CENTRE FOR AIR POWER STUDIES (CAPS)
Forum for National Security Studies (FNSS)

AEROSPACE NEWSLETTER

The Indian Air Force Tejas performs at the opening ceremony of the Singapore Air Show on February 15, 2022.

Source: eurasiantimes.com

VOL III NO 3 2 March, 2023

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"One who controls the Earth orbits, controls Near-Earth space. One who controls Near-Earth space, controls the Earth. And who dominates the Earth is the custodian of humankind."

-The space version of Heartland Theory put forth by US Maxwell Air Force Base[1].

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Air Marshal Anil Chopra (Retd)
Director General, Centre for Air Power Studies |

23 Feb 2023

Source: First Post | https://www.firstpost.com/opinion/indo-us-air-power-connect-why-there-is-pitch-for-an-american-fighter-12195552.html

Lockheed F-35. Image Credit: Gp Capt Beri

The United States contingent at the Aero India 2023 was one of the largest ever. For the first time a fifth-generation aircraft had not only been brought to an Indian airshow but also performed the flying display. The U.S. defence sales in the last over a decade have mostly been in the military aviation sector.

Having already sold transport aircraft and helicopters, the pitch now is to push an American fighter into the Indian defence ecosystem. The meetings and presentations were all geared towards the same.

The U.S. defence sales in the last over a decade have mostly been in the military aviation sector. Having already sold transport aircraft and helicopters, the pitch now is to push an American fighter into the Indian defence ecosystem.

US-India Strategic Congruence and QUAD Connection

The U.S. interests to contain competitor and possible rival China brought India into USA's Indo-Pacific strategy. India, a long term friend of now weakened Russia needed U.S. cooperation on global security matters; support for inclusion of India in United Nations Security Council (UNSC); greater role in World Bank and IMF; and admission into multilateral export control regimes like Nuclear Suppliers Group, MTCR, Wassenaar Arrangement, and Australia Group. Post 2000, the USA became more open to selling high end military equipment to India. In 2016, India and USA signed the Logistics Exchange Memorandum of Agreement (LEMOA) and India was declared a major defence partner of the USA. In September 2018 India and USA signed the Communications Compatibility and Security Agreement (COMCASA), thus increasing interoperability between two nation's militaries. It is the India specific version of the much wider Communication and Information on Security Memorandum of Agreement (CISMOA).

It allows India to procure and transfer specialised equipment for encrypted communications for US origin military platforms like the C-17, C-130, and P-8Is, thus improving operational efficiency. Basic Exchange and Cooperation Agreement, the last of the key foundational agreements was signed in 2020.

India is an important member of Quad now. All the four partners have regular summit level and 2+2 minister level meetings. There are military logistics agreements between all, and they all take part in regular military exercises. The USA has been supplying military equipment. President Barack Obama became the first US president to be the chief guest at Republic Day on 26 January 2015. Among the increasing cooperation in defence, aviation has seen the

fastest results.

US Military Aircraft in India

IAF first ordered the Lockheed C-130J-30 Super Hercules aircraft in early 2008 for special operations under the US government's Foreign Military Sales (FMS) program. The Indian Navy received the Boeing P-8I Poseidon for maritime surveillance, Electronic Intelligence (ELINT), anti-submarine warfare (ASW) roles.

In 2009, the IAF inducted three specially equipped Boeing 737 Business Jet (BBJ) for VVIP duties. Boeing C-17 Globemaster III strategic airlift military transport aircraft were inducted next. Two custom-made B-777 have also been procured to replace the older Air India B-747 jumbo jets for VVIP duties. Boeing Apache Longbow AH-64E attack helicopters, and Boeing CH-47 D/F Chinook heavy-lift helicopters formed the rotary-wing purchases.

In June 2017, the US State Department approved the sale of 22 General Atomics MQ-9 Guardian/Predator-B long-range unmanned combat aerial vehicle (UCAV) drones to India. The MQ-9 has both land and sea variants, and can be armed with up to four AGM-114 Hellfire air-to-surface missiles and laser-guided bombs. Two have been on lease with the Indian Navy since 2020. The case for procuring 10 each for the three armed forces is under processing.

Make In India: Boeing

Boeing has been a major player in India's commercial aviation sector, and Air India has recently announced a huge airliner order. Boeing also has a huge presence in military aircraft with Indian Air Force's (IAF) C-17, BBJ, VVIP B-777, and Chinook and Apache helicopters, and Indian Navy's P-8I. Boeing's F-18 Super hornet is vying for IAF (114 fighter program) and Indian Navy's (57 carrier aircraft) contracts. Boeing has set up a Research & Technology Centre in Bangalore.

A public-private partnership brings together Boeing, Hindustan Aeronautics (HAL) and Mahindra's global scale, manufacturing and supply chain expertise. HAL has been the single-source producer of 757 overwing exit doors. HAL has also manufactured the 777 up-lock boxes, F/A-18 gun bay doors, F/A-18 wire harnesses, P-8I weapons bay doors, and P-8I identification friend-or-foe transponders. BEL is also on contract to provide F/A-18 flight deck cockpit panels. HAL makes a gun-bay door for the F/A-18. Boeing has invested in engineering centres at Bengaluru and Chennai with a talented pool of over 3,000 engineers.

Boeing's joint venture with Tata Advanced Systems Limited (TASL) is for aerospace and defence manufacturing including unmanned aerial systems. The joint venture (JV) will manufacture aero-structures for aircraft and collaborate on integrated systems development opportunities in India. TASL is already manufacturing aero-structures for CH-47 Chinook and Apache helicopters, including for global customers.

In September 2014, Dynamatic Technologies (DTL) and Boeing inaugurated a plant to manufacture critical parts for Chinook helicopters, including ramp and pylons. Dynamatic Technologies and Tata Advanced Materials Limited (TAML) have already delivered P-8I power and mission equipment cabinets, and TAML is making auxiliary power unit door fairings and composite tail-cones for the P-8I. Boeing created a facility with TAL Manufacturing Solutions Ltd to manufacture floor beams for the Boeing 787-9 Dreamliner. TAL also makes ground support

equipment for the C-17.

Bharat Electronics Limited (BEL) has delivered the Indian-designed Data Link II for the P-8I. BEL has also delivered the identification friend-or-foe (IFF) interrogator. Electronics Corporation of India (ECIL) has provided the speech secrecy systems for the P-8I.

Hyderabad based Avantel Ltd has delivered the mobile satellite systems for P-8I. Hyderabad-based Cyient (formerly Infotech) has supported a number of critical design-engineering projects for Boeing aeroplanes, and currently provides design and stress support on the 747-8 Freighter and the 787-8 and 787-9.

Lockheed Martin: Big in India

Lockheed Martin, the world's biggest arms manufacturer, is looking for a "game-changing" partnership in India. Lockheed Martin is the pre-eminent designer, developer and manufacturer of the world's most advanced fighter aircraft like the F-16, F-22 and F-35. They have a joint venture company with TASL where airframe components for the C-130J airlifter and the S-92 helicopter are manufactured in India in large numbers. Production of more than 5,000 precision components that compose each S-92 cabin is 100 percent indigenous to India. All C-130Js delivered to customers around the world have major aero-structure components from India.

They are looking to sell F-21 aircraft (advanced version of F-16) for IAF. The proposal is meant to put India at the epicentre of the world's largest defence ecosystem and deliver unmatched sustainment and export opportunities. 2250 F-16 are still flying globally. TASL has been chosen to produce the F-16s in India. Meanwhile, Lockheed Martin has begun building F-16 wings and will start exporting from the facility in Hyderabad in 2020. In July 2019, Lockheed Martin signed MoUs with Indian start-ups such as Terero Mobility, Sastra Robotics, and NoPo Nanotechnologies to boost India's aerospace and defence industry.

As many as 24 Lockheed Martin's Sikorsky multi-role MH-60R Seahawk maritime helicopters for the Indian Navy's anti-surface and anti-submarine warfare operations are under induction. Lockheed Martin also provides research grants for teams from Indian universities to work with local industry partners to develop design specifications.

General Electric (GE)

General Electric is an American multinational that operates in aviation, healthcare, renewable energy, and transportation, among many others. GE's presence in India dates back to 1902 when they installed India's first hydropower plant. GE Aviation is the world's leading producer of large and small engines for commercial, military, business and general aircraft. GE supplies F404IN20 engines for the Light Combat Aircraft (LCA) 'Tejas' Mk-1. The F414-INS6 engines are selected to power the Mk-2 version. GE's CFM56 engines power the Indian Navy's P-8I. GE's some other systems have been deployed on various Indian platforms including the Hawk Mk 132, SEPECAT Jaguar, P-8I, C130J and HJT-36 Sitara. GE has joined with Tata group to make LEAP engines in India.

Military Exercises and Interoperability

Indo-US military exercises have come a long way since exercise 'Shiksha' of 1963 when IAF was exposed to modern air defence concepts and high performance air combat. The two armies have been conducting exercise 'Yudh-Abhyas'. U.S.,

India, Japan, and some other navies participate in annual exercise 'Malabar'. Rim of the Pacific Exercise (RIMPAC) covers the broad expanse of the Indo-Pacific. From 2004 onwards, 'Cope India' series of Indo-US air exercises began.

State of the art aircraft participate from both sides. Participation in Red-Flag advanced air combat training exercises at Nellis Air Force Base, Nevada, and at Eielson Airbase in Alaska give the IAF exposure to a NATO-like air environment. The USA had great presence in the recent Pitch Black exercise in Australia where many countries fielded F-35s.

India Innovation Growth Program

As a part of its larger commitment, Lockheed Martin has sponsored and supported the India Innovation Growth Program (IIGP) since 2007 in partnership with the Indian Department of Science and Technology, Indo-U.S. Science and Technology Forum, Federation of Indian Chambers of Commerce and Industry, Stanford Graduate School of Business, and the IC2 Institute at the University of Texas. IIGP has supported more than 400 innovators and start-ups with in-depth technology commercialization training and handholding support to commercialise and scale their ventures. To date, the revenue generated for the Indian entrepreneurs through this program is over $1 billion.

