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GOVERNMENT OF INDIA

Azadi Ka Amrit Mahotsav

FICCI

# ACHIEVING EXCELLENCE IN DEFENCE GRADE DRONES

## AIR FORCE STATION, YELAHANKA, BENGALURU

2023

AERO INDIA

# Background Paper

# Achieving Excellence in
# Defence Grade Drones

2023
AERO INDIA

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# DEFENCE GRADE DRONES

AIR FORCE STATION, YELAHANKA, BENGALURU

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# Introduction

Global trends show that the development, procurement, and adoption of Defence Grade Drones is exponentially increasing. This is primarily driven by the following reasons.

**Rising Conflict:** Geopolitical trends indicate an exponential rise in conflicts worldwide due to various reasons like economic disparity, control over natural resources, labour pools, supply chains, transportation routes and global markets.

**Rising Costs:** There has been a steep rise in the economic and political costs of conventional warfare. Lower military recruitment, higher equipment and consumable costs and higher logistics costs are acting as an economic deterrent.

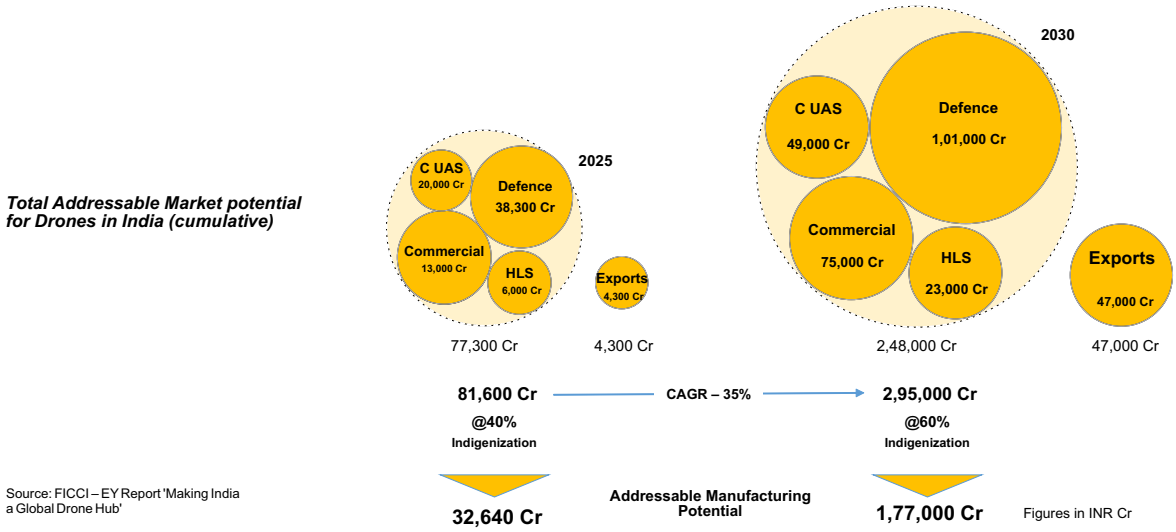
**Changing Tactics:** High costs have caused military leadership to develop alternative tactics for selective, targeted, and limited engagements with potentially lesser consequences include lower costs, higher precision, minimal escalation risk, slow enemy attrition, and plausible deniability.

**Enabling Technology:** The availability of cutting-edge technology, smartphones & internet adoption and other specific technology used for drones is accelerating the development of defence drones. Components like batteries, edge compute, cameras, sensors, cellular and wi-fi were miniaturized rapidly and manufactured at massive scales. More data and processing power drove advances in software including machine learning and AI.

# Market for Defence Drones

## Drones in India – a US$ 40 Billion Addressable Market

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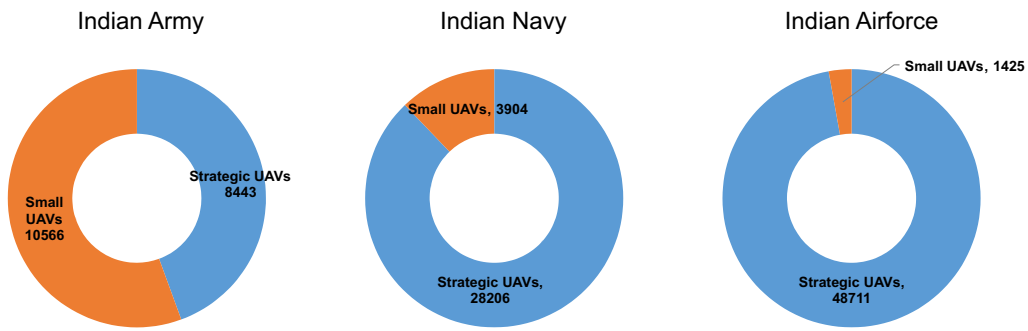

Source: FICCI – EY Report 'Making India a Global Drone Hub'

These are indicative market potential figures based on FICCI Drone Working Group and EY Study

As per FICCI-EY study, India has the unique opportunity to realize approximately INR 1.8 Lakh crore of aggregate domestic manufacturing potential through focused implementation of drone indigenisation projects, across defence, commercial, homeland security and counter UAV sectors. Defence sector is one of the major contributors to this potential.

Following graph shows drone manufacturing potential in all three defence forces.

## Drone Manufacturing Potential - Defence




Figures in INR Cr

Source: FICCI – EY Report 'Making India a Global Drone Hub'

Note: Small UAVs include Micro, Mini, Nano, Loitering Strategic UAVs include MALE, HALE, Tactical

# Tactical Advantages of Defence Grade Drones

**Unmatched Versatility:** Defence drones can augment almost all tactics such as:

- Surveillance
- Patrolling
- Reconnaissance
- Delivery
- Clearance
- Distraction
- Extraction
- Offensive tactics
- Defensive tactics
- Encirclement (swarm)

**Sizing:** From tiny microdrones weight less than 100g to cargo drones weighting over 500kg, defence grade drones can be appropriately sized for specific tactical use cases. Technology at all sizes has been de-risked, supply chains built, and manufacturing capability is available globally.

