TAKSHASHILA INSTITUTION

CHINA'S APPROACH TO MILITARY UNMANNED AERIAL VEHICLES AND DRONE AUTONOMY

Takshashila Discussion SlideDoc - September 2023

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* The author would like to acknowledge the research support provided by Manoj Kewalramani and Aditya Ramanathan.

EXECUTIVE SUMMARY

Unmanned Aerial Vehicles, largely referred to as UAVs or drones in this document, have become all the rage in performing a host of military and defence-related functions, including Intelligence, Surveillance, and Reconnaissance (ISR), ground attack, and countering electromagnetic interference from the enemy. Chinese military policy is paying significant attention to the development and deployment of drones around the world, and is deploying its own 'Military-Civilian Fusion' (MCF) strategy to create a drone industry capable of meeting the demands of modern warfare.

This also includes equipping drones with autonomous and Artificial Intelligence (AI)-enabled systems, in a quest to achieve the goals of 'intelligentised' warfare. This document assesses Chinese military policy on UAVs. It further details use cases of contemporary Chinese drone systems in military training, dogfighting, electronic countermeasures, and ISR, among others. It also identifies some Chinese drone systems with autonomous capabilities. In its annexure, the document discusses drone types and stakeholders involved.

In addition, this document studies drone deployments in the PLA Western Theater Command, the structural constraints faced by the Chinese military UAV ecosystem, and potential future points of emphasis for China's efforts in the domain.

CHINESE DOCTRINE ON INTELLIGENCE AND AUTONOMY IN MILITARY UAVS

SASTIND'S AMBITIOUS DEF-TECH INDUSTRY PLAN

- In June 2015, the **National Defense Science and Technology Industry 2025 Plan** (国防科技工业 2025) was released by the Chinese State Administration for Science, Technology and Industry for National Defense (SASTIND).
- This Plan discusses an 'Internet + Manufacturing' model for the national defence science and technology industry.
- It also attaches fundamental importance to integrating the processes of 'informatisation' and 'intelligentisation' in the 'Make in China 2025' programme.

SASTIND'S AMBITIOUS DEF-TECH INDUSTRY PLAN

- The Plan was followed up with 'Opinions on promoting the transformation of defence science and technology achievements in the defense science and technology industry'.
- This 'Opinions' document was issued by SASTIND in 2016 to encourage private player participation in domestic manufacturing of advanced defence technologies (like UAVs).
- In 2015 and 2016, SASTIND also issued Strategic Action Plans (SAPs) to achieve full implementation of CMI in high-technology defence equipment, such as UAVs.

EMPHASIS ON CIVIL-MILITARY INTEGRATION

- Cooperation between Civil (Industry) and Military (军民融合) is at the core of China's quest for the advancement and ‘intelligentisation’ of weapons systems suitable for future combat.
- Xi Jinping has taken personal responsibility for the implementation of this agenda, leading the Central Committee for Military-Civil Fusion Development (国家军民融合发展委员会), which was established in January 2017.[1]
- In China’s context, the civilian drone industry is much more vibrant than the industry for military drones.
- Analysts (Romaniuk and Burgers, 2018) even suggest that China is at par with, or even ahead of the other leading actors in the industry, such as the US and France.

EMPHASIS ON CIVIL-MILITARY INTEGRATION

- But in the defence sector, China is only starting up and its drone programme may be considered at par with some of the other developing countries.
- As a result, there is an emphasis on integrating the capabilities of the civilian and military sectors, especially in critical defence technologies like UAVs.
- An example is the private Chinese firm GalaxySpace, which is deploying its expertise in satellite communications to advance China's hypersonic aircraft programme. In this regard, the firm is preparing to provide broadband services for hypersonic drones.
- *Many similar examples will become evident in the course of this document.*

NEW GENERATION AI DEVELOPMENT PLAN

- China's '**New Generation Artificial Intelligence Development Plan**',[2] unveiled in July 2017, clearly sets out that achieving breakthroughs in AI in defense systems is a national priority.
- It designates intelligence in "autonomous unmanned operating systems" as a key technology.
- In doing so, it encourages the development of test environments for open, modular, reconfigurable unmanned systems.

NEW GENERATION AI DEVELOPMENT PLAN

- The three types of major AI innovation platforms the Plan accounts for are ‘group intelligent service platforms’, ‘hybrid augmented intelligence support platforms’, and ‘autonomous unmanned system support platforms’.
- Under the third category, a specific area it accounts for is enabling ‘autonomous collaborative control’ in unmanned systems.
- This refers to the ability of a swarm of unmanned systems like drones to cooperate with each other and accomplish joint tasks in a rapidly evolving environment, without support from human intervention.

THE SCIENCE OF MILITARY STRATEGY

- The 2020 '**Science of Military Strategy**',[3] issued by the PLA Academy of Military Sciences, explains why there is a need to invest in military capabilities such as intelligent drones.
- It iterates that "*Weapons and equipment with primary intelligence have shown an increasingly important role on the battlefield*," and that "*Military operations have become increasingly inseparable from the support of intelligent unmanned systems.*"

THE SCIENCE OF MILITARY STRATEGY

- SMS 2020 also identifies the use of electronic jamming drones as central to ‘Information Attack’ operations for creating “strategic deterrence” during warfare.
- It also recommends that the PLA Joint Logistics Support Force undertake training in unmanned intelligent support systems suitable for joint battlefield search and rescue, precise positioning, as well as nuclear, biological and chemical monitoring.

WHAT DOES THE MILITARY UAV INDUSTRY REPORT SAY?

Recognising the shortcomings of the contemporary Chinese UAV programme, the **2023 Military UAV Industry In-Depth Report** [4] published by the Hunan-based 'Research Capital' argues:

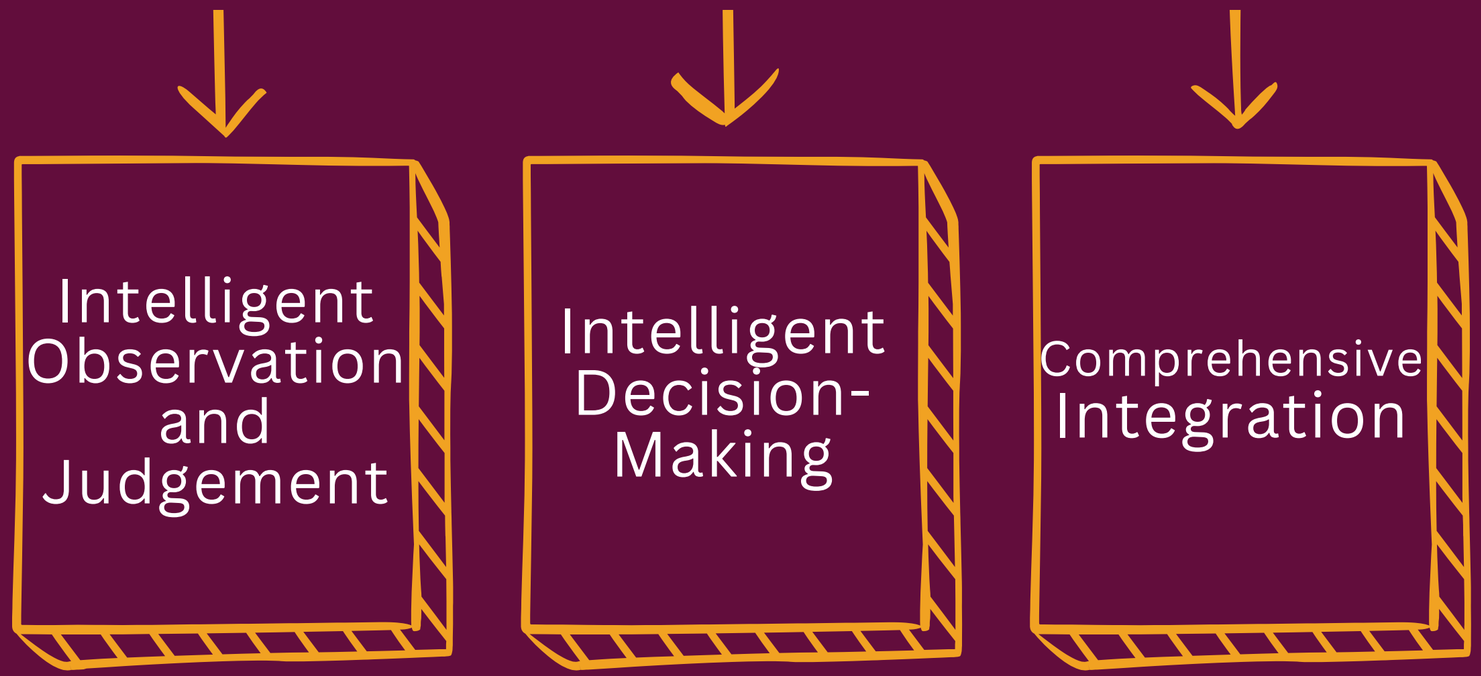
“At present, the intelligence level of drones is still relatively low, and the platform control methods are mainly simple remote control and pre-programmed control, which have a high dependence on the ground remote control system.”

WHAT DOES THE MILITARY UAV INDUSTRY REPORT SAY?

- As per the report, this insufficient combat capability makes it impossible for UAVs to deal with unexpected situations according to the on-site environment, gain battlefield adaptability, or conduct anti-interference.
- Hence, it suggests that autonomous control technology becomes the key to distinguishing UAV systems from manned aircraft, and is one step ahead of the flight control hardware, which acts as the ‘brain’ of unmanned systems.

RECOMMENDATIONS OF THE INDUSTRY REPORT

In the coming years, the Military UAV Industry Report recommends the following uses for increased intelligentisation of unmanned systems:



RECOMMENDATIONS OF THE INDUSTRY REPORT

- **Intelligent Observation & Judgement:** Because the large-scale spread of drones and sensors leads to the collection of massive amounts of data, AI algorithms can make data analysis fast, accurate, and fatigue-free, exceeding the scope of human capabilities.

- **Intelligent Decision-Making:** In a ‘kill chain’, a UAV is required to undertake a rapid, six-step decision-making process – find, fix, track, target, engage, and assess (F2T2EA) – to eliminate the enemy threat, and gain advantage in warfare.

- AI-enabled systems can create a ‘closed loop’ of the strike chain autonomously and rapidly, without facing communication lag from ground control.

- **Comprehensive Integration:** Requires autonomous coordination between swarm drones and UAV colonies.

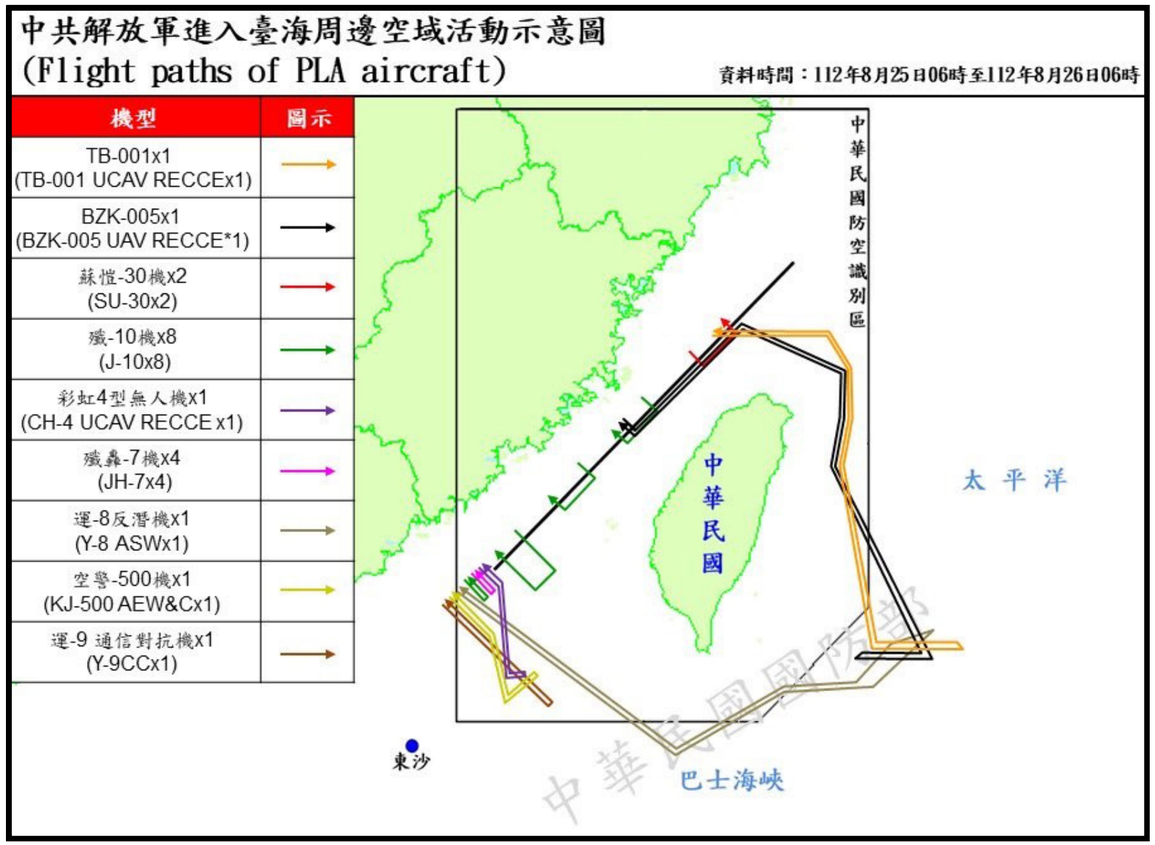
USE CASES OF UAVS IN THE CHINESE MILITARY DOMAIN

MODULAR DRONES FOR ISR AND ATTACK

- One of the most common deployments of drones in the PLA is for attack in combat. In 2019, China's domestically developed, made-for-export Wing Loong series of drones demonstrated firing more than 3,000 rounds of live munitions with an overall reported accuracy higher than 90 percent.[5]

- Modular drones deployed in the PLA engage in a host of functions, ranging from penetrating Intelligence (electronic and signals), Surveillance, and Reconnaissance (which means to conduct quickfire ISR across a vast expanse), to emitting electronic interference.

