IMC 25

5G AND BEYOND

A definitive guide to build the next-gen network of 5G and the future vision of 6G.

zamun.

Content

01

Hey, Digital Pioneers!

Do you remember the world before the seamless video calls and instant downloads of 5G? Now, let's step beyond. This is not just a book; it's your personal blueprint to the next digital revolution. We begin by deconstructing the journey from 1G to 6G, revealing the shift from enhanced connectivity to a world where AI-Native networks, THz beams, and holographic presence will converge. We will explore the ambitious Bharat 6G Mission, meet the thinkers like Dr. Chih-Lin I shaping this future, and understand the triple-helix that will build India's indigenous, secure, and sustainable digital ecosystem. Turn the page, and prepare to be the pioneer who understands the network before it arrives

Overview

Understanding the Basics

What is 5G and 6G?

5G and 6G represent generational leaps in wireless communication, each defined by higher speeds, lower latency, massive device density, and deeper integration with advanced computing and sensing technologies.

Defining 5G

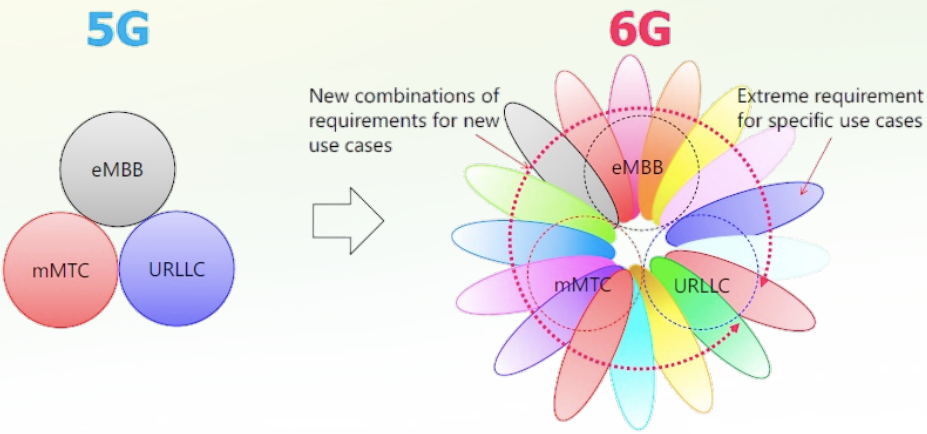
- Peak Speeds: Up to 10 Gbps.
- Latency: ~1 ms for ultra-reliable low-latency communications.
- Device Density: Supports up to 1 million devices per km².
- Core Innovations: Network slicing, Massive MIMO, millimeter-wave spectrum usage.

Defining 6G

- Projected Speeds: 100–1000 Gbps (target).
- Latency: Sub-millisecond (<0.1 ms) for near-instantaneous feedback.
- Expanded Capabilities: AI-native network control, Terahertz (THz) spectrum, integrated sensing and communications, holographic data transmission.

Feature	5G (2025)	6G (Projected 2030)
Peak Data Rate	10 Gbps	1 Tbps
Latency	~1 ms	<0.1 ms
Spectrum Range	Sub-6 GHz & mmWave	mmWave & THz
Network Intelligence	AI-assisted	AI-native, self-evolving
Key Use Cases	eMBB, URLLC, mMTC	Holography, tactile internet, massive digital twins

5G is enabling today's digital transformation, while 6G aims to merge the physical, digital, and human worlds into a unified intelligent network.



Sources. linkedin.com

From silicon chips to quantum leaps.

Technology Evolution

The evolution from 1G to 6G reflects successive leaps in spectrum utilization, modulation techniques, network architecture, and application diversity.

1G: 1980s

Speed : 2.4 Kbps
Features : Analog voice. For eg Voice calls

2G: 1990s

Speed : 64 Kbps
Features : Digital voice, SMS For eg Voice, messaging

3G: 2000s

Speed : 2 Mbps
Features : Mobile internet. For eg Web browsing, basic apps

4G: 2010s

Speed : 100+ Mbps
Features : High-speed broadband, IP-based networks For eg Streaming, gaming, social media

5G: 2020s

Speed : 10Gbps

Features : eMBB, URLLC, mMTC, network slicing
For eg IoT, AR/VR, autonomous mobility

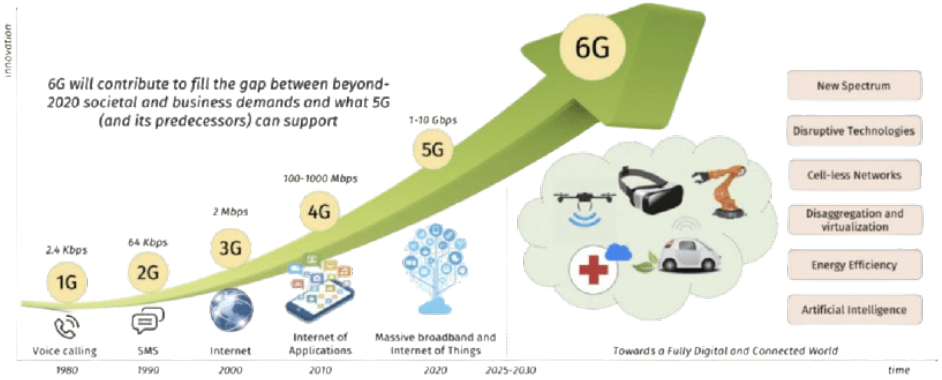
6G: 2030s

Speed : 1 Tbps

Features : THz comms, AI-native, integrated sensing For eg Holographic telepresence, brain-computer links

Observations

- Every generational shift has multiplied both speed and capacity by an order of magnitude.
- Transition times between generations have compressed—6G R&D began even before full 5G deployment.



Sources. mouser.ie

Core Components of 5G

1. **5G is built on three service pillars, each targeting specific performance needs.**

- Enhanced Mobile Broadband (eMBB)
- High-speed connectivity for data-intensive applications.
- Supports 4K/8K streaming, AR/VR, and cloud gaming.
- Peak data rates of up to 10 Gbps in optimal conditions.

2. **Ultra-Reliable Low-Latency Communications (URLLC)**

- Latency as low as 1 ms, ensuring mission-critical communication.
- Key for autonomous driving, industrial robotics, remote surgery.

3. **Massive Machine-Type Communications (mMTC)**

- Connects millions of IoT devices per km².
- Supports smart cities, connected agriculture, utility monitoring.

Pillars of 6G

6G builds upon 5G's foundation but aims to achieve seamless integration of communications, computing, and sensing at unprecedented scale.

1. **Terahertz (THz) Communications**
- Operating in the 100 GHz-10THz spectrum, THz offers 100 times the bandwidth of 5G.
- This ultra-high capacity supports real-time, high-speed applications like digital twins, hyperspectral imaging, and massive data transfers
- Challenges include addressing propagation loss and high energy consumption.

2. **AI-Native Networks**
- By embedding AI into the network core, 6G achieves real-time self-optimization, enabling automated network healing, intelligent resource utilization, and fault prediction.
- AI facilitates the deployment of semantic communications, transmitting meaning instead of raw data.

3. **Holographic Connectivity**
- This supports life-like, 3D, multi-sensory communication, enabling applications such as virtual offices and medical training.
- It promises holographic telepresence with ultra-low latency, requiring synchronized edge a nd backhaul computing.

6G will shift networks from reactive service delivery to proactive, intelligent ecosystems that blend physical and virtual realities.

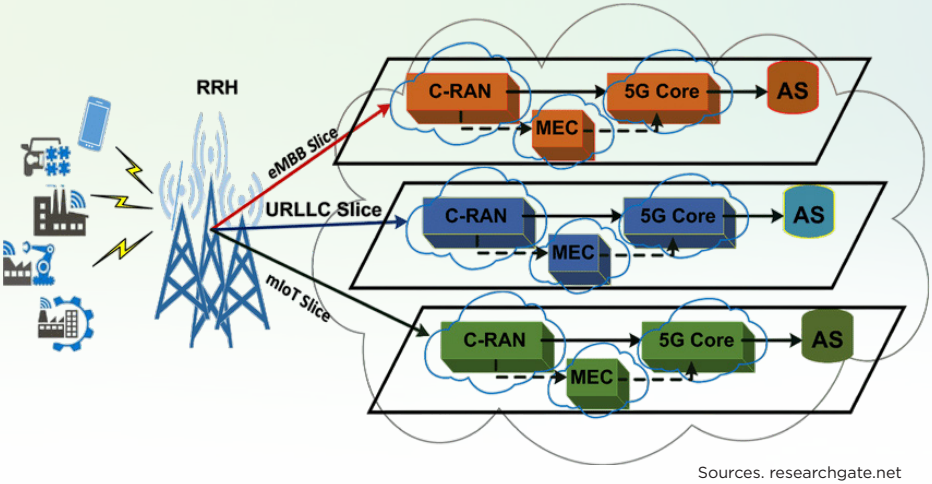
5G Architecture

The 5G network architecture is a cloud-native, service-based model engineered to meet the triple promise of ultra-high speed, ultra-low latency, and massive connectivity. It integrates radio, transport, and core layers into a programmable, interoperable ecosystem.

