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# ARTICLES
## JANUARY TO DECEMBER 2025

# INDEX

## Connecting India: Inclusion, Access & the Next Digital Leap

## Spectrum Strategies: Powering India's Next Digital Leap

# India's Telecom Rise:
## From Local Powerhouse to Global Trailblazer

# Indian telecom: **A global leader in the making**

## Indian telecom: A global leader in the making

### SP KOCHHAR
Director general, COAI

By fostering innovation, investing in infrastructure, and forging strategic global collaborations, the sector is well on its way to becoming a dominant player

THE INDIAN TELECOM industry is experiencing remarkable growth, both domestically and internationally. With approximately 1,187 million subscribers, urban teledensity has reached 131.01%, while rural areas lag at 58.31%. Despite this disparity, there remains immense potential for expansion across both sectors. The roll-out of 5G is progressing rapidly, facilitated by artificial intelligence (AI), indigenous data sets, and the establishment of localised data centres. However, affordability remains a key hurdle, particularly in rural areas where network accessibility and 5G-enabled handsets are still financially out of reach for many.

To address these challenges, the Indian government has implemented financial measures such as goods and services tax refunds and the removal of bank guarantees. Additionally, significant research is underway to develop cost-effective 5G handsets priced between ₹6,000 and ₹7,000. Furthermore, satellite technology is being introduced to provide connectivity to remote regions where terrestrial networks are unfeasible.

Unlike some nations with isolated pockets of industrialised areas lacking telecom infrastructure, India's development is more integrated. However, there are still inaccessible regions, such as high-altitude terrains, dense forests, and areas affected by Naxalite activity. The government has committed to ensuring fiber connectivity reaches every village, reinforcing its mission of comprehensive digital inclusion.

The Indian government has also prioritised domestic telecom manufacturing to reduce dependency on imports and position the country as a global hub. Policies such as the production-linked incentive scheme have attracted significant investments, fostering self-sufficiency and boosting export potential. To maintain secure and reliable networks, stringent security protocols have been enacted, including the zero-trust regime which mandates the use of trusted sources and periodic equipment testing. Ongoing discussions with telecom players and global companies to address concerns related to source code transparency and patent management are also underway.

India has emerged as a leader in data consumption, despite being one of the most cost-competitive telecom markets globally. While the average revenue per user is on the rise, the proliferation of over-the-top (OTT) services presents both opportunities and challenges. Telecom operators must make substantial infrastructure investments to sustain high-quality services, yet OTT platforms currently contribute little to network costs. The government is actively engaged in finding a fair and sustainable resolution to this issue.

Data security and privacy are also critical considerations in an increasingly connected India. To prevent data misuse, particularly by entities operating beyond Indian jurisdiction, policies such as data localisation have been implemented in line with global trends. Detailed discussions on data privacy are ongoing to establish a comprehensive and enforceable policy that safeguards individual rights while upholding national security.

The telecom sector has adopted a two-pronged approach to mitigating cyber fraud and spam. AI-driven warning systems have been deployed to alert subscribers to potential scams, with significant success in blocking fraudulent calls. The government has also leveraged blockchain and other advanced technologies to curb telecom-based cyber threats. However, regulatory measures for OTT communication services remain a work in progress, with continuing discussions on subjecting these platforms to the same compliance standards as traditional telecom services.

In fact, at the DIGICOM Summit organised by the Cellular Operators Association of India (COAI) in January, the Union minister for communications, Jyotiraditya Scindia, had rightfully pronounced that telecom is not just a horizontal sector today but a value-added horizontal which supports all the other verticals in the periphery. Moreover, the international interest in India's telecom sector is evident from the growing prominence of events like the India Mobile Congress (IMC). The overwhelming response to IMC 2025 has cemented its status as a global telecom showcase, with an announcement scheduled for the Mobile World Congress 2026 in Barcelona.

Yet, beyond technology and infrastructure, the industry's progress hinges on skilled manpower. Recognising this, the government has allocated ₹8,800 crore under the Skill India Programme for the period of 2022-2026 to enhance employment opportunities and technical competencies.

With a thriving domestic market and increasing global prominence, India's telecom industry is poised for unprecedented growth. By fostering innovation, investing in infrastructure, and forging strategic global collaborations, the sector is well on its way to becoming a dominant player on the world stage. The time is ripe for global stakeholders to partner with India and accelerate mutual progress in the telecom domain.

> With a thriving domestic market and increasing global prominence, India's telecom industry is poised for unprecedented growth

[TELECOM TALK]
**INVESTMENTS**

**LT GEN DR SP KOCHHAR**

# TELECOM TURNS TIDE
## WITH CAPITAL SPEED AND CONFIDENCE
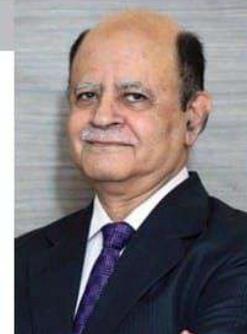
Record FPI inflows and strong policy support signal a new era for Indian telecom as global investors bet big on its digital growth and resilience.

India's telecom sector is not just about connecting people; it is about connecting ambitions, powering dreams and transforming the nation's digital landscape. As we move through 2025, the sector's remarkable journey from a low-cost, high-volume market to a global leader in digital infrastructure is drawing the world's attention.

The numbers tell their own story: India is now the world's second-largest telecom market, with over 1.2 billion subscribers and a tele-density of 85%. This massive network has become the backbone of India's digital revolution, enabling everything—from digital payments and telemedicine to e-learning and e-governance.

The sector's pivotal role in supporting next-generation technologies, including 5G, Artificial Intelligence (AI), the Internet of Things (IoT), and cloud computing, has made it a magnet for global investors. The telecom sector in India is now seen as a case study for emerging markets looking to leapfrog into the digital age.

### TELECOM TOPS CHARTS WITH RECORD FPI INFLOWS IN 2025

If there is one indicator that truly reflects global confidence, it is the flow of foreign portfolio investment (FPI). In 2025, Indian telecom is leading the pack. According to data from the National Securities Depository Ltd. (NSDL), telecom stocks attracted a record USD 1.88 billion in FPI inflows in
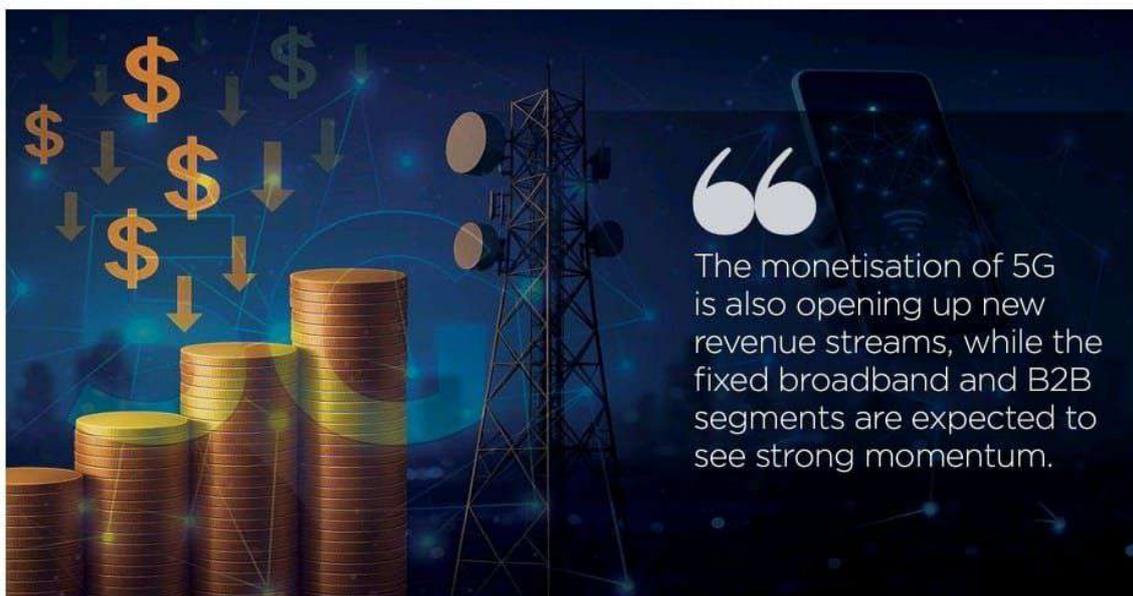
> The monetisation of 5G is also opening up new revenue streams, while the fixed broadband and B2B segments are expected to see strong momentum.

> India's telecom story is no longer just about connectivity—it is about resilience, capital confidence, and digital ambition on a global scale.



## IN BRIEF

- India's telecom sector drew USD 1.88 billion in FPI in May 2025, accounting for its highest-ever monthly share of 41% of all equity inflows.

- Consolidation, rising ARPU, and growing data demand are driving a structural reset, making the sector healthier and more investment-ready.

- 5G rollout, increasing tele-density, and surging rural demand are narrowing the digital divide and powering India's digital economy.

- Analysts project mid-to-high teen revenue growth for top telcos through FY27, led by ARPU gains, subscriber growth, and 5G monetisation.

- The 2025 Union Budget boosted telecom with Rs 81,005 crore and PLI-linked incentives, making India a manufacturing hub for the sector.

- FPIs and mutual funds are betting big on Indian telecom, signalling long-term confidence in its valuation, infrastructure, and policy stability.

May 2025. To put this in perspective, this accounted for 41% of all overseas equity inflows into India that month, the highest ever for the sector and a dramatic leap from USD 523 million in April.

What triggered this surge?

The sector's ongoing structural reset, marked by consolidation, rising average revenue per user (ARPU) and robust subscriber growth, has put telecom stocks back on the global investor's radar. In total, foreign investors pumped USD 2.32 billion into Indian equities in May 2025, with telecom leading the way. This is a clear indication that the world views the Indian telecom sector as one with strong fundamentals and a promising future.

### CONSOLIDATION AND DATA DEMAND RESHAPE THE SECTOR

The Indian telecom industry is undergoing a major structural shift. The days of fierce price wars and a fragmented market are giving way to a more consolidated and healthier ecosystem. By FY27, the telcos are expected to experience significant growth in both revenue and market share among subscribers. This consolidation is fostering a more competitive and efficient market, enabling operators to make bold investments in technology and infrastructure.

India's subscriber base surpassed 1.2 billion in Q1 2025, with urban tele-density reaching a remarkable 131.45% and rural tele-density increasing to 59.06%. Wireless subscribers alone grew by 1.14%, reflecting India's insatiable demand for mobile and data services. The digital divide is narrowing, but bridging the last mile, especially in rural areas, remains a key focus for both the government and private players.

The sector is also witnessing a surge in data usage, driven by the affordability of smartphones, competitive tariffs, and the rapid rollout of 5G services. It is not an exaggeration to say that data is the new oxygen for India's economy.

### REVENUE OUTLOOK DRIVEN BY ARPU AND 5G GAINS

The tariff needs to be improved to determine the industry's growth pattern, as well as the necessary financial gains to sustain and further enhance the business. The massive investments required for 5G infrastructure, spectrum acquisition and the rising operational costs need to be borne by the TSPs and thus

## [TELECOM TALK]
### INVESTMENTS

> From spectrum to smartphones, every layer of India's telecom value chain is now being reshaped by foreign capital and domestic innovation.

need to be funded essentially to secure a healthy and growing telecom ecosystem in the country.

According to analysts, mid-to-high teen percentage revenue growth is expected for the top players between 2025 and 2027, driven by improvements in ARPU and steady subscriber additions, which would be positive for the sector. The monetisation of 5G is also opening up new revenue streams, while the fixed broadband and B2B segments are expected to see strong momentum.

### BUDGET ALLOCATIONS AND PLI SUPPORT MANUFACTURING
Government policy has played a crucial role in this resurgence. The Union Budget 2025 allocated Rs 81,005 crore to the telecom sector, prioritising the expansion of BharatNet and domestic telecom manufacturing. The reduction in customs duties on key telecom equipment and fiscal incentives for local manufacturing are making India an attractive base for global telecom manufacturing.

The government's commitment to bridging the digital divide, especially in rural areas and fostering innovation through ease-of-doing-business measures has created a supportive environment for sustained growth. Initiatives such as the Production Linked Incentive (PLI) schemes are further encouraging domestic and foreign investment in telecom manufacturing.

### FOREIGN CAPITAL BOOSTS VALUATIONS AND UPGRADES
Foreign portfolio investments are more than just financial inflows; they are catalysts for growth and innovation. Increased FPI provides the capital needed for network expansion, 5G rollout and technology upgrades. These investments complement government initiatives, accelerating digital connectivity and infrastructure development across the nation.

Telecom's status as the top FPI destination is in stark contrast to sectors like healthcare and IT, which have seen outflows due to global margin pressures and trade uncertainties. The positive macroeconomic signals and robust sector fundamentals are drawing sustained foreign interest, further boosting sector valuations and investor confidence.

It is not just foreign investors who are bullish. Domestic mutual funds have also warmed up to the telecom sector. In May, mutual funds purchased Rs 5,768.7 crore worth of telecom stocks. Mutual fund holdings in telecom still trail the sector's 4% weight in the BSE 200 index, suggesting room for further domestic inflows.

### BRIGHT OUTLOOK AS TELECOM BUILDS DIGITAL BACKBONE
The outlook for Indian telecom remains bright and full of promise. As tariff hikes improve revenue visibility and sector profitability, foreign investor appetite is expected to stay strong. Market consolidation will further enhance the competitive positioning of major players, attracting even more global capital. The expansion of 5G, data centres, AI and IoT will drive long-term growth and innovation. Of course, challenges remain.

Managing rising costs, navigating the regulatory environment and balancing affordability with profitability will require ongoing adjustments. But with a robust subscriber base, strategic consolidation and supportive policies, Indian telecom is well-equipped to meet these challenges head-on. All of this is underpinned by strong policy support and government incentives for infrastructure and manufacturing, creating a virtuous cycle of growth and investment.

India's telecom sector is a global case study in transformation and resilience. Record FPI inflows in 2025 underscore the world's confidence in our growth trajectory. With continued innovation, infrastructure expansion and policy support, Indian telecom is set to remain a global hotspot for portfolio investments, powering India's digital future and inspiring economies worldwide. The journey ahead will require continued focus on affordability, innovation, and inclusive growth; however, the sector's achievements so far have set the stage for a new era of global leadership. 🌸

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# Path to global 6G leadership – What India needs!

**Communications Today - 16th July 2025**

India aims to establish itself as a global leader in the development and deployment of 6G technologies by 2030. Initiatives like the Bharat 6G Alliance highlight its aspirations for future technologies, including its goal of holding 10 percent of 6G patents by 2030. Through these efforts, India recognizes the significant economic and societal value of global standardization.

Indeed, global standardization fosters innovation, reduces production costs, and ensures interoperability across devices and networks. By enabling different technologies to work seamlessly together, global cellular standards allow companies to bring products to market more quickly and expand across borders. Innovations driven by cellular connectivity also have an enormous impact on the economy. According to PwC, by 2030, 5G investments are expected to boost the global GDP by USD 1.3 trillion (₹ 107.9 lakh crore) across

sectors like healthcare, manufacturing and smart utilities. India has rapidly emerged as a global leader in the deployment of 5G, achieving a national rollout in just over a year. As of now, the country has successfully deployed around 470,000 base stations. The cost of mobile data has plummeted by approximately 97 percent, from nearly ₹300 per GB in 2014 to just about ₹9 per GB in 2024.

Global cellular standards are developed in the 3rd Generation Partnership Project (3GPP), consistent with WTO principles. This process, based on technical merit, transparency, openness, and consensus, permits stakeholders from any country to contribute and be actively involved in decision-making. In other words, it provides local companies with the opportunity to collaborate on a global scale, a key advantage in our increasingly interconnected world.

## National vs global standards: Lessons learned from China and India

Considering the relevance of global standards, some may find it attractive to develop national standards independently. However, China's experience is a cautionary lesson on why such a strategy is unlikely to succeed.

In the early 2000s, as 3GPP promoted WCDMA for 3G, China attempted to develop its national standard: TD-SCDMA. As TD-SCDMA was only deployed in China, manufacturers and operators could not spread development and production costs over a large enough number of units. This was a key reason why the Chinese standard struggled to gain traction outside China and even faced reluctance for adoption from local telecommunications players. At the same time, WCDMA was adopted globally, allowing for economies of scale.

India's attempt to create its own 5G standard also faced similar challenges. While 5Gi was designed to address local challenges in India, its divergence from the global standard led to resistance owing to compatibility issues. Likewise, the standard did not present a feasible option for the domestic carriers. India ultimately merged 5Gi with the global 5G specifications in 3GPP's Release 17, aligning with established international standards.

What do these examples teach us? Both TD-SCDMA and 5Gi struggled due to initial failure to achieve a global scale. Recognizing these challenges, China eventually shifted its strategy to "embrace foreign players' involvement in standards development" and participation in global standards development. India's decision to align 5Gi with 3GPP specifications also showed how it is time- and cost-effective to develop standards at an international level from the beginning.

## Innovation leadership through sustained support in global standardization

Considering the above, India needs a different strategic approach to lead in 6G and future global standardization. Each cellular generation takes around ten years to launch. It requires significant R&D investments, technical expertise, and business risks that Indian start-ups may find challenging to sustain on their own. For example, according to Signals Research, less than 17 percent of the technical contributions to 3G and 4G were "approved contributions" that became part of the standard. In standardization, there is a substantial risk of non-acceptance for contributors. It only makes sense to engage in that risk if, afterwards, the license of the patented technologies incorporated into a standard provides a reasonable royalty. This allows innovators to continue investing in the next generation of the standard. At the same time, consumers enjoy interoperability and high-performance products and services at reasonable prices, while implementers, in particular startups, can build on existing standards rather than reinvent the wheel.

In contrast, closed ecosystems make it nearly impossible for start-ups to compete with large players. Without access to foundational technologies, they face overwhelming barriers to entry. Therefore, global standardization offers a pro-competitive environment.

India, too, could promote "licensing-in" of technology by offering "innovation incentives" to domestic companies, which can facilitate Indian companies in further innovating on top of existing technologies. Promoting good faith licensing negotiations, faster court decisions, and enforcement of injunctions against unwilling licensees would build trust in the system. This trust would encourage Indian companies to invest in R&D and develop strong in-house IP portfolios. This, combined with a collaborative research framework, would in turn facilitate India's realization of its ambition to secure a 10 percent share of patents in the 6G ecosystem.

Furthermore, India should encourage its companies to build expertise and participate in 3GPP. This would amplify India's influence and ensure Indian priorities are reflected in future technologies.

## Conclusion

With the rise of 6G, Artificial Intelligence, and the Internet of Things, India's path to technological leadership depends on global engagement. Experience has shown that deviating from an international standard has proven to be an unsuccessful strategy worldwide. Indeed, as the case of 3GPP demonstrates, global cellular standards provide the interoperability and scale necessary to deliver connectivity across devices and borders. This, in turn, fosters economic growth by promoting innovation, enabling cost-effective technologies, and driving societal progress through enhanced communication, improved safety, and increased access to vital services.

There are lessons for India to learn from the past. To become a leading contributor to cellular standards, India must continuously and dynamically rethink its strategy. India boasts a thriving startup ecosystem and a rapidly expanding digital infrastructure. By encouraging domestic companies to participate more actively in 3GPP, India can move closer to the leadership position it envisions.

# 30 years since India's first mobile phone call: With eyes on future, country aims to lead 6G

**ET Telecom - 31st July 2025**

It's astonishing to imagine that just three decades ago, in July 1995, mobile phones were a distant dream for most Indians. The telecom landscape changed forever on July 31 that year, when West Bengal Chief Minister Jyoti Basu dialled Union Telecom Minister Sukh Ram to make the country's very first mobile call, using a Nokia handset on the Modi Telstra network which operated on Nokia supplied telecom equipment. That simple moment marked the beginning of what would become a remarkable saga of technological transformation, reshaping how people live, work and communicate.

## From Luxury to Mass Connectivity

In those early days, mobile phones were a symbol of status - bulky, expensive and reserved for a privileged few. Networks were sparse and tariffs so high that calls were planned and brief. Fast forward to today, India's telecom sector is among the second largest and most vibrant in the world, serving more than 1.2 billion subscribers. It is not just a story of numbers; it's about how connectivity has woven itself into the fabric of Indian society, bridging distances, creating opportunities and powering aspirations.

Since that first call, the progress of India's telecom sector has been nothing short of spectacular. While the late 1990s and early 2000s saw a rapid expansion of mobile infrastructure, the sector truly came of age with the advent of affordable services and innovative prepaid models that made mobile access available to millions across both major cities and remote villages. From mere feature phones to smartphones, India's smartphone market has become the second largest in

the world by volume, having surpassed the US in 2024. Even the affordability factor for premium smartphones has come down significantly.

The turning point arrived with the introduction of data services and the internet via 2G, followed by a leap in adoption with the widespread rollout of 3G and subsequently the 4G. Over time, the focus shifted dramatically from just voice connectivity to data, reflecting the nation's hunger for information and communication.

While India followed the global curve during the 2G and 3G eras and caught up with the world in 4G, it surprised many by emerging as the country with the fastest 5G rollout in the world. Now, with a bold vision to lead in future technologies, India is actively working on developing 6G, not just to adopt, but to help shape and set global standards.