**Area and Time Scalability:** While defence grade drones can be operated individually, onboard connectivity offers the ability to operate them in a swarm. Their operations can be appropriately scaled from small to large area coverage. Onboard data and compute ensure that mission parameters are easily transferred from one to another. This offers the benefit of time scalability with multiple drones replicating the same mission over longer durations.

**Human Safety:** Most important of all, defence drones decrease the risk of soldier injury and fatality by augmenting or directly replacing boots on the ground. No other military technology is better suited because defence drones offer better proximity, stealth, speed control, and payload versatility.

# Security Risks of Imported Defence Grade Drones & Subsystems

While the Government is promoting Aatmanirbhar Bharat, there is procurement and use of foreign sub-systems and critical technologies in defence grade drones. Many of the indigenous drone manufacturers are using critical sub-systems (Camera payloads, auto-pilot, communication devices, etc.) which are imported from neighbouring countries. This is a serious security hazard because they have the capability to tamper with the drones having these critical sub-systems.

Armed Forces are rapidly leveraging the strategic advantages of defence grade drones by inducting new multi-capability drones across all branches. While such technology / critical sub-systems are available globally and could be imported, there are several security risks posed by imported drones.

**Spying Risks:** Imported defence drones could help foreign actors spy on tactical operations in real time by sharing video, audio, imaging and textual data, such as:

- Theatre data including location, engagement types, adversaries.
- Troop data include strength, hierarchy, movement, tactics etc.
- Equipment data including strength, capabilities, and current operating modes etc.
- Logistics data including storage, transportation, inventory, replenishment cycles etc.
- Infrastructure data including location, types, size, scale, usage frequency, modes etc.
- Communications data including location, types, capabilities, protocols, messages etc.
- Countermeasures data including physical and electronic capabilities, current countermeasure deployment, performance, success rates etc.

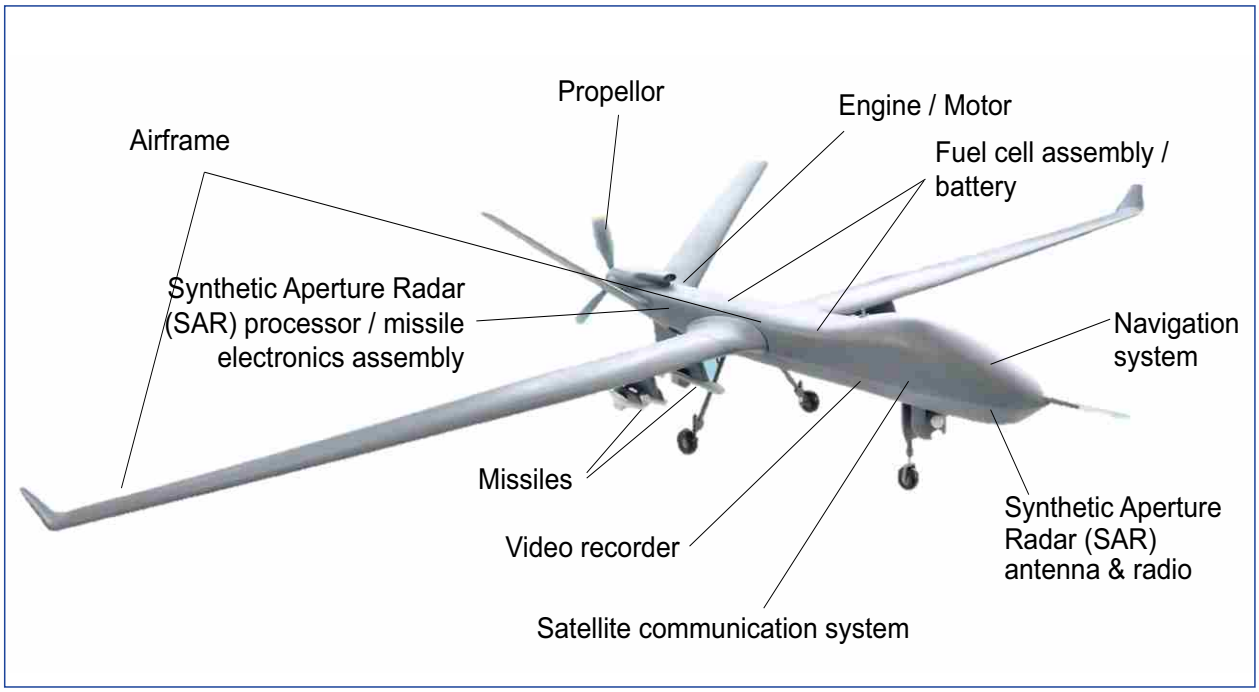
**Destruction Risks:** Concealed physical and digital payloads like malware could be activated causing injury, damage, or sabotaging missions.

- ***Detection Difficulty:*** The biggest challenge with concealed capabilities is the difficulty in detecting them. Defence Grade Drones are complex with multiple sub-systems comprising hundreds of components. It is very difficult to audit defence drones at a component or substrate level to detect compromised technology.