Defence Technology and Trade Initiative (DTTI)

The India US Defence Technology and Trade Initiative (DTTI) was signed in 2012. DTTI's main aim is to strengthen India's defence industrial base, explore new areas of technological development and expand Indo-US business ties.

The DTTI has now matured enough where its varied activities could be translated into accomplishments. Among the ambitious projects identified are a plan to share jet engine technology, an initiative that has floundered given a strict export control regime in the US and the lack of a strong business case. Focus on start-ups is likely to enable US-based research labs to work in coordination with Indian companies for cutting edge defence technologies. In addition, the two sides are also discussing the possibility of jointly developing systems for approved third nations to pursue export opportunities. Cooperation in the field of space technology is also of interest.

Strategic Trade Authorization

The United States has designated India as Strategic Trade Authorization-1 (STA-1) country that will allow the country to buy highly advanced and cutting-edge sensitive technologies from America. This coveted status brings India in par with US's closest allies and partners such as NATO, Japan, South Korea and Australia. With this, there is an ease in restrictions for high-technology product sales to India, and India will receive licence-free access to a wide range of dual-use technologies in conjunction with steps that India has committed to take to advance its export control objectives. It will benefit U.S. manufacturers while continuing to protect its national security. Bilateral defence trade which was essentially zero in 2008, has reached an estimated $22 billion by the end of 2022.

US-India Business Council (USIBC)

The U.S.-India Business Council (USIBC) was formed in 1975 as a business advocacy organisation to enlighten and encourage the private sectors of both India and the United States to enhance investment flows. The organisation serves as a direct link between business and

government leaders, resulting in increased trade and investment to strengthen ties between the two nations. Aerospace & Defence are a major area today.

Defence Policy Group (DPG)

The India-US Defence Policy Group (DPG) in Washington is the top official-level meeting mechanism between India and the US on defence issues, which comprehensively reviews and guides all aspects of bilateral cooperation between the two countries. The meetings take stock of the progress made in various fields of defence cooperation, including in defence trade, technology, procurement, industry, R&D and mil-to-mil engagement. There are various working groups.

Threat of Sanctions Against India

In October 2018, India inked the agreement worth $ 5.43 billion with Russia to procure five S-400 Triumf surface-to-air missile defence systems, ignoring America's Countering America's Adversaries Through Sanctions Act (CAATSA). The U.S. threatened India with sanctions. India was also threatened over India's decision to buy oil from Iran.

Sanctions if imposed could have a disastrous effect on Indo-U.S. relations. However, the USA is conscious of India's requirements and sensitivities and treads a mid-path.

Future Military Aircraft Push

Having already got into India's transport, maritime and helicopter sales ecosystem, USA is now keen to sell fighter aircraft. Large scale military sales will increase India's dependency on the USA and start reducing India's huge Russian military aircraft basket. The USA feels that it is still premature for India to be offered the F-35 fifth-generation fighter. They would prefer to first sell a 4.5 generation aircraft of the F-21, F-18 class or at best the F-15E/F.

India has currently been linking the fighter aircraft selection to both Make-in-India and transfer of important technologies, especially the aero-engine. Also some are questioning, is India ready for yet another fleet of aircraft in its already multi-fight fleet mix? USA has also been pushing for the Boeing KC-46 Flight Refuelling Aircraft (FRA). They are trying to strengthen the case that they will offer both 'flying boom' and 'probe and drogue' refuelling options, that are today required for India's diverse fleets. The other area of U.S. push is the General Atomics Predator drones. The Government of India that follows strategic autonomy will take appropriate calls.

India is today in an enviable position where the Russians, Americans and Europeans are wooing her as a geo-strategic friend and as a defence systems market. It is clear that the U.S. needs India to counter-balance China in the Indo-Pacific. They want India to dominate the Indian Ocean and act as a democratic pillar against Chinese expansion and threat. The future sees greater defence cooperation between the two largest and powerful democracies.

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Aerospace Power: IAF's Doctrinal Overview

Diptendu Choudhury | 10 Feb 2023

Source: ORF India | https://www.orfonline.org/expert-speak/aerospace-power-iafs-doctrinal-overview/

The biggest challenge faced by air power across the world is its complexity and the consequent difficulty in understanding it. Churchill's observation over eight decades ago "Air Power is the most difficult of military force to measure or even express in precise terms" holds especially true in the Indian context. While powerful militaries the world over have long accepted the salience of air power in their respective military and national strategies, India's surface-centric security focus, even today misperceives air power as a mere support service, adjunct to the service-specific operational strategies of the continental and maritime domains.

The newly revised doctrine seeks to overcome the past inadequacy in the wider knowledge and leveraging of air power in India's national security and interests.

This is exacerbated by a long history of restrained use of air power in all of India's wars, except for its sole unfettered exploitation in the 1971 war with Pakistan. Disconcertingly, it tends to limit the nation's security strategies and choices in its response matrix, especially considering that both China and Pakistan, our inimical neighbours, have strong air forces which will play an important role in any future conflict. Also, given India's growth trajectory, and Asia as the locus of future geopolitics, the review of the IAF doctrine is timely and pertinent. The opening words of the Chief of Air Staff in the recently revised Doctrine of the Indian Air Force "The IAF has, over the years, transformed into a modern aerospace power that is capable of controlling and exploiting air and space environments in order to achieve India's national and security objectives" serves to herald the present status of the nation's aerospace power and its inexorable future relevance.

The document begins with the IAF's transition to an aerospace power due to the air and space continuum, the extensive and inexorable space dependency of the service, and the need for robust security of the nation's space-based and space-related assets in the future. It explains how the technology-transformed core characteristics of reach, flexibility and versatility, mobility, responsiveness, offensive lethality, and trans-domain capabilities also blend and transform the very principles of war. It also provides conceptual clarity on the close intertwining of national security with the key contemporary and future premises of aerospace power, which also underpin the evolution process of the doctrine, and the articulation of objectives of the service. A novel inclusion is a chapter on air strategy, which covers its doctrinal and structural engagement with the nations' joint military strategy, as well as the land and maritime strategies, across the entire spectrum and levels of conflict. While sovereignty protection, deterrence, air diplomacy, and nation building constitute its peacetime strategy, in a first no-war-no-peace strategy,

covers the interregnum between peace and war is also laid down. Geopolitical and regional security realities, state-sponsored terror, the continuous simmering on India's hostile borders and internal security challenges serve as the basis for the employment of aerospace power in information dominance, shaping operations, and external and internal security operations.

The wartime strategy has considered the defining aspects of past, contemporary and likely future precepts in the employment of aerospace power in the unique multi-domain-multi-spectrum Indian security context. The critical doctrinal imperative of control of air for the holistic application of combat power of all three services has been underscored in the ongoing Russo-Ukraine war. The underpinning of IAF's historically demonstrated commitment to joint operations is clearly evident in the structural connection between IAF's combat-enabling, enhancing, and sustaining operations with the overall application of joint combat power. Equally importantly, the wartime air strategy underscores the distinction between coordinated air operations with the other services, and the independent critical strategic air operations of the IAF. These will carry the national resolve and the fury of war deep into the adversary's territory to strike its military and strategic centres of gravity, like it uniquely did deep inside West Pakistan, in the 1971 war. These include targets that will weaken the adversary's capacity to wage war, affect its long-term national capacity, and exert pressure on its political will. All future conflicts will be impacted directly and significantly by the capabilities of IAF's conjoined twins of air power – offensive air operations and air defence operations. Given that India's future battle spaces will be highly contested, the two factora will play a defining role in the surface operations in the tactical battle frontages which are likely to be of limited depth; the logistics nodes, lines of communications, and deployed military assets in the intermediate depths; the depth strategic targeting. The doctrine also elaborates how capabilities of battle-space transparency, combat networking, cyber and information warfare, electronic warfare, techno-logistics, administration and human resource management, and training, all come together for multi-domain operations in the expanded battle spaces of future conflicts.

While powerful militaries the world over have long accepted the salience of air power in their respective military and national strategies, India's surface-centric security focus, even today misperceives air power as a mere support service, adjunct to the service-specific operational strategies of the continental and maritime domains.

IAF's clear understanding of the relevance of space in its future capabilities and the close interconnect of research with the development of civil-military industrial capabilities are highlighted. Also remarkable, is the nuanced and mature approach taken in articulating that space is a larger national common and serves as a larger national interest. Future roles beyond the national security construct, enabled by the wide spectrum of choices which kinetic hard power and the immense non-kinetic soft power capabilities aerospace power provides, are elaborated in the closing chapters. It includes the furtherance of nation-building, assisting statecraft and foreign policy, regional security and stability in the IOR and Indo-Pacific, and other larger national interests. The technology-agile character of the service and its ability to swiftly adapt its tactics

doctrines and strategies allows for service-specific and joint future capability and capacity accretion by fostering niche indigenous technology development.

By articulating the IAF's character, ethos, objectives, roles, and capabilities, and very importantly by laying down what it can and cannot do, the doctrine seeks to overcome the past inadequacy in the wider knowledge and leveraging of air power in India's national security and interests. It is also timely given the efforts underway in the security establishment to evolve national defence and security strategies for the future.

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Air Power

IAF Develops Indigenous 'Vayulink' Platform for Jammer-Proof Communication with Base Station

17 Feb 2023

Source: Times of India | https://timesofindia.indiatimes.com/india/iaf-develops-indigenous-vayulink-platform-for-jammer-proof-communication-with-base-station-aero-india-2023/articleshow/98011207.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst

BENGALURU: The Indian Air Force has come out with an innovative solution that would help pilots to deal with bad weather and also provide them jammer-proof uninterrupted communication with the base station.

