

DIGITAL INFRASTRUCTURE FOR VIKSIT BHARAT @ 2047

A ROADMAP FOR INCLUSIVE GROWTH



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September 2025

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Published by



Acknowledgement

This paper acknowledges the Hon'ble Minister of Communications, Shri Jyotiraditya M. Scindia's call for Digital Inclusivity as a cornerstone for achieving the vision of *Viksit Bharat @2047*. His articulation of connectivity as an act of nation-building has provided both direction and motivation to the work presented here.

I would like to express my sincere gratitude to Mr. T.V. Ramachandran, President, Broadband India Forum (BIF), for considering me and entrusting me with the opportunity to author this paper. I also gratefully acknowledge the BIF team, whose insights, discussions and thoughtful contributions have been instrumental in shaping this paper into its present form.

With thanks and regards,
Sundeep Kathuria

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Executive Summary

This paper draws inspiration from the Hon'ble Minister of Communications, Shri Jyotiraditya M. Scindia's address at an event in June 2025, commemorating the World Wi-Fi Day, where he emphasised that connectivity is not just a commodity but a tool of empowerment and nation-building. His articulation that connectivity is not merely a commodity but an act of nation-building — exemplified by his call to make Wi-Fi stand for **Widespread Inclusion for Future India** — provides both the direction and urgency for this paper.

The Digital Infrastructure is infrastructure of opportunity, and therefore, what we build decides who we become. India's digital infrastructure achievements are undeniable: over a billion mobile connections, world-leading data affordability, near-universal 4G coverage, rapid 5G rollout and ongoing fibre backbone expansion. The BharatNet project has connected most Gram Panchayats to optical fibre, while mobile data consumption per user exceeds respective global averages. Yet, Internet access has plateaued at around 69% overall, with rural usage at just 45%. This means nearly half of India's citizens are yet to participate fully in the digital economy — a reminder that **bridging the divide is as much about affordability, devices and skills as about networks**. The fixed broadband penetration remains under 4%, rural connectivity quality lags behind urban benchmarks and public Wi-Fi density is far below developed-country standards.

The convergence of **Artificial Intelligence (AI), quantum communications, satellite-terrestrial networks, immersive content delivery and distributed computing** will reshape every facet of economic, social and governance life. **Tele-ICU and emergency services, Smart grids and renewable balancing, Public service "virtual**

rooms" at Gram Panchayats, **Disaster response efficiency, XR Classrooms and Precision Agriculture** are examples of such convergence.

However, the challenge is not merely technological; it is also about **inclusivity, trust, resilience and preparedness**. The challenge is no longer whether India should build digital infrastructure at scale, but how it should be **structured, governed and operationalised** so that it serves as the **backbone** of **inclusive economic growth, social empowerment and global competitiveness**. **Accessibility and affordability are production inputs for GDP**, not social add-ons. **Inclusivity, therefore, is an essential capability** for achieving the vision of *Viksit Bharat @2047*. **A transformation from a digitally connected nation to a digitally empowered civilization is imperative.**

To achieve this, the **digital infrastructure must be understood not only as physical networks and assets but as a layered ecosystem where policy, governance and inclusion are as critical as towers, cables and data centres**. At the base are the **physical assets** — fibre, mobile towers, Wi-Fi including Public Wi-Fi, landing stations, satellites and semiconductor capacity — that must be expanded and modernised. Above them sits the **logical layer** of software-defined networks, spectrum management and security frameworks, increasingly automated through AI. On top of these lies the **service layer** of payments, identity, content delivery, cloud and AI platforms, directly shaping citizen and business experiences. Finally, the **enabling environment** of rules, regulations, governance capacity and human capital determines whether this infrastructure can function at its full potential.

Opportunities & Imperatives

The **Telecommunications Act 2023** marks a **decisive shift away from colonial-era law**, while the **IndiaAI Mission** recognises compute, models and datasets as critical infrastructure in their own right. **However, the true test lies in transforming outcomes through their operationalisation** i.e. through subordinate rules, state-level harmonisation and effective enforcement.

To remain both globally competitive and domestically inclusive, India must **resolve key policy choices** on urgent basis: **spectrum posture (licensed and unlicensed), neutral-host and shared infrastructure models, open access to ducts and dark fibre, diversified players, resilience protocols and incentives for sustainable digital infrastructure**. Each carries trade-offs that will shape affordability, innovation, competition and resilience.

The next transformation wave will be defined by **AI-native networks, quantum-resilient communications, integrated satellite-terrestrial coverage and immersive learning and healthcare**. This will also mean that India continues to **create more platforms** and will have to **increase computing power manifold**. These capabilities, if deployed equitably, could narrow India's rural–urban divide; if not, they risk deepening it.

Digital infrastructure should be judged not solely by its capacity but also by the **outcomes it enables**, like :-

- **Universal High-Quality Access:** This includes fibre to every village, affordable fixed broadband integrated with high-speed, low-latency connections, modern and next-generation Wi-Fi, high-speed mobile services without latency or reliability gaps, public Wi-Fi, in-building solutions, advancing inclusion and accessibility for Persons with Disabilities (PwDs) and consumer broadband to rural and

remote areas through next-generation satellite communications. Seamless integration between terrestrial and non-terrestrial networks is also essential.

- **Infrastructure Diversification:** This involves decentralised edge computing, distributed data centres, climate-resilient networks powered by renewables, AI-ready cloud systems and self-reliance in semiconductors.
- **Affordability and Devices:** Subsidised access devices and targeted tariff structures for low-income households are crucial.
- **Self-Reliance in Digital Infra:** India's self-reliance in digital infrastructure is crucial for economic and strategic sovereignty. This involves accelerating indigenous semiconductor capacity, investing in domestic cable landing stations and encouraging homegrown open-source solutions.
- **Innovation (India's Competitive Edge):** India's competitive edge lies in fostering innovation in digital infrastructure. This involves investing in research and development, supporting startups and creating a conducive environment for entrepreneurship.
- **Human Capital Readiness:** Digital literacy beyond device use, cybersecurity awareness and continuous workforce re-skilling.

India's Digital Infrastructure Roadmap: 2025–2047

India's digital journey toward *Viksit Bharat 2047* can be envisioned in three sequential phases. Each phase builds upon the previous one, ensuring that the foundational infrastructure translates into advanced capabilities and ultimately positions India as a global leader in digital technologies.

2025–2030: The Foundation Phase

The initial priority should be to close critical connectivity gaps and establish the physical and institutional groundwork for long-term growth.

Right to Connectivity (RTC) and **Rural–urban parity** should be key components of policy blueprint. Without robust last-mile and backhaul infrastructure, higher-order capabilities cannot scale. Some of the suggested key milestones in this period are:

- Complete **rural fibre backhaul**, ensuring **universal backbone connectivity**;
- Achieve **fixed broadband penetration in majority of the households**;
- **Legally binding BharatNet targets** to prevent rural connectivity slippage;
- **Scale PM-WANI public Wi-Fi** to enhance affordable access - scaling toward the national target of **50 million hotspots by 2030**;
- **Indoors are the new last-mile** - Without 6 GHz Wi-Fi and neutral-host, 5G will under-deliver where people actually use data;
- **Establish accessibility as a non-negotiable standard by 2030**. Ensure all **government portals and public Wi-Fi rollouts** are accessible to **PwDs**;
- Achieve **ubiquitous 4G/5G adoption** across all regions;
- Shape forward-looking **spectrum policies**, **set research priorities** and **strengthen standards engagement for 6G**;

- Enable **satellite connectivity for remote and underserved areas** and it together with Wi-Fi and other technologies can be used for faster rollouts;
- **Tiered authorisations** under the new Telecom Act should open the door for **new players / networks, public Wi-Fi and neutral-host infrastructure**;
- Operationalise the **Digital Bharat Nidhi** to finance key initiatives in **rural infra including incentivising based on Rural-urban parity metric**;
- Drive the organic growth of **data centres in smaller towns** beyond Tier-1 cities;
- Deploy the **first district-level edge data centres**;
- Lay the **base for self-reliance in chips and cloud infrastructure**; and
- Governance reforms must culminate in a **National Digital Infrastructure Council** (with states fully represented).