Key Architectural Components

1. **Radio Access Network (RAN)**
   Comprises base stations (gNodeBs) for coverage and capacity. It utilizes Massive MIMO, beamforming, and small cell densification to boost spectral efficiency. The adoption of Open RAN (O-RAN) decouples hardware and software, reducing vendor lock-in.
2. **5G Core Network**
   Manages service control and routing. It is built on a Service-Based Architecture (SBA) with microservices. Its cloud-native design enables network slicing, dynamic resource allocation, and support for heterogeneous access (5G NR, Wi-Fi 6).
3. **Multi-access Edge Computing (MEC)**
   Places compute and storage closer to the user, reducing latency from ~50ms (4G) to sub-10ms. This is crucial for real-time applications like AR/VR and industrial robotics.

Network Slicing
A logical partitioning of the physical network to create service-specific virtual networks. For example, it provides a low-latency slice for remote surgery or a high-throughput slice for streaming.



Sources. researchgate.net

This pictograph illustrates network slicing in 5G/6G, where eMBB, URLLC, and mIoT slices run independently through C-RAN, MEC, and 5G Core to deliver tailored services.

Hey Buddies!
This was an amazing ride from learning the basics to framing the architecture of our networks.
But I guess, what is the current market scenario?
let us see the reach of our networks in our next segment.

6G Architecture

The 6G architecture aims to merge communication, computing, sensing, and AI into a unified platform capable of understanding and predicting context.

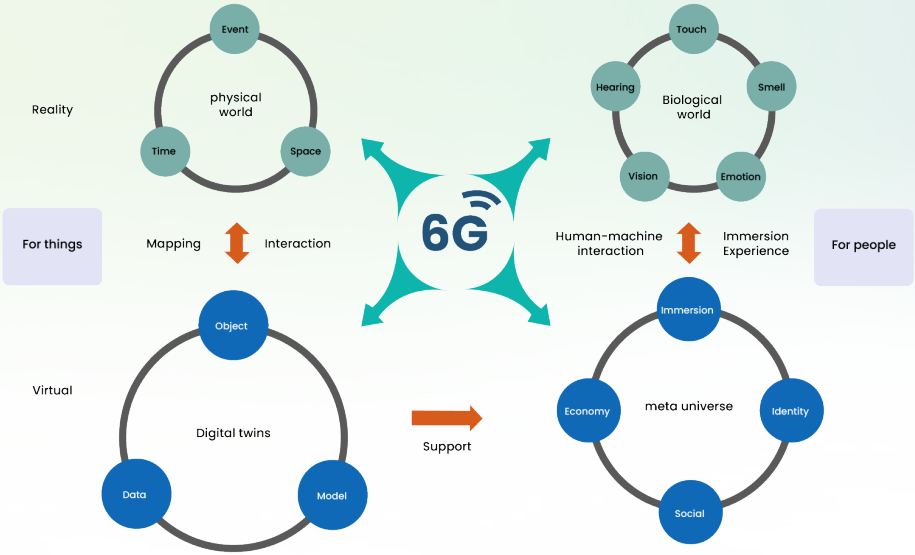
Architectural Innovations

1. **Integrated Sensing and Communication (ISAC)**
- Uses the radio network as a distributed sensor array for environmental awareness.
- Example: Vehicles detecting objects beyond line-of-sight using network sensing.
- Impact: safer Avs and disaster prediction.

2. **Semantic Communications**
- Focuses on transmitting meaning rather than raw bits, reducing redundancy by up to 90%.
- AI determines which parts of a dataset are contextually important.
- Impact: Bandwidth savings and faster decision making.

3. **Networked Digital Twins**
- Creates real-time, high-fidelity digital replicas of cities, factories, or even the power grid.
- Updates continuously through live sensor feeds.
- Impact: Preventive maintenance, urban planning

4. **Distributed Cloud-Edge-Core**
- Seamless orchestration across edge nodes, regional clouds, and the central core for service mobility and resilience.



Sources. techxplore.com

This figure shows 6G as the enabler linking physical, digital, and biological worlds through digital twins, immersive experiences, and the meta-universe.

Advance Connectivity
Re-defining lives Globally

Market Sizing and Trends

Global Snapshot

By 2025, fifth-generation (5G) mobile networks have transitioned from early deployment to large-scale adoption across major global markets. With 1.8 billion 5G connections expected worldwide by the end of 2025 (GSMA), the technology is now central to advanced connectivity applications such as autonomous mobility, extended reality (XR), remote healthcare, and industrial automation. Simultaneously, early-stage research and standardization efforts for sixth-generation (6G) networks are accelerating, targeting commercial readiness by 2030.

Global 5G Status (2025)

- Adoption: Over 100 countries have launched commercial 5G networks.
- Coverage: 5G now reaches more than 75% of the global population in advanced economies; 45–50% in emerging markets.
- Investment: Cumulative operator CAPEX on 5G (2019–2025) exceeds USD 500 billion globally.

Region	5G Coverage (Population %)	Projected 6G R&D Funding (2024–2030, USD Bn)
North America	90%	12
Europe	88%	8
East Asia	96%	15
South Asia	45%	5

India's 5G Rollout

India's 5G rollout, which started in October 2022, is one of the fastest in the world in terms of both coverage expansion and user adoption.

Coverage and Adoption (Q1 2025)

- Base Stations: ~700,000 sites, covering ~80% of inhabited areas.
- Subscriber Base: 250+ million active 5G SIMs (TRAI data).
- Average Speed: 240–280 Mbps (Ookla Q4 2024), up to 1 Gbps in mmWave zones.

Spectrum Auctions (2022–2024)

Band	Frequency Range	Auction Outcome & Allocation	Primary Applications
Sub-6 GHz	3.3–3.67 GHz	Widely acquired by Jio, Airtel	Nationwide coverage, rural broadband
mmWave	26 GHz, 28 GHz	Urban hotspot and enterprise zones	AR/VR, high-density industrial IoT
Mid-band ext.	4.9 GHz	Selective allocation to enterprises	Campus networks, critical infrastructure

- Manufacturing: Tata Steel Jamshedpur plant's private 5G for autonomous crane control.
- Healthcare: Airtel–Apollo Hospitals remote ultrasound pilot in rural Telangana.
- Education: Immersive XR classrooms in Karnataka and Maharashtra schools.

Bharat 6G Vision Document

India's Bharat 6G Vision, launched by the Hon'ble Prime Minister in March 2023, is the first nationally endorsed 6G strategy in the Global South. It positions India not merely as an adopter but as a standards-originating nation, aiming to influence how 6G evolves globally.

Strategic Mission

To "design, develop, and deploy affordable, secure, and globally interoperable 6G technologies, ensuring India is at the forefront of intellectual property creation, standards definition, and mass-market deployment by 2030."

National 6G Roadmap

Phase & Timeline	Strategic Focus Areas	Expected Outputs
Phase 1 (2023–2025)	Foundational R&D, testbeds, early prototypes	THz testbeds, AI-native core prototypes, quantum comms pilots
Phase 2 (2025–2028)	Large-scale field trials, global pre-standardization activities	Interoperability validation, sector-specific pilots (health, mobility, defence)
Phase 3 (2028–2030)	Commercial readiness and global alignment	6G spectrum allocation, first commercial rollouts, multi-operator 6G networks

Core Technology Pillars

- THz Communications: Targeting 100x 5G bandwidth for ultra-high-throughput links.
- AI-Native Networks: Self-configuring, self-healing, and energy-optimized.
- Integrated Sensing & Communication (ISAC): Merging radar-like sensing into the comms layer.
- Quantum-Safe Cryptography: Future-proof security for critical infrastructure.

Global Engagements

- Hexa-X-II (EU) – Research in ISAC and semantic communications.
- NextG Alliance (USA) – Joint work on AI-native and open networking standards.
- 6G Flagship (Finland) – Collaborative THz waveform research.
- Bilateral MoUs with Japan, South Korea, Singapore, and UAE for joint testbeds.

The Bharat 6G Vision reflects a dual mandate: to build future-ready networks for India's 1.4 billion citizens and to shape the international rulebook for 6G.

Key Players and Leaders

Dr. Chih Lin I

Chief Scientist, Wireless Technologies, China Mobile

Dr. Chih-Lin I Pioneered the green, AI-native architecture for 6G. She championed Open RAN energy efficiency frameworks and integrates AI into radio resource management. Her work on Zero Energy Networks heavily influences ITU and 3GPP standards for sustainable design.