- For example, in the past few months, the BZK-005 (developed by the Beihang UAS Technology Co., Ltd.) and the Tengden TB-001 drones have become a mainstay in Chinese incursions across the median line of the Taiwanese Air-Defence Identification Zone (ADIZ), for conducting penetrating ISR missions.



These indicate the use of UAVs by the PLA to conduct recce around the island of Taiwan, and the flight paths taken by them during their sorties.

These are graphics released by the Taiwanese Ministry of National Defense on Twitter on August 26 and September 12, 2023.

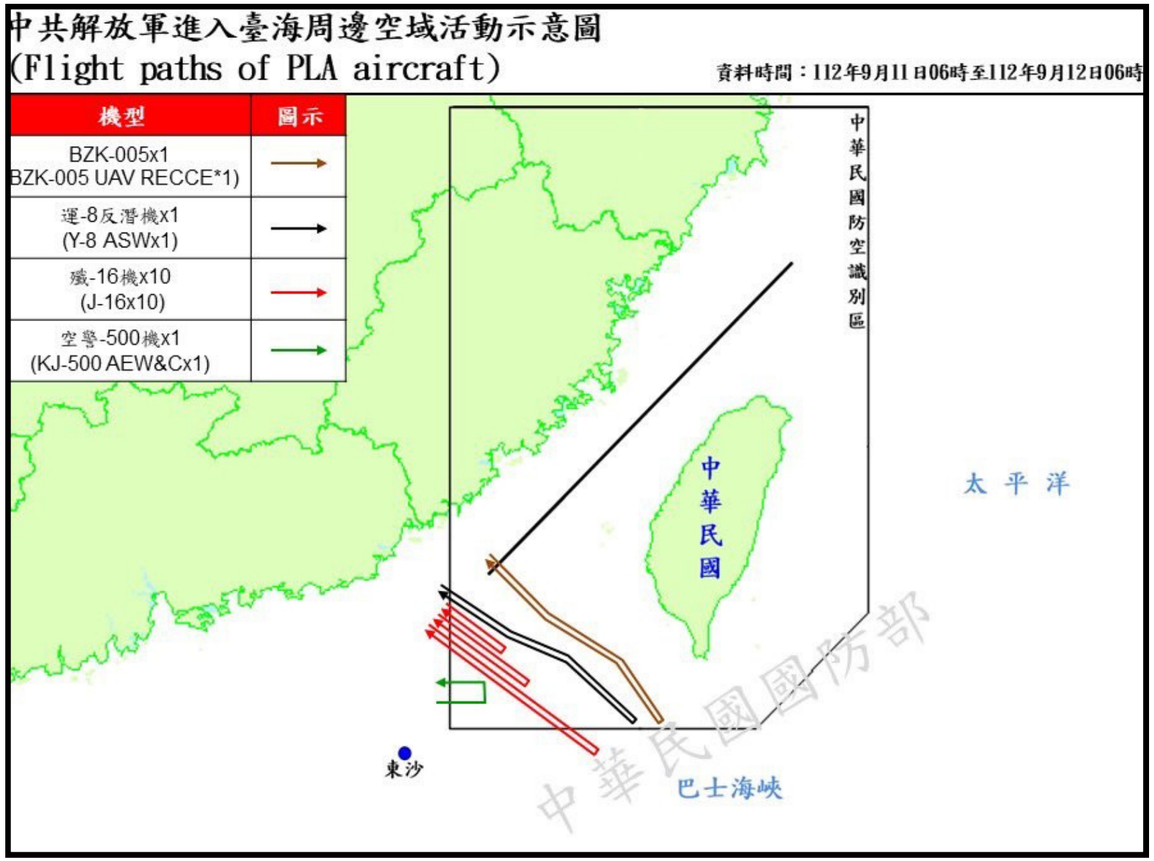


Photo Credits: X.com/MoNDefense; the official Twitter account of the Taiwanese Ministry of National Defense

MANNED-UNMANNED TEAMING

- Manned-Unmanned Teaming (MUM-T for short) refers to joint operations capacity between manned and unmanned systems (such as fighter jets or helicopters and UAVs) for the purpose of achieving a shared goal in a mission.[6]

- Usually, in a MUM-T arrangement, the UAV/UCAV acts as a force multiplier while the main mission tasks are carried out by the manned aircraft, and any high-risk tasks that may potentially risk the pilot’s life are performed by the UAV.

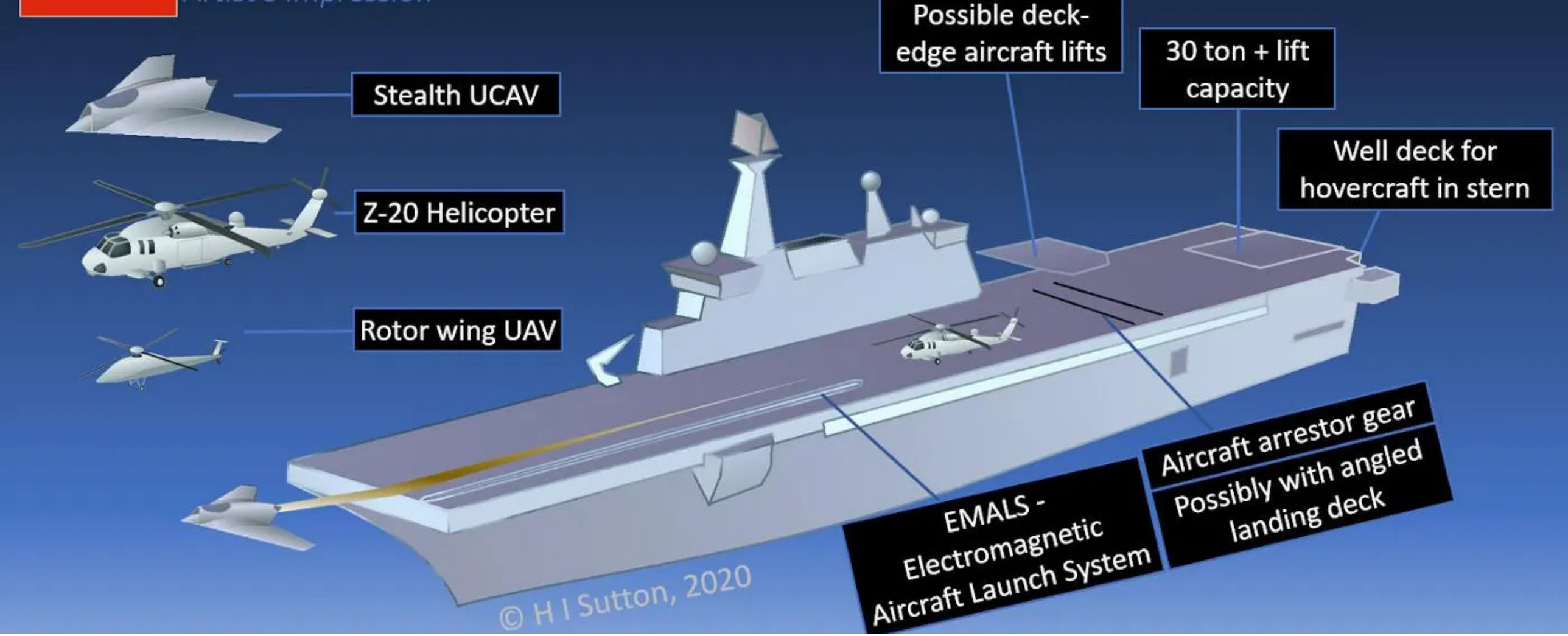
- China has experimented with MUM-T in its deployments within Taiwan’s ADIZ, as well as in the South China Sea and other realistic training scenarios.

MANNED-UNMANNED TEAMING

- As evident from the graphics released by the Taiwanese Defense Ministry (pictured above), recce UAVs such as the BZK and the TB-001 have complemented deployments of fighter aircraft such as the Chengdu J-10 and the Shenyang J-16.

- Moreover, Chinese media reported in September 2022 that during a PLA Eastern Theater Command exercise around Taiwan in the aftermath of the the-then US House Speaker Nancy Pelosi's visit to Taipei, a KVD-001 drone (an advanced variant of NTU's BZK-006A) was doing communications relay between helicopters, as they went beyond the median line of the ADIZ.

- In 2021, CCTV reported that the KVD-001 was tested for a similar capacity, where it sent real-time data of a target to the controlling center, and helicopters acted accordingly with precision to take-off, lock the target, and engage.[7]



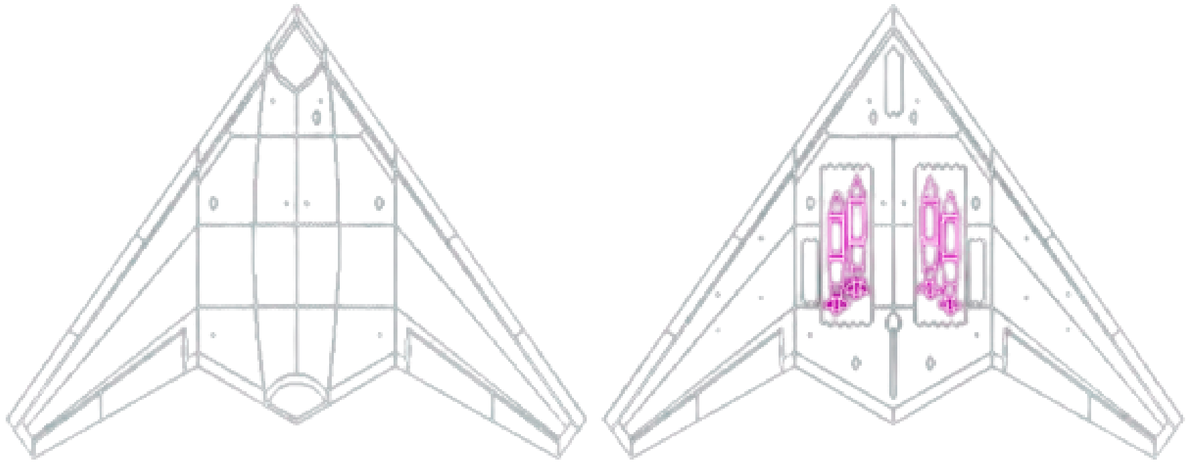
Similarly, it is likely that the PLA Navy's to-be-inducted Type 076 Next Generation Assault Carrier will deploy an angled landing deck and an Electro-Magnetic Aircraft Launch System (EMALS) which will have significant capacity to launch jet-powered UCAVs (unmanned combat aerial vehicles, which are UAVs that have the potential to carry a payload of offensive weapons). This was confirmed by Beijing-based naval expert Li Jie in an interview to SCMP in September 2023.[8]

Photo Credits: H.I. Sutton for Forbes

ELECTRONIC INTERFERENCE AND MUNITIONS DRONE

- Similarly, China has tested the Aerospace Times Feihong Technology-developed FH-95 drone to specifically perform electronic countermeasures (including soft kill measures such as electronic interference and electronic deception), and clear out enemy ‘electromagnetic fogs’ that cause signal jamming.[9]

GJ-11 ‘Sharp Sword’



- Chinese drones like the Lijian/ Hongdu GJ-11 ‘Sharp Sword’ can also serve the PLA Navy (PLA-N)'s aircraft carriers, as their payload accommodation provides for increased overall munitions carrying capacity of carrier groups. The *Lijian* consists of two bomb bays (pictured above) that can potentially hold two tons of artillery, adding on to the total firepower aboard a carrier.[10]

Photo Credits: Popular Science

INSTITUTIONAL CAPACITY: UAV REGIMENTS

The five PLA Theater Commands (TCs) operate UAV Brigades, Companies, and/or Battalions. Flight training exercises are a significant element of the mandate of these entities.