## Government Initiatives Fueling Digital Inclusion

Government policies have consistently played a catalytic role in this transformation. From liberalising the sector, encouraging healthy competition and reducing license fees to spearheading digital missions like Digital India and BharatNet, policymakers have made connectivity an inclusive goal. Programs such as the National Broadband Mission and the Universal Service Obligation Fund have focused on expanding networks to rural and remote areas, ensuring that the benefits of digital technology reach every corner of the country. The remarkable rise in rural tele-density, once lagging far behind urban India, is a testament to these inclusive efforts.

## Telecom by the Numbers

India can take pride in its robust telecom figures where wireless subscribers have reached more than 1.16 billion, broadband users exceed 974 million and total telecom connections have crossed the 1.2 billion mark. The national tele-density now stands at just over 85%, with remarkable progress in bridging the urban-rural gap. Another testament to the rapid digital transfor-

mation and to the strength of India's telecom infrastructure, is the surge in data consumption. As of September 2025, the average monthly wireless data usage per user in India crossed 21 GB. What was once a metropolitan luxury is today a lifeline for rural India; school children use smartphones for learning, farmers access market rates online and families stay connected regardless of geography.

## Quality and Innovation driving the Telecom Renaissance

Yet, the industry is not defined only by numbers. Quality, affordability and innovation are at the forefront of India's telecom renaissance. The expansion of 4G brought high-speed internet to the masses, positioning India as a global leader in data consumption. The arrival and rapid penetration of 5G are now setting the stage for breakthroughs in healthcare, education, manufacturing and digital government services. Even more exciting is the vision of Bharat 6G, where India aims to not only adopt but drive the development of next-generation connectivity technologies.

This technological evolution has had a profound and far-reaching economic impact. The sector accounts for approximately 6% of India's GDP, underpinning vast swathes of commerce, entrepreneurship, and employment. Affordable smartphones and ever-dropping data prices have not only democratised access but also incubated a thriving digital economy, startups, e-commerce, digital payments and content creation are flourishing like never before. Telecom infrastructure has become the backbone for everything from mobile banking to telemedicine, empowering individuals and businesses to dream bigger.

## Policy Evolution and Future Ready Networks

Policy evolution has been instrumental in supporting this dynamism. The Telecommunications Act of 2023, as one recent example, seeks to address the sector's contemporary needs by

focusing on inclusivity, transparency, consumer protection, and the modernisation of network infrastructure. Security, privacy and innovation are at the heart of the sector's new direction, ensuring that the next thirty years are as exciting and transformative as the last.

India's telecom revolution is a story of empowerment. A journey that has taken the country from a handful of mobile phones to more than a billion, with the promise that every citizen, no matter where they live, can be part of the nation's digital future. Recently, Hon'ble telecom minister Shri Jyotiraditya Scindia announced that

the Central government is preparing a $4-billion investment plan to connect every village in the country with high-speed broadband, in a bid to achieve a 100% telecom connectivity saturation in remote regions.

As we mark thirty years since the first historic call, the distance between dream and reality continues to shrink, powered by technology, vision and an unyielding commitment to connect every Indian. The next chapter, shaped by 5G, 6G, and homegrown innovation, promises to be even more transformative, cementing India's place as a global leader in digital inclusion and connectivity.

# Design, develop, deploy: India's end-to-end strategy for leading the next wave of digital infrastructure

**Fortune India – 7th October 2025**

India's digital journey is no longer about catching up. It's about leapfrogging, setting the pace, and shaping the future. In simple terms, the country is moving beyond just using digital tools; it is designing, building, and rolling out the world's next-generation digital backbone. This infrastructure powers everything from rural schools and tele-health clinics to smart factories and green energy grids, touching every aspect of how citizens live and work.

## Designing the digital future

The story begins with homegrown innovation. Unlike many countries that simply import global standards, India is now creating its own 5G and 6G blueprints. A remarkable 111 research and development projects focussed on 6G have already been sanctioned, along with national testbeds for the trial of new technologies. Over 100 laborato-ries across academic institutions are working on 5G innovations, producing cutting-edge solutions and aiming for India to secure 10% of the world's 6G patents by 2027.

This shift is more than technical; it is a statement of intent. Hosting the first-ever international 3GPP meetings on 6G in India signals that the country is not just a follower but a partner in defining global digital standards. Meanwhile, Artificial Intelligence (AI) is seamlessly woven into this strategy. The India AI Mission alone allocated over ₹10,300 crore in 2024 to strengthen AI capabilities, with thousands of GPUs deployed for research and innovation centres established in key sectors like healthcare and agriculture. These design efforts are laying the foundation for a digital ecosystem that is not only powerful but also inclusive and sustainable.

## Developing digital infrastructure at scale

Design is just the first step. Scaling innovation into tangible infrastructure requires an ambitious rollout, and India's position here is improving. The vast network developed under BharatNet doesn't just provide internet; it powers rural education, healthcare, and local businesses, uplifting millions across the countryside.

Simultaneously, Indian telecom operators have installed 4.98 lakh 5G base transceiver stations. The telecom network covers 99% of Indian villages and almost 82% of the population. Monthly broadband subscriber additions surpassed 4.2 million in June and July 2025, underscoring a digital appetite that is both deep and fast-growing. To boost self-reliance, India's manufacturing sector is rising impressively. The Production Linked Incentive (PLI) scheme for telecom and networking has generated export sales exceeding ₹14,000 crore, creating over 26,351 new jobs in the sector. Mobile manufacturing exploded from 5.8 crore units in 2014-15 to over 33 crore in 2024, with exports continuing to rise. This thrust towards indigenous production means the digital ecosystem is built on a robust, domestic supply chain.

## Deploying plug-and-play digital services

From infrastructure to accessible services, India's digital public platforms exemplify simplicity and openness. Aadhaar, with 1.39 billion biometric IDs and Unified Payments Interface (UPI), processing over 12 billion transactions monthly, is the backbone of India's digital economy. These systems, built as open-source, interoperable stacks, are now being adopted internationally, with countries ranging from Bhutan to France integrating or licensing India's digital payment systems.

By enabling easy access to identity verification, payment gateways, and connectivity via APIs, India's digital ecosystem transforms complex infrastructure into ready-to-use tools, empowering entrepreneurs from remote villages to urban innovation hubs.

## Accelerating growth and exporting digital expertise

This full-stack approach, from meticulous design to wide-scale deployment, is fueling India's economic expansion in multiple dimensions. The digital economy now accounts for over 11.7% of GDP and is projected to grow even faster in the coming years. Growth in data usage, cloud computing, and AI is creating millions of jobs and spawning a vibrant startup ecosystem.

Beyond national benefits, India is positioning itself as a trusted global exporter of digital infrastructure best practices. UPI's adoption in more than eight countries, training programs on India Stack, and collaborations around standards development are spreading India's digital DNA worldwide. Our country is not just exporting telecom hardware and software, but the blueprint for building inclusive, resilient, and scalable digital systems.

## The path forward

As India marches forward with its design, develop, and deploy strategy, it showcases an inspiring narrative of transformation. From cutting-edge R&D labs designing future networks to fibre optics lighting up distant villages, from open-source digital identities to plug-and-play telecom services, this integrated approach demystifies digital infrastructure.

It's a model that other nations watch with keen interest; proof that with vision, policy support, and relentless execution, digital technology can be harnessed to bridge divides, power economies, and open new horizons of opportunity. India's digital infrastructure is no longer just a national asset; it is a global beacon.

# India's techade: Accelerating 5G realities and shaping the 6G future

As India enters its defining techade, connectivity stands as the foundation of our nation's digital ambitions. From powering smart cities and connected factories to enabling secure financial ecosystems and inclusive digital services, telecom networks are the arteries of Digital India. Over the last few years, India has not merely deployed 5G, it has demonstrated to the world what a large-scale, inclusive and innovation-led rollout looks like. Today, as the country consolidates its position as a global 5G leader, the focus is already shifting to shaping the contours of 6G, a frontier where India's early leadership in R&D, standards and indigenous technology design is setting a new global benchmark.

In less than two years, India has achieved one of the fastest 5G rollouts globally. What distinguishes India's 5G story is its focus on use-case maturity rather than just coverage metrics. Through pilot projects in mining, ports, agriculture and manufacturing, telecom operators, in collaboration with startups, academia and enterprises, are demonstrating how 5G can enhance productivity, safety and sustainability. The creation of 5G use-case labs across IITs and universities is further nurturing local innovation and ensuring that India's digital growth is grounded in domestic intellectual capital.

India's leadership in 5G is not accidental; it is the outcome of visionary policymaking and coordinated action between the government, industry and academia. The policy ecosystem, encompassing spectrum reforms, the new Telecommunications Act and production-linked incentive (PLI) schemes, has created a foundation where innovation and investment reinforce each other.

Even as 5G deployment continues, India is al-

ready preparing for the next leap in 6G, which promises hyper-personalised connectivity, intelligent networks and seamless integration of communication and computing. Under the Bharat 6G Mission, India is among the first nations to establish a long-term roadmap for 6G R&D and standardisation, involving global collaborations and indigenous testbeds.

Indian researchers and companies are actively contributing to ITU and 3GPP standardisation processes, shaping protocols and architectures for the networks of the future. Initiatives such as telecom research labs, start-up accelerators and the Bharat 6G Alliance are ensuring that India is not a passive recipient but an active architect of global 6G standards.

The early emphasis on AI-native networks, green telecom and quantum-safe communications reflect India's ambition to align 6G with national priorities of security, sustainability and sovereignty. By linking the 6G roadmap with Aatmanirbhar Bharat, India is not only driving R&D but also positioning itself as a global hub for next-generation design, manufacturing and intellectual property.

As India's digital footprint expands, securing its telecom infrastructure becomes paramount. The sector's role has evolved beyond connectivity. It is now a critical enabler of national security, financial integrity and citizen trust. The government's recent initiatives such as the Digital Intelligence Platform (DIP), the Financial Fraud Risk Indicator (FRI) and the Chakshu portal illustrate how India is leveraging telecom intelligence to combat cyber threats, spoofing and fraud.

At the same time though, the requirement remains from the growth of OTT services riding on telecom networks without proportional regulatory responsibilities, which raises questions of fairness and sustainability. This needs to be addressed essentially.

Telecom networks are also the backbone of India's critical information infrastructure, supporting defence communications, emergency response and digital governance systems. Ensuring

resilience through trusted supply chains, indigenous manufacturing and quantum-secure networks will be essential as we move towards 6G and beyond. Cellular Operators Association of India (COAI) and its members continue to work closely with the Department of Telecommunications (DoT) and the Telecom Regulatory Authority of India (TRAI) to develop frameworks that reinforce both technological sovereignty and user trust.

India's telecom-led digital transformation is supported by progressive policy interventions that recognise the sector's strategic importance. The Telecommunications Act, 2023, streamlines licencing, promotes ease of doing business and modernises the regulatory architecture to support innovations in satellite, D2M broadcast, IoT, etc.

Complementing this, the PLI scheme for telecom and networking products has catalysed investments in domestic manufacturing, reducing import dependence and nurturing an ecosystem of component suppliers, design houses and R&D centres. The government's focus on Make in India for the world is turning India into a credible export hub for telecom equipment and software-defined network solutions.

However, sustaining this momentum requires continued policy support such as rationalising levies, ensuring predictable spectrum pricing and promoting infrastructure sharing to optimise capital efficiency. A forward-looking regulatory approach, coupled with public–private collaboration, can unlock the next wave of digital infrastructure investments.

The next decade will redefine how nations connect, communicate and compete. For India, the convergence of 5G maturity, 6G ambition, policy foresight and indigenous innovation marks a once-in-a-generation opportunity to lead the global digital transformation.

By building secure, sustainable and sovereign telecom networks, from the metros to the mountains, India is not just participating in the techade; it is defining it.

# Role of telecom in Viksit Bharat @2047 - Bridging the urban-rural divide

**Communications Today – 15ᵗʰ November 2025**

The Hon'ble Prime Minister's vision of a 'Viksit Bharat' by 2047 is not merely an economic target; it is a solemn pledge to build a nation where every citizen, regardless of their geography, has the opportunity to thrive. As we chart this ambitious course, it is clear that telecommunications infrastructure is not just a supporting pillar but the very foundation upon which this vision will be realized. For a truly developed India, digital empowerment cannot be a privilege of the few; it must be a fundamental right for all.

While a decade ago, the narrative of Digital India was one of massive potential, today, as we celebrate 10 years of this transformative mission, the vision looks much more imminent. The engine of India's digital growth is no longer confined to our bustling metros; it now hums in our villages. As we look toward 2047, bridging the urban-rural divide is not just a social imperative; it is our single greatest economic opportunity.

## The tale of two Indias - Understanding the persistent divide

The latest performance indicator reports from the Telecom Regulatory Authority of India (TRAI) indicate that as of June 2025, urban mobile teledensity stands at a saturated 125-3 percent, while rural teledensity is at 58.8 percent. This gap is a powerful reminder that our work is far from over, and this is the divide we must now conquer, the one towards meaningful, productive digital engagement.

## The rural revolution - Where India's digital future is being written

The most exciting chapter in India's growth story is now being written in its heartland. A recent report by Crisil Ratings projects that a staggering 74 percent of the telecom sector's future growth will originate from rural and semi-urban India. This is

a monumental shift, recasting the rural markets to a vibrant engine of commercial growth and national progress.

The data is compelling. Over the past four years, rural India (B and C Circles) has witnessed a 19 percent to 22 percent compound annual growth in data consumption, outpacing the 17 percent to 19 percent growth seen in metros. As rural users migrate to data plans and upgrade their usage, CRISIL expects them to contribute 55 percent-60 percent of the industry's incremental ARPU growth. This surge is powered by what has arguably been the world's most profound digital democratization.

Over the past decade, the cost of mobile data in India too has plummeted by an incredible 95 percent, from around 225 per GB in 2015 to a mere 9-12 today. According to the Economic Survey 2025, our data prices are 22 times cheaper than the world average, transforming a luxury into a utility accessible to all.

## 5G at scale, BharatNet at the last mile

India's telecom operators have responded to the growing data demand with one of the fastest 5G rollouts ever witnessed globally. In just 28 months since its launch, over 4.7 lac 5G base stations have been deployed, covering 99.6 percent of districts and bringing nearly 300 million users into the 5G fold. Ookla's recent analysis confirms that 5G signals are now detectable in over 77 percent of India's villages, a testament to the industry's commitment to broad-based deployment.

However, the last mile remains the most critical challenge. This is where the BharatNet project, with its vision to connect all 2.5 lakh Gram Panchayats, plays a pivotal role. With 87 percent of Gram Panchayats now service-ready, we must accelerate execution to reach every village. The Government's renewed focus, reflected in a massive 238 percent increase in the BharatNet budget allocation for FY2025-26, is a welcome step. We believe that making this infrastructure available to telecom service providers at minimal or no

cost, coupled with stringent service level agreements, will be the key to unlocking its true potential and lighting up every corner of rural India. For the most remote of the approximately 18,000 to 30,000 villages still without 4G, we must pragmatically embrace satellite-based connectivity solutions to complement the terrestrial networks.

## Telecom as a catalyst for rural transformation

The true power of telecom lies not in the infrastructure itself, but in the opportunities it unlocks. In agriculture, the backbone of our rural economy, connectivity is transforming the lives of rural communities. The impact is felt across every facet of life. Telemedicine is bringing quality healthcare to villages where doctors are scarce. Digital education platforms are enabling rural students to access world-class learning resources. And perhaps most visibly, financial inclusion has exploded. Telecom has rightly proved itself as a 'value-added horizontal' as stated by our Hon'ble Union Minister for Communications, Shri Jyotiraditya M. Scindia - supporting every other vertical today.

According to the National Sample Survey Office (NSSO), 99.5 percent of our youth can now perform online transactions, largely thanks to the UPI revolution. When a farmer can receive a subsidy directly in his bank account or a woman entrepreneur can sell her handicrafts to a global audience, we see Viksit Bharat taking shape.

## Atmanirbhar telecom - Building India's digital sovereignty

Integral to the Viksit Bharat mission is the principle of Atmanirbharta or self-reliance. And here too, India's telecom sector is at the forefront. For example, the focus on digital sovereignty, supported by initiatives like the Telecom Technology Development Fund, which has sanctioned over 550 crores for 132 R&D projects, ensures that our critical infrastructure is secure, resilient, and immune to global supply chain volatilities.

## The road to 2047 - Vision for a truly connected Bharat

The journey from 25 crore internet connections in 2014 to over 97 crores today has been extraordinary. As India's digital economy barrels towards its destiny of contributing nearly 20 percent to our GDP in the next decade, our path forward must be guided by a singular focus: inclusive and equitable growth. Telecom has become the foundational horizontal platform upon which every other sector of the economy is built. A strong, innovative telecom foundation directly translates to growth across all industries, which in turn enhances the overall GDP.

We remain steadfast in our advocacy for policies that will accelerate this mission. This includes rationalizing the Universal Service Obligation Fund (now Digital Bharat Nidhi) levy, streamlining Right of Way permissions in rural areas and ensuring that all entities benefiting from our nation's digital infrastructure contribute fairly to its expansion.

As we look towards 2047, our mission is clear. We must move beyond simply connecting villages to empowering every citizen within them. This requires a concerted push on digital literacy, creating content in regional languages, and designing use cases that solve real-world problems for rural communities. The telecom industry, in partnership with the Government and the people of India, is committed to building a Viksit Bharat where the digital dividend is a shared inheritance, not a divided asset.

# Tech Horizons:
# The Innovations Redefining Tomorrow's Networks

[TELECOM TALK]
**WIRELESS**

LT GEN DR SP KOCHHAR

# UNTANGLING THE WEB: FWA SPINS A NEW BROADBAND FUTURE

5G FWA is reshaping India's broadband landscape with faster, cost-effective connectivity, bridging digital divides and complementing fibre networks.

Recently, Fixed Wireless Access (FWA) has emerged as a transformative 5G use case in India, revolutionising how Internet services are delivered. Unlike traditional broadband networks, which rely on extensive wired infrastructure, FWA offers high-speed Internet access to homes and businesses. As a result, the technology has gained significant traction in the country owing to its ability to provide superior service quality, faster deployment and lower costs.

According to a recent report by Ericsson, 5G FWA connections in India reached nearly three million in the last year. The same report also projects that India will soon surpass the United States in the number of 5G FWA broadband subscriber homes, potentially reaching over 85-100 million by 2030.

## THE FWA OPPORTUNITY

Globally, FWA has gained considerable momentum as a viable alternative to traditional broadband, offering speeds comparable to fibre-optic technologies. In India's data-intensive and cost-conscious market, FWA represents a revolutionary solution for expanding Internet connectivity. It addresses the unique challenges of providing reliable broadband access across rural and semi-urban regions, where traditional fibre-optic installations face logistical and financial hurdles due to the country's vast and diverse terrain.

> " Traditional fibre-optic infrastructure requires significant investments in laying cables, ROW, and maintaining the network, making it slow and expensive.

> Globally, FWA has gained considerable momentum as a viable alternative to traditional broadband, offering speeds comparable to fibre-optic technologies.



## IN BRIEF

- 5G FWA is rapidly gaining traction in India, offering faster deployment and lower costs compared to traditional fibre-based broadband.

- India is projected to surpass the US in 5G FWA broadband users by 2030, with over 85–100 million subscriber homes.

- FWA's cost-effectiveness and quick rollout make it a game-changer for rural and semi-urban connectivity.

- Challenges include signal limitations due to terrain and distance from towers, making it a complementary, not standalone, broadband solution.

- The 6 GHz spectrum plays a crucial role in enabling high-speed 5G FWA, helping bridge India's digital divide.

- As FWA adoption grows, it is set to drive digital inclusion, supporting education, healthcare, and business transformation across India.

Traditional fibre-optic infrastructure requires significant investments in laying cables, securing right-of-way permissions, and maintaining the network, making it slow and expensive. In contrast, FWA leverages high-speed wireless signals to transmit data between base stations and end-user devices, eliminating the need for extensive cabling.

A report by GSMA Intelligence suggests that this technological approach has been shown to achieve cost savings of up to 80% compared to Fiber-to-the-Home (FTTH) deployments in rural areas. Additionally, FWA can be rolled out much faster, enabling quicker access to broadband services in underserved or unconnected regions. This speed and efficiency make FWA a game-changer in bridging India's digital divide.

FWA capitalises on existing mobile network infrastructure, enabling service providers to deliver high-speed Internet without extensive groundwork. This capability is critical for expanding access to essential services such as education, healthcare and e-commerce, fostering socio-economic development.

### THE ADOPTION OF FWA

The global adoption of FWA has been accelerating, driven by advancements in 5G technology and increasing demand for high-speed connectivity. FWA offers fibre-like speeds, enabling seamless streaming, online gaming and video conferencing, making it an attractive option for both residential and business users.

As of 2024, global FWA connections are projected to reach 160 million, with an estimated growth of 350 million by 2030. This would account for approximately 19% of all fixed broadband connections, with nearly 80% of these connections expected to operate on 5G networks. Interestingly, while 4G FWA connections are forecasted to peak by 2026, the growth of 5G FWA continues unabated, further highlighting its potential.

In India, leading telecom operators have been at the forefront of the FWA revolution. They began offering 5G FWA services in the fourth quarter of 2023, and by the first half of 2024, these services had already added

## [TELECOM TALK]
### WIRELESS

> FWA addresses the unique challenges of providing reliable broadband access in regions where fibre-optic installations face logistical and financial hurdles.

over two million subscribers. This rapid adoption has outpaced other fixed broadband technologies. According to Counterpoint Research, the rollout of fibre-optic services is happening much slower and is expected to lag behind 5G FWA in terms of net subscriber additions through 2025.

