WHITEPAPER

DRONE FEDERATION INDIA (DFI)

Building Bharat Drone Stack

A Blueprint for Self-Reliance in Drone Components and Critical Materials

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FOREWORD

India stands at a defining moment in its journey toward technological self-reliance. The exponential growth of the drone industry has not only opened up new frontiers in strategic defence and national security but also transformed how we approach agriculture, logistics, mining, disaster response, and infrastructure development. The Indian drone market is projected to be a $11.06 billion opportunity by 2030. At the heart of this revolution lies a critical challenge — the absence of a secure, resilient, and indigenous ecosystem for drone components and materials.

Over the past few years, the Indian government has taken bold and progressive steps to unleash the potential of unmanned aerial systems — from enabling regulatory reforms to incentivising manufacturing. Yet, despite this momentum, a significant portion of drone components continues to be imported, exposing us to supply chain vulnerabilities, cybersecurity risks, and lost opportunities for domestic innovation.

The **Bharat Drone Stack** initiative, launched by the Drone Federation India (DFI), is a response to this strategic imperative. It lays down a layered, mission-oriented roadmap to strengthen India's drone component ecosystem — not just in spirit, but in structure as well. This white paper serves as our foundational blueprint, identifying systemic gaps, outlining a strategic approach, and proposing flagship initiatives that will collectively shape India's transition from dependency to leadership in drone technologies.

Importantly, the Bharat Drone Stack will serve as a cornerstone in realising India's national vision of becoming a global hub for drone design, development, manufacturing, and exports by 2030. By nurturing deep-tech innovation, establishing certification frameworks, and facilitating resilient supply chains, the initiative aims to position India not only as a consumer of drone technology but also as a confident contributor to the global value chain.

We invite industry, government, academia, and investors to join us in this journey of co-creation and capability building. Together, we can build a future where India's skies are powered by technologies designed, developed, and manufactured in India.

"Technology must not only serve our needs today, it must secure our future. In drones, India's self-reliance is not an option; it is a strategic necessity."

- Smit Shah, President, Drone Federation India

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Building the "Bharat Drone Stack Whitepaper 2025" has been a collaborative effort involving experts, policymakers, entrepreneurs and institutional partners who share the vision of building a self-reliant and globally competitive drone component ecosystem for India.

Drone Federation India (DFI) extends its sincere gratitude to the many individuals and organisations that contributed their insights, data and feedback throughout the development of this whitepaper. We especially thank the domain experts from the fields of aerospace, electronics, materials science and strategic policy who participated in consultations and helped shape the document's direction.

We are grateful to the startups, MSMEs, OEMs and research institutions that candidly shared their ground realities, operational challenges and technical perspectives, ensuring that the whitepaper reflects both aspirations and on-the-ground feasibility.

Special thanks to senior officials from central ministries, regulatory bodies and defence agencies for their continued encouragement and guidance in aligning this initiative with India's broader national security and technology objectives.

This whitepaper represents a collective vision and its impact will be driven by the ongoing contributions of India's vibrant drone ecosystem. DFI acknowledges the support of all those who are working to transform this vision into reality.

ABOUT DRONE FEDERATION INDIA

Drone Federation India (DFI) is a non-governmental, not-for-profit industry body representing over 550 drone companies and a network of more than 5,500 licensed drone pilots across the country. DFI works closely with central and state government agencies, regulatory authorities, academic institutions and industry stakeholders to accelerate the adoption, innovation and safe integration of drones into India's socio-economic and strategic landscape.

DFI is committed to enabling India’s emergence as a global hub for drone design, development, manufacturing and services by 2030. The federation actively engages in policy advocacy, technical standardisation, ecosystem development and skill-building to foster a future-ready drone industry.

As a collaborative platform, DFI leads national initiatives, convenes cross-sectoral dialogue and builds institutional frameworks to drive sustainable and secure drone innovation. Its work spans multiple domains, including civilian applications, defence, disaster response, logistics, agriculture, infrastructure monitoring and smart governance.

