

Scaling Pre-6G Pilots to Commercial Deployment

Indigenous Tech Roadmap

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What India Actually Needs from 6G

✓ India's Reality — Five Imperatives

Universal Connectivity

Affordable, reliable broadband to urban and rural India — the digital divide cannot persist into the 6G era.

FWA Economics that Work

FWA that operates at ₹450–850/month ARPU economics. Viable unit economics are the prerequisite for deployment at scale.

Healthcare & Education at Scale

Rural healthcare and AI-powered smart classrooms need guaranteed QoS connectivity — not best-effort broadband.

Device-Level AI Applications

New class of AI devices — wearables, AI cameras, smart sensors — demand always-on, low-latency access.

Connectivity Anywhere, Any Time

Terrestrial + NTN (NB-IoT NTN, LEO) for ubiquitous coverage — including 600 000+ uncovered habitations.

India 2026–2040: The Real Wireless Drivers

eMBB + AI Devices

Smartphones, AI wearables & new device classes drive eMBB traffic. AI-on-device demands always-on low-latency connectivity.

Fixed Wireless Access

FWA is India's bridge technology. 5G proved the economics; 6G must design it in from the spec — not discover it by accident.

Rural Connectivity

600 000+ uncovered habitations. 6G must be deployable at Gram Panchayat scale — low cost, long range, high speed.

IoT at Scale

Narrow-band + broadband IoT across agriculture, logistics, smart cities. NB-IoT NTN will bridge the final coverage gap.

Healthcare & Education

Tele-medicine and AI-powered smart classrooms need guaranteed QoS.

Sensing & Safety

Massive MIMO arrays are communication AND radar. Drone detection, perimeter security — zero extra hardware.

5G FWA: The Market Discovered It. Not the Planners.

"5G FWA did not appear in the original IMT-2020 use-case charter. Operators leveraged under-utilised mid-band capacity and a market emerged. For 6G, FWA must be a first-class designed-in use case — not a happy accident."

Unplanned Success

No FWA mandate in 5G NR Release 15–17. Yet FWA became the dominant 5G revenue driver for Indian operators — unlocking the data-pipe dividend.

Mid-Band is the Sweet Spot

3.5 GHz + emerging 6.425–7.125 GHz combine coverage and capacity for outdoor CPEs. Upper mid-band is the natural home for 6G FWA in India.

The Indoor Challenge Ahead

At 6.425–7.125 GHz, building penetration degrades sharply. DAS and in-building solutions must be planned alongside outdoor 6G FWA rollout.

5G ORAN Fixed Wireless Access — Live Deployments

5G broadband to hospitals, schools, and homes

• LIVE

NIMS Hospital, Hyderabad



Rooftop RAN



WiFi AP · OPD



FWA CPE

- 5G RAN on rooftop, FWA CPEs across buildings
- WiFi APs serving OPD, labs, staff areas
- Real patients & staff — 50 Gb/day (increasing), live
- Institutional-grade FWA replacing fibre

Chinnapur Village, Sangareddy



Smart Classroom



BTS Tower

- Rural govt school — first broadband ever via 5G BTS
- Telangana State content + pre-school smart TV
- Home users averaging ≥ 2 Gb/day — real sustained usage
- 5G FWA + backhaul = self-sufficient village broadband

Ground Experience: IITH Live 5G FWA Deployments –O-RAN

• LIVE

NIMS Hospital, Hyderabad

5G RAN

Rooftop-mounted gNB covering OPD, labs, staff wards and visitors

FWA CPE

Multi-building campus: institutional-grade fibre replacement

Live Users

Real patients & staff on 5G internet — running 50 GB/day

Relevance

5G FWA $\equiv$ healthcare infrastructure · Template for Ayushman Digital

Chinnapur Village, Sangareddy

First Broadband

No wire, no fibre — first internet ever via 5G BTS

Smart Classroom

Telangana State content for children + pre-school smart TV

Home Usage

Home internet: ≥ 2 GB/day/user — real sustained usage

Lesson

5G FWA + backhaul = self-sufficient village broadband

Lessons from 5G FWA: What the Ground Taught Us

L1

CPE Height is Critical

Elevation is the single biggest link-quality lever. A 5–6 m height increase makes a decisive difference. Design CPE mounting into the deployment plan from day one.