Dr. Mischa Dohler

VP Emerging Technologies, Ericsson & Professor, King's College London

Dr. Dohler is A leading voice in semantic communications and the Internet of Skills (real-time skill transfer). His research focuses on human-centric design, holographic communications, and immersive telepresence.

Akihiro Nakao

University of Tokyo, Japan

Prof. Nakao is A key figure in network slicing and AI-defined orchestration. His contributions to integrated sensing and communication are crucial for V2X performance in the terahertz spectrum, leading Japan's 6G R&D.

Rajeev Chadrasekha

Minister of State for Electronics & IT, Government of India

As a policymaker, he accelerated India's Bharat 6G Mission. He drives spectrum reform, R&D grants, and international collaborations, securing India's early position in the 6G standards race.

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Insights and
Thought
Leadership
02

Latest Technology Trends

Use Cases of 5G/6G

5G is already redefining connectivity as critical infrastructure, while 6G is set to transform networks into intelligent, predictive, and immersive ecosystems. The shift from connected services (5G) to context-aware, sensing-enabled services (6G) will drive unprecedented socio-economic impact.

Key Sectoral Use Cases

Sector	5G Capabilities in 2025	6G Enhancements by 2030+
Smart Cities	IoT-based traffic, waste, and energy management	Predictive urban governance via ISAC and live digital twins
Healthcare	URLLC-powered remote robotic surgeries, real-time diagnostics	Holographic telepresence for immersive, multi-sensory consultations
Extended Reality (XR)	4K/8K AR/VR streaming, immersive classrooms	Full-spectrum XR with tactile feedback, holographic learning
Drones & UAVs	Automated delivery and aerial surveillance at low latency	Swarm AI coordination with sub-0.1 ms response time
Autonomous Vehicles	V2X collision avoidance, adaptive cruise	Collective AI driving with cooperative environment mapping

Cross-Industry Enablers

- Edge AI & MEC: Localized decision-making for latency-critical tasks.
- Network Slicing: Dedicated, SLA-driven slices for healthcare, defence, or logistics.

- Satellite–Terrestrial Integration: Bridging rural and remote coverage gaps.
- Quantum-Resilient Security: Protecting critical networks against next-gen cyber threats.

Economic & Societal Impact

- 5G (2025): Estimated to contribute USD 1.3 trillion to global GDP annually (GSMA).
- 6G (2035): Expected to unlock a USD 4–6 trillion economic value pool, with transformative effects on healthcare, energy, and mobility.

5G is the foundation for connected economies, while 6G will be the nervous system for an intelligent, interconnected planet.

Satellite + 5G Integration

The convergence of terrestrial 5G and non-terrestrial networks (NTN)—including LEO, MEO, and GEO satellite systems—is a critical step toward seamless global coverage. This integration ensures consistent connectivity across rural, remote, maritime, and disaster-prone regions.

Satellite + 5G Integration

- 3GPP Release 17 introduced NTN specifications for 5G NR over satellite links.
- Satellites function as transparent payloads (bent-pipe) or regenerative payloads (on-board processing).
- Gateways connect satellite networks to the 5G core via standardized interfaces.

Low-Earth Orbit (LEO) Systems in Focus

Operator	Planned Constellation Size	Target Services	Relevance to India
Starlink (SpaceX)	~12,000 satellites	Broadband internet	Rural broadband pilots in remote India
OneWeb	648 satellites (Phase 1)	Enterprise, government, maritime	Bharti-backed; gateway in Tamil Nadu
Project Kuiper	3,236 satellites	Consumer & enterprise broadband	Potential collaboration for rural schools

Key Benefits

- Extends 5G coverage to >99% of geography.
- Enables emergency network restoration post-disasters.
- Supports maritime & aviation 5G applications.
- Critical for 6G's space–air–ground integrated networks (SAGIN) vision.

By 2030, satellite–terrestrial hybrid networks are expected to serve over 2 billion users globally, with India leading large-scale deployments in rural connectivity.

Spectrum Management

Efficient spectrum allocation underpins the success of both 5G and 6G. India's spectrum policy must balance coverage, capacity, and innovation while preparing for future THz allocations.

Current 5G Spectrum Landscape

Band	Frequency Range	Advantages	Challenges
Low Band	<1 GHz	Long-range, deep indoor coverage	Limited bandwidth, lower throughput
Sub-6 GHz	1–6 GHz	Balance of coverage & capacity	Moderate bandwidth
mmWave	24–40 GHz	High throughput, urban densification	Short range, high attenuation

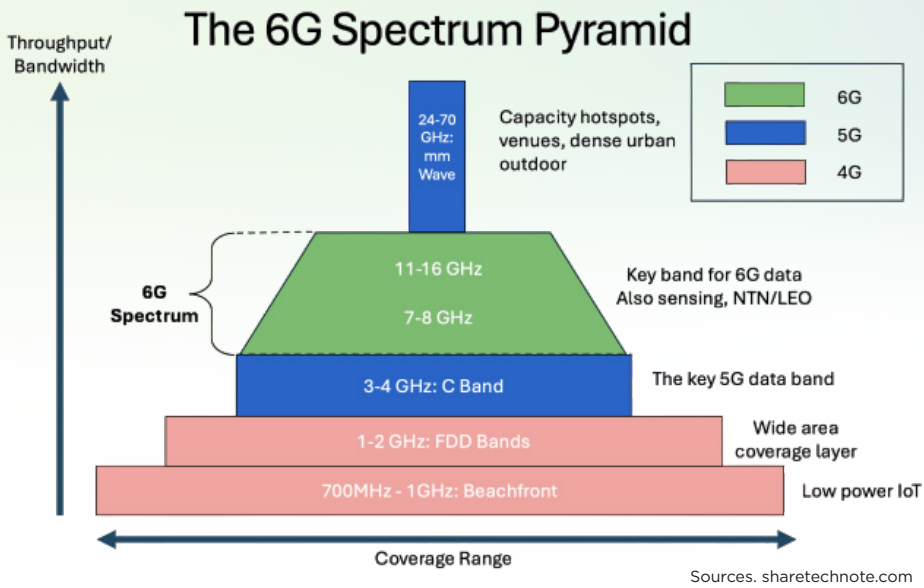
6G & THz Spectrum Outlook

- Target Bands: 100 GHz–10 THz.
- Potential Throughput: Up to 1 Tbps.
- Use Cases: Holographic communications, ultra-HD mapping, tactile internet.
- Technical Barriers: High propagation loss, atmospheric absorption, device-level THz transceivers.

Spectrum Allocation Strategies for India

- Dynamic spectrum sharing between licensed and unlicensed bands.
- Refarming underutilized bands (e.g., 600 MHz, 4.9 GHz).
- Coordinated satellite spectrum use for NTN integration.

Proactive spectrum policy, aligned with 3GPP Release 18+ and ITU WRC-27 outcomes, will be crucial to India's leadership in 6G.



This figure shows the 6G spectrum pyramid, where higher frequencies (7–16 GHz, 24–70 GHz) enable ultra-high throughput while lower bands ensure wide coverage and IoT support.

Private 5G Networks

Private 5G networks enable dedicated, secure, and ultra-reliable connectivity for enterprises, campuses, and mission-critical operations.

Architecture & Deployment Models

- Standalone (SA): Independent core & RAN, fully controlled by enterprise.
- Hybrid: Enterprise RAN with operator-managed core.
- Network Slices: Virtual private network on a public 5G infrastructure.

Industry 4.0 Enablement

Sector	Private 5G Application	ROI Impact (India Examples)
Manufacturing	Predictive maintenance via IoT sensors	20% reduction in downtime (Tata Steel Jamshedpur)
Logistics	Automated guided vehicles (AGVs)	15% faster throughput in container yards
Healthcare	Secure medical device connectivity	Apollo Hospitals' connected ICU trials
Education	XR-enabled smart campuses	IIT Madras AR/VR labs for engineering

Advantages over Wi-Fi / LTE

- Guaranteed latency <10 ms for real-time operations.
- Superior mobility handling for moving assets.
- Enhanced security through SIM-based authentication.

Regulatory Landscape in India

- DoT guidelines (2022) permit direct spectrum allocation to enterprises for private 5G.
- Band options: 3.3–3.67 GHz (mid-band) and 26 GHz (mmWave).

Private 5G is projected to account for 30% of enterprise wireless deployments in India by 2030, catalyzing Industry 4.0 adoption.

Building agile, software-driven network systems.

Open RAN and Software-Defined Networking

Democratizing Infrastructure

Open RAN (O-RAN) and Software-Defined Networking (SDN) are transforming telecom infrastructure from proprietary, hardware-centric systems into open, software-driven ecosystems.

