparency, and safety. Similarly, the USA emphasises accountability and the protection of civil liberties

in its AI guidelines. In Asia, China and Singapore are developing AI governance frameworks balancing innovation with security and public welfare. These efforts involve cross-sectoral collaboration with academia, industry leaders, and international bodies to create holistic and effective AI policies. Many institutions and industry bodies have also developed ethical guidelines for AI. For example, the IEEE Global Initiative on Ethics of Autonomous and Intelligent Systems provides a comprehensive framework for ethical considerations in AI development and deployment, while the AI Ethics Guidelines by the European Commission aim to protect individuals' rights and ensure responsible AI deployment.

While effective regulation is crucial for safeguarding privacy, ensuring data security, and fostering fairness by setting standards for algorithmic transparency and data quality, there are challenges which include regulating AI's rapid development pace and global applications.

AI technologies often transcend national boundaries, operating across multiple countries and complicating the establishment of uniform regulatory standards, as different nations have varying priorities, values, and legal frameworks. Internationally, different priorities and legal frameworks influence AI regulation. The EU, for instance, emphasises strict data privacy through its General Data Protection Regulation, while other regions focus more on innovation and economic competitiveness.

Additionally, the rapid pace of AI development often outstrips slower legislative processes, making it difficult for laws to keep up with technological advancements. This disparity necessitates international cooperation to harmonise regulations and establish a consensus on fundamental principles, leading to regulations that provide clear guidance while respecting each nation's sovereignty.

Beyond regulation, standardisation of AI practices and technologies ensure safety, interoperability, and trust. Common standards enable effective communication across different AI systems and platforms, enhancing global integration and operational efficiency. They address ethical issues such as data privacy, bias mitigation, and transparency, building trust among users and stakeholders. For instance, standardised AI protocols in surveillance can balance security needs with individual privacy rights.

Standardisation also extends into the realm of content moderation and fraud detection, where uniform AI applications can improve the detection and handling of harmful or illegal content and financial fraud. Standardised AI systems can more consistently and transparently determine what constitutes harmful or illegal content across different platforms, reducing bias and errors. In fraud detection, standard protocols can enable the seamless sharing of threat intelligence across financial institutions, improving fraud detection and response. Moreover, in combating deepfakes, standardised detection

> By establishing common standards for AI APIs, developers can ensure compatibility across platforms and systems

tools are imperative for effective identification and mitigation.

Standardisation can significantly enhance the monetisation of AI technologies as well, particularly through application programming interface (API) and devices. By establishing common standards for AI APIs, developers can ensure compatibility across platforms and systems, making it easier to integrate and sell their services in a broader market. This uniformity reduces costs and increasing scalability. For devices, standardisation allows AI to be easily embedded into a wide range of products, from smartphones to home appliances, facilitating widespread adoption. This creates a cohesive ecosystem making AI applications more accessible and appealing to a larger audience, driving greater adoption and enhancing the overall value of AI investments.

As we look to integrate AI more deeply into our society, lessons from past technological integrations must guide us. Responsible implementation, adaptability, public engagement, and proactive measures are essential. These strategies not only foster inclusivity and trust, but also ensure that AI's benefits are broadly shared while minimising its potential harms.

AI embodies a powerful tool — one that holds immense promise for advancing human welfare but also poses significant risks. Balancing these aspects requires a multifaceted approach involving robust regulation, international cooperation, and rigorous standardisation. Thoughtful stewardship is essential to harness AI's full potential while safeguarding our societal values and individual rights, ensuring it benefits all.

TELECOM TRENDS

LT GEN DR S P KOCHHAR

HARNESSING THE
POWER OF TERAHERTZ
TECHNOLOGY IN ICT

THz technology can bridge the gap between the technical and regulatory landscape, ushering in an era of communication that is faster, more reliable and adaptable

In the ever-evolving world of wireless communications, the allocation and utilisation of the electromagnetic spectrum has emerged as critical elements in ensuring seamless flow of data, voice and information, across the globe. In this regard, Terahertz (THz) technology presents an exciting frontier within the spectrum landscape. THz frequencies occupy a unique position in the electromagnetic spectrum, offering both an alluring promise and formidable technical challenges.

This article explores the world of THz frequencies, their strategic significance in modern communications, the global and regulatory perspectives that shape their utilisation, and the innovative solutions that are reshaping the way we harness this valuable portion of the spectrum.

TERAHERTZ BAND: UNVEILING THE SPECTRUM
The electromagnetic spectrum, a continuum of electromagnetic waves, spans from radio waves to gamma rays. Terahertz frequencies occupy a distinctive space in this spectrum, typically ranging from 0.1 THz (100 GHz) to 10 THz. Positioned between microwave and infrared frequencies, THz waves offer a sweet spot for communication technologies. Their ability to carry vast amounts of data is rooted in their shorter wavelength and higher frequency, allowing for faster and more precise information transfer.

> "
> THz wave's ability to carry vast data is rooted in their shorter wavelength and higher frequency, allowing for faster and more precise information transfer.

Terahertz Gap
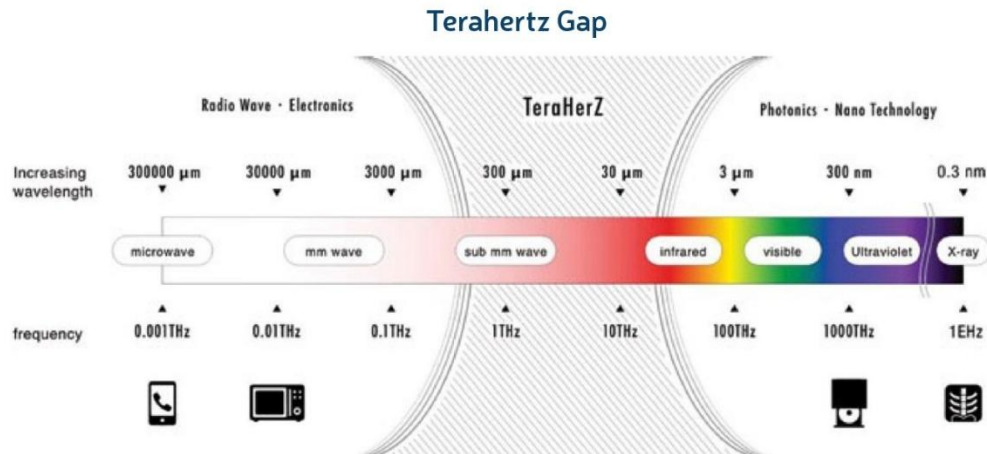
Source: National Institute of Information and Communications Technology

They combine properties of both microwaves and infrared light, enabling them to penetrate various materials, while offering high-resolution imaging capabilities. This dual nature has historically made the generation and detection of THz waves challenging, leading to the term 'terahertz gap' in technology, which is used to explain the infancy of this band as compared to well-developed neighbouring spectral regions. This has led researchers from disciplines such as physics, material science, electronics, optics and chemistry to investigate the various unexplored or less-explored aspects of THz waves.

SIGNIFICANCE IN MODERN COMMUNICATIONS

The insatiable demand for high-speed, high-capacity wireless communications has fueled the quest for next-generation technology. Terahertz technology holds the promise of breaking through the bandwidth limitations that plague current wireless technologies. Communication in the sub-terahertz (sub-THz) range is expected to be a feature of 6G systems. With the unique ability to serve very high data rates, sub-THz communication can enable the extreme speeds and low latencies required to enable 6G use cases such as professional high-resolution holographic communications and machine-to-machine interactions.

Sub-Terahertz Range for Use in 6G
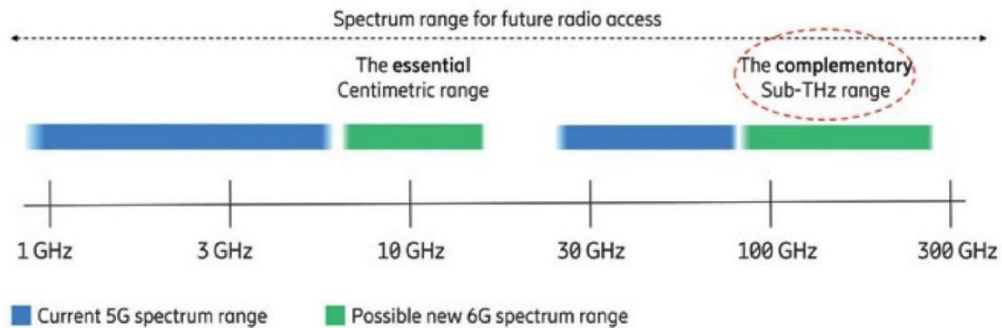
Source: Ericsson

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> THz waves can overcome the limitations of traditional radio waves, enabling faster and more reliable communications between spacecraft and Earth.

Further, Terahertz waves are ideal for remote sensing due to their ability to detect low-mass molecules and ions, making them useful in environmental monitoring and space exploration. They can identify water, oxygen and carbon dioxide on other planets, aiding in space exploration and the search for extraterrestrial life.

CHALLENGES AND INNOVATIVE SOLUTIONS

Despite its immense potential, THz communication faces some technical challenges. One such challenge is signal attenuation, which limits the effective range of THz waves. The atmosphere absorbs THz waves, particularly in the 0.1 THz to 1 THz range, making long-distance communications challenging.

When it comes to tapping into terahertz waves, the world of electronics faces a fundamental problem. To enter the gap, the silicon chips in our electronics need to pulsate quickly, at trillions of cycles per second (hence a terahertz). The chips that power phones or computers can operate perfectly well at millions or billions of cycles per second, but they struggle to reach the trillions. The highly experimental terahertz components that do work can cost as much as a luxury car. Engineers are working to address this issue and bring the prices down.

The other realm, the world of light, has long sought to make devices like lasers that could cheaply create terahertz waves at specific frequencies.

Researchers are exploring various strategies, including the development of metamaterials that can manipulate THz waves and reduce signal loss. Beamforming techniques, like those used in millimeter-wave technology, are being adapted to THz frequencies to focus and direct signals efficiently. Additionally, advancements in ultra-sensitive detectors and high-power sources are enhancing the viability of THz communication systems.

PROSPECTS AND APPLICATIONS

The future of THz technology extends far beyond high-speed Internet. Telemedicine, environmental monitoring, space communications and more, await transformation through THz waves.

In telemedicine, THz imaging can provide non-invasive, high-resolution scans, enabling early detection of diseases. Environmental monitoring systems can leverage THz technology to precisely analyse atmospheric conditions and detect pollutants. In space communications, THz waves can overcome the limitations of traditional radio waves, enabling faster and more reliable communications between spacecraft and Earth. THz systems have a potential market for security applications, solid explosive material detection and mail screening.

Moreover, the synergy between THz technology and emerging technologies like Artificial Intelligence (AI) and Machine Learning (ML) holds tremendous potential. AI-powered THz devices can autonomously optimise communication parameters, adapt to changing conditions, and enhance security.

Terahertz technology stands at the forefront of innovation in wireless communications. Its unique position in the electromagnetic spectrum and its potential to revolutionise various industries make it a technology worth pursuing. However, the journey ahead involves not only technical advancements but also the creation of supportive regulatory environments.

As we continue to explore the transformative potential of THz technology, collaboration, research and regulatory foresight will be the guiding stars on this exciting journey. Terahertz technology is poised to bridge the gap between the technical and regulatory landscape, ushering in a new era of communication that is faster, more reliable and adaptable to the demands of our ever-connected world. The future might be THz, and its possibilities can be limitless. 🏵️

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Revolutionizing healthcare via telecom - Through telemedicine and beyond

The telecom industry has always been at the forefront of technological advancements. From the early days of 2G and 3G to the more recent 4G, each generation has brought about a significant shift in the way we communicate, work, and live. However, it is the transition from 4G to 5G that has truly opened the floodgates of innovation, propelling various sectors, including healthcare, into a new realm of possibilities.

The development of the fifth-generation wireless networks, with its ultra-fast speeds, low latency, and massive connectivity, has become the backbone of the emerging digital ecosystem, fuelling seamless integration of a wide array of technologies, including Internet of Things (IoT), artificial intelligence (AI), machine learning (ML), and big data analytics, all of which are now being harnessed to improve efficiency, productivity, and service delivery across industries.

These developments can potentially address some of the most urgent challenges facing healthcare providers and policy makers including universal, equitable, and sustainable healthcare. Together, the entire cohort of technologies spawned by 5G can fundamentally change screening, diagnosis, and monitoring of diseases, enable more accurate profiling of disease progression and further refine health treatments.

The rise of telemedicine

Telemedicine, the practice of providing medical care remotely, using telecommunications technology, has been on the rise for several years. The Covid-19 pandemic accelerated its adoption as patients and healthcare providers sought ways to minimize in-person interactions while still ensuring access to medical care. Even after the height of the pandemic, telemedicine has remained a critical component of healthcare delivery, particularly for patients in remote or underserved areas.