Known as 'Vayulink', the data link communication uses the Indian Regional Navigation Satellite System (IRNSS) that is also known as NAVIC, to send radio communication to the base station when the signals are low, an IAF officer involved in the project said.

The important aspect of the technological solution is that it prevents fratricide or friendly fire, he added.

The IAF has put up a gallery on Vayulink to provide information about its platform at the India Pavilion in the ongoing Aero India 2023 here.

"Vayulink is an ad-hoc data link

communication system, which when installed in an aircraft, gives position of other aircrafts close by, encrypted traffic data over secured channel," Wing Commander Vishal Mishra told PTI.

When the planes are flying close to any friendly forces on grounds during a combat situation, the aircraft display gives the position of such forces on the ground including tanks and troops beneath, the IAF officer said.

"The advantage of the system is when you are going into combat, it prevents fratricide. It means, you are able to know where our ground forces are present," he claimed.

The Vayulink system also prevents aircraft collision, provides better combat teaming and helps plan real-time basis where multiple teams can get together and go towards the target coming from different areas, Wing Commander Mishra pointed out.

The system can also give the pilots data on the weather, he added. "When you are flying above the hills where there is no radio communication, the system can give you radio communication also," Wing Commander Mishra said.

According to him, Vayulink is helpful for the Air Force, Army and Navy, while it can be given to government services as well since the technology has been made by the Indian Air Force.

He claimed Vayulink has been developed by the IAF only and it is a very secure system.

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The Mystery of the Chinese Balloon. It Violates International Practices

Air Cmde Prashant Dikshit VM (Retd) | 11 Feb 2023

Source: Financial Express| https://www.financialexpress.com/world-news/the-mystery-of-the-chinese-balloon-it-violates-international-practices/2978850/

China has also set up a research center to design and develop high-altitude balloons and stratospheric airships under the Chinese Academy of Sciences, a top government think tank.

In the realm of strategic initiatives reviving a practice of using a balloon for reconnaissance by the Chinese regime is certainly a mysterious methodology. It needs to be examined. Believed to be quite a simple and a cost effective way of looking into the adversary. But it is very old technology like a weather balloon. And will it work is the cardinal question? On the face of it, it appears to be a publicity drive by the Chinese Regime for the Chinese Academy of Sciences. We are aware that while China already deploys a sprawling satellite network for sophisticated long-range surveillance, Chinese military experts have now highlighted the advantages of lighter-than-air vehicles.Unlike rotating satellites or traveling aircraft, stratospheric airships and high-altitude balloons “can hover over a fixed location for a long period of time” and are not easily detected by radar.But hovering over a spot is not easily possible and balloons will go where the wind

takes it and the device does not carry any power propelling capacity. And all radars managing air spaces for civilian traffic will easily detect it.

The Balloons are at an altitude between 60 to 70 thousand feet. This is "near space" and is considered beyond the jurisdiction of National Air Defence Zones and controlled air spaces of countries. It also does not interfere with the Outer Space Treaty. I believe that this is the singular advantage.There is an unconfirmed report that one such balloon has been spotted in the vicinity of Andaman and Nicobar Islands.

Chinese researchers, both military and civilian, have published more than 1,000 papers and reports on "near space," many of which focus on the development of "near space flight vehicles." China has also set up a research center to design and develop high-altitude balloons and stratospheric airships under the Chinese Academy of Sciences, a top government think tank.

Reports suggest that these high altitude Balloons have been spotted in parts of USA's Air Defence network. A US military commander on Monday accepted that the US has a "domain awareness gap" that allowed three other suspected Chinese spy balloons to transit the continental US undetected during the previous administration.That appears to be a political statement. What emerged however was that the American Air Force was working on methodologies to bring the device down without causing harm to its environment and strategic ripples in the North American Continent. It is learnt that they are no suitable aircraft available to undertake these missions to totally immediately stop the balloon from what it is engaged in because it can continue to remain in space for several days despite being hit.

Then there is a unique aspect of legality of bringing down a satellite without its owner's consent which is beyond its control zones. According to International Civil Aviation Organization (ICAO) rules, the Chinese Civil Aviation organization was expected to issue a NOTAM before launching the balloons. Which it seems has not been done although they are signatories to all ICAO norms. Although, an FBI team is working on understanding more about the equipment reclaimed from the balloon shot down over the sea – including what kind of data it could collect and whether it could transmit that in real time. Using a Geosynchronous satellite for real time transmission of the data is feasible but not easily possible considering the power pack onboard the balloons.

Chinese researchers, both military and civilian, have published more than 1,000 papers and reports on "near space," many of which focus on the development of "near space flight vehicles."

An example of advances China has made in this domain is the reported flight of a 100-meter-long (328 feet) unmanned airship known as "Cloud Chaser." A professor at Chinese University said the vehicle had transited across Asia, Africa and North America in an around-the-world flight at 20,000 meters (65, 616 feet) above the Earth.

According to Chinese state news agency Xinhua, a military expert explains how near-space lighter-than-air vehicles can survey and take higher resolution photos and videos at a much lower cost compared to satellites.An expert at the National University of Defense Technology in China, highlighted the progress by the US, Russia and Israel in developing these vehicles, adding China has also made its own "breakthroughs."

Another scientist on the team told the newspaper that compared with satellites; stratospheric airships are better for "long-term observation" and have a range of purposes from disaster warning and environmental research to wireless network construction and aerial reconnaissance.

US intelligence officials believe the Chinese balloon identified over the US in recent days is part of an extensive, Chinese military-run surveillance program involving a fleet of balloons that has conducted at least two dozen missions over at least five continents in recent years.

Beijing on Thursday said the US assessment was "likely part of the US' information and public opinion warfare" against China. It has maintained that the device identified over the US is civilian in nature, and made by private companies. But what we cannot escape is the Chinese attitude towards the world community in not conforming to international protocols and practices. A freely floating balloon is dangerous.They need to be publicly chastened for these misdemeanors.

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IAF Clears more than 119 Routes for Commercial Flights

Parvez Sultan | 14 Feb 2023

Source: News Indian Express | https://www.newindianexpress.com/nation/2023/feb/14/iaf-clears-more-than-119-routes-forcommercial-flights-2547279.html

Image used for representational purpose only. (File Photo | Martin Louis, EPS)

NEW DELHI: The Indian Air Force (IAF) has released 119 'conditional' air routes for commercial flight operations, which will bring down consumption of aviation turbine fuel (ATF), and travelling time and cut carbon emissions. The availability of airspace for civilian use will lead to a potential savings of Rs 1,000 crore per annum for airlines.

Briefing about the decision, Union Tourism and Culture Minister G Kishan Reddy on Monday said that the matter had been debated over the years but due to indecision civilian flights had to detour. "The issue was discussed at different levels in the government. The IAF, which controls the airspace, has agreed to leave the upper air space for civilian use under Atmanirbar Bharat initiative and around 119 conditional routes were given the nod," said the minister.

A conditional route (CDR) is a route or a portion, which can be planned or used under certain specified conditions only. Around 40 per cent of the airspace was unavailable for civilian

use till now forcing the airlines to adopt circuitous routes, leading to inefficient use of fuel and time along with avoidable extra expenditure.

"IAF controls 30 per cent of national airspace out of which 30 per cent has been released as upper airspace under flexible use of airspace (FUA)," Reddy added. FUA is an airspace management concept based on the principle that airspace should not be designated purely as civil or military, but rather as a continuum in which all user requirements are accommodated.

He added under regional connectivity scheme (RCS) Udan, the government so far has spent Rs 2,360 crore as viability gap funding to compensate the losses of the airlines operating on non-profitable routes.

"Till 2026, the target is to start 1,000 routes to connect small towns," Reddy added.

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Russian Bombers Intercepted by NORAD Near Alaska

15 Feb 2023

Source: Reuters | https://www.reuters.com/world/russian-bomber-jets-intercepted-by-norad-near-alaska-2023-02-15/

A Russian Tu-95MS strategic bomber performs a flight over the neutral waters of the Bering Sea, in this still image taken from a handout video released February 14, 2023. Russian Defence Ministry/Handout via REUTERS

Feb 15 (Reuters) - Several Russian strategic bombers and fighter jets were intercepted by North American air defence forces as they flew over international airspace near Alaska, the North American Aerospace Defence Command (NORAD) said, in routine incidents unrelated to tensions over the war in Ukraine.

The aircraft, which were identified on Monday, did not enter U.S. or Canadian airspace and did not pose a threat, the joint U.S.-Canadian centre said in a statement dated Feb. 14.

It added that the Russian flights were in no way related to the mysterious spate of airborne objects shot down by the U.S. military over North America in the past few weeks, the details of which remain unknown.

"NORAD had anticipated this Russian activity ... Two NORAD F-16 fighters intercepted the Russian aircraft," it said.

The United States also frequently carries out

surveillance operations that do not enter other countries' airspace and such flights are a common part of military operations.

"NORAD routinely monitors foreign aircraft movements and as necessary, escorts them," the statement added.

Russia said on Wednesday that it had carried out several flights over international waters in recent days, including in the Bering Sea between Alaska and Russia.

It said two of its Tu-95MS strategic missile carriers had flown over the Bering Sea accompanied by Su-30 jets, and that it had made similar "routine" flights north of Norway and over international waters near Russia's far east.

It did not say whether its aircraft had been intercepted.

"Long-range aviation pilots regularly perform flights over the neutral waters of the Arctic, North Atlantic, Black Sea, Baltic Sea and Pacific Ocean," Russia's defence ministry said.

North American security forces have been on high alert since a suspected Chinese surveillance balloon crossed into U.S. airspace, prompting the United States to shoot it and other objects down as it combs the skies.

While Russia has carried out flights over the Bering Sea before, its neighbours in the region have become more concerned about Moscow's military activity since its invasion of Ukraine last year.