2030–2040: The Capability Phase

With foundational networks in place, the next decade should be about scaling penetration, building resilience and integrating advanced technologies into everyday life. The emphasis will shift from “connectivity access” to network performance, security and advanced capacity. The suggested broad key milestones in this period are:

- Focus on **Rural–urban parity**;
- **Public Wi-Fi as common as public lighting** ensuring universal affordability;
- Deliver **symmetrical multi-gigabit nationwide access**;
- Ensure **seamless integration of satellite and terrestrial systems**;
- Bring **rural nodes fully into advanced service networks** with adequate capacity;
- Build **redundancy in sub-sea cables** to secure international connectivity;
- **Roll out 6G networks nationwide**;
- **Enable AI-native network optimisation** for efficiency and predictive maintenance;

- Deploy **quantum key distribution** for secure communications;
- Ensure **PwDs** fully participate in the **capability expansion of AI-native and resilient networks**; at least **10 million PwDs** should receive subsidised assistive technologies and **scaling of vocational training** and **digital literacy programmes** to train them;
- Establish a **fully redundant, fail-proof National Critical Communications network, essential for disaster recovery and national security**; and
- Create Innovation **sandboxes** enabling startups, MSMEs and entrepreneurs to **test AI-native networks, Satcom convergence and rural IoT applications**.

2040–2047: The Leadership Phase

With robust capabilities and resilience achieved, the final stretch should be about global leadership and sovereignty. The focus should move towards symmetry, equity and technological self-reliance, ensuring India as a global digital leader. The broad key milestones during this phase should be:

- **Eliminate the rural–urban gap** in both **speed and latency**;
- **Digital opportunity** for **every citizen**;
- **Enable fully immersive education, healthcare and governance platforms**;
- **Achieve parity** in **digital access indicators** for **PwDs**;

- **Sovereign digital capabilities** -Indigenous semiconductor manufacturing, quantum networking, AI chipsets, secure satellite systems and resilient cloud infrastructure;
- Build **quantum and AI infrastructure** for strategic independence;
- **Export models** for **Digital Public Infrastructures**; and
- Operationalise **climate-resilient digital systems** to withstand environmental risks.

By 2047, India's global digital leadership will not be measured only in network speeds or technological sophistication but in equitable opportunity. Success will mean that a student in rural Odisha accesses immersive STEM labs with the same quality as one in Bengaluru and a farmer in Rajasthan uses AI-driven market forecasting as easily as a corporate trader in Mumbai.

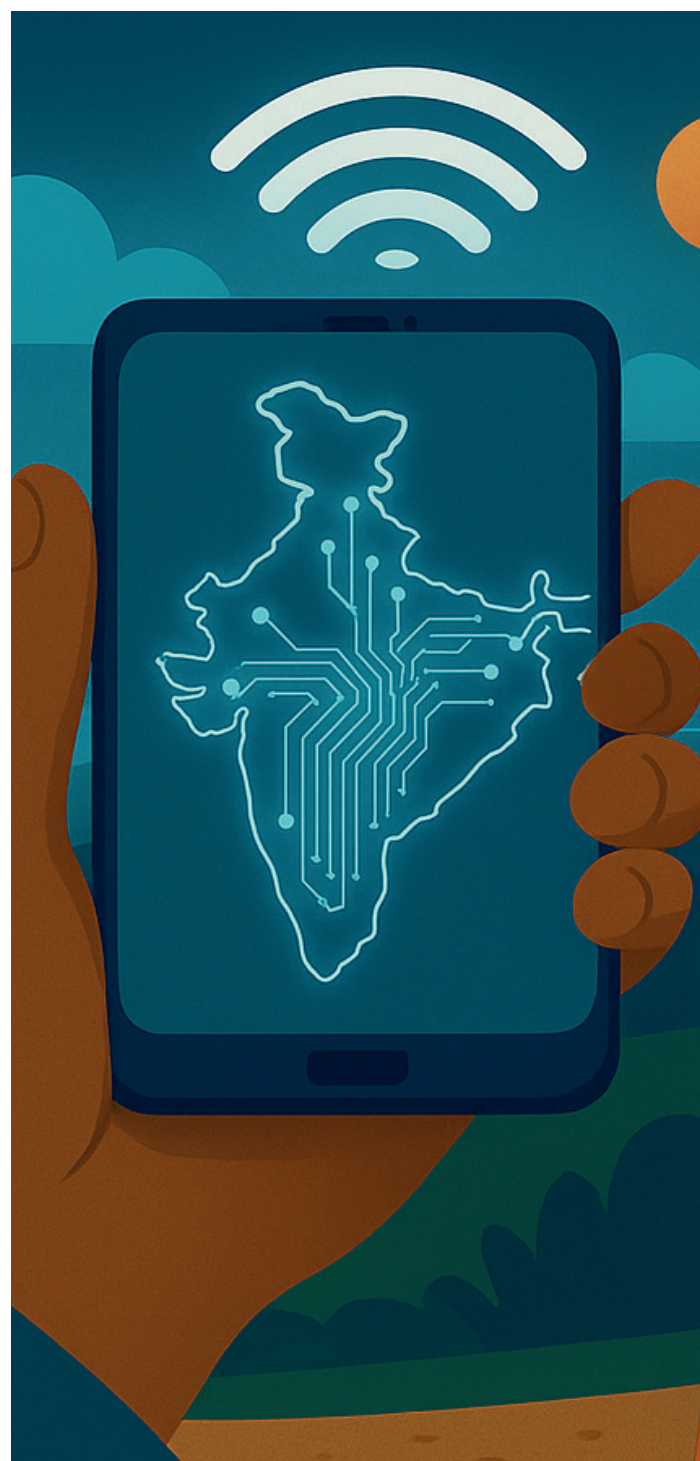
The path is clear: connect everyone, empower everyone, prepare everyone. The next two decades are not just about building networks — they are about building a digital civilization that is inclusive, resilient and globally competitive.

1. Introduction

India stands at a pivotal moment in its economic and technological evolution. The last decade has witnessed one of the most rapid expansions of connectivity and digital services anywhere in the world. A country that once struggled to ensure reliable telephone lines now processes more real-time digital payments than any other nation. From the proliferation of 4G networks to the fast deployment of 5G and the scaling of public digital platforms like Aadhaar and UPI, the story of India's digital rise has been as much about policy innovation as it has been about infrastructure buildout.

Yet, these achievements, remarkable as they are, represent only the first stage of a much longer journey. The Government of India's vision of *Viksit Bharat 2047* — a fully developed, globally competitive and inclusive economy — cannot be realised without a **digital infrastructure that is robust, future-proof and capable of supporting technologies and services** that, in many cases, do not yet exist in commercial form. This will be about **connecting more people to the internet** as well as about **enabling meaningful participation in a fully digital society**, where **artificial intelligence augments decision-making** in every sector, where **quantum communication ensures unbreakable security** and where **seamless satellite-terrestrial integration allows connectivity** to follow the citizen wherever they are.

This paper examines what digital infrastructure means in this new era, why it is central to the 2047 vision, where India stands today and what must be done — legislatively, regulatory and operationally — to ensure that every citizen can benefit from the transformation.