However, the limitations of pre-existing networks had sometimes hampered the full potential of telemedicine and beyond. Issues like high latency and limited bandwidth have posed challenges, particularly for more complex applications such as real-time video consultations, remote surgeries, and large-scale data transmission.

The role of 5G in healthcare

5G technology brings several critical advancements to telemedicine, including ultra-low latency, which enables near-instantaneous communication between devices vital for real-time data transmission and related diagnostics. It also offers high-speed data transfer, with speeds up to 100 times faster than 4G, allowing rapid transmission of large files like high-definition medical images or videos. Additionally, 5G's increased bandwidth can support a massive number of connected devices simultaneously without compromising performance, which is especially beneficial in hospitals or urban settings. Furthermore, network slicing allows for the creation of multiple virtual networks within a single physical 5G network, ensuring that critical healthcare applications receive the necessary resources.

5G in telemedicine and beyond

The unique capabilities of 5G make it exceptionally well-suited for telemedicine, enhancing both the quality and accessibility of healthcare services. Here's how 5G aligns with the specific needs of telemedicine:

Real-time remote consultations and diagnostics. One of the primary benefits of 5G in telemedicine is the ability to conduct real-time remote consultations without the lag or connectivity issues often associated with older networks. For example, a doctor in a metropolitan hospital can seamlessly consult with a patient in a rural area, conducting virtual examinations and providing accurate diagnoses without the need for the patient to travel.

Moreover, 5G's low latency is particularly beneficial in telemedicine applications where timing is critical, such as in emergency situations or during virtual consultations that require real-time analysis of high-definition video or medical imaging.

Remote patient monitoring and chronic disease management. Remote patient monitoring is a cornerstone of modern telemedicine, allowing healthcare providers to track patients' vital signs and health metrics continuously. With 5G, the data from wearable devices, home monitoring equipment or implanted sensors can be transmitted to healthcare providers in real time, facilitating immediate interventions when necessary.

This is particularly important for managing chronic conditions, such as diabetes, heart disease, and hypertension, where ongoing monitoring can prevent complications and reduce the need for hospital visits. The reliability and speed of 5G ensures that this data is both accurate and timely, improving the overall quality of care.

Tele-surgery and remote robotic procedures. One of the most exciting applications of 5G in telemedicine is in the field of telesurgery. The ultra-low latency and high reliability of 5G networks make it possible for surgeons to perform operations on patients located miles away, using robotic systems. This has enormous implications for access to specialized surgical care, particularly in remote or underserved regions where such expertise may not be readily available. Further, the flexibility offered by robotic telesurgery also leads to shorter waiting times for surgeries by enabling surgeons to operate on patients across different regions or time zones more efficiently.

The precision and real-time feedback enabled by 5G ensure that remote surgeries are safe and effective, providing patients with access to life-saving procedures that might otherwise be out of reach.

Virtual reality (VR) and augmented reality (AR) in telemedicine. The integration of VR and AR into telemedicine is another area where 5G is proving to be a game-changer. These technologies can be used for a variety of applications, from virtual consultations where doctors can interact with 3D models of a patient's anatomy, to training simulations for medical students and professionals.

For instance, AR can overlay digital information onto the physical world during a telemedicine session, helping doctors to better diagnose and treat patients by providing visualizations of conditions and potential treatments. VR, on the other hand, can be used to simulate surgeries or other medical procedures, providing a realistic training environment that can be accessed remotely.

Enhanced data security and privacy. 5G's advanced encryption and network slicing capabilities provide enhanced security for telemedicine applications, addressing one of the primary concerns in the digital health space data privacy. As telemedicine involves the transmission of sensitive patient information, ensuring that this data is protected from breaches is crucial.

Network slicing in 5G allows healthcare providers to create dedicated, secure channels for telemedicine applications, ensuring that critical healthcare data is isolated from other network traffic and protected by the highest levels of security.

Emerging application areas of 5G in telemedicine and more. Beyond the immediate benefits, 5G is paving the way for innovative telemedicine applications that were previously unimaginable. Some emerging areas include:

AI-driven diagnostics. 5G's ability to handle large datasets and connect numerous devices facilitates the integration of AI into telemedicine. AI can analyze patient data in real time, providing doctors with diagnostic insights or alerting them to potential health issues before they become critical. For example, various multi-specialty hospitals around the world are producing advanced learning algorithms to detect symptoms of various cancers, enhancing the preciseness and timeliness of diagnoses.

IoT-powered healthcare ecosystems. The combination of IoT and 5G is revolutionizing healthcare by enabling the creation of highly interconnected ecosystems, where devices, sensors, and medical equipment communicate seamlessly. This integration allows for more coordinated and comprehensive patient care, with every aspect of a patient's health being monitored, analyzed, and managed in real time. From wearable devices that track vital signs to smart implants that transmit data directly to healthcare providers, this interconnected network ensures timely interventions and personalized treatment plans, ultimately leading to improved patient outcomes and a more proactive approach to healthcare.

Smart ambulances and mobile healthcare units. 5G technology paves the way for the deployment of smart ambulances equipped with advanced telemedicine capabilities, allowing paramedics to consult with specialists in real time during patient transport. These smart ambulances can transmit critical data, such as EKG readings, patient vitals, and high-definition video feeds directly to hospital teams, enabling more informed decision making before the patient even arrives. Similarly, mobile healthcare units can bring high- quality medical care to remote and underserved communities, leveraging 5G to connect seamlessly with hospitals and specialists. This connectivity ensures that patients receive timely and expert care regardless of their location, bridging gaps in access and significantly enhancing emergency response and rural healthcare delivery.

Conclusion

The deployment of 5G technology is setting the stage for a new era in telemedicine, where the barriers of distance, time and resources are being dismantled. The unparalleled speed, reliability, and security offered by 5G make it ideally suited for telemedicine applications, from routine remote consultations to complex robotic surgeries. As 5G continues to expand, it will unlock new possibilities for healthcare delivery, making high-quality medical care more accessible and effective than ever before.

In the coming years, as 5G networks become more widespread, we can expect to see telemedicine evolve into an even more integral part of the healthcare ecosystem, driving innovation and improving health outcomes on a global scale.

A telecom puzzle: Data boom beyond metro cities

As data usage rises in Tier 2 and 3 cities, telecom companies wrestle with infrastructure and pricing challenges

LT GEN DR S P KOCHHAR

Metropolitan cities like Delhi, Mumbai and Bengaluru had been the epicentres of data usage in India. However, that is changing, thanks to the proliferation of smartphones in Tier 2 and 3 cities, leading to rapid growth in data consumption. According to the recent Ericsson Mobility Report, India has the highest average monthly usage per smartphone at 29 GB which is anticipated to rise to an unprecedented 68 GB by 2029.

Also, according to Nokia India Mobile Broadband Index 2024, the 5G network is penetrating and being adopted not just in metro cities but also in Tier 2 and 3 towns and rural regions. While the share of 5G in metros amounted to 20% of total traffic, it was 17%, 12% and 14% in categories A, B and C of telecom circles, which cover the rest of India. While this growth presents an opportunity for telecom service providers (TSPs) in India to scale their business, revenue generation still remains low owing to many reasons.

Smaller cities and rural areas

The availability of affordable data plans and smartphones has made internet access easier and more cost-effective compared to the past. The growing popularity of video streaming platforms, online gaming and social media is driving data usage, particularly during major events like sports tournaments. The digitalisation of services has spurred the usage of e-commerce, online education, mobile payments and e-governance in small cities and rural areas. Generally, users in these regions are price-sensitive, which poses a challenge for telecom operators in monetising this surge in consumption.

To support the momentum, the Department of Telecommunications (DoT) also recently launched the '5G Intelligent Villages' initiative, a programme aimed at bridging the digital divide and promoting sustainable development across key sectors such as agriculture, education, healthcare and governance. Initially covering 10 villages across Gujarat, Uttar Pradesh, Haryana, Maharashtra, Rajasthan and Assam, this initiative is set to catalyse innovation by integrating cutting-edge 5G technology with traditional rural practices. As telecom operators witness a surge in rural subscribers, the demand for robust network services has become critical in even the remotest areas.

▶ **Data boom, Page 2**

Deployment of 4G and 5G networks is a capital-intensive endeavour

Data boom from Page 1

While mobile data usage has grown significantly in semi-urban and rural areas, there is emerging demand for reliable Wi-Fi connections. This is driven by the rise in online activities due to work-from-home roles and online learning opportunities, especially after the pandemic. As smart devices become more prevalent, there is a growing need for uninterrupted, high-speed connectivity. Wi-Fi services are considered ideal to provide high-speed connectivity across multiple devices that support smart homes and Internet of Things (IoT) applications and across multiple users.

However, Wi-Fi services in rural and semi-urban areas face significant challenges due to congested networks. As 5G adoption grows, conditions are expected to improve over time. Interestingly, there is also a growing appetite for 5G Fixed Wireless Access (FWA) solutions in rural regions, which could play a pivotal role in connecting the unconnected.

While TSPs are aware of the opportunities presented by the rising data demand in Tier 2 and 3 cities, they are concerned about the challenges they must address to fully capitalise on this growth.

Addressing infrastructure gaps

While 4G penetration is widespread, many semi-urban and rural areas may still suffer from inconsistent coverage and slow speeds compared to 5G. Therefore, expanding 5G networks to these regions will be crucial, but this requires significant investment in infrastructure. The deployment of networks like 4G or 5G is a capital-intensive endeavour due to the need for new and better infrastructure. Setting up fibre-optic networks and upgrading to 5G in remote areas is expensive indeed, and returns on investment may take longer to materialise. A robust fibre-optic backbone is also required to ensure fast, reliable data services. While telecom operators in India have been investing hugely in network infrastructure, many rural areas still lack the necessary infrastructure, creating a bottleneck for expansion.

With 5G, data consumption has touched a new level, in line with the rising demand for high-speed connectivity. The rapid rise in Large Traffic Generator (LTGs) companies, such as YouTube, Facebook, WhatsApp and Netflix, has put tremendous strain on telecom networks, significantly impacting the quality of service (QoS). This scenario is totally unwarranted as these large traffic generators gain significantly from the data usage, both through subscription fees and advertising costs. At the same time, telcos lose both in terms of infrastructure exploitation and dip in traditional services that are channelled to the LTGs' data services. As data consumption grows, this will emerge as a major challenge, upsetting the balance of the telecom industry.

The telecom operators in India have long been demanding that regulators adopt a fair usage policy to get fair compensation from LTGs, who consume a large share of the network resources to support their applications. According to COAI's recent analysis, telecom service providers spent Rs 10,000 crore additional in capital expenses (capex) in 2023 to augment network infrastructure, supporting seamless data traffic consumed by top LTGs. While the enhanced data traffic due to LTGs does contribute to operator revenues, it remains grossly inadequate to cover the increase in infrastructure capex.

In fact, this is in line with the global asks by telcos in the USA, EU, South Korea and Brazil.

Future-proofing telecom

Effective allocation of spectrum, too, is critical for delivering high-quality data services. As demand grows, telecom companies will need to secure more spectrum to avoid network congestion and deliver better services. The relevance of the 6 GHz spectrum comes into the picture in this scenario. The 6 GHz is the only mid-band spectrum range where a contiguous bandwidth to the order of 300-400 MHz per TSP is possible, to address the rapidly evolving demands around data. Therefore, it would be imminent that this bandwidth be allocated for 5G and further, no delicensing of International Mobile Telecommunications spectrum be done.

The industry needs to innovate pricing models to offer affordable data plans in rural and semi-urban areas, which are more price-sensitive. This is crucial to ensure sustainable growth in the future, especially with upcoming innovations around 5G and then 6G.

One of the objectives of the Telecommunications Act 2023, introduced last year, is to create robust telecom networks through a well-defined Chapter on Right of Way (RoW). Subsequently, the RoW 2024 rules, which were recently notified, include granting RoW in a non-discriminatory manner and clarifying that this network shall not be considered for the purposes of tax, levy, cess, fees or duties on that property. This will be a major relief for operators to deploy telecom infrastructure in urban and Tier 2 and 3 cities.

The rising demand for data in India's Tier 2 and 3 cities presents an enormous opportunity for telecom operators. This can be fully harnessed only if they are prepared to invest in the necessary infrastructure and adopt innovative business models that cater to the unique needs of these regions. With the right support from the government and strategic interventions from the industry stakeholders, India's smaller cities and rural areas could drive the next wave of growth for the telecom industry.

(Lt Gen Dr S P Kochhar is the director general, Cellular Operators Association of India)

[TELECOM TALK]
SERVICE PROVIDERS

LT GEN DR SP KOCHHAR

TELCOS TO TECHCOS: GEARING UP FOR A TECTONIC SHIFT

Telcos are evolving into tech companies, embracing cloud, AI, and IoT to unlock new revenue streams and reshape the future of digital services

The role of Telecom Service Providers (TSPs) has undergone a profound transformation over the past couple of decades. The transition from being a traditional voice and data provider to a dynamic Digital Service Provider (DSP) has been inevitable, driven by the growing demand for seamless connectivity, personalised experiences and innovative digital solutions that cater to the diverse needs of modern consumers and enterprises.