Two Dutch F-35 fighters intercepted a formation of three Russian military aircraft near Poland and escorted them out, the Netherlands' defence ministry said in a statement late on Monday.

NATO member states have also ramped up military exercises in the Arctic in recent years, as Russia has expanded and renewed its military infrastructure in the region.

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F-22 Safely Shoots Down Chinese Spy Balloon Off South Carolina Coast

Jim Garamone | 04 Feb 2023

Source: Space Force| https://www.spaceforce.mil/News/Article/3288599/f-22-safely-shoots-down-chinese-spy-balloon-off-south-carolina-coast/

The Port of Duqm in Oman officially opened in February, 2022. Photo: Port of Duqm

President Joe Biden ordered the action on Wednesday, but it was delayed until the balloon was over water off the coast of South Carolina to ensure no Americans on the ground were harmed.

"The balloon, which was being used by the PRC in an attempt to surveil strategic sites in the continental United States, was brought down above U.S. territorial waters," Austin said.

The action was taken in coordination and support of the Canadian government. "We thank Canada for its contribution to tracking and analysis of the balloon through [North American Aerospace Defense Command] as it transited North America," Austin said. "Today's deliberate and lawful action demonstrates that President Biden and his national security team will always put the safety and security of the American

people first while responding effectively to the PRC's unacceptable violation of our sovereignty," Austin said referring to the Peoples Republic of China.

U.S. officials first detected the balloon and its payload on January 28 when it entered U.S. airspace near the Aleutian Islands. The balloon traversed Alaska, Canada and re-entered U.S. airspace over Idaho. "President Biden asked the military to present options and on Wednesday President Biden gave his authorization to take down the Chinese surveillance balloon as soon as the mission could be accomplished without undue risk to us civilians under the balloon's path," said a senior defense official speaking on background. "Military commanders determined that there was undue risk of debris causing harm to civilians while the balloon was overland."

An F-22 Raptor fighter from the 1st Fighter Wing at Langley Air Force Base, Virginia, fired one AIM-9X Sidewinder missile at the balloon.

The balloon fell approximately six miles off the coast in about 47 feet of water. No one was hurt.

Long before the shoot down, U.S. officials took steps to protect against the balloon's collection of sensitive information, mitigating its intelligence value to the Chinese. The senior defense official said the recovery of the balloon will enable U.S. analysts to examine sensitive Chinese equipment. "I would also note that while we took all necessary steps to protect against the PRC surveillance balloon's collection of sensitive information, the surveillance balloon's overflight of U.S. territory was of intelligence value to us," the official said. "I can't go into more detail, but we were able to study and scrutinize the balloon and its equipment, which has been valuable."

The balloon did not pose a military or physical threat. Still its intrusion into American airspace over several days was an unacceptable violation of U.S. sovereignty. The official said Chinese balloons briefly transited the continental United States at least three times during the prior administration.

While Chinese officials admitted that the balloon was theirs, they said it was a runaway weather balloon. "The PRC has claimed publicly that the high-altitude balloon operating above the United States is a weather balloon that was blown off course. This is false," the official said. "This was a PRC surveillance balloon. This surveillance balloon purposely traversed the United States and Canada, and we are confident it was seeking to monitor sensitive military sites."

The mission now transitions to one of recovery. There are a number of U.S. Navy and Coast Guard vessels establishing a security perimeter around the area where the balloon came to Earth. They are searching for debris, said a senior military official also speaking on background.

There is no estimate for how long the recovery mission will take, the military official said, but the fact that it came down in such a shallow area should make recovery "fairly easy".

The military official gave some detail of the engagement. The F-22 fired the Sidewinder at the balloon from an altitude of 58,000 feet. The balloon at the time was between 60,000 and 65,000 feet.

F-15 Eagles flying from Barnes Air National Guard Base, Massachusetts, supported the F-22, as did tankers from multiple states including Oregon, Montana, South Carolina and North Carolina. Canadian forces also helped track the

overflight of the balloon.

The Navy has deployed the destroyer USS Oscar Austin, the cruiser USS Philippine Sea and the USS Carter Hall, an amphibious landing ship in support of the effort.

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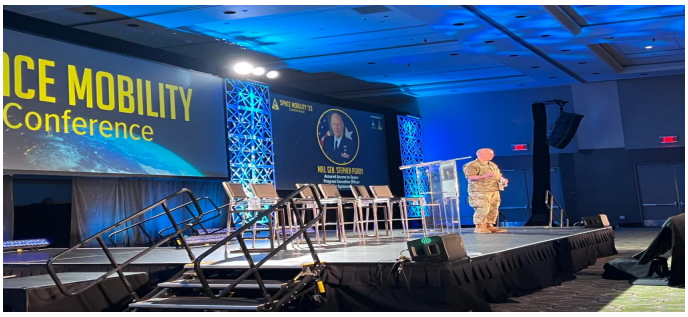
Space

Military to Tap Commercial Industry for 'Space Mobility' Services

Sandra Erwin | 21 Feb 2023

Source: Space News | https://spacenews.com/military-to-tap-commercial-industry-for-space-mobility-services/



Maj. Gen. Stephen Purdy, program executive officer for assured access to space, speaks Feb. 21, 2023, at the Space Mobility conference in Orlando, Fla. Credit: SpaceNews

ORLANDO — The U.S. Space Force is looking for ways to support future military operations with nontraditional space transportation systems and on-orbit logistics, the head of the national security launch program said Feb. 21.

The idea is to tap commercially available space vehicles and logistics services to fill the needs of military combatant commanders, said Maj. Gen. Stephen Purdy, program executive officer for assured access to space at the Space Systems Command.

Purdy's office oversees the procurement of national security space launch services and he also runs the East Coast space launch ranges.

He said the military can benefit from commercial capabilities to deliver cargo via rockets, deploy satellites to nontraditional orbits and refuel satellites to extend their operational life.

To promote this concept and strike up conversations with the private sector, the Space Systems Command hosted a "Space Mobility" conference Feb. 21 that drew about 1,100 executives from the space industry.

"It's hard to describe how fast we've matured and come along on the rocket cargo concepts and on-orbit maneuver and servicing and things like that," Purdy told SpaceNews.

"Just two years ago, we weren't even talking about or thinking about this," he said. "And now we're actually having a conference about it. We have to rapidly get after commercial capability," he added. "It's going to be an amazing future."

A number of space launch companies over the past few years have signed agreements with the U.S. Transportation Command, the organization that oversees global military logistics operations, to explore "rocket cargo" concepts to transport equipment across Earth via space. Now the Space Force wants to figure out how to buy these nontraditional services.

He said the Space Force traditionally has focused on launching payloads to orbit "but we didn't really look at the end-to-end logistics piece."

The Pentagon spends more than a billion dollars a year on launch services but it's still too early to project what it might spend on rocket cargo deliveries or on-orbit services. Purdy said it will take some time to complete the analysis

needed to justify budget requests, but in the meantime the goal is to send a message to the private sector that there will be a market.

"I would project that in the future there's probably some kind of a separate line for this that's different than launch," he said. "But we have to do our homework to go justify all that stuff, do your analysis and prove in a combative budget session."

There are commercial companies spending private capital to develop these types of services "so I'm not spending government money to do what they're doing themselves," Purdy said. "The question is how do I leverage that?" and build an acquisition organization to deliver that capability," he added. "So that's what we're trying to do with rocket cargo and on-orbit services."

The Space Force also wants to talk to companies developing commercial space stations for NASA. These will be multi-use orbiting space stations and there might be a national security application that hasn't yet been thought about, Purdy said.

Satellite Refueling

Refueling services for military satellites could grow into a sizeable market as the United States needs maneuverable spacecraft, Purdy said. U.S. Space Command, responsible for ensuring the safety of the nation's satellites, has warned that U.S. spacecraft are increasingly at a disadvantage because operators have to minimize maneuvers in order to preserve fuel.

Space Command has been asking for refuelable satellite for years and it is now finalizing "actual requirements language and documents," he said. The command is essentially saying the U.S. "cannot do warfighting in the space domain with satellites that have to last 15 years so we have to measure every drop of fuel … That's a horrible place to put the warfighters in."

Purdy pointed out recent comments by Lt. Gen. John Shaw, deputy commander of U.S. Space Command, highlighting U.S. satellites' lack of mobility. "We don't build a ship or a tank or an aircraft and say you're going to operate this for the next 15 or 20 years and you need to plan your fueling and all your operations based on the fact that you're never going to refuel these ever again."

The Space Force will be closely watching NASA's planned On-orbit Servicing, Assembly, and Manufacturing 1 (OSAM-1) mission to robotically refuel Landsat 7, a satellite that wasn't designed to be serviced. In this mission planned for 2025, NASA is "basically going to punch a hole in the fuel tank and try to fuel it," said Purdy. "I'm super interested in that, obviously, because if that's successful, we can prove that technology and go refuel a bunch of our satellites."

The other side of the equation is building the next generation of satellites so they're easily refueled. The next step in that area will be to agree on a standard so the industry can build interoperable refueling hardware. Purdy said the Space Systems Command's systems integration office is currently studying that issue.

Rocket Cargo

Purdy said he is in discussions with U.S. Transportation Command on forming a Space Force "sustainment operations and logistics" component to support the rocket cargo program, both for suborbital and orbital point-to-point cargo delivery.

"We absolutely would buy this as a service,"

Purdy said. "We have no plans to go lay down billions of dollars to build out spaceports and launch pads and go buy these kinds of rockets," he added. "Our desire is that commercial industry gets to a point where they can responsibly deliver military goods and logistics."

Right now SpaceX — which won a major contract from the Air Force Research Laboratory — is the leading contender "but there are other companies looking at that as well," he said.

SpaceX has said it plans to launch 200 to 300 times a year in the future, a number that got Purdy's attention. "If they're going to do that, the cost of launch is getting pretty negligible at that point, and that's really intriguing," he said. "From a rocket cargo perspective, the cost could end up being lower than delivering cargo on a military C-17 aircraft."