2. Digital Infrastructure: Concept, Current Status and Relevance in the Intelligent & Inclusive Era

A. What it means?

The term “digital infrastructure” once referred narrowly to the physical hardware that enabled telecommunication — copper lines, cellular towers, satellite dishes. According to the International Telecommunication Union (ITU), such infrastructure includes fibre optic cables, mobile towers, modern Wi-Fi and satellite technologies, Li-Fi, FSO Mesh Wi-Fi, data centres, internet exchanges, content delivery networks and under-sea cables with standalone Cable Landing Stations (CLS). **Building on the ITU’s definition, the current global discourse and India’s own vision for 2047, digital infrastructure can be viewed as an integrated ecosystem of networks, platforms and services, enabling both technological advancement and inclusive socio-economic transformation.**

At its base are the **physical assets: fibre-optic cables** stretching across continents and under oceans and, at the same time, critical for meaningful access; **data centres** that store, process and distribute information; **wireless towers and small cells** that deliver connectivity to mobile devices; **Wi-Fi, Public Wi-Fi, In-building solutions**, capabilities in areas of design and manufacturing of **semi-conductors and chips**; and **satellite constellations** that provide coverage to remote regions. These elements are the visible and tangible foundations of the digital world.

Above the physical layer sits the **logical infrastructure** — the **software-defined networks, routing protocols, security frameworks and spectrum management systems** that control how data moves. This layer is increasingly **dominated by automation and AI**, with **machine learning models optimising network traffic flows, predicting faults** before they occur and **dynamically allocating bandwidth** to meet shifting demands.

Then there is the **service layer**, comprising the **platforms and APIs** that deliver functionality directly to end users or to other services — **payment systems, identity authentication, content delivery networks and cloud computing platforms**. These services rely on both physical and logical infrastructure to function, but they also, in turn, drive demand for more capacity and better performance. The **IndiaAI Mission recognises compute, models and datasets** as part of this broader service and infrastructure landscape.

Finally, there is the often-overlooked **enabling environment** — **policies, regulations, governance mechanisms and human capital**. Without licensing frameworks that lower barriers to new entrants and without data protection laws that build trust, the best physical networks can remain underused or misused. And without a workforce trained to design, deploy and manage these systems, digital infrastructure cannot reach its full potential. A passing reference to the DPDP Act 2023 is relevant here as part of the trust

framework, though this paper does not delve into its details.

In India's case, the **enabling environment is especially critical** because of the **country's diversity — in geography, in socio-economic conditions and in governance structures across states**. The **Telecommunications Act 2023**, which replaces the colonial-era Indian Telegraph Act, is a step toward modernising this environment, but **how it is operationalised** through the enabling Telecom Rules will determine whether India's digital infrastructure remains reactive to global trends or proactively shapes them.

B. Current Status of Digital Infrastructure in India

India's digital infrastructure has undergone a **remarkable transformation over the past decade, yet its development has been uneven**, with pockets of world-class capability coexisting alongside areas of acute under-service. The national picture is thus a composite of both progress and persistent disparity.

The most visible achievement has been the **democratisation of data access**. Affordable connectivity has expanded the user base and has redefined who participates in the digital economy.

Equally transformative has been the creation of **Digital Public Infrastructure (DPI)**. Aadhaar, the world's largest biometric identity system, has over 1.42 billion enrolments¹ and has enabled secure authentication across government and private services. The Unified Payments Interface (UPI) has become a global case study in open, interoperable digital payments, handling over 16.7 billion transactions in December 2024.² The **Jan Dhan-Aadhaar-Mobile (JAM)** trinity has facilitated direct benefit transfers to hundreds of millions, drastically reducing leakages and corruption. These platforms are more than services; they are **public utilities that have lowered transaction costs and increased transparency** in a way that rivals physical infrastructure in economic impact.

On the **mobile connectivity** front, India is a global giant with over 1.1 billion wireless³ subscribers, with 4G covering almost the entire population and 5G networks being deployed at a good pace. However, mobile dominance has also meant that **fixed broadband penetration remains low**. There are 3.15 fixed broadband connections per 100 people in India, compared to penetration rates of 47.8 in South Korea and 47.2 in China. The BharatNet programme has succeeded in bringing fibre to most Gram Panchayats, but the **"last mile" challenge** — extending that fibre into homes, schools, health centres and businesses — remains unresolved in many rural and peri-urban areas. Commercial viability constraints for private ISPs, high upfront deployment costs and hurdles in securing right-of-way are persistent bottlenecks.

From a mobile usage perspective, India is an **outlier in terms of mobile data consumption per user — averaging 21.5 GB⁴ per mobile user per month**, among the highest in the world. The average revenue realisation per GB for wireless data usage is about **₹9 per GB** (Rs.8.97 for the year 2024-25)⁵, which is among the lowest mobile data costs to users globally. But the affordability metric masks an **"affordability paradox"**: while the mobile data at average per GB is cheap, the **devices and services remain out of reach for many**. India's overall **internet density**, including both narrowband and broadband connections, has plateaued at around **68.63%**, with **rural areas** significantly lower at **45.03%**.⁶ Given India's economic structure, this stagnation indicates that the **bottom half of India's population is digitally excluded**, primarily due to affordability barriers. The **average revenue for wireless data per data subscriber per month for wireless services** is Rs.231.46⁷ (Rs.2777 annually), which is **far exceeding the UN Broadband Commission's affordability benchmark of 2% of monthly Gross National Income (GNI) per capita for low-income groups** considering that per capita income for half of India's working population is less than ₹75,000 annually.⁸

Public Wi-Fi infrastructure, envisioned as a complement to mobile and fixed networks, has **yet to see promising developments** through the **PM-WANI** framework. This innovative, unlicensed model for Wi-Fi hotspots lowers barriers for small entrepreneurs to become connectivity providers. While recognised by the International Telecommunication Union as a model for affordable broadband access in rural areas⁹, its actual footprint remains a fraction of what is required to match the hotspot density of countries like Japan or the United States. Scaling PM-WANI to millions of hotspots will require not just **policy support** but also **local awareness campaigns, integration into everyday commerce** and **targeted subsidies** (both on the supply as well as on the demand side) in low-income areas.

The **maximum data consumption** is **inside buildings**. Therefore in-building digital connectivity and supporting infrastructure has become critical. The **mobile networks** in 4G and 5G, use high frequency bands and they get **attenuated due to walls**. There is an urgent need to **create an ecosystem for creation of in-building Digital Connectivity Infrastructure**. The regulations and bye-laws are being formalised and implemented for the same. This highlights **need for multiple technologies, diversified players** and **neutral hosts** so that such services can be provided.

Satellite communications are entering a **new phase** in India, with **global Low-Earth Orbit (LEO) players receiving in-principle authorisations** and **domestic space-tech firms exploring indigenous constellations**. The Telecommunications Act 2023, by providing for **administrative assignment of spectrum for satellite services**, has laid the legal foundation for faster rollout. Still, **affordability is a concern** — satellite broadband costs remain significantly higher than terrestrial alternatives, making it a niche rather than a mass-market solution unless supported by targeted schemes for remote areas.

Data centre capacity has expanded rapidly, driven by the growth of **cloud computing, digital services** and regulatory moves toward **data localisation**. India's data centre industry is attracting both domestic investment and foreign capital, with **major hubs in Mumbai, Chennai, Hyderabad and NCR**. However, the **distribution is heavily skewed toward urban cores, leaving edge computing capabilities** — critical for low-latency AI applications and Industry 4.0 use cases — **thinly spread outside major cities**. The ability to **garner sufficient power** for the mushrooming data centres and enabling **climate sustainability** through the use of **renewable energy** with growth shall be the key in making India a datacenter hub in the near future.

India has only **17 submarine cables** and **14 Cable Landing Stations (CLS)**, despite its strategic location connecting Southeast Asia to Europe and the US.¹⁰ In contrast, the US is linked to the global internet via around 88 submarine cables¹¹ and the EU has around 166 submarine cables.¹² China has invested in or built more than 65 subsea cables.¹³

Strengthening internet infrastructure requires equal emphasis on both access and content infrastructure. This means **prioritising** and **liberalising subsea and inland fibre along with cable landing stations**, as well as **data centres, CDNs and IXPs**. CDNs and IXPs work in tandem to bolster reliable and high-speed internet accessibility and optimise data flow.