Today, telcos are no longer just communication enablers; they now shape the infrastructure of our hyper-connected world by leveraging advanced technologies such as the cloud, the Internet of Things (IoT), Artificial Intelligence (AI), and Machine Learning (ML). This evolution from telco-to-techco comes with challenges but holds significant promise for business expansion and revenue optimisation. According to Accenture, telcos could unlock at least USD 700 billion in new revenue through this tech transformation.

TELCOS' TRANSFORMATION JOURNEY

The rapid pace of technological advancement has dramatically reshaped industries over the past few decades. The proliferation of smartphones and high-speed mobile networks has ushered in a new era of connectivity, significantly increasing reliance on digital solutions. This growing dependence has naturally elevated consumer

> "By embracing new technologies and fostering a culture of innovation, telcos are positioning themselves as key players in the digital economy."

50

> To evolve into a techco, telcos must embody four key characteristics, including client centricity, digital experience, automation, and data utilisation.

expectations from telecom service providers. Today, customers demand more than just reliable connectivity; they seek innovative digital solutions.

To evolve into a techco, telcos must embody four key characteristics: client centricity, digital experience, automation, and data utilisation, according to KPMG. This approach requires a radical shift from the traditional modus operandi. Telcos that adopt these traits are more likely to thrive in the Digital Service Provider (DSP) journey and maintain a competitive edge in the evolving telecommunications landscape.

This transition involves offering platform-based products and services as part of a broader digital ecosystem. Beyond providing essential network infrastructure, telcos are now delivering various innovative digital services, including mobile banking, enterprise mobility solutions, cloud services, connected vehicles, smart homes, smart factories, pay TV, and solutions in cloud computing, IoT, AI, and cybersecurity.

For instance, Reliance Jio recently outlined its plans to evolve into a technology leader in India, announcing advancements in AI, cloud computing, and digital streaming. The company also revealed its intent to establish a national AI infrastructure aligned with its vision of 'AI Everywhere For Everyone.' Similarly, Bharti Airtel has partnered strategically with Google Cloud to provide cloud and generative AI solutions to Indian businesses. Through this partnership, Airtel will adopt Google Cloud's suite of solutions to accelerate its cloud adoption and modernisation efforts.

By investing in cutting-edge technologies, telcos are striving to deliver best-in-class services to their customers and contributing significantly to the country's technological progress.

KEY ENABLERS OF A TECHCO BUSINESS MODEL

To facilitate a smooth transition from telcos to techcos, telecom operators are increasingly partnering with various vendors to ensure the solutions they adopt are both future-proof and cost-effective. This strategic shift also involves embracing new business models built around three key components.

#1

Cloud Infrastructure: The integration of cloud technologies enables telcos to launch new services and respond to demand surges rapidly. It also helps reduce capital and operational expenses by streamlining data management and application deployment. Migrating to cloud infrastructure not only cuts costs but also improves profit margins.

#2

Artificial Intelligence and Machine Learning: AI and ML enhance network management through predictive maintenance and automatic fault detection. They also help deliver a more personalised customer experience with advanced analytics and intelligent automation.

#3

Internet of Things: Embedding digital with IoT allows telcos to expand into the B2B space with industry-specific services in healthcare, transportation, agriculture, and smart cities. In the B2C domain, they can offer connectivity services and IoT-specific data plans. IoT applications in telecom drive differentiation, open up fresh product offerings and provide assured revenue streams.

Moving toward an open, modern, software-based architecture enables telcos to become modular, cloud-native, AI-ready, and built with standardised components. This transition also improves agility, allowing them to quickly respond to market demands and stay competitive in a rapidly evolving landscape. A cloud and automated software-based architecture also drives significant cost savings, further supporting the shift to a techco business model.

CHALLENGES IN THE TECHCO TRANSITION

While the shift to the techco model is imperative for TSPs to remain competitive in the digital age, the transformation is fraught with challenges. Many telcos are weighed down by legacy systems that can be difficult to integrate with newer technologies.

The costs associated with maintaining and upgrading these outdated systems can be substantial, diverting valuable resources away from innovation. Additionally,

> A cloud and automated software-based architecture can drive significant cost savings, supporting the shift to techco business model.

IN BRIEF

- Telcos are shifting from communication to technology by leveraging cloud, AI, and IoT to meet evolving consumer demands.

- Cloud infrastructure enables telcos to reduce costs, improve profit margins, and respond rapidly to service demands, boosting efficiency.

- AI and ML help telcos enhance network management and customer experiences with predictive maintenance and intelligent automation.

- IoT is opening new B2B and B2C opportunities for telcos, allowing them to offer industry-specific solutions in healthcare, smart cities, and beyond.

- Legacy systems and skill gaps are barriers in its transition to techco, making it difficult for telcos to harness new technologies fully.

- 5G presents a massive opportunity for telcos in India, with 65% of all mobile subscriptions projected to be 5G by 2029, driving digital transformation.

despite various initiatives and programs, a significant skills gap continues to hinder progress, preventing telcos from fully harnessing the potential of cutting-edge technologies.

OPPORTUNITIES AMIDST THE OBSTACLES

For years, telcos have faced declining traditional revenue streams due to the rise of Internet services, a lack of monetisable 5G use cases, and insufficient returns on massive infrastructure investments. However, these challenges also present opportunities. Telcos now have the chance to turn the tide by leveraging new technologies and diversifying their business models.

Moving forward, telcos will find an expanding business landscape, driven by new technologies and data-centric use cases, allowing them to diversify their revenue streams while optimising network resources. In India, the momentum around 5G has just begun, and it is only a matter of time before telcos fully capitalise on the new business opportunities that will shape the digital economy.

The transformation from telcos to techcos is a strategic move designed to ensure long-term sustainability and growth in an increasingly competitive digital landscape. By embracing new technologies, diversifying offerings, and fostering a culture of innovation, telcos are positioning themselves as key players in the digital economy.

India is waiting to witness the next digital revolution driven by 5G. It is estimated that 5G subscriptions will contribute about 65% of all mobile subscriptions by the end of 2029. The impact of this growth will be felt across sectors and applications beyond communications. With telcos at the forefront as enablers of this technological transformation, the growth potential is immense, and the opportunities are boundless. ✿

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52

India's strides towards the design and component ecosystem in telecom

The Pioneer - 21st October 2024

India's strides towards the design and component ecosystem in telecom

The telecom sector is evolving from a service-led growth model to a robust manufacturing ecosystem

The telecommunications sector in India has grown to become the world's second-largest, contributing around 6.5 per cent to the nation's GDP and emerging as a key economic growth engine. While we take pride in this impressive growth, there is something even more exciting - the rise of the telecom manufacturing ecosystem. India's growth as a telecom equipment manufacturing destination can be attributed to the 'Make-in-India' and 'Atmanirbhar Bharat' initiatives launched by the Government in recent years.

The Production Linked Incentives (PLI), launched in 2020, and its subsequent amendments in 2022 to facilitate design-led manu facturing at an additional incentive rate with an allocated sum of Rs 4,000 crores also provided a major boost to telecom manufacturing in India. As per the latest update by the Ministry of Communications, sales of telecom equipment have surpassed the Rs 50,000 crore milestone under the PLI scheme, with exports at about Rs 10,500 crore. During this period, India exported mobile phones worth Rs 1.28 lakh crores and with 300 million units produced, it has emerged as the second-largest producer of mobile phones in the world.

On the telecom equipment front, India has become almost self-reliant in antennae, Gigabit Passive Optical Network (GPON) and Customer Premises Equipment (CPE). As a result, India's status has turned from importing telecom equipment worth Rs 74,116.21 crore in FY 13-14 to exporting equipment worth over Rs 1.49 lakh crore in FY 23-24.

Though we are still importing certain products, the gap between imports and exports has gone down significantly. Apart from fostering self-reliance, indigenous manufacturing of telecom equipment also addresses the national security concerns associated with telecom imports.

Manufacturing has emerged as an important aspect of the telecom sector's contribution to the GDP through the creation of substantial employment opportunities across the value chain, from manufacturing to research and development.

So far, telecom manufacturing has created more than 17,800 direct jobs and several indirect jobs. The Indian telecom industry is likely to attract investments in the areas of core competency and cutting-edge technologies; ensure efficiencies and create economies of scale, in turn, enhancing exports and making India an integral part of the global value chain. Government's Push for 'Atmanirbhar' Under the government's 'Atmanirbharta Abhiyan', the Department of Telecom (DoT) aims to promote the ecosystem for research and development, transforming India into a global hub of technology development and telecom equipment manufacturing.

The Union Minister Jyotiraditya Scindia recently announced the Government's ambitions to set up telecommunication equipment manufacturing zones as the country expects more inflow of foreign direct investments (FDI). Prime Minister Narendra Modi too emphasised the need for "Design in India, Design for the World", calling for indigenous design capabilities and urging the citizens to create products that cater to both domestic and international markets. The Government has further established several task forces to ensure the smooth functioning of the telecom ecosystem.

These include initiatives for creating a component ecosystem, developing telecom chips from design to production, training skilled workers and designers, aggregating the demand for manufacturing from different departments and allocating them to eligible manufacturers, and optimising the use of test beds for product testing and certification. Following the Government's decision to allow 100 per cent FDI in telecom, the sector has attracted USD 39 billion in FDI for manufacturing, further boosting the momentum and solidifying India's role as a global telecom manufacturing hub.

Thanks to these concerted efforts, India has been able to bring down the trade deficit in telecom from Rs 68,000 crores to Rs 4,000 crores, over the last five years.

Focus on design and creation of IP is crucial to fulfilling India's ambitions as a product nation as design elements add substantial value to products. To build a strong ecosystem for 5G, DoT has sanctioned 17 companies under design-led manufacturing within the PLI scheme.

Further, global telecom equipment manufacturers like Cisco and Nokia have set up their manufacturing units in India, fostering world-class manufacturing prowess. These efforts, among others, emerge as a testament to the country's indigenous engineering and entrepreneurial capabilities, as well as manufacturing prowess.

(The writer is Director General, COAI; views are personal)
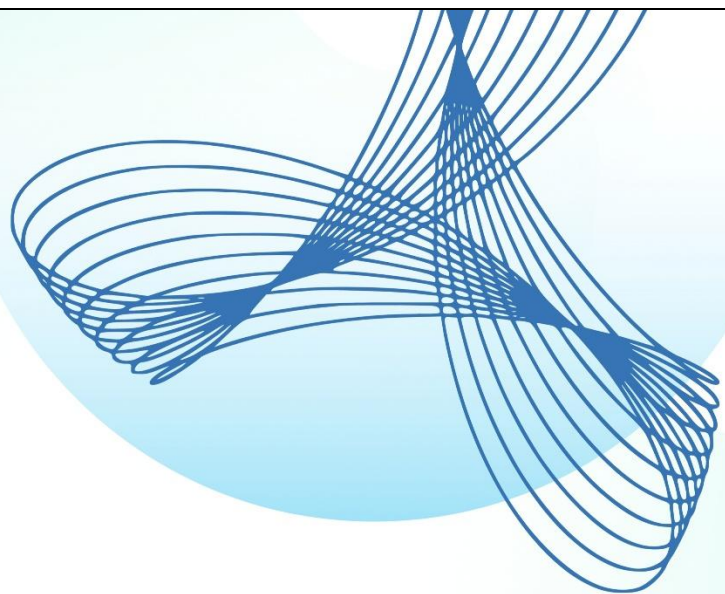
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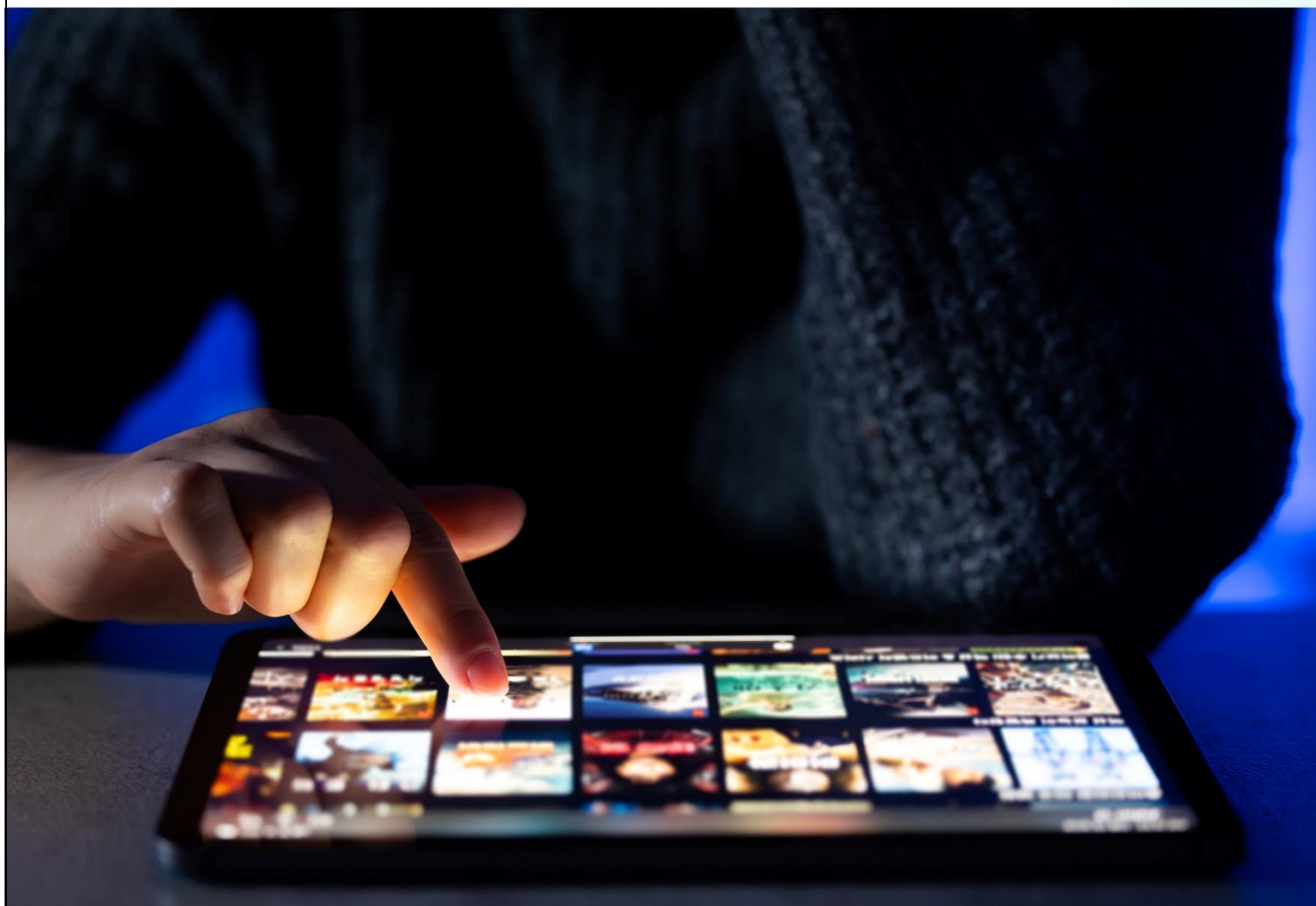
The debate over private networks in India: A nuanced review