- For example, in June 2023, a UAV Brigade of the 82nd Group Army of the PLA Central Theater Command conducted a flight test and training exercise.[11]

- The UAV was recognisable as the BZK-006 (pictured on the right), a variant of the ASN 205/207 (WZ-6 series) developed by the 365th Research Institute (RI) of the Polytechnical University's Xi'an Aisheng Technology Corp.

Photo Credits: Global Times

INSTITUTIONAL CAPACITY: UAV REGIMENTS

- At the 14th Zhuhai Airshow conducted in November 2022, China also unveiled an Army formation called ‘Military Trade Army Synthetic Brigade’, which comprises 9 battalion-level units, including a UAV battalion.

- This ‘New Type’ of battalion includes artillery reconnaissance and medium-altitude long-endurance (MALE) reconnaissance drones to conduct target acquisition, and potentially even aerial or ground-based attacks.

- The PLA Rocket Force (PLA-RF) also operates a UAV Regiment under the 61st operations base. Its Staff Department hosts a UAV Regiment in Quanzhou city of China's Fujian province (facing Taiwan), while the PLA-RF Reconnaissance Regiment also hosts a UAV Battalion.[12]

USE CASES OF AUTONOMY IN CHINESE DRONE SYSTEMS

CASIC'S WJ-700 UAV

- In November 2022, at the 14th iteration of the China International Aviation and Aerospace Exhibition (Zhuhai Airshow), the Third Academy's of the China Aerospace Science and Industry Corporation (CASIC), a pioneer in UAV manufacturing in China, displayed an upgraded version of its WJ-700 drone.

- The initial version of this HALE drone was first displayed in 2018.

Photo Credits: Global Times

CASIC'S WJ-700 UAV

- Latest in the CASIC WJ line of drones, the WJ-700 includes key capabilities, some of which are autonomous and paired with a basic human-on-the-loop function.[13]

- For example, the UAV can check its equipment autonomously through one-button detection, and it has a one-button, autonomous take-off and landing capability.

- The drone also deploys China's first domestically produced one-ton thrust turbofan engine for high performance, and has the potential to carry multiple advanced missiles, airborne photoelectric equipment, and Synthetic Aperture Radar as well as other early-warning equipment.

- Reportedly, in September 2022, Algeria has purchased four WJ-700 drones from China worth US$ 145 million, making it the second user of this highly autonomous drone after the PLA.[14]

BREAKING THE SWARM DRONE WORLD RECORD

- In 2016, the night sky in the Guangzhou city of China's Guangdong province lit up as 1,000 drones (EHang Ghostdrone 2.0 UAVs; pictured below) were flown to celebrate the Lantern Festival.
- This display set a new Guinness World Record, breaking Intel's 2016 world record of flying a swarm of 500 drones in Germany. The Chinese private drone manufacturer 'Guangzhou EHang Intelligent Technology Co. Ltd' was responsible for this feat.
- Then, in December 2017, EHang flew a swarm of 1,180 illuminated drones in Guangzhou during the Fortune Global Forum.
- In 2018, to beat another world record set by a swarm of 1,218 drones flown by Intel, EHang displayed a swarm of 1,374 drones in Xi'an during a Labour Day show.[15]
- Here, however, the company faced challenges in syncing the drones, and cited "external interference" with GPS mechanisms of 496 drones.

EHANG DRONES IN GUANGZHOU

- Regardless, EHang’s exhibitions comprise the largest global display of swarm/collective intelligence drones and demonstrate China's unique capabilities in being able to synchronise miniature civilian UAVs at a large scale.

- The evidence of utilisation of AI in this demonstration came from the fact that drones unable to perform their functions or stay in sync in this formation executed their own landing.

- Owing to the policy of MCF/CMI, EHang’s civilian drone capabilities can be deployed in the military domain.

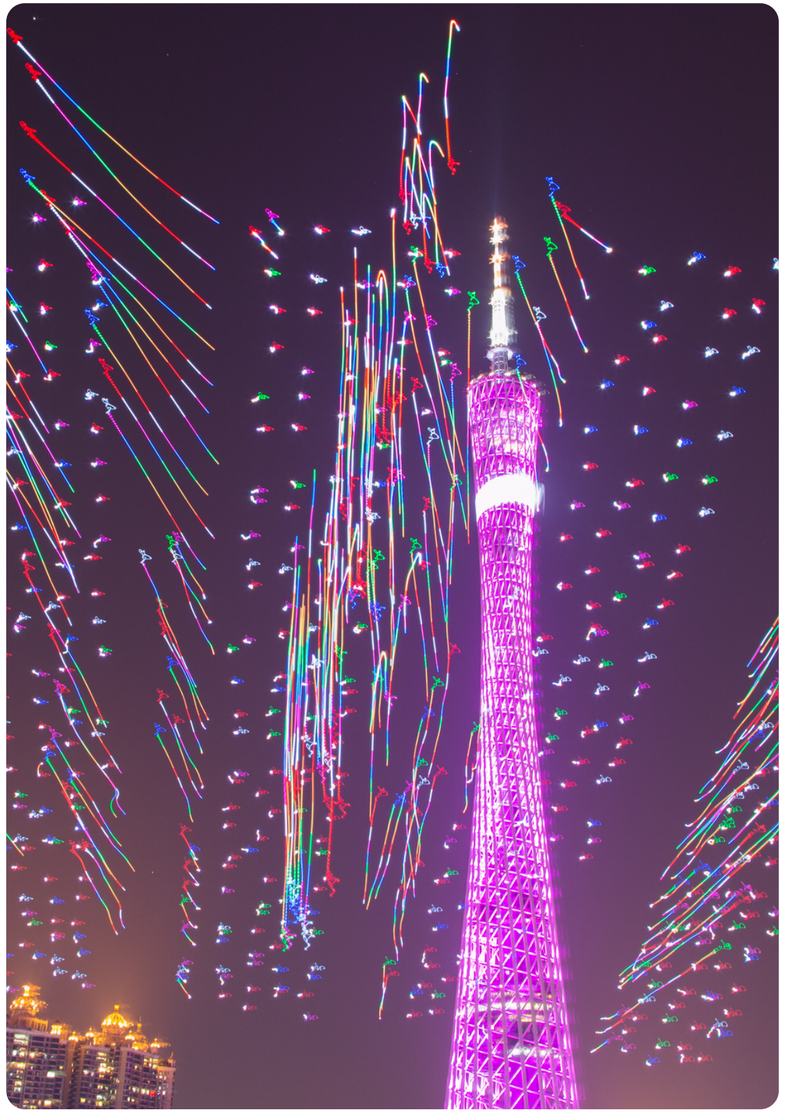


Photo Credits: Digital Photography Review

CETC'S EXPERIMENTATION WITH SWARMING

- In May 2018, the state-owned defense conglomerate China Electronics Technology Group Corporation (CETC) released a special action plan for 'A New Generation of Artificial Intelligence', in which it adopted 'three directions' in which the future of AI research and deployment in military equipment is headed: data intelligence, machine intelligence, and swarm intelligence.
- Under a 'Product+AI' approach, it has also launched an open innovative competition on creating leading-quality UAV clusters with swarm intelligence.
- In 2016, the CETC first tested a swarm of 67 fixed-wing drones, and then broke its own record in 2017 by swarming 119 such drones.[16]
- By 2020, it swarmed 200 fixed-wing drones, and also released a video that same year claiming to show the successful test of a 'barrage swarm' that launched 48 attack drones to overwhelm a target.[17]

CETC'S EXPERIMENTATION WITH SWARMING

- The CETC has also developed a swarm drone system (pictured on the right) which uses compressed nitrogen energy for simultaneously launching 48 fixed-wing UAVs that can form autonomous drone swarms. The drones can be deployed as loitering munition.[18]

- The technical features of the swarm include a minimum flat speed of 50 m/s (with a cruise speed of 30-40 m/s), an endurance of 60 minutes, a maximum take-off weight of over 10 kilograms, and a maximum take-off altitude of 5000 meters.

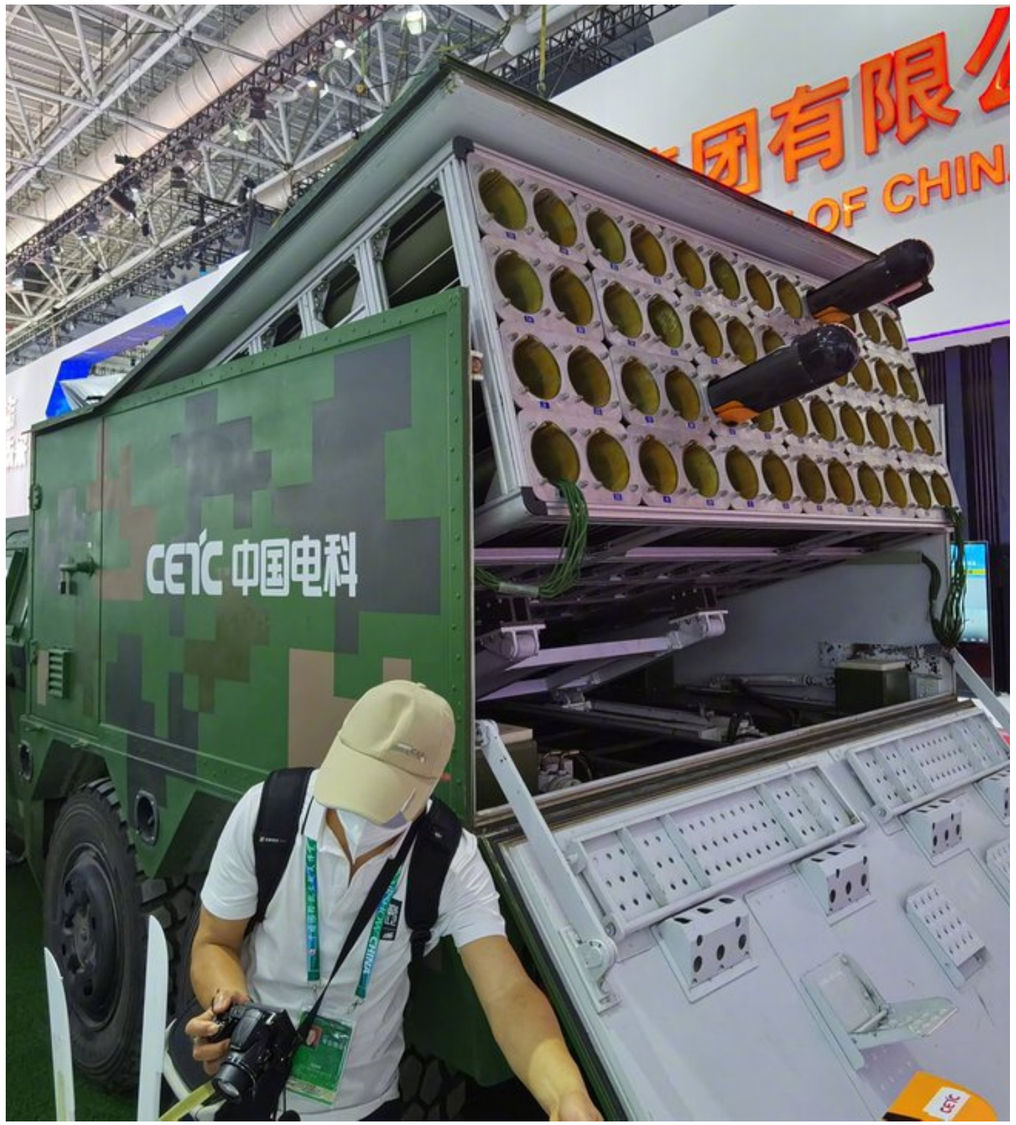


Photo Credits: x.com/jesusfroman

DOGFIGHTING WITH AI

Faint aerial shots of AI versus human-piloted drones in a dogfight

- In a widely-discussed peer-reviewed paper published in Chinese journal ‘Astra Aeronautica et Astronautica Sinica’, authors argued that experiments conducted on a simulation platform indicate that an AI-piloted UAV *“not only completes aerial combat tasks in different simulation environments but also outperforms human pilots*.”[19]

- The paper comprehensively considers the advantages of attack angle, speed, altitude, and distance in close-range aerial combat on both sides, and recommends the use of ‘Deep Reinforcement Learning’ to train AI drone pilots in battle tactics.