The **policy environment** has also shifted notably. Initiatives such as **Right of Way Rules, Digital Connectivity Rating for buildings, 5G regulatory sandboxes** and **administrative spectrum allocation for satellite** reflect a willingness to **innovate in regulation**.

In sum, India's digital infrastructure is at once a **global leader in some dimensions** — notably mobile network scale and cost efficiency — and **an emerging challenger in others**, such as fibre

penetration, public Wi-Fi density, in-building data consumption, affordability and edge compute distribution. The **next stage of development** will require **closing these structural gaps** while simultaneously **preparing the network** for the **demands of AI-driven services, quantum-resilient security, integrated satellite-terrestrial handover and immersive high-bandwidth applications**.

C. Relevance of Digital Infrastructure in National Development

Digital infrastructure is not a parallel sector of the economy; it is the **substrate upon which every other sector increasingly depends**. Its relevance spans economic growth, social development, governance, national security and environmental sustainability.

From an economic perspective, **broadband connectivity** is now recognised as a **key driver of GDP growth**. Studies indicate that in developing economies, a **10% increase in broadband penetration** can yield a **GDP growth boost of 1%-1.5% percentage points**. Further, research confirms that increased broadband speed contributes significantly to economic growth, i.e. **doubling the broadband speed** for an economy **increases GDP by 0.3 per cent**.¹⁴

In India, the **expansion of affordable mobile broadband** has already enabled the emergence of entirely new sectors — **app-based logistics, fintech, digital content production** — and has enhanced the productivity of traditional sectors like manufacturing and agriculture through **e-commerce, supply chain optimisation** and **real-time market information**.

Socially, digital infrastructure is the bridge to inclusion. Telemedicine platforms like **eSanjeevani** have made specialist consultations available in rural health centres without requiring patients to travel long distances. Educational platforms such as **DIKSHA** and **SWAYAM** have brought structured learning into

homes, overcoming limitations of physical school/college infrastructure. These applications, however, require not just any internet connection, but connections with the **reliability, bandwidth and latency** necessary for video streaming, real-time interaction and large-scale data exchange.

For **governance**, digital infrastructure enables **transparency, efficiency and reach**. India's **Direct Benefit Transfer (DBT)** schemes, which transfer subsidies directly into bank accounts, are possible only because of the combined power of Aadhaar for identity verification, mobile networks for outreach and banking infrastructure for financial inclusion. As **government services move towards predictive and AI-assisted decision-making**, the **demands on infrastructure will only grow**, with a premium on **security, low latency and resilience** against cyber threats.

National security considerations also intertwine with digital infrastructure. In an era where **critical infrastructure** — **power grids, transportation systems, defence communications** — is increasingly connected to networks, the **resilience and sovereignty** of those networks are **strategic imperatives**.

Satellite connectivity offers **redundancy** in case of terrestrial network failures and also **access to remote areas**.

In the context of **environmental sustainability**, digital infrastructure plays a **dual role**. On the one hand, it **enables efficiency gains that reduce carbon footprints** — from smart grids to IoT-based waste management. On the other, it **must itself become greener**, as data centres and network operations are significant energy consumers. **India's commitment to renewable energy** provides an **opportunity to power its digital expansion sustainably**, turning green infrastructure into a competitive advantage.

The **pace of change in Digital Infrastructure** requirements will be **unrelenting**. By the mid-

2030s, AI models will be deeply embedded in governance, healthcare, education and manufacturing. By the **early 2040s, quantum communication networks** are expected to operate alongside classical internet infrastructure, reshaping trust and security models. Global commerce, entertainment and education will move toward **immersive, high-bandwidth platforms** powered by **extended reality (XR) technologies**. The **competitiveness of nations** will be defined as much by the **latency** and **security** of their networks as by their GDP growth rate.

The convergence of **Artificial Intelligence (AI)**, **quantum communications**, **satellite-terrestrial networks**, **immersive content delivery** and **distributed computing** will reshape every facet of economic, social and governance life, some examples given in following infographic:

For **India**, the implications are profound. A country of over 1.4 billion citizens, with its unique demographic dividend, will need to create a digital environment in which **opportunities** are **geographically and socially inclusive**. Digital infrastructure must not only **keep up with global technological shifts** but also **address India's own structural realities** — from the **vast rural-urban divide to the affordability constraints** faced by half of its population. Digital infrastructure will act as an engine of economic growth by creating new forms of employment and raising productivity across sectors.

Transformational Use Cases Powered by Convergence



Precision Agriculture

AI-powered crop guidance using satellite imagery, IoT sensors, and XR visualization for enhanced rural productivity



Tele-ICU Networks

Continuous emergency care through satellite connectivity, AI triage, and immersive telepresence for remote regions



XR Classrooms

Immersive learning hubs with AI co-tutors, satellite streaming, and localized content for village education



Smart Factory Solutions

Edge-enabled MSME manufacturing with AI quality control, quantum optimization, and XR maintenance guidance



National Supply Chains

Real-time provenance tracking with AI predictions, AR interfaces, and quantum-secure distributed ledgers



UPI-Next Infrastructure

Quantum-safe payment rails with millisecond AI fraud detection and satellite-enabled financial inclusion



Smart Grids with Renewable Balancing

AI-powered grid optimization using satellite weather data, quantum computing for load balancing, and XR interfaces for technician training and maintenance



Disaster Response Coordination

Real-time emergency management through satellite communications, AI-powered resource allocation, XR situation rooms, and quantum-encrypted coordination networks

3. Digital Divide - Socioeconomic Impact

Digital infrastructure is more than a pipeline for data; it is the **circulatory system** of the modern economy and society. Its presence **reshapes how citizens learn, work, transact and govern** themselves. The **spillovers of digital infrastructure** — in **employment, education, healthcare, governance and social equity** — reveal both its transformative **potential** and the **risks of exclusion**. Understanding these impacts requires acknowledging the persistent digital divide between rural and urban India, between men and women and between those equipped with digital skills and those left behind.

Employment, Productivity and Skills Transformation

Digital infrastructure acts as an engine of economic growth by creating new forms of employment and raising productivity across sectors. The IT and telecom industries directly employ millions, but the indirect spillovers are far greater. E-commerce, fintech, logistics and the platform economy have grown exponentially on the back of affordable data and mobile connectivity. For example, small businesses in remote districts now access national and even global markets through online platforms.

At the same time, **digitalisation transforms the nature of work** itself. The rise of gig platforms, freelancing opportunities and digital-first enterprises has **expanded income opportunities** for youth and women. **Remote working** has proven viable, enabling global work from small-town India. However, this transformation also **poses risks**: automation and AI **threaten low-skill, repetitive jobs, especially**

in manufacturing and back-office services.

The **spillover** is therefore **twofold**: while infrastructure opens up new jobs, it simultaneously disrupts existing livelihoods. To harness the positive side of this transition, India must **complement infrastructure with large-scale re-skilling initiatives**, especially in **rural areas** where job displacement would otherwise exacerbate inequality.

Inclusion and Social Equity

The inclusive potential of digital infrastructure is perhaps its most profound contribution. **Affordable broadband access** enables rural children to attend **online classes**, women to **access telemedicine** without social barriers and farmers to obtain **weather updates, market prices and credit**. **Digital financial inclusion**, powered by the JAM trinity— Jan Dhan, Aadhaar and Mobile along with UPI— has already demonstrated how the poorest citizens can **leapfrog into the formal financial system**. Direct Benefit Transfers (DBT) ensure subsidies reach households without leakage, improving trust in governance.

Yet the **benefits remain uneven**. Rural households, women and marginalised communities often face **barriers of cost of usage burden, device affordability, connectivity reliability and digital literacy**. For example, although mobile penetration is high, meaningful use — streaming education, running an online business or accessing healthcare consultations — requires reliable fixed broadband or high-capacity mobile networks, which should be affordable.