ET Telecom - 19th March 2024

The advent of 5G technology marks a new era in wireless communications, boasting high speeds, low latency and extensive device connectivity. Private 5G networks have garnered global attention across sectors, promising tailored configurations to revolutionize industries from manufacturing to healthcare and beyond. In the Indian context though, deploying and operating these networks come with some critical considerations.

The topmost question: Whether private networks are required in India?

In the 4G era, integrating machines and humans was not feasible, leading to the preference for Wi-Fi for machines and mobile for humans. With 5G, seamless integration between humans and machines is achievable on a larger scale, enhancing efficiency and productivity for enterprises. This underscores the necessity for private 5G networks in India.

Whether private networks should be operated directly by enterprises, or should they be managed by the Telecom Service Providers (TSPs), who have inherent expertise in the technology.

The flavour of private 5G networks depends entirely on the environment, geography and availability of public networks in the vicinity of the facility. Isolated private captive networks are required where there is a huge deviation of availability/quality of telecom service in the area, i.e., where there is either no 5G network or where it is not technically possible to meet the demands imposed by the private network envisaged.

The Unique Indian Context

India's extensive telecom connectivity challenges the premise that isolated private captive networks are necessary or even feasible for most enterprise scenarios. India boasts of widespread telecom coverage, leaving little justification for enterprises, especially in industrial/business hubs, to establish isolated networks.

Importantly, with the Hon'ble Prime Minister of India Shri Narendra Modi's vision and drive to enable 5G connectivity to all corners of the country, the private networks derived from the TSPs can meet the SLAs of the enterprises at operational costs only, via technically robust networks deployed and operated by them, without the additional burden on the enterprise to manage a complex network which is outside their domain of expertise.

Therefore, the need for isolated private captive networks is confined to very few areas with exceptional geographical or social constraints. For example, mining companies often have their installations in hard-to-reach areas yet to be covered by public networks. Like in Indonesia, Telkomsel installed a private 5G network for PT Freeport at the Grasberg mine in the Papua region. However, in this case too, the expertise of a Telecom Service Provider – Telkomsel, was used to set up this network with critical requirements.

Operational Challenges

The allure of an isolated private captive network managed by an enterprise itself is marred by several technical and operational challenges. First, the expertise required to design, deploy and manage a telecom network is highly specialized, and few enterprises possess such capabilities in-house.

Another important aspect is that of technology refresh. TSPs keep upgrading their networks at pace with the advancements in technology across the globe, a practice that might not be economically viable for an isolated private captive network. This presents a risk of technological obsolescence, whereby such private captive networks may fall behind, leading to inefficiencies and reduced performance over time, defeating its very purpose of achieving enhanced performance. Moreover, outdated hardware or software, if used by such isolated private captive networks, can become vulnerable if they do not undergo consistent security updates.

A crucial point to remember is that an isolated private captive network would have to bear the costs of capex, opex, technology, refresh, and conformity to security, regulatory and policy related expenses (which would be over and above the opex). It may also require the enterprise to create a pseudo-TSP type organisation within its folds. There have been instances where enterprises, who tried to manage their private captive networks by themselves, have gone back to the TSPs after a while, as they found out that it is a complex mechanism which is best left to be managed by the professionals, and is more cost-efficient that way.

Technical Considerations

The isolated private captive network does not eventually connect to the external network/PSTN, in contrast to the one provided by TSPs which would facilitate the same. It is impractical to suppose that the operations and outcomes of a private network, would remain locked and not be used thereafter for communications with the external world, other offices, HQ, etc. It is imminent that an external network would eventually be used to utilise the results of the working of the private network to be shared with some entity, whether for business purposes or otherwise.

On the other hand, TSP-managed private networks, derived from public networks using tech derivatives like network slicing or radio segmentation, can offer assured quality and service parameters without requiring additional capex from the applicant enterprise. TSPs will be able to deliver 5G services using low, mid and high band frequencies to support the full range of industrial use cases across local and wide area deployments via:

- **Network slicing** – to offer differentiated QoS as per enterprise needs.
- **Spectrum leasing** – A carefully planned spectrum leasing approach can be a viable option for supporting verticals who want to build private networks.
- **Higher bandwidth use-cases or device densities with access to wider spectrum** – Use cases that may require network access outside of the confines of the industrial campus with service continuing onto the public network.

Further, in a densely populated country like India, managing/controlling the interference or spillover of the in-campus private network spectrum frequency into the unintended external public network area is also a major technical challenge. It may be easier for the TSP which owns both the networks to demarcate and prevent such mishaps.

Last but not the least - Security, Regulation and Policy to govern such networks. The aspect of security is paramount in this debate. While telecom networks and TSPs adhere to stringent security measures mandated by the regulatory framework in India, isolated private captive networks currently lack such regulations. Similar to the unregulated OTT vertical, they pose a serious threat to national and citizens'

security, potentially compromising vital facilities and systems. Policymaking in this domain must prioritize national security above everything else, recognizing the risks associated with unregulated private captive networks.

The Way Forward

Considering the above, TSP-operated private networks emerge as a pragmatic and secure solution for India. These networks also mitigate security risks and support national initiatives like 'Make in India', by bringing the telecom networks containing the marketplace and the knowledge repository to the entrepreneurs and startups, thus promoting ease of access and facilitating the growth of this vital ecosystem in the country. These entities, in turn, would drive innovations and solutions, enhancing efficiencies and accelerating Industry 4.0 in India.

While the global momentum towards private 5G networks is undeniable, the Indian context demands a tailored approach that balances operational autonomy with technical feasibility, security and regulatory compliance. As India strides forward in its digital journey, it must navigate such debates with a strategic vision that ensures technological empowerment without compromising on the critical aspects of national development, security and equity.

Telecom sector must get a fair share

SP KOCHHAR

Director-general, Cellular Operators Association of India

Large traffic-generating platforms are propagating fallacies on proposal for responsible fair-share contribution to network costs

THE INDIAN TELECOM industry has found itself at the centre of a heated debate on fair-share contributions from large traffic-generating (LTG) platforms to telecom service providers (TSPs). The industry has vehemently advocated a system where LTGs contribute equitably to the infrastructure costs incurred for the upkeep and advancement of networks.

Its stance centres on ensuring sustainability and progress of the network infrastructure to efficiently deliver the ever-increasing data traffic, chiefly due to the rise of LTGs and their business offerings. In the wake of rising misinformation in various fora, it is crucial to restate the key considerations to debunk the dubious arguments being put forth by some vested interests.

Unravelling double standard

One of the concerns raised is that fair-share charges might lead to double charging: one through mobile tariffs for internet access, and the other from LTGs. However, a closer examination of this argument reveals a double standard.

While LTGs vehemently oppose fair-share charges, they simultaneously generate substantial revenues from both users through subscription fees, and also via advertising income. This is in stark contrast with the dedication of TSPs to provide affordable digital connectivity, even in challenging financial conditions. It demonstrates how LTGs profit substantially while refusing to balance fair-share charges with their massive advertising gains, further dispelling the apprehensions they've raised about the impact of such charges

on their revenues and profitability.

Burdening end consumers

It is also recommended that TSPs raise consumer tariffs to recover the network expenses and ensure the sector's sustainability. This contradicts the LTGs' purported commitment to provide affordable and accessible services to end users. But TSPs have promptly dismissed this proposal, emphasising their decision to refrain from increasing consumer tariffs for this purpose, which aligns with the national objective of promoting affordable digital connectivity for all. This willingness of the LTGs to shift the financial burden onto end consumers while safeguarding their own profits raises questions about their commitment to the welfare of citizens and our economy.

Unconvincing international precedents

LTGs have sought to support their claims by invoking international precedents, particularly citing the lack of decision on similar fair-share proposals by some European Union nations yet. However, recent global market developments provide a different picture. For instance, the recent settlement between Netflix and SK Broadband in South Korea signifies a potential trend for resolving disputes on network usage fees. Furthermore, the European Commission's investigation has recognised the contribution of large global platforms to network traffic, paving the way for establishing a "fair contribu-

> The need for a fair-share mechanism that ensures equitable contributions by entities benefitting from the burgeoning app economy is imperative

tion mechanism" for network usage.

Lowering Broadband Costs for Consumers Act

Another pivotal development is the introduction of the Lowering Broadband Costs for Consumers Act of 2023 in the US Senate. Sponsored by three senators, this bipartisan legislation clearly establishes the need for various "edge service providers" which generate disproportionately large traffic, i.e. LTGs, to contribute to infrastructure costs so as to make digital connectivity affordable for end users.

The Act proposes that large-edge providers that annually account for more than 3% of the total internet traffic in the US and earn over $5 billion in revenues be assessed to share the financial load of delivering affordable digital connectivity. The acknowledgement of this need by LTGs to contribute to network costs vindicates the position of the Indian telecom sector.

LTGs have also tried to mislead the public through various campaigns, claiming that a fair-share policy will harm small players. Such malicious campaigns persist despite TSPs' repeated clarifications that they are seeking contributions exclusively from the big players — the multinational giants that rake in substantial profits channelled to their home countries. This exposes the false claims about LTGs' substantial contribution to the Indian digital economy. On the other hand, the Indian telecom sector has established its support for the interests of small, indigenous players. The public may already be aware,

though, that the LTGs are attempting to shift attention away from the real issue by using small players as a shield.

## Telecom revenue dynamics and flawed revenue claims

LTGs claim that their presence on telecom networks increases customer retention, but this is questionable. Telecom networks existed and served users long before the advent of over-the-top (OTT) platforms, and a large portion of internet users do not use OTT apps.

Moreover, the sheer number of telecom users in India creates a sizeable market for OTT platforms, granting them a distinct advantage without corresponding investments in telecom networks. This situation implies increased capital and operational expenses, exacerbating the challenges faced by telecom providers.

LTGs have also made flawed revenue claims, citing data revenue growth. However, their simplistic before-and-after comparison overlooks crucial factors, including mounting capital and operational expenses which outweigh the revenues, inflation, and other variables. A substantial portion of TSP revenues is also being eroded due to the cannibalisation by OTT communication services.