With more than 350 million households in India, it is evident that fibre alone cannot bridge the digital divide. Complementary technologies like 5G FWA are essential to meeting the demand for high-speed Internet services at scale.

### LIMITATIONS OF THE FWA TECHNOLOGY

Despite the rapid rise of 5G FWA in India, the technology is not without its limitations. FWA's transmission distance is limited. Since FWA connections depend on proximity to cellular towers, areas far from these towers may experience weaker signals or lack coverage. Factors such as trees, buildings, and terrain-related path loss can also affect these signals. These obstacles can obstruct or weaken the wireless signal, with the degree of impact varying depending on the density of vegetation, the height and placement of buildings and the specific topography of the area.

This indicates that while FWA can complement existing broadband solutions, it may not serve as a standalone solution to bridging the digital divide across all regions of India. Rural areas, in particular, may face signal strength and availability issues due to their distance from network infrastructure. These challenges suggest that while 5G fixed broadband and FTTH can coexist in urban and rural areas, FWA may significantly extend connectivity to remote villages and bridge the digital divide.

The 6 GHz spectrum band offers substantial advantages for FWA deployments, making it one of the major bands for delivering high-speed broadband. High data throughput, larger bandwidth and beamforming capabilities make 6 GHz one of the most efficient bands for delivering 5G FWA services. By adopting the 6 GHz spectrum for 5G FWA, TSPs can meet the growing demand for faster, more reliable Internet.

As per GSMA, enhanced Mobile Broadband (eMBB) services have been the primary use case for 5G launches to date, and holds true for 6 GHz plans. As per GSMA, 92% of operators say eMBB is a planned 6 GHz IMT use case. The second most popular use case, cited by 54% of operators, is FWA. 6 GHz can enable FWA to serve a role towards diversifying operator revenues and helping to close the digital divide.

### A CASE FOR INCLUSIVE GROWTH

While the 5G FWA technology has its limitations, it not only addresses connectivity challenges but also paves the way for inclusive growth by supporting digital transformation across various sectors. From improving access to online education in rural areas to enabling remote healthcare services and enhancing business operations, FWA has far-reaching implications. Its ability to provide reliable and high-speed Internet, even in the country's remotest corners, underscores its role as a cornerstone of India's digital future.

In rural India, where traditional fibre deployments can be expensive and slow, FWA offers a feasible alternative for delivering broadband. This technology is particularly suited to areas where infrastructure challenges, such as rugged terrain or dense urbanisation, hinder the reach of wired broadband solutions. With the number of 5G FWA subscribers expected to double by 2025 compared to the end of 2024, this technology is poised to play a pivotal role in India's journey towards becoming a digitally empowered society.

As India pushes for a more digitally connected future, combining 5G FWA and other complementary technologies will be instrumental in bridging the divide and ensuring access to high-speed Internet for all citizens, regardless of location. ♣

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[TELECOM TALK]
**INTERNET OF THINGS**

### LT GEN DR SP KOCHHAR

# EXPANDING THE IOT FRONTIER WITH 5G-POWERED INNOVATION

India's telecom industry is at the heart of IoT expansion, enabling smart cities, industrial automation, and a connected digital ecosystem.

The Economic Survey 2025 suggests India has become the second-largest telecommunications market globally, with over 1.18 billion telephone subscribers and 941 million broadband connections as of October 2024. This remarkable expansion in telecom infrastructure has played a crucial role in accelerating the growth of Internet of Things (IoT) services across the country.

India's telecom industry has experienced remarkable growth, culminating in a rapid transition to 5G technology. By October 2024, the average monthly data consumption per wireless user reached 21.2 GB, with the number of 5G Base Transceiver Station sites crossing the 4.6 lakh mark to meet the growing demand. This swift expansion elevated India's global mobile broadband speed ranking from 118th to 18th as of January 2025.

The government's commitment to digital inclusion and substantial investments from major telecom operators have been instrumental in this progress. As the industry moves towards 5G Advanced, it is poised to enhance connectivity further and drive socioeconomic development across the nation.

## 5G AND 5G ADVANCED: ACCELERATING IOT ADOPTION

This widespread availability of affordable smartphones and IoT-enabled devices, coupled with advancements in cloud computing, big data analytics and AI-driven insights, has fuelled the rapid adoption of IoT solutions. Additionally, the increasing penetration of high-speed broadband, 5G networks, has provided the necessary connectivity framework for seamless machine-to-machine or M2M communication and real-time data exchange. This IoT

> " The government's initiatives to promote digital transformation and investments from telecom operators are propelling the integration of IoT solutions.

> Telecom operators are not just connectivity providers but key enablers of India's digital economy, accelerating IoT adoption through robust 5G infrastructure.



## IN BRIEF

- India's telecom sector is the second largest globally, with rapid 5G expansion driving increased broadband adoption and IoT integration.

- 5G networks enable IoT growth in industries like healthcare, agriculture, and smart cities, improving efficiency and connectivity.

- AI-powered IoT solutions enhance urban infrastructure, traffic management, energy grids, and public safety in India's smart cities.

- Industry 4.0 is leveraging IoT for predictive maintenance, automated production, and real-time tracking, optimising manufacturing processes.

- 5G Advanced will enhance IoT with ultra-reliable low-latency communication, AI-driven automation, and large-scale device connectivity.

- Security risks and infrastructure costs remain challenges, but telecom players are investing in AI-driven security and cost-effective IoT models.

adoption can potentially drive efficiency, innovation, and economic growth across various sectors, such as healthcare, agriculture, manufacturing, and smart cities.

The seamless integration of technology fosters innovations in industries like manufacturing, healthcare, agriculture, and smart cities. For instance, 5G-powered IoT devices in agriculture facilitate precision farming by providing real-time data on soil health, weather conditions and crop monitoring, thereby enhancing yield and resource efficiency. Similarly, IoT devices connected via 5G networks in healthcare enable remote patient monitoring and telemedicine services, improving access to medical care, especially in rural areas.

The government's initiatives to promote digital transformation, coupled with investments from telecom operators, are further propelling the integration of IoT solutions, positioning India to harness the full potential of a connected ecosystem.

### TRANSFORMING INDUSTRIES WITH CONNECTED ECOSYSTEMS

India's strong push for 5G expansion has paved the way for widespread IoT adoption, driving advancements in smart cities and Industry 4.0. With high-speed, low-latency networks, IoT-powered solutions are transforming urban management and industrial automation, making them more efficient, sustainable and data-driven.

IoT plays a crucial role in smart cities by enabling real-time data collection and automation across multiple urban systems, making them smarter and more efficient. AI-driven traffic management optimises signals to ease congestion, while smart public transport enables real-time tracking and automated ticketing for smoother commutes. IoT-powered smart grids enhance energy efficiency and integrate renewables, and intelligent water and waste systems monitor quality, detect leaks and streamline garbage collection. Environmental sensors track pollution levels, aiding proactive interventions, while AI-driven surveillance and emergency systems bolster public safety.

Similarly, smart buildings optimise energy use, and digital kiosks powered by enhanced digital connectivity

## [TELECOM TALK]
### INTERNET OF THINGS

> The shift to 5G Advanced will bring ultra-reliable, low-latency communication, empowering critical IoT applications in healthcare, transport, and security.

avenues ensure seamless and uninterrupted connectivity. Together, these innovations are shaping sustainable, technology-driven smart cities. India's 100 Smart Cities initiative is already driving these innovations, with cities like Pune, Bhopal and Hyderabad implementing command-and-control centres to streamline urban management.

On the industrial front, Industry 4.0 is revolutionising manufacturing and supply chains by integrating technologies like IoT. Factories are increasingly using predictive maintenance, where IoT sensors detect anomalies in machinery, allowing repairs to be scheduled before costly breakdowns occur.

Automated production lines, powered by AI and IoT-enabled robots, enhance precision and efficiency while reducing human errors. Supply chains have become more transparent and responsive with real-time tracking of goods and IoT-driven smart warehouses optimising inventory management. Additionally, industries are leveraging digital twins — virtual models of physical assets that use real-time IoT data to simulate operations and optimise performance.

### ADVANCEMENTS, CHALLENGES, AND THE ROAD AHEAD

As the 5G technology progresses and evolves into 5G Advanced or 5.5G, it will provide ultra-reliable low latency communication—URLLC, ensuring that critical IoT applications, such as autonomous vehicles and industrial automation, operate with minimal delays and high dependability. Furthermore, by incorporating AI and ML, Advanced 5G networks can intelligently manage and optimise IoT device operations, leading to more efficient and responsive systems.

With enhanced capacity and performance improvements, Advanced 5G can handle a vast number of connected devices simultaneously, facilitating large-scale IoT deployments in smart cities and across sectors, including healthcare and agriculture.

However, implementing 5G-enabled IoT solutions in India presents several challenges. One such hurdle is

security. The integration of 5G with IoT increases the risk of cyberattacks, as many IoT devices lack robust security features, making them vulnerable entry points for hackers. Furthermore, substantial investment is required for sustainable infrastructure development.

The Indian telecom industry is actively trying to address these challenges. Companies are known to have entered into multi-billion-dollar agreements with global equipment manufacturers to secure and enhance their 4G and 5G network coverage. These partnerships aim to deploy advanced solutions, including centralised radio access networks and Open RAN-ready technologies, to improve network flexibility and performance. The focus is also on developing cost-effective solutions and scalable models to make IoT adoption more accessible for small and medium-sized enterprises.

### DRIVING IOT-DRIVEN GROWTH IN INDIA

The rapid expansion of 5G and Advanced 5G in India is laying the groundwork for a highly connected and intelligent digital ecosystem. This convergence of telecommunications and IoT is set to revolutionise industries, drive innovation and contribute significantly to India's digital economy.

The Indian telecom industry is working to make these technologies more accessible, particularly for SMEs, through partnerships, investment in AI-driven security frameworks, and scalable IoT solutions. As digital connectivity deepens, India's digital transformation journey will accelerate, fostering economic growth, innovation, and global competitiveness.

The future of IoT in India, backed by strong telecom infrastructure, is poised for exponential growth, ensuring sustainable progress and technological empowerment across the nation. 🧩

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*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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# How network digital twins are transforming the telecom Industry

**Communications Today – 2nd March 2025**

Digital twins have emerged as a lifeline across sectors in India and the telecom industry is no exception to this global phenomenon. In telecom, this revolutionary technology provides a virtual replica of real-world infrastructure and networks which enable operators to monitor performance in real time, predict potential issues, optimize resource allocation and make data-driven decisions. According to a report by EY, the global digital twin market is expected to reach $137.67 billion by 2030, with this momentum led by countries like South Korea, Japan, India and China.

## Network digital twins: Shaping the future of connectivity

The network digital twins (NDTs) essentially serve as a "digital lab" to test changes before implementing them on the physical network. As a highly detailed virtual replica of the real network, it not only models physical elements like radio towers, routers, switches and data centre servers, but also the 'invisible' parts of the network such as signals, coverage, interference, traffic behaviour and user mobility across frequency layers throughout different and difficult Indian terrains. This, in turn, allows operators to improve network reliability and customer experience by increasing overall operational efficiency while also helping them reduce necessary costs and time.

## Unlocking telecom efficiency

Last year, the Finnish telecommunications company, Nokia, released a research report identifying 35 use cases across the entire network lifecycle where network digital twins (NDTs) could have a positive impact. According to the report, an analysis conducted by Nokia's research arm, Bell Labs, found that implementing 16 of these use cases could result in potential annual network operational cost savings of 24.8 percent.

The sector can put the technology to use in the following ways:

- **Network planning**: Digital twins can be testbeds for assessing scenarios related to network planning to determine the best configuration in India's various terrains. This helps detect and resolve issues early in the process.

- **Resource efficiency**: Network digital twins provide operators with granular visibility into network utilization and traffic patterns. This knowledge allows for judicious resource allocation across India's high teledensity areas for better QoS.

- **Predictive maintenance**: By analysing network behaviour, digital twins can predict service performance and identify potential degradations, enabling proactive measures to maintain optimal functionality.

- **Validating AI-driven decisions**: Digital twins enable the verification of AI/ML-based automation decisions before their implementation, enhancing the reliability and trust in autonomous network operations.

- **Energy consumption analysis**: NDTs can effectively identify energy inefficiencies within the network by analysing data from cell towers and other equipment through the digital twin and allowing optimum allocation for each process.

- **Enhanced compliance**: Dynamic compliance with Service Level Agreements (SLAs) enables precise and efficient network performance and quality standards monitoring. It aids in identifying and addressing potential issues or violations, reducing downtime and service interruptions.

## The transformative impact of network digital twins

Employing NDT technology can bring significant advantages to Indian telecom operators. With delivering quality services to customers as a core priority, operators can detect network bottlenecks and potential issues before they affect users, enabling proactive problem resolution and maintaining high service standards. Additionally, by facilitating preventive maintenance and optimizing network operations, digital twins can substantially lower operational costs related to network management, which provides Indian telecom operators the necessary relief in the current high Infrastructure cost environment. They also save time by ensuring the deployment of the right infrastructure, leading to faster and more efficient implementation.

Beyond enhancing networks, digital twin technology is also driving the adoption of Industry 4.0 practices and creating new opportunities for Indian telecom companies to monetize their 5G services. It will also help telecom operators generate revenue from their fibre networks, 5G spectrum, and data center assets. They can further capitalize on opportunities in edge computing and network slicing.

## A two-way road: Telecom sector fuelling NDT growth

While Network Digital Twins significantly contribute to the growth of India's telecom industry, advancements in telecom technologies further enhance Digital Twin capabilities. To improve their networks, Indian telecom operators are continuously developing technologies using advancements such as artificial intelligence and machine learning (AI/ML), generative AI (GenAI) and edge computing. These next-generation technologies play a crucial role in the ongoing evolution of NDTs.

In addition to leveraging AI technology for various network processes, NDTs can be further automated through AI, enhancing efficiency and reducing errors. Generative AI (GenAI) is also being utilized to streamline digital twin development and deployment by generating synthetic data to complement real-world data. This enables training digital twin models without requiring extensive datasets while aiding in visual insights and

realistic scenario generation. According to a report by Capgemini, GenAI-accelerated digital twins have demonstrated a 10x improvement in ROI and a reduction in OpEx by up to 50 percent. Additionally, edge computing facilitates real-time data processing closer to the source, essential for creating an accurate and responsive virtual representation of a physical network.

## India's role in scaling digital twins driving digital transformation

Recognizing the increasing importance of digital twin technology in India's ambition to become a global telecom leader, the government is actively promoting its adoption. Recently, the Department of Telecommunications (DoT) signed a Letter of Intent (LoI) with the International Telecommunication Union (ITU) to drive innovation in digital twins and other emerging technologies. Additionally, the government has launched various initiatives such as the 'Sangam: Digital Twin' initiative to harness infrastructure planning and development technology.

## The road ahead

Network digital twins are transforming how telecom operators manage their networks by enabling proactive decision-making, enhancing network performance and improving customer experiences. While the industry and government are making strides in advancing these technologies, more must be done to unlock their potential fully. Moreover, as the technology evolves, so do the associated risks and security challenges. Since network digital twins depend heavily on data and real-time updates, ensuring robust security and privacy measures is essential.

LT GEN DR SP KOCHHAR

# POWERING A
# GREENER FUTURE WITH
# SUSTAINABLE GROWTH

India's telecom sector is aligning 5G expansion with sustainability, adopting green energy, AI, and e-waste solutions for a cleaner digital future.

Over the last couple of years, the world has undergone a massive digital transformation. This change not only marks a shift towards a more digitally connected society but also a more sustainable one. Across industries, there has been a growing awareness of the adverse environmental impact that rapid technological transformation has had and the need for urgent action.

As a crucial and ever-evolving sector, the global telecom industry is shifting towards sustainable practices to develop more sustainable and environmentally friendly telecom networks.

The industry's emissions are primarily due to energy consumption from network equipment, such as base stations and data centres, the use of diesel generators for backup power, and the increasing energy demands of newer technologies like 5G. According to Nokia's MBiT Report 2025, pan-India monthly 5G traffic surged threefold (year-over-year) to reach 7.6 EB in 2024.

This surge in data traffic has led to major investments in telecom, resulting in widespread infrastructure upgrades across the country and catapulting India to the forefront of global telecom infrastructure innovations.

Since its launch, 5G has pushed the country's telecom infrastructure to an unprecedented scale, with over 4.69 lakh 5G base stations installed in record time, powering over 25 crore 5G users in the country. As the infrastructure scales, it poses a challenge for the industry's sustainability

> " Prioritising sustainability is essential not only to minimise the industry's carbon emissions but also to tap into potential cost savings.
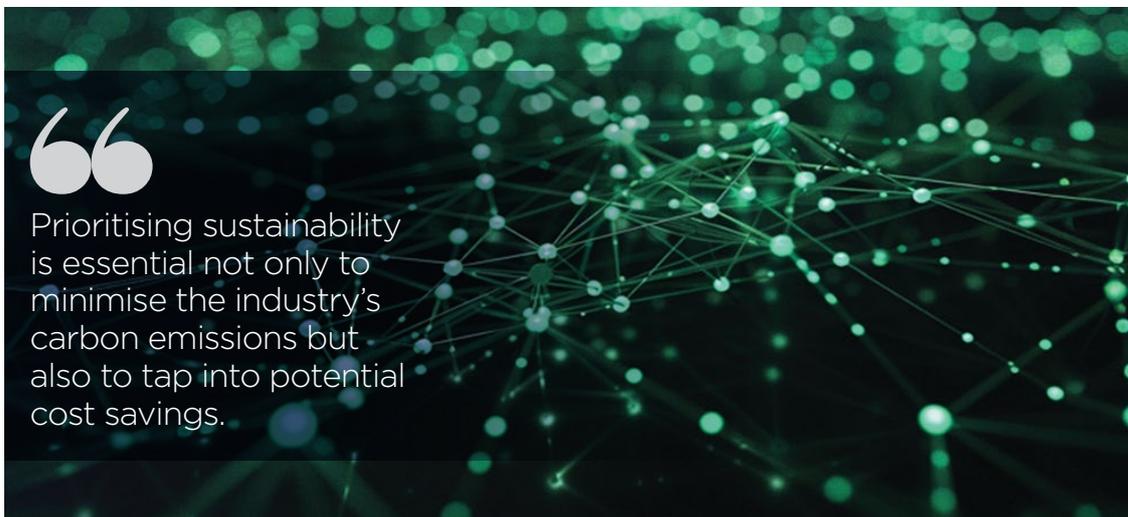
[TELECOM TALK]

**GREEN NETWORKS**

> Telcos' emissions are primarily due to energy consumption from base stations and data centres, as well as the use of diesel generators for backup power.

## IN BRIEF

- India's 5G surge has raised energy demands, prompting telcos to embrace sustainable practices to cut emissions and optimise networks.
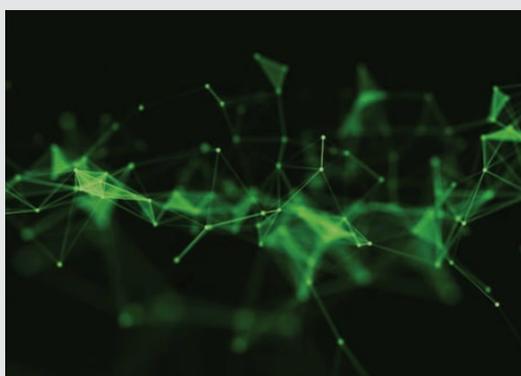
- Operators are adopting ESG frameworks, AI-led optimisation, and energy-efficient cooling in data centres to meet sustainability goals.

- Airtel, Jio, and Vodafone Idea have set ambitious net-zero targets, aiming to slash GHG emissions across Scopes 1, 2, and 3 by 2035–2050.

- India generated 3.8 million metric tonnes of e-waste in FY24, driving telcos to strengthen recycling and disposal efforts.

- Policies such as the 2022 E-Waste Rules and EPR mandates are encouraging manufacturers and telcos to adopt more responsible waste practices.

- Industry collaboration and smart regulation will be critical in balancing digital expansion with climate commitments and resource limitations.

goals. In these times of enhancing connectivity and environmental goals, the Indian telecom industry has intensified its focus on sustainable innovation.

### TELCOS' EFFORTS FOR GREENER NETWORKS

Recognising the urgent need for action and the importance of building more sustainable networks, Indian telecom companies are increasingly implementing Environmental, Social and Governance (ESG) strategies and initiating green initiatives. They are actively pursuing net-zero emissions targets, aiming to reduce their carbon footprint and address the environmental impact of their operations.

Data centres, often described as the unseen backbone of the digital world, consume substantial amounts of energy due to the extensive server farms they house, which demand constant cooling to operate efficiently. To address this, telecom companies in India are adopting a range of strategies aimed at enhancing data centre efficiency and reducing energy consumption. One key approach includes the use of advanced cooling technologies, such as air-side economisers and high-efficiency cooling fluids, to optimise temperature control and lower their environmental impact.

Additionally, the Indian telecom companies are increasingly leveraging AI solutions to optimise network performance and enhance operational efficiency. Through AI-driven analytics, telecom operators can predict network congestion, automate maintenance and dynamically allocate resources, leading to improved service quality and reduced energy consumption. These intelligent systems help in real-time decision-making, enabling faster responses to network issues while supporting the industry's broader goals of sustainability and digital transformation.