Photo Credits: SCMP

WORLD'S FIRST AI-POWERED DRONE CARRIER

- While explaining the current development trend in military technologies, especially naval, the 2020 ‘Science of Military Strategy’ Document of the PLA Academy of Military Sciences argues that “*There will be more and more unmanned platforms participating in maritime operations. One is the carrier-based drone. Shipborne UAVs have the advantages of high performance, miniaturization, stealth, and strong attack capabilities*.”

- Further, it states that “*The use of carrier-based UAVs will bring revolutionary changes to surface warship operations, including aircraft carriers, and prompt changes in aircraft carrier flight deck operation procedures, carrier-based aircraft take-off and landing methods, and carrier-based aircraft structure.”*

- In tandem, in January 2023, China delivered ‘*Zhu Hai Yun*’, the world's first unmanned system scientific research ship with an autonomous navigation system and remote-control functions.

WORLD'S FIRST AI-POWERED DRONE CARRIER

Photo Credits: 'Public Defense' on YouTube

WORLD'S FIRST AI-POWERED DRONE CARRIER

- Developed by the Southern Marine Science and Engineering Guangdong Laboratory (Zhuhai), along with the Huangpu-Wenchong Shipyard based in Guangdong province, the 88.5-meter-long ship is a landmark design, with an aluminium hull, a 2,100 ton-displacement and a top speed of 18 knots.[20]

- It has the capability to autonomously navigate the waters, conduct intelligent path planning, create a topographic map of its environment, and deploy UUVs or USVs based onboard into the surrounding waters to conduct surveillance and marine research. Hence, its primary function would be to act as a mothership for swarms of drones, both aerial and underwater.

- This marks a step further in the integration of AI within the entire unmanned ecosystem. At the same time, it must be acknowledged that the vessel is not entirely uncrewed, and requires humans on-board to conduct energy management and joystick-operated dynamic positioning system.[21]

CASE STUDY OF DRONES IN THE PLA WESTERN THEATER COMMAND: WHAT SHOULD INDIA LOOK OUT FOR?

DEPLOYING DRONES IN DELIVERY SERVICES ACROSS TOUGH TERRAIN

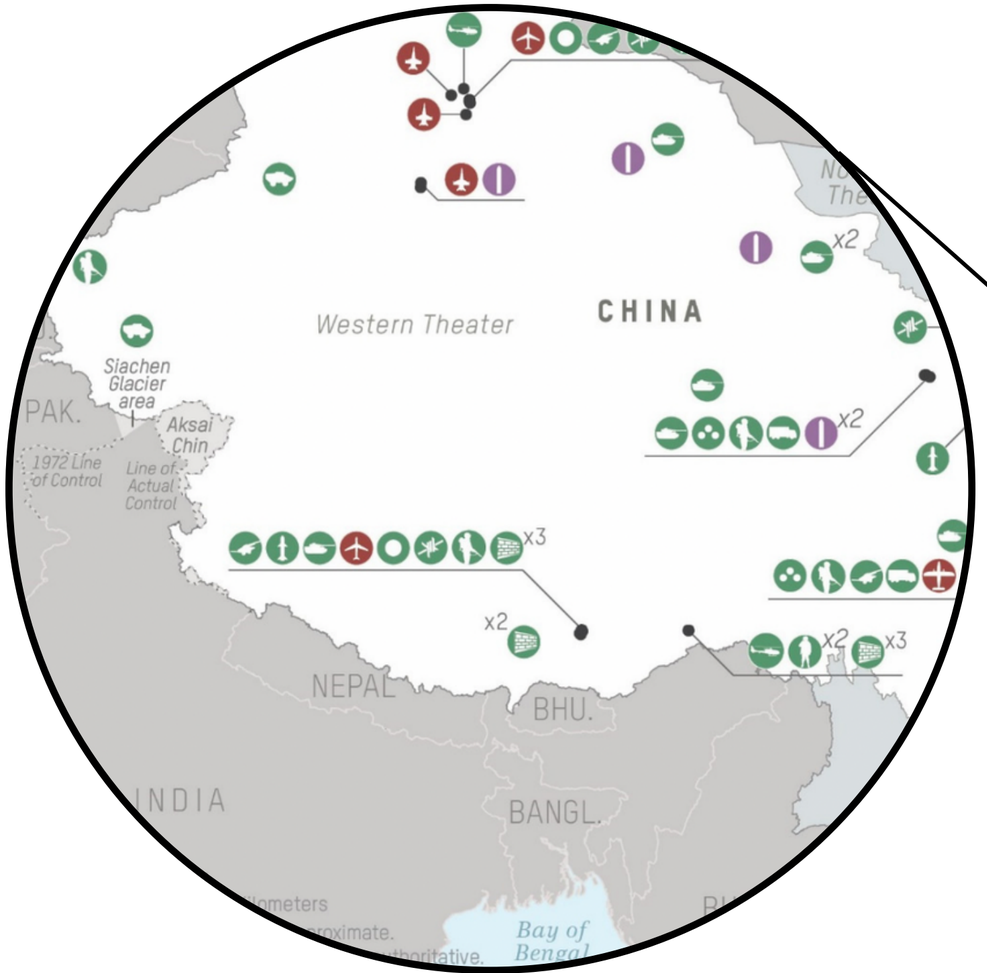
- Drone delivery systems have now become a subject of increased testing by the PLA for the purpose of servicing personnel in tough terrains, such as the mountainous/plateau regions in Tibet, along the border with India.
- In 2020, the Chinese military media network reported that *“PLA Army’s Logistics Department has organized multiple drone delivery tests in the plateau areas to unblock the "last mile" of material supplies for plateau troops*.”[22]
- To fulfill this purpose, the PLA-Joint Logistic Support Force (JLSF) has partnered with private entities such as SF Express and Jingdong Express for the rapid deployment of quadcopter drones.[23]

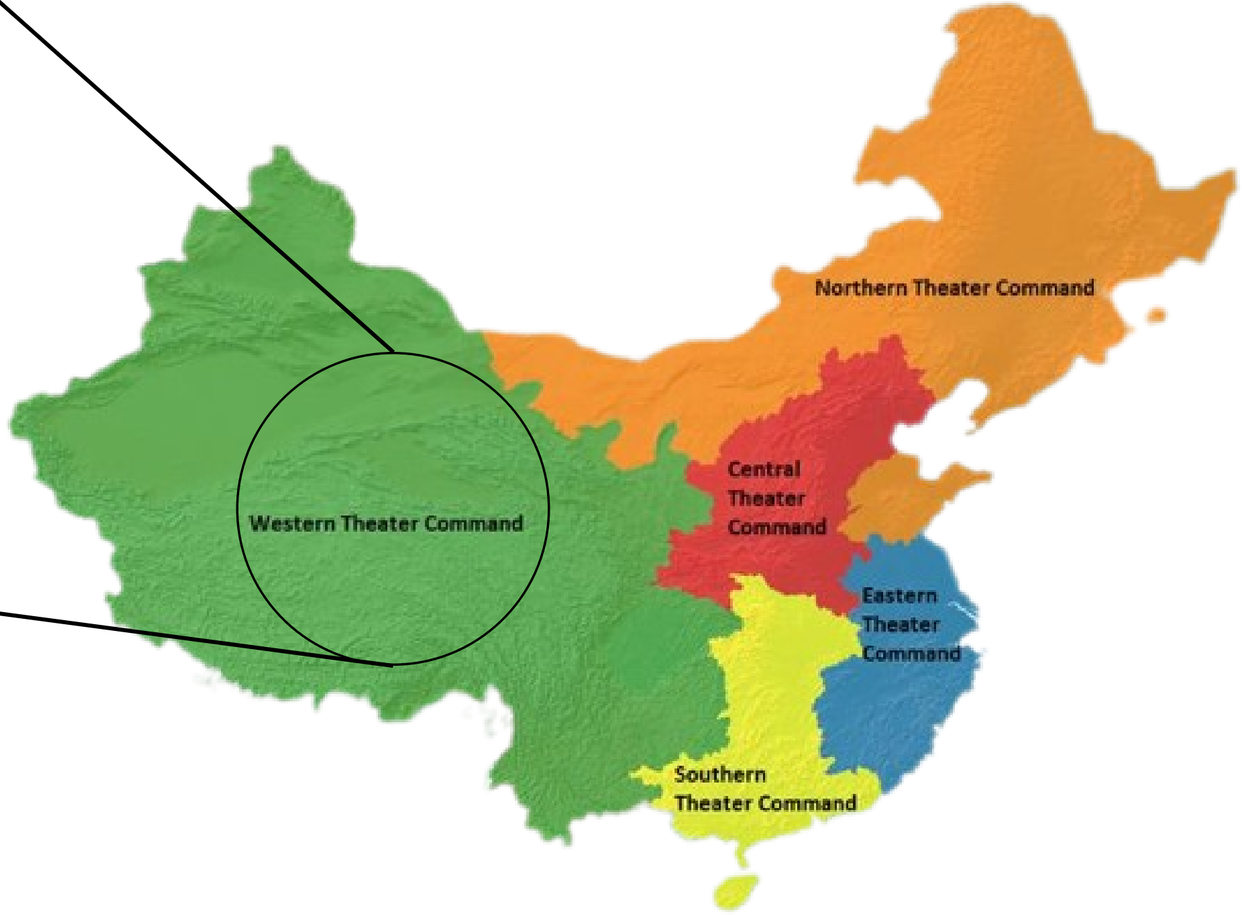
DEPLOYING DRONES IN DELIVERY SERVICES ACROSS TOUGH TERRAIN

- Seemingly, the drone transportation unit, made up of 9 drones, was meant to transfer hot food, drinking water, medicine, and other urgently needed materials into the drones' incubators across bases of the Tibet Military Command, but faced challenges from high altitude and bad weather, which destabilised said drone systems.

- The operators of the unit then commented that there was a need to make a "comprehensive judgement" on the terrain, wind speed, temperature and other factors, to ensure the drones' safe landing at the predetermined area.

PLACING THE PLA-WTC





PLA Air Force
- Theater Air Force HQ
- Base
- Fighter/Ground attack Brigade
- Transport Division
- Transport Brigade

PLA Army
- Theater Army HQ
- Group Army HQ
- Military District HQ
- Air Defense Brigade
- Army Aviation Brigade
- Artillery Brigade
- Border Defense
- Combined Arms Brigade
- Engineering and Chemical Defense Brigade
- Infantry Brigade
- Infantry Division
- Service Support Brigade
- Special Operations Brigade

PLA Rocket Force
- Missile Base
- Missile Brigade
- Theater Command HQ
- Theater boundary

Photo Credits: 2022 China Military Power Report (US Department of Defense; Pinterest

COMPLEMENTING CREWED TRANSPORT PLATFORMS

- Because India has regularly faced blockage of motorable roads in mountainous border regions due to a lack of infrastructure development and frequent landslides (among other factors), creating efficient delivery mechanisms of food and other necessary equipment in sub-zero temperatures has become difficult.

Y-20 ‘Kunpeng’

- China is attempting to circumvent this using drones. The drone systems used for this purpose complement other manned military equipment such as the Xi’an Y-20 Kunpeng Military Transport Aircraft, which has recently achieved the feat of being able to lift 200 tonnes of cargo for weapons and aid deliveries over long distances.