With the fast-evolving trend of digital convergence across sectors, the need for a fair-share mechanism that ensures equitable contributions by entities benefitting from the burgeoning app economy is imperative. Without such a government directive, a big portion of the economic gains from data usage may continue to be channelled offshore, depriving the Indian economy of its deserved share.
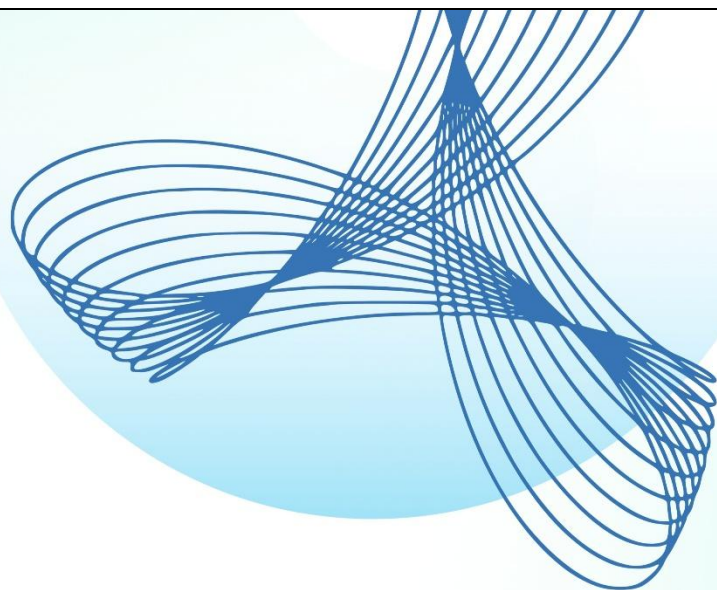
CYBERSECURITY

LT GEN DR S P KOCHHAR

NAVIGATING THE COMPLEX
CYBERSECURITY TERRAIN

As technology continues to advance and the security landscape becomes more interconnected, businesses must adopt a multi-pronged strategy to deal with it

In today's ever-accelerating technological landscape, the intricate relationship between emerging technologies and the imperative of cybersecurity is more pronounced than ever. As our world becomes increasingly interconnected through digital systems and innovations, the need to safeguard our digital existence becomes a paramount concern.

In this era of unparalleled technological progress, the boundaries between the physical and digital worlds blur as data flows ceaselessly through our interconnected devices and systems. The very fabric of our society, from finance and healthcare to transportation and communication, relies heavily on these technological marvels. Yet, with the immense benefits of these innovations come equally significant risks. The vulnerabilities inherent in our interconnected world can expose us to a myriad of threats, from data breaches and cyberattacks to identity theft and financial fraud.

Evolving digital technologies such as edge computing, blockchain, artificial intelligence (AI), digital tokens, and the Internet of Things (IoT) also bring in multifaceted challenges and opportunities. It is also important to deal with crucial aspects of skilling, awareness, policy, and the convergence of technologies and telecommunications, to get a clear view of the current cybersecurity landscape.

IMPACT OF NEW-AGE TECHNOLOGIES

Emerging technologies are transforming the way businesses and individuals interact with data and information. Edge computing, for instance, represents a significant shift in data processing, moving it closer to the source. This shift reduces latency, saves bandwidth and enhances privacy. However, it also presents security challenges, with increased attack surfaces requiring adaptable security strategies.

Blockchain, known for ensuring data integrity through its immutable ledger system, finds applications in finance, supply chain management and identity verification. Yet, it poses security concerns such as smart contract vulnerabilities, 51% attacks, DeFi exploits, cross-chain attacks and the looming threat of quantum computing.

Artificial Intelligence (AI) is another game-changer. Its predictive analytics, anomaly detection and automation capabilities are invaluable in various sectors. However, AI introduces security threats like sophisticated phishing and AI-powered malware. Ethical frameworks for AI development and deployment are crucial.

The emergence of digital tokens and currencies, like Bitcoin, has challenged traditional financial models. While they offer decentralised transaction systems, they also

> " Artificial Intelligence plays a dual role in cybersecurity. It acts as both a defence tool and a potential weapon for attackers.

> The emergence of digital tokens and currencies, like Bitcoin raise security risks related to wallet security, exchange vulnerabilities and regulatory challenges.

raise security risks related to wallet security, exchange vulnerabilities and regulatory challenges.

DATA SECURITY IN THE NEW ECOSYSTEM

The rise of these technologies has led to an unprecedented increase in data generation, necessitating robust data management and security strategies. Data security now requires a proactive approach, emphasising secure coding practices and system design. The principle of security-by-design advocates for integrating security considerations right from the initial stages of system and software development.

There are several examples of security breaches resulting from neglect in the early stages of development that highlight the importance of this approach.

Marriott: In March 2020, Marriott announced a security incident that compromised the data of more than 5.2 million guests. Hackers used the login credentials of two employees to steal sensitive information from a third-party application. This was the second time Marriott suffered a data breach within two years, highlighting the importance of robust security measures from the onset.

EasyJet: In May 2020, EasyJet revealed it had been the target of a cyber-attack that exposed the email addresses and travel details of nine million customers The airline also confirmed that 2,208 customers had their credit card details and CVV security codes accessed.

Electronic Arts: Hackers broke into the systems of Electronic Arts, one of the world's biggest video game publishers, and stole source code used in company games. The company made the announcement earlier this month.

McDonald's: McDonald's announced that it was affected by a data breach, which exposed the private information of customers and employees in South Korea and Taiwan.

Such incidents underscore the importance of prioritising security from the early stages of development.

Neglecting to do so can lead to significant problems, including poorly built security processes, outdated software, lack of infrastructure isolation and inadequate threat protection.

THE EVOLVING SECURITY RISKS

IoT and Edge devices have become ubiquitous, integrating into every aspect of our lives. From healthcare, like patient monitoring systems, to smart cities with traffic control, and home automation including smart thermostats and security systems, they offer convenience and efficiency but also introduce numerous security challenges.

The diversity and complexity of these devices, coupled with limited security features, create significant security vulnerabilities. Implementing robust security protocols, regular firmware updates, and secure network architectures is necessary to mitigate these risks.

AI plays a dual role in cybersecurity. It acts as both a defence tool and a potential weapon for attackers. Balancing automation with human expertise and developing ethical frameworks for AI in cybersecurity are critical steps in ensuring effective defence against evolving threats.

SKILLING AND AWARENESS

The cybersecurity skills gap is widening due to the growing demand for skilled professionals. Strategies for workforce development include specialised training programs, certifications, industry-academia partnerships, clear career pathways and mentorship programs. Skilled cybersecurity professionals are needed to oversee AI systems, provide context to AI findings, and make critical decisions, especially in complex threat scenarios.

End-users are the first line of defence against cyber threats. Educating them about common threats like phishing, malware and social engineering tactics is crucial. Regular workshops, online courses and security advisories keep users informed and vigilant. Organisations should foster a culture of security where cybersecurity is seen as a shared responsibility.

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IN BRIEF

- As technology advances, the cybersecurity landscape is becoming more intricate, demanding a multifaceted approach for a secure digital future.

- Emerging technologies like edge computing, blockchain, AI, IoT, and digital tokens offer opportunities but also pose security challenges.

- Security breaches, exemplified by incidents like Marriott and EasyJet, emphasise the importance of prioritising security from the early development stages.

- Robust protocols, firmware updates, and secure architectures are essential for mitigation.

- Organisations need to focus on workforce development, user education, and comprehensive policies for effective cybersecurity.

POLICY AND REGULATIONS

A comparative analysis of global cybersecurity policies and India's evolving framework highlights the need to balance global best practices with local needs. Comprehensive policies that cover emerging technologies and a collaborative, interdisciplinary approach involving government, industry, academia and civil society are crucial. Effective cybersecurity policies require the involvement of various stakeholders and must address emerging technologies. Public-private partnerships are key to successful policy implementation.

TECH CONVERGENCE AND TELECOM

Seamless integration between technology and telecommunications is vital for efficient data flow and management. Strategies for effective collaboration include information sharing, joint ventures and standardisation of security protocols. The development of international standards for cybersecurity in telecommunications is also essential.

Balancing security with innovation is essential to ensure that integration does not stifle progress. User-centric design and responsiveness to user needs are paramount. Organisations must prioritise user experience while maintaining robust security measures.

As technology continues to advance, the cybersecurity landscape becomes more complex and interconnected. Addressing these challenges requires a multi-faceted approach that encompasses technology, workforce development, awareness, policy and collaboration. By staying vigilant and proactive, organisations can navigate this landscape successfully and ensure a secure digital future for individuals, organisations, and nations. The evolving cybersecurity landscape demands continuous adaptation and a commitment to security at all levels of society. 🧩

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Telecom for optimizing digital infrastructure and national security in India

Telecom infrastructure underpins a vast range of digital services that drive economic growth, improve social inclusion and enhance public service delivery. However, with the rapid expansion of digital infrastructure, arises critical challenges for the telecom sector, especially in emerging technologies with complex cyber threats which have to be tackled, in order to shape the future of national security. At the same time, it would be critical to protect public and critical assets as well, while safeguarding security.

Building a resilient digital infrastructure

India's digital landscape is built on the foundation of robust telecom infrastructure, which includes essential components such as telecom towers, fiber-optic networks, GPUs, data centers, servers, switches and radio communications which have enabled its advancements in 4G, 5G and now, heading towards 6G. As digital services increasingly drive everyday transactions and interactions, telecom operators must ensure their networks are equipped to manage and secure the exponential growth in data traffic

- **Software-defined infrastructure (SDI):** The adoption of software-defined elements has transformed telecom networks by enhancing their flexibility, scalability and automation. With SDI, telecom networks can dynamically allocate resources, quickly adjusting to traffic demands and providing high-speed connectivity to underserved areas. However, the programmable nature of SDI introduces vulnerabilities that can make networks more susceptible to cyber threats. Each new endpoint added to the network expands the attack surface, requiring robust cybersecurity protocols to prevent unauthorized access and safeguard user data.
- **Cloudification and edge computing**: The shift towards cloud and edge computing has further optimized network operations. By moving data processing closer to the data source (edge), telecom providers can reduce latency, improve service reliability and enhance user experience. Cloudification enables telecom networks to be more responsive to demand surges, improving quality of service (QoS) for customers. However, cloud and edge computing also expand the attack surface, as data must travel across multiple points, each requiring security protocols. Edge devices, operating outside central network protections, are vulnerable to interception or manipulation, making continuous threat monitoring essential.
- **Digitalization in data management**: Digitalization has revolutionized how telecom providers store, manage, and process data. Centralized storage offers easy monitoring and streamlined control, while decentralized storage enhances resilience by distributing data across nodes, reducing single points of failure. Yet, both methods present unique risks: centralized storage may become a high-value target for cyber-attacks, while decentralized systems complicate control and require sophisticated encryption to secure data across multiple access points.

Evolving cybersecurity risks in a digitalized ecosystem

Digitalization and the proliferation of connected devices create both opportunities and risks. As telecom networks support a range of legacy systems (1G and 2G) alongside more advanced technologies (3G, 4G and upcoming 5G and 6G networks), the number of exploitable endpoints continues to grow. This

heterogeneous network environment presents complex security challenges that telecom providers must manage effectively to prevent cyber threats.

- **Zero trust security model**: The Zero Trust model has emerged as a key framework for securing telecom networks. Zero Trust security ensures strict identity verification at various levels, reducing data breaches by limiting access, continually verifying users/devices and protecting sensitive resources. It also enforces continuous monitoring, multi-factor authentication and micro-segmentation, which prevents widespread damage in the event of a breach and supports a more resilient security posture.
- **Policy-driven security management**: Rather than relying solely on legislative frameworks, telecom security must be guided by adaptable, policy-driven mechanisms that evolve with technological advancements. Measures such as Central Know Your Customer (C-KYC) processes, blockchain applications and AI-driven monitoring allow telecom providers to detect and respond to threats in real-time. Blockchain can enhance transaction integrity, while tokenization ensures that user data remains protected during transmission. This policy-driven approach provides a dynamic defense against evolving threats, better suited to the rapid pace of digitalization.
- **Citizen safety and public security**: Beyond network security, telecom infrastructure plays a pivotal role in supporting public safety and emergency response systems. Through real-time surveillance, disaster recovery networks and public awareness platforms, telecom networks help protect citizens during critical situations. During natural disasters, for example, telecom providers can enable quick dissemination of alerts, while data from connected devices aids emergency responders by providing real-time situational information. This ensures that telecom networks are not only operationally efficient but also critical enablers of public security.

National security imperatives for telecom

Telecom networks support an extensive range of critical services across defense, healthcare, energy, finance, and government sectors, making them integral to national security. As India's digital infrastructure expands, telecom networks must be equipped to protect these critical assets from interference or cyber threats that could disrupt essential services or compromise sensitive data.