Telcos in India have also introduced focused measures in their quest to build greener networks. Bharti Airtel, for instance, has pledged to cut its absolute Scope 1 and 2 greenhouse gas (GHG) emissions by 50.2% by FY2031, using FY2021 as the base year, and aims to achieve net-zero emissions by 2050. It has also committed to reducing absolute Scope 3 emissions by 42% within the same timeframe.

> India has emerged as the world's third-largest generator of e-waste, after China and the USA, with 3.8 million metric tonnes produced in FY24.

Meanwhile, Reliance Jio has set its sights on becoming a net-zero company by 2035 and has earned an 'A-' leadership rating from CDP for its transparency and performance across climate change, forests and water security categories. Similarly, Vodafone Idea (VI) is advancing its sustainability efforts with a strong emphasis on improving energy efficiency and cutting emissions.

Prioritising sustainability is essential not only to minimise the industry's carbon emissions but also to tap into potential cost savings. A McKinsey report highlights that decarbonisation measures can help companies cut energy expenses by 15–30%.

### ADDRESSING THE GROWING E-WASTE CHALLENGE

Besides emissions, another growing concern for the sector is managing the mounting challenge of electronic waste. India has emerged as the world's third-largest generator of e-waste, after China and the USA, with 3.8 million metric tonnes produced in FY24. Given that the electronic devices market has grown significantly since then, this percentage could have only increased. However, to address the challenge, India has made significant strides in promoting green telecom through early policy frameworks and industry initiatives.

The Telecom Regulatory Authority of India laid the foundation with the 2011 guidelines, encouraging the use of renewable energy, and introduced the Green Passport certification for energy-efficient telecom equipment. The E-Waste (Management) Rules 2022 specifically aim to introduce environment-friendly processing technologies to help formalise the e-waste management sector. It mandates that the manufacturers of electrical and electronic equipment are responsible for meeting recycling targets through registered recyclers.

The norms also encourage the reuse through the generation of refurbishing certificates and include provisions for the generation of digital extended producer responsibility (EPR) certificates. The Ministry of Environment & Forest has also introduced the EPR regime, which holds electronic manufacturers responsible throughout their lifecycle.

In response to these mandates, telecom service providers in India have adopted several e-waste management practices to reduce the environmental impact of the outdated electronic equipment. They are actively pursuing strategies to dispose of and responsibly recycle the e-waste. For example, Reliance Jio has partnered with The Pegasus, an authorised e-waste recycler, to facilitate end-of-life disposal of devices for both the company and its customers.

Vodafone Idea has also taken significant steps to manage e-waste responsibly. Airtel has adopted a comprehensive strategy to trace the e-waste generated through network upgrades and capacity expansions, ensuring that it is handled and recycled in compliance with the Waste Electrical and Electronic Equipment (WEEE) guidelines. These are a few among the several initiatives adopted by industry players in India.

### BUILDING A SUSTAINABLE DIGITAL ECOSYSTEM

The telecom industry in India is at a pivotal point where digital growth must go hand-in-hand with environmental responsibility. Through strategic ESG initiatives, energy-efficient technologies, AI-driven optimisation and responsible e-waste management, telecom players are actively addressing the sector's environmental challenges.

While substantial progress has been made, sustained collaboration between industry leaders, policymakers and consumers will be essential to achieving a truly green telecom ecosystem. By embracing sustainability today, Indian telecom companies are not only securing a better future but also setting a global example for responsible growth. 🪔

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

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## INTERVIEW

> Telecom is becoming a universal digital fabric, with horizontal networks weaving together every sector. This shift to an open, programmable platform will power a dynamic, inclusive digital economy.

# Telecom meets every sector – The rise of horizontal networks as universal infrastructure

**Lt Gen Dr SP Kochhar | Director General | Cellular Operators Association of India**

India's telecom landscape is not just evolving; it's witnessing a massive transformation. There were times when networks were siloed, rigid, and built for specific services or sectors. But now, those days are fading fast. At this point, we are witnessing a shift toward horizontal networks, with digital infrastructure serving as the backbone for everything and supporting the economy as a whole. But why does this horizontal shift matter? Because it's not just a technology upgrade, it's a complete reimagination of how connectivity enables inclusion, innovation, and growth everywhere from crowded cities to the remotest villages.

### Building a unified digital spine

At the heart of this revolution are two game-changing initiatives. 5G rollout has taken off with 365 million subscribers already, in a span of mere 3 years. Alongside this, BharatNet has expanded its optical fiber to over 2,14,325 gram panchayats, laying down about 7 lakh kilometers of optical cable. That means reliable broadband isn't a dream anymore, it's a reality for countless rural Indian villages. This isn't just connectivity, it's a foundation for a digital ecosystem where cities, villages, businesses, and new-age digital economies all thrive on the same platform.

### Horizontal networks – Why are agility and interoperability the new norms?

A critical factor to consider here is how telecom networks have evolved to become a "value-added horizontal" - in the words of the Hon'ble Minister for Communications, Jyotiraditya M. Scindia - rather than a vertical, as all businesses, social needs, and Government administration work today are highly dependent on telecommunications. Whether it is agriculture or education, medicine or disaster recovery, from professional activities to personal outreach, telecommunications has evolved to be a critical part of our lives.

Moreover, telecom is currently cloud-native, flexible, and built on cutting-edge open architectures, which means networks are not only faster to deploy but also smarter to manage. Network slicing, too, has emerged as a real game-changer, with the ability to carve out virtual networks from the same physical infrastructure, each tailored to unique needs with never-before innovation, from ultra-low latency for driverless cars to bulletproof security for enterprise IoT. And with open APIs and Network-as-a-Service (NaaS) models, developers and businesses can tap into telecom's power on demand, creating a wave of digital apps.

### Catalyzing industry innovation across sectors

This horizontal approach is rewriting the rules for industries. Take manufacturing, for instance: 5G networks are making real-time automation and predictive maintenance the new norm, keeping sensitive data close to home while powering efficiency to new heights. In finance, telco APIs embedded in rural kiosks enable quick payments and microloans, expanding financial inclusion. Healthcare is also getting a makeover, with village clinics connected over the internet, conducting remote diagnostics in sync with urban specialists. At the same time, agriculture is also stepping into a smarter era, leveraging IoT sensors via a unified network to optimize yields based on soil and weather data. These examples reveal a bigger picture: when connectivity is a shared, programmable, secure utility, innovators can focus on what they do best.

### The economic transformation – From asset to platform

Beyond technical transformation, horizontal networks fundamentally reshape telecom economics from asset-intensive to platform-driven models. Programmable infrastructure enables dynamic resource allocation through software-defined architectures, allowing operators to monetize network capabilities rather than bandwidth alone. This shift creates new ecosystem opportunities where telcos act as digital service enablers, fostering innovation through open interfaces that third-party developers can leverage. The platform approach transforms traditional Operations Support Systems (OSS) and Business Support Systems (BSS) into business-enabling tools. This economic model mirrors the success of tech platforms, positioning telecom infrastructure as the foundation for diverse digital services across various industries.

### Governance for a wireless future

Of course, such a transformation cannot happen without smart governance. India's regulatory environment is evolving alongside. The Telecom Act 2023 and the upcoming National Telecom Policy 2025 both push for spectrum reforms and easier licensing. This isn't about tightening controls; it is about tearing down old barriers and empowering businesses to create private, hybrid networks tailored to their unique needs.

Security, naturally, remains at the forefront of our minds. Technologies like Zero Trust architecture are stepping up to keep these increasingly interconnected networks safe and resilient. Meanwhile, innovations such as spectrum leasing and infrastructure sharing are helping to cut costs and boost efficiency.

### The road to a digital-first India

This year's India Mobile Congress 2025 also marks a pivotal event in the journey toward a fully horizontal telecom infrastructure. As our hon'ble Union Minister, Jyotiraditya M. Scindia recently said *"This (IMC) is not only a platform where we will discuss only 5G, 6G, AI, IoT, M2M and so on and so forth, but it's also a platform where we will be talking about how farmers, children in schools, MSMEs, etc. are connected and how society will find new opportunities and new hopes"*. This perspective highlights how IMC 2025 is positioned not just as a tech showcase but as a convergence point where digital infrastructure meets inclusive societal impact.

Looking ahead, the rise of horizontal networks signals a future where telecom isn't just a utility but the universal digital fabric, weaving together every sector, scaling seamlessly with demand, and evolving with emerging technologies. By embracing open ecosystems, cloud-native infrastructure, and flexible service models, India is not just keeping pace; it's set to lead the world in building a dynamic, inclusive digital economy. ●

**AI Breakthroughs:
Transforming Networks,
Experiences & the Road to 6G**

# Agentic AI - The next frontier for the Indian telecom revolution

**Communications Today - 2nd April 2025**

The Indian telecommunications sector is at a transformative juncture, propelled by the rapid evolution of artificial intelligence (AI). The emergence of Agentic AI – autonomous, goal-driven software agents capable of acting independently – marks a shift beyond traditional automation. As India's telecom industry scales to serve over a billion users, Agentic AI promises to redefine network operations, customer engagement, and business outcomes, positioning India as a global leader in AI-driven telecom innovation. The advent of Agentic AI represents a significant leap forward for today's AI strategies by enabling autonomous, proactive decision-making, moving beyond reactive analytics and automation. This transition will be transformative for communications service providers, enabling self-optimizing networks, enhancing customer experience, and compelling new levels of operational efficiency.

## From automation to orchestration: What sets Agentic AI apart

Unlike conventional AI, which relies on deterministic commands and human oversight, Agentic AI systems are designed for autonomy and proactive orchestration. These agents interpret high-level objectives, formulate dynamic plans, and execute tasks across complex environments—often collaborating with other agents and learning from every outcome. This shift enables telecom operators to move from mere task automation to intelligent orchestration of entire workflows, delivering foresight, agility, and resilience at scale.

## How Indian telecom operators are leading with Agentic AI

India's unique telecom landscape, with its massive subscriber base, rapid 5G rollout and digi-

tal inclusion initiatives, creates fertile ground for Agentic AI adoption. According to Deloitte's "State of GenAI Report, Wave 4", over 80 percent of Indian organisations are exploring the development of autonomous agents, and 50 percent prioritize multi-agent workflows that allow sub-agents to collaborate under a master agent's supervision. The same report found that 70 percent of firms leverage GenAI for automation, and almost 70 percent of respondents said that their AI integration efforts met or surpassed ROI estimates. This underscore both the scale of adoption and the tangible business impact.

Reliance Jio is deploying "JioBrain", an AI-driven digital twin platform for advanced network planning and real-time operations. JioBrain leverages Agentic AI to simulate, monitor, and optimize network performance, enabling predictive maintenance and dynamic resource allocation. Jio's AI Cloud also democratizes access to enterprise agentic capabilities across sectors. Bharti Airtel has partnered with Nokia to infuse AI into its 4G and 5G infrastructure, using agentic models for network optimization and predictive maintenance. Airtel's Nxtra data centers employ AI agents to boost energy efficiency and preemptively address system faults. Airtel pioneered India's first network-based, AI-powered spam detection solution, demonstrating agentic AI's role in proactive security. Vodafone Idea leverages HCL's ANA platform, an agentic AI system for network operations and automation to enhance VoLTE services and customer experience. Vi's focus on AI-driven automation is improving service reliability and operational efficiency, especially as the company navigates market challenges.

By April 2025, India had deployed over 460,000 5G base stations, with more than 125 million users – a scale where agentic AI is critical for real-time traffic management, network self-healing, and hyper-personalized service delivery (industry data, sector updates). Agentic AI enables ecosystem-level intelligence, integrating telecom networks with IoT, smart cities, and partner platforms for seamless, cross-domain services.

## Real-world benefits: Efficiency, personalization and security

Network optimization. Agentic AI enables telecom operators to continuously monitor network performance and autonomously adjust parameters such as signal strength, frequency allocation, and traffic routing in real time. This dynamic optimization is crucial as networks face fluctuating demand patterns, especially with the surge in video streaming, cloud gaming, and connected smart devices. By proactively balancing loads and mitigating congestion, agentic AI reduces latency and packet loss, ensuring smooth user experiences. These AI agents can also simulate "what-if" scenarios to prepare the network for upcoming events or sudden spikes, improving resilience and capacity planning.

Predictive maintenance. Beyond simple fault detection, agentic AI analyzes historical and streaming sensor data to identify subtle degradation trends in hardware components like base stations, routers and power supplies. This early warning system allows operators to schedule maintenance during low-traffic periods, minimizing service disruption. Furthermore, AI agents can recommend optimal replacement cycles and spare parts inventory management, reducing costs and improving asset utilization. This proactive approach significantly lowers the frequency of emergency repairs and enhances network uptime.

Enhanced customer service. Agentic AI-powered virtual assistants are evolving to provide hyper-personalized experiences by integrating data from multiple sources, including call history, usage patterns, and social media sentiment. These agents can anticipate customer needs by suggesting data top-ups before depletion or alerting users to plan changes based on their behavior. They also enable seamless omnichannel support, switching effortlessly between chat, voice, and messaging platforms, thus improving accessibility and convenience for diverse customer segments.

Fraud detection and security. Agentic AI continuously refines its understanding of normal network behavior by learning from vast datasets, enabling it to detect subtle anomalies that may indicate fraud or cyberattacks. Unlike traditional rule-based systems, these AI agents adapt to new attack vectors in real time, coordinating responses across network layers to isolate threats swiftly. This adaptive security is critical in preventing SIM cloning, subscription fraud, and denial-of-service attacks, safeguarding operator revenue and customer trust.

Process automation. Agentic AI automates complex workflows that involve multiple departments and systems, such as regulatory reporting, inter-carrier settlements, and contract management. By orchestrating these processes end-to-end, AI agents reduce cycle times and eliminate bottlenecks caused by manual handoffs. This not only improves compliance accuracy but also accelerates time-to-market for new services. Automation also extends to dynamic resource allocation in cloud-native network functions, enabling telecom operators to scale services efficiently in response to demand fluctuations.

## Challenges and the road ahead

Despite rapid progress, challenges remain. High investment costs, data quality issues, and cybersecurity risks can hinder AI deployment. The shortage of skilled AI/ML professionals, cited by over a quarter of industry leaders, remains a significant barrier. Addressing these requires industry-academia collaboration, targeted reskilling, and robust AI governance frameworks to ensure ethical, secure, and unbiased AI adoption.

## India's Agentic AI advantage

Agentic AI is not just an incremental upgrade; it is the strategic brain powering the next phase of India's telecom revolution. With strong policy support, world-class talent, and pioneering operator initiatives, India is poised to lead in the global agentic AI landscape. The future of Indian telecom depends on intelligent automation, innovation, and talent development. Agentic AI embodies these imperatives, offering the industry a path to resilient, efficient, and customer-centric growth.

**TECH** **SPECIAL**

**COLUMN** **TELECOM**

From network optimisation to personalised services, AI is redefining telecom's core—making connectivity smarter, faster, and future-ready

# AI CALLING: THE NEW DIAL TONE OF TELECOM



**T**HE Indian telecom industry is rapidly evolving, with artificial intelligence (AI) playing a crucial role in transforming the network operations and services. COAI has consistently emphasised the importance of AI in optimising network efficiency, enhancing user experience and managing the increasing demand for bandwidth-heavy applications. With the advent of 5G and the impending arrival of 6G, AI is poised to revolutionise telecommunications in India.

## Managing Bandwidth Demands

As broadband consumption in India skyrockets, telecom networks face a tremendous strain due to data-intensive applications such as HD video streaming, cloud gaming, and high-quality video conferencing. In 2023, mobile data consumption in India reached an average of 24.1 GB per month, with mobile data traffic totaling 17.4 exabytes per month, indicating a 26 per cent CAGR over the past five years. COAI emphasises the importance of telecom companies investing in AI-driven solutions

By **S.P. KOCHHAR,** *DG, Cellular Operators Association of India*

to efficiently address network congestion. AI facilitates real-time traffic analysis, predictive maintenance, and automated troubleshooting, ensuring seamless connectivity even during periods of high or peak demand.

### AI Adoption

While the adoption of AI in the Indian telecom industry had started as early as 2010, a major milestone was achieved in 2023, when the Telecom Regulatory Authority of India (TRAI) recommended the implementation of AI across network operations and emphasised the need for a regulatory framework for responsible AI in India. In 2024, India's telecom sector experienced the widespread integration of AI across key functions, including network optimisation, fraud detection, and customer engagement. A KPMG report in October 2024 revealed that AI adoption in India's Technology, Media, and Telecommunications (TMT) sector is growing, with 55 per cent of organisations fully implementing AI and 37 per cent in the scaling phase.

### Major AI Deployments

RJio has developed Jio-Brain, an AI-driven digital twin technology that helps in network optimisation. It also launched Reliance Jio AI Cloud, a dedicated AI-powered cloud computing platform for businesses. Bharti Airtel has collaborated with Nokia for AI-enhanced 4G and 5G infrastructure, while its Nxtra data centres utilise AI for enhanced energy efficiency, streamlined operations, and predictive maintenance. Airtel also launched India's first network-based, AI-powered spam detection solution. Vodafone Idea (Vi) leverages HCL's ANA platform for AI-driven network operations and Machine Learning (ML)-based automation for improving VoLTE services. The government is also collaborating with the International Tel-

**AI services in India are projected to reach $17 billion by 2027, with an increasing number of telecom companies investing in AI-powered innovations**

Photograph by Frolopiaton Palm

ecommunications Union (ITU) to implement AI-driven digital twin technology, aiming to create future-ready network infrastructure.

### Challenges

Indian telecom operators face several challenges. The significant investment required by AI infrastructure may be a hurdle for smaller operators. AI-powered networks are prone to adversarial attacks, software vulnerabilities and supply chain threats if security protocols are not prioritised. AI models in telecom rely heavily on vast amounts of data for training and decision-making. Inaccurate, incomplete or biased data can lead to flawed predictions and suboptimal performance. Implementing AI requires significant investment in infrastructure, skilled talent, and ongoing maintenance. However, measuring its return on investment (ROI) can be complex. Many AI benefits, such as improved customer experience, operational efficiency and fraud prevention, are qualitative and take time to translate into financial gains. Differentiating AI's impact from other technological and process improvements is also challenging.

### The Future of AI

AI services in India are projected to reach $17 billion by 2027, with an increasing number of telecom companies investing in AI-powered innovations. India also boasts the world's second-largest AI talent pool, with over 420,000 professionals working in AI-related domains. The government has also played a crucial role in fostering an AI-forward ecosystem through various policies, infrastructure support and public-private collaborations, helping to create an environment conducive to innovation and sustainable growth. With all this, India is well-positioned to emerge as a global leader in AI-powered telecommunications.

*Full column on www.businessworld.in*

# Gen AI in Indian telecom – Reimagining networks, customer experiences, and the road to 6G

Communications Today – 1st August 2025

Generative AI is rapidly redefining the core of the telecom industry, promising far-reaching impacts across operations, customer engagement, revenue models, and future network architectures. As India's digital ambitions grow, driven by the world's largest user base and relentless demand for innovation, the role of generative AI (GenAI) in telecom is not just a technological upgrade; it's a strategic necessity, with transformative potential now being realized at scale.

## The digital core GenAI's arrival

Once confined to pilot projects and proofs of concept, GenAI is now woven into India's leading telcos. According to a PwC India report, 76 percent of telecom companies have ranked GenAI among their top five strategic priorities, with 40 percent reporting very high GenAI usage in daily routines. Meanwhile, the KPMG 2024 Technology and Telecommunications CEO Outlook reveals that it's more than hype; 55 percent of companies have already achieved full-scale AI implementation, and another 37 percent are scaling fast.

Why is GenAI so indispensable? It learns from vast, diverse telecom datasets, whether words from millions of support chats, diagnostic codes from network sensors, or user signals from real-time service events. Large language models (LLMs) have moved beyond chatbots; they now underpin intelligent search, automate workflows, and create synthetic data for better network planning. As ChatGPT, Gemini, and new enterprise models enter the scene, telcos are reimagining not just what's possible, but what's next.

## Transforming customer engagement

Let's consider the scale-Indian telcos tackle millions of customer queries daily, often across myriad languages and regional dialects. GenAI-pow-

ered virtual assistants and chatbots are slashing call center volumes, automating bill payments, enabling recharge reminders, and even managing accounts with regional language support.

Real-world impact is tangible. Today's conversational IVR systems are more knowledgeable and empathetic, offering real-time coaching to live agents while freeing up employees for value-added work. Hybrid human-AI support models are the new standard, enhancing both employee satisfaction and operational efficiency.

## GenAI - The backbone of network optimization

Network performance, though, is a frontline concern. GenAI crunches vast volumes of network data, predicts congestion before service hits, and proactively optimizes resources. It's not just about keeping the lights on; GenAI-driven predictive maintenance means equipment failures are anticipated and averted before users ever notice.

Telcos now analyze historical patterns and anomalies across a sprawling infrastructure to detect early warnings and continuously improve service delivery. The operational upside? Higher reliability, better resource allocation, and smoother network runs, all with compelling boosts to customer satisfaction scores.