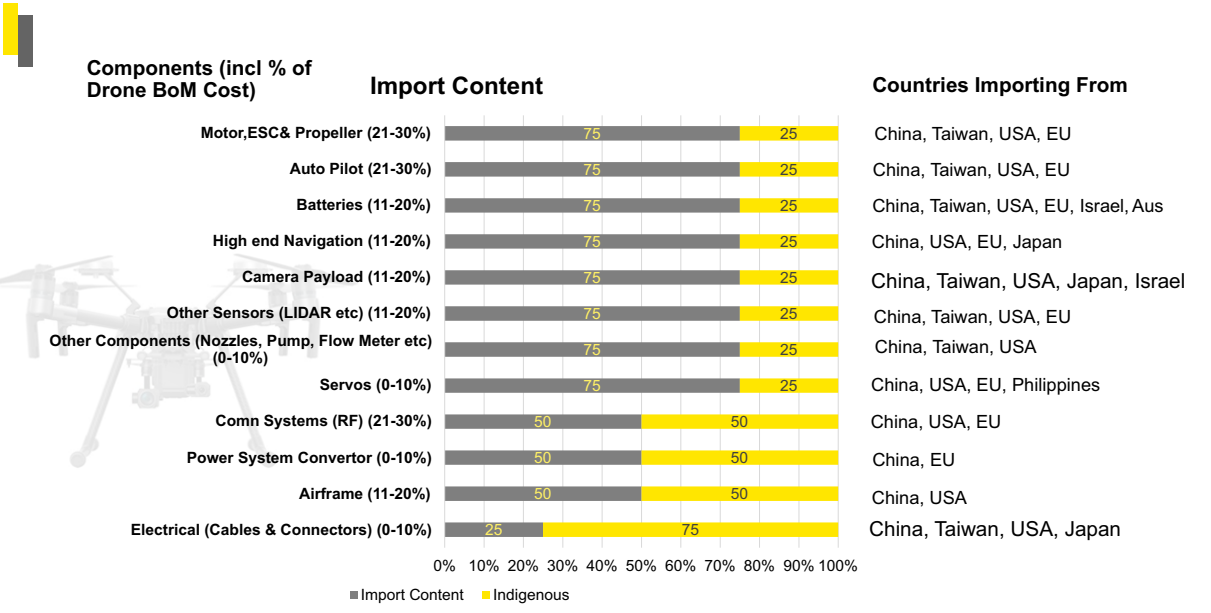
- ***Remote Control:*** capabilities could help foreign actors constantly change the targets and spying methods and make countermeasures reactive. Remote control could also be used to completely disable Defence drone remotely.

There have been instances that some critical active components coming from some specific countries have had security loopholes, leading to compromise in critical military data of National importance. Taking cognizance of this serious security issue, the Government has banned the usage of critical subsystems from countries sharing land borders with India. ***Considering these risks, indigenisation is the way forward.***

# Key components of a Defence Grade Drone




**Major part of the Bill of Materials (BOM) of drones consists of imported components today, with China being a major supplier of the drone BOM.**



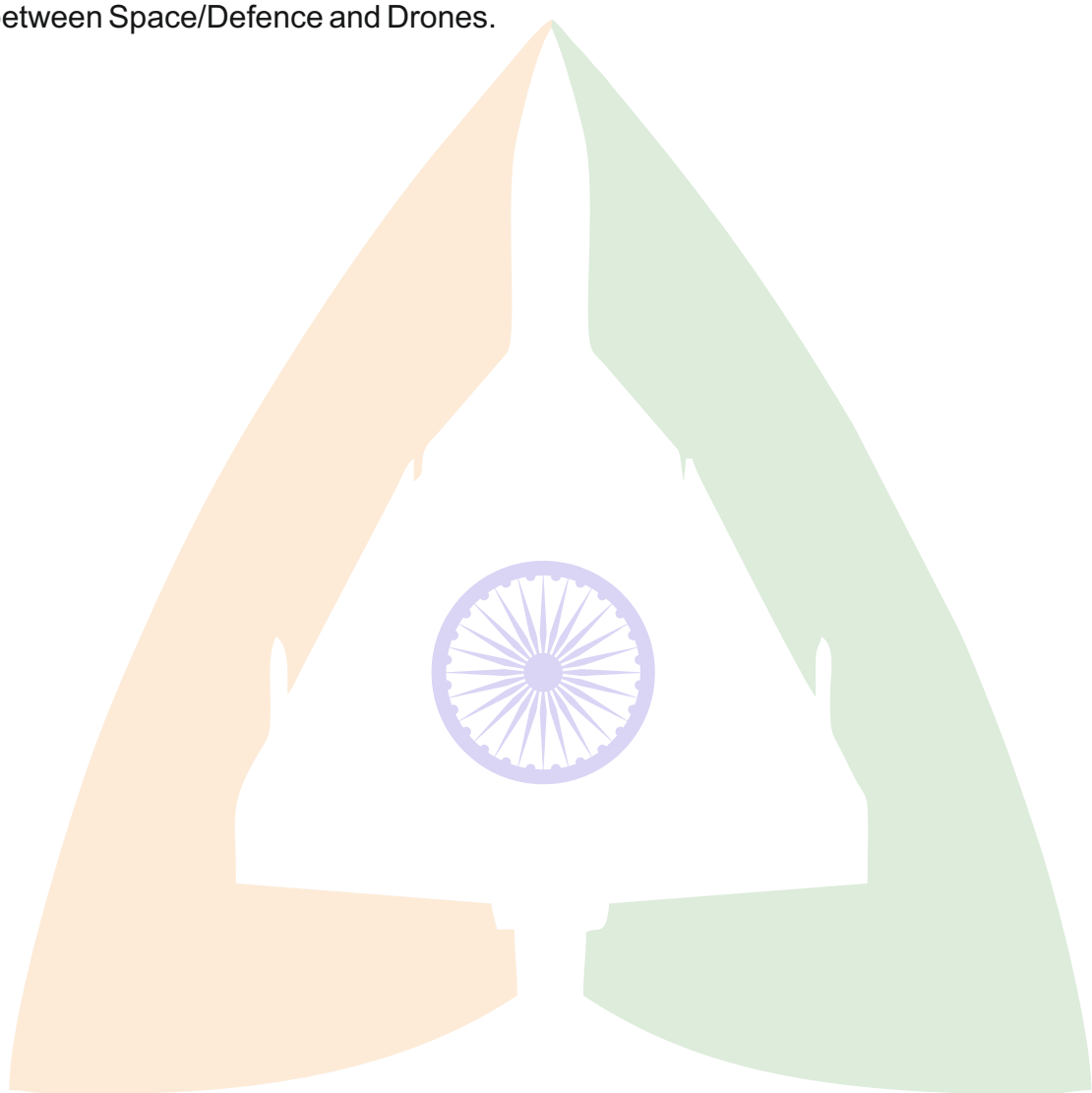

Source: FICCI-EY Report – Making India a Global Drone Hub

According to the recent survey conducted by FICCI on component level with drone manufacturers & service providers, it was found that -

