CENJOWS

CENTRE FOR JOINT WARFARE STUDIES (CENJOWS)

PRESENTS

SEMINAR REPORT

ON

UAS WARFARE WITH SPECIAL FOCUS ON COUNTER-UAS

10 MAR 2025

Ashoka Hall, Manekshaw Centre, Delhi Cantt

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(Prepared by Team CENJOWS)

1. Executive Summary

(a) **Transformation of Warfare through UAS.** The seminar highlighted how Unmanned Aerial Systems (UAS) have revolutionized warfare by integrating speed, autonomy and intelligence, transforming drones from surveillance tools into frontline combat systems.

(b) **General Anil Chauhan, PVSM, UYSM, AVSM, SM, VSM, Chief of Defence Staff,** inaugurated the seminar and emphasised that UAS warfare marks a transformative shift in the character of conflict, driven by speed (celerity), autonomy (robotics), and intelligence (AI/ML), urging India to adopt a generational framework for UAS development, pursue layered counter-UAS strategies, and implement a whole-of-nation approach to build a secure, self-reliant, and future-ready unmanned warfare ecosystem.

(c) **Maj Gen (Dr) Ashok Kumar, VSM (Retd), DG CENJOWS**, highlighted the historical evolution and rising lethality of UASs, stressing their integration into modern warfare beyond surveillance—into precision strikes, swarm operations, and grey-zone engagements—and called for indigenous capabilities and a whole-of-nation approach to develop resilient drone and counter-drone ecosystems amid rising regional threats from China, Pakistan, and non-state actors.

(d) **Urgency for Indigenous Capabilities.** A recurring theme was India's critical dependence on foreign components for drones and the urgent need for self-reliance in UAS and counter-UAS (C-UAS) technologies, especially in light of China's and Pakistan's advancements.

(e) **Multi-Domain Threat Spectrum.** Presentations highlighted that drone threats are not confined to air but span across land, sea, and even underwater domains, demanding a comprehensive multi-domain defence framework.

(f) **Integrated Counter-UAS Strategies.** Effective counter-drone systems require a hybrid, layered approach combining AI, jammers, DEWs (Directed Energy Weapons), kinetic weapons, and real-time command and control systems.

(g) **Call for Policy and Institutional Reform.** The seminar emphasized a "Whole-of-Nation" approach including industry, armed forces, academia, and

regulatory bodies. Recommendations included setting up a National Counter-UAS Authority and refining the Drone Rules 2021.

2. **Objectives**

(a) To assess and analyze the evolving landscape of UAS warfare and its implications for India's national security.

(b) To understand global conflict trends involving drones and extract strategic lessons for the Indian Armed Forces.

(c) To evaluate current gaps and future requirements in indigenous drone and counter-drone technologies.

(d) To facilitate cross-sector collaboration among the military, industry, and academia for robust UAS/C-UAS strategies.

SPEAKERS' PROFILES

General Anil Chauhan, PVSM, UYSM, AVSM, SM, VSM, Chief of Defence Staff (CDS)

General Chauhan is an alumnus of the National Defence Academy, Khadakwasala. He was commissioned into the Sixth Battalion, the Eleventh Gorkha Rifles in Jun 1981, from Indian Military Academy, Dehradun.

He is a graduate of the Defence Services Staff College, Wellington, the Higher Command and National Defence College courses. He was awarded M.Phil in Defence Studies from Madras University in 2012.

General Chauhan has a distinguished career spanning 43 years. He has varied operational experience of most conflict and terrain profiles. His last operational assignment in the army was as the General Officer Commanding-in-Chief Eastern Command. He served as the Military Adviser to National Security Council Secretariat (NSCS) before being appointed as the second CDS of the Armed Forces.

As the highest ranked military officer, Gen Anil Chauhan is triple hatted and concurrently holds the appointment of Chairman Chiefs of Staff Committee, Secretary Department of Military Affairs, besides tenanting the appointment of the Chief of Defence Staff. He is the principal Military Adviser to the Raksha Mantri and to the national leadership on all tri-services matters.

He has been instrumental in fostering a Joint Culture amongst the three services and has spearheaded several integration initiatives that have bolstered the combat potential of the armed forces to fight an integrated battle. As CDS and Chairman, COSC, he is also formalising the roadmap towards creation of the integrated Theatre Commands.

Academically inclined, the General has authored two books namely 'Aftermath of a Nuclear Attack' and 'History of 11 Gorkha Rifles Regimental Centre'. He has also supervised the writing of the 'History of 19 Inf Div'.

Maj Gen (Dr) Ashok Kumar, VSM (Retd), DG CENJOWS

Maj Gen (Dr) Ashok Kumar, VSM, DG CENJOWS is a Kargil war veteran. He commanded an Infantry formation in Arunachal Pradesh. He was MD ECHS and PSO at HQ Eastern Command prior to retirement. He is a prolific writer and has written on a wide range of topics including China, India's neighbours, Border management, Theaterisation and capability development within the Armed Forces. He has authored two books to include 'China Betrays Again' and 'Indian Churnings on the Global Stage'.

Air Marshal SP Dharkar, PVSM, UYSM, AVSM, Vice Chief of Air Staff (VCAS)

Air Marshal SP Dharkar, PVSM, UYSM, AVSM took over as Vice Chief of the Air Staff at Air Headquarters, after relinquishing appointment as the Air Officer Commanding-in-Chief of EAC. Prior to this, he was the Senior Air Staff Officer at HQ SWAC. He has earlier been the Director General of the Defence Space Agency at Bengaluru, Air Defence Commander at HQ EAC and Assistant Chief of the Air Staff (Training) at Air Headquarters. Air Mshl Dharkar is a fighter pilot with more than 3600 hrs of flying experience.

Lt Gen Ajay Kumar, VSM, Director General of Infantry

Lt Gen Ajay Kumar, VSM, assumed the apt of the Director General of Infantry on 01 Oct 2024. The Gen Offr was commissioned in the 16th Bn The Punjab Regt in 1990, he later commanded 9 Punjab. The Gen Offr is an alumnus of IMA Dehradun.

The Gen Offr has attended imp courses at the prestigious Def Service Staff College, Wellington, Army War College, Mhow and national Def College, New Delhi apart from mandatory courses. BHe has tenanted prestigious instructional and staff appts to incl Instr CI 'C' at IMA; Dehradun; GSO-1; DGMO; New Delhi; Def Attache; Embassy of India; Riyadh (Saudi Arabia); Brig MS (HQ DG NCC, New Delhi) & Brig Intl (HQ IDS, New Delhi).

Air Vice Marshal Rajiva Ranjan, VM (Retd)

Air Vice Marshal Rajiva Ranjan, VM (Retd) was commissioned into the Fighter Stream of the Indian Air Force in June 1987. He is a Fighter Combat Leader and a Qualified Flying Instructor. He is an alumnus of the National Defence Academy, Khadakwasla, the Defence Service Staff College, Wellington, and the National Defence College, New Delhi.

The Air Officer has approx 3,850 hours of flying experience, all of which are accident/incident-free. He has flown 15 types of fighter and trainer aircraft held by the Indian Air Force. He has commanded the MiG Operation Flying Training Unit, Air Force Station Jaisalmer, and Air Force Station Bhatinda.