Open RAN: Core Principles

- Disaggregation: Splits RAN into Radio Unit (RU), Distributed Unit (DU), and Centralized Unit (CU).
- Open Interfaces: Standardized fronthaul, midhaul, and backhaul connections (per O-RAN Alliance).
- Vendor Interoperability: Enables multi-vendor deployments, reducing dependency on single OEMs.

India Impact

- Vodafone Idea, Airtel, and Jio are trialing O-RAN with Tejas Networks, HFCL, and Rakuten Symphony.
- Reduces TCO (Total Cost of Ownership) by 20–25% over 5 years.

Software-Defined Networking (SDN) in 5G

- Control Plane–Data Plane Separation: Enables centralized control of network traffic flows.
- Programmability: APIs allow rapid service deployment and QoS adjustments.
- Integration: Works with NFV (Network Function Virtualization) to virtualize network services.

Open RAN	Vendor-neutral, cost-efficient	Airtel–Tejas Networks O-RAN pilot
SDN	Dynamic traffic optimization	BSNL SDN integration for backbone management

Open RAN + SDN is the foundation for flexible, cost-effective, and innovation-friendly 5G/6G networks.

India Stack and DPI

India Stack and Digital Public Infrastructure (DPI) act as service delivery accelerators for telecom-enabled applications.

5G + DPI Synergy

- Aadhaar + eKYC: Enables instant, SIM-based onboarding at scale.
- UPI Integration: Facilitates microtransactions for IoT services and prepaid data packs.
- Account Aggregator Framework: Enhances fintech applications over 5G.
- ONDC: E-commerce reach via 5G-enabled last-mile logistics.

Example: A rural healthcare IoT device using 5G for diagnostics can:

- Authenticate via Aadhaar eSign.
- Process payments through UPI.
- Store patient data in NDHM Health ID.

DPI Layer	5G Use Case Example
Identity	Aadhaar-enabled SIM activation
Payments	UPI microtransactions for IoT services
Data Exchange	DEPA consent for patient health data

Pillars of India's DPI ecosystem

Unified Payment Interface (UPI)

UPI (introduced in 2016) has revolutionised the digital payments landscape in India, facilitating real-time, interoperable, and seamless transactions across various platforms and devices.

DigiLocker

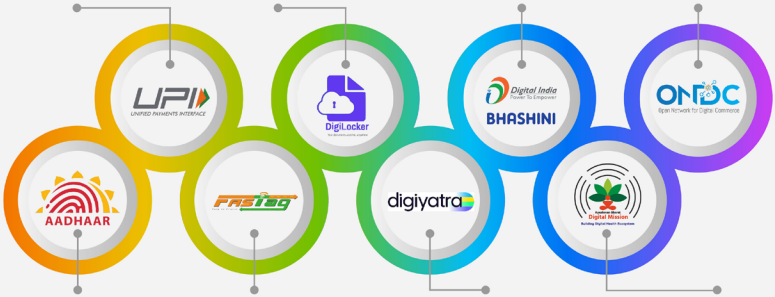
Digilocker users can store their documents, such as insurance, medical reports, PAN cards, passports, marriage certificates, school certificates, and other documents, in digital format.

Bhashini

Bhashini is an AI-based language translation tool to facilitate communication and understanding across various Indian languages.

ONDC

ONDC is an initiative to create an open, inclusive, and democratic e-commerce ecosystem in the country.



Source: Nasscom and Arthur D.Little

Aadhaar

Aadhaar is a policy tool for social and financial inclusion, public sector delivery reforms, managing fiscal budgets, increasing convenience, and promoting hassle-free people-centric governance.

FASTag

FASTag is an electronic toll collection system in India, operated by the National Highways Authority of India.

DigiYatra

DigiYatra is a Biometric Enabled Seamless Travel (BEST) experience based on a Facial Recognition System (FRS). It envisages that travellers pass through various checkpoints at the airport through paperless and contactless processing.

Ayushman Bharat Digital Mission (ABDM)

The Ayushman Bharat Digital Mission aims to develop the backbone necessary to create a nationwide digital health ecosystem.

India's 6G Roadmap

India's path to 6G is guided by the Bharat 6G Vision (2023), mandating the country to be among the top three global leaders in AI-native, high-capacity, and ultra-low latency networks by 2030. This strategy ensures a transformative leap in technological sovereignty and economic output.

Strategic Timeline and Milestones

- 2024–2025: Focus on Nationwide 5G densification and deploying mmWave/sub-THz R&D testbeds.
- By 2027: Shift to early-stage 6G research, global consortium participation, and AI-driven PoCs.
- 2028–2029: Prototype field trials in smart cities, testing Tb/s throughput.
- 2030: Commercial 6G launch, integrated with satellite systems.

Core Enablers for Transition

Key success factors include Spectrum Preparedness (allocating 7–15 GHz and THz bands), establishing Innovation Clusters (with ~ ₹18,000 crore investment), and regulatory support for infrastructure sharing. Global collaboration (e.g., Japan, Finland) is crucial.
This initiative is projected to generate USD 120–150 billion in annual direct telecom revenue by 2030, plus an additional USD 500–550 billion in indirect GDP contribution, finally achieving 100% broadband coverage.

Buddies, I feel we have more to learn and see what new innovations involving other technologies is taking place. Hop in, and enjoy the ride.

Interactions with Other Tech

Telecom Equipment Ecosystem

India aims Big

India's telecom equipment ecosystem is evolving from import-reliant to self-reliant through policy incentives, R&D investment, and export focus.

Domestic OEM Growth

- Tejas Networks: Optical transport, O-RAN gear.
- HFCL: Fiber optics, 5G RAN systems.
- Sterlite Technologies: Optical fiber and network solutions.

Policy Push

- PLI Scheme (₹12,195 Cr) for telecom manufacturing (2021–2026).
- Mandates 50% local value addition for government procurement.

Global Positioning

- India aims to supply 30% of telecom gear demand in developing markets by 2030.
- Export markets: Africa, ASEAN, Middle East.

5G and Cybersecurity

Key Threat Vectors

New risks include exploiting control plane vulnerabilities via Signaling Storms, massive IoT Botnets launching DDoS attacks, and API Abuse targeting open network interfaces in Open RAN and MEC environments.

Zero Trust in 5G

The core strategy is “Never Trust, Always Verify,” demanding continuous authentication across device, network, and application layers. This is enabled by Micro-Segmentation to isolate network slices and End-to-End Encryption. Control mechanisms range from SIM/eSIM MFA at the device level to slice isolation and API security gateways.

India Initiatives

India addresses these threats through CERT-Telecom for sector-specific incident response and the DoT Security Directive (2022), which mandates rigorous source code review for all telecom gear. Cybersecurity is an operational prerequisite.

Cybersecurity in 5G is not an add-on—it’s an operational prerequisite for national infrastructure resilience.

AI and ML in Network Optimization

AI and ML are becoming native capabilities in telecom networks, enabling automation, predictive insights, and real-time adaptation.

AI Applications in 5G

Predictive Maintenance: AI models forecast equipment failures, reducing downtime by up to 30%.
Dynamic Resource Allocation: ML optimizes spectrum and bandwidth use in real time.
Self-Healing Networks: Automated fault detection and rerouting without human intervention.
Energy Optimization: AI-driven sleep modes for base stations, reducing power use by up to 15%.

AI Function	Benefit	Example Deployment
Predictive Maintenance	Avoids unplanned outages	Airtel core network AI
Traffic Prediction	Balances load, reduces congestion	China Mobile
Energy Optimization	Cuts OPEX, supports ESG goals	Vodafone UK

AI-native networks are the stepping stone from reactive 5G to proactive, self-optimizing 6G.

Cross-Industry Impact of 5G and 6G

The transformative potential of 5G and 6G reshapes entire industry verticals through ultra-reliable, high-capacity, and low-latency connectivity, creating new services and market opportunities.

Key Sectors and Impact

Sector	Current 5G	Future 6G
Fintech	Real-time banking, biometrics	AI fraud, quantum-secured transactions
Healthcare	Remote diagnostics, AR surgery	Immersive surgery, patient digital twins
Education	Hybrid/AR/VR learning	Holographic classrooms, AI curricula
Agriculture	IoT farming, drone monitoring	Soil analysis, autonomous robotics

Strategic Advantages

These technologies offer significant gains: enhanced Operational Efficiency via predictive analytics automation, substantial Revenue Growth through new digital service streams, and improved Sustainability via network energy efficiency. By 2030, cross-sector 5G/6G adoption is projected to contribute over USD 1.5 trillion to global GDP, with Asia-Pacific driving ~40% of this growth.

Buddies, one thing is sure, we are going to upgrade our lifestyles very soon with these upgradations in technologies. But what contributes to structural developments of these technologies? Let's peek in.