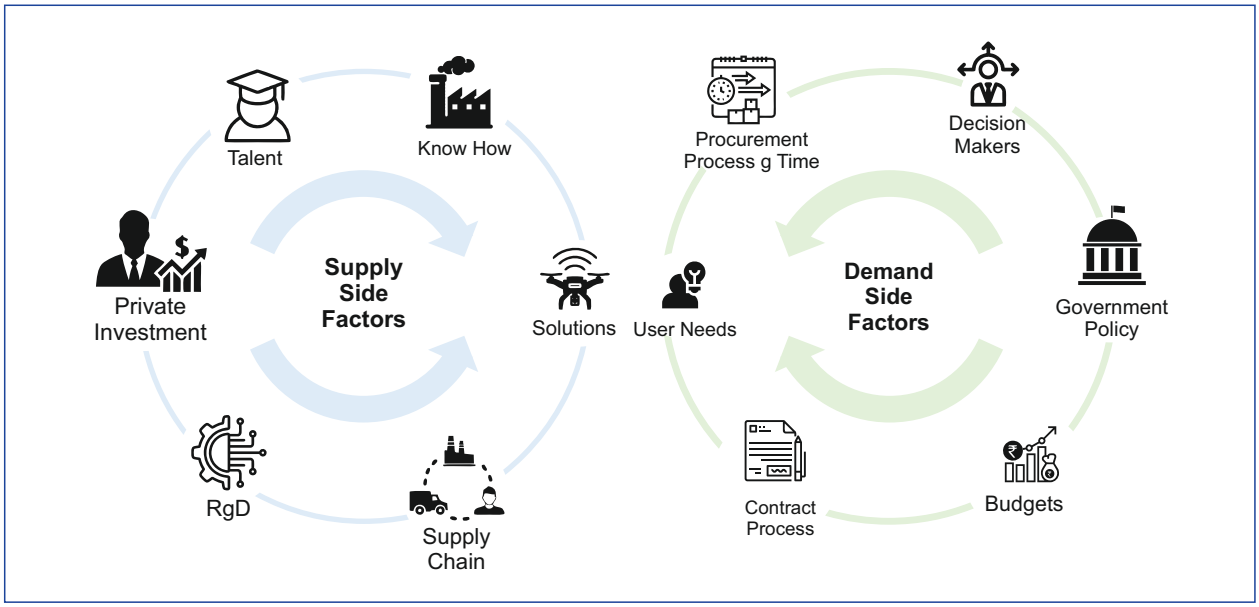
- Strong opportunities in 3 areas - battery, airframe & motors for drones, however industry needs to find out aggregated demand with other associate industry volumes to build a case for local manufacturing of battery cell, carbon fiber and light weight BLDC motors for drones.

- Components like Auto Pilot, High end Navigation, LIDAR/RADAR, which are heavily dependent on chips & sensors are not being manufactured in India and could be seen as long-term focus areas.

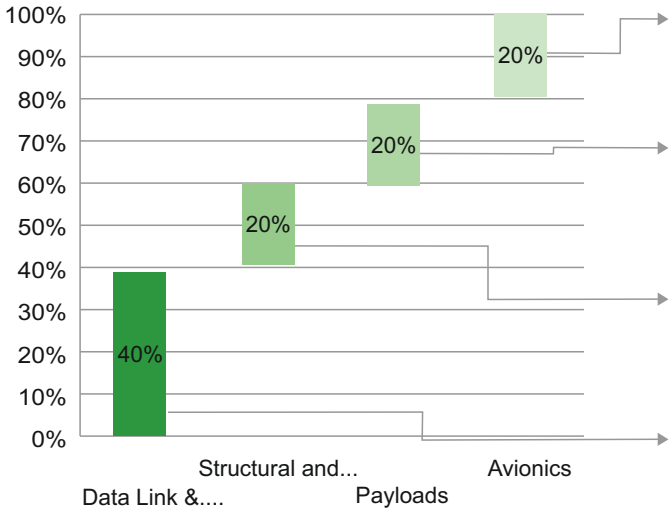
- Tremendous opportunity to localize for non-static imagery cameras, thermal imagery, migration proofing and optics and electronics level. Collaboration could be explored between Space/Defence and Drones.



# Ecosystem of Defence Grade Drones




**Key components in manufacturing value chain**




What are our challenges in the Defense and HLS Drone manufacturing ecosystem?

- **Controlled by strategic suppliers-** Key flight control systems capabilities are tightly controlled by few foreign suppliers - e.g/, powerful onboard computers and their associated software
- **Limited capabilities in payloads-** Covers~20% of defense drone systems. Manufacturing capabilities will need to enhanced through transfer of Technology (ToT) arrangements
- **Labor intensive value addition-** Covers~20-30% fo defense drones. Currently value addition done after importing raw materials - e.g., Composite Airframe structures. Potential to enhance the scale of through indian manufacturers
- **Mature Capabilities-** Reasonably matured indigenous capabilities which serve not only indian customers but enable defense exports as well.

# Indian Defence Grade Drone Programmes

In view of the increasing importance of drones in gaining strategic edge and operational excellence for defence forces, Government of India has initiated drone development programmes in order to achieve atmanirbharta (self-reliance) for making and upgrading defence grade drones in India. Defence forces, PSUs, academia and industry collaborated in developing some of the path-breaking unmanned / remotely piloted and autonomous aerial platforms to be deployed by forces. Such key flagship programmes include -

## Combat Air Teaming System (CATS) program

CATS is an automated-operated unmanned drone developed by HAL with an investment of INR 400 million. The Combat Air Teaming System will be valid for the Indian Navy and Indian Force. The twin-seated HAL Tejas is the mothership aircraft. Government organisations like National Aerospace Laboratories (NAL), Defence Research and Development Organisation (DRDO) and industry have contributed to it.