Photo Credits: Wikipedia

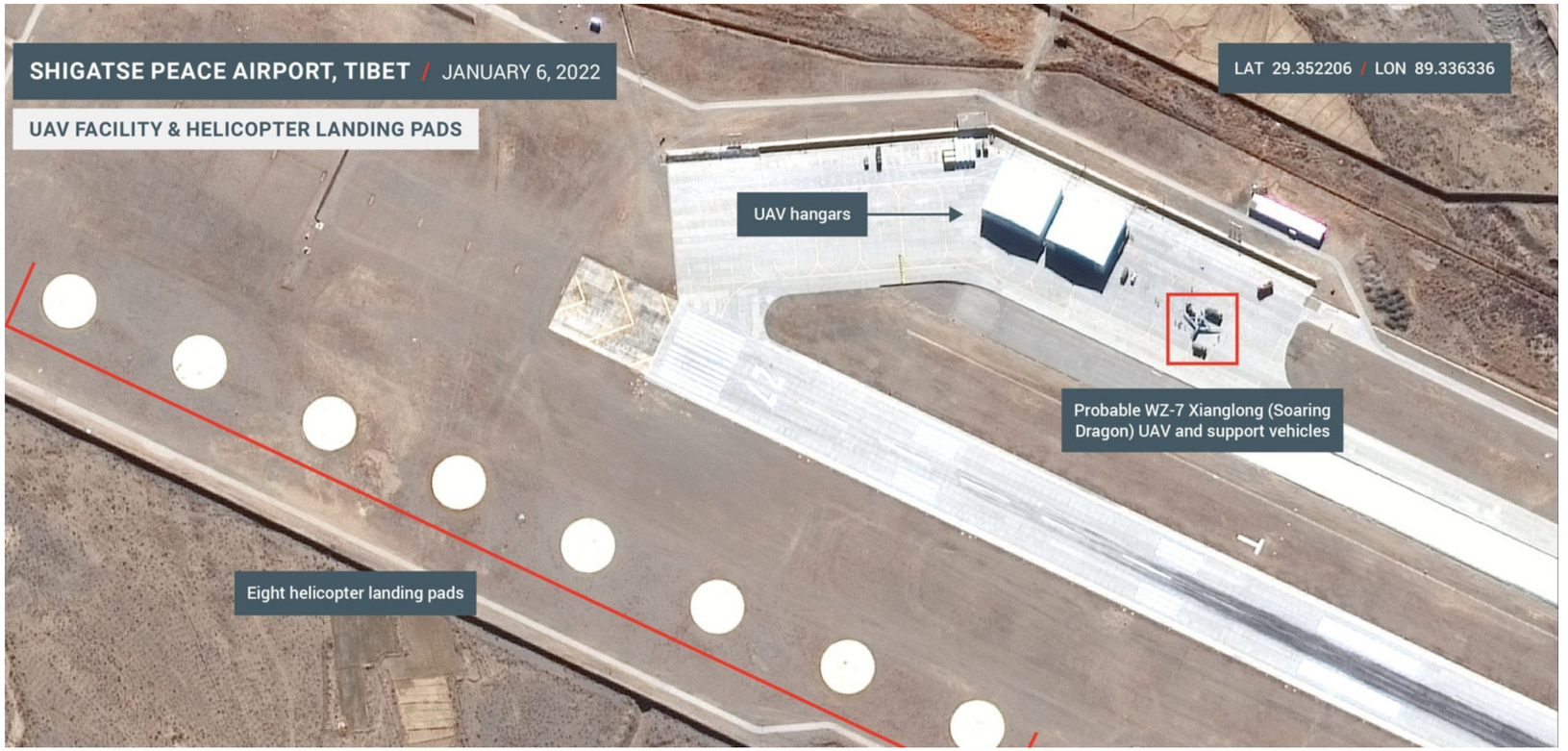
UAV DETACHMENTS ACROSS PLA-WTC BASES

- The PLA-WTC has a UAV battalion with a detachment of CH-5s at the Aksu/ Wensu base in Xinjiang, a UAV Brigade with detachments of drones such as BZK-005 and 006, as well as GJ1 at the Hotan base, and a brigade detachment of UAVs and J-11 fighter aircrafts at the Kashgar airbase just 475 km away from the Karakoram Pass – making it a direct deployment for India to face.

- As also discussed in this document before, these UAV battalions and regiments have an important role to play in battle-readiness.

- It is reported that during the standoff between Indian and Chinese forces at the Doklam plateau in 2017, a UAV regiment of the PLA-WTC was deployed on the Shigatse (Tibet) Peace Airport, with a detachment of 3 WZ-9 ‘Soaring Dragon’ drones (captured also in satellite image sourced from @jetfighter2000 on Weibo; see below). [24]

SATELLITE IMAGERY PLA-WTC UAV DEPLOYMENTS



As per satellite imagery obtained from Maxar Technologies by the CSIS 'ChinaPower' initiative, as of January 2022, the development of UAV hangars and potential deployment of WZ-7 drones is visible at the Shigatse Airport in Tibet – approximately 155 km north of the LAC.

Satellite image showing three WZ-9 drones at the Shigatse airport.

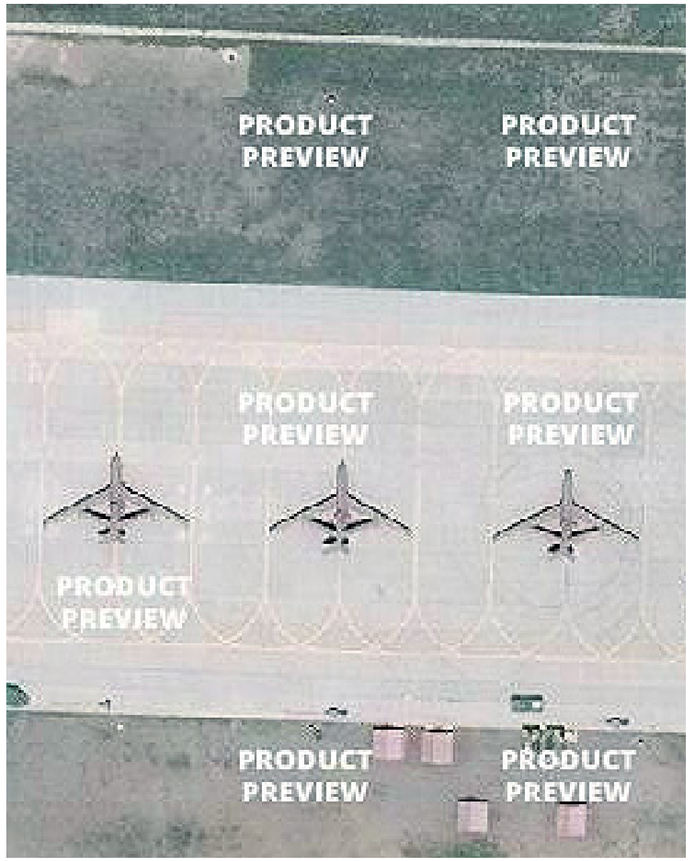


Photo Credits: CSIS ChinaPower; China Times

TESTING CAPABILITIES

- In August 2023, it was reported that an Air Force Unit under the PLA-WTC is now testing the Chengdu GJ-2 armed Reconnaissance Drone for reconnaissance and strike training capabilities in realistic combat scenarios in the Northwestern deserts of Xinjiang. The exact location remains undisclosed.[25]

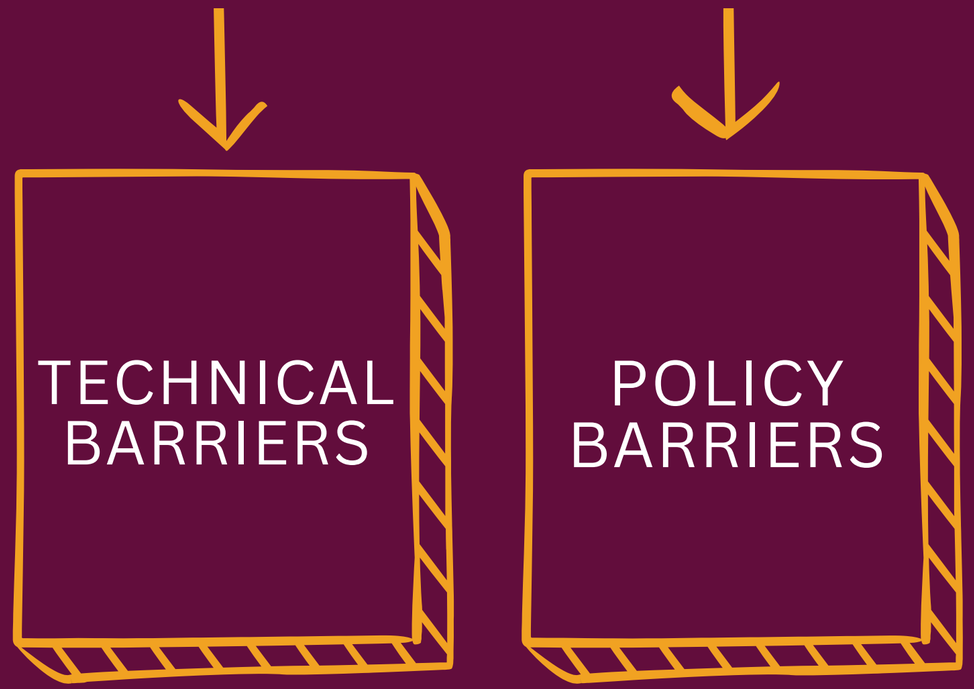
- Reportedly piloted by remote operators, the drone was tasked with searching, detecting, identifying, locating and attacking multiple targets within a single sortie.

Photo Credits: Air Recognition

STRUCTURAL CONSTRAINTS IN CHINESE MILITARY DRONES ECOSYSTEM

DOMESTIC CONSTRAINTS

Research Capital’s 2023 ‘Military UAV Industry In-Depth Report’ recognises that there are two-types of high entry barriers to the participation of private industry players in the country's military UAV ecosystem.



TECHNICAL BARRIERS

- Technical barriers indicate that not a lot of the firms have access to the kind of intensive time and money investment required to be put into the manufacture and operations of military drones.

- This is primarily because of the high-technology elements associated with such UAVs, such as intelligent control and engine power technologies, as well as the management of stealth, speed and size (the 3S’s of drone quality superiority).

- Manufacturing requirements are also very high, whether it be the quality of basic components like battery, engine/motor, propellers, landing gear, and antenna, or the sophisticated fabrication of core components such as on-board electronics and semiconductor chips.