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Secret Russian Satellite Breaks Apart for Second Time, Spawning Debris Cloud

George Dvorsky | 08 Feb 2023

Source: Gizmodo.com | https://gizmodo.com/russian-satellite-breaks-up-orbit-kosmos-2499-1850088333

Illustration: Mark Garlick/Science Photo Library (AP)

A mysterious Russian satellite that launched to space in 2014 has experienced its second breakup event. The cause of Kosmos-2499's demise is unknown, and we may never find out the truth, given the satellite's veiled and suspicious history.

The U.S. Space Force's 18th Space Defense Squadron confirmed the breakup of Kosmos-2499 in a February 6 tweet. The squadron is now tracking 85 new pieces of debris associated with the event, which happened at 10:57 p.m. on January 3, 2023. At an estimated altitude of 727 miles (1,170 kilometers), it will take 100 years or more for the pieces to fall back to Earth, adding to the growing clutter in orbit.

That Kosmos-2499 collided with another object, such as a small piece of space debris or micrometeorite, is a distinct possibility, but the satellite's prior behavior in space and suspected purpose offers a more plausible explanation: it simply exploded. And, strangely, it would not be the first time, as Kosmos-2499 experienced its first breakup event on October 22, 2021, which likewise produced trackable debris, as Jonathan

McDowell, an astronomer at the Harvard-Smithsonian Center for Astrophysics, explained in an email.

The satellite's story began in May 2014, when it launched to space alongside three Russian Rodnik-type satellites, according to RussianSpaceWeb reporter Anatoly Zak. The satellite wasn't included in the rocket's payload manifest, so when it inexplicably appeared alongside the three Rodnik satellites, U.S. trackers presumed it to be a fragment and was designated as such: space debris Object 2014-028E.

But the object began to perform a series of complex orbital maneuvers, strongly suggesting the presence of an undisclosed fourth satellite. By October 2014, the U.S. reclassified the object as being payload and not debris. What's more, the U.S. military "was now rechecking orbital parameters of the mysterious satellite three or four times a day," Zak writes. The following year, Kosmos-2499 performed a rendezvous with its own Briz-KM rocket stage, and it continued to perform maneuvers up until 2017.

McDowell said the satellite seems related to Russia's Nivelir project, "most probably a project to build small satellites designed to inspect other satellites in space," according to an article from The Space Review published in May 2019. Russia has launched four of these satellites to date, two of which rendezvoused with their respective rocket stages.

Five years ago, a senior U.S. military official described the behavior of these satellites as "inconsistent with anything seen before from on-orbit inspection or space situational awareness capabilities" and alluded to the possibility that the satellites were related to a program for developing space weapons, that is, satellites capable of disabling other satellites in orbit. Years earlier, Roscosmos chief Oleg Ostapenko denied similar accusations, saying the devices were not "killer satellites," while refraining from explaining their purpose, according to RussianSpaceWeb.

As to why Kosmos-2499 has now seemingly exploded on two occasions, McDowell suspects it's tied to the liquid propulsion stage that allowed the satellite to perform multiple orbital changes, specifically the Fakel K50-10.6 propulsion system powered by hydrazine monopropellant. "There may be some who suggest it carried an explosive warhead for [anti-satellite] use, but I find that extremely unlikely," he said, adding that it also carried the RS-47 amateur radio payload.

The U.S. Space Force is tracking 85 fragments associated with the unexplained breakup event.

Ground observations suggested that Kosmos-2499 measured about one foot (0.3 meters) in length, but McDowell said those observations aren't very reliable and that the satellite might be closer to around 3 feet (1 meter) in length. That tracks in my mind, given the amount of debris spotted by U.S. trackers.

And yes, satellites can spontaneously explode while in space, a recent example being the Russian SOZ ullage motor, which exploded on April 15, 2022. Those motors date back to the Cold War, whereas modern spacecraft are designed to avoid this problem. Well, the Kosmos-2499 satellite being an apparent exception.

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United States and India Expand Civil Space Cooperation

Jeff Foust | 04 Feb 2023

Source: Space News | https://spacenews.com/united-states-and-india-expand-civil-space-cooperation/#:~:text=The%20biggest%20cooperation%20between%20the,launched%20by%20India%20in%202024

U.S. and Indian officials, including ISRO Chairman S. Somanath and JPL Director Laurie Leshin (center), reviewed the status of the payload for the NISAR mission as part of a visit to the U.S. by Somanath that secured expanded cooperation between the two countries in space. Credit: NASA/JPL-Caltech

WASHINGTON — U.S. and Indian officials agreed this week to expand civil space cooperation, including training Indian astronauts and flying payloads on commercial lunar landers.

In meetings this week in Washington, held with little public fanfare, the United States and India agreed to expanded cooperation in civil space and laid the groundwork for potential new efforts.

In a White House statement Jan. 31, the countries announced they would arrange for training of an Indian astronaut at NASA's Johnson Space Center. They did not disclose when the training would take place or what the "advanced training" would entail.

India has relied on Russia for astronaut training, sending several Indian Air Force pilots to the Star City cosmonaut training center for training in 2020. That training was part of India's Gaganyaan human spaceflight program that includes development by the Indian space agency ISRO of a crewed spacecraft that would launch on a version of its GSLV Mark 3 rocket.

In 2018, Indian Prime Minister Narendra Modi announced that the Gaganyaan program would place Indian astronauts into orbit by August 2022, the 75th anniversary of the country's independence. However, that first crewed launch has slipped to at least 2024 as ISRO gears up for a series of abort tests and uncrewed orbital test flights starting in the coming months.

The White House also announced that NASA and ISRO will work together to identify cooperation on NASA's Commercial Lunar Payload Services (CLPS) program, where NASA purchases flights of research payloads on commercial lunar landers. NASA and ISRO will convene a meeting of companies that have CLPS contracts with Indian aerospace companies within the next year.

As soon as this summer, ISRO is expected to launch Chandrayaan-3, its second lunar lander mission. The lunar lander that was part of Chandrayaan-2 crashed while attempting a landing in 2019, although the orbiter is operating. ISRO is also collaborating with the Japanese space agency JAXA on a future lunar lander mission, called Lunar Polar Exploration or LUPEX, projected to launch later in the decade.

The meetings this week also sought to expand commercial space activities between the companies. The White House announced a new initiative between the Commerce Department

and India's Department of Space that "will foster U.S.-India commercial space engagement and enable growth and partnerships between U.S. and Indian commercial space sectors."

India has started efforts to build up a commercial space industry in the country, with initiatives to support startups and give them access to ISRO facilities. Those startups include Skyroot Aerospace, which conducted a suborbital launch of its Vikram-S rocket in November from India's main spaceport as a precursor to its Vikram 1 small launch vehicle, and Pixxel, which is developing a constellation of hyperspectral imaging satellites.

American companies, particularly communications and geospatial service providers, are looking to expand into India, but have long complained of regulatory challenges for doing so. SpaceX, for example, has been working since late 2021 to secure permission to offer its Starlink broadband service in the country. However, that service is still "pending regulatory approval," according to a SpaceX map showing availability of Starlink globally.

The biggest cooperation between the United States and India in civil space currently is the NASA-ISRO Synthetic Aperture Radar (NISAR) Earth science mission, which features a jointly-developed SAR payload that will be integrated onto an Indian-built satellite and launched by India in 2024.

Indian officials who met with American counterparts in Washington, including ISRO Chairman S. Somanath, later went to the Jet Propulsion Laboratory to see the NISAR payload, which is scheduled to be shipped to India in February.

The White House stated that NASA Administrator Bill Nelson will travel to India in a reciprocal visit later in the year.

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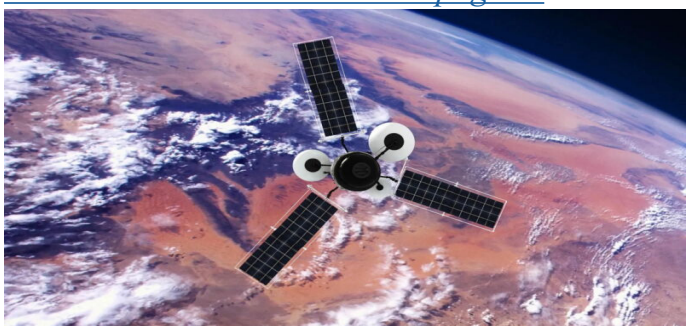
Enter the Hunter Satellites Preparing for Space War

Mark Harris | 02 Feb 2023

Source: Astechnica.com | https://arstechnica.com/science/2023/02/enter-the-hunter-satellites-preparing-for-space-war/?comments=1&comments-page=1



Enlarge / True Anomaly's satellites (not pictured) will spy on each other, using thrusters, radar, and multi-spectral cameras to approach within a few hundred meters.

Former US Air Force major Even "Jolly" Rogers is worried about a space war. "Conflict exists on a continuum that begins with competition and ultimately leads into full-scale conflict like what you're seeing in Ukraine," he says. The US, he adds, is already "in active competition with Russia and China for freedom of action and dominance of the space domain. And it's evolving very quickly."

So on January 26 last year, the former US Air Force major incorporated True Anomaly, Inc to "solve the most challenging orbital warfare problems for the US Space Force," he later tweeted.

According to a recent filing with the US Federal Communication Commission (FCC), True Anomaly is now gearing up for its first

orbital mission. In October, True Anomaly hopes to launch two Jackal "orbital pursuit" spacecraft aboard a SpaceX rocket to low earth orbit. The Jackals will not house guns, warheads, or laser blasters, but they will be capable of rendezvous proximity operations (RPO)—the ability to maneuver close to other satellites and train a battery of sensors upon them. This could reveal their rivals' surveillance and weapons systems or help intercept communications.