## RUSTOM-1

RUSTOM-1 is an all composite, 800 kg class Short Range Remotely Piloted Aircraft System (SR-RPAS) having capabilities of Intelligence, Surveillance, Reconnaissance, Target Acquisition/ Tracking and Image Exploitation. Rustom-1 is the first Indian RPAS to have conventional take-off and landing capability. It has autonomous flight mode and Get-To-Home features. Rustom-1 RPAS has completed 65 flights and demonstrated flight endurance of 10 hrs, range of 200 km and an altitude of 20,000 ft. Up-gradation of SR-RPAS with Automatic Take-off & Landing (ATOL), Synthetic Aperture Radar (SAR) and Store carrying capability is achievable.

## Archer

Archer short range armed UAV is based on Rustom 1 and can be classified in the same category as Turkey's Bayraktar TB2 that has played a key role in wars in Ukraine and Azerbaijan. It is expected to have a range of 220 km and endurance of 12 hrs. It would carry 4 air-to-surface anti-tank missiles developed by DRDO or laser guided rockets.

## Tactical Airborne Platform for Aerial Surveillance-Beyond Horizon-201 or TAPAS BH-201

TAPAS BH-201 is a Medium Altitude Long Endurance (MALE) unmanned aerial vehicle (UAV) being developed in India by Aeronautical Development Establishment (ADE) on the lines of General Atomics MQ-1 Predator. The first flight of the UAV took place in November 2016. TAPAS BH-201 has a range of 250 km and is capable of carrying out day & night missions. It can carry payload of upto 350 kg and is designed to perform intelligent gathering and surveillance operations. As per a recent report, it achieved a milestone of reaching an altitude of 28000 feet and endurance of 18 hrs. Work is in progress to further increase its capabilities.

## Ghatak

Ghatak is an autonomous jet powered stealthy Unmanned Combat Air Vehicle (UCAV), being developed by Aeronautical Development Establishment (ADE) of the Defence Research and Development Organisation (DRDO) for the Indian Air Force. The design work on the UCAV is to be carried out by Aeronautical Development Agency (ADA). Autonomous Unmanned Research Aircraft (AURA) was a tentative name for the UCAV. The DRDO Ghatak will be having an internal weapons bay to carry a variety of Missiles, bombs, and munitions. This UCAV will be powered by a turbofan engine of GTRE, DRDO. Ghatak UCAV will be integrated with Onboard Computers, Secured data links, friend and foe identification systems, and fire control systems. The service ceiling is expected to be 30,000 ft. Its design will be based on flying-wing concept, and will be powered by a turbofan engine. The first flight of a scaled down Stealth Wing Flying Testbed (SWiFT) was carried out in July 2022, and that of a full scale prototype is expected in 2025. SWiFT, a "scaled-down version" of Ghatak demonstrated the stealth and high-speed landing technology in autonomous mode.

## Logistics Drones

A Logistic Drone (LD) is used for 'last mile' transportation of items. Payloads would include rations, medical supplies, documents, equipment spares, military equipment and ammunition. They could be autonomous/manual or a combination of both these flight modes. These drones would have 'return home' capability - a 'failsafe' mechanism that allows the LD to return to a pre-fed 'home' location when there is an undesirable change

in flight parameters or when directed to do so by the remote controller. LD are normally operated as part of a logistics UAV fleet, to ensure uninterrupted logistics sustenance to deployed forces. These could be Single/Multi-Rotor/Fixed-Wing/Fixed-Wing Hybrid Vertical Take-Off and Landing (VTOL). While Multi-rotor and hybrid VTOL drones have more stability, greater payload capability and lesser requirement of real-estate for landing/ delivery of cargo, Hybrid VTOL drones can offer greater speed and lesser noise during fixed-wing flight.

Logistic drones as per the requirements of the Ministry of Defence (MoD) are expected to be compatible with Defence Series Map and Shape file format with a mission range of not less than 10 km. The drones should consist of one audiovisual per system, one MPGCS, one colour day video camera, a Monochromatic night Thermal Sensor, a container for carriage of stores and one set of a spare battery. Weight of the drones should not be more than 100 Kg (+10%) but suitable to withstand high altitude strong wind currents/ gusts. The endurance of both the drones should be minimum of 40 minutes with a payload capacity of about 15 Kg for High Altitude drone and not less than 20 kg for the medium altitude drone. In medium altitude, the operational altitude should be 3000m AMSL and 1000m AGL.

**Swarm drones:** Indian Army initiated a Make II case for acquisition of Autonomous Surveillance and Armed Drone Swarm (ASAD-S). The induction of IDDM swarm drones into its mechanised forces describing it as a "niche" and "disruptive technology". The Army said the drones will provide an "edge" in meeting future security challenges.

India's swarm drone system is equipped with cutting-edge technology that can identify targets using artificial intelligence-driven software. The drones consist of a number of drones controlled from the same station which can be programmed using an algorithm to carry out various tasks including surveillance.

# Issues Concerning Indigenisation

## Investments

Private sector investors perceive defence as risky business because of a single end customer, which is Government with unique requirements, complex decision making, unpredictable budgets and lengthy procurement processes. The numbers ordered by the Indian armed forces and CAPFs are normally small and based on their unique requirements, which adversely impacts the economic viability of the design and development projects. Most private sector entities are reluctant to accept indigenous designs for production, which have no economic viability in the long run.