- **Protecting critical assets**: Telecom networks are increasingly vital for secure communications within critical sectors, such as defense, power, and emergency services. Advanced protective measures, including signal intelligence (SIGNT), internet protocol security (IPSec), network slicing, and intrusion-detection systems (IDS) enable telecom providers to secure both civilian and military networks. Network slicing, for instance, creates dedicated network segments for sensitive services, isolating them from public networks and enhancing security. These protocols ensure that mission-critical communication remains uninterrupted and secure, even in times of national crisis.
- **Environmental monitoring and disaster preparedness**: Telecom plays a key role in developing environmental monitoring systems and disaster response frameworks. IoT-based sensors deployed by telecom networks can monitor environmental conditions and send real-time data to government agencies, allowing for early warning and rapid response in case of natural disasters. During emergencies, telecom providers enable resilient communication channels for emergency responders, reducing response times and ensuring the efficient coordination of resources.

- **Proactive and reactive cyber defense measures**: Protecting national security requires a combination of preventive and reactive measures that allow telecom providers to mitigate and respond to cybersecurity threats effectively.
    - **Preventive measures**: Telecom providers implement preventive security mechanisms, such as distributed denial of service (DDoS) mitigation, which includes rate limiting, traffic filtering, and scrubbing centers to prevent network overloads. Intrusion prevention systems (IPS), coupled with continuous network authentication protocols, further fortify telecom networks by blocking unauthorized access and detecting threats in real time.
    - **Reactive response protocols**: Establishing robust response protocols is essential for managing and mitigating the impact of cyber incidents. In the event of a breach, telecom providers must have predefined response plans to contain the threat, minimize damage and restore services as quickly as possible. Developing legal frameworks and response protocols with governmental collaboration allows telecom providers to respond effectively and ensure continuity of service, thereby protecting national interests.

Future trends and the role of telecom in national security

As India moves toward 5G and 6G, the role of telecom in optimizing digital infrastructure will become even more critical for national security. Emerging technologies like artificial intelligence (AI) and quantum computing are set to transform how telecom networks operate, offering powerful tools for predictive analytics, automated threat detection, and enhanced data processing capabilities.

- **AI and ML for enhanced security**: AI and ML enable telecom providers to analyze large volumes of data for unusual patterns that may indicate cyber threats. By automating threat detection and response, AI can identify and neutralize potential threats faster than human operators, improving overall network security. Al's predictive capabilities also allow telecom providers to anticipate threats based on historical data and emerging trends, allowing for proactive measures to prevent security breaches.
- **Quantum-resistant security**: As quantum computing advances, telecom providers must prepare for the possibility of quantum-based attacks that can decrypt traditional encryption. Implementing quantum-resistant encryption algorithms is essential to future-proof telecom networks, ensuring they remain secure in a post-quantum era. Investing in these technologies will help India's telecom industry stay ahead of security challenges, protecting both public and private data from future threats.

Conclusion

The telecom sector is an essential pillar in India's pursuit of optimized digital infrastructure and national security. As the industry integrates advanced technologies and digitizes its operations, telecom networks are not only enabling seamless connectivity but also safeguarding critical assets, public safety, and national sovereignty. By investing in resilient digital infrastructure, adopting security frameworks like zero-trust, and collaborating with government agencies on cyber-security policies, the telecom sector is well-positioned to protect India's digital future. Through a combination of robust cyber- security measures, innovative technologies, and a forward-looking approach to national security, the telecom sector will be instrumental in shaping a secure, connected, and resilient India.

Cyber security is our shared responsibility amid threats

जागरूकता की दरकार : सतर्क और पहले से ही सक्रिय रहना होगा, कुशल साइबर सुरक्षा पेशेवरों की भी जरूरत

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टेक्नोलॉजी ने समुदायों के विकास और उनमें परिवर्तन लाने में एक महत्त्वपूर्ण भूमिका अदा की है। आज हमारी जिंदगी का एक महत्त्वपूर्ण हिस्सा विभिन्न रूपों में टेक्नोलॉजी के साथ गुंथा हुआ है, चाहे वह मोबाइल, टीवी, कैमरा, वाहन हों या फिर घरेलू वस्तुएं। पिछले एक दशक में आर्टिफिशियल इंटेलिजेंस (एआइ), मशीन लर्निंग (एमएल), ड्रोन्स, इंटरनेट ऑफ थिंग्स, एज कंप्यूटिंग जैसी नई चीजों के रुख से डिजिटल टेक्नोलॉजी में उल्लेखनीय प्रगति हुई है और ये चीजें आम आदमी की रोजाना की बातचीत में चर्चा का केंद्र बन गई हैं। इसके उलट, इन टेक्नोलॉजीज का प्रभाव हमारी कल्पना से परे चला गया है जिनमें से कई चीजों ने इस समाज के लिए साइबर सुरक्षा को खतरे में डाल दिया है।

कनेक्टेड डिवाइसेज के तेजी से बढ़ने और डिजिटल टेक्नोलॉजी में तेज उन्नति से साइबर सुरक्षा की दुनिया अकल्पनीय स्तर पर उभर कर आई है। स्मार्टफोन और सोशल ऐप्स के व्यापक उपयोग से साइबर अपराध भी तेजी से बढ़े हैं। साथ ही डिजिटल भुगतान ऐप्स का उपयोग बढ़ने से वित्तीय धोखाधड़ियों में नए आयाम जुड़े हैं। साइबर अपराधी लोगों को अपने जाल में फंसाने और कानून प्रवर्तन एजेंसियों से बचने के लिए अच्छी खासी टेक्नोलॉजीज का उपयोग करते हैं। आइडेंटिटी स्कैम और वित्तीय धोखाधड़ी नए स्तर पर पहुंच गई है जहां अपराधी स्वयं को कानून प्रवर्तन एजेंसियों के तौर पर पेश करके लोगों के साथ बड़े पैमाने पर वित्तीय धोखाधड़ी करते हैं। एज कंप्यूटिंग, ब्लॉकचेन, एआइ और इंटरनेट ऑफ थिंग्स (आईओटी) जैसी उभरती टेक्नोलॉजी ने इस उद्योग में क्रांति ला दी है। साथ ही इन्होंने नई साइबर सुरक्षा चुनौतियां भी पैदा की हैं। ऑटोनोमस व्हीकल्स और रिमोट हेल्थकेयर जैसे महत्त्वपूर्ण एप्लीकेशंस खोजने वाले एज कंप्यूटिंग में डेटा उल्लंघन की संभावना रहती है। इसलिए ऐसी प्रणालियों में अंततः सुरक्षा सुनिश्चित करना महत्त्वपूर्ण है। इसी प्रकार, रीयल टाइम डेटा पर निर्भर रहने वाला ब्लॉकचेन भी हैकरों के निशाने पर रह सकता है जिससे वित्तीय धोखाधड़ी का जोखिम बढ़ जाता है। साइबर अपराध परिदृश्य में विरोधात्मक एआइ और मशीन लर्निंग से युक्त ऑटोमेटेड बॉटनेट्स का इस्तेमाल कर शैतानी दिमाग वाले लोग अपना काम कर रहे हैं। क्रिप्टोकरेंसी जैसे डिजिटल टोकन, हैंकिंग, धोखाधड़ी और चोरी के लिए मुख्य रूप से निशाने पर रहते हैं।

साइबर खतरों की बढ़ती आशंकाओं को देखते हुए दूरसंचार ऑपरेटर और अन्य भागीदार अपने नेटवर्कों की सुरक्षा और उपभोक्ताओं के डेटा की रक्षा के लिए सक्रियता के साथ मजबूत उपाय अपनाते रहे हैं। खतरों की पहचान और उन्हें कम करने के लिए एआइ और मशीन लर्निंग (एमएल) जैसी टेक्नोलॉजीज का उपयोग, डेटा सुरक्षा के लिए एंड-टू-एंड एंक्रिप्शन को लागू करना और साइबर सुरक्षा मानकों के लिए विश्व की सर्वोत्तम व्यवस्थाओं को अपनाने जैसे प्रयास इसमें शामिल हैं। नियमित ऑडिट, रीयल टाइम निगरानी प्रणालियां और टीमों द्वारा घटना को लेकर त्वरित प्रतिक्रिया यह सुनिश्चित करती है कि जोखिम को तुरंत पहचान कर उन पर कार्रवाई हो। सरकार के साथ गठबंधन में दूरसंचार सेवा प्रदाता नेशनल साइबर सिक्युरिटी स्ट्रेटेजी जैसी पहल में एक सुरक्षित डिजिटल इकोसिस्टम भी तैयार किया जा रहा है और दूरसंचार विभाग एवं इंडियन कंप्यूटर इमरजेंसी रिस्पांस टीम द्वारा स्थापित नियामकीय रूपरेखा का भी अनुपालन कर रहे हैं। सुरक्षित डिजिटल व्यवस्था के बारे में उपभोक्ताओं को शिक्षित करने के लिए जन जागरूकता अभियान चलाए जा रहे हैं जिससे वे साइबर धोखाधड़ी से बच सकें।

जैसा कि भारत 5जी और 6जी की तरफ बढ़ रहा है, दूरसंचार सेवा प्रदाताओं की भूमिका राष्ट्रीय सुरक्षा के लिए कहीं अधिक महत्त्वपूर्ण होगी। एआइ और क्वांटम कंप्यूटिंग जैसी उभरती टेक्नोलॉजीज दूरसंचार नेटवर्क के काम के तरीके में बदलाव लाने को तैयार हैं और इनके द्वारा पूर्वानुमानित एनालिटिक्स, ऑटोमेटेड खतरे की पहचान और बढ़ी हुई डेटा प्रोसेसिंग क्षमताओं के लिए शक्तिशाली टूल्स की पेशकश की जाएगी। एआइ की पूर्वानुमान की क्षमताओं से दूरसंचार कंपनियों को डेटा और उभरते रुखों के आधार पर खतरों को भांपने में मदद मिलेगी जिससे वे सुरक्षा में सेंध रोकने के लिए पहले से ही उपाय कर सकेंगी।

एआइ प्रणालियों को देखने, एआइ तथ्यों का संदर्भ उपलब्ध कराने और महत्त्वपूर्ण निर्णयों खासकर जटिल खतरों के परिदृश्य में निर्णय करने के लिए कुशल साइबर सुरक्षा पेशेवरों की जरूरत है। अंतिम यूजर्स इन साइबर खतरों से रक्षा के लिहाज से पहली पंक्ति में हैं। फिशिंग, मालवेयर और सोशल इंजीनियरिंग दांव-पेंच जैसे आम खतरों के बारे में उन्हें जागरूक करना जरूरी है। नियमित कार्यशालाएं, ऑनलाइन कोर्स और सुरक्षा परामर्श इन यूजर्स को जानकारी से लैस और सतर्क बनाए रखते हैं। संगठनों को सुरक्षा की एक संस्कृति का निर्माण करना चाहिए, जहां साइबर सुरक्षा को एक साझा जिम्मेदारी के तौर पर देखा जाए। संगठनों को जबरदस्त सुरक्षा उपाय करते हुए यूजर के अनुभव को प्राथमिकता देनी होगी। टेक्नोलॉजी के निरंतर आगे बढ़ने के साथ साइबर सुरक्षा परिदृश्य अधिक जटिल और एक दूसरे से जुड़ा हुआ बन गया है। इन चुनौतियों से निपटने के लिए एक बहुआयामी दृष्टिकोण अपनाने की जरूरत है जिसमें टेक्नोलॉजी, कार्यबल विकास, जागरूकता, नीति और गठबंधन समाहित हो। सतर्क और पहले से सक्रिय रहकर हम इस परिदृश्य में सफलतापूर्वक आगे निकल सकते हैं।
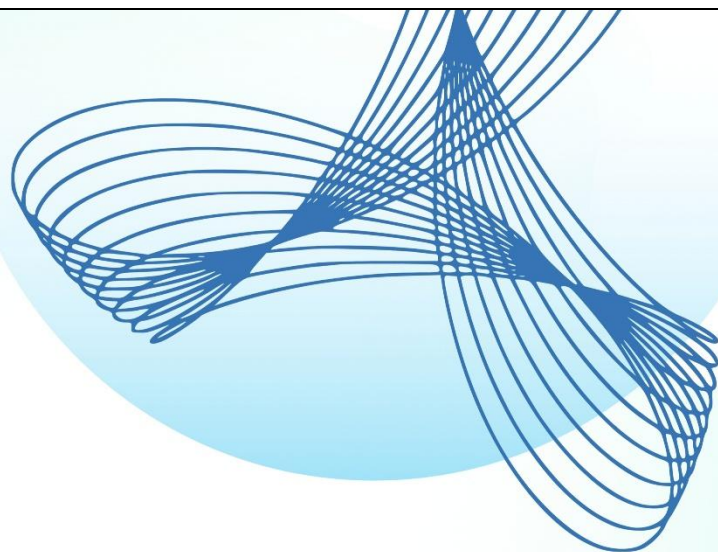
STARTUPS TRANSFORMING TELECOM SECTOR

[TELECOM TALK]
STARTUP ECOSYSTEM

LT GEN DR SP KOCHHAR

SEEDS OF STARTUPS
SOWING INDIA'S TELECOM TRANSFORMATION

India's startups are redefining telecom with 5G and 6G innovation and cutting-edge tech, positioning the nation as a global leader in connectivity

Over the past decade, India has undergone a significant transformation driven by the government's vision of building a self-reliant Bharat. The country, once known as the global IT services hub, has transitioned into a key manufacturing destination. Investment opportunities have surged, spurred by the FDI flows and the supportive regulations. The telecom industry has been the focal point of this transition, emerging as the second largest in the world, with a total subscriber base of 1.2 billion as of August 2024.