In their first mission, dubbed Demo-1, the Jackals will merely spy on each other, using thrusters, radar, and multi-spectral cameras to approach within a few hundred meters. If that goes well, Rogers envisages deploying thousands of autonomous spacecraft in service of the US military, controlled by a team of human operators and AI "to pursue adversaries wherever they fly, and to provide the tools of accountability."

Those tools start with understanding what technologies America's adversaries are deploying in space. "But an active defense is going to be required," says Rogers, now True Anomaly's CEO. "If you take the job of defense and protection of the domain seriously, you have to have the ability to do the joint functions of maneuver and fires." Although the military often uses "fires" to mean kinetic weapons like guns and shells, in the space context, it usually refers to jamming, electronic warfare, and cyberattacks.

Nothing on True Anomaly's website suggests that it is developing its own offensive weapons. However, in a series of posts last summer, Rogers tweeted: "Tactically disabling enemy spacecraft can be the difference between the loss of an entire Carrier Strike Group or its survival... And there are many ways to destroy spacecraft that don't ruin the environment. After all, they are just floating computers."

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Global Aerospace Industry

Russian Presence Nominal as US Aggressively Projects itself at Aero India 2023

Aksheev Thakur | 17 Feb 2023

Source: Indian Express | https://indianexpress.com/article/cities/bangalore/russian-presence-nominal-as-us-aggressively-projects-itself-at-aero-india-2023-8451798/

It has been a decade since Russia brought a fighter jet to Bengaluru. (Express Photo)

Engaged in a war with Ukraine for over a year now, Russia had only a nominal presence at Aero India 2023, which ended Friday, even though United Aircraft Corporation, Rosoboronexport and Almaz-Antey displayed miniature models of aircraft, radars and tanks that the country has deployed in the war.

Rosoboronexport used to occupy a central position with a wide range of air and defence products at the show's previous editions. In 2021, Russia's joint display incorporated exhibits of Rosoboronexport, Shvabe Holding and Almaz-Antey Corporation. Top officials of other leading Russian aircraft, helicopter and engine manufacturers had also participated.

An exhibitor at the Russia pavilion said on the condition of anonymity that no major

breakthrough happened this year.

"Unfortunately, we cannot deliver any products to India at a speed owing to the war. Indian defence establishments did visit our stall and went through the products we had to offer but no major breakthrough happened. While the Indian government is stressing on Make in India and wants us to make products here, there are certain products like transmitters, missiles, receivers and radars which we cannot manufacture here due to security reasons. Each system has its own frequency parameters which are used by the Russian army. However, the military cooperation between Russia and India is an example of industrial partnership. We would definitely want to do something for India," the exhibitor said.

It has been a decade since Russia brought a fighter jet to Bengaluru.

"We do not think we need to project ourselves too much. The world knows our capabilities. During the war itself we enhanced the Ka-52 helicopter, also referred to as the Alligator K. Today, it has a better stealth and navigation system," the exhibitor added.

Meanwhile, the United States aggressively projected itself at the show trying to make its way into India's defence market. The US air force's fifth-generation fighters F-35A Lightning II and F-35A Joint Strike Fighter roared in the sky of Bengaluru. The F-16 Fighting Falcon conducted an aerial display with scintillating manoeuvres and spins. On static display were the F/A-18E and the F/A-18F Super Hornet, both multi-role fighters. Two B-1B Lancers also landed at the Yelahanka air force station.

Major US companies such as Aero Metals Alliance, Astronautics Corporation of America, Boeing, GE Aerospace, General Atomics Aeronautical Systems, Lockheed Martin, Pratt & Whitney and TW Metals also had their presence at the country's pavilion.

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U.S. Tries to Woo India Away from Russia with display of F-35s, Bombers

Krishn Kaushik | 17 Feb 2023

Source: Reuters | https://www.reuters.com/business/aerospace-defense/us-tries-woo-india-away-russia-with-display-f-35s-bombers-2023-02-17/

A U.S. Air Force F-35 fighter jet taxis during the Aero India 2023 air show at Yelahanka air base in Bengaluru, India, February 13, 2023. REUTERS/Samuel Rajkumar/ File Photo

BENGALURU, Feb 17 - The United States brought its most advanced fighter jet, the F-35, to India for the first time this week alongside F-16s, Super Hornets and B-1B bombers as Washington looks to woo New Delhi away from its traditional military supplier, Russia.

India, desperate to modernise its largely Soviet-era fighter jet fleet to boost its air power, is concerned about Russian supply delays due to the Ukraine war and faces pressure from the West to distance itself from Moscow.

The American delegation to the week-long Aero India show in Bengaluru, which ends on Friday, is the biggest in the 27-year history of the show and underlines the growing strategic relationship between the United States and India.

In contrast, Russia, India's largest weapons supplier since the Soviet Union days, had a nominal presence. Its state-owned weapons exporter Rosoboronexport had a joint stall with United Aircraft and Almaz-Antey, displaying miniature models of aircraft, trucks, radars and tanks.

At previous editions of the show, Rosoboronexport had a more central position for its stall, although Russia has not brought a fighter jet to Bengaluru for a decade after India began considering more European and U.S. fighter jets.

Boeing (BA.N) F/A-18 Super Hornets have already entered the race to supply fighter jets for the Indian Navy's second aircraft carrier and Lockheed Martin's (LMT.N) F-21, an upgraded F-16 designed for India unveiled at Aero India in 2019, are also being offered to the air force.

A $20 billion air force proposal to buy 114 multi-role fighter aircraft has been pending for five years, brought into sharp focus by tensions with China and Pakistan.

The F-35 is not being considered by India "as of now", according to an Indian Air Force (IAF) source, but the display of two F-35s at Aero India for the first time was a sign of New Delhi's growing strategic importance to Washington.

It was "not a sales pitch" but rather a signal to the importance of the bilateral defence relationship in the Indo-Pacific region, said Angad Singh, an independent defence analyst.

"Even if weapons sales aren't the cornerstone of the relationship, there is a cooperation and collaboration at the military level between India and the U.S.," he added.

The United States is selective about which countries it allows to buy the F-35. When asked if it would be offered to India, Rear Admiral Michael L. Baker, defence attache at the U.S. embassy in India, said New Delhi was in the "very early stages" of considering whether it wanted the plane.

An IAF spokeperson did not respond to a request for comment on its interest in F-35s.

Ahead of the show, Russian state news agencies reported that Moscow had supplied New Delhi with around $13 billion of arms in the past five years and had placed orders for $10 billion.

The United States has approved arms sales worth more than $6 billion to India in the last six years, including transport aircraft, Apache, Chinook and MH-60 helicopters, missiles, air defence systems, naval guns and P-8I Poseidon surveillance aircraft.

India also wants to manufacture more defence equipment at home in collaboration with global giants, first to meet its own needs and eventually to export sophisticated weapons platforms.

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IAF's Acquisition of 114 Fighter Jets to be Part of a Major Procurement Plan

Dinakar Peri | 16 Feb 2023

Source: The Hindu | https://www.thehindu.com/news/national/iafs-114-fighter-tender-to-move-in-3-4-months-part-of-over-500-jet-procurement/article66516620.ece

The IAF is set to phase out the remaining three MIG-21 squadrons by 2025. | Photo Credit: AP

The delayed process for the procurement of 114 multi-role fighter jets (MRFA) is set to take off soon and along with three different indigenous fighter development programmes, will result in a mega 500-fighter aircraft acquisition process for the armed forces. This would arrest the dwindling fighter strength of the Indian Air Force and enable it reach the sanctioned strength of 42 squadrons.

A mega 500-fighter aircraft acquisition process on the anvil for the armed forces; reaching the sanctioned 42 squadrons will take time and the immediate effort is to arrest the drawdown in strength, says Air Marshal Narmdeshwar Tiwari.

"We are hopeful the Acceptance of Necessity (AoN) for MRFA will be issued in three to four months," Air Marshal Narmdeshwar Tiwari, Deputy Chief of Air Force told The Hindu at Aero India. It is a "budgetary decision" and also how fast the aircraft are available, he stated. The AoN will begin the formal procurement process following which the IAF will issue the detailed Request For Proposal.

On the delay in the process, he said they were evaluating how much of Make in India can happen, localisation and capability for them to upgrade the aircraft locally rather than depend on the foreign manufacturer, he said.

The IAF is currently down to 31 fighter squadrons as against the sanctioned strength of 42 squadrons which is set to dwindle further as the remaining three MIG-21 squadrons are phased out by 2025. By end of the decade phasing out of other aircraft would also begin.

On this, Air Marshal Tiwari said reaching 42 squadrons will take time and the immediate effort is to arrest the drawdown in strength. The 83 Light Combat Aircraft (LCA)-Mk1A that will begin coming in from next year followed by the LCA-Mk2 and fifth-generation Advanced Medium Combat Aircraft (AMCA) in the near future along with the MRFA will arrest this, he added.

There is also a Twin Engine Deck Based Fighter (TEDBF) on the drawing board for the Navy's aircraft carriers. Dr. Girish S. Deodhare, Director General of Aeronautical Development Agency (ADA) under the Defence Research and Development Organisation (DRDO), said they are looking at six Squadrons of LCA-Mk2 (108 aircraft), seven Squadrons of AMCA (126 aircraft) and up to 100 TEDBF. Besides, the IAF would receive 83 LCA-Mk1A and 114 MRFA. Hindustan Aeronautics Limited (HAL) officials also said that they expect an additional order for up to 50 LCA-Mk1A. In addition, a decision between 26 multi-role aircraft for the Navy is expected shortly, between Boeing F/A-18 E/F Super Hornet and the Dassault Aviation Rafale.

Also, the final deal to procure 12 additional

SU-30MKIs to replace the ones lost in accidents and 21 MIG-29s from Russia has been stuck, which both IAF and Russian officials said has only been delayed but is on track.