The Bharat Drone Stack is one such strategic initiative by DFI to address the foundational challenges of component-level indigenisation, to build a self-reliant and globally competitive drone manufacturing ecosystem in India.

EXECUTIVE SUMMARY

India's drone industry is rapidly expanding across strategic and civilian sectors, including defence, surveillance, agriculture, logistics and disaster response. Yet, this progress masks a structural vulnerability: the Indian drone ecosystem remains heavily reliant on imported components, subsystems and critical materials. This dependence restricts the scalability of indigenous drone platforms and exposes the sector to risks from supply chain disruptions, cybersecurity threats and geopolitical instability.

The Bharat Drone Stack is a strategic initiative by the Drone Federation India (DFI) to address these challenges by building a vertically integrated, self-reliant foundation for India's drone technology ecosystem. It envisions a layered stack, beginning with raw materials, progressing through components and subsystems and culminating in complete systems that enable mission-level deployment across key sectors. Each layer must be developed, standardised and validated in alignment with the rest of the stack to ensure system-wide resilience.

The initiative focuses on five core areas: identifying ecosystem gaps and accelerating research; developing certification and recognition frameworks; facilitating domestic and global partnerships; driving adoption through ecosystem-wide engagement; and advocating for supportive policies and incentives. These areas support Bharat Drone Stack's overarching mission of driving self-reliance in drone components and critical materials. The aim is to accelerate India's journey to a fully indigenous unmanned systems ecosystem by reinforcing capabilities across all layers of the stack.

This whitepaper envisions flagship initiatives such as the National Drone Research Platform, a mission-mode initiative to consolidate academic and industrial research for critical drone technologies; the Bharat Drone Stack Network, a collaborative platform of component manufacturers, OEMs, researchers and government stakeholders; the Bharat Drone Stack Conference 2025, a national convening to drive visibility and collaboration; the Component Certification & Recognition Framework, focused on evaluating and promoting indigenous technologies; and the proposed Incentive Scheme for Drone Component Manufacturing, to boost domestic production capacity, attract investment and reduce import dependency.

Together, these initiatives form the foundational pillars of the Bharat Drone Stack initiative, each playing an equally vital role in catalysing research, standardisation, collaboration, visibility and scale across India's indigenous drone components and materials ecosystem. Serving as the blueprint for this national initiative, the Bharat Drone Stack whitepaper sets the strategic context, outlines the systemic challenges and presents an implementation roadmap, inviting the entire ecosystem to co-create India's indigenous drone backbone.

"Self-reliance is not a choice, it is the runway to sovereignty and scale."

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CONTEXT & STRATEGIC IMPERATIVE

India’s journey in unmanned aerial systems(UAS) began in 1983 with ADE’s Project Kapothaka, marking the country’s early exploration into UAS technology. For decades, the technology remained confined to military applications only. Early civilian use of drone technology was scattered and largely ad hoc, driven by sector-specific needs in agriculture, disaster response and infrastructure. While multiple agencies and enterprises piloted drones, there was no cohesive framework to enable scalable adoption, localisation or interoperability.

Recognising the sector’s strategic and economic potential, the Government of India introduced transformative reforms in 2021. The Drone Rules 2021 simplified operational clearances and opened over 90% of Indian airspace as green zones. Complementary initiatives such as the PLI scheme for drones and a ban on foreign CBUs and SKDs spurred domestic manufacturing.
Today, drones are increasingly used to map land parcels under SVAMITVA, empower rural women through Namo Drone Didi, inspect infrastructure, monitor mining, and deliver critical aid in disaster zones.

Yet, the ecosystem remains dependent on foreign flight-critical components, such as GNSS modules, ESCs, flight controllers, onboard processors, datalinks, and motor drivers. These typically integrate both hardware and code, making them difficult to audit and localise. The industry is also reliant on imported battery cells, sensors, motors, and camera gimbals, most of which are sourced from China due to cost and availability.