He was the first Flight Commander of the MiG-21 (Bison) fleet and, as Joint Director Operations (Air Defence), was responsible for formulating the Operational Exploitation Philosophy of Bison aircraft and its Standard Operating Procedures and other associated rules and regulations. He also served as Air Attaché at the Embassy of India, Kabul, Afghanistan.

The Air Officer is a recipient of the Chief of Air Staff Commendation Award twice, in 1998 and 2003, for flight safety and devotion to duty, respectively. He was also awarded the Vayu Sena Medal (VM) in January 2008 for his exemplary performance as Commanding Officer, during which his unit was declared the "Best Fighter Squadron" of the Eastern Air Command.

Mr Sarjan Shah

Born in Mumbai in 1989, Sarjan received his BSc in International Relations and History from the London School of Economics in 2010, an Advanced Diploma in Philosophy at Cambridge and his MBA from Harvard, both in 2016.

In 2019-20, Sarjan established Ikigai Capital, with a view to bringing critical future-facing technology partnerships to India, focusing on defence, aerospace and artificial intelligence.

Sarjan has led the India market entry for Shield AI, one of the US's most promising new defence technology businesses. Since the establishment of the strategic partnership between JSW & Shield AI, Sarjan now sits on the board of JSW UAV.

Sarjan writes on geopolitics and national security affairs for the Indian Express, one of India's leading English dailies.

Brig Anshuman Narang (Retd)

Brig Anshuman Narang (Retd) is an alumni of prestigious Rashtriya Indian Military College, National Defence Academy and Defence Services Staff College. He holds the "Adani Defence Chair of Excellence" on Counter-UAS at CENJOWS and is the Founder of an independent Think-Tank "Atma Nirbhar Soch" which is successfully running courses on PLA and Multi-Domain Operations, Future warfare and Technologies. He is also an Adviser at Suhora Technologies.

A keen China watcher and author of three books, his PhD topic is "Chinese RMA and Centennial Goals - Implications for India". His fourth book "PLA's ORBAT Compendium" is under publishing. He has attended courses in all quad countries- American Artillery's Captain Career Course, Australian Joint Warfare Course and Japanese National Institute of Defence Studies Course.

He took voluntarily retirement after commanding a prestigious Composite Artillery Brigade. He has been GSO1 of an Independent Armoured Brigade, Colonel GS of an Armoured Division, Col MS4D at MS Branch, and Directing Staff at Senior Command Wing, Army War College.

Vice Admiral Tarun Sobti, AVSM, VSM Deputy Chief of Naval Staff (DCNS)

Vice Admiral Tarun Sobti was commissioned into the Indian Navy on 01 Jul 1988. He is an alumnus of the 72nd Course, National Defence Academy, Khadakwasala. The Flag Officer is a Navigation and Direction specialist. The Flag Officer did the Overseas Staff Course from France during 2002-2003 and Naval Higher Command Course in 2009-2010.

The Flag Officer has Commanded three warships which includes the Commissioning Command of INS Kolkata, the first of its kind guided missile destroyer. The Flag Officer has also held important staff appointments at Naval Headquarters in New Delhi. He served as the Naval Attaché at the Embassy of India, Moscow from 2016 to 2018. On promotion to the

rank of Rear Admiral, he was appointed as the Deputy Commandant and Chief Instructor at Indian Naval Academy, Ezhimala from Mar 2019 to Jan 2021 and as Flag Officer Commanding Eastern Fleet from Feb 2021 to Dec 2021.

On promotion to the rank of Vice Admiral on 24 Dec 21, he was appointed as Director General Project Seabird from Dec 21 to Aug 24. He held additional charge as Director General Naval Operations from Jul-Sep 23, prior taking over his present appointment as Deputy Chief of Naval Staff at Naval Headquarters.

In recognition of his distinguished service and outstanding contributions to the Indian Navy, the Flag Officer has been awarded the Ati Vishisht Seva Medal (AVSM) on 26 Jan 22 and Vishisht Seva Medal (VSM) on 26 Jan 2020.

Shri Surender Singh Rathore, DIG, BSF

Shri S S Rathore, joined BSF as Direct Entry Assistant Commandant on 2nd July'1993. During his more than 31 years of service, he has served on a wide variety of borders, starting from High Altitude areas of Line of Control to the Deserts of Rajasthan and in the North Eastern region, the remote and thickly forested borders of Assam and Tripura.

He has also served in the G Branch, the BSF Intelligence wing, in Jammu frontier. An alumnus of prestigious Defence Services Staff College, he has served on various staff appointments at the BSF Force HQs. A qualified Instructor for almost all streams he served as an instructor for Senior Command in the Tactical Wing at the BSF Academy Tekanpur.

He has also been on deputation to the prestigious Special Protection Group where he served for Six years with distinction. Presently, he is posted in the Operations Directorate at BSF HQs New Delhi, looking after the Western Command & the Technology Cell with has a mandate to identify new technologies and Innovations for induction in the force. He is the member secretary of Anti Rogue Drone technology committee (ARDTC), a central body constituted by MHA for the purpose of evaluating Anti Drone technology in the country.

Mr Asbir Solanki

Veteran, CEO & Global Thought Leader in Defence & Security, Mahindra Defence

Jasbir is a distinguished veteran of the Indian Navy and the Chief Executive Officer of Mahindra Defence System Limited (Naval Systems, Homeland & Cyber Security). An accomplished business leader with over 25 years of experience in Defence, Homeland Security, and Cyber Security, he has played a pivotal role in positioning Mahindra Defence as one of India's leading providers of cutting-edge Defence & security solutions.

Under his leadership, Mahindra Defence has successfully executed landmark projects, including the world's largest Integrated Emergency Management System, serving 220 million people from a single command and control center. His unwavering commitment to customer-centric innovation continues to set new industry benchmarks.

Jasbir holds an engineering degree with distinction from Pune University, is a qualified Marine Engineer from the Indian Naval Institute, and has a Master's in Financial Management from the Jamnalal Bajaj Institute of Management in Mumbai. He has further

honed his expertise through executive leadership programs at MDI Gurgaon, the Stephen M. Ross School of Business, and Harvard Business School.

A seasoned public speaker, Jasbir has delivered keynote addresses at TEDx and premier global conferences, including the Counter Terror Expo (London), Oil & Gas Summits (Singapore), Smart Cities (Delhi), Port Security (Mumbai), Cybertech (Tel Aviv), and the ISMG Cyber Security Summit. His insights are sought after by industry collaboration bodies and government committees on National Security.

Commodore Manjit Thomas, IN

Commodore Manjit M Thomas was commissioned into the Indian Navy on 01 Jul 1996. He is an alumnus of the National Defence Academy (NOA), Khadakwasla, JMSDF Staff College, Tokyo and National Defence College, New Delhi. He is an Anti Submarine Warfare Specialist.

He has held several operational appointments including command of an ASW Corvette, Missile Corvette and Stealth Frigate. The Officer has teneted the appointments of Fleet ASW Officer of Eastern Fleet and Officer in Charge of ASW School at Kechi. He has also been the Naval Assistant of FOC-in-C West and the Defence Adviser to the High Commission of India at Pretoria, South Africa with concurrent accreditation to Zimbabwe, Mozambique and Lesotho.

The Officer has taken over his current appointment as Commodore (Staff Requirements) at NHQ in Dec 23.