Ecosystem Leadership

Global 6G Initiatives

The race to define and lead 6G is a high-stakes endeavour blending technology innovation with geopolitical positioning. Each major economic bloc is advancing its own programme to shape global standards, intellectual property, and deployment models.

Key Programmes

Initiative	Region	Primary Focus Areas
Hexa-X-II	European Union	Integrated sensing, AI-native networking, security
NextG Alliance	USA	Open architectures, spectrum policy, supply chain resilience
IMT-2030	China	THz communications, space–air–ground integration
6G Flagship	Finland	Sustainability, holographic communications
KDDI 6G Initiative	Japan	Underwater and deep-space connectivity

India's Strategic Position

- Founding member of ITU's Focus Group on 6G.
- Leads the low-cost, high-reach technology track in the BRICS Tech Forum.
- Bharat 6G Vision is aligned with 3GPP Release 21+ and WRC-27 spectrum priorities.

Leadership in 6G will hinge on a country's ability to influence standards, control IP portfolios, and deploy cost-effective solutions at global scale.

Policy & Regulatory Framework in India

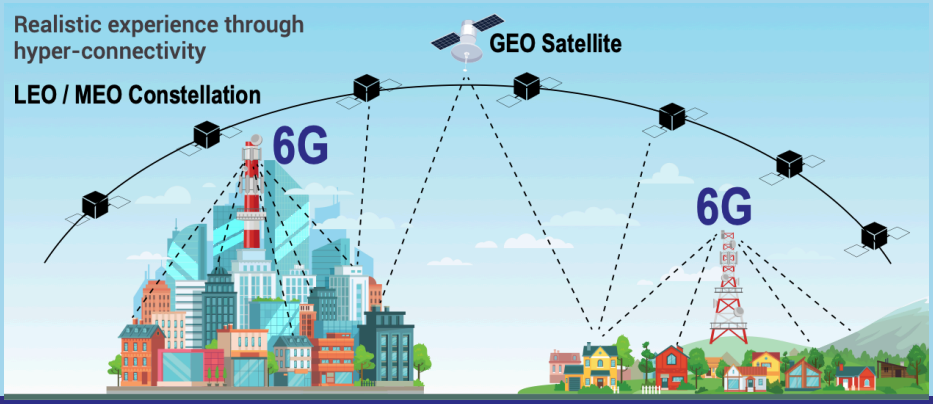
Principal Regulators

- TRAI: Oversees tariffs, quality of service, and spectrum pricing recommendations.
- DoT: Manages spectrum allocation, licensing, and infrastructure policy.
- MeitY: Aligns telecom growth with digital ecosystem development and cybersecurity frameworks.

Key 5G Policy Milestones (2022–2024)

- India's telecom policy rapidly advanced 5G from 2022–2024 with the largest spectrum auction and the liberalization of satellite broadband, alongside enabling direct spectrum assignment for private enterprise networks.
- Simultaneously, the nation is preparing for 6G by initiating THz band research and early spectrum planning (100GHz+ allocations). Strategic directions include patent creation incentives for indigenous tech, embedding ESG compliance, developing Bharat 6G testbeds, and establishing a Quantum-safe encryption roadmap to future-proof network security.

Regulatory foresight will determine whether India transitions from being a fast adopter in 5G to a first mover in 6G.



UBIQUITOUS CONNECTIVITY

- Robotic Healthcare Center
- Connected Fire station
- Online Police services
- Smart Electric Devices
- Smart Classes
- Multi-National Companies
- Augmented & Virtual Reality
- e-Commerce
- Ultra High Connectivity
- Industry Hubs
- Smart waste Management
- Secured POS Services
- Automated Public Transport
- Digital library
- Advance Agriculture Technology
- Connected Fire station
- Online Police services
- 6G Connected Homes
- Smart Classes
- Digital Post Office
- Augmented & Virtual Reality
- e-Commerce
- Ultra High Connectivity
- Connected Transportation
- Online Banking
- Remote ATM
- Connected Retail Services
- Digital Schools

Source. mpriindia.com

Standardization Bodies

Standards bodies are the custodians of global interoperability, ensuring that networks and devices function seamlessly across borders and vendors.

Core Institutions

- ITU (International Telecommunication Union), sets the global stage, defining the IMT-2020/2030 frameworks, spectrum, and performance KPIs.
- The 3GPP (3rd Generation Partnership Project), publishes the technical specifications for 5G/6G in iterative releases.
- TSDSI (Telecommunications Standards Development Society, India), India's apex body, adapts global standards regionally, contributing indigenous solutions like the Low Mobi lity Large Cell (LMLC) profile.
- India also influences the ITU with Bharat 6G inputs. The IEEE focuses on interoperability and protocols like Wi-Fi.

Standards work is a long game — consistent contributions over multiple release cycles secure lasting influence in the telecom value chain.

Telecom ESG Agenda

The 5G-6G evolution intensifies energy demands due to denser networks and higher data throughput, making ESG (Environmental, Social, and Governance) integration a core business imperative.

Environmental Priorities

The 5G-6G evolution demands strong ESG focus due to rising energy use. Priorities include deploying Green Base Stations and using AI-Optimized RAN to cut consumption, with 6G adding Energy Harvesting and Carbon-Aware Scheduling.

Global Benchmarks

Operator	Initiative	Result
China Mobile	300K+ solar sites	Avoids ~ 900K tonnes CO2 yearly
Vodafone Group	100% renewable power in Europe	On track for net-zero by 2030
Bharti Airtel	Hybrid power in rural towers	14% drop in annual energy cost

ESG-driven telecom operations do not just mitigate environmental impact — they deliver long-term operational savings and strengthen operator reputation.

Talent Landscape

The 5G-6G transition requires a workforce skilled in telecom engineering, AI, cloud, and cybersecurity. This talent pool dictates the pace of network value delivery.

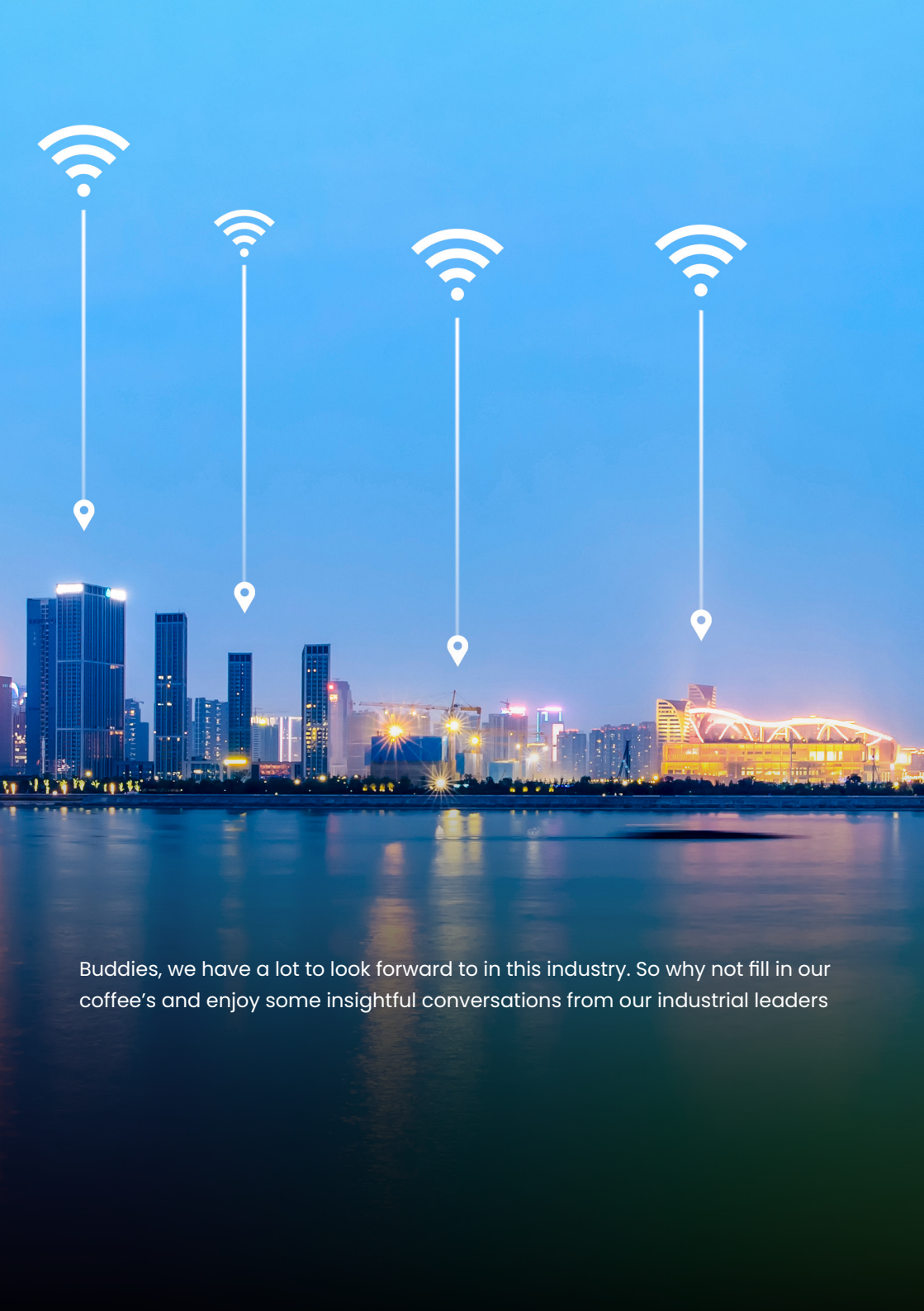
Priority Skill Domains

Key areas include Network Engineering (Open RAN, densification), AI/ML Applications (predictive resource allocation), Telecom Cybersecurity (securing network slices/APIs), and IoT Architecture (vertical-specific solutions).