This open-channel reliance introduces vulnerabilities in cybersecurity, performance, and the supply chain. It also saturates the market with low-complexity assemblers, discouraging innovation and suppressing investment in high-value subsystems.

Operational feedback from missions like Operation Sindoor has highlighted the urgent need for EW-hardened and cyber-secure UAVs. Inconsistent performance of imported parts and the lack of hardened communication and navigation systems compromise mission readiness. The absence of trusted, interoperable, and certifiable components further limits the platform's scalability, as well as the lack of domestic validation infrastructure for testing and integrating critical subsystems.

India's component ecosystem remains fragmented, characterised by isolated innovation, limited standards, poor supplier visibility, and limited long-term investment. While final assembly has scaled with policy support, upstream resilience is still weak.

The strategic imperative is clear: India must build indigenous capabilities across all layers of the drone stack. The Bharat Drone Stack initiative provides a structured national effort to bridge these gaps, reduce dependency, and secure India’s place in the global UAV value chain.

CHALLENGES & GAPS IN THE CURRENT ECOSYSTEM

India's drone journey, despite significant progress in recent years, still faces persistent and structural bottlenecks at the component and subsystem level. These gaps are both technological and institutional, limiting innovation, deepening India's import dependency, and compromising the country's ability to scale secure, indigenous UAV platforms. The following categories outline the core challenges that the Bharat Drone Stack initiative aims to address.

Scarcity of Critical Minerals and Materials: Drone components rely on rare and advanced materials, including lithium, cobalt, neodymium, and gallium. India lacks domestic capabilities to mine or refine many of these inputs, making the country dependent on costly and strategically risky imports. Ministry of Mines in 2023 identified 30 critical minerals are essential for India's economic development and national security. The report also highlights India's complete import dependency for at least 10 critical minerals (like gallium, lithium, germanium etc) out of the 30 identified as essential.

This challenge is marked by:

- No operational lithium mining or refining capacity
- REE-rich monazite sands remaining underutilised
- High cost and supply insecurity for key material inputs

Weak R&D and Academia-Industry Collaboration: India's public and private R&D remains siloed, underfunded, and misaligned with real-world industry needs. Deep capabilities in areas like GNSS-denied navigation, secure communication links, mission computers, and propulsion systems remain scarce. These systems often rely on foreign firmware, creating security and adaptability risks.

Meanwhile, much of the research conducted in academic institutions is generic, fragmented, or misaligned with industry demand. Structured, collaborative R&D platforms are limited, and commercialisation outcomes remain poor.

Key symptoms include:

- Lack of mission-driven research in high-impact domains
- Inability to audit or customise embedded systems due to foreign code
- Weak institutional mechanisms for tech transfer and co-development

Supply Chain Dependence and Import Dumping: India's component market is flooded with low-cost, off-the-shelf imports, mainly from China, that reduce incentives for domestic innovation. These imports are often integrated without verification or traceability. Media reports suggest that between March 2022 and February 2023, India imported drone components like motors, sensors, batteries, and cameras worth $50-70 million, a 53% growth over the previous year

Absence of Component-Level Standards and Certification: While the Drone Rules 2021 provide certification for entire drone platforms, no equivalent framework exists for individual components. This limits trust and scalability within the domestic supply chain.

This gap results in:

- OEM's reluctance to adopt local components due to quality uncertainty
- Barriers to modularity, upgradability, and platform standardisation
- Missed global opportunities due to misalignment with international benchmarks

Fragmented Demand and Procurement Landscape: Component demand is dispersed across multiple sectors with varied requirements, timelines, and procurement processes. Without long-term demand signals or unified procurement frameworks, manufacturers are unable to plan production or justify R&D investments.

This fragmentation causes:

- Absence of anchor buyers or long-term offtake agreements
- Unstable, project-based demand patterns
- Low confidence in scaling production or pursuing cutting-edge development

Investment Barriers and Weak IP Ecosystem: Drone hardware ventures require long gestation cycles and significant capital; however, India lacks a supportive investment and IP ecosystem. Risk capital is limited, and IP protection mechanisms are weak.