Mr Rajiv Mehrotra, Chairman, Shyam VNL Private Limited

Rajiv Mehrotra, a veteran of the telecom industry, is the Founder and Chairman of the Shyam Group of companies. The group has interests in a wide range of successful telecom ventures, guided by his entrepreneurial vision. In 1974, as a young electronics engineer, Rajiv pioneered the manufacture of low-cost satellite TV equipment that brought cable TV to millions of village homes in India. Inspired by this revolution, he took telecom to the masses by installing wireless telephones in over 100,000 Indian villages.

He went on to launch Shyam Telecom, the flagship of the Shyam Group and now a leading name worldwide for mobile coverage solutions. Hexacom (now Bharti Hexacom) was launched by Rajiv in the 1990's to provide GSM services in Rajasthan, the largest state in India.

Mehrotra is also the founder of Shyam Telelink Limited (now Sistema Shyam Teleservices Ltd.), one of the first operators in the world to deploy CDMA technology for fixed wireless services. His efforts established Essel Shyam as the leading name in VSAT services in India.

Rajiv founded VNL (Vihaan Networks Ltd.) in 2004. VNL is based on his vision to take telecom to the next frontier – connecting the billions of unconnected across the world. He sees VNL as a catalyst in the transformation of rural communities through telecom. His vision and wealth of experience, combined with his far- reaching contacts in the telecom industry, makes him the ideal leader for the company.

Lt Gen Vipul Singhal, AVSM, SM, Deputy Chief of Integrated Defence Staff (Doctrine, Organisation and Training)

Lt General Vipul Singhal, a second generation army officer is an alumnus of the Doon School, Dehradun & National Defence Academy, Khadakwasla. He was commissioned into the Armoured Corps in Dec 1988. Recognised for his strategic foresight and keen ability for thinking out of the box, he steered critical transformation initiative during his tenure in the Perspective Planning Directorate, the Indian Army's Strategic Think Tank. The General has an abiding interest in leadership development and has mentored both cadets and officers at all levels at the Indian Military Academy, Dehradun, School of Armoured Warfare, Ahmednagar and the National Defence College, Delhi.

An expert in Mechanised Warfare, he has commanded an independent Armoured Brigade, an Armoured Division and a Strike Corps in the Desert Sector. In his current assignment as Deputy Chief in the Integrated Defence Staff Headquarters, he plays a key role in the ongoing initiatives of 'Jointness' Integration and Transformation of the Indian Armed Forces, and is responsible for all joint training in the Indian Armed Forces.

Academically accomplished he holds two M.Phil degrees in Defence and Strategic Studies and is pursuing a PhD from Madras University. He regularly addresses Armed Forces establishments and corporate entities on Leadership and related subjects. For his distinguished service, he has been awarded the Sena Medal and the Ati Vishisht Seva Medal.

Shri Mukesh Singh, IG, Indo Tibetan Border Police (ITBP)

Shri Mukesh Singh is a distinguished officer of the Indian Police Service (IPS) with extensive experience in counterterrorism, law enforcement, and national security. A graduate of the FBI National Academy (2011) and the Indian Institute of Technology, New Delhi (1992), he has served in key leadership roles, including Inspector General (IG) in the Indo-Tibetan Border Police (ITBP) and Additional Director General (Jammu Province).
His career includes critical tenures with the National Investigation Agency (NIA), where he led investigations into major terrorism cases such as the 2008 Mumbai attacks, Pathankot airbase attack, and Pulwama CRPF attack. He also headed the Terror Funding and Fake Currency (TFFC) cell of the NIA and contributed to FATF projects on terror financing and money laundering.

Recognized for his bravery and service, he has been awarded multiple gallantry and meritorious service medals, including the Police Medal for Gallantry (2001, 2005, 2022) and the Sher-e-Kashmir Medal for Gallantry (2003).

Mr Navneet Singh (Kepler Aerospace)

Navneet Singh is the current Chief Executive Officer at Kepler Aero, where Navneet has been working since July 2018. Prior to their role at Kepler Aero, Navneet served as a System Engineer at ISRO - Indian Space Research Organization from July 2015 to April 2018, focusing on Small Satellite Development at the IRS office. Navneet Singh graduated

with a Bachelor of Engineering in Aerospace, Aeronautical, and Astronautical/Space Engineering from Embry-Riddle Aeronautical University in 2015.

Maj Gen CS Mann, PVSM, AVSM, ADG, Army Design Bureau

Maj Gen CS Mann, AVSM, VSM, Head of the Army Design Bureau is a key facilitator of indigenization and infusion of niche technologies in the Indian Army. He was commissioned into the Armoured Corps in 1990. He commanded an Armoured Regiment and an Independent Armoured Brigade in the Western Theatre. He was GSO1 of an Independent Armoured Brigade, Colonel GS Concept/ Mech at HQ Army Training Command, Director WE-15(A) at Army HQ, BGS at Area HQ and Brigadier Capability Development at Army HQ. He has been an instructor at ACC&S and has attended the Defence Services Staff College and the Higher Defence Management Courses. He has also attended the International Disaster Management Course at Bournemouth University, United Kingdom.

Lt Gen NS Raja Subramani, PVSM, AVSM, SM, VSM, Vice Chief of Army Staff

Lt Gen NS Raja Subramani has assumed the appointment of the Vice Chief of Army Staff today. The General Officer was tenanting the appointment of General Officer Commanding-in-Chief of the Central Command based at Lucknow. The General Officer was commissioned into The Garhwal Rifles in Dec 1985. He has graduated from the prestigious National Defence Academy and Indian Military Academy. He is an alumnus of Joint Services Command Staff College, Bracknell (UK), and National Defence College, New Delhi. He holds a Master of Arts Degree from King's College London and an M Phil in Defence Studies from Madras University.

He has in his illustrious career spanning over 37 years served across a wide spectrum of conflict and terrain profiles and has tenanted a host of Command, Staff and Instructional appointments. The General Officer has insightful knowledge and a deep understanding of operational dynamics on both the Western and Northern Borders.

For his distinguished service to the Nation, the General Officer has been awarded Param Vishisht Seva Medal, Ati Vishisht Seva Medal, Sena Medal and Vishisht Seva Medal.

Shri Taha Jamal, TM, DIG, Indian Coast Guard

Deputy Inspector General Taha Jamal is a distinguished officer in the Indian Coast Guard, with an illustrious career. Holding a Master's degree in Aerospace Engineering from IISc, Bangalore, and Industrial Engineering from AMU, Aligarh, he has consistently demonstrated his proficiency in aviation and logistics.

DIG Taha Jamal has held multiple key positions, including Dy Director General (Aviation), Principal Director (Air Materiel), and Officer-in-Charge at CGSD Chennai & CGAIS Goa. His notable contributions include the implementation of Performance-Based Logistics for the ICG/ALH Mk III fleet, conceptualization of CCTV networks, and introduction of a new maintenance philosophy for the Dornier fleet.

A recipient of the Tatrakshak Medal for distinguished service, DIG Taha Jamal has also been ranked First in Order of Merit in MESC and AEO.

Lt Gen Manish Erry, UYSM, AVSM, SM, Director General Strategic Planning

Lieutenant General Manish Erry, UYSM, AVSM, SM, is an alumnus of the National Defence Academy, Khadakwasla. He was commissioned into 9th Battalion of JAMMU AND KASHMIR LIGHT INFANTRY (9 JAK LI) on 17 December 1988 from Indian Military Academy, Dehradun.