Without bridging this divide, spillovers risk becoming asymmetric, empowering those already advantaged while leaving others behind. Thus, the digital divide is not merely technological; it is social and economic, amplifying existing inequalities unless addressed through **deliberate policy action**.

Persons with Disabilities (PwDs)

Among the most excluded communities in India's digital transformation are PwDs. Despite progressive legislation such as the Rights of Persons with Disabilities Act, 2016 and India's ratification of the UN Convention on the Rights of Persons with Disabilities (UNCRPD), **digital access remains a formidable barrier for millions. Close to 70% of PwDs reside in rural areas**, where connectivity itself is limited, **compounding exclusion** from education, health services, livelihoods and civic participation.

Digital barriers for PwDs operate at multiple levels. At the infrastructure level, **poor or no connectivity prevents meaningful access**, particularly in villages where the majority of PwDs live. Even when connectivity exists, the **high cost of assistive technologies** such as screen readers, magnifiers and AAC (Augmentative and Alternative Communication) devices limits adoption. Furthermore, much of India's **digital content**, including educational resources, **remains inaccessible due to the absence of sign language interpretation, captions or disability-friendly formats**. This exclusion **denies millions of PwDs the opportunity to participate in the digital economy and deepens their socioeconomic marginalisation**.

Governance, Transparency and Service Delivery

India's digital public infrastructure has already redefined governance. The JAM trinity has enabled the delivery of subsidies, pensions and entitlements directly into bank accounts. UPI has reduced transaction costs and enhanced transparency in financial flows.

These advances illustrate how digital infrastructure generates governance spillovers: better service delivery, reduced corruption and improved citizen trust.

Future governance spillovers depend on **expanding the digital rails** further into **health, education and agriculture**. The **Ayushman Bharat Digital Mission** seeks to create a national health ID to streamline medical records and tele-consultations. The **National Education Policy** encourages digital platforms for hybrid learning. Agricultural platforms can integrate farmers into value chains. But these gains **hinge on robust and affordable connectivity**. Without **universal and meaningful broadband**, ambitious **e-governance programs risk excluding precisely those citizens who need them most**. Thus, **bridging the divide is a governance imperative**, not only an economic one.

Rural–Urban Digital Divide and Its Consequences

The rural–urban divide is the **defining challenge** in realising the full socioeconomic spillovers of digital infrastructure. Urban areas enjoy higher-speed networks, denser fibre deployment and greater affordability. This enables cities to leverage digital tools for startups, AI adoption and advanced services. Rural India, by contrast, often remains limited to patchy mobile broadband. The result is a growing divergence in opportunities for education, healthcare and economic activity.



For instance, telemedicine platforms can solve rural health deficits, but only if bandwidth supports video consultations. Similarly, rural schools cannot meaningfully participate in online education without stable connections.

Farmers benefit from digital advisory platforms only if access is affordable and continuous. As urban India benefits from AI, data-driven economies and digital services, **farmers risk being left out of the productivity and income gains of the digital era. Digital adoption in agriculture is not optional, it is existential.** If done right, it will transform farming into a high-productivity, climate-resilient and globally competitive sector. If ignored, it locks millions of farmers into stagnation, poverty and vulnerability, undermining the vision of a prosperous and inclusive *Viksit Bharat*.

The divide therefore translates into **lost productivity, missed opportunities** and a **perpetuation of rural–urban migration.** **Bridging** it is not only about equity but about **national efficiency: a digitally empowered rural India contributes to GDP, reduces urban congestion and enhances overall social stability.**

Gender and Youth Dimensions

Gender disparities are a key axis of the digital divide. **Women**, especially in rural India, **face lower levels of device ownership and digital literacy.** Studies show that rural India faces a **pronounced divide**, with **men twice as likely as women to have used the internet** (49% vs 25%).¹⁵ Cultural barriers compound technological ones, resulting in reduced participation in the digital economy. Yet, evidence shows that **when women access digital tools, they experience outsized benefits** — whether in maternal healthcare, micro-entrepreneurship or financial empowerment. Thus, **digital inclusion policies must prioritise women as key beneficiaries, with tailored programmes for skills and access.**

The youth dimension is equally significant. India's **demographic dividend depends on channeling the energies of its young population** into productive, digitally enabled opportunities. While urban youth are relatively well positioned, rural youth risk being trapped in low-productivity activities unless access to digital skills and platforms is universalised. The long-term spillover effect of digital infrastructure is therefore intimately tied to how inclusively it integrates women and youth into the growth story.

Risks of Exclusion and Inequality

The spillovers of digital infrastructure are double-edged. When access is inclusive, they democratise opportunity; when access is uneven, they magnify inequality. The risk is **particularly acute in the context of emerging technologies like AI, blockchain and quantum computing**, which require high-quality networks. **If rural India lags, a new technological underclass could emerge.** This divide would not only harm individuals but also weaken national productivity and undermine social cohesion.

Preparing Citizens for Digital Maturity

Infrastructure alone will not create a digitally mature society; citizens must be equipped to use it productively, safely and creatively. This requires a deliberate national strategy that blends digital literacy, trust-building, skills development and cultural adaptation.

Digital Literacy Beyond Device Use

In many rural and low-income urban areas, “digital literacy” still means knowing how to operate a smartphone or make a payment through a UPI app. This narrow skill set is insufficient for the AI-native, data-rich future ahead. Citizens will need to **understand concepts like online safety, data privacy, misinformation filtering and the basics of cloud-based collaboration tools.**

In schools, digital literacy must be taught alongside reading and arithmetic, with curricula designed for progressive mastery from primary grades through higher education. This can include hands-on labs and credit-bearing apprenticeships with local ISPs, data centres and public Wi-Fi operators. Introducing such knowledge early will help create a pipeline of skilled professionals through early exposure and hands-on learning.

Trust and Cybersecurity Awareness

As more governance and financial transactions move online, trust in digital systems will become a key determinant of adoption. **Awareness programmes** must demystify technologies like biometric authentication, AI-driven decision-making and blockchain, explaining both benefits and limitations. **Cybersecurity hygiene** — from password management to recognising phishing attempts — should be part of routine community workshops, particularly in rural areas where formal exposure to such risks is limited.

Workforce Re-skilling and Adaptability

Automation and AI will inevitably change employment patterns, displacing some roles while creating new ones. A **robust re-skilling framework must be in place**, allowing mid-career workers to acquire competencies in areas like network maintenance, AI model operation, remote service delivery and digital content creation. Special focus must be placed on **training rural youth for digital economy jobs** that can be performed remotely, preventing migration pressures on cities.

Inclusivity in Digital Culture

The digital ecosystem must reflect India's linguistic and cultural diversity. Services, interfaces and educational platforms must be available in **multiple Indian languages**, with **voice-based access options** for populations with low literacy levels. **Local content creation should be encouraged** through grants and

incubators, ensuring that digital adoption is not a process of cultural homogenisation but one of enrichment.

Community-Level Enablers

Village-level digital resource centres — staffed by trained digital facilitators — can serve as **hubs for e-governance, telemedicine, online education and skills training**. Such centres can **anchor community trust** in digital systems, provide troubleshooting support and act as **gateways for citizens to explore advanced applications without prohibitive personal investment in devices or connectivity**.

Preparing citizens for digital maturity is not merely an educational challenge — it is an **empowerment agenda**. The ability to use, adapt to and innovate with digital tools will determine whether India's infrastructure translates into individual and collective prosperity.

To sum up, the **socio-economic spillover effects** of digital communications infrastructure in India are **immense: jobs, productivity, inclusion, governance efficiency and empowerment**. But they are not automatic; **they depend on how comprehensively and inclusively the infrastructure is deployed together with citizens' digital maturity and empowerment**. The rural–urban divide, gender gaps and skills deficits are the primary obstacles. Addressing them is not merely a moral obligation but an economic necessity, ensuring that the dividends of digital transformation uplift every citizen. **As India advances toward its 2047 aspirations, the measure of success will be whether digital infrastructure narrows divides and expands opportunity or whether it deepens inequality**. The challenge and the opportunity are clear.