## Productivity, revenue, and cost efficiency

GenAI isn't only making telecom smarter, it's making it more profitable. According to a 2025 survey of telecom executives reported by Microsoft, nearly 50 percent of telcos are now realizing tangible benefits from adopting GenAI, which is double the adoption rate from the previous year. In the survey itself, one telecom company shared that by refining its upselling techniques using GenAI, it achieved a 5-15 percent increase in average revenue per user (ARPU). Another telecom company deployed an AI-powered help desk bot, which reduced per-call costs by 35 percent while increasing resolution rates by 60 percent. These early adopters are demonstrating meaningful

returns through cost efficiencies and enhanced customer engagement driven by hyper-personalized AI solutions.

## Preparing for 6G - The era of intelligent networks

If 5G is a platform for AI-driven innovation, 6G will be the network's AI-native future. India aims to contribute up to 10 percent of global 6G patents, a testament to its bold ambitions. The Bharat 6G Vision document sets out a roadmap for a collaborative, multidisciplinary 6G ecosystem, one where GenAI powers immersive XR, smart cities, and autonomous industries.

With 6G, high-performance interconnections meet ultra-low latency and dynamic reliability, enabling global-scale generative AI applications with seamless security and adaptive cognition. The synergy here is profound--AI optimizes 6G networks, which in turn provide the ideal platforms for AI-as-a-Service, post-quantum security, and context-aware experiences.

## Strengthening security and fraud detection

Digital payments and mobile banking growth make telecom frauds like SIM card cloning and identity theft a rising concern in India. GenAI enables sophisticated, real-time fraud analytics, flagging anomalous activities and unusual usage patterns before threats escalate. Telecom operators in India have reported significant reductions in both cyber threats and financial fraud, utilizing AI-powered systems.

Security is more than a technical challenge, though, as distrust can cripple customer relationships and trigger regulatory penalties. GenAI defenses are regularly audited and updated to mitigate risks, with ongoing progress.

## Overcoming talent, trust, and technology barriers

Despite its promise, GenAI faces hurdles. Legacy systems, often deeply embedded, slow the pace

of modernization and complicate integration. Upgrading infrastructure is not just costly, it's strategically vital to avoid service disruption and realize AI's full value.

Security vulnerabilities, data privacy concerns, and a lack of robust policy frameworks linger as key obstacles. To manage these risks, leading telcos involve boards in oversight, prioritize regular audits, and invest in continuous training for both leadership and front-line employees.

Talent is the wildcard. With an acute shortage of skilled AI professionals, resistance to change, and fears over job security, the challenge is further amplified. The answer? Aggressive skilling initiatives, educational partnerships, and clear career pathways to attract and keep the very best minds.

## Thought provocation - Beyond the hype

If GenAI in telecom seems like another "next big thing", remember that the transformation is not just technological. It's about building trust, embracing disruption, and asking more profound questions. How will jobs evolve in the age of machine intelligence? How can telcos ensure that AI-powered progress remains inclusive in a country as diverse as India?

Amidst relentless growth and mind-boggling data volumes, the Indian telecom sector faces both an unprecedented opportunity as well as a challenge; a chance to harness GenAI for more connected, secure, and equitable futures, if it navigates wisely. What will telecom look like once every call, click, and connection is shaped by generative intelligence? The answer will depend not just on algorithms, but on vision, culture, and the boldness of those willing to act.

LT GEN DR SP KOCHHAR

# FROM SYNTAX TO SENSE: LRMS REWIRING TELECOM AI

As India eyes 6G and cognitive networks, Large Reasoning Models could become the telecom sector's most strategic digital asset in the coming decade.

The world is witnessing a remarkable surge in the capabilities of Large Language Models (LLMs)—systems that can compose, converse, and code with near-human fluency. Yet, even as these models reshape industries, they stand on the cusp of a far more transformative era—that of Large Reasoning Models (LRMs).

If LLMs gave the industry intelligent language, LRMs are equipped to provide intelligent logic. They mark the next evolution of artificial intelligence—moving from the ability to generate text to the ability to reason, infer, and decide. For India's telecom and digital communications sector, this transition could be as consequential as the leap from 4G to 5G—redefining how their networks, systems, and institutions think, learn, and act.

**HOW REASONING MODELS DIFFER FROM LLMs**

LLMs have been trained on vast datasets to predict the next word—mastering language but not necessarily logic. LRMs, by contrast, combine language understanding

> "Telecom networks of the future will not just carry information, they will understand it, adapt to it, and act on it autonomously.
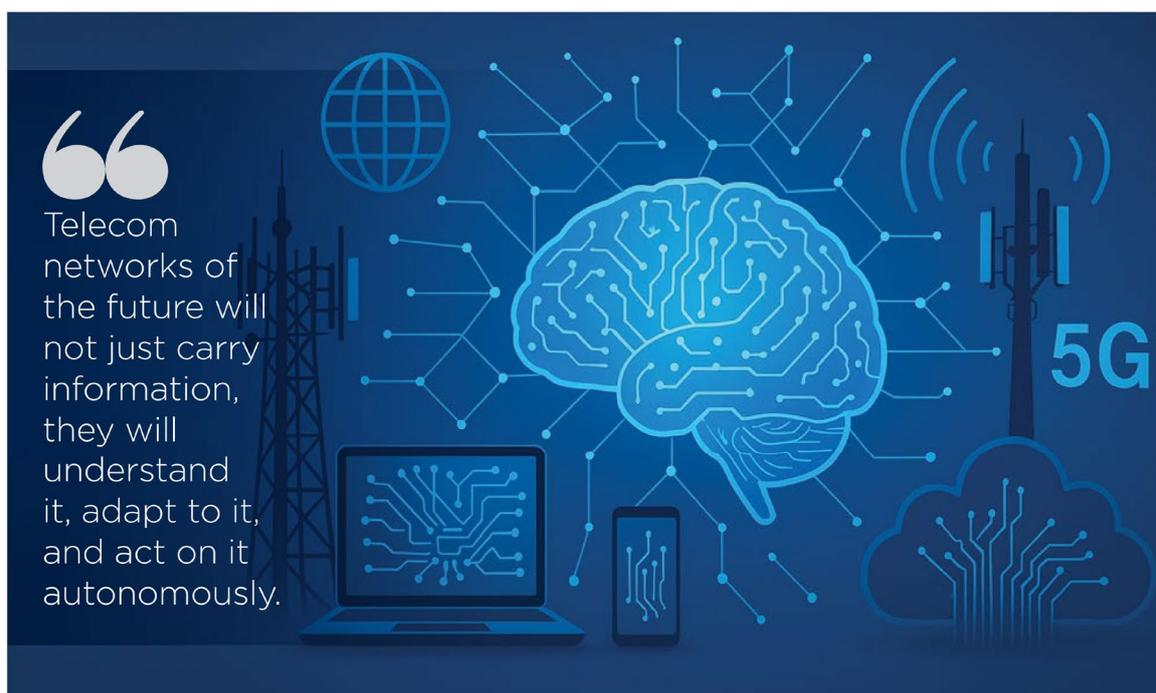
> Large Reasoning Models shift AI from language prediction to structured decision-making across network, policy, and customer layers.

with structured reasoning. They can interpret cause and effect, evaluate multiple variables, and apply logical constraints to arrive at solutions that make sense both statistically and contextually.

This also means they can explain their thinking, adapt to complex environments, and handle multi-step decision processes—from policy interpretation to network optimisation. They move AI from "talking smart" to "thinking smart."

## TRANSFORMING TELECOM AND COMMUNICATION NETWORKS

The Indian telecom sector is the nervous system of the country's digital economy—powering initiatives such as Digital India, BharatNet, UPI, and ONDC. As India moves towards AI-native 6G networks and the vision of Viksit Bharat 2047, the introduction of LRMs can revolutionise every layer of the telecom stack—from infrastructure to customer interface.

**Smarter network operations:** Telecom networks generate vast amounts of real-time data. Today's AI tools can analyse this data, but LRMs will go further—they can reason across performance metrics, interference patterns, and energy use to suggest or even implement optimised configurations. They can also infer why a fault might occur and pre-empt it before it affects service.

This could move operators towards truly autonomous, self-healing networks, improving uptime, reducing costs and enhancing customer experience.

**Cybersecurity and fraud prevention:** Telecom is increasingly at the front line of cybersecurity—from financial fraud to deepfake misuse. LRMs can reason through sequences of events, detect anomalous signalling behaviours and connect seemingly unrelated data points to flag coordinated attacks.

Their ability to simulate threat scenarios and generate logical defence strategies could help secure not just networks but the entire digital ecosystem—complementing



## IN BRIEF

- LRMs combine language with logic, enabling AI systems to reason, infer, and decide— not just generate text like earlier language models.

- In telecom, LRMs can optimise networks, reduce outages, and support autonomous decision-making through contextual reasoning.

- LRMs can bolster cybersecurity by simulating threats, detecting coordinated fraud, and enhancing proactive defence strategies.

- Telecom regulators may use LRMs as compliance co-pilots to decode overlapping laws and monitor policy gaps in real time.

- LRMs will personalise user experiences, trace service issues to their root, and boost trust through intelligent customer interaction.

- India's scale and digital maturity make it a fertile ground for developing indigenous LRMs tailored to national priorities.

> From fraud detection to self-healing networks, LRMs promise deeper cognition across telecom infrastructure and services.

initiatives such as the Financial Fraud Risk Indicator (FRI) and the Chakshu fraud-reporting platform.

**Regulatory and compliance co-pilots:** India's regulatory architecture, spanning the Telecommunications Act 2023, TRAI directions, and the DPDP Rules 2025, is complex and dynamic. LRMs can act as intelligent assistants, reasoning through clauses, identifying overlaps or gaps, and cross-referencing compliance obligations.

**Reimagining customer experience:** While LLM-powered chatbots have improved customer interaction, LRMs can reason about customer intent and context. They can dynamically adapt service plans, resolve complaints by tracing root causes, or guide users toward optimal data use. All of this while remaining aligned with frameworks such as the TCCCPR 2018. This deeper, contextual intelligence will redefine digital trust and satisfaction for millions of consumers.

**Accelerating Innovation and R&D:** As India drives initiatives in ubiquitous connectivity, direct-to-mobile (D2M) broadcasting, in-device coexistence, and Quantum-resilient networks, LRMs can dramatically speed up innovation. By analysing experimental data, they can simulate how different parameters affect performance, thereby reducing the time from research to deployment.

This is particularly vital for India's 6G research agenda, where design iteration and systems optimisation depend heavily on complex reasoning.

### FROM DIGITAL TO COGNITIVE TRANSFORMATION
The leap from LLMs to LRMs reflects a larger evolution in India's digital journey — from enabling connectivity to embedding cognition. Telecom networks of the future will not just carry information; they will understand it. They will self-analyse, self-optimise, and self-secure.

This transformation is not about replacing humans but augmenting them. Engineers, analysts, and policymakers will be empowered to focus on higher-order judgment, strategy, and ethics, while LRMs handle the intricate reasoning behind routine or data-intensive decisions. The synergy of human oversight and machine reasoning will define the next phase of digital governance and service excellence.

### INDIA'S LRM OPPORTUNITY AND GLOBAL EDGE
India's digital ecosystem—with its scale, linguistic diversity, and policy maturity—offers a unique testbed for developing telecom-specific reasoning models. Indigenous LRMs, trained on local data, network topologies, and policy frameworks, could become strategic assets for both industry and national security.

To realise this potential, collaboration across academia, startups, and industry is essential. Facilitating such partnerships—aligning with national missions such as Digital India, Bharat 6G Vision, and Aatmanirbhar Bharat—would ensure responsible, explainable, and interoperable AI systems that serve both business efficiency and societal trust.

The next decade in telecom will not just be about faster connectivity; it will be about smarter connectivity. Large Reasoning Models will move us from data-driven networks to reason-driven networks capable of anticipating needs, defending themselves, and evolving intelligently.

For India's telecom industry, this is the moment to lead globally and to turn these networks into intelligent ecosystems that embody the nation's ambition for Viksit Bharat 2047.

While LLMs enabled communication, LRMs will enable comprehension—together shaping the cognitive evolution of connectivity. 🧡

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# Digital Defence:
## Securing India's
## Connected Future

**[TELECOM TALK]**
**DATA SECURITY**

**LT GEN DR SP KOCHHAR**

# REGULATING OTT SPAM: WHY THE RULES MUST CATCH UP TO CHANGE

With OTT platforms growing rapidly, the lack of regulation fuels the surge in spam, posing risks to consumer safety and national security, urging urgent reforms.

India has witnessed a sharp rise in spam communications in the last few years. According to the Telecom Regulatory Authority of India (TRAI), in 2023 alone, a staggering 12.2 million grievances were filed against unregistered telemarketers (UTMs), a sharp climb from 8.5 million in 2021. While the government and the telecom service providers are continuously putting in efforts to have in place robust measures to curb these unwanted communications over mobile networks actively, unfortunately, over-the-top (OTT) communication platforms remain largely unregulated, chiefly owing to the growing popularity of these platforms and the subsequent lack of regulation in this domain.

India is one of the largest markets for communication OTTs. Such platforms have over two billion active monthly users globally, of which over 400 million are from India.

## GOVERNMENT MEASURES TO TACKLE TRADITIONAL SPAM CHANNELS

The Government of India has introduced various policies and reforms to effectively manage unsolicited commercial communications (UCC) through traditional SMS and voice call channels. As per the TRAI data, the regulator has blacklisted over 1.85 million phone numbers since August 2024. The Department of Telecommunications, too, has launched the International Incoming Spoofed Calls Prevention System, which blocks approximately 13 million such calls daily.

Telecom operators are also working closely with the government to curb spam communications. In 2018, TRAI introduced the Telecom Commercial Communication Customer Preference Regulation (TCCCPR) to address the menace of UCC, which has been reasonably successful. The TCCCPR involves multiple stakeholders—telcos,

> "Since no checks or balances are there to govern the OTT communication platforms, they have a free run on spam and fraud calls and messages."

## [TELECOM TALK]
## DATA SECURITY

> OTT players have relied on internal mechanisms, which have proven inadequate, as seen in the increasing cases of online scams and unsolicited communications.



## IN BRIEF

- The rise in OTT-based spam is unregulated, creating risks for consumer safety and national security.
- Telecom regulations have reduced UCC, but OTT platforms remain outside the scope.
- TSPs have implemented measures like DLT and complaint management to curb UCC.
- A unified regulatory framework is needed to address spam across telecom and OTT services.
- TRAI's penalties focus on TSPs, not OTT platforms or telemarketers responsible for spam.
- OTT platforms' unregulated nature fuels financial crimes and complicates spam control efforts.

telemarketers (TMs), aggregators, and Principal Entities (PEs). It uses a technological solution, Blockchain—distributed Ledger Technology (DLT), to curb UCC.

TRAI has also mandated blacklisting and service disconnection for entities involved in spam activities, sharing this information across networks to prevent reactivation. In addition, the government has allocated the 140 series for promotional voice calls and has now prescribed the 160 series for transactional and service voice calls.

## OTT PLATFORMS: EXEMPTION FROM SAME REGULATIONS

While these regulations imposed on telecom service providers have yielded positive results, OTT communications remain outside this regulatory ambit. This has resulted in a significant increase in the quantum of unsolicited communications that have moved to OTT communication apps, substantially leading to the rise in financial crimes in the country.

This negates the level playing field between telecom service providers (TSPs) and messaging platforms, which provide the same services as telcos without requiring similar regulatory compliance. While lakhs of fraudulent numbers have been suspended or disconnected in the telecom space, this parallel OTT stream, which is running without any regulations, gives fraudsters an outlet to run their businesses from there. Since no checks or balances are there to govern the OTT communication platforms, they have a free run on spam and fraud calls and messages.

This lack of regulation poses a significant risk not just to customer safety but also to national security, as this spam originating from OTT platforms goes unchecked by existing telecom spam controls. Anonymity and encrypted communication on OTTs make tracing and preventing spam much harder. In addition, cross-border spam originating from international numbers or accounts adds complexity beyond domestic regulation.

## INDUSTRY RESPONSE: STRENGTHENING THE FIGHT AGAINST UCC

With the regulatory framework and strict penalties under the TCCCPR, the industry has introduced several measures to combat UCC. The implementation of DLT has played a crucial role, contributing to a noticeable reduction in UCC originating from SMS in recent years.

TSPs have rolled out various modules designed to curb UCC. These include the Consumer Preference Registration Module, which allows users to block unwanted messages, and the integration with TRAI's DND and the Umang app to facilitate seamless communication preferences. Additionally, TSPs have implemented Entity/RTM

> TSPs have introduced Entity/RTM and Header Registration for better transparency and a Complaint Management Module to streamline the reporting process.

and Header Registration to improve transparency and a Complaint Management Module to streamline the reporting process.

Other measures include blocking traffic from unregistered headers, registering content templates and scrubbing to ensure compliance, and whitelisting and scrubbing URLs/APKs/OTT links to ensure only legitimate links are used for communication. The PE-TM Chain Binding ensures accountability between PEs and TMs, while voice solutions (140xx series) have been implemented for different types of voice communications. Furthermore, efforts to increase the user-friendliness of mobile apps and websites have made it easier for users to manage preferences and complaints.

Telecom resources are also being disconnected from entities with high spam complaints. While many of these modules were not part of the 2018 TCCCP Regulation, they have been introduced either through TRAI directions or proactively by TSPs. These efforts have helped reduce the volume of UCCS, but TSPs continue to work on developing additional solutions to address voice call-driven UCCs more effectively.

### A HOLISTIC APPROACH TO TACKLING SPAM AND UCC

While the industry is making ample efforts to curb the spam menace, a more comprehensive approach is required to tackle the issue effectively. In the current digital landscape, both OTT communication providers and TMs have become major stakeholders. Thus, it is critical to establish a regulatory framework to ensure accountability from all stakeholders in the ecosystem, including OTT platforms, TMs and PEs.

It is a cause of great concern that the TRAI's amendment to the TCCCP Regulation to tackle spam calls and messages still does not include OTT communication service providers in this regulation. It makes no sense that one section of the traffic (TSPs) is regulated while the other section (OTT Communication Services) has no regulation.

At the same time, it is also concerning that the authority has substantially increased the penalty imposed on the TSPs. Financial Disincentives on TSPs, being only intermediaries in this process, do not serve any purpose and have failed to address the issue in all of TRAI's attempts to curb UCC. Instead, if these penalties are required, they should be directed to the TMs with delivery functions or the PEs who are the actual originators and beneficiaries of the commercial communications.

### THE REGULATORY VACUUM AND THE NEED FOR EVOLUTION

The lack of direct regulatory control over OTT communications has led to a fragmented response to spam. While telecom operators are held accountable for spam originating on their networks, OTT players have relied mainly on internal mechanisms, which have proved insufficient, as is evident from the growing cases of online scams and unsolicited commercial communications.

It is encouraging to note the recent announcement that DoT is collaborating with one of the top OTT communication players in the country to prevent spam and scam communications in India through a safety and educational campaign. While this is noteworthy, in the same spirit, we believe that it would be critical for the proper regulatory and security measures to be in place for all these other players like the OTTs to come under the same regulatory control as the TSPs, so that uniform and effective solutions can be offered to the consumers, with visible results and corrective measures that can be put in place, as and when required.

The OTT spam surge is a clear and present danger to India's digital ecosystem. As India continues its march towards a USD 1 trillion digital economy, trust and safety in communication channels will be foundational. This cannot be achieved without evolving our regulatory frameworks to address the challenges of OTT-based spam. 🔥

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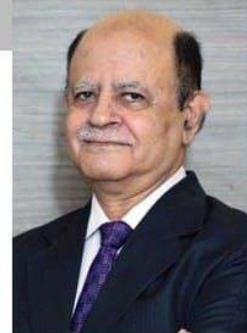
[TELECOM TALK]

**OTT**

LT GEN DR SP KOCHHAR

# REIN IN OTT SPAM WITH UNIFIED COMMUNICATION RULES

OTT platforms bypass telecom-level regulations, exposing users to spam, fraud, and unfair practices— India urgently needs a uniform compliance code.

In a world increasingly shaped by digital communication, protecting consumers from unsolicited and often harmful messages has become not just a regulatory obligation but a national imperative. While India's telecom sector has made significant strides under stringent oversight to curb spam and fraudulent communication, Over-The-Top (OTT) platforms continue to operate with minimal checks and balances. This regulatory vacuum undermines consumer trust and poses serious risks to privacy and national security.

In February 2025, a critical amendment to the Telecom Commercial Communication Customer Preference Regulations introduced a suffix-based header system for commercial SMS. Under this framework, all SMS communications now carry suffixes to identify whether the message is promotional, transactional, service-related, or from the government. This change has brought a new level of transparency, allowing recipients to recognise the nature of incoming messages instantly. More importantly, it strengthens spam mitigation, supports regulatory compliance, and enhances consumer protection.

However, while these reforms enhance accountability and safeguard telecom subscribers, they also highlight a glaring inconsistency: OTT communication platforms remain outside the ambit of such regulation.