MANY PARTS, MANY INVESTMENTS: BASIC COMPONENTS OF A DRONE

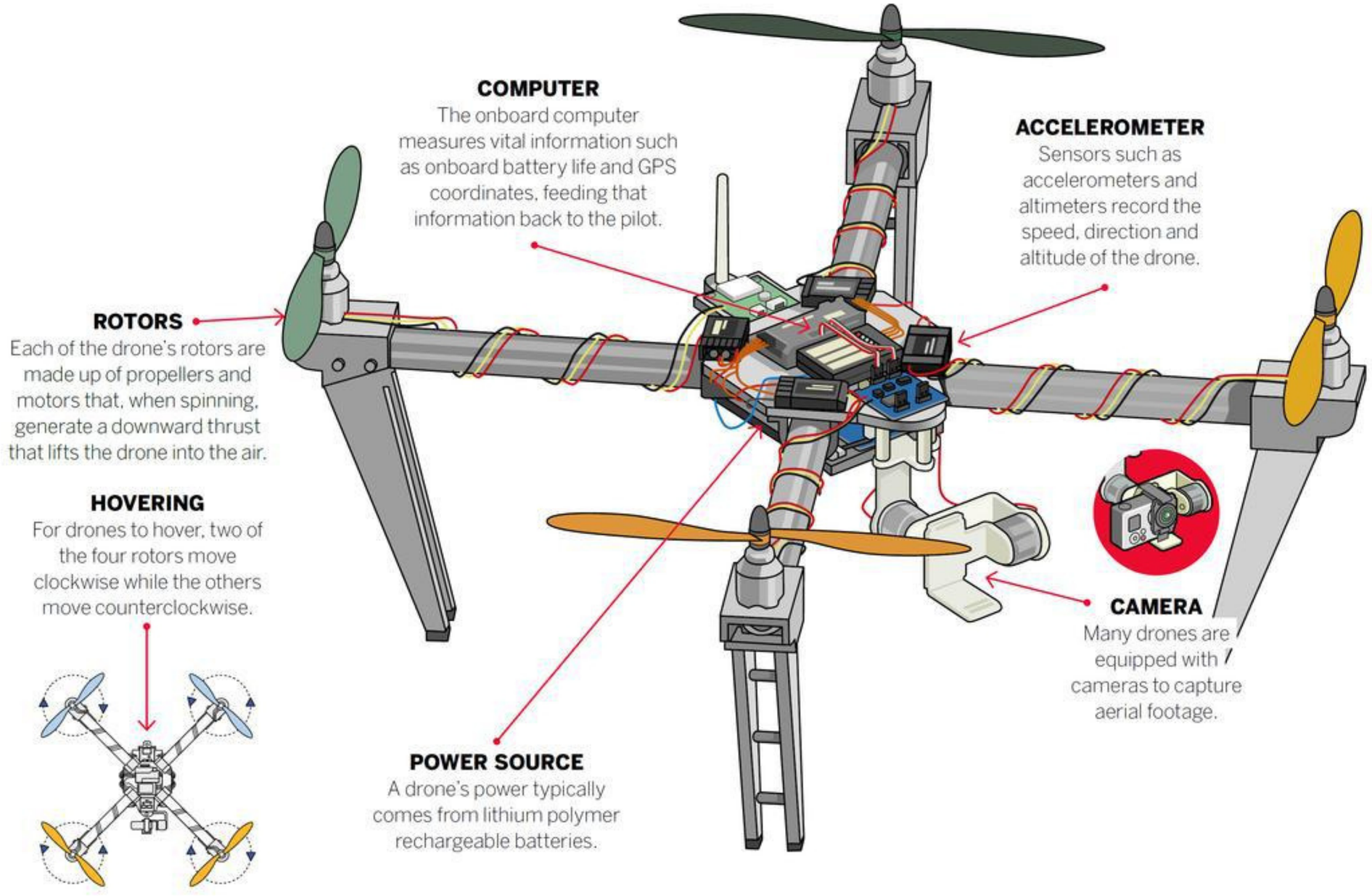


Photo Credits: SCRIBD

POLICY BARRIERS

- Policy barriers indicate that because of the high national security value of military UAVs, corporate brands engaged in the manufacture of such UAVs are subject to strict quality control and compliance requirements, which are applied much more strictly on newer industry entrants.

- As such, most of the current big players in this industry are Chinese SOEs, PLA RIs, and state-backed defense universities and laboratories.

- While it is understandable that these barriers exist, lack of access to capital and excessive compliance requirements for newer entrants in the industry can potentially stifle innovation, especially in the automation of future combat-ready military UAVs.

- And even though the party-state continues to fund old players in the field and places similar compliance requirements on them, a lack of fresh competition may also induce redundancy in their innovation strategies.

EXTERNAL CONSTRAINTS

- China's competition with external actors such as India and the United States is impacting the Chinese military drone ecosystem both internally and externally.

- For example, as part of the ongoing high-technology and trade contestation with the US, through an Executive Order signed in August 2023, the Joe Biden administration placed restrictions on American firms investing in Chinese semiconductors, autonomy and AI, advanced computing, and quantum sectors.[26]

- This automatically restricts China's access to American investment and critical technology in military UAVs, especially those that are being prepared to be AI-enabled.

EXTERNAL CONSTRAINTS

- Similarly, Reuters reported in early August that sources from India's defence authorities and industry have indicated that there is a possibility of drone-based Indian intelligence gathering being compromised by Chinese-made parts for communications functions, as well as cameras, radio transmission and operating software.[27]

- As a result, India has banned the import of Chinese military drones and drone components/ technologies for the past few months.

- Moreover, the Russia-Ukraine war endures and China’s position on the war has focused on the maintenance of peace and stability.

- Hence, as a face-saving measure on the international stage, on 31 July 2023, China has announced restrictions and controls on export of long-rang civilian (many of which are dual-use) drones to Russia, with the intent of preventing them from being used in war-fighting.[28]

EXTERNAL CONSTRAINTS

- Figures indicate that in the five months between December 2022 and April 2023, Russia imported at least 37 drones from China worth around US$ 103,000.[29]

- Before this, by April 2022, DJI Technology Co., a leading Chinese drone developer and exporter, had already exited the Russian market.

- China has had to deal with tech-related restrictions with haste by attempting to strengthen domestic production, which may not be viable in the immediate future.

- Hence, the closing up of access to markets in India and the US, and the additive impact of restrictions on drone exports to Russia, may contribute to financial constraints of China’s drone-makers.

POTENTIAL EMPHASIS POINTS FOR FUTURE CHINESE EFFORTS ON MILITARY DRONES

CIVIL-MILITARY INTEGRATION: A CORNERSTONE POLICY

- With the CMI/MCF strategy at their base, Chinese enterprises working on military drones will likely continue seeking collaboration with civilian drone manufacturers and exporters, to leverage commercial advantage in cutting-edge drone systems and technologies that may not necessarily be available in the military-industrial complex.

- A major component of this strategy would be integrating into military drones some key '4IR' technologies (referring to the technologies being developed and championed by commercial and private sector enterprises during the 'fourth Industrial Revolution'), such as AI-enabled decision-making technology, advanced sensors, and wireless command and control.

- Moreover, 5G, which is expected to be a significant component for machine-to-machine interaction in swarms of drones in the near future, requires intensive private sector participation.[30]

INTELLIGENT SWARMING SYSTEMS

- ‘Smart Swarming’ will continue to dominate the Chinese AI-enabled UAV ecosystem.
- China has already achieved significant strides in making take-off, landing, and synchronisation in swarms of drones autonomous.
- Chinese state-owned and private entities like CETC, EHang and Zhuhai Ziyan are now expanding their research and innovation in swarming (similar to the examples of CETC and EHang discussed above, in 2019, Ziyan demonstrated that swarms of autonomous drones could take-off and engage in coordinated strikes with a single operator command).
- Swarming will also become a critical node for the realisation of MUM-T, by combining swarms of air-launched decoy drones with manned tankers and combat aircraft to build a clustered air combat system.

COMPREHENSIVE INTEGRATION AND MDIJO

- Ambitious reforms in the Chinese military have now led to a shift in focus of outlook towards Multi-Domain Integrated Joint Operations (MDIJO; 克服大陆军的影响).

- UAVs (especially drone clusters) are an excellent tool to realise this goal, which refers to combining power and potential of varied uses and warfare capabilities across **services, stakeholders, and systems**.

- Training scenarios show an emphasis on this. For example, in July 2022, Global Times reported that drone developers are now imagining combat scenarios where an FH-95 electronic warfare drone could conduct electromagnetic interference first, providing cover for an FH-97, a high-speed stealth drone, to penetrate and destroy hostile defense lines. Then, an FH-92A, a type of traditional armed reconnaissance drone, can conduct follow-up attacks.[31]

AUTONOMOUS SITUATIONAL AWARENESS

- In 2019, speaking on the future of China's military drones on a China Central Television (CCTV) program aired in August, Li Yidong, chief designer of China's Wing Loong series drones, said, "*We want [drones] to fly intelligently, [and] have smart situational awareness*."[32]

- The Military UAV Industry-Report 2023 further suggests that a good 'Inertial Navigation System' (self-contained navigation system that operates independently of external information) is like a drone's 'cerebellum', providing it data on position, velocity, heading, and attitude angles, and concealing it well from EMI and path obstacles.

- This indicates that industry experts in China will focus on expanding localisation capabilities of drones and enabling them to autonomously rely on local spatial, temporal, and electromagnetic information without colliding or hampering the assigned mission.

CHAMPIONING COMMUNICATIONS & COORDINATION

- Enhancing the quality of communications and information sharing in the military drone ecosystem will continue to remain a focal point of future research and development, especially since communication lags and lack of relay technology can hamper mission success during critical times.

- This will be especially significant since data linking in such a dynamic and ever-evolving ecosystem is highly complex, engaging equipment such as Radio Frequency receivers, transmitters, antennas and modems, used between diverse stakeholders such as Air Traffic Control, as well as Airborne and Ground Data Terminals.

- In China's case, such work is being pioneered by the 54th RI of the CETC, as well as China Aviation Industry Group's Shanghai-based 615 Aeronautical Radio Electronics Research Institute.

MAKING DRONES MULTI-PERFECT

- In line with global trends in the use of drones for warfare or other non-conventional purposes, the Chinese drone industry is likely to engage in integrating functionality in UAVs that can serve a host of purposes.

- Given the dynamic nature of regional threats and special operations such as counter-terrorism, there is a simultaneous emphasis on drones being high-speed, long-endurance, as miniaturised, lightweight and compact as possible, stealthy, cost-effective, and easy to operate.

- Stealth in itself will require a significant calibration of advanced tech such as radar, infrared, optical, acoustic, and visual.

- Therefore, for ensuring the greatest penetration and survivability capability, China will likely invest in making drones as modular and near-perfect in design as possible.

CONCLUSION

- As China’s robust emphasis on scientific and technological self-reliance carries on in the context of an increasingly unfavourable external environment, military UAVs will likely become a key weapon of choice for the PLA’s multi-domain, integrated joint operations.

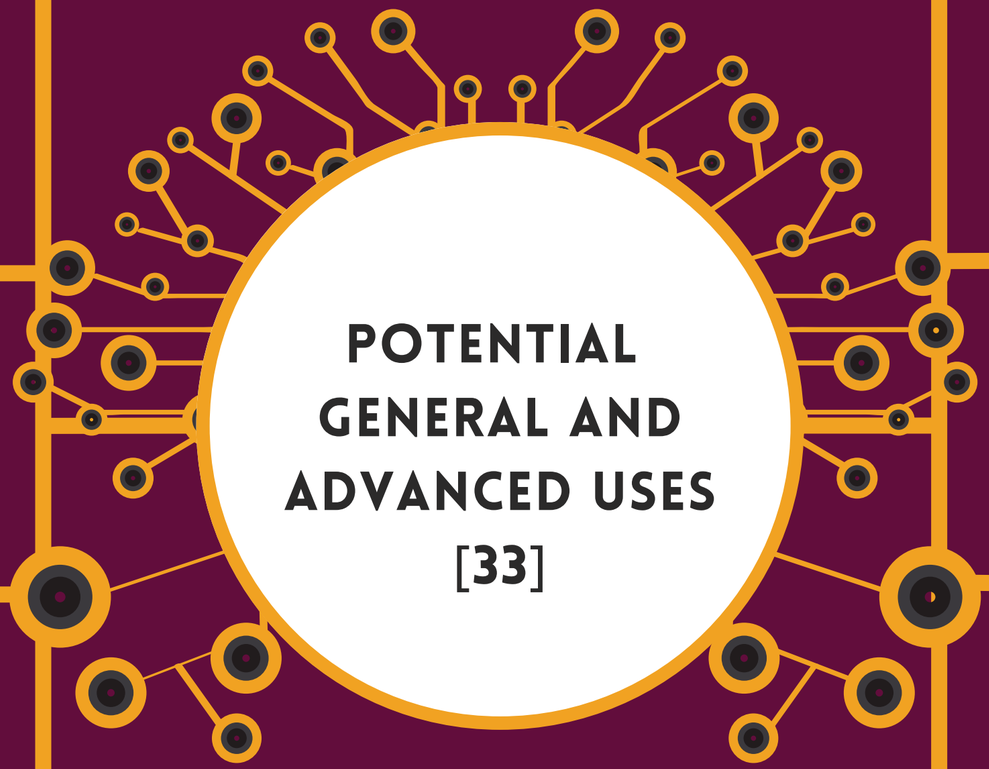
- Ranging from deployment of 4IR technologies in military UAVs to the use of swarms and manned-unmanned cluster weapons systems to achieve long-range objectives in a short-duration, China has demonstrated its willingness and capacity to invest in wide-ranging unmanned capabilities for the future of warfare.

- The PLA in general and the PLA-WTC in specific are testing drone systems for combat, transport and delivery, and ISR, and the focus now is on achieving more sophistication through advanced communications system, greater autonomy, and intelligent swarming through CMI.