India's Current Readiness (2025)

- Only one in four telecom engineers has direct experience with cloud-native 5G core systems.
- Less than 10% have exposure to AI-native network management or THz communication concepts.
- The Telecom Sector Skill Council aims to retrain over 1 million professionals by 2030.

India is responding with targeted interventions: joint Skill India–TSSC programs for Open RAN training, MeitY–IIT collaborations to integrate 6G into postgraduate curricula, and AICTE electives focused on AI for Wireless Networks and Telecom Cloud Architecture. Without a highly skilled workforce, the profound societal impact promised by 6G will remain underdeveloped.



Buddies, we have a lot to look forward to in this industry. So why not fill in our coffee's and enjoy some insightful conversations from our industrial leaders

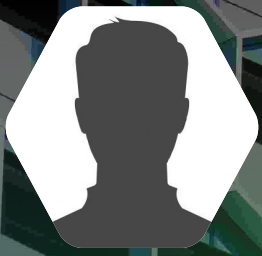
Leading through change with expert advice.

03

IMC 2024 Discussions and Engagements

Panelists

Shantonu Mukherji
Head of Growth Segments, Reliance Jio



Shilpa Mallia Singhai
MD, Communications, Media & Technology Industry, Accenture Strategy

Panel Title

From Principles to Practices: AI for Tomorrow

Sunit Kumar
Technical Director, KPMG

Moderator

Panelists

Akaash Agarwal
Senior Director of Engineering, Wireless System R&D, MediaTek

David O'Brien
Senior Business Development Manager, Athonet

Panelists and Their Insights

Dr. Thang

Dr. Thang said, “By the end of this year, we expect 1.5 billion 5G subscribers worldwide, with India alone reaching around 700 million by 2028. The most successful use cases so far are enhanced mobile broadband and fixed wireless access.”

Shantonu Mukherji

Mr. Mukherji emphasized Jio’s rapid SA 5G rollout covering almost all of India, unique millimeter-wave deployments, and use cases in healthcare, immersive media (like IPL 360° content), AI-powered advertising for SMEs, and more. He sees 5G as the ubiquitous connectivity layer enabling cross-industry innovation.

Shilpa Mallia Singhai

Ms. Singhai emphasized 5G as a convergence platform, showcasing Telstra’s stadium transformation and Walt Disney’s immersive collaboration, noting these are only viable with 5G.

David O'Brien
David O'Brien compared 5G to infrastructure like electricity, advocating for enterprise and industrial use cases (ports, logistics). He urged easing private spectrum access to foster innovation.

Akaash Agarwal
Akaash Agarwal called for shared investment and supportive policies, including subsidies for 'Make in India' hardware, private spectrum, fiberization, and the adoption of NTN and RedCap devices.

Conclusion
The experts concluded that 5G's transformation is broad, driving Operational Efficiency and Revenue Growth. Monetization is driven by premium applications like low-latency slicing and high-ARPU FWA. The transition is projected to create 22 million global jobs, demanding urgent upskilling in networking and data science.

IMC 2025 Discussions and Engagements

Panelists

Prof. R. David Koilpillai
Professor, IIT Madras
& Chairperson, Bharat 6G Alliance

Dr. Charles Clancy
Senior Vice President & Chief Future Technology Officer, MITRE (USA).

Panel Title

Panel on Global 6G Initiatives (International Bharat6G Symposium)

Prof. Bhaskar Ramamurthi

Senior leader, Bharat 6G Alliance.

Moderator

Panelists

Prof. Harald Haas
Professor & Director, LiFi, University of Cambridge

Dr. Magnus Frodigh
Vice President & Head of Ericsson Research, Ericsson

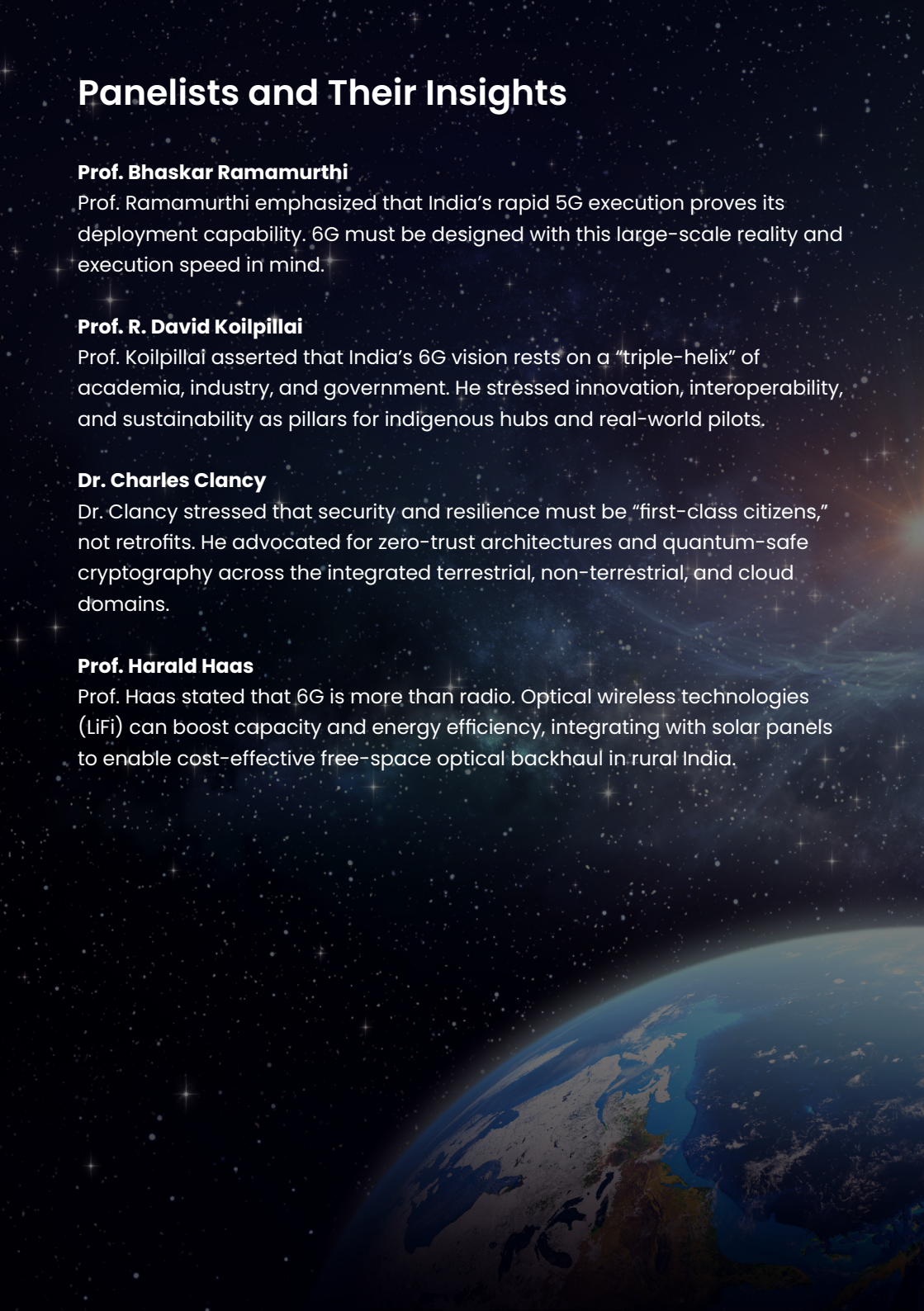
Panelists and Their Insights

Prof. Bhaskar Ramamurthi
Prof. Ramamurthi emphasized that India's rapid 5G execution proves its deployment capability. 6G must be designed with this large-scale reality and execution speed in mind.