## Financial Constraints

Start-ups and MSMEs often come up with innovative and unique designs and technological solutions, which can meet the requirements of the armed forces as well as provide them a technological edge. However, they are expected to pledge a certain minimum amount of capital to be eligible for supplying products to defence PSUs, which they may not have. They also face difficulty in raising the working capital after winning the contracts.

## Procurement Process

Most defence suppliers echo the message that the current procurement process has long lead times, especially for trials, with no guarantee of purchase and no compensation for Product Development effort put in. The procurement system could be improved by ensuring predictable timelines, consistent selection process and some progress tracking through the system. In addition, it is desired that there is a Demand Aggregation and Forecast by MoD based on the requirements of all the forces pertaining to drone & related systems, which would help industry with their investments and development plans.

## Lack of Skilled Resources

There is a critical shortage of talent required to design and engineer drones, and specifically for Defence grade drones. This includes several specialized areas like advanced materials, avionics, edge computing, sensor engineering, tactical systems, armour systems, ML/AI, etc.

## Drone Testing Sites

Drone testing infrastructure is a critical part of the innovation infrastructure, as it provides a safe space for drone manufacturers and researchers to test technologies in real-world scenarios. Support is required across various layers:

- The government should establish a Central framework for states to apply for testing sites.
- Test sites can even be revenue generators while accelerating development and testing of UAV and C-UAV technologies
- It is imperative to leverage PPP models by states to incentivize investments to set up, operate and maintain the test sites.

## Push to localisation of Components

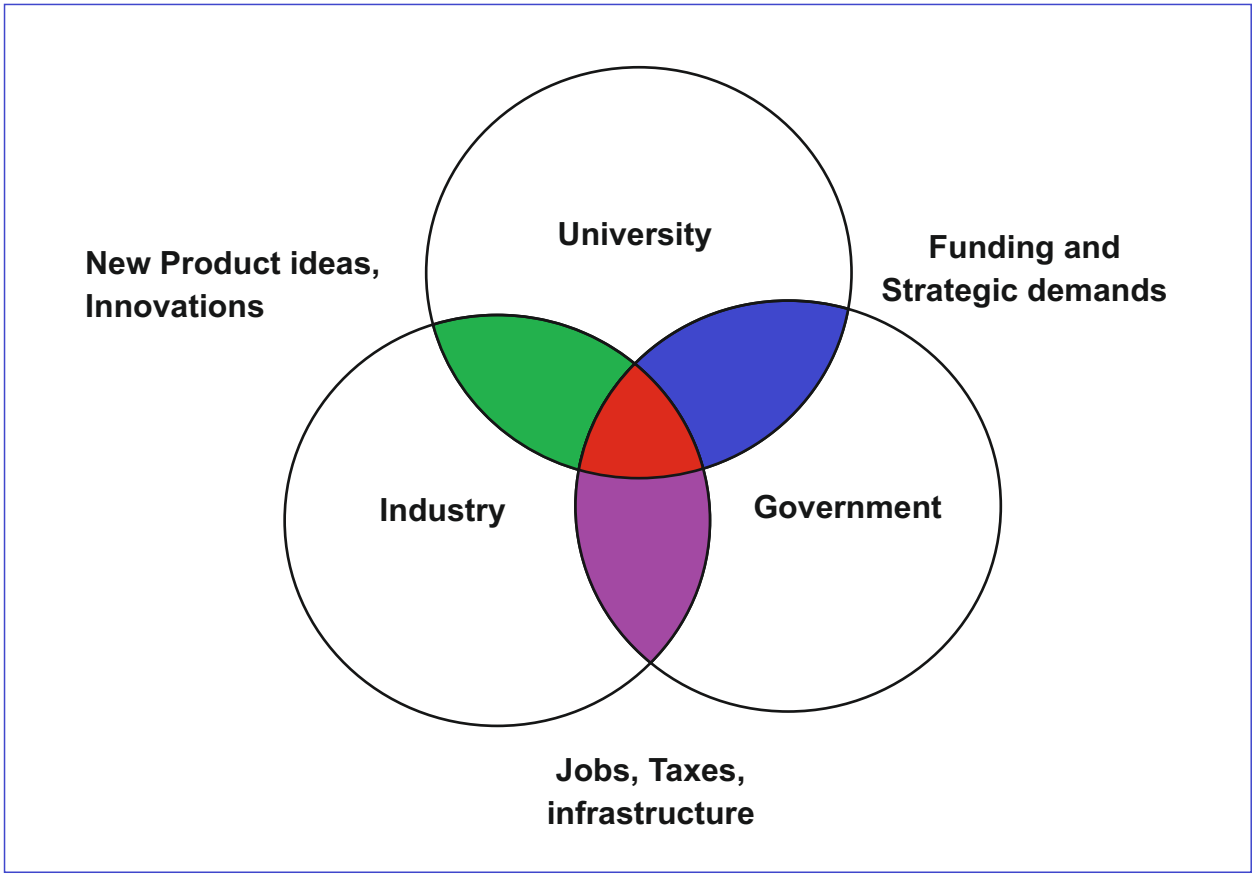
Government to support local manufacturing of components and value addition. There are strong opportunities in components like battery, airframe and motors for drones, which is visible along with demand emerging from other associate industry to build a case for local manufacturing of battery cell, carbon fiber and light-weight BLDC motors for drones. Long-term focus areas remain other high-value components like Auto Pilot, Navigation, LIDAR/RADAR, which are heavily dependent on chips and sensors and are not being manufactured in India.

## R&D and Innovation

Innovation is the key to build intellectual property. Indigenisation of defence grade drone manufacturing requires accelerating innovation and building Indian unicorns. To this end, there must be a modality to incentivize innovation. Support from the government would be required for:

- Creation of a dedicated fund to provide Grants for research in drone enabled technologies and policies
- Deployment through incubation centers for growth of indigenous drone related IPs and startups.
- Funding (via fund of funds) to scale the share of Indian ecosystem across drone technology and manufacturing value chain.