ANNEXURE

1. POTENTIAL USES OF AI AND AUTONOMY IN DRONES
2. TYPES OF CHINESE DRONES (CLASSIFIED INFORMALLY BY IMPORTANT USES)
3. MIND-MAPS OF STAKEHOLDERS INVOLVED
4. GLOSSARY/ ABBREVIATIONS

POTENTIAL USES OF AI AND AUTONOMY IN DRONES



- Introduction of AI to war gaming as a tool for training and evaluating the dynamics of intelligent confrontation
- Use of AI to improve communications and to secure networks against jamming, spoofing & cyber-attacks
- New algorithms like neural networks for swarm intelligence aimed at enabling 'swarm synchronisation & combat'
- AI technologies are expected to have applications in detection and Recce, flight path planning, and other task management
- Automatic Target Recognition, including identification of multiple targets in real-time based on deep-learning
- Integration of AI-based high-power imagery processing onboard UAVs to reduce lag time and enhance sensor fusion
- Increased autonomy in ‘unmanned’ systems, with the purpose of launching multi-domain attacks in the battlefield
- Reducing human intervention in the loop to enable automatic decision-making by UAVs in high-intensity situations

TYPES OF CHINESE DRONES (CLASSIFIED INFORMALLY BY IMPORTANT USES)[34]

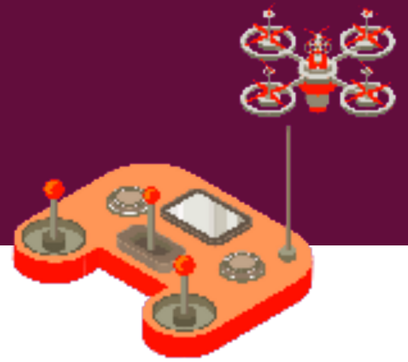
TYPES OF CHINESE MILITARY DRONES

WING LOONG - 1

- Manufacturer: CAIG
- Unmanned Aerial Vehicle (No Crew)
- Length: 9.05 meters
- Wingspan: 14 meters
- Gross Weight: 1100 kilogram
- Max. Speed: 280 kmph
- Range & Endurance: 4000 km, 20 hours
- Service Ceiling: up to 5000 meters
- Powerplant: Rotax Turbocharged

GUIZHOU WZ-9 'SOAR DRAGON'

- Manufacturer: AVIC-GAIC
- Unmanned Aerial Vehicle (No Crew)
- Length: 14.33 meters
- Wingspan: 24.86 meters
- Thrust-to-Weight Ratio: 5.8
- Cruise Speed: 750 kmph
- Range & Endurance: 7000 km, 10 hours
- Service Ceiling: up to 18000 meters
- Powerplant: Guizhou WP-13 turbojet



RECONNAISSANCE DRONES

Gathering intelligence on enemy positions, movements, and capabilities; Using radio remote control for artillery positioning, surveillance and range reconnaissance

- WING LOONG 1
- CASC CAI HONG RAINBOW SERIES
- SOAR DRAGON

Photo Credits: Wikipedia (CAIG Wing Loong); Ingelec Group (Guizhou AVIC Soar Dragon UAV Drone)

TYPES OF CHINESE MILITARY DRONES

CASC FH-95

- Manufacturer: CAS&TC
- Unmanned Aerial Vehicle (No Crew)
- Length: Undisclosed
- Wingspan: Undisclosed
- Max. Weight (Take-off): 1000 kilogram
- Max. Speed: 280 kmph
- Flight Endurance: 24 hours
- Service Ceiling: up to 8000 meters
- Powerplant: Likely Piston Engine

WING LOONG - 10

- Manufacturer: CAIG
- Unmanned Aerial Vehicle (No Crew)
- Length: 9 meters
- Wingspan: 20 meters
- Max. Weight (Take-off): 3200 kg
- Max. Speed: 750 kmph
- Flight Endurance: 20 hours
- Service Ceiling: up to 15000 meters
- Powerplant: 1 Turbojet or 2 Turbofan Engines

ELECTRONIC COUNTERMEASURES DRONES

Using radar jammers and signal generators to create an 'electronic fog' and confuse enemy systems

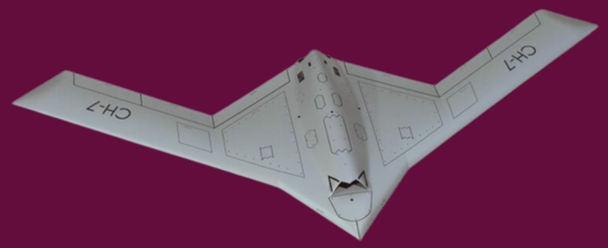
- **FH-95**
- **WZ-10**

Photo Credits: The Droning Company; EurAsian Times

TYPES OF CHINESE MILITARY DRONES

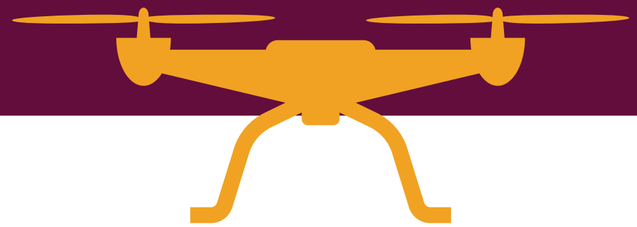
TB-001 'TWIN-TAILED SCORPION'

- Manufacturer: Sichuan Tengden
- Unmanned Aerial Vehicle (No Crew)
- Length: 10 meters
- Wingspan: 20 meters
- Max. Weight (Take-off): 2800 kg
- Max. Speed: 300 kmph
- Range & Endurance: 6000 km, 35 hours
- Service Ceiling: up to 8000 meters
- Powerplant: 2 Turbocharged Piston



RAINBOW CH-7 STEALTH DRONE

- Manufacturer: CAS&TC
- Unmanned Aerial Vehicle (No Crew)
- Length: 21.95 meters
- Wingspan: 14 meters
- Max. Weight (Take-off): 12250 kg
- Max. Speed: 885 kmph
- Range: 3500 km
- Service Ceiling: up to 10000 meters
- Powerplant: 1 Turbofan Engine



COMBAT DRONES

Used in air-to-air combat and ground attack, carry out deep-depth attack and defense suppression

- **TB-001**
- **CH-7**

Photo Credits: Reddit/ China Aviation Photography; militarydrones.org.cn

TYPES OF CHINESE MILITARY DRONES

DECOY DRONES

Distracting and confusing enemy aircraft to draw fire away from targets, simulating flight paths and radar signal characteristics to induce enemy defence systems to attack

- **ASN-209 (RKL-165 VARIANT)**
- **GJ-11**

AISHENG-206

- **Manufacturer: Xi'an ASN Tech Group**
- **Unmanned Aerial Vehicle (No Crew)**
- **Length: 3.8 meters**
- **Wingspan: 6 meters**
- **Gross Weight (Take-off): 222 kilogram**
- **Max. Speed: 210 kmph**
- **Flight Endurance: 4-8 hours**
- **Service Ceiling: up to 6000 meters**
- **Powerplant: HS-700 Piston Engine**

HONGDU G-11 'SHARP SWORD'

- **Manufacturer: HAIG**
- **Unmanned Aerial Vehicle (No Crew)**
- **Length: 11.65 meters**
- **Wingspan: 14.4 meters**
- **Max. Weight (Take-Off): 20215 kg**
- **Max. Payload: 2000 kg**
- **Max. Speed: 1100 kmph**
- **Range: 4000 km**
- **Powerplant: WS-13 Turbofan Engine**

Photo Credits: Militarydrones.org.cn (Aisheng ASN-206/207 Reconnaissance UAV); 19FortyFive.com

TYPES OF CHINESE MILITARY DRONES

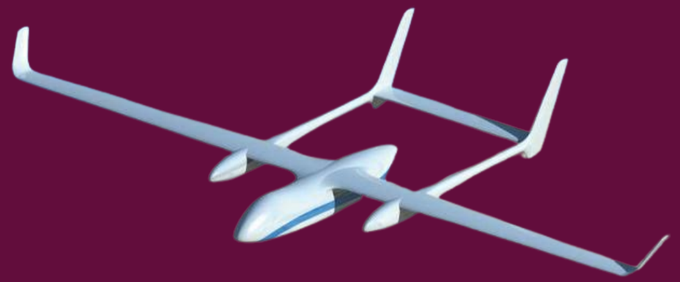
COMMUNICATIONS RELAY DRONES

Performing data-transmission & command and control between actors in a networks-based warfare scenario

- **HW-350**
- **WJ-600**

CASIC HW-350

- **Manufacturer: HIWING GAE Co.**
- **Unmanned Aerial Vehicle (No Crew)**
- **Length: 5.45 meters**
- **Wingspan: 7.9 meters**
- **Gross Weight (Take-off): 220 kilogram**
- **Cruise Speed: 160 kmph**
- **Flight Endurance: 24 hours**
- **Service Ceiling: up to 5000 meters**
- **Automated wheel take-off & landing**



WJ-600 'SKYHAWK'

- **Manufacturer: CASIC**
- **Unmanned Aerial Vehicle (No Crew)**
- **Length: 6.5 meters**
- **Wingspan: 5.8 meters**
- **Max. Weight (Take-Off): 1000 kg**
- **Max. Payload: 130 kg**
- **Max. Speed: 500-700 kmph**
- **Endurance: 3-5 hours**
- **Powerplant: Turbojet engine requiring 400 L Aviation Kerosene**

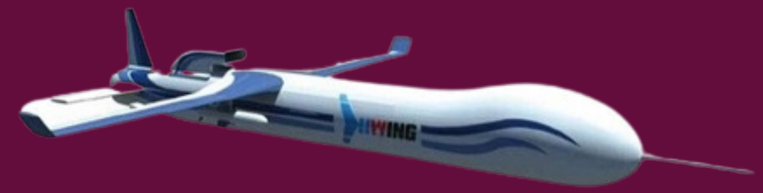


Photo Credits: People's Daily; militarydrones.org.cn

TYPES OF CHINESE MILITARY DRONES

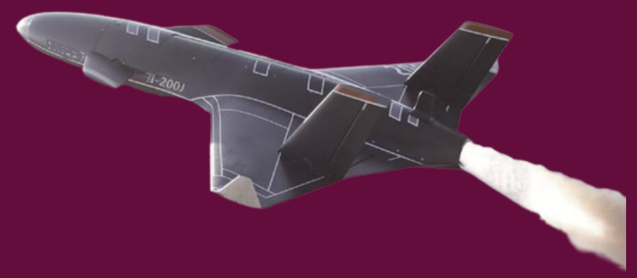
TARGET DRONES

Used in simulating air combat with enemy aircraft in live-fire training exercises, or as a target for shooting training; are usually made of lightweight and inexpensive material

- **TD-F200J**
- **II-150Y**

TD-F200J HIGH-SPEED DRONE

- **Manufacturer: PLA-GSD 60th Research Institute**
- **Unmanned Aerial Vehicle (No Crew)**
- **Length: 3 meters**
- **Wingspan: 2 meters**
- **Max. Weight (Take-off): 180 kilogram**
- **Max. Speed: 230 mps**
- **Flight Endurance: One hour**
- **Service Ceiling: up to 10000 meters**
- **Advanced high-manoeuver target**



