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5G'S NEXT TEST: TURNING INFRASTRUCTURE INTO REAL RETURNS

India built a vast 5G infrastructure at a remarkable speed, yet the next phase demands course correction to translate networks into enterprise productivity.

The nascent 1990s saw the advent of 2G, the first GSM-based digital mobile system. Since then, the juggernaut of successive generations has rolled forward inexorably. Seven years ago, 5G was launched commercially on 3 April 2019 in South Korea by SK Telecom, KT, and LG U+.

Within weeks, Verizon launched 5G in the United States. By October 2019, China's three national carriers had begun nationwide deployments. Through 2020 and 2021, Europe, the Middle East and parts of Asia followed. By 2021, more than 60 countries had operational 5G networks.

India entered later. Commercial services began on 1 October 2022. Yet the pace since then has been exceptional. By early 2025, 5G services were reported to be available across more than 99% of districts and to reach roughly 85% of the population. By global standards of rollout velocity, India stands among the fastest.

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The scale of investment underscores that seriousness. In the 2022 spectrum auction, telecom operators committed Rs 1,50,173 crore—one of the largest single-cycle spectrum commitments globally. That figure excludes network capital expenditure, which itself has been substantial. Industry assessments suggest that capex during the 5G build phase has remained in the range of Rs 70,000–75,000 crore annually (excluding spectrum), directed towards Massive MIMO radios, mid-band densification, fibre backhaul and core modernisation.

The government has also backed the transition in an unprecedented manner, committing an estimated Rs 1,200 crore across at least five initiatives covering test beds, R&D for use cases and other development programmes for 5G and beyond-5G domains. On the surface, the narrative is one of extraordinary momentum.

Yet seven years into global 5G deployment—and nearly three years into India's rollout—the deeper economic question remains open.

ADOPTION VERSUS PERCEPTION IN 5G

Globally, there is still no conclusive evidence that 5G has enabled mass-market consumer applications or speeds that were technically impossible on 4G LTE-Advanced. Its advantages remain largely architectural rather than experiential: greater spectral efficiency, lower theoretical latency, higher device density support, improved energy efficiency per bit and enhanced programmability of networks. None of these improvements, however, is directly visible or necessarily of interest to the average consumer. These are meaningful technical improvements, but they are not, by themselves, transformative.

The adoption curve suggests that, for the average user, the incremental benefit of 5G over 4G LTE-Advanced may not yet be compelling enough to alter switching behaviour. This pattern is not unique to India. In many advanced markets, 5G has primarily improved network capacity and peak speeds rather than enabling visibly new digital behaviours.

NSA AND SA ARCHITECTURE: THE GAP

A critical technical nuance often overlooked in public

IN BRIEF

- India completed one of the fastest 5G rollouts globally, with services reaching over 99% of districts and nearly 85% of the population.
- Consumer experience gains remain modest because many deployments still rely on non-standalone architecture anchored to existing 4G cores.
- The strongest economic case for 5G lies in enterprise deployments across manufacturing, ports, logistics, mining and utilities.
- China's large-scale industrial 5G deployments demonstrate how repeatable enterprise use cases convert trials into viable economics.
- Policy uncertainty around private 5G spectrum access continues to slow enterprise adoption in India.
- High spectrum costs, network capex and rising energy consumption make new revenue models essential for telecom operators.

> 5G's real economic value will emerge when networks integrate deeply with industrial systems rather than remaining a faster consumer connectivity layer.

discourse is the distinction between Non-Standalone (NSA) and Standalone (SA) 5G architectures. Most early deployments globally—including those in the United States, Europe and Asia—were NSA, anchored to existing 4G cores. NSA improves throughput but does not fully enable ultra-reliable low-latency communications (URLLC), deterministic slicing or deeper network programmability.

The transition to enterprise-grade applications typically requires SA cores, network slicing capabilities, and high-fibre connectivity—often exceeding 70% site fibreisation for consistent mid-band performance. The monetisation inflexion point, therefore, is less about rollout and more about architectural migration.

ENTERPRISE 5G AS THE MULTIPLIER

Internationally, the strongest monetisation pathway for 5G has not emerged from consumer speed upgrades but from enterprise deployments in sectors such as manufacturing, ports, mining, logistics and utilities.

Countries that are extracting an economic multiplier from 5G share a common characteristic: industrial deployments are operational at scale rather than on an episodic basis. When 5G becomes embedded in production environments, it begins to deliver measurable operational outcomes.