- Subsidizing skilling costs for training and development of human resources.
- Set up a mechanism for transformation of innovation into commercially viable products to bridge the gap between prototyping and production.
- Set up accelerators for innovation and growth of indigenous drone-related IPs and startups.




In order to further push R&D in defence grade drones, triple helix approach should be followed, involving all actors.

# Indigenisation Initiatives

## Bravo Tango UCAV (Unmanned Combat Aerial Vehicle)




Bravo Tango is a unique tandem wing configuration, capable of short takeoff and landings the large 12 meter combined wing span gives it the advantage to carry large payloads with a big endurance in its class.

This compact size UCAV delivers a big punch, deep into enemy territory with a choice of payloads or a more impactful role as a loitering missile. Bravo Tango is ready, in the shortest time with a top speed of 250 kilometer per hour and a range of 1,000 kilometers, remain airborne for over 20 hours and carry payloads twice its own weight. Bravo Tango employs some of the latest guidance navigation systems and cutting edge communication and vision computers onboard.

Bravo Tango is capable of self-assigning targets, track in and destroy. Small and proudly made in India.

## Ajeet Mini

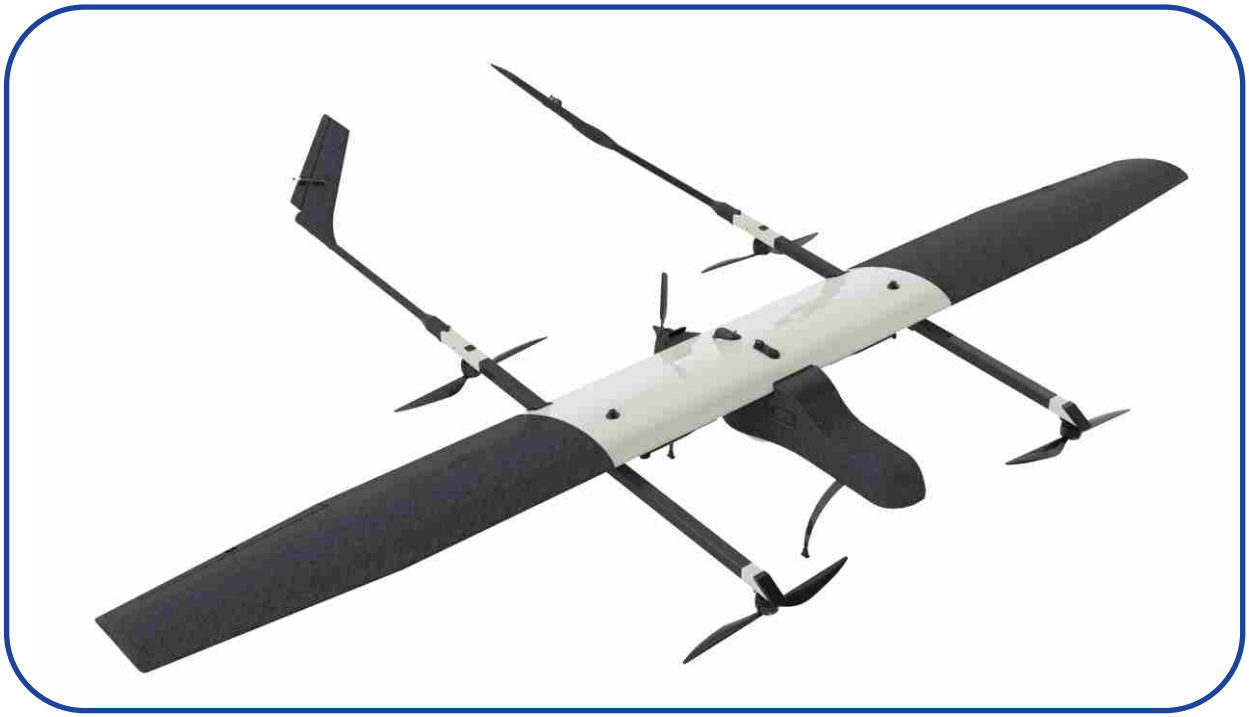



Ajeet Mini is the Indian drone that is powered by India's fully Aatmanirbhar Autopilot NavGati which has a far smaller footprint and lower weight as compared to opensource autopilots being used.

It is fully indigenous  drone designed from ground up with compactness and lightweight in mind . Every single component that goes into the making of Ajeet is designed with mass manufacturing, ease of use and user experience.

Weighing in between 1100 - 1600 grams in weight depending on the variant with an operating range between 0.5 - 1.5 kms at international level competitive pricing Ajeet Mini is turning out to be a secure Indian drone of choice for frontline troops across India with the trainer version waiting in the wings to jump start the Indian drone training ecosystem.