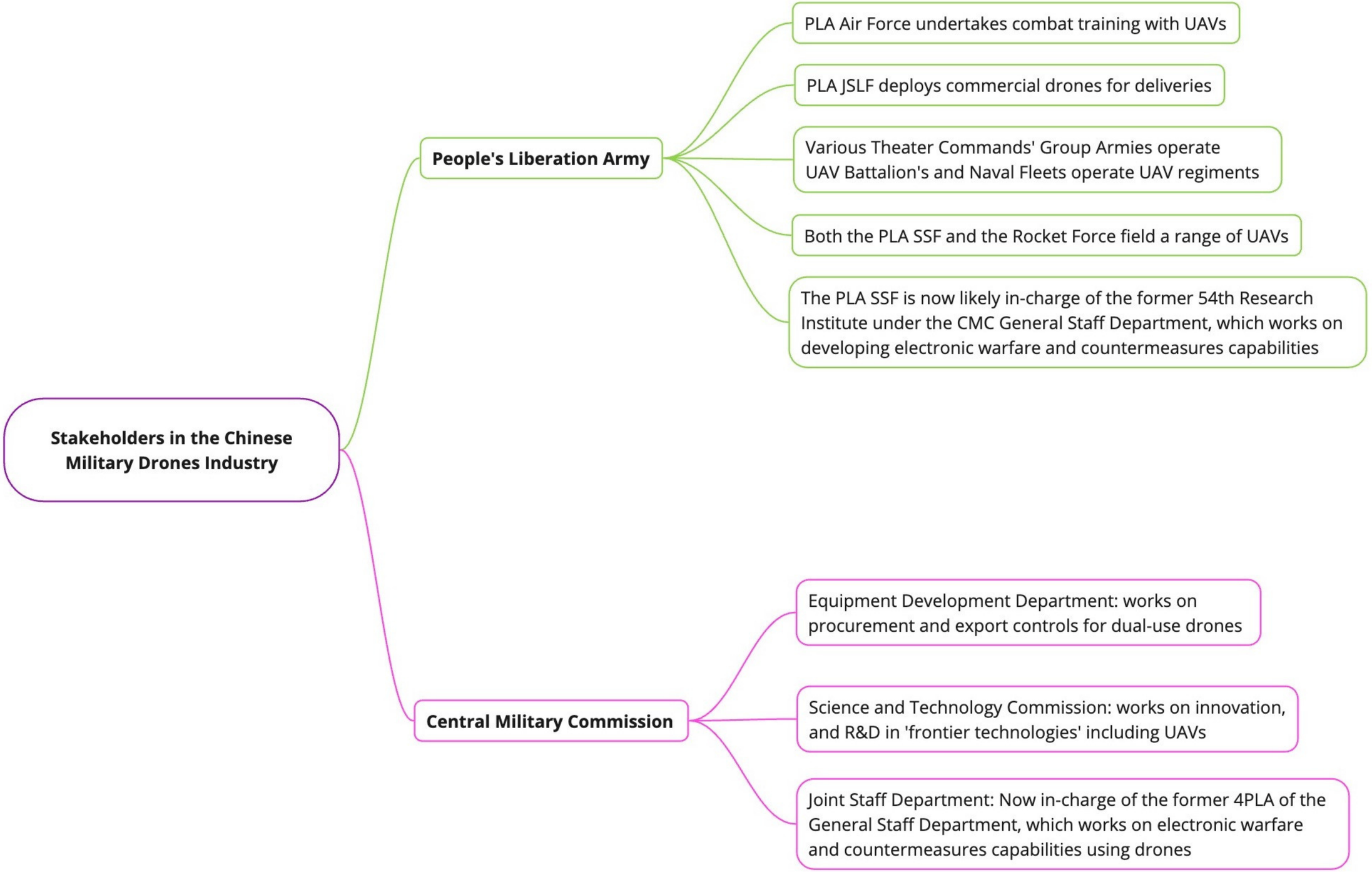
II-150Y/ WF-K150Y

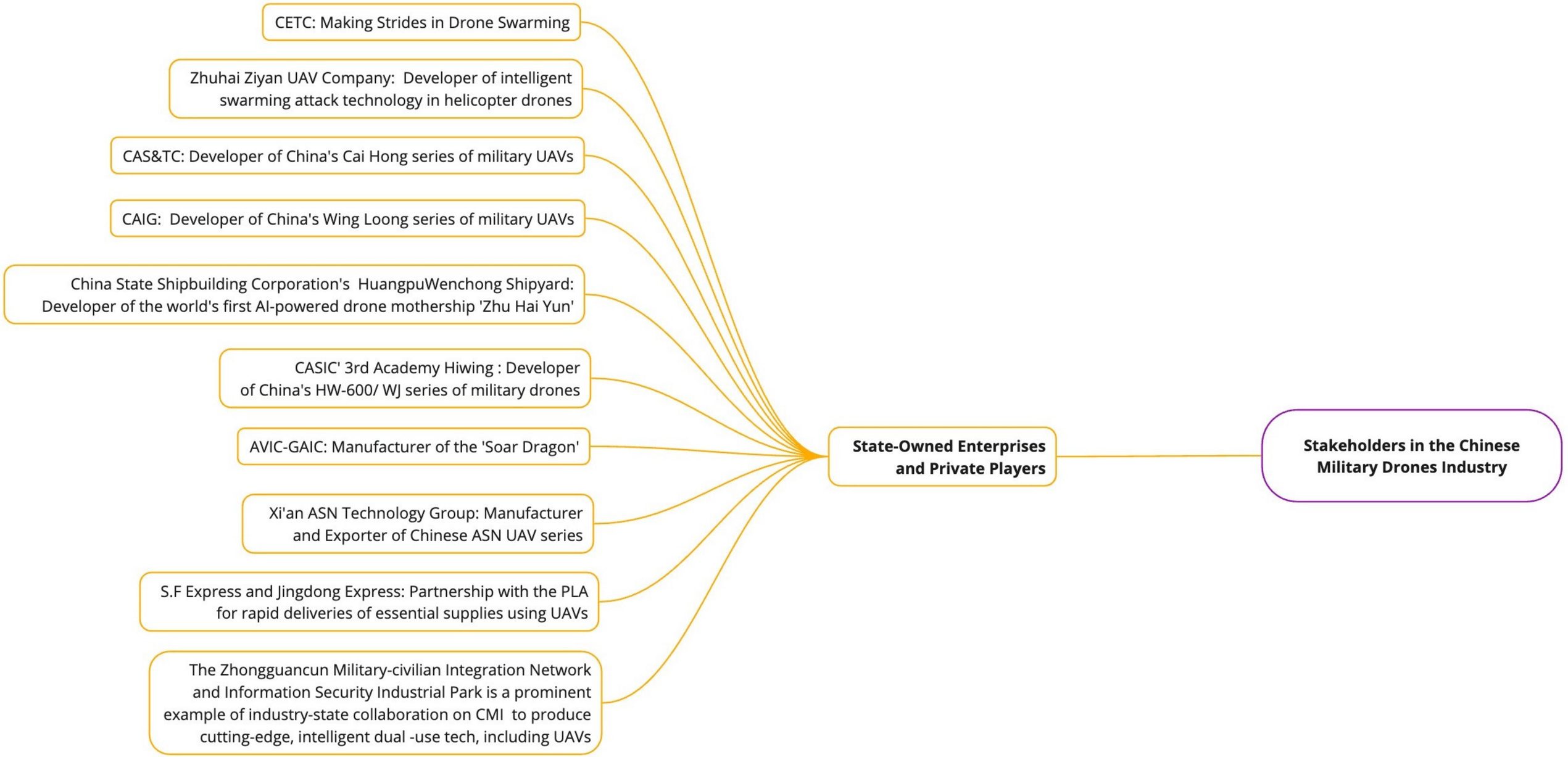
- **Manufacturer: Undisclosed**
- **Unmanned Aerial Vehicle (No Crew)**
- **Length: 3.2 meters**
- **Wingspan: 1.4 meters**
- **Mission Payload: 15 kilogram**
- **Max. Weight (Take-off): 150 kilogram**
- **Max. Speed: 230 mps**
- **Flight Endurance: One hour**
- **Service Ceiling: up to 10000 meters**
- **Max Manoeuver of G-Force: 5G**

Photo Credits: militadrones.org.cn

MIND-MAPS OF STAKEHOLDERS INVOLVED

Made using Miro Board


Stakeholders in the Chinese Military Drones Industry
People's Liberation Army
PLA Air Force undertakes combat training with UAVs
PLA JSLF deploys commercial drones for deliveries
Various Theater Commands' Group Armies operate UAV Battalion's and Naval Fleets operate UAV regiments
Both the PLA SSF and the Rocket Force field a range of UAVs
The PLA SSF is now likely in-charge of the former 54th Research Institute under the CMC General Staff Department, which works on developing electronic warfare and countermeasures capabilities
Central Military Commission
Equipment Development Department: works on procurement and export controls for dual-use drones
Science and Technology Commission: works on innovation, and R&D in 'frontier technologies' including UAVs
Joint Staff Department: Now in-charge of the former 4PLA of the General Staff Department, which works on electronic warfare and countermeasures capabilities using drones


Stakeholders in the Chinese Military Drones Industry
State-Owned Enterprises and Private Players
CETC: Making Strides in Drone Swarming
Zhuhai Ziyan UAV Company: Developer of intelligent swarming attack technology in helicopter drones
CAS&TC: Developer of China's Cai Hong series of military UAVs
CAIG: Developer of China's Wing Loong series of military UAVs
China State Shipbuilding Corporation's HuangpuWenchong Shipyard: Developer of the world's first AI-powered drone mothership 'Zhu Hai Yun'
CASIC' 3rd Academy Hiwing : Developer of China's HW-600/ WJ series of military drones
AVIC-GAIC: Manufacturer of the 'Soar Dragon'
Xi'an ASN Technology Group: Manufacturer and Exporter of Chinese ASN UAV series
S.F Express and Jingdong Express: Partnership with the PLA for rapid deliveries of essential supplies using UAVs
The Zhongguancun Military-civilian Integration Network and Information Security Industrial Park is a prominent example of industry-state collaboration on CMI to produce cutting-edge, intelligent dual -use tech, including UAVs

Stakeholders in the Chinese Military Drones Industry

Academic Institutions [35]

- Academy of Military Sciences: PLA's premier defense science institution; operates the Intelligent Unmanned Systems Research Center (无人系统研究中心)
- National University of Defense Technology: Works on key military tech; Developer of a new drone swarm system with AI-enabled 'self-repair'
- Beijing Normal University: Developer of 'Polar Eagle' fixed-wing UAV for Arctic Exploration
- Northwestern Polytechnical University: Parent company of ASN drones; operates an Institute of Special UAV Technology (无人机特种技术国家重点实验室/无人机特种技术国防科技重点实验室)
- Air Force Engineering University: Operates an Equipment Management and Unmanned Systems Engineering School (装备管理与无人机工程学院)

Other Governmental institutions

- SASTIND: It's National Defense Science and Technology Industry 2025 Plan lays out policy priorities in defense manufacturing, such as intelligent UAVs; organiser of 'China Defense' exhibition for unmanned and anti-drone systems
- National and provincial level 'Military-Civil Fusion Development Committees' coordinate sharing of knowledge and know-how on military UAV tech between state authorities (PLA, CMC, State Council) and industry players

GLOSSARY/ ABBREVIATIONS

- **AI:** Artificial Intelligence; a field of computer science that focuses on the creation of machines that mimic human cognition to perform tasks that typically require human intelligence
- **UAV:** Unmanned Aerial Vehicles (used interchangeably with drones)
- **USVs:** Unmanned Surface Vehicles
- **PLA:** People's Liberation Army; the armed forces wing of the Communist Party of China (CPC)
- **PLA-N:** PLA Navy; PLA-AF: PLA Air Force; PLA-SSF: PLA Strategic Support Force; PLA-LSF: PLA Logistics Support Force; PLA-RF: Rocket Force; TC: Theater Command
- **MCF:** Military-Civil Fusion; the pooling of knowledge and know-how-based resources between civilian/ industry and military entities (such as a drone manufacturing conglomerate and the PLA)
- **CMI:** Civil-Military Integration; same as above
- **CAIG:** Chengdu Aircraft Industry Group
- **AVIC-GAIC:** Guizhou Aircraft Industry Corporation
- **ASN:** Aisheng
- **HAIG:** Hongdu Aviation Industry Group
- **CAS&TC/ CASC:** China Aerospace Science and Technology Corporation

GLOSSARY/ ABBREVIATIONS

- **CASIC:** China Aerospace Science and Industry Corporation
- **CETC:** China Electronics Technology Group Corporation
- **RI:** Research Institute
- **HALE:** High-Altitude, Long-Endurance (used in the context of range and endurance of UAVs)
- **MALE:** Medium-Altitude, Long-Endurance (used in the context of range and endurance of UAVs)
- **EO/IR:** Electro-Optical/Infrared; refers to a combined technology that involves the use of both electro-optical and infrared sensors for imaging and detecting objects in various applications
- **SAR:** Synthetic Aperture Radar; a remote sensing technology that uses radar to create high-resolution images of the Earth's surface, even in adverse weather conditions and during nighttime
- **DNN:** Deep Neural Networks; also known as deep learning; are a class of artificial neural networks (ANNs) with multiple hidden layers between the input and output layers
- **CNN:** Convolutional Neural Networks; a specialized type of deep neural network specifically designed for processing grid-like data, such as images and videos
- **Kill Chain:** As per the 2023 Military UAV Industry In-Depth Report by 'Research Capital', "Kill chain" refers to "an orderly chain of interdependent links in the process of striking a target." From the perspective of a 'kill phase', the kill chain can usually be divided into six stages: find, fix, track, target, engage, and assess.

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