He has commanded a team of 31 Rashtriya Rifles (Commando) in Counter Insurgency at Surankote (Jammu & Kashmir) and his battalion 9 JAK LI in Northern Glacier & Chushul in HIGH ALTITUDE AREA. The General Officer raised 124 Infantry Brigade in the Eastern theatre as part of Mountain Strike Corps and commanded 27 Mountain Division and Gajraj Corps in the Eastern Theatre.

The General Officer has attended the APPPA Course on Public Policy and Administration at Indian Institute of Public Administration, New Delhi and is a graduate of Higher Defence Management Course and Defence Services Staff College. He was awarded Sena Medal on 26 January 2001, Chief of Army Staff Commendation Card on 15 August 2015, Ati Vishisht Seva Medal on 26 January 2022 and Uttam Yudh Seva Medal on 26 Jan 2024.

The General officer took over as Director General of Strategic Planning at Integrated Headquarters of Ministry of Defence (Army) on 12 Aug 2024 and Colonel of The JAK LI Regiment on 01 January 2024.

Air Vice Marshal PV Shivanand, VM, ACAS AD, IAF

Air Vice Marshal PV Shivanand, VM, ACAS Operations (Air Defence), Air Hq AVM PV Shivanand was commissioned in the fighter stream of the IAF in 1988. He has a cumulative flying experience of 2790 hours on al variants of MIG-21 and the IL 76 AWACS in mission role. He is a Fighter Combat Leader and Pilot Attack Instructor and a graduate of the Defence Services Staff College, Wellington. He commanded two frontline Squadrons - a MIG-21 Bison Sqn and an AWACS Sqn. His was COO at a forward airbase, Director Operations (Air Defence) at Air HQ, Ops-1A & Air-1 at HQ South Western Air Command and Defence & Air Attache at the Embassy of India, Washington DC, USA. Before being appointed ACAS Ops (AD), he was Air Officer Commanding, AF Station Chabua.

Ashok Wadhawan, Head Land Systems, Defence and Aerospace

Ashok Wadhawan is Head Land Systems at Adani with 30+ years of domestic and international experience in Manufacturing, Sourcing & Financial Services. He has been in leadership positions, having extensive experience in starting and growing businesses, developing strategy, financial modeling, building infrastructure for growth, developing teams, and nurturing client relationships. Ashok is part of CII and FICCI defence councils and has been the Founder Member of the Society of Defence Manufacturers. His areas of specialization include business start-up, strategy to implementation, financial feasibility and modeling, technology transfer, operational excellence, and he is a Quality Leader and Black Belt Certified.

INAUGURAL SESSION

3. **Opening Address by Maj Gen (Dr) Ashok Kumar, VSM (Retd), DG, CENJOWS.** The Director General of the Centre for Joint Warfare Studies (CENJOWS) Maj Gen (Dr) Ashok Kumar, VSM delivered an insightful address highlighting the historical, strategic, and operational significance of unmanned aerial systems (UAS) and the imperative for counter-UAV capabilities in India.

4. He began by recounting the early history of unmanned aerial vehicles, stating that their first use dates back more than two centuries, when the Montgolfier brothers used balloons to carry livestock. However, it was in 1849 that these aerial platforms were weaponized for the first time by Austrian forces in their attack on Venice. UAVs were also employed during World War II, though not in significant numbers. Post-1960, significant focus has emerged on the development of unmanned aerial system (UAS) warfare, which has evolved into multiple applications and variations. The DG noted that the potential of these platforms is only limited by human imagination.

5. With time, UAS has seen widespread adoption across both military and civilian domains. In the military, their usage is no longer confined to reconnaissance and surveillance. They are now actively employed for precision targeting, especially against hard-to-reach or high-value targets that conventional weapon systems struggle to engage. The Gen emphasised the dynamism, innovation, and rapid application of these platforms, which are reaching unprecedented levels of performance.

6. He noted that their combined capabilities, particularly in swarm configurations, now offer lethal operational potential. So transformative are these advancements that conventional platforms such as aircraft are being revaluated in terms of their continued effectiveness. Special attention was drawn to first-person view (FPV) drones, which have altered combat engagements significantly. In many cases, these drones have become as integral to soldiers as rifles or personal weapon systems.

7. The Gen pointed to the ongoing Russia-Ukraine conflict as a case in point, where both countries have established organic drone forces within their armed services. These forces have adapted and evolved as the war progresses into its third year. He highlighted that advancements in UAS technologies continue at a rapid pace, including the

development of systems capable of operating in GPS-denied environments. This underscores the urgent requirement for effective counter-UAV measures.

8. He stressed that a single-method approach to counter-UAS is insufficient. Instead, a hybrid solution is essential—one that combines both hard-kill and soft-kill options. While some countries have made significant progress in these areas, China remains particularly noteworthy as a key supplier of such technologies to many global buyers.

9. He also outlined the strategic alignments shaping global UAS capabilities. China and Russia are aligned, while Ukraine has received substantial support from NATO nations, including the United States. Initially, Ukrainian forces depended on drones sourced from China. However, due to backdoor software vulnerabilities, Ukraine shifted toward building indigenous platforms. Their innovation and urgency led to rapid capability development, including reports of using nearly 10,000 drones in a single day of combat. Russia has similarly made notable progress in this domain.

10. The Gen noted that this level of innovation and production is required in India as well. He cited reports that the People's Liberation Army (PLA) of China has placed orders for nearly one million kamikaze drones. He warned that any technology in Chinese hands is likely to be accessible to Pakistan, and further noted that Bangladesh has procured drones from Turkey. In such a regional context, he underscored the imperative for India to achieve indigenous capabilities in both UAS and counter-UAS technologies, across all operational domains.

11. Highlighting the significance of the event, the DG stated that the current seminar represents a new milestone for CENJOWS. It is the first time such an event is being conducted independently. The purpose of this initiative is to ensure that all stakeholders, including the Army, Navy, Air Force, Coast Guard, ITBP, BSF, Delhi Police, and others can collectively deliberate on UAS warfare and required countermeasures.

12. He reiterated that a whole-of-nation approach is critical to success, given that these systems are not limited to wartime use alone. Drones and counter-drones are expected to play an important role during peacetime, in grey-zone operations, and in periods of heightened tension even when there is no open conflict.

13. Concluding his address, the Gen expressed hope for a professionally enriching session. He noted that the seminar is also part of the Adani Defence Chair of Excellence,

currently held by Brigadier Anshuman Narang (Retd), who played a key role in organizing the event.

14. **Keynote Address by Gen Anil Chauhan, PVSM, UYSM, AVSM, SM, VSM, Chief of Defence Staff.** The Chief of Defence Staff (CDS) General Anil Chauhan stated that warfare is undergoing rapid transformation, largely driven by advancements in technology. He outlined three dominant technology-driven trends shaping the future of warfare:-

(a) The first is celerity, relating to velocity and speed. According to the CDS, modern weapon systems now feature smaller radar cross-sections, high speed, and intelligent routing, making them nearly inaudible, invisible, and undetectable. This transformation is supported by developments in hypersonics (both glide and cruise), fractional orbital systems, and swarm drones, all of which significantly reduce the survivability of large platforms and make virtually every location a potential target.