This achievement has been made possible through robust digital infrastructure, supportive government policies, industry-wide collaboration, and, importantly, the rise of new-age companies—startups—creating solutions for a broader consumer base.

The start-up ecosystem, hailed as the backbone of India's economy, has elevated the country's prestige on the global front through astonishing innovations and contributions across sectors. Home to over 1.25 lakh DPIIT-recognised startups and 110 unicorns, India's startup ecosystem has been recognised globally as a dynamic and rapidly growing force. According to governmental data, these startups, with immense potential to drive innovation and economic growth, are solving problems in more than 56 diverse industrial sectors. Among these, over 13% are engaged in IT services.

TRENDS SHAPING THE TELECOM SECTOR

The introduction of 5G technologies in India has enhanced the quality of services and positioned the country as a global leader in technological innovation, with one of the fastest rollouts. India is also setting an example for other developing countries by contributing to the establishment of global technological standards and research patents in emerging technologies such as 6G. Startups and academia are also pivotal in this transformation, driving India's evolution into a digitally advanced nation.

> The startup ecosystem in India has emerged as a powerhouse, driving innovation and contributing significantly to the country's GDP.

> The government aims to achieve at least 3% of IPRs in the next-gen essential patents by 2027 and secure a 3% share in the global telecom equipment market.

Developing cutting-edge technologies like blockchain, edge computing, Artificial Intelligence (AI), and the Internet of Things (IoT) enables significant advancements in network optimisation, customer experience, fraud detection, operational efficiency and data security. Major technology companies and startups are creating more personalised and reliable services for users by leveraging their capacity to analyse vast amounts of data, automating processes and ensuring transparency through decentralised ledgers.

EMERGING ROLE OF STARTUPS IN INDIA

The startup ecosystem in India has emerged as a powerhouse, driving innovation and contributing significantly to the country's GDP. With exponential growth in recent years, startups have created over 12.42 lakh direct jobs, as highlighted in the Economic Survey 2023-24. Beyond strengthening the country's economy, these startups are also transforming the telecom sector, playing a pivotal role in advancing technologies such as 5G and 6G.

As part of the Bharat 6G Alliance, startups are at the forefront of developing 6G technologies and contributing to India's target of owning 10% of global 6G patents within three years, with over 200 patents already secured. Simultaneously, companies like Mymo Wireless and VVDN are leading innovations in 5G and collaborating with telecom operators to deploy these networks nationwide.

Startups are also driving advancements in IoT, creating solutions for smart cities, homes, and industries. Companies such as IOTTIVE, Bluepixel Technologies, dotcom and Facilio offer innovative platforms to aggregate data from the facility, optimise performance and streamline operations. Alongside IoT, AI is revolutionising the telecom landscape. Startups like Helpshift are leveraging AI to improve customer communication, while firms like Techvantage Analytics and KeyPoint Technologies are enhancing network efficiency and reducing operational costs through AI and Machine Learning (ML).

Similarly, India's semiconductor ecosystem, backed by robust government initiatives, propels telecom innovation, while fabless chip startups like AGNIT Semiconductors and Saankhya Labs play a critical role. CleanTech companies like Gegadyne Energy and Lohum are addressing sustainability challenges by developing eco-friendly battery alternatives and recycling solutions.

There are, of course, challenges startups face in the telecom ecosystem. These include regulatory hurdles, policy uncertainties, access to funds, infrastructure and technology use, tale nt acquisition, and lack of testing environment. To address most of these challenges, the government needs to push through various initiatives like seed funding, promoting ease of doing business by removing regulatory hurdles, bringing policy level certainty, providing the facility of regulatory and technology sandbox, etc.

COLLABORATION FOR COLLECTIVE GROWTH

The Department of Telecommunications (DoT) encourages collaboration between global firms like Nokia, Ericsson, Cisco, and Qualcomm and academic institutions to develop home-grown telecom gear. Ericsson has signed a memorandum of understanding (MoU) with IIT-Kharagpur to conduct joint research in AI and develop 6G networks. Ericsson and Qualcomm are also driving the development of several intellectual property rights (IPRs) in the sector.

With a focus on homegrown Open Radio Access Network technologies, collaboration among multiple vendors also gains paramount importance. The government aims to achieve at least 3% of IPRs in the next-gen essential patents by 2027 and secure a 3% share in the global telecom equipment market. DoT has also set a target for India to achieve a 5% share in global research areas, including network technologies, wideband spectrum sensing, autonomous control and intelligent communication systems.

INITIATIVES AND SUPPORT FOR ROBUST GROWTH

Apart from the growing entrepreneurial spirit, another reason for the flourishing startup ecosystem in the country is supportive governmental policies and

> DoT aims to achieve a 5% share in global research on network technologies, wideband spectrum sensing, autonomous control, and intelligent communication systems.

IN BRIEF

- India's startup ecosystem boasts 1.25 lakh DPIIT-recognised ventures and 110 unicorns, driving economic growth across 56 diverse sectors.

- Startups play a pivotal role in 5G and 6G advancements, securing 200+ patents under the Bharat 6G Alliance to achieve a 10% global share in 6G patents.

- Startups' innovations in IoT and AI enhance smart city solutions, network efficiency, customer experience, and operational cost reduction.

- Semiconductor startups and Cleantech firms address sustainability challenges with eco-friendly battery solutions and advanced chip technologies.

- Government initiatives like seed funding, policy certainty, and regulatory sandboxes are critical to overcoming startup challenges.

- Collaborative R&D among startups, academia, and global firms fosters cutting-edge technologies, boosting India's competitiveness in the telecom sector.

initiatives. Alongside programmes like 'Startup India' and the 'Startup Mission', the government has introduced targeted initiatives to foster the growth of startups in specific sectors.

The DoT proactively engages with startups and academic institutions to foster collaboration and develop intellectual IPRs for the sector. They target next-generation technologies, including quantum communications, AI, and ML. For example, the Centre of Excellence on Classical and Quantum Communications for 6G at IIT, Chennai, focuses on the development and deployment of 6G technology, promising unprecedented speeds, ultra-low latency, and enhanced connectivity.

Another notable example is the BuildForBharat IoT Startup Challenge, which seeks to inspire startups to ideate, design, and develop IoT solutions. Additionally, in July 2023, the government announced a grant of Rs 48 crore for 66 Startups and MSMEs under the Digital Communication Innovation Square. As part of this effort, the DoT recognised 75 innovators for their remarkable contributions to the field.

The telecom industry, as a whole, has ventured far and beyond providing traditional telecommunication services. In an era where telcos are evolving into high-end tech companies, startups operating at the intersection of telecom and technology are bound to thrive.

The combined efforts of startups, industry and the government underscore the transformative impact of startups in India's telecom sector. By leveraging cutting-edge technologies and addressing critical challenges such as connectivity gaps and environmental sustainability, startups are reshaping the industry and establishing India as a global leader in technological innovation. 🏵

The author is a decorated military veteran who retired as Signal Officer-in-Chief, the head of the Indian Army's ICT. He was also the first CEO of the Telecom Sector Skill Council (TSSC) and is the Director General of the Cellular Operators Association of India (COAI).

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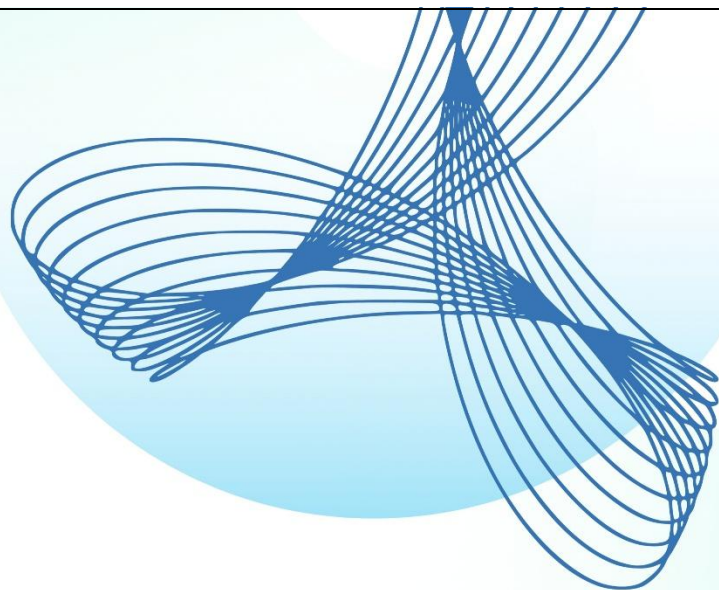
POLICY AND REGULATIONS

Tax reforms, regulatory relief: Indian telecom's call to action in Union Budget 2024-25

As India rapidly evolves into a digital economy, the telecom industry emerges as an indispensable thread, connecting people, communities and even things. As an omni-channel enabler of daily interactions and transactions, telecom has become a cornerstone of economic growth in our nation. In this context, we have been a consistent advocate for reforms, understanding the urgency of eliminating the roadblocks in the growth of the industry. We hope that the upcoming interim Budget, planned ahead of the 2024 Lok Sabha Election, not only addresses the existing challenges faced by the telecom sector, but also propels it towards a resilient and financially robust future.

With India's rapid stride in the global 5G rollout, the telecom industry finds itself at the forefront of technological advancement. By achieving the fastest 5G rollout globally, the Indian telecom industry has showcased its potential to drive the vision of a digitally empowered India. We are also marching ahead in the 6G race thanks to the indigenous Bharat 6G Vision nurtured by our great visionaries and industry representatives. We hope the forthcoming Budget will acknowledge these and address the industry's requirements by adopting a favourable tax regime and other supportive measures, in continuance of the progressive, reforms-based approach adopted by the government in recent years.

To address the aspect of high regulatory levies on the sector, we have suggested the abolition of the Universal Service Obligation Fund (USOF) levy, ideally. In case that is not possible, the USO contribution must be suspended till the existing USOF corpus is exhausted. Additionally, we are advocating for a reduction in license fee from 3 percent to 1 percent, to cover only administrative costs by the Department of Telecommunications (DoT)/government.

The industry earnestly urges the DoT to initiate a comprehensive consultation process on the matters surrounding adjusted gross revenue (AGR). It is crucial to ensure that revenue generated from activities not requiring a license is explicitly excluded from the gross revenue calculation. This adjustment will contribute significantly to creating a fair and balanced regulatory framework for the telecom sector, aligning with the industry's evolving dynamics and challenges.

Similarly, in the direct taxes segment, we urge the introduction of a special regime under Section 72 of the Income Tax Act, allowing telecom operators to carry forward and set off business losses for 16 assessment years, instead of 8 years. This becomes particularly relevant in the face of the challenges faced by the industry, including the Supreme Court's rulings on AGR matters.

Inclusive governance and seamless connectivity - The multifaceted approach behind India's digital revolution

In the vast expanse of the global technological landscape, India emerges as a trailblazer of digital innovation, taking the lead in transformative initiatives like digital public infrastructure (DPI). India's APIs (application programming interfaces) like UPI (unified payments interface), Aadhaar, Digi Yatra, ONDC (open network for digital commerce), Bhashini, and e-Sanjeevani, collectively known as India Stack, have not only reshaped the country's own digital landscape, but have also set a leading example for nations worldwide. At the heart of this digital revolution lies the telecom sector, acting as the backbone for seamless connectivity and data transmission, facilitating the success of these initiatives.

Before diving into the remarkable journey of India Stack, it is crucial to understand what it is a set of open, interoperable APIs that serve as the digital plumbing for countless innovative services in India. Think of it as a foundation upon which developers can build apps and services that leverage secure digital identity verification (Aadhaar), cashless payments (UPI), seamless travel experiences (Digi Yatra), open e-commerce platforms (ONDC), multilingual content access (Bhashini), and even telemedicine consultations (e- Sanjeevani). These components work together seamlessly, empowering both citizens and businesses with a range of convenient and efficient digital solutions.

A journey of innovation India's digital revolution

India's digital revolution commenced with Aadhaar, a groundbreaking biometric identification system providing each citizen with a unique digital identity, fostering inclusive governance and seamless access to government services. UPI accelerated the shift to a cashless economy, enabling effortless financial transactions via smartphones. In aviation, Digi Yatra's digital boarding initiative, integrating biometric authentication and digital IDs, garnered global attention and inspired similar worldwide implementations.

The open network for digital commerce (ONDC) revolutionized e-commerce by creating a unified digital marketplace, facilitating seamless transactions and nurturing a thriving digital economy. Additionally, the government introduced Bhashini to address linguistic diversity, empowering content creators to reach wider audiences by translating content into regional languages. Simultaneously, e-Sanjeevani, a telemedicine service accessible via smartphones, promises to revolutionize healthcare in India. Together, these initiatives showcase India's commitment to digital innovation across diverse sectors, serving as a global inspiration.