China's "5G + Industrial Internet" programme is best understood as an industrial policy instrument rather than merely a telecom upgrade. Public briefings indicate that China had already established more than 30,000 5G virtual private networks, over 300 5G-enabled factories and more than 13,000 "5G + industrial internet" projects by mid-2024.

This scale matters because it changes the economics. Once industrial 5G becomes repeatable, it stops being "trial cost" and becomes "unit economics." China is deploying 5G as a backbone for factory modernisation rather than simply as a consumer access layer. In such deployments, monetisation emerges from measurable operational outcomes, such as improved uptime, production yield, predictive maintenance, safety automation, machine vision, and closed-loop control, rather than generic claims of faster internet connectivity.

Region	Policy Approach	Industrial Deployment Scale	Key Enablers
China	National industrial policy integrating "5G + Industrial Internet"	- 30,000+ virtual private networks - 300+ 5G factories - 13,000+ industrial projects	- Centralised industrial digitisation strategy - Strong manufacturing ecosystem - State-backed investments
Europe (Germany focus)	Local spectrum licensing for enterprise campus networks	- 431 local spectrum licences in the 3.7–3.8 GHz band for private networks	- Regulatory support for campus networks - Industry 4.0 integration - Strong manufacturing clusters
India	CNPN framework allowing private networks via telecom operators or direct spectrum assignment	- Limited and largely pilot-based enterprise deployments	- Regulatory uncertainty around direct spectrum vs telecom-mediated models - Evolving enterprise ecosystem

Source: *State Council of the People's Republic of China (English.Gov.Cn); Digital Regulation Platform, The World Bank; and DoT CNPN Guidelines and Spectrum Leasing Framework.*

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Europe's approach differs but remains equally structural. A key enabler has been local spectrum licensing for campus networks, particularly in Germany. By November 2024, Germany's regulator had awarded 431 local licences in the 3.7–3.8 GHz band for enterprise and private networks, enabling deployments across manufacturing sites, airports and logistics parks.

INDIA'S PRIVATE 5G POLICY GAP

India's framework for private networks exists in principle, with the Union Cabinet approving recommendations related to captive non-public networks. However, enterprise adoption remains limited.

The reasons appear to lie less in technological capability and more in policy execution and market design. Uncertainty persists over whether enterprises should receive spectrum directly or rely on telecom operators through leasing or slicing. Eligibility thresholds and demand-assessment requirements have further contributed to a cautious "wait-and-watch" approach among potential adopters.

The consequence is that India's 5G narrative risks remaining consumer-led even when consumer demand alone may not produce significant incremental value. The enterprise layer—particularly across manufacturing, ports, mining, utilities and logistics—could provide the economic multiplier. However, policy friction continues to delay that transition.

ENERGY ECONOMICS OF 5G NETWORKS

Another dimension of 5G that receives limited attention is energy intensity. Mid-band Massive MIMO radios used in 5G deployments are more power-intensive per site compared with legacy 4G infrastructure.

Energy optimisation, therefore, becomes central to long-term network sustainability. Techniques such as AI-driven sleep modes, dynamic spectrum management and more efficient network architectures are increasingly important.

Network economics must simultaneously balance spectrum amortisation from the Rs 1.50 lakh crore auction commitment, sustained annual capital expenditure of roughly Rs 70,000–75,000 crore during deployment phases, and ongoing operating expenditure, including energy consumption and fibre maintenance. Without proportional revenue expansion, financial returns remain constrained.

EXTRACTING VALUE BEFORE 6G ARRIVES

Even as 5G monetisation continues to evolve globally, attention is already shifting towards the next generation. India has articulated a Bharat 6G Vision and approved grants of approximately Rs 240.51 crore for two advanced 6G test beds focusing on terahertz communications and advanced optical networking.

Early participation in research is strategically sensible because standards and intellectual property positions are established years before commercial deployment. However, the strategic risk does not lie in pursuing 6G. The risk lies in treating it as a substitute for extracting value from 5G.

Telecom history suggests that each generational transition follows two phases. The first is a coverage phase marked by rapid rollout, heavy capital expenditure and aggressive marketing. The second is a realisation phase in which networks become economically meaningful through enterprise integration and platform capabilities.

India has completed the first phase with remarkable speed. The next phase must ensure that this foundation produces measurable economic dividends through enterprise deployments, operational efficiency improvements and platform-level revenue opportunities. Only then will 5G evolve from a generational label into programmable productivity infrastructure—and become the most credible bridge to the 6G era.

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