(b) The second trend is the advancement in *robotics*, driven by developments in automated, autonomous, and intelligent systems. The CDS noted that this evolution is introducing man-unmanned teaming concepts, significantly reducing the risks to human combatants. Technologies such as exoskeletons are enhancing endurance and further revolutionizing the combat landscape.

(c) The third trend pertains to the rise of *intelligent warfare*, marked by data-centric operations. Integration of data analytics, artificial intelligence (AI), and machine learning (ML) is enabling quicker and more accurate decision-making for both human operators and machines. The CDS highlighted that supercomputers, AI, and ML will play vital roles in the battlespace of the future.

(d) He emphasised that UAS embodies all three trends—celerity, robotics, and intelligence—and have evolved from support tools to frontline executors of combat missions. He cited recent conflicts such as those in Ukraine and between Armenia and Azerbaijan as key examples of innovative UAS applications.

(e) Reflecting on the evolution of warfare, the CDS noted the historical human-versus-human nature of combat, stating that the battlefield is now entering an era where engagements may occur between humans and machines, and even between intelligent machines. This transformation, he asserted, fundamentally alters both the nature and character of warfare.

(f) Furthermore, the CDS referenced the use of balloons by Austrian forces in 1849, the introduction of radio-controlled aircraft by the British and Americans during World War II, and the U.S. use of the Ryan Model 147 during the Vietnam War. He further detailed the pivotal role of Predator drones in the 1990s and 2000s, which were used for surveillance and later combat in Afghanistan.

(g) The CDS noted that non-state actors have also adopted UAS technology. In 2004, Hezbollah became the first such group to deploy drones, followed by ISIS, the Houthis, and others. These groups have employed drones for significant tactical and strategic effects.

(h) Discussing the Ukraine conflict, he explained how unmanned systems now operate across air, ground, water, and underwater domains. The CDS emphasized the increasing affordability and accessibility of UAS, referencing cardboard drones, homemade loitering munitions, and DIY kamikaze kits as examples of low-cost, high-utility tools.

(j) Despite their ubiquity, he pointed out ongoing ambiguities in terminology. The interchangeable use of terms like drones, UAVs, RPAs, and UAS underscores the need for standardized vocabulary and grammar, which must be defined by the Armed Forces to facilitate research and development by academia and industry.

(k) He provided an illustrative classification:-

(i) All UAVs are drones, but not all drones are UAVs.

(ii) UAVs can operate autonomously.

(iii) RPAs require a human pilot.

(iv) UAS encompasses the complete ecosystem, including operators, communication links, launch/recovery systems, and the UAV platform.

(l) The CDS emphasized the importance of understanding this distinction, particularly in the context of developing counter-UAS systems. He compared this to sixth-generation aircraft, which are not merely platforms but integrated systems involving data fusion, AI, cyber capabilities, and loyal wingmen.

(m) He proposed a generational classification of UAS:-

(i) **First Generation.** Remotely piloted systems (man-in-the-loop), controlled via radio or satellite.

(ii) **Second Generation**. Man-unmanned teaming; one manned platform controlling several unmanned systems (e.g., loyal wingmen or naval drones).

(iii) **Third Generation.** Fully autonomous systems operating independently in GPS-denied environments.

(iv) **Fourth Generation.** Intelligent systems with embedded AI capable of autonomous decision-making, target reassignment, evasion, and self-healing.

(n) He urged the seminar to explore and refine this classification to establish a comprehensive Indian understanding of UAS systems.

(o) Regarding counter-UAS technologies, the CDS pointed out that warfare innovations always invite corresponding countermeasures. Tanks led to anti-tank weapons, aircraft to air defence systems, and UAS to anti-UAS systems such as electronic warfare tools, laser interceptors, and kinetic options.

(p) He noted that India's strategy must involve layered countermeasures that address the entire system and not just the individual platform.

(q) The CDS asserted that India's journey in developing UAS and counter-UAS systems must begin with conceptual clarity and standardized terminology. He emphasised the need for synergy among users, designers, and manufacturers, coupled with innovation and responsiveness to operational feedback. The Ministry of Defence's initiatives such as IDEX, DISC, iDEX Prime, SPRINT, and ADITI were cited as catalysts for innovation. The declaration of 2025 as the *Year of Defence Reforms* was highlighted as a timely opportunity.

(r) He stressed the importance of balancing innovation with cost-effectiveness and scalable production. Citing lessons from contemporary conflicts, he reiterated the need to prepare for surge capacity during crises.

(s) While the focus is often on machines, the CDS reminded the audience that the "man behind the machine" remains critical. Whether near or far from the battlefield, human operators must be adequately trained and equipped. As warfare moves from

man-in-the-loop to man-on-the-loop, and eventually to man-out-of-the-loop systems, human expertise remains indispensable.

(t) The CDS concluded by stating that modern combat is becoming intelligent, decentralised, transparent, multi-domain, and autonomous. With emerging domains like cyber and space, the Indian Armed Forces must develop robust cross-domain capabilities.

(u) He reiterated that while technology will shape strategy and tactics, it is strategy that wins wars. Integrating UAS systems optimally with manned capabilities will strengthen deterrence, enhance operational efficiency and achieve strategic surprise. Failing to do so could lead to strategic and tactical vulnerabilities and concluded with a call to collectively build a "Shaktishaali, Surakshit, and Viksit Bharat."

SESSION 1

Advancements in Drones Technologies and Campaign Strategy

Presented by AVM Rajiva Ranjan, AVSM, VM (Retd)
Topic: Indian Military's Drones' Requirements for 'Surakshit Bharat 2047' Technological Advancements in Drone Warfare

15. AVM Rajiva Ranjan emphasized the critical role that technological advancements play in drone warfare. He highlighted that the rapid improvements in **artificial intelligence (AI), edge computing, and battery efficiency** are transforming the battlefield. AI is enabling drones to operate with greater autonomy, reducing dependence on human operators and allowing for quicker decision-making in combat.

16. Further, **jam-resistant communication/data links** and **advanced navigation systems** are making drones more resilient against electronic warfare threats. This is particularly important as adversaries are increasingly using electronic warfare to jam GPS signals and disrupt UAV operations. These advancements collectively enhance **ISR (Intelligence, Surveillance, and Reconnaissance) capabilities**, providing the military with real-time situational awareness and precision targeting.

Lessons from Global Conflicts

17. Drawing from recent conflicts, AVM Ranjan provided key insights into how drone warfare has evolved globally. He cited the **Ukraine-Russia War**, where **low-cost drones** were extensively used for surveillance, airstrikes, and psychological operations. Despite Ukraine deploying **Western counter-drone systems**, Russian drone swarms have managed to overwhelm their defences through sheer numbers.

18. Similarly, in the **Middle East**, state and non-state actors have been leveraging drones for **asymmetric warfare**, conducting precision strikes against military and civilian targets. The use of **Iranian drones in Syria and by Houthi rebels in Yemen** highlights how relatively inexpensive UAVs can be used to disrupt conventional military forces.

India’s Drone Requirements & Strategic Vision

19. AVM Ranjan outlined a vision for India's drone strategy under the **Surakshit Bharat 2047** initiative. He opined that the technologies and large force of PLA could be offset through asymmetric, innovative and massed application of uncrewed platforms. He proposed the establishment of **UAV strike platoons** within **each regiment, squadron, and unit**, ensuring that personnel across the Indian Armed Forces are skilled in drone warfare.