The story behind the success

India's success in DPI initiatives can be attributed to a multifaceted approach that combines innovative technologies, strategic government initiatives, and collaborative efforts across industries. This is remarkable, considering the vast population and the disparate socioeconomic culture the country encompasses. The India Stack underscores the viability of such initiatives and their potential to empower citizens in any country. The thriving Fintech ecosystem, created by the collaborative efforts of various industries, banks, and the government, has also complemented these initiatives. Another major factor contributing to the success is India's growing digital economy, powered by over 1150 crore mobile

subscribers who access different digital facilities at their fingertips, regardless of their social and educational background.

Telecom - The digital enabler

India Stack's remarkable journey is intricately linked to the relentless efforts and substantial investments made by telecom operators. The industry has played a pivotal role in expanding fiber optic networks, upgrading towers and embracing next-generation technologies like 5G to meet the escalating demand for data bandwidth and low latency. The entire India Stack ecosystem relies heavily on this robust and ubiquitous telecom network, ensuring real-time data services and connectivity.

The interplay between digital services and the telecom sector highlights the critical role the sector plays in ensuring the success of India Stack's ambitious projects. The industry's commitment to bringing affordable internet access to remote and rural areas has played a pivotal role in bridging the digital divide. This effort not only facilitates wider participation in India Stack initiatives, but also empowers citizens in underserved regions. Vernacular language interfaces and content localization platforms like Bhashini leverage telecom networks to reach diverse populations, preserving cultural diversity and ensuring that India Stack services are accessible to every citizen. The overall contribution has been instrumental in fostering financial inclusion and social development, aligning with India's vision of a digitally inclusive society.

India's 4G/5G stack - Homegrown powerhouse fuelling connectivity freedom

Further propelling India's digital revolution is its indigenously developed 4G/5G technology stack. This groundbreaking achievement transcends mere network infrastructure, marking a shift toward self-reliance and unfettered connectivity. Unlike traditional, vendor-locked systems, India's open-source stack empowers domestic innovation, democratizing access to a robust technological foundation. This fosters a vibrant ecosystem where not just tech giants, but also local startups and entrepreneurs can build applications tailored to India's unique needs.

This revolutionary spirit extends beyond open architecture. The indigenous stack boasts impressive scalability and adaptability, evolving alongside India's ever-growing digital demands. From empowering smart cities to bridging the rural-urban divide, it holds the key to equitable internet access for all. Imagine Indian villages transformed by telemedicine powered by this stack, doctors just a tap away across remote terrains. This homegrown innovation empowers not just cities, but rural communities too, ensuring that no corner of India gets left behind in the digital race. As India embraces 5G, its homegrown stack stands ready to unlock transformative applications in healthcare, education, and agriculture, propelling the nation beyond mere connectivity toward a truly digitally empowered future.

India Stack goes global - A blueprint for nations

The global potential of India Stack lies not just in its innovative APIs, but in its underlying principles. Its open, interoperable, and inclusive philosophy offers a blueprint for other nations to build their own digital foundations. India's success proves that DPI initiatives can flourish even in diverse and complex environments, paving the way for financial inclusion, streamlined governance, and enhanced access to essential services.

While not directly adopting India Stack itself, France has signed an agreement with India to pilot UPI for cross-border payments between tourists from both countries. This demonstrates the potential of individual components within the stack to address specific needs even outside India's borders. In June 2023, Armenia signed a Memorandum of Understanding (MoU) with India to explore leveraging India Stack components like Aadhaar and UPI for its own digital initiatives. They are particularly interested in Aadhaar's secure digital identity verification capabilities to streamline access to government services and benefits. Witnessing the success in India, nations like Mauritius and Saudi Arabia are currently in advanced stages of discussions with India for potential adoption of various India Stack elements, highlighting wider interest in the model.

Recently, India Stack has gained widespread global recognition, leading to its adoption by numerous countries. The G20 Summit that concluded last year, served as a major platform, allowing delegates from other nations to gain a first-hand experience of these solutions. India Stack has already received positive response, with early adopters being Antigua, Barbuda, Trinidad and Tobago, Sierra Leone, Suriname, Armenia, and Papua New Guinea. Additionally, countries such as France, Saudi Arabia, Japan, the UK, the US, Canada, Russia, and Indonesia have expressed interest in adopting various forms of the stack in the coming months.

India Stack signifies more than just India's technological prowess; it emerges as an example of how digital infrastructure can revolutionize nations, fostering inclusivity, progress, and unparalleled connectivity.

'Telecom sector awaits next frontier in communications via policy reform'

BUDGET IN FOCUS

Lt. Gen. S.P. Kochhar

Over the past decade, India has achieved remarkable progress in digital connectivity and local manufacturing, propelled by the ambitious policy reforms aimed at raising India's status as a leading digital economy in the world.

And, thanks to these efforts, India is today the third-largest digitised country in the world, after U.S.A. and China. Telecommunications infrastructure acts as the cornerstone of these developments, providing connectivity across myriad devices and applications, contributing to a higher standard of living and economic growth.

The telecom industry submitted a few policy recommendations to the Ministry of Communications, which are crucial for achieving the government's vision of digital empowerment and inclusivity. The recommendations are vital for creating a favourable environment for the growth of telecom sector and to ensure the interests of the operators and consumers are addressed.

'Cut tax burden'

First, the government should consider the industry's recommendations for reducing the levy and tax burden experienced by the operators for several years. These include the long-standing demands for abolishing the USOF levy, as well as reducing the licence fee from 3% to 1%.

Another important recommendation is related to gross revenue (GR). There is an ambiguity in the current definition of GR, which leads to imperfect calculation of taxes pertaining to non-telecom activities.

Operators' revenue from activities for which no licence is required must not be considered to be part of GR.

'Service Tax exemption'

The industry strongly urges the government to exempt Service Tax on additional AGR liabilities imposed by the Supreme Court's judgment. These recommendations are essential for the recovery of the industry's financial health, ensuring efficient 5G roll-out and sustaining the sector's growth and competitiveness.

Besides, reduction of customs duty to zero and gradually increasing for the manufacturing ecosystem, especially for 4G and 5G products, is desirable. Telcos also urge for exemption of GST under Reverse Charge Mechanism (RCM) on payments made to DoT for licence fee, spectrum-usage charges and spectrum acquired in auctions.

At the same time, with the current customs duty exemption for submarine cable vessels set to expire in September, it would be crucial to prevent an increase in cable-laying costs in the future.

Another major recommendation pertains to the prioritisation of 6 GHz spectrum for 5G in India.

A recent report by GSMA says India can save as much as $10 billion annually in 5G network deployment through the use of 6 GHz spectrum.

'Plan 6 GHz resources'

This spectrum reserve is also crucial for India to advance in the 6G era.

The industry urges the government to strategically plan the 6 GHz resources for 6G as well.

The availability of 6 GHz will significantly enhance the quality and coverage of the mobile network in India. It will not only boost the growth of data usage but also help position 5G as a pivotal technology for a wide range of applications, including drones, telemedicine and smart cities.

The Telecommunications Act 2023 has brought hopes for the industry, especially in issues like Right of Way (RoW).

The Bill has incorporated several crucial measures such as standardising the RoW rules across States, simplifying the licensing process, delinking telecom infrastructure from property taxes and facilitating the telecom infrastructure build-out on private properties.

'Streamline RoW'

These provisions are vital for the rapid deployment of telecom infrastructure, especially for the rollout of 5G services.

To realise the full potential of these reforms, it is imperative the government prioritise its implementation. Streamlining RoW policies will help reduce bureaucratic delays and operational hurdles, enabling telecom operators to expand and upgrade their networks more efficiently.

Moreover, clear and uniform RoW regulations will provide much-needed clarity and certainty for telecom investments and drastically improve the Ease of Doing Business (EoDB) of the sector, which is critical to achieve the targets set by the government.

As India aims for global leadership in 5G deployment and awaits the next frontier in 6G communications, there is optimism within the industry about the transformative opportunities they offer for the country's overall growth.

Boosting coverage

Enhancing coverage, speed and accessibility is pivotal for effective implementation and ensuring seamless service delivery.

This ambitious goal can be achieved through collaborative efforts between the government and industry, bolstered by supportive policies that foster a sustainable ecosystem benefiting all stakeholders.

(Lt. Gen. S.P. Kochhar is DG, Cellular Operators Association of India (COAI))

Make B'luru Great Again (GCC Remix)

S P Kochhar

In a step expected to streamline the deployment of telecom infra, facilitate faster rollout of 5G networks and be a game-changer for the industry, DoT has asked states to 'mandatorily' follow right-of-way (RoW) rules notified recently under the Telecommunications Act, from January 1.

To understand why this directive is a crucial development, one must look at Bengaluru. With 800-plus GCCs with a market size of $22.2 bn, India's tech capital accounts for more than 30% of the country's GCCs and 35% of GCC workforce. It has bigger dreams.

Earlier this week, the Karnataka government launched its dedicated GCC policy at the Bengaluru Tech Summit 2024. The state wants to establish 500 new GCCs by 2029, creating 3.5 lakh additional jobs and more than doubling the sector's economic output to $50 bn. The policy also focuses on going beyond the capital city and promoting development in the state's tier-2/3 cities.

Yet, one of the critical issues affecting the city's growth and its communications infra is the lack of proper implementation of RoW rules for telecom service providers (TSPs). The RoW framework governs access and usage of public land and thoroughfares for laying telecom cables and other network equipment.

In Bengaluru, the absence of a streamlined, transparent RoW policy has created roadblocks for telcos seeking to upgrade and expand their network coverage. This, in turn, has hampered the ability of GCCs to access reliable, high-speed connectivity — a fundamental requirement for the data-intensive work they undertake.

Disruption stemming from the removal of optical fibre cables (OFCs) by Bangalore Electricity Supply Company (Bescom) initiated a debate over how the city's telecom infra should be constructed and maintained. Since

First, get your direction sorted

April, Bescom has removed 7,175.48 km of OFCs and data cables out of the total 9,250.25 km. While efforts to remove unauthorised cables must be appreciated, they create operational challenges for businesses and consumers.

When these critical OFC lines are removed, businesses find their operations crippled without reliable phone and internet access, while public services like hospitals, schools and emergency response systems become hamstrung in their ability to function effectively.

Bengaluru requires robust network infra to cater to its growing demand for data, particularly with the onset of 5G, which requires additional OFC capacity to fiberise mobile towers. TSPs have been applying for permissions for underground cable-laying under formal processes like open trenching or horizontal directional drilling (HDD). They have sought permission to deploy aerial OFCs, either by using their poles or leasing poles from utilities. But government approvals have either been delayed or stopped.

The telecom industry requires permissions from respective government agencies to lay structured aerial fibre across Bengaluru, enabling TSPs to connect towers for 4G/5G/fixed wireless access (FWA), and facilitate the rollout of these services.

TSPs are aligned and eager to transition existing aerial OFCs to underground ones in a phased manner, wherever possible, to mitigate the challenges of maintaining aerial networks that are vulnerable to damage and theft. A viable solution is to provide pre-laid common ducts or cable corridors that TSPs can use for a reasonable fee. This would reduce both time and infrastructure disruptions.

Also, the industry faces logistical issues because parallel urban development projects, such as metro construction and road expansions, often impact underground installations. To protect OFCs, TSPs are required to move to aerial installations temporarily, a process that requires timely approvals. With these multiple challenges and the objective to deliver seamless connectivity, telecom networks are under intense pressure.

Resolving these infra bottlenecks will not only solidify Bengaluru's status as India's premier tech hub and promising GCC destination, but also provide far-reaching benefits for the city's vital public services and businesses that rely on robust, high-speed connectivity.

With the right policy interventions and collaborative efforts between public and private sectors, Bengaluru can strengthen its digital backbone and cement its position as a global innovation centre that continues to drive India's technology-led growth.

The writer is DG, Cellular Operators Association of India (COAI)

Lt. Gen. Dr. S. P. Kochhar

Director General
COAI (Cellular Operators Association of India)

A decorated military veteran, he retired as 'Signal Officer in Chief', the head of the ICT wing of the Indian Army, where he was responsible for planning, executing and operating all Telecom and IT networks of the Army. He was the Additional Director General Personnel of the Indian Army earlier to that, wherein he was handling HR and Empowerment of the 11-lakh strong force.

He was the first CEO of the Telecom Sector Skill Council (TSSC) and served there prior to joining COAI. He holds a PhD, MTech, two MPhils, and has been a member on the Executive Council of National Board of Accreditation, Jamia Millia Islamia and on the Academic Councils of IGNOU, Veltech and others. He also served as an Adjunct Professor with BITS Pilani and IGNOU for several years. Besides, he has also been a member of the interviewing boards of UPSC for Civil Services and Engineering Services.

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