4. The Next Digital Transformation Wave and Digital Divide

While India's current strengths lie in scale and affordability, the **coming decades will redefine competitiveness** in terms of quality, resilience and future-readiness. The next digital transformation wave will be characterised by **deep integration of emerging technologies into everyday life, requiring infrastructure that can deliver ultra-reliable, low-latency and secure connectivity at unprecedented scales.**

However, as mentioned earlier, these benefits will not be evenly distributed unless the **digital divide — both rural–urban and socio-economic — is addressed in parallel.** Without targeted policy interventions, there is a real risk that AI-powered services, quantum-secure communications and immersive education platforms will first take root in dense, affluent urban areas, leaving rural communities in a technological backwater. The result could be not just a gap in connectivity but a **gap in opportunities, skills and participation.**

Artificial Intelligence (AI) at scale will permeate governance, healthcare diagnostics, personalised education, predictive agriculture and industrial automation. In urban centres, AI-powered traffic management or hospital triage systems may become standard. But for rural areas, the immediate promise lies in **AI-enhanced telemedicine, crop advisory services and market forecasting** — all of which demand both bandwidth and low latency. Without **robust rural backhaul and affordable access devices**, these possibilities remain aspirational.

Quantum communication networks will be deployed first in high-value sectors like defence, finance and research. Yet, the security benefits of **quantum-safe systems — protecting land records, citizen data and government**

transactions — are equally **critical in rural administrations**, which often operate with weaker cybersecurity safeguards. Ensuring **rural nodes in national networks are quantum-ready** will require deliberate design, not afterthought inclusion.

Satellite–terrestrial convergence is perhaps the most promising **equaliser**. The ability for a user to move from a dense urban centre to a remote mountain village without losing service quality can **collapse the distance-based disadvantages that rural India faces.** For this to translate into real opportunity, **rural households** should be able to **afford the services** in order to **participate in the same digital economy as their urban counterparts.**

Immersive services such as AR/VR will power urban classrooms and corporate training facilities. In rural India, immersive education could **enable students to “walk through”** a science lab or attend lectures by the best teachers in the country. But immersive content is among the **most bandwidth-intensive services** imaginable — without **last-mile fibre, and robust and secure PM-WANI-based Public Wi-Fi in villages**, these opportunities will remain inaccessible.

The combined effect is clear: the next wave of technology could either be the **greatest equaliser or the deepest divider**. The outcome will depend on whether **rural digital infrastructure is treated as a parallel priority** to urban network enhancement, rather than a sequential “after urban” rollout strategy.

5. Regulatory & Policy Landscape — Opportunities and Gaps

The Telecommunications Act 2023 marks a significant departure from the colonial-era framework it replaces. By consolidating disparate laws and introducing an authorisation regime, it opens the door for a **more dynamic and inclusive telecom sector**. The Act's **intent for technology-neutral authorisations** mean that a public Wi-Fi provider, a LEO satellite operator and a private 5G network for a manufacturing cluster can all operate under tailored conditions rather than forcing all into the mould of a traditional telecom licensee.

For rural and underserved areas, the Act's flexibility could be transformative — if the **Rules under it are designed to actively encourage new entrants** including small-scale operators. This means proportionate compliance, lower entry fees, simplified quality-of-service reporting and streamlined access to spectrum, especially in unlicensed and lightly licensed bands.

The Act also **addresses right-of-way (RoW)** — a long-standing bottleneck for fibre deployment — by granting a statutory framework for access to public property for network rollout. However, the **real challenge will be harmonising and implementing RoW processes across states and municipalities**. **Enforceable timelines** can prevent delays in RoW, especially in rural areas where bureaucratic procedures are often more cumbersome.

Where the Act remains silent or thin is in future-proofing for emerging technologies. While it is technology-agnostic in principle, it **lacks explicit provisions for integrating quantum networks, edge computing nodes or AI-driven spectrum allocation systems** into the regulatory mainstream.

Similarly, while it contemplates spectrum for **satellite communications through administrative mechanisms**, it **does not yet outline mechanisms to ensure that satellite bandwidth can be priced affordably** enough for rural and remote users.

The Rules under the Act should **explicitly incorporate rural parity, environmental sustainability and open-access principles as enforceable conditions** on authorised entities. Baselines for AI-native network operations in public networks can be provided through the Rules.

Globally, leading digital economies such as Singapore¹⁶ and the EU¹⁷ are embedding **digital inclusion initiatives/mandates into telecom regulations** — both as optional social projects and as core regulatory conditions. India's regulatory apparatus could draw from these examples, making rural parity, legally binding on network operators.

In sum, **"Technology should be used to unite and not divide, people. The digital transformation should contribute to a fair and inclusive society and economy."**¹⁸

6. Bridging the Gaps — The Policy Blueprint

Bridging India's digital infrastructure gaps will require a multi-layered policy blueprint that addresses physical infrastructure, affordability, governance, innovation and human capital in an integrated way. This blueprint must be rural-inclusive by design, ensuring that the march toward advanced technologies does not deepen existing divides.

Right to Connectivity (RTC) and Rural–Urban Parity as a Core Metric

India should recognise a RTC i.e. an obligation to provide affordable and reliable broadband to every habitation. The country should be mapped into connectivity zones/clusters with tiered KPIs (from basic access to advanced industrial), enabling targeted investments while assuring a minimum service level everywhere.

Instead of tracking connectivity purely in terms of national averages, policy should **measure** and **target parity** between **rural and urban** indicators — **average speeds, latency, uptime** and **affordability**. Such **comparison** inclusion between rural and urban into a **public scoreboard** will **highlight lagging areas**, and will keep policy and investment aligned with outcomes. Incentives for operators should be linked to narrowing these gaps, with disincentives for persistent disparities.

Parity for PwDs

The digital divide strategy must explicitly integrate disability inclusion. This will require -

- **Accessible Infrastructure** i.e. Universal broadband and Wi-Fi deployments must be designed with accessibility in mind, ensuring compatibility with assistive technologies.

- **Affordable Assistive Technologies** i.e. Subsidies and public–private partnerships should expand access to devices like screen readers and AAC tools, making them affordable and widely available.
- **Inclusive Content Standards:** Government portals, digital education platforms and private services must comply with accessibility standards (IS 17802), ensuring features like captioning, audio description and sign language support.
- **Skills and Livelihoods:** Tailored digital literacy and skill development programmes for PwDs must be scaled, linked to vocational training and employment opportunities, so that digital access translates into socio-economic empowerment.
- **Monitoring and Feedback:** Impact evaluation frameworks should be created to track inclusion outcomes for PwDs, incorporating their voices into policymaking.

Tiered Authorisation Framework

Under the Telecommunications Act 2023, create clearly defined authorisation categories:

- Simplified Network/Service Authorisations for enabling more players, small-scale rural operators, community networks and specialised sector services.
- These should be light touch and automatic.
- Neutral-Host Infrastructure Authorisations for in-building and shared fibre deployments.
- Specialised Service Authorisations for sectors like agriculture, IoT, rural telemedicine or education networks.

Infrastructure Financing Reform

Reorient the Universal Service Obligation (USO) fund into a Digital Bharat Nidhi with a broader mandate — funding not only rural towers but also fibre, Public Wi-Fi, community networks, Satcom in rural areas and rural edge data centres. Encourage blended finance through infrastructure bonds and public–private partnerships, with viability gap funding for projects in low-income areas.

Spectrum Policy for Inclusivity

Since 80% or more data is generated and consumed inside buildings/residences /offices, it is equally important to focus on ensuring, enabling and incentivising robust, reliable and secure **in-building connectivity** through modern and next-generation **Wi-Fi based on Wi-Fi 6E, Wi-Fi 7 and Wi-Fi 8** (in future) - all of which need **delicensed spectrum** in the **globally harmonised 6 GHz band**. Next-generation Wi-Fi (Wi-Fi 7/8) can complement cellular/mobile networks (which are unable to penetrate indoors) by providing **high data throughputs and low latency communications indoors**.