Additionally, he recommended the creation of a dedicated **Unmanned Systems Force (USF)** integrating aerial, ground, and maritime drones under a unified command structure.

20. One of the key aspects of this vision is the **development of highly autonomous, AI-driven drones with edge computing** that can **process data in real time** and render decision support. He emphasized that collaborations with domestic and international defence technology firms was essential to accelerate the development of cutting-edge drone systems.

21. He called for procurement of diverse types of drones in huge quantities and allocation of requisite portion of budget for the purpose along with fast-track procurement of **Blue UAS (ie Made in India)**.

Counter-Drone Strategies

22. Recognizing the growing threat from enemy drones, AVM Ranjan stressed the need for advanced **counter-UAS (C-UAS) measures**. He proposed the use of:-

(a) **Quantum sensors** and **AI-driven detection systems** for early identification of drone threats.

(b) **Directed Energy Weapons (DEWs)** and **Electromagnetic Pulse (EMP) technology** to neutralize incoming UAVs.

(c) **Satellite-enabled drone detection grids** for real-time interception of hostile drones.

23. He also highlighted the need for developing specialized training for military personnel to ensure proficiency in utilizing electronic warfare tools and counter-drone strategies, and enhancing operational readiness.

24. These strategies would ensure that India is prepared to counter the increasing proliferation of drone warfare in future conflicts.

Future Battlefield Trends

25. The speaker concluded by emphasizing that future battlefields will be dominated by **AI-enabled drone swarms**. These swarms can execute **Suppression of Enemy Air Defence (SEAD)**, conduct **autonomous reconnaissance**, and act as force multipliers. **Multi-domain operations (MDO)** will further integrate drones across air, land, maritime, space, and cyber domains, ensuring enhanced battlefield awareness and joint-force effectiveness.

Presented by Mr Sarjan Shah, JSW UAV

Topic: The Future of the Battlefield: Drones and AI Disaggregated Mass & Distributed ISR

26. Sarjan Shah discussed the concept of "disaggregated mass" and "distributed ISR", which focuses on deploying large numbers of smaller, more affordable drones instead of relying on expensive, limited UAV assets. He provided a case study of MQ-35A V-BAT, an advanced ISR drone that has been successfully deployed in EW-contested zones such as Ukraine and the Black Sea.

27. He argued that instead of using a few highly expensive UAVs, militaries should shift toward high-attrition ISR platforms that can be deployed in large numbers. This strategy not only enhances surveillance capabilities but also ensures combat resilience by making it harder for adversaries to degrade ISR coverage.

Network-Centric Warfare

28. Shah emphasized the importance of instantaneous networked information transmission, allowing ISR drones to act as real-time data nodes in combat. A major highlight was the need for sensor-to-shooter links, where drones provide direct targeting data to aircraft, artillery, and missile systems.

29. Further, he stressed the importance of resilience to GPS jamming and electronic warfare, as adversaries are increasingly deploying EW systems to disrupt drone communications. He cited the MQ-35A's ability to operate seamlessly in GPS-denied environments, demonstrating the necessity of secure, jam-resistant navigation systems.

Role of AI in Drone Warfare

30. AI is playing an increasingly crucial role in modern drone warfare. Shah elaborated on automatic target recognition (ATR) and pattern-of-life analysis, which allow AI-driven drones to identify enemy tactics and movements autonomously. AI also reduces the reaction time for engagement, enabling UAVs to rapidly detect, track, and neutralize threats.

Operational Flexibility of MQ-35A V-BAT

31. The MQ-35A V-BAT was presented as a model for **next-generation ISR drones** due to its:-

(a) VTOL (Vertical Take-Off and Landing) capability, allowing deployment from any terrain, ship, or urban area.

(b) Modular payloads, including EO/IR, Synthetic Aperture Radar (SAR), and kinetic strike munitions.

Strategic Implications for India

32. Shah concluded by stressing the importance of Made-in-India drone development. India should focus on producing affordable, AI-driven ISR drones for:

(a) **Border security and counter-infiltration operations**.

(b) **Maritime domain awareness (MDA)** to enhance naval surveillance.

(c) **Counter-insurgency and anti-terrorism operations** in dense urban areas and jungle warfare.

Presented by Lt Gen Ajay Kumar, VSM, DG Infantry

Topic: Advancements in Small & Medium Range Drones & Indian Requirements

33. Lt Gen Ajay Kumar highlighted the importance of small and medium-range drones in modern warfare, emphasizing that India must accelerate its adoption of advanced UAV technology to keep pace with adversarial capabilities. He categorized drones into three levels based on their operational use—Tactical, Operational, and Strategic. Tactical-level drones, such as Nano, Micro, and Mini UAS, are crucial for frontline surveillance, target acquisition, and infantry support. These small UAVs are portable, easy to deploy, and provide real-time intelligence to ground forces, making them indispensable in counter-insurgency and border operations.

34. At the operational level, India needs swarm drones, runway independent, and MALE (Medium-Altitude Long-Endurance) class UAVs to enhance battlefield dominance. These drones can conduct long-range surveillance, electronic warfare (EW) missions, and limited strike capabilities. They form an essential component of network-centric warfare, ensuring seamless integration with ground and air assets. Strategic-level drones, such as HALE (High-Altitude Long-Endurance) UAVs, play a pivotal role in deep surveillance, precision strikes, and long-endurance ISR (Intelligence, Surveillance, and Reconnaissance) missions.

35. A significant concern raised by Lt Gen Kumar was India's growing capability gap in drone technology compared to its adversaries, particularly China. He emphasized that China has already integrated swarming drones, AI-driven UAVs, and loitering munitions into its combat strategy, whereas India still struggles with technological dependence on foreign-made drones. A large portion of UAV components used in India—including sensors,

communication modules, and flight controllers—are sourced from Chinese manufacturers, which poses a critical national security risk.

36. Moreover, he pointed out that India's indigenous production capacity is limited, with only a handful of companies involved in manufacturing drones at scale. Unlike China, which has vertically integrated drone production with government support, India's fragmented industrial ecosystem and lack of regulatory clarity slow down development. Additionally, there is a shortage of trained personnel in drone operations, electronic warfare (EW), and counter-UAS warfare, further widening the gap between India and its adversaries.

37. To overcome these challenges, Lt Gen Kumar proposed a multi-pronged roadmap for Indian drone capabilities. He stressed the need for a comprehensive drone warfare doctrine, ensuring that UAVs are integrated seamlessly into joint military operations across the Army, Navy, and Air Force. He called upon the industry to innovate faster and invest more in R&D.

38. He recommended deeper joint ventures for acquiring critical technologies, upscaling of workforce and exploring Public-Private partnerships through DRDO and DPSUs. He said that there was an urgent need to establish dedicated R&D fund for critical technologies and proposed the creation an Indian Blue UAS framework. He also brought out the need to invest in development of testing infrastructure and ranges.

39. He concluded by highlighting the need for urgent focus on homegrown technology that could replace foreign parts, assuring users of higher security and also of the commitment to keep the forces supplied through such production over extended conflicts.