Prof. R. David Koilpillai
Prof. Koilpillai asserted that India's 6G vision rests on a "triple-helix" of academia, industry, and government. He stressed innovation, interoperability, and sustainability as pillars for indigenous hubs and real-world pilots.

Dr. Charles Clancy
Dr. Clancy stressed that security and resilience must be "first-class citizens," not retrofits. He advocated for zero-trust architectures and quantum-safe cryptography across the integrated terrestrial, non-terrestrial, and cloud domains.

Prof. Harald Haas
Prof. Haas stated that 6G is more than radio. Optical wireless technologies (LiFi) can boost capacity and energy efficiency, integrating with solar panels to enable cost-effective free-space optical backhaul in rural India.



Dr. Magnus Frodigh

Dr. Frodigh discussed transforming networks into programmable platforms combining sensing, compute, and AI. He highlighted joint communication-and-sensing and anchored global 6G standards around the "three Cs": cost, coverage, and capacity.

Conclusion

The consensus highlights that India's 6G success depends on indigenous, secured, and sustainable innovation driven by collaboration. Security, optical integration, and platform programmability are critical design elements to ensure 6G transitions the country from a rapid adopter to a key global standards contributor.

these were some interesting insights and I believe we are moving forward towards a sustainable partnership.

Buddies. Now get ready for some fun in our next section, be creative as much as you feel.. grab your pens and have some fun!

04

Learning with Fun

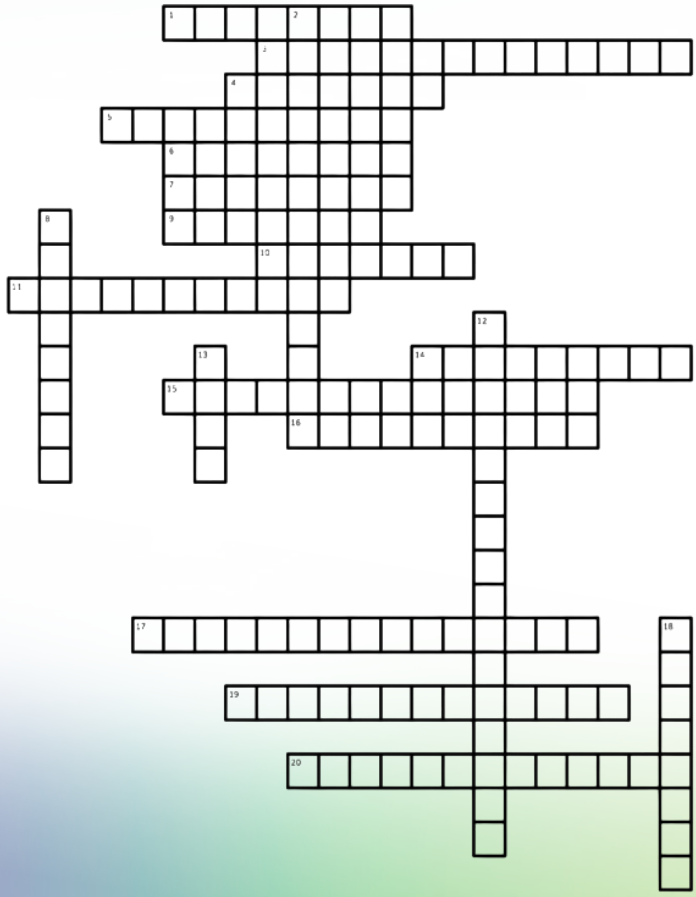
Crossword

Across

1. High-speed connection between cell towers and the main network
3. Segmenting a network into multiple virtual networks with different characteristics
4. Measure of delay in data transmission
5. Maximizing performance while minimizing resources or costs
6. Protection against unauthorized access or manipulation of data
7. Set of rules for exchanging data between devices
9. Frequency range below 6 gigahertz used in 5G networks
10. Measure of the number of devices that can connect to a network within a given area
11. Technology used to focus radio waves towards specific users in 5G networks
14. Amount of data that can be transmitted in a given time
15. Process of creating virtual versions of hardware and software components
16. Short-range wireless access points used in 5G networks
17. High-frequency waves used in 5G technology
19. Capable of providing dependable service even in challenging conditions
20. Increase in the number of small cells used in a network

Down

2. Consisting of diverse elements or components
8. Range of frequencies used for wireless communication
12. Ability of different systems or devices to communicate and work together
13. Multiple-input multiple-output, technique used to increase data transfer speed
18. Devices used for transmitting and receiving wireless signals



Find the Words

M D S I M U L A T I O N E I N A C
S O M U L T I P L E X I N G S G Q
Y M D U T E R A H E R T Z U H G U
N M R U T D O E N C M L O O N V A
C I L A L R V C G M N E E I S I N
H L A K A A Z S U E N I T B M R T
R L T F C B T T N E S U I E A T U
O I E H G R B I G S P A N A R U M
N M N M I M O O O M E H G M T A C
I E C T B O R L O N C E I F C L O
Z T Y A T E N C H U T M D O I I M
A E R F T P D L O S R A U R T Z P
T R E E L U X S A M U C U M I A U
I W H R O T N O A S M E I I E T T
O A T L A N T E N N A S R N S I I
N V C N C B I G D A T A U G B O N
G E E D G E C O M P U T I N G N G
I N T E R N E T O F T H I N G S E

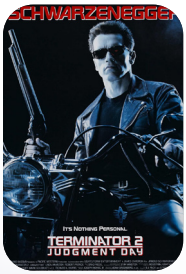
Fiction and Literature

Rainbows End by Vernor Vinge

Envisions seamless AR and AI-mediated communication. Its depiction of contextually filtered, instantly projected information reflects 6G's semantic communications and integrated sensing, delivering only relevant data based on user intent.

The Peripheral by William Gibson

Describes remotely operating synthetic avatars with no perceptible delay. This mirrors the sub-0.1 ms latency and holographic telepresence envisioned for 6G, enabling remote physical presence and precision control

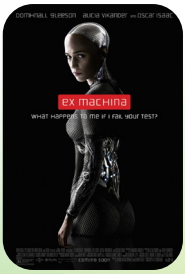


Neuromancer by William Gibson

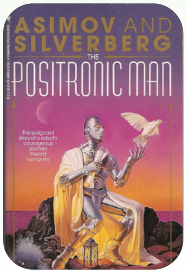
Gibson Introduces "The Matrix," a fully immersive, real-time cyberspace. The scale and sensory richness align with the 6G vision for photorealistic digital twins supported by terahertz spectrum and AI-native orchestration.

Inception by Christopher Nolan

This read constructs a shared, instantly synchronized dream architecture. This requires 6G-level bandwidth, integrated multi-sensory I/O, and predictive network intelligence to synchronize feedback across distributed users.



5G in Movies

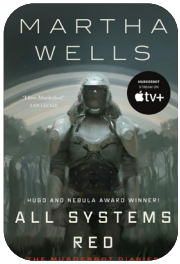


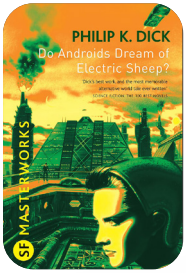
Upload (Amazon Prime, 2020–present)

Upload depicts virtual consciousness with instantaneous sensory feedback. This parallels 5G's enhanced mobile broadband and edge computing, essential for sustaining ultra-high-fidelity, immersive environments without lag.

Fast & Furious 9 (Film, 2021)

this franchise shows remote control of connected vehicles, illustrating the V2X possibilities enabled by 5G URLLC and the necessity of robust cybersecurity for critical infrastructure.