For **satellite communications**, provide spectrum on **administrative basis** enabling basic connectivity in remote areas and services should be **subsidised** through the Digital Bharat Nidhi.

Planning and implementation should be guided by a predictable 5–10-year spectrum roadmap that positions new bands for next-generation use cases.

Self-Reliance (Atmanirbharta in Digital Infra)

For India, self-reliance in digital infrastructure is not just an economic aspiration but a matter of **strategic sovereignty**. The backbone of tomorrow's economy — semiconductors, telecom equipment, satellite systems, cable landing

stations and cloud infrastructure — **cannot remain dependent on fragile or uncertain global supply chains**. As technologies like 5G and 6G evolve, India must ensure that **critical components are designed, manufactured and secured within its own ecosystem**. This means accelerating **indigenous semiconductor capacity, investing in domestic cable landing stations and subsea partnerships and encouraging homegrown open-source solutions** for spectrum management, cybersecurity, and network optimisation. Building such capabilities during the foundation stage up to 2030 will ensure that India enters the next decade with the confidence of being an infrastructure sovereign, not merely an infrastructure consumer.

Innovation (India's Competitive Edge)

India has already shown the world how digital public platforms — UPI, Aadhaar, ONDC — can transform inclusion and efficiency. The next frontier is to **extend this culture of innovation into digital infrastructure itself**. This will mean **treating infrastructure** not just as pipes and towers, but **as platforms for experimentation, entrepreneurship and new service delivery models**. **Regulatory sandboxes** should enable trials of AI-native networks, satellite–terrestrial convergence and early 6G prototypes. **Policy and financing must encourage startups, MSMEs and small entrepreneurs to co-create infrastructure solutions** — whether in rural Wi-Fi, edge data centres or agricultural IoT networks.

Technologies such as immersive reality, holography and metaverse platforms will be strategic enablers for education, healthcare and governance. By embedding innovation into the very fabric of infrastructure, India can move from catching up with global technologies to setting benchmarks that others seek to emulate.

Edge Infrastructure for Local Empowerment

Mandate deployment of **data centres in rural districts**, powered by renewable energy, to support AI-based agriculture services, local content caching and digital governance platforms.

Human Capital for Digital Sovereignty

Launch a **Rural Digital Corps programme** — a **national network of trained young professionals deployed to villages** to install, maintain and train communities on advanced digital tools. Link this to vocational and higher education programmes so skills are continuously replenished.

Academia-Industry Skills Partnership — Build on existing **Centres of Excellence** and add new ones where needed, co-funded with industry, focused on network operations, edge computing, cybersecurity and accessibility engineering. The Centres can run industry-supervised apprenticeships to staff the Rural Digital Corps and priority public deployments.

Governance Reform

Establish a **very high-level National Digital Infrastructure Council**, which must include state participation, to ensure **alignment of targets, resources and execution across all layers of government. Integrate digital infrastructure goals** into every **sectoral policy** from health to transport — so connectivity is planned alongside other public works.

With such a blueprint, India can avoid a two-speed digital economy, ensure **rural inclusion from the outset** and position itself to lead in the **high-performance and innovation-driven infrastructure era** of the 2030s and 2040s.

7. Phased Roadmap to 2047

Achieving the vision of Digital Infrastructure @Viksit Bharat 2047 requires a strategic sequencing of actions that matches the natural rhythm of technological cycles, investment horizons and institutional reform. Digital infrastructure evolves in waves of technologies/platforms like, fibre rollouts, new generations of wireless network, satellite constellations, edge computing and artificial intelligence and each wave must be aligned with financing models, regulatory clarity and the development of human capital. **A phased roadmap is therefore essential as it prevents fragmentation, ensures that progress in one area is not undermined by gaps in another and guarantees that the benefits of innovation reach citizens simultaneously across rural and urban India, rather than in uneven or staggered patterns.**

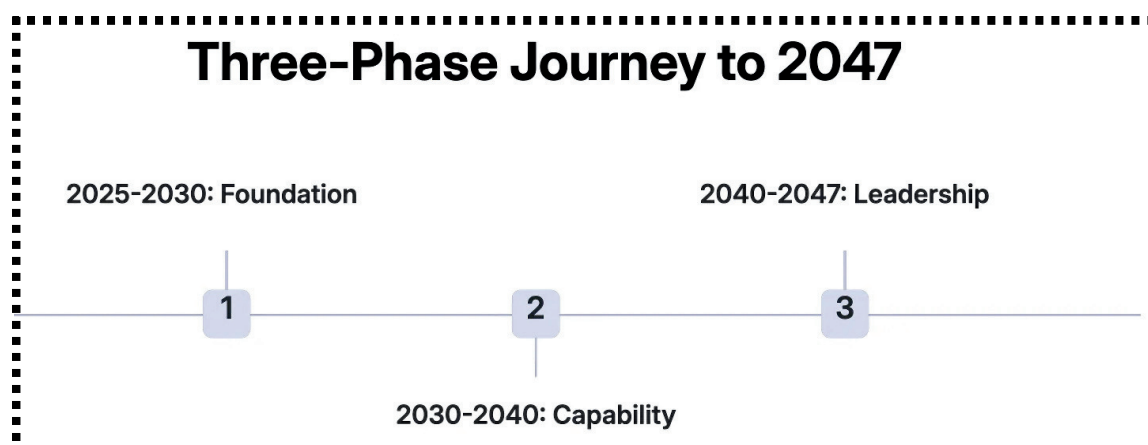
The phased roadmap presented here sets out a sequenced approach and it seeks to inform debate, shape consensus and encourage collective action, ensuring that India's progress is both technologically ambitious and socially inclusive. Further, as technologies, markets and social priorities evolve, the roadmap should not be seen as fixed, but as a **guiding framework** to be revisited and refined over time.

Phase I: Foundation (2025–2030)

The first phase is about creating the essential **baseline of connectivity and infrastructure**. The priority here is to ensure that **high-quality broadband becomes as common as basic utilities** and that every citizen has access to reliable, affordable networks. This requires **completing fibre backhaul to every block and village cluster** and **extending high-speed connectivity of 100 Mbps or more to the majority of households**. **Rural India** must see **full 4G saturation**, while cities move rapidly into **5G densification**, with district headquarters and peri-urban belts brought firmly within its fold.

In parallel, this phase must prepare India for the **6G horizon** by engaging in **standards-setting, research partnerships and pilot R&D programmes**, ensuring India does not remain a late adopter when the next wave of technologies emerges post-2030.

Since 80% or more data is generated and consumed inside buildings/residences /offices, indoor coverage becomes the new last mile.



It is important to focus on ensuring, enabling and incentivising robust, reliable and secure in-building connectivity through modern and next generation **Wi-Fi** and **effective neutral host regulations**. Without 6 GHz Wi-Fi and neutral-host, 5G will under-deliver where people actually use data.

Execution discipline will be vital. **BharatNet's last-mile targets** must carry **legal enforceability**, with timelines strictly monitored and penalties imposed for delays. **Public Wi-Fi** should become **ubiquitous across public institutions** — schools, colleges, health centres, police stations, post offices, Gram Panchayat offices and community spaces — in line with the national vision of **50 million hotspots by 2030**, as articulated in the **Bharat 6G Vision released by the Hon'ble Prime Minister**. **Edge data centres** should also begin to appear at the **district level**, with priority use cases in agriculture, healthcare and education, where low latency and local storage are critical.

The foundation period must not only universalise connectivity but also **establish accessibility as a non-negotiable standard**. Fibre, broadband and Wi-Fi deployments should be fully **compatible with assistive technologies** and all **central and state government portals must move toward accessibility compliance by 2030**. Public Wi-Fi rollouts under **PM-WANI** should ensure **inclusive design for PwDs**, enabling access through screen readers, voice-based navigation and simple interfaces.