Presented by Brig Anshuman Narang (Retd)

Topic: Missiles-Drones-Rockets Campaign Strategy – Lessons from Ongoing Conflicts

40. Brig Anshuman Narang provided a strategic analysis of modern drone and missile warfare, drawing insights from recent global conflicts such as the Russia- Ukraine war and the Iran-Israel conflict. He noted that drones, precision-guided missiles, and rocket artillery are now being used in hybrid warfare to overwhelm enemy defences and cripple infrastructure.

41. One of the key takeaways from the Russia- Ukraine war has been the effectiveness of drone saturation attacks. Russia has been utilizing Shahed-136 drones in large numbers, often in coordination with ballistic missile strikes, to saturate Ukrainian air defence systems. He highlighted that Ukraine, despite receiving Western air defence support, has been

unable to fully counter Russia's evolving drone and missile strategies due to the sheer volume of attacks.

42. Similarly, the Iran-Israel conflict in April 2024 showcased how Iran effectively launched multi-layered drone-missile attacks against Israel's Iron Dome air defence system. Iranian forces used a combination of decoy drones, cruise missiles, and ballistic missiles to overwhelm Israeli missile defences, demonstrating that even the most advanced air defence systems can be breached with high-volume, low-cost attacks.

43. Brig Narang highlighted three key strategic lessons from these conflicts that India must consider: -

(a) **The significance of 'Quantity' in drone warfare.** He emphasized that low-cost drones, when used in large numbers, can overwhelm expensive air defence systems, making mass production of drones essential for future conflicts.

(b) **The importance of multi-domain integration**. He explained that drones should be integrated with missile strikes, electronic warfare, and cyber operations to maximize their impact.

(c) **The necessity of counter-drone and electronic warfare capabilities**. He noted that India must develop AI-enabled jamming systems, cyber warfare tools, and hardened communication networks to defend against enemy drone swarms. He further emphasized the need for layered drone defences incorporating kinetic interceptors, high-powered lasers, and electromagnetic warfare tools. He proposed that India should establish an Integrated Rockets-Missiles-Drones Air Defence System.

Chairperson's Closing Remarks: Air Marshal SP Dharkar, PVSM, UYSM, AVSM, VCAS

44. In his closing remarks, Air Marshal SP Dharkar underscored the growing importance of drones in modern warfare and the urgent need for India to develop indigenous UAV capabilities. He stated that drones will not just be force multipliers but will define the future of military operations, with AI-driven autonomous systems playing a dominant role.

One of his key concerns was India's reliance on foreign-made drone technologies, which poses a significant security vulnerability. He stressed that India must invest in domestic drone research and development, ensuring that UAVs are produced indigenously with secure, non-foreign components. He also called for greater collaboration between the government, private sector, and defence research institutions to accelerate innovation.

45. He further highlighted the need for a centralized counter-UAS command, which would be responsible for detecting, tracking, and neutralizing hostile drones. He outlined the importance of electronic warfare, AI-driven countermeasures, and directed-energy weapons in defending against the next generation of aerial threats.

46. He concluded by reiterating that the Indian Armed Forces must fully integrate drones into their multi-domain operations, ensuring that UAVs work in coordination with ground, naval, and air assets. He emphasized that preparing for a drone-dominated battlefield is essential for maintaining India's strategic edge, and that investments in AI, hypersonic drones, and swarm-based SEAD operations must be prioritized.

Session Focus

47. The session provided critical insights into the future of drone warfare and India's strategic preparedness. The speakers emphasized that:-

(a) India must rapidly scale up indigenous drone production and reduce reliance on foreign technology.

(b) AI-driven drone swarms and network-centric ISR platforms will define future multi-domain warfare.

(c) Counter-drone and electronic warfare capabilities must be developed at scale, with a focus on layered defence mechanisms.

(d) Collaboration between the military, industry, and research institutions is essential for keeping pace with global advancements in UAV warfare.

48. The discussion concluded with a strong consensus that India must act now to build a robust, self-reliant drone ecosystem, ensuring technological superiority in future conflicts.

SESSION 2

Manifestation of Drones Threat along Indian Borders & IOR

Chairperson's Opening Remarks: Vice Adm Tarun Sobti, AVSM, VSM, DCNS.

49. As Chair of the session, Vice Adm Tarun Sobti, AVSM, VSM, DCNS spoke about drone threats which do not remain confined to the air but have proliferated across multiple domains. The threat posed by drones on land and in the maritime domain especially in IOR, is emerging as a serious challenge. Drones in the hands of asymmetric adversaries like terrorists and non-state actors are disruptive and damaging tools. Yemen-based Houthi group effectively used drones to attack oil and LNG vessels in the Red Sea, reducing the oil supply through the region by as much as 60%. The same group used drones to attack Saudi oil installations at the heart of Saudi Arabia's oil industry, reducing its output to almost half and globally sending oil prices soaring. This makes it imperative to have effective counter-measure systems to neutralise threats posed by the drones. As with any newly developed weapon system/ platform, the initial advantage remains skewed towards the weapon system; however, gradually, the countermeasure systems are developed, restoring the offence-defence balance.

Presented by Brig Anshuman Narang (Retd)

Title: Drones Threat Along Northern Borders

Introduction

50. UAS and multi and cross-domain uncrewed systems (UxS) offer a suite of novel opportunities beyond existing technologies. In addition to generating mass and scalable effects, there use offers protection to our soldiers and relive them from undertaking dangerous tasks at the battlefield. The Ukraine war is an example of changing character of war. The futuristic scenario of war perpetuated by robots, land drones, sea drones and air drones are not far. The amalgam of two technologies: AI and drones will transform the contours of battlefield.

51. **Key Takeaways/Recommendations.**

(a) Chinese Premier Xi Jinping while speaking at Air Force Aviation University said that, “the proliferation of drone system and unmanned operations are profoundly changing the face of war. It is necessary to strengthen unmanned combat research, strengthen the professional development of drones, strengthen practical education

and training, and accelerate the training of UAV use." The statement sums up the trajectory of UAS of PLA.

(b) The multi-domain, multi-tiered, autonomous & intelligent unmanned systems of systems have been developed and in use across the spectrum. Near-space, solar powered with advanced navigation systems, marsupial drones / bee swarms, manned-unmanned teaming, hybrid drones, UGVs, UUVs & USVs-multi-domain wall, UAV carriers are some of the technologies which are in use or in advance state of development. The AI-based deep learning analysis will make the UAS more capable and dangerous.

(c) The types of drones' operations by PLA include single unmanned platform, loyal wingmen coordinated air operations, early warning aircraft and mixed formation air operations, Manned/unmanned coordinated ground operations, air-launched drone swarm operations, land-air joint unmanned operations, combat ground-to-ground operations, mother-ship Swarm Operations, anti-stealth and unmanned space operations.

(d) For India, the doctrines and structures need to evolve to be in sync with new technology revolution and for fighting in multi-domain environment. Our ISR / non-contact domain / IW structures need to be capable and resilient to counter Chinese threat by building a coherent picture and carrying out joint operations using multi-domain assets.

Presented by Mr Jasbir Solanki, CEO, Mahindra Defence
Title: Advancement in Drone Detection Technologies

Introduction

52. The global drone market is expected to reach US $ 57.8 billion by 2030, which in itself is an assertion of importance and magnitude assigned to drone technology. Drones are no longer a niche threat. They have become pervasive, highly adaptable and lethal challenges in present security scenario. The drone technology proliferation and its malicious uses continues unabated. The use of drones in ongoing conflicts including Russia – Ukraine, Israel – Hamas, Armenia – Azerbaijan and Houthis in Yemen is an assertion of its proliferation in conflict zone.