Major roadblocks include:

- Limited access to early-stage or patent capital
- Delays in patent approvals and a lack of clarity in patentability
- Weak mechanisms for licensing, IP monetisation, and enforcement

Operational Feedback from Field Deployments: Deployments such as Operation Sindoor have exposed limitations in system integration and performance in real-world scenarios. Crucially, they highlight the absence of structured feedback loops between end-users and developers. Operators often lack formal mechanisms to communicate technical gaps, limiting the speed with which manufacturers can iterate or customise solutions.

Such operational gaps reflect:

- The need for cyber-hardened, ruggedised components
- Weak integration resilience in contested environments
- Poor alignment between user needs and R&D priorities

These interconnected challenges, from raw material scarcity to fragmented procurement and feedback, underscore the need for a coordinated, standards-driven, and innovation-led response. The Bharat Drone Stack initiative aims to address these systemic gaps and build a secure, self-reliant, and globally competitive UAV component ecosystem.

THE LAYERED ARCHITECTURE OF DRONE STACK

To systematically localise and strengthen India's UAV ecosystem, the Drone Stack adopts a vertically layered framework that mirrors the complete lifecycle of drone technology development, ranging from raw material sourcing to final mission execution. Each layer in this architecture represents a critical building block of capability, which, when indigenised, collectively contributes to the resilience, self-reliance, and global competitiveness of Indian drones.

Layer 1: Raw Materials & Advanced Inputs
The foundation of the stack comprises critical minerals and rare earth elements such as lithium, cobalt, neodymium, and gallium. These inputs form the basis for essential materials like composites, magnets, energy storage systems, and semiconductors. Strengthening this layer entails securing mineral access, investing in refining infrastructure, and promoting material science innovation.

Layer 2: Components & Modules
This layer comprises essential drone components, including motors, flight controllers, GNSS modules, ESCs, communication transceivers, sensors, power systems, and electronic boards. It also encompasses firmware, embedded code, and interfaces that ensure component-level functionality and security. Standardisation, validation, and domestic production of these items are vital to gain self-reliance.

Layer 3: Subsystems & Payloads
Subsystems combine various components into cohesive functional units that enable propulsion, power management, navigation, communication, computing, and safety. Payloads include imaging units, LiDAR, delivery mechanisms, and custom tools tailored to specific use cases. The indigenous design of subsystems and payloads enhances modularity and robustness across various mission profiles.

Layer 4: Integrated Platforms
Complete drone systems combine multiple subsystems into a unified, certifiable platform. These systems must adhere to airworthiness, cybersecurity, and reliability norms. Development at this layer includes design for manufacturability, environmental ruggedisation, and integration of open and interoperable standards.

Layer 5: Mission Systems & Use-Case Deployment
Drones operate as part of larger mission workflows at the outermost layer, whether for agriculture, surveillance, logistics, disaster response or military applications. This includes autonomy stacks, ground control stations, edge-cloud connectivity, and data workflows. Indigenous capability at this level ensures India can field drones that are fully secure, interoperable and optimised for its unique geographical and strategic needs.

Together, these five layers represent the whole vertical of India's drone value chain. The BharatDrone Stack initiative targets all of them simultaneously, aiming to reduce systemic vulnerabilities, catalyse R&D and industrialisation, and position India as a trusted source of drone technologies for the world.

WHAT IS THE BHARAT DRONE STACK INITIATIVE?

The Bharat Drone Stack is a strategic initiative by the Drone Federation India (DFI) to strengthen India's capabilities in the design, development and manufacturing of indigenous drone components and subsystems. It serves as a strategic response to the critical gaps outlined earlier to transform India into a supply-side powerhouse in the global drone value chain.

The initiative seeks to catalyse the growth of deep-tech startups and MSMEs within the component manufacturing through a structured ecosystem of certification, procurement linkages and stakeholder collaboration. It brings together government agencies, military leaders, research institutions and industry players to build resilient supply chains that are secure, scalable and future-ready.