## THE GROWING UNSEEN PROBLEM OF SPAM ON OTT PLATFORMS

As communication OTT apps become deeply embedded in our lives, they have also become breeding grounds for unsolicited marketing messages, scam attempts, and
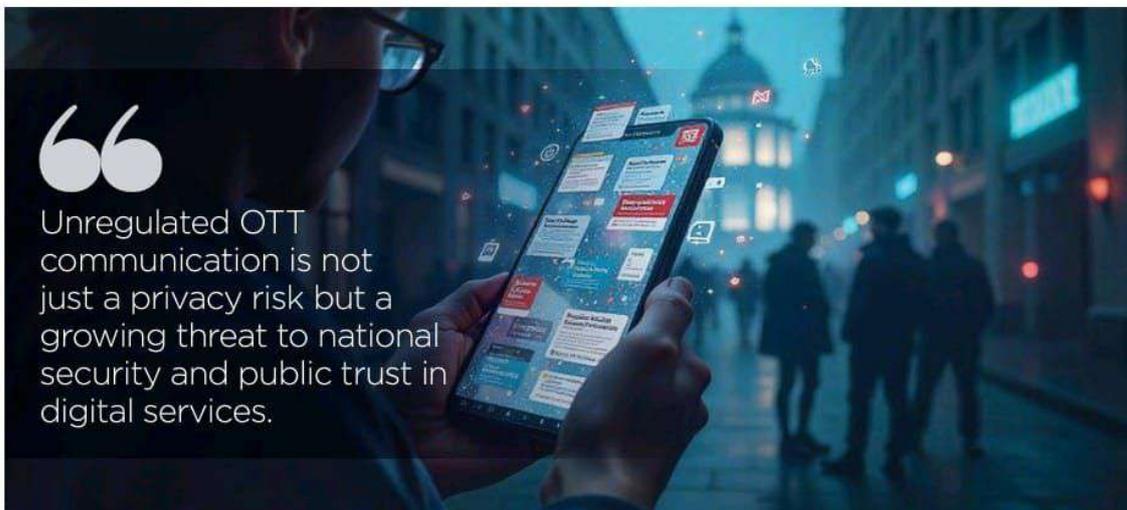
> **"** Unregulated OTT communication is not just a privacy risk but a growing threat to national security and public trust in digital services.

> Consumers deserve equal protection whether using SMS or OTT apps—fragmented rules only widen the gap between convenience and accountability.
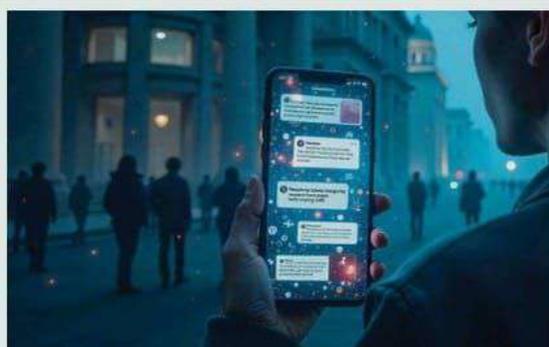


## IN BRIEF

- OTT messaging apps are rife with scams and spam due to the lack of uniform traceability and consumer protection standards.

- Design tricks like hidden cancellation steps violate consumer rights and discourage users from opting out of OTT subscriptions.

- TSPs invest heavily in compliance and infrastructure, while OTTs exploit the same networks without equivalent regulatory burdens.

- Consumers face rising cyber fraud, non-transparent charges, and few remedies on unregulated OTT platforms.

- A unified regulatory framework should mandate message labelling, opt-outs, complaint redressal, and fair infrastructure cost sharing.

- Oversight parity is essential to protect users, strengthen digital trust, and ensure balanced competition across all communication platforms.

phishing attacks. In contrast to SMS and voice services, which are subject to categorisation and filtering norms, OTT platforms often lack similar consumer protection protocols. Because many of these apps rely on end-to-end encryption, tracing the source of spam or malicious messages is often not feasible.

This is giving rise to a troubling dual standard. Telecom Service Providers (TSPs) invest heavily in infrastructure, comply with strict regulatory norms, and shoulder significant costs to maintain communication security.

Meanwhile, OTT players offer equivalent services—messaging, calling, file sharing—without bearing the same regulatory responsibilities or operational overheads.

## HOW DARK PATTERNS UNDERMINE USER AUTONOMY

Making matters worse is the growing use of so-called "dark patterns" on OTT and streaming platforms. According to recent industry reports, many of these platforms intentionally design user experiences to make it difficult to cancel subscriptions. Techniques may include burying the cancellation button within obscure menus, requiring numerous steps to opt out, or masking charges behind vague notifications. These manipulative design practices not only frustrate users but may also be in breach of India's Consumer Protection Act and the E-Commerce Rules, which mandate that cancellation options be accessible and clear.

A recent report by LocalCircles stated that nearly 50% of users find it difficult to unsubscribe from OTT platforms, highlighting the scale of the issue. Legal experts have echoed these concerns, pointing out that the Consumer Protection (E-Commerce) Rules, 2020 require platforms to make cancellation processes easily accessible. OTTs employing such convoluted procedures could soon face regulatory scrutiny, if not class-action lawsuits. Yet, the lack of enforcement continues to embolden these practices.

This is not merely a consumer rights issue—it may also be anti-competitive. By locking users into auto-renewals and obscure cancellation loops, OTT platforms reduce the ability of users to switch services or compare alternatives. This distorts healthy market competition and may skew the digital economy in favour of monopolistic behaviour.

## TELECOM VERSUS OTTS: AN UNEVEN PLAYING FIELD

The disparity in regulatory treatment between TSPs and OTTs has created an uneven playing field. TSPs are required to comply with data retention mandates, enable lawful interception, and ensure traceability of communications—all of which entail substantial operational costs. OTT platforms, despite relying on the same telecom infrastructure to deliver their services, face no such obligations. They do not contribute to the cost of

## [TELECOM TALK]
**OTT**

> OTT platforms have no accountability for spam, scams, or user protection, yet deliver the same services as tightly regulated telecom players.

maintaining the network, nor are they held to the same standards for consumer protection. This inconsistency raises a fundamental policy question: Why should one group of service providers be held accountable while another offering similar services remains exempt?

More concerning is the growing national security risk posed by unregulated OTT communications. Encrypted services with little oversight have already been linked to fraudulent schemes, misinformation campaigns, and even serious criminal activity. Without a unified framework to govern both TSPs and OTT platforms, these risks will likely continue to escalate.

### THE RISING CONSUMER RISKS OF DIGITAL IMBALANCE

At the centre of these issues are the consumers, who must navigate rising volumes of spam messages, unsolicited marketing, and exposure to fraud. While telecom subscribers benefit from regulations such as Do Not Disturb (DND) services and the new header-based SMS labelling system, users of OTT platforms are largely left to fend for themselves.

The Ministry of Home Affairs' annual report for 2023–24 revealed that, in the first quarter of 2024 alone, over 80,000 complaints were registered concerning cyber fraud via the top three communication OTT platforms. Unlike SMS, where spam is strictly monitored, OTT spam frequently goes unreported and unaddressed, leaving millions of users vulnerable.

Further exacerbating consumer distress is the opaque and aggressive monetisation model employed by some OTTs. Subscription terms are often revised without adequate notice, and consent for additional charges is frequently buried in fine print. This lack of transparency amounts to digital manipulation and is drawing growing scrutiny from consumer bodies and regulators alike.

### WHY UNIFIED REGULATION IS NOW UNAVOIDABLE

The solution is straightforward: there must be a unified consent and compliance framework that applies uniformly across all communication platforms, regardless of the delivery method. OTT communication platforms should be brought under the same or complementary regulations that govern telecom services.

Such a framework should enforce mandatory message labelling and categorisation across platforms, standardise opt-in and opt-out procedures, and establish uniform complaint redressal systems for spam and fraud. OTT platforms should also be required to contribute proportionally to the cost of the telecom infrastructure they utilise. Additionally, subscription models must follow clear disclosure norms, and cancellations should be made simple, with no hidden conditions.

The aim is not to inhibit innovation, nor to introduce unnecessary bureaucracy, but to create a level playing field—one that protects consumers, strengthens the digital economy, and upholds national security.

### STRENGTHENING DIGITAL RULES FOR EQUAL PROTECTION

India has made commendable progress in regulating spam and commercial communication within the telecom sector. But these efforts risk becoming ineffective if a large portion of the communication ecosystem continues to operate unchecked. OTT communication platforms have undeniably transformed the way we connect, but this convenience must not come at the cost of consumer rights, transparency, or safety.

With the rise of dark patterns, mounting consumer grievances, and loopholes being exploited, the time has come for policymakers to act. Extending regulatory oversight to OTT communication services is the logical next step in India's digital governance journey. All service providers must be held to the same standard, and all users must be afforded the same level of protection. Anything less risks undermining the integrity of both the industry and the billions who depend on it every day. 🖐

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**LT GEN DR SP KOCHHAR**

# SECURITY AND COMPETITION: BALANCING THE TELECOM ACT

The Telecom Act 2023 strengthens security and consumer trust, but gaps in competition, OTT parity, and licensing stability raise new challenges.

In an era defined by hyper-connectivity, digital dependence touches every facet of life and business in India. Against this backdrop, the introduction of the Telecommunications Act, 2023, marked a pivotal legislative moment, meant to modernise the legal framework that governs an industry central to India's digital ambitions. Yet, even with a refreshed framework, certain provisions have triggered deeper conversations around how the Act addresses national security, licensing and equitable competition.

Between 2021 and 2023, India's telecom sector experienced a surge that exposed the limitations of its legacy regulations. Gross revenue climbed from Rs 3.33 trillion in FY2022-23 to Rs 3.36 trillion in FY2023-24, while total telephone subscribers grew from 1.17 billion to 1.19 billion in the same period.

Broadband subscriptions increased by 9% to 924 million, and the Number of Internet users rose 8.3% to 954 million. Data consumption exploded by nearly 22%, driven by rapid smartphone adoption and 5G rollouts. Foreign investments and strong user growth pointed to an industry in transformation. Yet, these dynamic trends underscored the urgent need for a modern, flexible telecom law to govern emerging technologies, consumer habits and sectoral expansion.

The need for a new telecom law was clear. The previous Indian Telegraph Act (1885) and Wireless Telegraphy Act (1933) were not equipped for a landscape disrupted by data, satellite Internet, Over-the-Top (OTT) platforms and the Internet of Things. Thus came the Telecommunications Act, 2023, built on the principles of inclusion, security, growth and responsiveness to the changing technological environment.

## NATIONAL SECURITY AND COMPLIANCE COSTS

Section 20 (2) of the Telecom Act empowers the government to suspend the transmission of messages,

> The Act's success depends on balancing national security with fair competition, ensuring stability while enabling digital growth.

## [TELECOM TALK]
**POLICY**

> The Telecom Act brings stronger safeguards and modern rules, but security costs and compliance overlap worry industry stakeholders.



### IN BRIEF

- The Telecom Act 2023 modernises governance but raises challenges in balancing national security and industry competitiveness.
- Security powers strengthen resilience, but excessive compliance without cost-sharing could burden telecom operators.
- Shifting from contracts to authorisations creates uncertainty for investors and fails to resolve AGR revenue disputes.
- Uneven spectrum pricing for satellite versus terrestrial operators threatens fair competition and digital sovereignty.
- OTT platforms escape regulation, creating a competitive imbalance and adding security risks to India's networks.
- Consumer safeguards and Right-of-Way reforms offer positives, but practical implementation remains critical.

intercept communications and impose controls for national security and public order. Such powers are certainly not new; legacy laws also permitted similar interventions. The sector acknowledges that in a world of escalating cyber threats and borderless digital risks, proactive national security measures are vital for safeguarding citizens and critical infrastructure.

However, telecom service providers (TSPs) already comply with overlapping obligations regarding security mandates from various security agencies. Hence, there should not be any additional or avoidable compliance burden on TSPs that imposes unnecessary costs on the industry. Furthermore, it is important to envisage and implement a cost-sharing mechanism between TSPs and LEAs or user government departments to meet the security requirements.

Moreover, the Act restricts the authorisation of Internet shutdowns to the central government, thereby ensuring continued, uninterrupted and seamless telecom connectivity for all citizens. While some industry voices advocate for ongoing clarity in procedural safeguards and technical standards to preserve user trust and privacy, there is a broad recognition that robust security measures are foundational for a resilient and truly digital India.

### LICENSING OVERHAUL AND AGR UNCERTAINTIES

One of the Act's most challenging reforms is the overhaul of the licensing regime. The new service authorisations plan to replace time-tested contractual license agreements between telecom operators and the Department of Telecommunications (DoT) with a government-issued authorisation process. Side-lining this contractual stability could introduce regulatory uncertainty, undermine investor confidence and deter long-term capital commitment. These arrangements have driven enormous investment and expansion in the sector over three decades.

Additionally, the calculation of Adjusted Gross Revenue (AGR), which is critical for determining government levies and dues, remains inadequately addressed. The industry has repeatedly advocated for revenues from licensed telecom activities to be considered as a part of AGR. This reform was unfortunately omitted even in the later TRAI recommendations tied to the Act.

### SATELLITE SPECTRUM AND DIGITAL SOVEREIGNTY

The government has introduced security measures such as mandatory localisation of key network functions within India, geo-fencing to restrict cross-border data flow and prohibited the decryption of Indian data outside the country to mitigate risks.

Nonetheless, disparities in pricing and obligations between satellite and terrestrial operators, along with worries about foreign control over sensitive

Unequal treatment of satellite operators and OTT platforms risks distorting competition in India's digital economy.

communications, highlight vulnerabilities in India's security framework.

A balanced, transparent spectrum policy is essential to ensure satellite connectivity supports, rather than undermines India's digital sovereignty and national defence.

### OTT EXCLUSION AND NATIONAL SECURITY RISKS

Beyond spectrum and authorisation reforms, a pressing concern is the exclusion of app-based communication services from the regulatory framework. Despite offering similar critical services, these platforms operate outside licensing norms, unlike telecom operators who must meet stringent compliance and security obligations. This disparity creates regulatory arbitrage, undermines fair competition and raises national security concerns.

The sector is already under financial pressure from high spectrum fees and legacy dues, limiting investments in infrastructure. Meanwhile, App based communication services handle a large share of communication traffic without contributing to network upkeep, further straining operator revenues.

Additionally, the absence of oversight over app-based communication services creates security vulnerabilities. While licensed telcos adhere to strict interception and data protection rules, unregulated services can become entry points for cyber threats. Addressing this gap through balanced regulation is essential to safeguard the integrity and resilience of India's telecom networks.

### CONSUMER PROTECTION AND INFRA REFORMS

Despite these concerns, the Act does introduce forward-looking features, particularly in consumer data protection and infrastructure development.

The Act introduces vital consumer protection and anti-spam measures to address the growing threat of cyberattacks such as data breaches and ransomware, which pose risks to national security and public safety. It mandates prior user consent for commercial messaging, enforces the maintenance of Do Not Disturb (DND) registers, and strengthens grievance redressal mechanisms to shield consumers from unsolicited communications and spam.

Alongside these, the Act enforces robust data localisation requirements and enhances privacy safeguards, aligning with global standards and India's vision to set new benchmarks in data privacy. These measures ensure that user data remains secure from unauthorised access and misuse, thereby fostering greater consumer trust and confidence, critical foundations for realising Digital India's aspirations.

Building on this momentum, the Act also simplifies Right-of-Way procedures, allowing telecom operators streamlined access to public and private lands for deploying vital infrastructure such as cables and towers. This modernisation reduces duplication of efforts and cuts costs, expediting network expansion. All that remains here is the uniform and effective implementation by local authorities to fully unlock their potential in accelerating digital infrastructure growth.

### BALANCING STABILITY WITH DIGITAL AMBITION

As India marches towards becoming a digitally empowered society, the Telecom Act is both an enabler and a catalyst for change. It attempts to modernise India's telecom governance, with strong steps toward consumer protection, infrastructure ease and digital sovereignty. But as implementation unfolds, key concerns remain.

To truly deliver on its promise, the Act must retain the contractual stability that has long guided industry investment. Spectrum allocation, especially for satellite and enterprise use, must be equitable to avoid scarcity for core operators. Crucially, regulatory parity with OTT communication platforms is essential to ensure both fair competition and national security.

While the Telecommunications Act, 2023, is a critical step forward, clear, consistent policies and a level playing field are essential to align it to the digital future that the country and its people deserve. 🤝

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**LT GEN DR SP KOCHHAR**

# SECURING THE
# 5G ENGINE FOR A
# SAFER DIGITAL WORLD

India's 5G revolution demands a defence-first mindset as cyber threats escalate, making trust, resilience and Zero Trust security essential for a digital economy.

As India stands proudly at the cusp of a technological renaissance, our nation's 5G networks are rapidly becoming the central nervous system of a trillion-dollar digital economy. This is not just an upgrade. It is a fundamental rewiring of how we live, work and innovate. From smart cities and autonomous factories to AI-driven healthcare and immersive education, the promise of 5G is the promise of a Viksit Bharat. Yet, as we build this hyper-connected future, a formidable shadow looms: the escalating threat of cyberattacks.

Globally, cybercrime is projected to inflict damages worth an astronomical USD 10.5 trillion by 2025, an economy of its own that thrives on disruption and theft. In India, where the telecom cybersecurity market is galloping at a high of 20.6%, the average cost of data breaches has already climbed to a staggering Rs 22 crore in 2025, according to IBM. As stewards of the nation's critical digital infrastructure, the telecommunications industry recognises that its primary responsibility is not just to connect India, but to protect it. Cybersecurity is no longer a technical

> **"** Zero Trust is no longer optional; it is the only architecture capable of protecting 5G networks where every identity, device and workload must be continuously verified.

> Zero Trust has become the foundation of 5G security, allowing operators to verify every identity and access request across dynamic, software-driven networks.

feature; it is the very bedrock of trust upon which our digital future must be built.

### THE NEW BATTLEFIELD OF 5G SECURITY

The 5G era presents a fundamentally different security paradigm. Unlike the closed architectures of the past, 5G networks are dynamic, software-defined and massively interconnected. With billions of IoT devices coming online and network functions becoming virtualised, the world is now defending a fluid, ever-expanding ecosystem with countless new entry points for malicious actors.

There have been devastating real-world consequences of this new reality. The 2023 cyberattack on Ukraine's Kyivstar, which disabled services for 24 million people and crippled national infrastructure, and the massive 2024 "Salt Typhoon" breach targeting US telecom networks are stark reminders that the industry is on the front lines of a global cyber conflict. These are not isolated incidents; they are signals of a persistent and sophisticated threat to the connectivity that underpins modern society.

In this new environment, a reactive security posture is a recipe for failure. The only viable path forward is to adopt a Zero Trust Architecture (ZTA), a paradigm shift rooted in a simple but powerful principle: "never trust, always verify". In a Zero Trust model, no user or device is trusted by default, whether inside or outside the network. Every access request is rigorously authenticated, authorised and encrypted before being granted.

For telecom operators, this means embedding security into the very fabric of their networks. It requires continuous verification of identities, enforcing the principle of least privilege access, and leveraging micro-segmentation to contain threats and prevent lateral movement. This is not just a best practice; it is a mandate for survival and a prerequisite for earning customer trust in the 5G age.

The good news is that technology is also the greatest ally. IBM's latest 2025 Cost of a Data Breach Report shows that organisations leveraging AI and automation in their security operations save nearly USD 1.9 million per breach and detect incidents 80 days faster. By harnessing these



## IN BRIEF

- 5G expands the attack surface with virtualised, software-driven networks, forcing operators to adopt stronger, identity-based security models.

- Global cyberattacks on telecom networks show that operators now sit on the frontline of national security, requiring proactive, not reactive, protection.

- Zero Trust has become essential as billions of IoT devices connect, ensuring every user, device and workload is authenticated before access is granted.

- Quantum computing threatens current cryptography, pushing India's telecom ecosystem to adopt quantum-safe standards.

- India is shaping global norms with new ITU-T work items on AI threats and cybersecurity maturity, signalling its leadership in secure connectivity.

- A unified regulatory approach is vital to ensure OTT communication apps follow the same cybersecurity standards as telecoms.

> Quantum computing threatens today's encryption, making early adoption of quantum-safe algorithms crucial for safeguarding India's digital sovereignty.

tools, businesses can move from a reactive stance to a predictive and automated defence.

## QUANTUM RISKS ON THE DIGITAL HORIZON

Even as the world tackles today's challenges, it must keep a watchful eye on the horizon. The advent of quantum computing, while promising incredible breakthroughs, poses an existential threat to our current cryptographic standards. A sufficiently powerful quantum computer could theoretically break the encryption that protects virtually all digital communications today.

The telecom industry in India, in line with the vision of the National Telecom Policy 2025, is actively preparing by exploring Post-Quantum Cryptography (PQC). Further, the National Quantum Mission (NQM), India's national initiative to develop and scale quantum technologies, includes creating a secure quantum communications network and advancing quantum computing capabilities in its objectives.

By beginning the transition to quantum-resistant algorithms now, the industry is future-proofing its networks and ensuring that India's digital sovereignty remains secure for decades to come.

## INDIA SHAPING GLOBAL SECURITY NORMS

It is important to recognise that India is not just a participant but a leader in shaping a secure digital future. The country's government has taken decisive action to establish a robust regulatory framework that strikes a balance between security and innovation. The Telecom Cyber Security Rules, 2024, which mandate stringent incident reporting within six hours and the appointment of Chief Telecommunication Security Officers, establish clear accountability. Furthermore, the designation of Critical Telecommunications Infrastructure (CTI) underscores the government's recognition of the telecom sector's central role in national security.

This proactive approach has earned India a place at the global high table. In a landmark achievement this year, the International Telecommunication Union (ITU-T) accepted three new security work items proposed by India, focusing on AI-generated threats and a cybersecurity maturity

model. This demonstrates that the world is looking to India not just for scale, but for standards.