L2

Power & Antenna Gain Trade-off

Splitting gain between BTS and UE is a fundamental trade-off. Maximise UE Tx power within regulatory limits — never under-power the CPE.

L3

Rural Range: 2-3 km Is Achievable

At 3.5 GHz, macro-cell reach beyond 2 km and up to 3Km for FWA use case is demonstrated.

L4

Licensed + Unlicensed: A Natural Stack

5G/6G for outdoor backhaul, Wi-Fi 6E/7 for last-metre indoor. This hybrid stack is cost-optimal and already proven in our deployments.

L5

DAS for Upper Mid-Band Indoors

At 6.4–7.1 GHz, building penetration degrades significantly. Distributed Antenna Systems are the right answer for enterprise and campus indoors.

6G-Ready Architecture & Research



6G Testbed at IITH



OTFDM Waveform

Orthogonal Time-Frequency Division Multiplexing — novel waveform targeted for IMT-2030. Ultra-low latency single-symbol transmission, 500 km/h mobility, low PAPR.



FR3 Upper Mid-Band

Frequency Range 3 extension in development. Upper mid-band spectrum for enhanced capacity and coverage — critical for 6G requirements.



Structural MIMO

Advanced MIMO architecture meeting IMT-2030 performance targets.

IITH Pre-6G PHY: Proof, Not PowerPoint

Phase-0 · OTFDM Waveform · OTA Validated · IIT Hyderabad Campus

✓ NOT a paper study. NOT a simulation. A real FPGA modem transmitting OTFDM waveforms over a live >1 km air link at IIT Hyderabad right now.

200 MHz

Instantaneous BW

*Widest of any
Indigenous PHY*

>1 km

OTA Validated Range

*Live campus
air link*

1.2 Gbps

Peak Rate / Layer

*Full PHY layer
throughput*

8.93 μ s

Symbol Duration

*Pilot + data in
one symbol*

7 GHz

Carrier Frequency

*6.425–7.125 GHz
band*

What OTFDM Delivers for 6G India

Spectral Efficiency

Pilot tones and payload data share every 8.93 μ s symbol — no symbol wasted on reference signals alone. Higher net throughput at the same bandwidth.

Energy Efficiency

Low PAPR means the power amplifier runs at full rated power with zero back-off. More bits-per-watt — critical for rural 6G networks

Three Modes — One Hardware

OFDM · DFT-s-OFDM · OTFDM switchable by firmware. Commercial FWA, high-mobility transport.

6G + Sensing: The Free Lunch from Massive MIMO

DST NMICPS-COMET funded IITH
WiSig RU

32TR

The Core Insight

Both 5G and 6G base stations deploy large active antenna arrays with digital beamforming — designed for communication.

The same hardware — without modification — can perform radar-class sensing.

3GPP is defining open data interfaces for sensing fusion. But at a fundamental level, hardware reuse requires no special specification.

For India: a 32T32R Massive MIMO base station is simultaneously a broadband AP and a precision sensing platform.