Mission-level insights from missions like Operation Sindoor, where domestically developed loitering munitions and ISR drones were deployed in live combat, highlight the strategic necessity of building cyber-hardened, mission-ready and locally manufactured UAV platforms. Localisation of critical components is not just desirable; it is a foundational requirement for national security, strategic autonomy and economic competitiveness.

Vision

To realise the goal of AtmaNirbhar Bharat by achieving 90% indigenisation in drone component manufacturing by 2030 and to establish India as a globally trusted hub for secure, high-quality and self-reliant drone technologies.

The initiative targets a ₹15,000 crore market value for Indian drone components, aims to reduce imports by 75%, envisions the creation of over 5,000 direct and indirect jobs and seeks to build a robust base of more than 500 Indian drone component and material suppliers.

₹ 15,000 Cr	75%	5,000+	500+
Market Value Targeted For Indian Drone Components	Import Reduction Goal In Drone Components	Jobs Creation Direct and Indirect Employment	Indian Drone Component and Material Suppliers

Approach

Identify Gaps & Accelerate Research
The initiative aims to diagnose critical vulnerabilities and unmet needs in the drone component ecosystem and translate them into targeted, mission-oriented R&D programmes. These research efforts are designed to address both technological constraints and strategic requirements emerging from real-world deployment scenarios.

Develop Certification & Recognition Frameworks
Bharat Drone Stack is formulating robust standards and validation protocols for drone components to ensure they are safe, cybersecure, interoperable and globally benchmarked. These frameworks will also recognise indigenous innovations and establish credibility across domestic and international markets.

Facilitate Domestic & Global Partnerships
The initiative creates platforms to connect Indian component developers with domestic drone OEMs and international manufacturers, enabling technology licensing, joint R&D, sourcing partnerships and integration into global supply chains.

Initiate Ecosystem-wide Dialogue for Adoption
Through structured engagement with industry, armed forces, academia and policymakers, the initiative facilitates adoption pathways for indigenous components, aligning product development with user feedback, operational requirements and policy direction.

Advocate for Incentives & Policy Support
Bharat Drone Stack works closely with government stakeholders to recommend procurement-linked incentives, R&D grants and policy interventions that promote long-term investment in domestic drone component manufacturing.

KEY INITIATIVES

The strategic vision under the Bharat Drone Stack initiative proposes a set of flagship programmes and ecosystem enablers. These initiatives aim to strengthen foundational capacities, bridge systemic gaps and institutionalise collaboration for a secure and self-reliant drone component ecosystem.

National Drone Research & Innovation Platform
A mission-mode programme to consolidate and accelerate academic and industrial R&D in critical drone technologies, which include navigation, propulsion, communication systems, sensors and advanced materials. It will also serve as a structured interface between research institutes and industry, to enable co-created problem statements, technology transfer and commercialisation.

Bharat Drone Stack Network & Portal
A verified national consortium of component manufacturers, subsystem developers, OEMs, material innovators and research organisations, hosted on a digital platform. This integrated network will enable visibility, matchmaking and procurement of Indian drone components to foster co-development, supply chain transparency and sourcing efficiency.

Bharat Drone Stack Certification Framework (BDS-CF)
An independent, industry-led framework to codify standards and validate the safety, performance, cybersecurity and interoperability of Indian drone components. It will also facilitate third-party certification, international alignment and support for startups/MSMEs through testing infrastructure and guidance.

Supply Chain Audit & Resilience Framework
A national initiative to audit and classify drone components based on strategic criticality and build a structured framework to enhance sourcing transparency, import vigilance and procurement traceability, to enable end-to-end supply chain visibility and resilience.

Incentive and Policy Framework for Indian Drone Components
A comprehensive package of fiscal and regulatory measures to boost domestic manufacturing, including targeted subsidies, production-linked incentives, increased import duties on localisable components and sunset clauses for certain imports. It also advocates for strict monitoring of trans-shipment pathways to ensure true origin tracking.