On the AMCA which is awaiting government sanction, Air Marshal Tiwari said based on global trends it would take 10-12 years for its development and around three to five years after that to begin production. Dr. Deodhare, chief of ADA which is designing the aircraft, has also stated that the development would take 10 years once the project is sanctioned.

HAL has said that they are on track to deliver the first LCA-Mk1A to the IAF in February 2024. As reported by The Hindu, ADA officials have said that the LCA-Mk2, which would be much more capable than the LCA-MK1A, is expected to be ready for production by 2027.

Speaking on the sidelines of Aero India, Navy Chief Adm. R. Hari Kumar said that they may get upto 45 TEDBF by 2040. Dr. Deodhare has said that the TEDBF is expected to take first flight by 2026 and expected to be ready for production by 2031.

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IAF to Procure New Transport Aircraft to Replace AN-32

Dinakar Peri | 03 Feb 2023

Source: The Hindu| https://www.thehindu.com/news/national/iaf-issues-tender-to-procure-a-medium-transport-aircraft-to-replace-an-32s/article66467760.ece

An AN-32 aircraft of the Indian Air Force. | Photo Credit: Dinakar Peri

The Indian Air Force (IAF) has initiated the process to find a replacement for the AN-32 transport aircraft in service. It has issued a Request For Information (RFI) for the procurement of a Medium Transport Aircraft (MTA) with a carrying capacity of 18 to 30 tonnes.

In addition to the AN-32s and AVROs, the transport fleet of the IAF consists of the IL-76 heavy transports and IL-78 mid-air refuelling tankers from Russia, 12 C-130J Super Hercules and 11 C-17 Globemaster strategic airlift aircraft from the U.S.

The RFI was issued on December 9, 2022, and the earlier bid submission date of February 3 has now been extended till March 31.

"The overall time frame of production, delivery with stage wise breakup of the entire project post conclusion of contract is required to be submitted. It is envisaged to commence deliveries of platform within 36 months of signing of Contract," the RFI said. The vendors are to provide Rough Order of Magnitude (ROM) cost of aircraft and associated equipment among others for a batch of 40 aircraft/60 aircraft/80 aircraft,

respectively, it stated.

In the past, several IAF officials had stated that the just C-295MW, 56 of which have been just contracted, which falls in similar category as the AN-32 in terms of cargo carrying capacity would be considered as a potential replacement for the AN-32 given that a running assembly line would be available once the 56 aircraft are delivered. However, based on load carrying capacity specified in the RFI, 18 to 30 tonnes, the C-295 no longer fits the bracket as it is in the 5-10 tonnes category. Essentially, the IAF is looking to replace the AN-32s with an aircraft of higher carrying capacity, sources stated.

An earlier project to jointly co-develop and produce a MTA of 20 tonnes with Russia to replace the AN-32s was scrapped few years back after initial design discussions.

The IAF operates around 100 AN-32s which are the work horse of the force and they all been upgraded recently under a $400-million deal signed with Ukraine in 2009. Some of them were upgraded in Ukraine a decade ago to improve avionics and increase engine lifespan, while several others are being upgraded at an IAF repair facility in Kanpur.

In September last year, the Defence Ministry signed a 21.935 Crore contract with Airbus and Space S.A., Spain for procurement of 56 C-295MW transport aircraft to replace the Avro aircraft in service with the IAF which it is executing in partnership with Tata Advanced Systems Limited (TASL). An Airbus-TASL joint venture will assemble the C-295s at a manufacturing facility being set up in Vadodara, Gujarat.

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Under Make in India

The RFI has asked aircraft manufacturers to indicate the scope of work related to MTA, which would be undertaken under Make in India under appropriate category with estimate of indigenous content mandatorily.

Also state the capability to undertake indigenous manufacture of systems, subsystems, components, consumables, spares, ammunition and materials of the main equipment and platform in India, either through its own subsidiary or in a Joint Venture and the time period for developing infrastructure for manufacture.

"Methods to enhance indigenisation and to setup dedicated manufacturing line, including design, integration and manufacturing processes in India, either through its own subsidiary or in a joint venture," the RFI said. Capability of Indian vendors to indigenously design and develop the required equipment along with level of indigenisation including use of indigenous military material, delivery capability, maintenance support and Life Cycle Support is also to be specified.

The vendors should also consider making India, a regional or global hub for manufacturing and Maintenance, Repair & Overhaul (MRO) of the equipment. Among other details requires, the RFI added that vendors are also to specify capability to provide maintenance infrastructure, and to set up an ecosystem of indigenous vendors and manufacturers for sustenance of the platform

and also indicate feasibility of using indigenous military materials and raw materials already being manufactured in the country.

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Taiwan Orders 100-Plus Indigenous Radar-Killing Suicide Drones

Inder Singh Bisht | 18 Nov 2022

Source: The Defence Post| https://www.thedefensepost.com/2022/11/18/taiwan-radar-killing-suicide-drones/

Chien hsiang loitering munition. Image: Creative Commons

The Taiwanese military has contracted a state-run weapons developer to produce 104 suicide drones by 2025, Focus Taiwan reported, citing the National Chung-Shan Institute of Science and Technology (NCSIST).

The drone's production and delivery are on schedule, NCSIST official Chi Li-ping said without revealing complete details.

The NCSIST first displayed the Chien Hsiang anti-radiation drone in 2017, attracting comparisons with the Israel Aerospace Industries Harpy loitering munition.

$2.57 Billion in Drone Development

Two years later, the Taiwanese air force's air defense and missile command confirmed plans to invest $80 billion New Taiwan dollars ($2.57 billion) into the drone's production over five years.

The truck-launched drone is designed to detect airborne, waterborne, grounded radar, and electromagnetic systems through their emissions and strike.

Aimed at China

The drone's endurance of five hours and flight range of 1,000 kilometers (621 miles) enables it to target Chinese radar systems in the sea, on the coast, or inland, Focus Taiwan reported, citing the NCSIST's Chi Li-ping.

The drone weighs 6 kilograms (13 pounds) and is 1.2 meters (4 feet) long and 2 meters (6.56 feet) wide. It searches for targets with an electro-optical/infrared payload and selects them through an "intelligence object detection system," according to Alert 5.

The drone hovers over a target for hours until it is activated, swooping down at a speed of 600 kilometers (373 miles) per hour to crash into it, Focus Taiwan wrote.

Two Versions Being Developed

A total of 12 Chien Hsiangs can be launched from a truck simultaneously.

The NCSIST is developing two versions of the drone: one for attack and the other as a decoy to protect more valuable systems and installations from anti-radiation missiles and drones..

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Indian Aerospace Industry

Half of DRDO's Mission Mode Projects Running Behind Schedule, Parliament Informed

Rajat Pandit | 14 Feb 2023

Source: Times of India | https://timesofindia.indiatimes.com/india/half-of-drdos-mission-mode-projects-running-behind-schedule-lok-sabha-informed/articleshow/97889332.cms?from=mdr

The lightweight Tejas Mark-1 and the medium-weight Mark-2 will eventually replace obsolete fighters in the IAF

NEW DELHI: Almost half of Defence Research andDevelopment Organisation 's ongoing 'mission mode'projects - high priority programmes based on specificoperational requirements of the armed forces that have tobe completed within a definite time-frame - have beendelayed.

These range from the Tejas Mark-2 light combat aircraft(LCA), the naval LCA and unmanned aerial vehicles to airindependent propulsion (AIP) for greater underwaterendurance of submarines, light machine guns andadvanced towed artillery gun systems (ATAGS), the told Parliament on Monday.

In a written reply in Rajya Sabha, junior defence minister AjayBhatt said 23 of the 55 mission mode projects have beendelayed. These projects, incidentally, involve technologies that are already available and readily accessible in India or abroad at short notice.

The other delayed projects are in the areas of surface-to-air missiles, surface-to-surface missiles, electronic warfare (EW) systems for fighters and warships, air droppable containers, simulators, tactical radios, rockets, bombs, infantry combat vehicle-command (ICV-C), life support systems, periscopes and torpedoes.

Cost escalations have taken place in 12 of the 55 projects. "However, cost escalations may not be treated as loss, as in certain cases cost has been increased for change or enhancement of scope," Bhatt said. These are the LCA for IAF and Navy, AIP, surface-to-air missiles, ATAGS, rockets, ICV-C, periscopes, torpedoes and EW systems.

The single-engine Tejas, in particular, is crucial for the IAF to stem the depletion in the number of its fighter squadrons, which is down to just 30-31 when 42 are required for the collusive threat from China and Pakistan.

IAF has inducted just over 30 of the 123 Tejas jets ordered till now, with the last Rs 46,898 crore contract for 73 improved Mark-1A fighters and 10 trainers being inked in February 2021 for delivery in the 2024-29 timeframe.

In August 2022, the Cabinet Committee on Security had sanctioned another Rs 6,500 crore, in addition to the earlier Rs 2,500 crore, to develop the much more capable Mark-2 version of Tejas with more powerful GE-414 engines.

While the lightweight Tejas Mark-1 (13.5 tonne weight) was designed to replace obsolete MiG-21s, the medium-weight Mark-2 (17.5 tonne) is supposed to eventually succeed fighters like the Mirage-2000s, Jaguars and MiG-29s in the IAF. The naval LCA, in turn, is the forerunner

for the twinengine deck-based fighter that the Navy actually wants for its aircraft carriers. It will take at least a decade to be operationally ready.

In Parliament, Bhatt outlined the various steps being taken by the government to overcome such delays. They include increased frequency of project reviews, enhanced participation of the armed forces and higher delegation of financial powers to DRDO lab directors.

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IAF Plans To Order 50 More LCA Mk1A Jets

15 Feb 2023

Source: Live First Defence | https://www.livefistdefence.com/iaf-plans-to-order-50-more-lca-mk1a-jets/

A concept image of a NASA nuclear rocket.