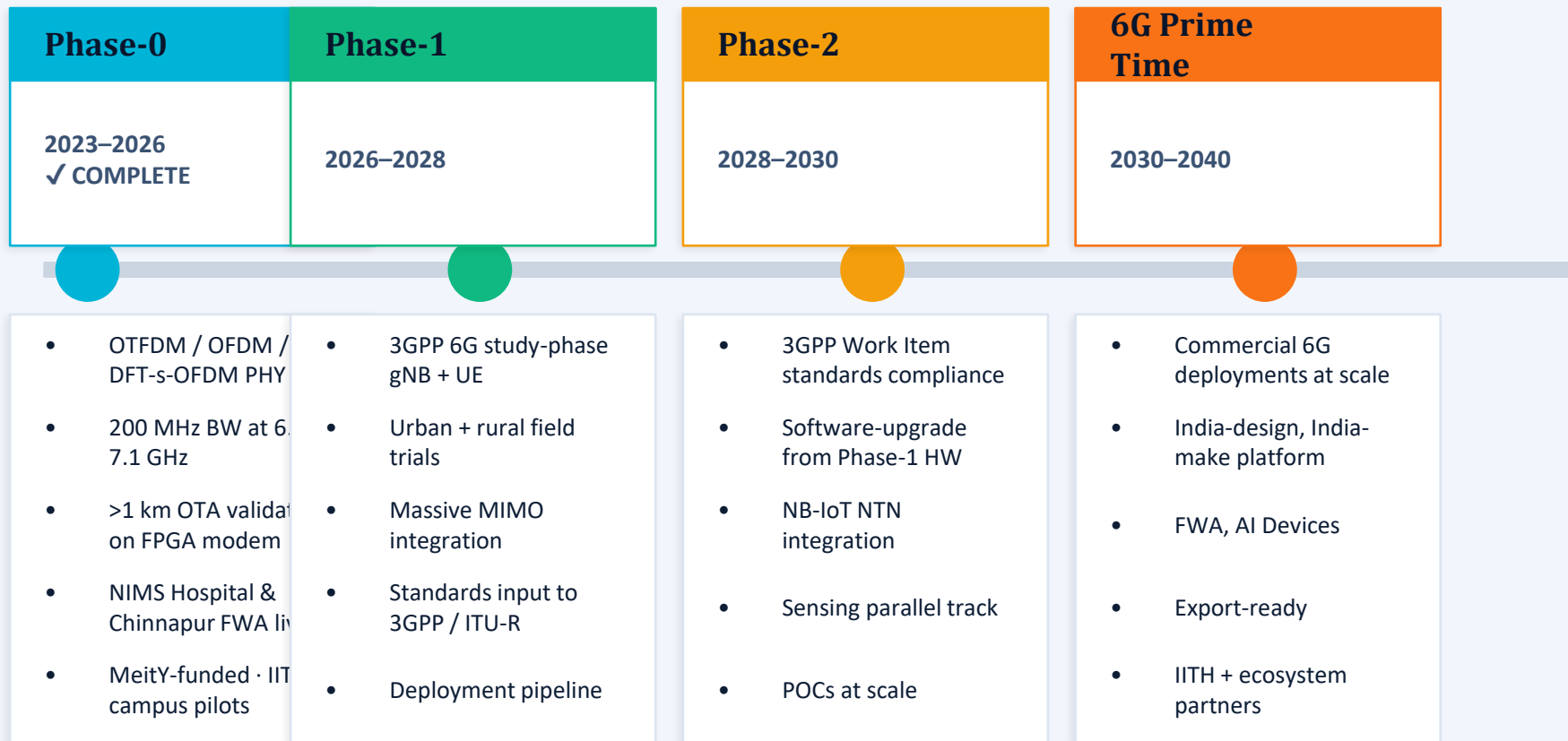
Drone Detection & Tracking

Beamforming arrays detect, track and classify UAVs in real-time. Critical for India's rapidly expanding drone policy. A 32T32R base station provides 360° azimuth coverage with degree-level angular resolution — no additional radar hardware required.

Perimeter & Defence Security

Radar modes of Massive MIMO for forward operating base protection and critical infrastructure security. The OTFDM waveform's A single base station serves as both comms node and surveillance sensor.

India's Pre-6G → 6G Roadmap: Lab to Standard to Market



What 6G Must Actually Solve for India

1

Bridge the Urban–Rural Digital Divide

6G must be deployable at Gram Panchayat scale — low-cost, low-power, long-range. The 5G economics gap in rural India cannot repeat itself.

2

FWA as a First-Class Citizen

Design 6G PHY and MAC with FWA as a primary use case from first Release. CPE form factor, link budget, and beamforming must be co-optimised from day one.

3

Build the Indigenous Solutions & Platform Stack

WiSig/IITH experience proves a full stack is buildable indigenously.

4

Spectrum Policy: Act Before WRC-27

6.425–7.125 GHz IMT allocation must be finalized.

5

Calibrate Timelines — Stop the Marketing Hype

3GPP 6G standards freeze ~2029. Commercial scale is 2030–40. Plan the ecosystem for these time lines.

A Grounded Vision for India's 6G

6G at commercial scale is 2030–40. Build the ecosystem now.

5G FWA was India's great accidental use-case. 6G must make FWA a first-class designed-in specification — not another happy accident.

IITH has demonstrated India's first OTFDM pre-6G PHY — 200 MHz, 1.2 Gbps/layer, OTA validated at 7 GHz. Lessons learnt will be published shortly.

Indigenous 6G stack — from PHY to System to Open Interfaces. It is underway.

Spectrum is the policy lever. Upper mid-band IMT allocation before WRC-27.

Thank You

Questions & Discussion

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