## COLLABORATION FOR A STRONGER DEFENCE

Cybersecurity is a team sport. No single operator, government agency or vendor can win this battle alone. The complexity of the 5G ecosystem demands a collaborative, whole-of-nation approach. The industry is deeply committed to fostering these public-private partnerships, creating platforms for real-time threat intelligence sharing and building a collective defence that is stronger than the sum of its parts.

This collaborative spirit must extend to the entire digital communications landscape, and the industry firmly believes in the principle of 'Same Service, Same Rules'. Hence, it is imperative that all players, including Over-The-Top (OTT) communication apps that handle vast amounts of user data, are held to the same stringent cybersecurity and data protection standards as licensed telecom operators. Creating regulatory gaps only creates vulnerabilities that put Indian citizens at risk. This should be addressed as soon as possible.

Furthermore, the country must collectively address the glaring cybersecurity skills gap. With only 14% of global organisations reporting adequate security talent, it has a shared responsibility to invest in training and capacity building to create a new generation of cyber warriors.

As India continues on its journey to connect every citizen and power the engine of a new economy, its commitment is unwavering. The industry will also continue to invest in cutting-edge technology, collaborate with all stakeholders and champion policies that foster a secure, resilient and trusted 5G ecosystem. The path to a digitally empowered India is paved with innovation, but it is secured by trust. ♣

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**DIGITAL DIVIDE**
SPECTRUM **EQUALITY**
TECH HORIZONS
NETWORKS **DEFENCE**
STRATEGY **DIGITAL LEAP**
CONNECTED FUTURE
**INNOVATIONS**
CONNECTING INDIA

**Connecting India:**
**Inclusion, Access &**
**the Next Digital Leap**

LT GEN DR SP KOCHHAR

# BUILDING BRIDGES
# IN THE DIGITAL MAZE

APIs, gaming, and federated data centres are revolutionising digital communication, driving the shift to a seamless, platform-centric future

The digital communications landscape is undergoing a fundamental transformation, embracing a platform-centric approach to meet the demands of an interconnected world. The application programming interface (API) is central to this evolution, as it facilitates seamless interactions across systems and devices, driving innovation, scalability, and efficiency.

As industries adapt, the role of APIs is reshaping the digital ecosystem, from addressing security vulnerabilities to managing data overloads. A prime example of this transition is the gaming industry, where advanced technologies such as 5G, edge computing, graphics processing unit (GPU), Augmented Reality (AR), and Virtual Reality (VR) are redefining user experiences.

## THE ROLE OF APIs IN A PLATFORM-CENTRIC ERA

APIs are the backbone of the platform-centric approach, enabling developers to build integrated, scalable applications. However, several factors must be prioritised to ensure consistent quality.

**Strengthening security:** As APIs connect diverse platforms, the risk of security breaches rises. Strong authentication protocols, encryption, and rate limiting are essential to safeguard sensitive data and build user trust. Security measures must evolve alongside threats, ensuring robust protection in an increasingly interconnected world.

**Standardising for simplified integration:** Standardised API design and documentation streamline integration processes, allowing developers to create new applications efficiently. Adopting best practices ensures interoperability across platforms, fostering a cohesive ecosystem and enhancing user experiences.

**Managing data overloads:** The growing reliance on APIs has led to exponential data generation. Efficient payload management, scalable architectures and data compression techniques are critical to mitigate latency and ensure real-time responsiveness, particularly in industries like gaming that demand high-performance systems.

**Ensuring backward compatibility:** Frequent updates can disrupt older integrations, frustrating users and developers. Maintaining backward compatibility through clear versioning and gradual migration ensures continuity, minimising disruptions in dynamic digital ecosystems.

## GAMING: A BENCHMARK FOR PLATFORM-CENTRIC INNOVATION

Gaming exemplifies the platform-centric shift, showcasing how APIs, edge computing, and specialised hardware redefine industries. With gaming no longer restricted to children, its growth offers valuable insights into digital communications' future.

**APIs powering immersive experiences:** In gaming, APIs power multiplayer functionality, cross-platform play and real-time interactivity. For example, APIs optimise Quality of Service (QoS) by managing bandwidth allocation and latency, enabling seamless gameplay in environments like cloud gaming. This optimisation is vital for immersive technologies like AR and VR, where even minor delays disrupt user experiences.

**Edge computing and 5G connectivity:** The integration of edge computing with 5G networks transforms gaming and digital communications. By processing data closer to users, edge computing reduces latency and enhances responsiveness. With 5G providing ultra-fast, low-latency connectivity, gaming platforms can deliver richer,

> Standardised API design and documentation streamline integration processes, allowing developers to create new applications efficiently.

more dynamic experiences, particularly in multiplayer and AR/VR environments.

In fact, 5G reduces latency to as low as 1 ms, compared to 30-50 ms with 4G, critical for real-time gaming and AR/VR applications. It also offers speeds up to 10 Gbps, enabling high-definition streaming and cloud gaming without performance degradation.

**GPUs enhancing computational efficiency:** GPUs have become essential for rendering hyper-realistic visuals and running complex simulations. Unlike CPUs, GPUs excel at parallel processing, enabling real-time graphics and physics-based interactions. APIs such as Vulkan and DirectX allow developers to harness these capabilities, elevating gaming to unprecedented levels of realism and interactivity.

### THE ROLE OF AFFORDABLE SOFTWARE-BASED HANDSETS

Affordable, software-centric mobile devices are expanding access to gaming and digital services. These handsets leverage APIs to integrate advanced features, making high-quality gaming accessible to a broader audience. With 5G connectivity, such devices democratise gaming by reducing entry barriers and enabling users from diverse demographics to participate.

**OLAP and OLTP in gaming analytics:** Online Analytical Processing (OLAP) and Online Transaction Processing (OLTP) play critical roles in gaming. OLAP supports data-driven decision-making by analysing user behaviour, game performance and monetisation strategies. For example, OLAP systems identify player preferences, enabling personalised recommendations.

Similarly, OLTP handles real-time transactions, such as in-game purchases and multiplayer matchmaking. Efficient OLTP ensures seamless gameplay and enhances user satisfaction. By combining OLAP and OLTP, gaming platforms achieve a balance between real-time interactivity and long-term strategic insights, creating optimised user experiences.

### FEDERATED DATA CENTRES: MANAGING DATA OVERLOAD

The multifold increase in data generation and consump-

tion, coupled with rapid technological advancements, has made it essential to establish a robust infrastructure that ensures both efficiency and effectiveness. Federated data centres address this challenge by distributing data storage and processing across multiple locations. This decentralised approach enhances scalability, reduces latency, and ensures data redundancy, making it well-suited to the demands of a data-intensive digital ecosystem.

By eliminating single points of failure, federated systems enhance resilience, ensuring uninterrupted service even during system disruptions. Proximity to users further reduces latency, a critical factor for real-time applications like gaming and healthcare. Localised data centres also comply with regional regulations, addressing privacy concerns while maintaining operational efficiency.

Cost efficiency is achieved through shared infrastructure across organisations or regions, minimising redundancy and leveraging existing data centres. Intelligent data distribution processes optimise operations by storing and processing only essential information locally, avoiding unnecessary data loads. Additionally, federated data centres support multi-cloud and hybrid cloud environments, offering a unified interface for seamless management and enhanced flexibility.

This innovative approach positions federated data centres as a cornerstone of modern infrastructure, enabling organisations to handle growing data demands effectively while maintaining reliability and compliance.

### GAME THEORY: A FRAMEWORK FOR STRATEGIC ALIGNMENT

Game theory, a framework for understanding strategic interactions, is central to shaping the platform-centric landscape. In these immersive ecosystems, various stakeholders—developers, platform owners, network operators and end-users—must align their objectives to ensure seamless integration, robust performance and user satisfaction. Game-theoretic models help them navigate complex trade-offs, from resource allocation to pricing structures.

For developers, game theory informs which APIs and standards to adopt, fostering smoother integration

## [TELECOM TALK]
**API**

| Software-centric mobile devices leverage APIs to integrate advanced features, making high-quality gaming accessible to a broader audience.



### IN BRIEF

- APIs are transforming digital ecosystems, ensuring seamless integration and enabling industry scalability.

- Gaming exemplifies platform-centric innovation, showcasing how APIs, edge computing, and GPUs drive immersive experiences.

- Federated data centres decentralise storage, enhance resilience, reduce latency, and optimise multi-cloud environments for growing data demands.

- Affordable, software-based handsets with 5G connectivity democratise gaming, making high-quality experiences accessible to broader audiences.

- Game theory guides strategic decisions in platform ecosystems, ensuring equilibrium amidst evolving technologies and user demands.

- The shift to platform-centric digital communication unlocks innovation and efficiency, reshaping industries for a connected future.

and reducing fragmentation. Platform owners apply these insights to guide investment in edge computing, balancing latency reduction against cost and competition. Network operators leverage predictive modelling to optimise data flows, ensuring low-latency connectivity that meets user expectations. Meanwhile, users benefit from stable, well-designed ecosystems offering immersive and accessible AR/VR experiences.

By modelling cooperative and competitive dynamics, game theory predicts how each party will respond to changing conditions - emerging technologies, evolving user demands, or new market entrants. This reduces uncertainty, streamlines decision-making, and encourages value-aligned outcomes.

As AR/VR technologies merge with 5G, federated data centres and edge computing, the complexity of digital ecosystems grows. Game theory provides the strategic tools to maintain equilibrium, ensuring that platform-centric AR/VR environments remain technologically sophisticated and user-focused.

### GAMING: A CASE STUDY IN THE PLATFORM-CENTRIC PARADIGM

Gaming illustrates how a platform-centric approach can transform industries. No longer confined to children, gaming now appeals to a diverse audience, with the average player aged 35 years or older. The integration of cutting-edge technologies has broadened gaming's scope, influencing fields such as healthcare, education, and AI.

The shift to a platform-centric digital communications world is reshaping industries, with APIs as the cornerstone of innovation. APIs enable seamless integration and scalability, from managing security risks and standardisation to addressing data overloads.

As federated data centres and affordable hardware evolve, the platform-centric model will unlock new possibilities across sectors, ensuring a connected and efficient digital future. ♣

*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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# Bridging the Digital Divide

## Focus on innovation and inclusivity to create a connected nation

**Lt General Dr S.P. Kochhar, Director General, Cellular Operators Association of India**

From the humble beginnings of basic telephony to the revolutionary era of 4G and the dawn of 5G, the Indian telecom industry has undergone a remarkable transformation, evolving from a nascent market to a global leader in connectivity. The sector has been the backbone of the nation's digital revolution, reshaping lives, businesses and governance, and the journey has been a testament to innovation, resilience and the unwavering pursuit of bridging the digital divide. With over 1.18 billion telecom subscribers (January 2025) across the country, this journey has been marked by visionary policies, groundbreaking technological advancements and an unwavering commitment to connect every Indian.

### From 2G to 5G: A technological odyssey

The evolution of technology in India's telecom sector is a testament to its rapid progress. The launch of 2G in 1995 marked the start of the digital era, introducing encrypted calls, better sound quality and basic data services such as SMS and MMS. Fourteen years later, in 2008, 3G was introduced, revolutionising mobile internet with seamless browsing and streaming capabilities. The roll-out of 4G in 2012 ushered in an era of high-speed connectivity, enabling live video calls, online gaming and instant access to information, making India one of the largest consumers of mobile data globally. The launch of 5G in 2022 ushered in hyper-connectivity with speeds of up to 10 GB per second, transforming sectors such as healthcare, education and manufacturing through massive internet of things (IoT) deployments and low-latency connections. The first steps into 6G research have already been taken, ensuring India remains at the forefront of global telecom innovation.

The transition from 2G to 3G to 4G and then to 5G highlights the rapid progression of the evolving telecom landscape. This has positioned India as a global leader in connectivity, with a telecom subscriber base of over 1 billion and ranking second in mobile broadband internet traffic and international internet bandwidth. 5G subscriptions are projected to reach 350 million by 2026, accounting for 27 per cent of all mobile subscriptions. The industry's growth reflects robust policy frameworks, such as the National Digital Communications Policy (NDCP), 2018, which aims to achieve "broadband for all". The government's focus on rapid 5G deployment and investment in 6G research further underscores its commitment to maintaining India's telecom leadership.

### Surge in data usage: Driving the digital revolution in India

In 2014, the average data consumption per month was 0.3 GB and the cost per GB was Rs 269. Come 2022, data consumption rose to 19.5 GB per month and the cost decreased to Rs 13.50 per GB. The adoption of 5G has driven a shift in India's mobile data landscape, with users consuming 3.6 times more data compared to 4G. Mobile data traffic reached 17.4 exabytes per month in 2023, with a compound annual growth rate of 26 per cent over five years. Metro circles lead the charge, accounting for 20 per cent of the total traffic. Global projections estimate mobile data traffic to grow 2.5 times

to 303 exabytes per month by 2030, reflecting the increasing appetite for high-speed connectivity. With faster speeds and greater capacity, 5G is fostering new possibilities in applications such as augmented reality, virtual reality and smart cities, further driving data consumption.

### Pioneering initiatives: Policies shaping the telecom landscape

The government has been taking several policy initiatives, which have helped shape India's digital evolution. The National Telecom Policy, 2012, emphasises broadband connectivity, infrastructure development and spectrum allocation, focusing on mobile devices as tools for socio-economic empowerment. The Telecommunications Act, 2023, introduced an effective right-of-way framework to enable network roll-outs and established the Digital Bharat Nidhi to fund research and development initiatives and pilot projects. The act modernised the legal framework to accommodate rapid technological advancements, ensuring seamless adaptation to evolving global standards.

Further, several flagship initiatives have accelerated the growth of the country's telecom sector. These include the NDCP for affordable and ubiquitous broadband access; the BharatNet project to connect all gram panchayats with high-speed broadband and bridge the rural-urban divide; the Digital India Initiative to promote digital literacy, infrastructure and technology adoption across sectors; and the production-linked incentive scheme to boost domestic telecom equipment manufacturing and reduce import dependency. Successful 5G spectrum auctions have and will further facilitate the rapid roll-out of 5G services, transforming sectors such as healthcare and education. The BharatNet project, in particular, has brought high-speed connectivity to remote villages, empowering communities with digital tools and access to essential services.

### Telecom shift towards technology

According to Accenture, telcos could unlock at least $700 billion in new revenue through technological transformation. Telecom service providers have become the backbone of digitalisation, enabling seamless communication and collaboration through advanced technologies such as cloud, IoT and artificial intelligence (AI)/machine learning. Generative AI has emerged as a standout unlocking new possibilities in modern technology and enabling immersive, innovative use cases.

Telcos are no longer just communication enablers; they are shaping the infrastructure of our hyper-connected world by leveraging these advanced technologies. They now support multiple verticals, ranging from enterprise applications to apps for use by the public. For instance, IoT applications in smart cities, healthcare, manufacturing and governance continue to grow, leveraging 5G to meet the demand for reliable and secure connectivity. The economic impact of 5G includes significant job creation and enhanced connectivity for urban and rural populations. With an estimated 40 per cent of global IoT connections expected to leverage 5G, the technology is paving the way for the next wave of innovation in connected devices and systems, with telecom serving as a stepping stone.

### Closing the connectivity gap: Empowering a digital India

The expansion of telecom networks has played a pivotal role in reducing the digital gap. Government initiatives such as expanding 4G and 5G connectivity to remote areas of the country, including areas such as Ladakh, have ensured last-mile connectivity, bridging the rural-urban divide. Telecom connectivity has enabled financial inclusion across the country through mobile banking and digital payments, while also providing access to education, healthcare and government services, empowering citizens and promoting self-reliance (Atmanirbhar Bharat). These efforts have unlocked socio-economic benefits, enabling rural communities to integrate into the broader digital economy and improving quality of life.

### Overcoming barriers: Addressing challenges on the path to connectivity

Bridging India's digital divide also requires addressing several critical challenges. The high infrastructure costs associated with building and maintaining robust digital infrastructure, including broadband connectivity and data centres, pose a significant hurdle. Efficient spectrum allocation is crucial for supporting emerging technologies such as 5G and 6G, which are essential for making high-speed connectivity possible. However, the growing demand for data and bandwidth necessitates an increase in available spectrum. Given this scenario, it is essential to ensure a level playing field and fair sharing of digital resources and services across all demographics towards infrastructure costs from large traffic generators (LTGs), as they freely ride on the networks created by telecom operators. Finally, effective policy regulation is needed to promote competition, innovation and affordability in the digital market.

### The road ahead: Sustaining progress in a digitally connected nation

Over the past 25 years, the Indian telecom industry has achieved extraordinary milestones, bridging the digital divide and transforming millions of lives. This success is a testament to the collective efforts of cellular operators, policymakers, the government and other stakeholders. The telecom industry is a critical pillar in India's quest for improved digital infrastructure and national security. As the sector integrates sophisticated technology and digitises its processes, telecom networks enable seamless communication while also protecting key assets, public safety and national sovereignty. The government's implementation of supportive reforms has boosted the country's digital objectives and enhanced the growth of the sector.

As India enters the 5G era, its telecom industry is expected to play an even greater role in promoting economic growth and social development, ensuring that connectivity reaches every part of the country. Addressing current issues, such as ensuring fair share contributions from LTGs and lowering levy burdens, will help create a more favourable environment and promote investment opportunities for telecom service providers. With a focus on innovation, inclusivity and sustainability, the future of Indian telecom looks promising, paving the way for a truly connected and empowered nation. ▲

# India's telecom sector as champion of digital equality

**Hindustan Times - 15th May 2025**

Telecommunication services have emerged as a truly transformative force today. This has not only changed the way we interact with one another but have also contributed to the creation of a digitally connected society. Although this digital transformation is occurring at a rapid pace, a large section of women, especially in rural areas, still remain untouched by its benefits. While it has enabled more women to access education, acquire skills, take up entrepreneurship and become self-sufficient, the digital gender gap remains a serious concern that needs to be addressed promptly.

According to the GSMA Mobile Gender Gap Report 2023, women in India are 30% less likely than men to use mobile internet-a gap wider than the global average of 19%. More than a third of Indian women who own a mobile phone still do not use it to access the internet. This highlights a deeper challenge that access isn't just about infrastructure, but also about empowering women with the knowledge, tools and freedom to go online.

These barriers to digital inclusion for women in India are complex and deeply rooted. Affordability remains a significant challenge; only about 20% of girls aged 14-18 in rural areas own a smartphone, compared to nearly 44% of boys in the same age group, reflecting how women are often deprioritised for device access within households. Digital literacy also lags behind given that just one in three women in India have ever used the internet, compared to 57% of men, with urban-rural divides further widening this gap.

India's telecom revolution has delivered far more than just faster speeds. With a combination of policy support, sustained investments and home-grown innovation, the sector has worked to make digital tools more accessible and affordable.

Competitive tariffs, low-cost data plans and the widespread availability of mobile services have helped bring millions of previously disconnected citizens online.

Even the government's vision of Digital India has provided a major push in expanding internet access and digital literacy, especially in rural and semi-urban areas. However, this would not have been possible without the efforts of telecom operators, who have not only built the physical infrastructure but also created practical, scalable solutions to help bridge the digital divide.

India's digital journey is fundamentally about enhancing lives, with women emerging as key agents of change. The Pradhan Mantri Gramin Digital Saksharta Abhiyan (PMGDISHA) has been instrumental in this transformation, providing digital literacy training to over 63.9 million rural residents between 2017 and 2024, it has helped over 60 million rural citizens, mostly women, pick up basic digital skills that let them access services, find opportunities, and connect with the world. A significant example of grassroots digital empowerment is the network of more than 67,000 women entrepreneurs managing Common Service Centres (CSCs) across India. These aren't just access points, they're change agents.

But the story doesn't stop there. Telecom companies have also stepped up with customised digital literacy campaigns, offering content in local languages, mobile money know-how and tools that help women stay safe online. Add to this the Ayushman Bharat Digital Mission, SANKALP hubs across all districts, and BharatNet's high-speed connectivity in gram panchayats, and you see a full-circle approach. These efforts aren't just about plugging women into the digital world; they're about helping them lead it.

The growth of digital commerce, social media platforms and remote work opportunities has opened new avenues for women's employment and entrepreneurship. Access to mobile-based financial services has also enabled many women to take control of their earnings and financial decisions. From digital wallets to mobile banking, women are now better positioned to save, invest and plan for their future. According to GSMA, closing the gender gap in mobile ownership and usage could generate an additional $230 billion in revenue for the mobile industry over eight years, highlighting the commercial and societal benefits of this very digital inclusion vision I am talking about.

While the progress made so far is really commendable, achieving full digital gender parity requires continued focus and here the telecom sector has a pivotal role to play and it is already working continuously to innovate around affordability, creating pricing models and device solutions that lower the barriers to entry for women.

Collaboration with policymakers is equally important to embed gender-sensitive principles in digital strategies which includes data-driven approaches to track progress, assess the impact of interventions, and course-correction wherever needed. The vision is pretty clear. We need a digitally inclusive India where every woman, regardless of location or background, has access to the tools and opportunities of the digital age. We believe that the telecom industry's role would be crucial to turn this vision into a reality, with sustained efforts and shared responsibility.

# WTD 2025: Bridging digital gender divide for inclusive future for India

**ET Telecom - 15ᵗʰ May 2025**

Over the past two decades, the telecom sector has transformed the social and economic fabric of the country, serving as a powerful engine for empowerment and inclusive growth. From urban hubs to the remotest corners of rural India, telecom networks have not only connected people but have also acted as catalysts for social transformation, especially for women and marginalized communities.