At the institutional level, **mandatory accessibility audits** should begin for **education and governance platforms**, ensuring that content is available in formats accessible to the visually, hearing and cognitively impaired. A start must also be made with **subsidised assistive technologies** — screen readers, magnifiers and AAC devices — **funded through** a dedicated window in the **Digital Bharat Nidhi**.

The regulatory environment must evolve in tandem. The **Telecommunications Act 2023** should, within this phase, **translate into a clear set of enabling authorisation categories, proportionate compliance norms for smaller operators and a modern spectrum policy that allows growth of Wi-Fi and Satcom services**.

Financing structures will also need reform: the **Digital Bharat Nidhi** should be operationalised early, channelling resources not just to rural towers but also to **fibre, public-wifi, satellite services and localised digital hubs**.

Equally important, the seeds of **self-reliance** in digital infrastructure must be planted during this period. **Investment in domestic semiconductor capacity, indigenous telecom equipment, subsea cable landing stations and cloud ecosystems** will provide India with the confidence of being a creator of infrastructure, not merely a consumer of imported systems.

Human capacity will also need mobilisation through a **Rural Digital Corps**, deploying young professionals to villages to manage Wi-Fi, edge centres and digital services, while also training communities in their productive use.

Governance must also rise to match: a **National Digital Infrastructure Council**, with full participation of states, will **ensure coherence and accountability in planning, resource allocation and execution** across the country.

The outcome of this foundation phase must be more than national averages of connectivity. It must deliver **real improvements in service quality, affordability and reliability across all regions**, setting the stage for the next leap.

Phase II: Capability (2030–2040)

With a nationwide baseline of connectivity secured, the 2030s must be the decade of **capability-building and resilience**. Networks must move beyond providing access to enabling advanced services, new applications and intelligent management of complexity.

By this stage, **networks should be AI-native**, capable of optimising spectrum dynamically, rerouting traffic in real time and managing millions of IoT connections without degradation. **Public Wi-Fi** must become an everyday fixture of community life, **as common and reliable as street lighting**. The **integration of terrestrial and non-terrestrial systems** should ensure seamless national coverage, with **basic satellite access available as a right to those in geographically remote or difficult terrains**.

As networks become AI-native and resilient, this decade must ensure that **PwDs fully participate in the capability expansion**. Quantum-resilient and AI-driven systems should include accessibility features by default, for example, **AI-enabled real-time captioning, sign language interpretation or personalised adaptive interfaces**. By the mid-2030s, **at least 10 million PwDs should receive subsidised assistive technologies**, making digital access affordable and mainstream. **Vocational training and digital literacy programmes** must be scaled to train PwDs, **linking them to employment in data centres, network operations and rural digital service delivery**.

Public Wi-Fi, edge data centres and district-level digital hubs must also integrate **PwD-friendly access points**, creating environments where disabled users can use digital services without dependence.

Security will become a central concern of this phase. **Quantum-resilient encryption** must be embedded across government networks and critical infrastructure, with quantum key

distribution pilots extended into healthcare, agriculture and financial systems. Resilience must also extend to physical infrastructure: a **redundant, fail-proof national critical communications and disaster recovery network** should be fully operational by the late 2030s.

The location of compute power will also transform. **Decentralised data centres and district-level edge facilities** must proliferate, ensuring that **rural districts have the same access to low-latency, high-capacity processing** as urban centres. These facilities will enable applications such as precision farming, real-time telemedicine, digital classrooms and disaster response systems.

Human capital must grow alongside infrastructure. Vocational and higher **education curricula** should routinely **include advanced digital system management**, preparing a workforce ready to sustain AI-driven networks, cybersecurity protocols and next-generation service delivery.

Regulatory policy should foster innovation during this period, with **sandboxes for experimenting with AI-native architectures, rural IoT deployments and early prototypes of 6G**.

Financing instruments — including **blended finance and viability-gap funding** — should **direct capital into underserved districts**, making sure that capability expansion does not bypass those who need it most.

The measure of success in this phase will be whether India has developed not just strong networks, but networks that are **intelligent, resilient and equitably distributed**, enabling transformative applications across both rural and urban India.

Phase III: Leadership (2040–2047)

India should **achieve parity in digital access indicators for PwDs**, ensuring no measurable gap in connectivity, affordability or usability compared to the general population.

Persons with visual, hearing, mobility or cognitive impairments, should be able to **access immersive education, real-time tele-health, governance services and AI-assisted productivity tools** with the same ease as any other Indian.

This phase will also test the maturity of India's **sovereign digital capabilities**. **Indigenous semiconductor manufacturing, quantum networking, AI chipsets, secure satellite systems and resilient cloud infrastructure** must be established at scale, ensuring that **India's digital backbone is shielded from global supply chain shocks and strategic vulnerabilities**. At the same time, India's digital systems must be **climate-resilient**, powered largely by **renewable energy** and designed to **withstand extreme environmental stresses**.

Equally, India's global role will be defined by its ability to **export models of inclusive digital public infrastructure**. Just as UPI and Aadhaar set benchmarks for the world in financial and identity systems, **India's approaches to community Wi-Fi, rural-first edge deployment and equitable broadband access can shape the future of digital inclusion worldwide**.

By 2047, the true test of success will not lie in whether Indian cities match the digital standards of advanced economies — that is inevitable. It will lie in whether **India has delivered world-class digital opportunities to every citizen, in every village, town and city alike**. Achieving that **parity** will mark the arrival of India not only as a digital powerhouse, but as **a digital civilisation**.

Conclusion — Towards Viksit Bharat @2047: A Digital Civilization

India's digital infrastructure journey is no longer a question of whether we will connect the nation — that has been substantially achieved. The real challenge now lies in **how well we connect it, how inclusively we deliver services and how intelligently we prepare for technologies** that will define the coming decades.

The next 20+ years will be shaped by a **convergence of forces — artificial intelligence, quantum communications, satellite-terrestrial integration, immersive content delivery and billions of interconnected devices.**

For India, the opportunity is unique: to leapfrog into a **leadership position by designing infrastructure** that is not only **technologically advanced** but also **socially equitable, economically sustainable and environmentally responsible.**

The **Telecommunications Act 2023** provides a **legislative springboard**, with its authorisation framework, right-of-way provisions and flexibility for new categories of players. But the Act's potential will only be realised if the **Rules and subordinate regulations are written with inclusivity as a guiding principle** — ensuring that rural India, small entrepreneurs and community networks are not peripheral but central to the ecosystem.

Viksit Bharat @2047 will not be judged merely by the density of its fibre, the speed of its mobile networks or the sophistication of its quantum encryption. It will be judged by whether a farmer in Bundelkhand can use AI-based market

forecasting as easily as a trader in Mumbai, whether a child in a Ladakh village can access immersive science lessons with the same clarity as her urban counterpart and whether digital trust is as strong in a remote panchayat office as in the corridors of Delhi.

The transformation ahead is as much human as it is technological. Infrastructure must be matched by skills; connectivity by affordability; innovation by regulation; and opportunity by inclusion. In this equation, **the rural-urban digital parity will be the most decisive metric** of national digital maturity.

If we get this right, by 2047 India will not just be a global digital powerhouse — it will be a **digital civilization**, exporting not only technology and infrastructure models but also a vision of how technology can empower every citizen, in every corner of a diverse and complex nation. That, more than any data speed or device count, will be the true measure of a *Viksit Bharat*.

This perspective draws deeply from the vision of the Hon'ble Minister of Communications, whose call to treat connectivity as an act of nation-building has provided the intellectual and moral anchor for this paper. His emphasis on obliterating the digital divide and placing people at the centre of policy is not just a guiding principle — it is the very foundation of India's journey from a digital economy to a true digital civilization.

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