Government-Funded Mineral Exploration & Processing Programmes
DFI recommends exploration and refining missions led by GSI, MECL, IBM and PSUs such as NALCO and HCL to secure raw material inputs for high-performance drone components like batteries, motors and sensors.

IP Protection Enablement Scheme
A national support programme to equip innovators with legal, technical and financial resources to safeguard their drone-related intellectual property. The initiative will streamline filings, enhance IP awareness and facilitate licensing and monetisation through institutional backing.

Bharat Drone Stack Conference
An annual convening that brings together industry leaders, defence users, researchers, policymakers and investors to drive visibility, dialogue and actionable outcomes. The conference will focus on component innovation showcases, policy consultations, supplier recognition and strategic partnerships.

Together, these initiatives form the operational blueprint of the Bharat Drone Stack, which translates its vision into tangible, systemic transformation across India's drone manufacturing ecosystem.

CALL TO ACTION

The time to build India's indigenous drone backbone is now.

As the global drone industry evolves into a multi-billion-dollar opportunity with strategic and commercial implications, India cannot afford to remain dependent on foreign supply chains for its critical components. The Bharat Drone Stack is not limited to policy agenda, but presents a national imperative. Its realisation demands collective commitment, decisive policy action and broad-based participation across government, industry, research and investment communities.

We call upon:

- **Government ministries and regulatory bodies** to prioritise policy interventions and targeted incentives that promote indigenous component manufacturing.
- **Industry leaders, OEMs and component innovators** to actively participate in the Bharat Drone Stack Network, adopt certified indigenous technologies and contribute to standardisation and co-development efforts.
- **Academic institutions and R&D centres** to align research with real-world industry needs and participate in the National Drone Research & Innovation Platform.
- **Investors and funding agencies** to support deep-tech hardware startups building critical drone technologies, enabling long-term capability and IP creation.
- **State governments and user agencies** to build demand pipelines, adopt certified indigenous components and create procurement pathways that favour Indian technologies.

Together, we can create a trusted, export-ready and resilient drone supply chain rooted in Indian innovation — one that not only powers our skies but also protects our sovereignty and enables our industries to lead on the global stage.

"We don't just need innovators; we need integrators, implementers, and investors."

CONCLUSION

The Bharat Drone Stack is more than an initiative; it is the foundational blueprint for India's ascent as a global leader in drone manufacturing and strategic autonomy. As the world pivots towards next-generation autonomous systems and digitally connected ecosystems, the imperative for self-reliant, secure and interoperable drone technologies has never been more urgent. India's unique strategic positioning, growing defence and commercial demand and vibrant innovation landscape offer an unparalleled opportunity to lead this transformation.

However, unlocking this potential will require a shift from fragmented efforts to a unified national mission, one that aligns policy, research and industry to achieve critical mass in indigenous capability. This whitepaper presents not only the rationale for such a mission but also a structured roadmap of implementation-ready interventions that can be activated today. These include research platforms, certification frameworks, incentive structures and supply chain resilience models, each designed to close specific gaps in the ecosystem.

Through the focused execution of initiatives under the Bharat Drone Stack, India can drastically reduce import dependency, catalyse component innovation and position itself as a global source of trusted drone technologies. By laying these strong foundations today, the Bharat Drone Stack ensures that India is not merely a consumer of drone technology but an architect of its future.

"The future of unmanned systems will be written by those who build them, and build them right."

Building Bharat Drone Stack

A Blueprint for Self-Reliance in Drone Components and Critical Materials

India's vision to become a global drone hub by 2030 demands a robust, indigenous backbone of drone components, subsystems, and materials. The Bharat Drone Stack is a strategic initiative by **Drone Federation India (DFI)** to transform India from a net importer to a trusted global supplier of secure, certified, and scalable drone technologies.

This whitepaper lays the blueprint for strategic interventions across certification, R&D, supply chain resilience, and industrial collaboration — enabling India to build a future-ready drone ecosystem that is not only self-reliant but globally competitive.

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