Battling its notorious and long-spiralling depletion in fighter aircraft squadron strength, the Indian Air Force is is believed to have firmed up plans to order at least 50 more LCA Tejas Mk1A jets from Hindustan Aeronautics Ltd. These would be in addition to 83 Mk1A jets currently on order as part of $6.5 billion contract signed in February 2021.

The IAF operates two squadrons of the LCA Mk1 in Sulur in southern India, with a total of 40 aircraft across operational capability tiers on order. The Mk1A is a significantly improved iteration of the Tejas that's better armed, better performing, superior survivability and avionics and crucially easier to maintain and turn around. You can read our detailed piece on improvements the Mk1A brings to the table here. The first LCA Mk1A jets are slated to be delivered to Indian Air Force in the first half of 2024.

Adding numbers to the LCA order book has been obvious option in front of the IAF for years now, though Air Force HQ has preferred to hedge amidst frictions with HAL on production rates and ongoing ambiguity over the faltering MRFA contest, a quest to add 114 foreign fighters from among a stack of seven competitors from the US (F-15EX and F-21), Russia (Su-35 and MiG-35), Sweden (Gripen E), France (Rafale) and Germany (Typhoon).

In this detailed chat two years ago, aviation writer and researcher Angad Singh advocates quick orders of more LCA Tejas variants to bolster numbers on the bumpy road to meaningful force accretion.

In a column in 2019, Livefist founder Shiv Aroor had advocated that it was time for the Indian government to commit resources to getting the LCA inducted in larger numbers to replace legacy fleets like the MiG-21 as quickly as possible. The plans we're reporting now for expanded Mk1A contracts appear to be in line with that intent.

Given budgetary constraints, it's unclear if the IAF will commit to the 50 additional LCA Mk1As before most of the 83 from the original 2021 contract are delivered. The IAF has been in extended discussions with the Aeronautical Development Agency (ADA — the agency effecting the Mk1A improvements) and HAL on the planned additional order. HAL hopes to close a deal for 50 more Mk1As by 2024-25, though there remains little clarity on when that will happen. The original contract for 83 Mk1A jets

took eight years to come to fruition. This Livefist tweet from 2013 was from a time before the Mk2 was watered down to an Mk1A variant.

The need for additional Mk1As is clearly to minimise timeline risk on the far more capable LCA Mk2 jet that's expected to be ready for service in the latter half of this decade. The Indian government and IAF have made it clear that the Mk2 will be the truly combat capable iteration of the Tejas. The Indian Air Force has revealed plans to order 108 of the type. The LCA Mk2, currently under a prototype fabrication phase, will be a true blue 'fourth generation' fighter, sporting an AESA radar, the more powerful GE F414 engine, canard foreplanes for greater agility and several additional systems across the spectrum of capability, survivability and maintainability.

Finally, and perhaps most anticipated of all, the Indian Air Force has quantified its intended orders — 126 — of the stealth fifth generation fighter AMCA currently under development with a rollout unlikely before the end of the decade. In 2020, Livefist scooped plans for the AMCA to be taken forward as a public-private partnership between HAL and Indian private sector giant Larsen & Toubro.

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Indian Navy Greenflags Rafale In Deck Jet Contest

15 Feb 2023

Source: Live First Defence | https://www.livefistdefence.com/indian-navy-greenflags-rafale-in-deck-jet-contest/

A concept image of a NASA nuclear rocket.

French firm Dassault Aviation is gathering big momentum towards an Indian Navy contract for 26 Rafale-M naval fighters intended for operations off the deck of India's new aicraft carrier INS Vikrant. Livefist can confirm that the Indian Navy has formally indicated to the Indian Ministry of Defence that the Rafale meets more of its requirements than the only other contender in the fray, Boeing's F/A-18 Super Hornet. While Indian defence contracting has been notorious for the distance — and pitfalls — between contest win and contract award, top Indian Navy sources said that the Rafale "has this one".

The Rafale moves into pole position a year after the two competing aircraft went through weeks of field tests at the Indian Navy's shore-based test facility in Goa. You can read about the Rafale's trials here and the Super Hornet's here.

No formal comment was available from either airframer, but officials at both confirmed to Livefist that while there had been no communication from the Indian Navy or MoD yet, they had heard about the development. Formal next steps could happen

this year.

A contract award would make the Indian Navy the first export customer of the naval carrier-based Rafale-M, having already exported the air force variant to a slew of countries including Egypt, Qatar, Greece and India. The Indian Air Force's 36 Rafale jets, populating two squadrons, arrived in India between 2020-2022. The same variant is a contender in the Indian Air Force's multirole fighter aircraft (MRFA) contest that seeks to buy and build 114 fighters, a replay of the collapsed M-MRCA tender at the tail end of which the Rafale won out against a slew of competitors, including the F/A-18 Super Hornet, Eurofighter Typhoon, F-16 Super Viper, Gripen NG and MiG-35. This time the Rafale prospectively goes up against the same stack of jets, with the addition of two — the Russian Su-35 and Boeing's F-15 Eagle II.

In the last two years, Boeing has crafted its India strategy, pointing the F/A-18 towards the Indian Navy and the F-15EX at the Indian Air Force.

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Technology Development

Revolution In Drone Tech? Researchers Develop 'Flapping Wing UAVs' From Taxidermied Pigeons & Pheasants

Parth Satam | 25 Feb 2023

Source: Eurasian Times | https://eurasiantimes.com/revolution-in-drone-tech-researchers-develops-flapping-wing/

The two ornithopters – or aircraft with flapping wing mechanisms – have tremendous military as well as civilian applications, where they can spy on enemy movements and at the same time fly among real birds for wildlife monitoring.

The team led by Prof Mostafa Hassanalian built two such 'dead bird bots' – one fusing artificial body parts with an actual pheasant's head and feathers and the other of a mechanical body combined with real pigeon wings.

Many aerospace projects have drawn inspiration from the aerodynamics of real birds, the most prominent being the B-2 Spirit stealth bomber. Many aviation observers have noted how the side profile of the jet and its nose look strikingly similar to that of a Hawk.

Dead-Bird Bots – Quite & Real

Flapping wings are more efficient and wind-tolerant than fixed wings, making them more agile, maneuverable, and even stop mid-flight to hover in the air. Presently, military drones are limited in their ability to stop and start in the air – a serious barrier to drones offering surveillance of a given area.

The current effort is similar to the robot dog by Boston Dynamics, Spot, and a copy created by China, which has been weaponized.

The underlying science behind the projects has been replicating actual living beings' musculoskeletal and sensory systems for more realistic robot movement functions. It has often been perceived as a step towards more autonomous robots.

The researchers' motivation was outlined in a paper presented at the American Institute of Aeronautics and Astronautics SciTech 2023 Forum, where they highlight the benefits of using genuine bird parts over artificial materials that have been engineered to behave like them.

Through evolution, birds have acquired lightweight bodies, hollower bones, and flexible feathers. This allows them to stay afloat and support their bodies solely through wind propulsion driven by their exertion, unlike aircraft with a powerful propulsive force in the form of engines.

Nature & Evolution Ahead of Technology

Birds use their muscles to bend and contort the shapes of their wings, which aid tight maneuvers. Feathers also allow stealth, as the flapping sound of the wind can only be heard from a close distance.

However, the dead bird drones in the video don't look nearly as stable in flight as the actual winged creatures. Nevertheless, with some technical refinement, the scientists hope to achieve the fluidity that would allow them to fly overhead and land without arousing suspicion.

The ornithopters can both sneak up on other aerial targets or watch people while remaining completely undetected. If not for military use, drones also have a significant zoological research purpose, where they can observe other bird species without alarming them. A drone with a spinning propeller and a lot of noise scares away birds and is easily detected by enemy eyes.

The drone also doesn't seem to have any onboard camera that relays video feedback to the operator, making it a line-of-sight aircraft, i.e., the operator always has to keep eye on it.

This, however, isn't the first drone to move on mimicked movements of real birds. As far back as 2013, the Avitron v2.0 Bionic Remote Controlled Bird had become quite popular and appeared to show very stable and controllable flight. That drone's flapping wings were, however, the result of regular spinning motors that ran various intricate gears, which made two rods make a constant 'up and down' motion.

The taxidermied birds have a large lever exposed outside their body that moves their wings in what looks like a hydraulic or pneumatic system. This is, however, unclear as the video of the New Mexico Institute of Technology drones is very short and doesn't possess that information.

US Military Eyed Animal Capabilities In Drones For Long

This is not the first time the military has looked at replicating animal bionic-based technology on their drones. In 2012, the US Army was reported to have been allotted $2 million to conduct research into drones that mimic avian flight to be able to navigate more hostile, rugged, and unpredictable environments.

AeroVironment's nano hummingbird drone was one of the top inventions in 2011. It was developed under a project sanctioned by the Defense Advanced Research Projects Agency (DARPA).

In 2021, the Air Force Research Laboratory

(AFRL) developed a "micro drone for open surveillance to perform insect-like maneuvers with two physical actuators while utilizing minimal computer processing power."

Back in 2010, the US Navy was funding research into replicating the movement of fish and the echolocation of bats. The Pentagon has also been interested in the tiny hairs of insects to be able to sense changes in the wind and other environmental factors.

Commentary

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[1] (As Stated by Air Chief Marshal VR Chaudhari PVSM AVSM VM ADC, Chief of the Air Staff, Indian Air Force, at the Geointelligence-2022 conference on June 14, 2022.)

"The term 'Aerospace' was introduced in 1958 by the USAF Chief of Staff, General Thomas D White, as a new construct that depicted air and space as a seamless continuum stretching from the Earth's surface to infinity."

The Centre for Air Power Studies (CAPS) is an independent, non-profit think tank that undertakes and promotes policy-related research, study and discussion on defence and military issues, trends and developments in air power and space for civil and military purposes, as also related issues of national security. The Centre is headed by Air Marshal Anil Chopra, PVSM AVSM VM VSM (Retd).

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