As we celebrate World Telecommunication and Information Society Day (WTISD) with the theme, "Gender equality in digital transformation", it is an opportunity to reflect on the telecom sector's role in narrowing the digital gender divide and also to chart the path forward for accelerating true digital inclusion.

## The Digital Gender Divide: A Stark Reality

While digital innovations are unlocking unprecedented opportunities, the full potential of this transformation remains constrained by persistent gender gaps in digital access, participation and leadership. GSMA Mobile Gender Gap Report 2023 underscores this challenge. It says although global internet use has risen steadily, gender disparities persist. In 2023, 70% of men worldwide accessed the internet compared to just 65% of women.

## Telecom's Role in Driving Access and Empowerment

India's telecom revolution, powered by progressive policy frameworks, continued investment and technological innovation, has played a central role in democratizing access to digital tools. The rollout of affordable mobile services and data plans, spearheaded by both private and public telecom operators, has brought internet access within the reach for millions of citizens who were previously excluded.

Flagship initiatives like Digital India have further deepened this impact by acting as a catalyst to drive universal digital literacy and boost internet penetration across rural and semi-urban areas. Telecom companies have been key enablers of these goals, providing extensive network infrastructure and developing tailored solutions that make digital access affordable and inclusive.

## Women-Centric Telecom Initiatives

India's commitment to digital inclusion is reflected in a range of ambitious Government initiatives that have empowered women to contribute towards the digital economy. Key initiatives under Digital India include the following:

- **Prime Minister's Digital Saksharta Abhiyan (PMGDISHA)**: Under the PMGDISHA, over 60 million rural citizens, mostly women, have been equipped with essential digital literacy skills, enabling them to access online services and opportunities.

- **Common Service Centres (CSCs)**: The network of CSCs has seen remarkable success, with 67,000 women entrepreneurs — known as Village Level Entrepreneurs (VLEs) — operating digital service centers that bring critical e-governance, financial and educational services to underserved communities.

- **Ayushman Bharat Digital Mission (ABDM)**: The ABDM is further bridging gaps in healthcare by enabling digital health records and telemedicine, ensuring more equitable healthcare access.

- **The SANKALP Hubs for Women Empowerment**: SANKALP hubs are active across 742 districts in 35 States and Union Territories, offering targeted skilling, mentoring and entrepreneurial support to enhance women's participation in the workforce and digital ecosystem.

- **BharatNet**: Backed by telecom companies, this national broadband initiative has connected thousands of gram panchayats, providing women-led self-help groups and entrepreneurs with new platforms for financial inclusion, health services and e-governance.

In addition to these, several telecom-led programs aimed at improving digital access and skills among women have been conducted in recent years.

- **Internet Saathi**: A collaborative effort between Google and Tata Trusts, supported by telecom operators, trained over 30 million women in rural India on how to access and use the internet, creating a massive impact by improving digital literacy within communities.

- **Customized Digital Literacy Campaigns**: Telecom operators have also introduced localized campaigns to address gender-specific challenges, offering vernacular content, mobile financial literacy and safety tools that enable women to navigate the digital landscape with greater confidence.

## Digital Platforms Unlocking New Work Opportunities

The shift towards ICT-enabled services and digital platforms has opened new employment avenues for women. Telecom networks have laid the foundation for online work, which offer flexible, remote career options, especially useful for women constrained by mobility or family responsibilities.

The growth of digital commerce and social media has brought several entrepreneurial opportunities, which are reshaping the participation of women in the country's economy. Moreover, mobile-based financial services have empowered women to gain greater control over their earnings and financial decisions, accelerating their journey toward economic independence.

## Building the Future: The Road Ahead

While significant progress has been made, the path to true digital gender equality requires sustained efforts. The telecom sector plays a major role in this mission. Expanding digital literacy initiatives through local partnerships can create grassroots impact. Equally crucial is the need to innovate around affordable access, developing inclusive pricing models and low-cost devices that make digital connectivity universally attainable. Lastly, close collaboration with policymakers is essential to establish gender-responsive frameworks that not only advance women's digital inclusion but also ensure transparent progress tracking. Together, these efforts will help build a more inclusive digital future, where every woman has the tools and opportunities to thrive.

LT GEN DR SP KOCHHAR

# WHY RURAL INDIA IS TELECOM'S NEXT GROWTH ENGINE

With digital adoption accelerating beyond cities, India's villages are reshaping the telecom landscape as users, innovators, and revenue contributors.

For years, India's telecom growth narrative has mainly been urban-centric. Metros and tier-I cities led the surge in data consumption, smartphone penetration, and digital transformation. But for some time now, a quiet revolution has been unfolding in the heart of the country. Rural India is no longer a passive participant—it is becoming a formidable engine of telecom growth, and this shift is both promising and profound.

According to Crisil Ratings, Internet penetration in rural India rose dramatically from 59% in January 2021 to 78% in December 2024, surpassing the growth rate in urban areas. With an expected increase of 4-5% by the end of FY2026, this expansion is being powered by widespread digital adoption, changing user behaviour, and increasing accessibility to affordable smartphones and data plans.

## RURAL INDIA: THE NEW DIGITAL GROWTH DRIVER

Today, digital tools are as integral to the lives of rural citizens as they are to their urban counterparts. From farmers checking weather forecasts and commodity prices online, to students attending virtual classrooms and small business owners managing inventory or payments via apps, rural India is fully embracing the digital age.

This widespread reliance on mobile data has created a tectonic shift in consumption patterns. Notably, despite broadband being traditionally viewed as more sophisticated, rural users have demonstrated a sustained appetite for it. While urban subscriber additions slowed, the rural demand remained robust, underlining the indispensability of mobile Internet in these regions.

> "Rural users depend heavily on mobile networks for Internet access, making data consumption a core necessity, not a discretionary expense.

## [TELECOM TALK]
## RURAL CONNECTIVITY

> In Tier II and III cities and small towns, better access to digital tools has fostered the growth of local entrepreneurs, tech-driven start-ups, and remote workers.



### IN BRIEF

- Rural Internet penetration in India rose to 78% by end-2024, outpacing urban growth and reflecting a significant shift in national digital usage patterns.

- Dependence on mobile data has made Internet access essential in rural areas, driving sustained data consumption across small towns and villages.

- Telcos are investing in spectrum, towers, and satellite solutions to extend coverage and meet rising demand in B and C category circles.

- India's 5G rollout has reached 99.6% of districts, with FWA emerging as a vital tool for broadband in underserved and remote areas.

- Programmes like BharatNet and PMGDISHA are creating digital-ready villages by combining infrastructure rollout with digital literacy.

- Rural users are projected to contribute 55–60% of ARPU growth, reinforcing the business logic for continued rural telecom investment.

Rural users depend heavily on mobile networks for Internet access, making data consumption a core necessity, not a discretionary expense. It is no surprise, then, that rural areas are contributing increasingly to the telecom sector's data traffic growth.

### TELCOS EXPAND FOCUS ON NON-URBAN MARKETS

India's telecom service providers (TSPs) have recognised the massive untapped potential in rural regions and are taking focused steps to tap into this demand. Whether it is about optimising tariff plans, rolling out new spectrum, or investing in tower infrastructure, the push to expand rural coverage is well underway.

The June 2024 spectrum auction saw a large share of spectrum acquired in category B and C circles, signalling a clear pivot towards non-urban markets. To extend the benefits of digital connectivity beyond the reach of terrestrial networks, telecom companies are also investing in satellite-based services. Certain entities are also exploring high-speed, low-latency connectivity solutions to serve remote communities, schools, health centres, and enterprises.

In addition, the launch of affordable devices like JioBharat—an affordable 4G handset—has democratised access to data services. Airtel's 'Rural Enhancement Project' aims to improve last-mile connectivity and deliver high-quality, affordable services to underserved areas. Vi is enhancing its 4G network by deploying new tower locations and boosting existing infrastructure across rural and semi-urban pockets.

### 5G AND FWA FUEL DEEPER RURAL PENETRATION

India has witnessed the world's fastest 5G rollout, with telecom operators working relentlessly to bring high-speed connectivity to even the most remote corners of the country. Indian telcos have fulfilled their minimum 5G rollout obligations across all 22 circles, and 5G services are now available in 99.6% of India's districts. As of September 2024, Airtel's 5G network spanned over 140,000 villages, while its 4G services reached 800,000 villages. Jio has a large-scale standalone 5G access network leveraging the 700 MHz band to strengthen rural connectivity.

Vodafone Idea, meanwhile, has introduced 5G in four major metro cities, but plans to roll out across the rest of India in a phased manner. According to the Nokia MBiT 2025 report, 5G traffic across India tripled in just a year, with rural and semi-urban areas emerging as the epicentres of this growth. Fixed Wireless Access (FWA)

> As 5G networks grow, FWA will become a crucial tool in bridging the digital divide and making Internet access more inclusive and equitable across India.

is emerging as a game-changer in this space, enabling reliable broadband delivery in underserved regions. As 5G networks grow, FWA will become a crucial tool in bridging the digital divide and making Internet access more inclusive and equitable across India.

### GOVERNMENT INITIATIVES BUILD DIGITAL BACKBONE

Parallel to industry efforts, the government is also playing a vital role in strengthening rural digital infrastructure. Initiatives like BharatNet are being rolled out in phases to bring broadband connectivity to every Gram Panchayat and beyond.

The recently launched National Broadband Mission 2.0 (January 2025) aims to accelerate the creation of digital communication infrastructure and bridge the digital divide. Under the Pradhan Mantri Gramin Digital Saksharta Abhiyan (PMGDISHA), six crore rural households are being equipped with digital literacy, laying the groundwork for inclusive digital growth. Together, these programmes are creating a conducive environment for telecom expansion, ensuring that digital services are not just accessible but also usable and beneficial to rural citizens.

### CONNECTIVITY DELIVERS BROAD SOCIO-ECONOMIC VALUE

The rural telecom revolution is about more than just better coverage or faster Internet. It is creating ripple effects across the economy and society. Over the past decade, the number of rural telephone connections has increased from 377 million in March 2014 to over 527 million as of October 2024. This surge in connectivity is enabling a host of transformational outcomes. In Tier II and III cities and small towns, better access to digital tools has fostered the growth of local entrepreneurs, tech-driven start-ups, and remote workers. Educational platforms, certification courses, and online skill-building programmes are empowering young people to discover new opportunities without having to leave their hometowns.

Digital payments and fintech services are helping rural populations transition to formal financial systems. This, in turn, supports financial inclusion, a critical component of long-term economic stability. Notably, the push for rural connectivity is also reinforcing the digital economy's contribution to GDP. In FY2022–23, the digital economy accounted for 11.74% of India's GDP, equivalent to INR 31.64 lakh crore (USD 402 billion). Much of this momentum can be attributed to the expansion of digital access and participation in non-urban regions.

### THE BUSINESS CASE: RURAL GROWTH DRIVES PROFITABILITY

Beyond social impact, rural connectivity also makes sound business sense. According to Crisil, the average revenue per user in the industry is projected to increase by Rs 20–25 to reach Rs 225–230 by the end of this fiscal year. Rural users are expected to contribute nearly 55–60% of this growth.

Consequently, the return on the capital employed for telcos is expected to improve from 10% in FY2025 to 12% in FY2026. This underscores a crucial point: investing in rural infrastructure is not just a developmental obligation, but also a strategic business opportunity. The returns, both economic and social, are compelling.

### LOOKING AHEAD: THE ROAD TO INCLUSIVE DIGITAL INDIA

Rural India is no longer on the periphery of digital progress. It is, in many ways, leading the charge. With strategic collaborations, focused investments, supportive Government policies, and increasing affordability of services and devices, the telecom sector is well-positioned to unlock the full potential of India's heartland.

As we look to the future, it is clear that rural connectivity will be central to building a digitally inclusive, economically vibrant, and socially empowered India. For the telecom industry, this is more than a growth opportunity — it is a chance to create a lasting impact where it matters the most. The rural telecom revolution has begun. And it is here to stay. 🤝

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

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**Spectrum Strategies:**
Powering India's Next
Digital Leap

**LT GEN DR SP KOCHHAR**

# INDIA'S SPECTRUM RETHINK: UNLOCKING THE DIGITAL FUTURE

India's surging data needs demand a smarter spectrum policy—refarming, fair auctions, and a mid-band strategy are key to sustaining its digital growth.

India's digital journey is nothing short of remarkable. With over 365 million 5G subscribers and growing, the telcos have helped the nation emerge as a global leader in mobile connectivity. However, to keep pace with the swelling demand and rapid technological evolution, the telecom sector must optimise its spectrum strategy, the invisible backbone of all wireless communications. Let us delve into the critical components of this strategy: spectrum refarming, sharing frameworks and future spectrum auctions, illustrating how these pillars are vital to building a Digital India that is competitive, inclusive and future-ready.

## THE SPECTRUM IMPERATIVE: A GROWING DEMAND

Spectrum is the lifeline for the telcos and, by extension, India's digital economy. As more Indians come online and emerging technologies, such as the Internet of Things (IoT), artificial intelligence or AI-driven networks, and autonomous systems, grow, wireless data consumption
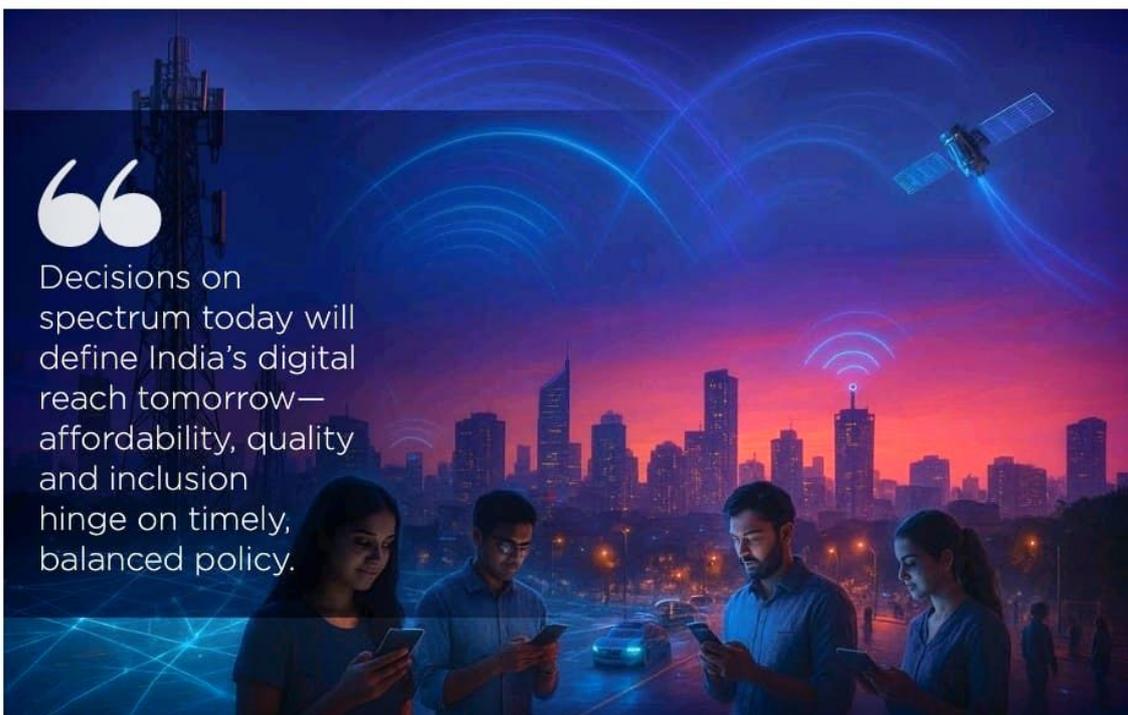
> Decisions on spectrum today will define India's digital reach tomorrow— affordability, quality and inclusion hinge on timely, balanced policy.

## [TELECOM TALK]
### POLICY

> Refarming idle government spectrum unlocks national assets for telecom use, boosting 5G capacity while protecting mission-critical services.



## IN BRIEF

- India needs over 2 GHz of new mid-band spectrum by 2030 to meet the soaring demand for data and comply with global IMT-2020 standards.

- Refarming 687 MHz from government users boosts available spectrum to 1,587 MHz without disrupting critical national operations.

- High reserve prices have slowed past spectrum uptake; rational pricing can drive faster rollouts and affordable networks.

- Spectrum costs already consume 26% of operators' recurring revenues, one of the highest rates globally, and negatively impact investments.

- The 6 GHz band is critical for 5G and future 6G; licensed use ensures better coverage, capacity and rural inclusion.

- Private 5G should stay with licensed operators to safeguard security, revenue equity and efficient network management.

is soaring exponentially. Meeting this surging network load requires more spectrum, particularly mid-band frequencies that strike a balance between geographic coverage and network capacity.

Currently, India holds approximately 900 MHz of IMT spectrum (per Circle) for mobile services. However, to deliver world-class 5G performance and fulfil international IMT-2020 standards requirements, the telcos estimate that India needs to more than double the current amount, or an additional 2 GHz of mid-band spectrum would be required by 2030. The 6 GHz band could be the only viable solution for addressing this shortcoming.

### REFARMING: UNLOCKING IDLE NATIONAL ASSETS

The Government of India took a landmark step this year by approving the refarming of 687 MHz of spectrum previously held by government agencies such as the defence forces and ISRO. This initiative, strongly backed by the telcos through sustained advocacy, raises India's total IMT spectrum from 900 MHz to approximately 1,587 MHz, a game-changer in addressing network capacity constraints.

Refarming is not just spectrum reallocation; it represents a strategic unlocking of underutilised national assets. Many government departments hold spectrum that can simultaneously fulfil their operational mandate while enabling commercial use for 5G and upcoming 6G services.

This phased refarming approach ensures that critical government functions continue uninterrupted, while significantly boosting spectrum availability for the telcos. Ultimately, it positions India to capture the vast socioeconomic opportunities that 5G promises, including an estimated USD 41 billion GDP boost by 2030, primarily driven by the deployment of mid-band spectrum.

### FUTURE AUCTIONS: PRICING TO STIMULATE GROWTH

Past spectrum auctions in India have been marred by high reserve prices, resulting in significant portions of

> Rational spectrum pricing could accelerate India's digital rollout, making high-quality mobile broadband affordable and widely available.

spectrum remaining unsold and constraining network investments. Unsold spectrum translates directly into slower network expansion and limits consumers' access to affordable, high-quality mobile services.

The telcos firmly believe that auction reserve prices must be realistic and reflective of India's market and financial realities. Aligning reserve prices with roughly 50% of the Telecom Regulatory Authority of India's valuations, down from the prevailing 70%, is likely to promote competitive bidding, attract new entrants, and encourage more aggressive network rollouts.

The acquisition of new bands to support 5G and enhanced 4G networks has resulted in a gradual increase in the spectrum cost burden between 2015 and 2023. This currently stands at 26% of the operators' recurring revenues and is among the highest in the world.

Rationalised spectrum pricing can be seen as a catalyst for the recent accelerated 5G rollouts and improved network quality in India. However, the burden of spectrum cost will continue to influence India's progress towards its digital goals for years to come.

### THE 6 GHZ BAND:
### THE MID-BAND CORNERSTONE

Among all spectrum bands, the 6 GHz range stands out as the linchpin for India's mid-band strategy. Given that a large portion of existing 5 GHz unlicensed Wi-Fi spectrum remains underutilised, delicensing the remaining 6 GHz band for Wi-Fi would be a lost opportunity. Licensed deployment of the full 6 GHz band provides a superior balance of coverage and capacity, enabling the delivery of robust mobile broadband to both urban and rural areas in India. Occupying this mid-band spectrum is critical not just for meeting immediate 5G needs but for sustaining network excellence through 6G and beyond.

### PRIVATE 5G:
### LICENSED OPERATORS SHOULD LEAD

The debate over direct spectrum allocation to enterprises for private 5G networks continues, but telcos firmly advocate for a model in which licensed service providers manage these networks.

Telcos have invested trillions in licensed spectrum and infrastructure, bringing expertise, economies of scale, and regulatory oversight that are crucial to both security and performance. Enterprises can benefit from customised connectivity solutions via network slicing. Direct spectrum allocation, on the other hand, risks National Security, Government revenues and regulatory equity, potentially skewing competitive fairness and complicating network interference management.

### POLICY CHOICES SHAPING WIRELESS ACCESS

As India looks to the immediate future, the priorities for telecom operators are clear: ensuring that the full 1200 MHz in the 6 GHz band is allocated for IMT and refining auction methodologies with realistic pricing that promotes efficient spectrum use without compromising competition.

Over the medium and long term, the sector must prepare for the demands of 6G spectrum, developing strategies for new frequency bands and evolving network architectures that will define the next decade of wireless innovation.

India's telecom sector stands ready to lead the next digital revolution. Building on a strategy that simultaneously unlocks idle spectrum, along with market-friendly auction frameworks, is imperative.

The spectrum policy choices made today will determine the quality, affordability, and inclusivity of connectivity for the country's 1.4 billion-plus citizens tomorrow. Through thoughtful and collaborative policymaking, India can emerge as a global leader in advanced wireless technologies, transforming societies, fuelling economies, and expanding opportunities for all. 🔶

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

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![COAI logo]

## Lt. Gen. Dr. S. P. Kochhar

Director General
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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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