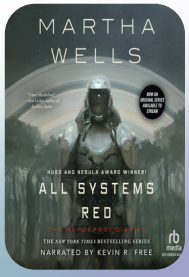


Black Mirror – Nosedive (Netflix, 2016)

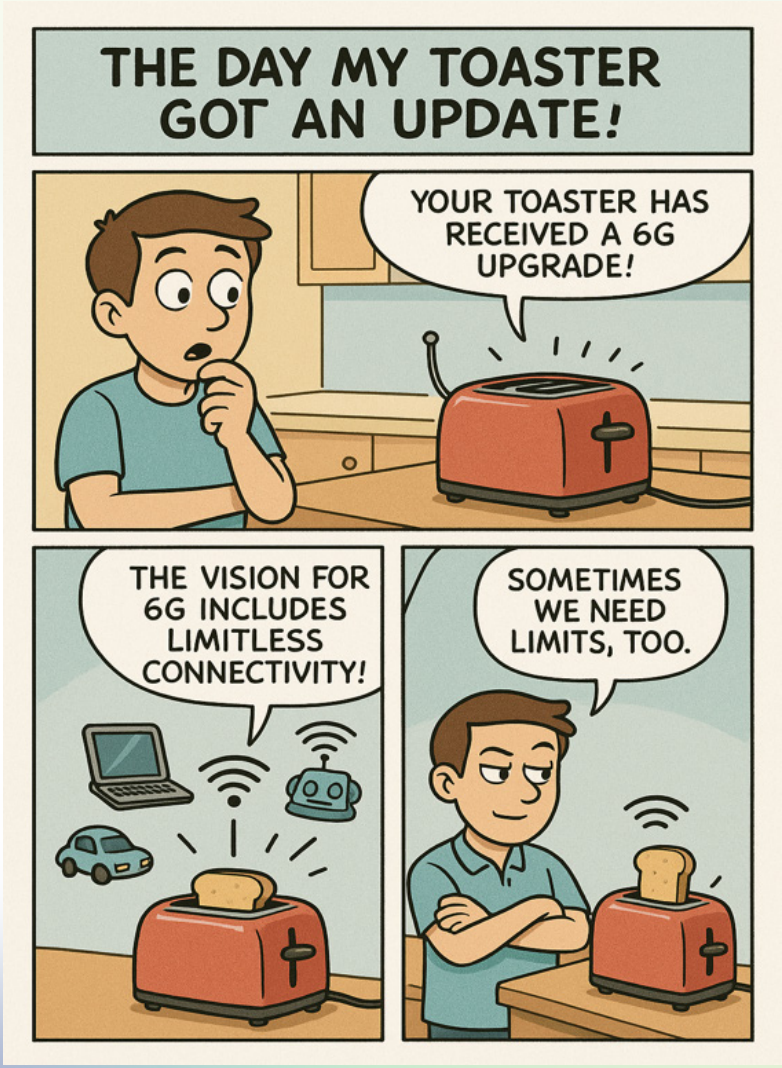
This movie presents a real-time, pervasive social credit system based on continuous data exchange, mirroring the dedicated, high-priority resource allocation provided by 5G Network Slicing.

Minority Report (Film, 2002)

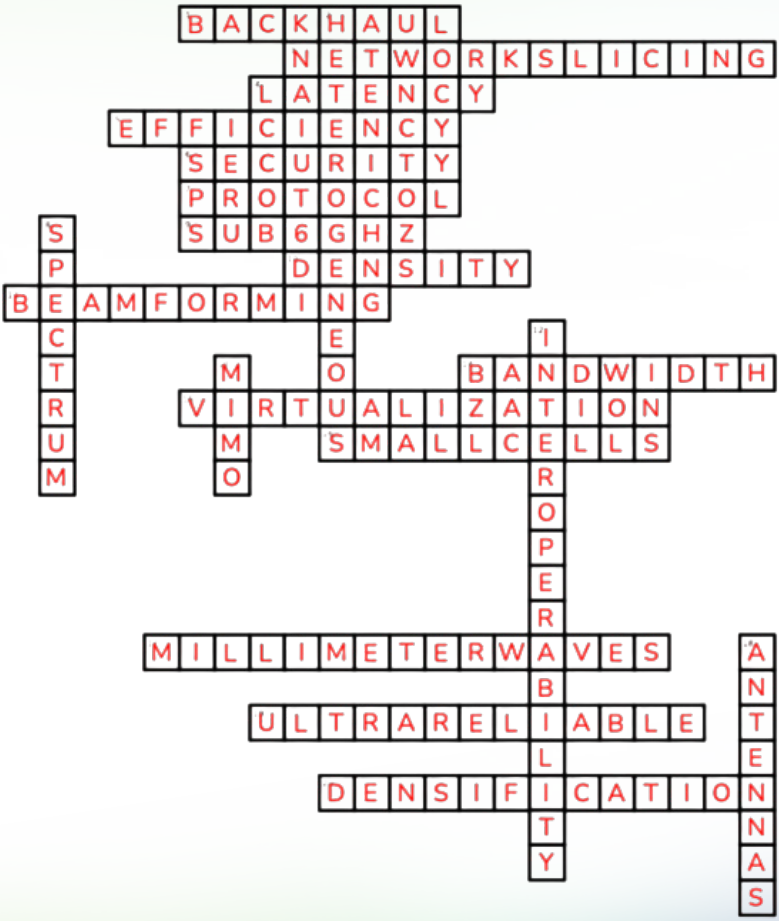
This gem features cities with biometric recognition and predictive policing requiring instantaneous data access, aligning with 5G's bandwidth and real-time analytics for pervasive IoT and smart cities.



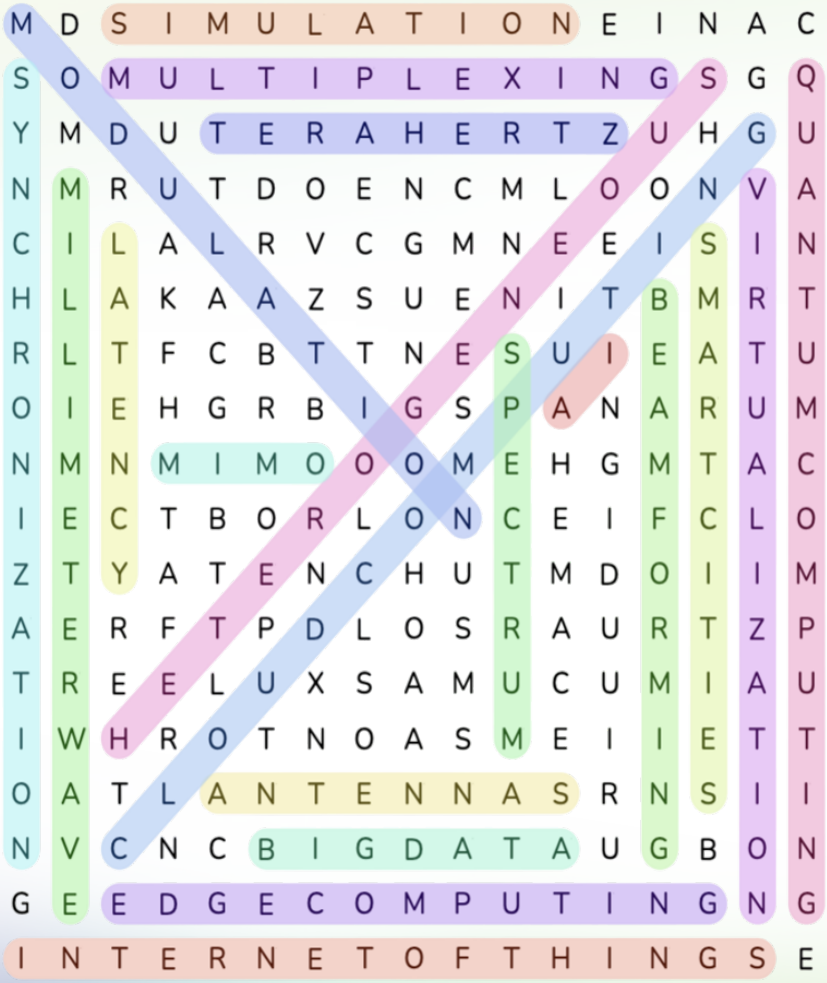
Comic Strip


THE DAY MY TOASTER GOT AN UPDATE!
YOUR TOASTER HAS RECEIVED A 6G UPGRADE!
THE VISION FOR 6G INCLUDES LIMITLESS CONNECTIVITY!
SOMETIMES WE NEED LIMITS, TOO.

Solutions


BACKHAUL
NETWORKSLICING
LATENCY
EFFICIENCY
SECURITY
PROTOCOL
SUB6GHZ
DENSITY
BEAMFORMING
MIMO
VIRTUALIZATION
SMALLCELLS
BANDWIDTH
ROPER
MILLIMETERWAVES
ANTENNAS
ULTRARELIABLE
DENSIFICATION

Find the words



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4. https://www.civilsdaily.com/news/issues-in-the-phased-manufacturing-policy/
5. https://www.digitalengineeringawards.com/article/infographic-digital-twin-use-cases
6. https://blog.lnsresearch.com/what-is-quality-4.0-and-what-it-isnt
7. https://blog.lnsresearch.com/veeva-systems-expands-their-impact-in-boston


IMC 25
The year is 2030, and the impossible is now real: you are remotely performing surgery via a holographic twin, and your city grid is managed by a self-healing, AI-driven core. How did we get here? This book is your deep dive into the architecture that makes magic possible. Discover the secrets of Network Slicing that deliver remote surgery and the Quantum-safe security that protects it. Track the transition from 5G's URLLC to 6G's Integrated Sensing. Uncover the role of Open RAN and LiFi in democratizing infrastructure and see how sci-fi dreams like The Peripheral are becoming technical roadmaps. This is the definitive guide for every aspiring architect and strategist ready to build the next-generation network.
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