## SWITCH UAV



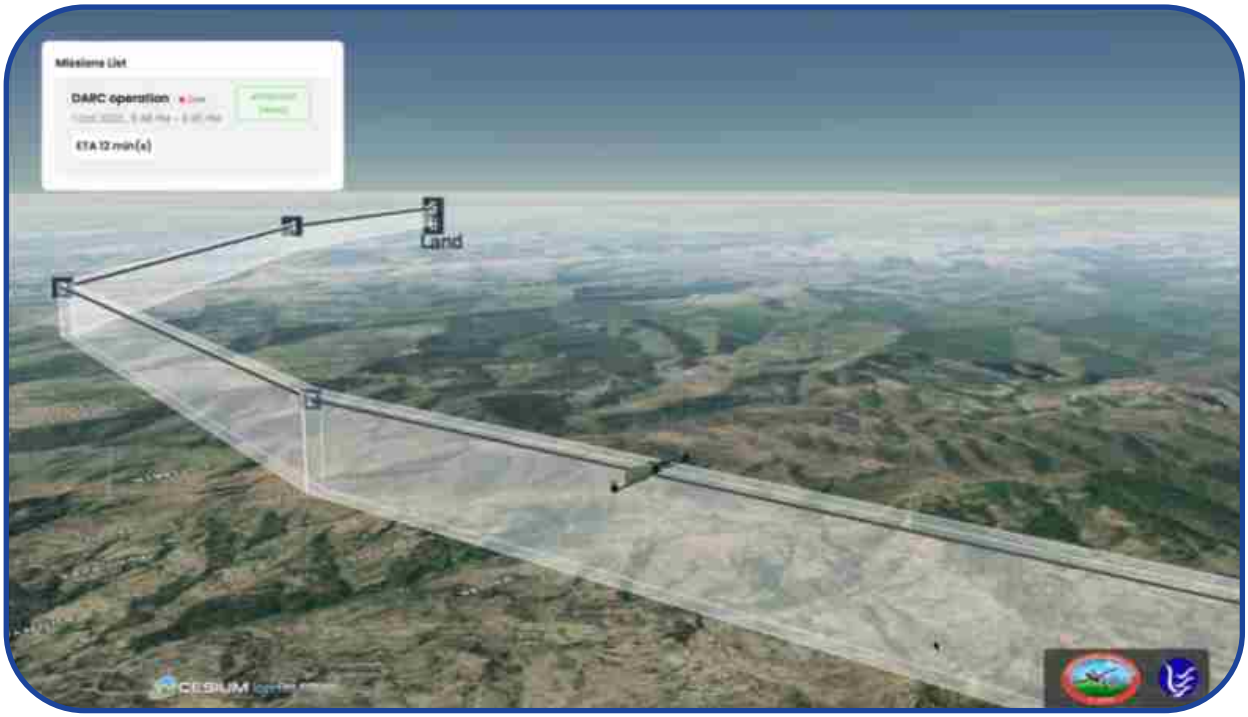
SWITCH UAV is a first of its kind VTOL and fixed wing hybrid Uncrewed Aerial Vehicle. Being an all-terrain dominator, SWITCH features advanced flight time, higher safety, and simple operation with additional fail-safe redundancies. It is used for long range, high endurance last mile surveillance and security operations. It can be deployed seamlessly at high altitudes and in harsh environments for day and night surveillance in intelligence, surveillance, and reconnaissance (ISR) missions.

## A410-XT



The A410-XT UAV is a vertical take-off and landing small UAV with best-in-class endurance and versatile payload capabilities for intelligence, surveillance & reconnaissance missions. Boasting a flight time of more than 60 minutes with maximum payload, a range of more than 5 km, and secure encrypted communications, the A410-XT provides persistent coverage of large areas of interest. The A410-XT can be equipped with high resolution electro-optical, thermal or dual payloads providing outstanding surveillance capabilities as an eye in the sky. The UAV has been used at altitudes more than 4500 meters above mean sea level making it a true workhorse operable in all terrain regions.

## Sky UTM




Skye UTM is a cloud-based Aerial traffic management system that stitches unmanned air traffic with the manned aviation airspace. Skye UTM is the most advanced and indigenised Aerial traffic management platform that has been built towards providing situational awareness, autonomous navigation, risk assessment, and traffic management to all drone/other aerial mobility operators across the airspace. Skye UTM has already supported 300+ successful BVLOS (Beyond Visual Line of Sight) drone flights till date. The Skye UTM captures more than 255+ parameters of UAV movements and stores them into its 'Blackbox' which is a published systematic description of the entire flight. The platform offers the first 3-Dimensional view of the drone airspace along with operations and regulations mapping servers which offer the latest airspace status, verified paths, and display real time UAV movements. The platform offers Regulatory access to Air Traffic Controllers and other regulatory authorities allowing them to have real-time drone traffic movement information, pilot information and other necessary data for evaluation and coordination. Skye UTM introduced its proprietary tunnel-based navigation system for autonomous navigation across multiple air corridors for defined application segments. The tunnel-based navigation utilises a 3-dimensional map of the corridor and overlays the infrastructure and slender obstacles to provide accurate information to the drone operator for avoiding collision and enhancing air safety.

## Quick Reaction Loitering Missile (QRLM)



Indigenous (IDDM) Quick Reaction Loitering Missile (QRLM) and Launcher with more than 90% Indigenous Hardware was developed in 24 months with the following scope of development:

- Design & Development, Manufacturing and Testing of QRLM involving Air vehicle, Autonomous flight controls, Communications, Turbo jet engine Power plant
- High energy hydro-pneumatic launcher
- Ground Control station

| PARAMETER | VALUE |
|---|---|
| All up weight | 120 kgs |
| Speed | 220m/s (792 Kmph) |
| Endurance | 60 Mins |
| Range | 500 Kms |
| Payload | 30 Kg War Head |

# Key Questions

Drone ecosystem comprising public and private R&D efforts, manufacturing of select components & sub-systems and development of value chain have started taking shape in India. There is a need to leverage this knowledge pool with experience and expertise in diverse fields of technological development, adoption and applications.

There are some key issues for drones sector to find a way through, which needs critical thinking. Some of the key questions that can be addressed through collaborative efforts of government, industry and academia are -

- Is there a need to change the IC Performa of DAP 2020 to further the cause of Indigenisation?
- Which specific areas should be earmarked for R&D initiatives?
- Are the QRs being given in the RFIs realistic and is the drone industry taken on board?
- What hand holding can the MoD do further than the already announced measures in terms of policy, regulations, investments etc.?
- How can the big industrial and corporate houses further the cause of achieving Indigenisation and make India a Drone Hub by 2030?
- What is the role of PSUs in R&D, and what drives innovation roadmap?
- What lessons can be learnt from other drone manufacturing countries like Switzerland, Turkey and Iran?
- How does India project itself in the mid and long term for export of high-quality drone?
- Is the drone industry doing enough as far as IPR or patents is concerned. Is there any incentive for patents in the sector?
- Has the PLI scheme energized the drone sector. Is it sufficient or more needs to be done?

# Contributors

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