53. **Key Takeaways/Recommendations**

(a) Advancements in drone technology are making its detection difficult. Drones are using encrypted & 5G communications, optical fiber communications, frequency hopping and FPV. Autonomous UAS and tethered drones have emerged as security challenge of great magnitude. The complexity of detection and interception methods must keep pace with these technological advancements.

(b) Counter-UAS must undergo significant innovation and integration of cutting-edge technologies to counter the evolving threats posed by advanced drone technologies. These include AI-powered signal analysis, advanced detection algorithms, real-time airspace monitoring, automated decision making and multi-layered detection systems.

(c) Multi-layered detection and mitigation capabilities need to leverage the advanced technologies to ensure comprehensive situational awareness including RADAR, EO/IR, RF Detector and Spectrum analyzer. Once a drone threat is detected, the system must activate a multi-layered mitigation approach including RCWS, LASER systems, jammer and killer drone.

Presented by Commodore Manjit Thomas

Title: DRONES THREAT – IOR

Introduction

54. The types of drones include Uncrewed Aerial Vehicles (UAV), Uncrewed Surface Vehicles (USV), Uncrewed Underwater Vehicles (UUV), Small Uncrewed Aerial Vehicles (SUAV) and Hybrid (Surface / Submerged). Multiple Drone attacks on commercial shipping using weapons like Kamikaze UAV (Shahed 136) and Kamikaze USV (Toofan – 1) caused major disruptions. Similarly attacks on NATO warships (USS Gettysburg incident) highlight issues of intrusive surveillance, vulnerability of legacy systems and need for a cost-effective response. The lessons from sinking of Moskva include importance of ISR capabilities and precision strikes.

55. **Key Takeaways/Recommendations**

(a) The operational philosophy of drone operations includes intrusive surveillance, low tech low cost and decentralised ops, disruption especially close to coast ops, swarming of defences and area denial / mobile mine fields.

(b) C-UAS technologies that can be exploited include radar and RF Frequency direction finders. To achieve Soft Kill, use of RF jammer by disrupting the control link and GNSS Jammer is preferable. To achieve hard kill, use of small arms, MR / CR guns, direct energy weapons, MANPADS, low cost surface to air missiles are some of the options. There is a need for expediting R&D of weapons and sensors for C-UAS technologies.

Presented by Mr Rajiv Mehrotra, Chairman, Shyam VNL Pvt Ltd

Title: Advancements in Drones Detection Systems &Challenges in Operations

Introduction

56. The rapidly evolving technology in UAS domain is playing catch-up with detection technology. Low-tech drones need very high-tech response to counter, hence are not cost effective. Fusion of sensors such as Radar, LidaR, RF, Electro-optics, Acoustics etc. needs to be undertaken to counter Drones threat. Counter drone operations sequence include detection using electronic / acoustic / physical sighting and neutralization using soft and hard kill options. The neutralization methods include Jamming, Directed energy weapons like LASER / EMP / Micro Wave, Anti drone drones and Physical Destruction. Identification of drones is an evolving field including using Database for models & types.

57. **Key Takeaways/Recommendations.** The drone system has for significant pillars which are discussed in the following paragraphs: -

(a) **Power.** A drone's power system is crucial, acting as the "heart" of the drone, directly impacting its flight time, performance, and overall efficiency. Different types of UASs are used for different applications and there is a suitable power source for each application. Some options include fuel cells, combustion engines and batteries of various technologies. These power sources are crucial for the operation of UASs and must meet certain requirements such as size, weight, cost, and power density.

(b) **Secure System**. Secure systems are crucial for drones to ensure data privacy, prevent unauthorized access and cyber-attacks, and maintain safe and reliable operations, especially with their increasing use in sensitive applications like surveillance and infrastructure inspection. Data encryption, secure communication channels and GPS anti-spoofing are some of the cutting edge technologies to archive this.

(c) **Integrated Command &Control and Sensors**. An integrated Command & Control (C2) system for drones facilitates remote management of UAS, enabling operators to control navigation, payloads, and mission execution through secure communication links and real-time monitoring tools.

(d) **Sensors**. Drones utilize a variety of sensors for navigation, flight control, and data acquisition, including Inertial Measurement Units (IMUs), GPS/GNSS, LiDAR, barometers, and cameras (RGB, thermal, multispectral).

These four pillars support the drone operations parapet and collapse of any of this pillar will degrade/ deny drone operations. For a self-reliant anti-drone industry Lab testing of specifications, Field testing & validation needs to formalized.

Presented by Shri SS Rathore, DIG (Ops), BSF

Title: Peacetime Drones' Threat Along Western Borders including Rogue Drones

Introduction

58. Evolving drone threat along Indo-Pak border has become a major challenge. The modus operandi includes use of commercial and DIY drones, high-tech modifications for precision drops, night operations to evade detection, multiple small-scale drones for diversion tactics, multi-directional flights and cross-border networks of terror groups and criminals.

59. Pakistan increasingly using drones modified to fly longer distances with heavier loads. These drones can operate in a semi-autonomous mode with pre-fed GPS coordinates.

60. The coordinated approach to counter drone threat includes enhanced surveillance & detection technologies, jamming and anti-drone deployment, increased border patrols & quick reaction teams, collaboration with private sector for Anti-Drone tech and intelligence gathering and cross-border operation and engaging local population.

61. Legal framework and operational strategies to include coordination between BSF, Indian Army and Police and public awareness & reporting of Drone sightings.

Key Takeaways

(a) Development of Indigenous Anti-Drone Systems for drone detection and neutralization. Collaborations between DRDO and private firms to develop sophisticated anti-drone systems using AI and machine learning technologies:

(b) Future strategies may involve deployment of AI and machine learning algorithms to identify drone patterns, predict smuggling attempts, and respond to them with greater efficiency.

(c) BSF is also looking into using its own fleet of drones to counter enemy drones and conduct surveillance. These tactical drones would be equipped with sensors and cameras to track any suspicious aerial activity.

SESSION 3

ADVANCEMENTS IN COUNTER-UAS GRID

Chaired by Lt Gen Vipul Singhal, AVSM, SM, DCIDS (DOT)

Presented by Shri Mukesh Singh, IG, ITBP

Title: Counter UAS requirements in HAA along borders

Introduction

62. Till 2019, the use of drones was limited for event management activities for the amusement of guests. In addition, sketchy bits of news about Taliban being targeted precisely by the US and drone usage in Turkey Syria and Iraq were doing rounds.. From 2019 onwards, the drones started coming in from the from across the border especially in Samba Kathua region. Some of them were intercepted based on intelligence received, however many could not be intercepted. The alarm bells went off in June 2021 when a drone was used to drop bomb at the Jammu Air Force Station which was located 14 km from the nearest international border. The distance covered and dropping at a precise location was demonstration of capabilities acquired by our adversaries. The event was a wakeup call to ramp up counter drone capabilities. However there were no effective solutions available. The NSG had one such system with was brought and installed at Jammu airport. It was a system with reasonable capabilities but its detection range was limited up to a radius of 3 km and could neutralize a drone at a distance of 800 meters. In January 2023, in the backdrop of a VVIP event, from across the international border a drone was used to drop a bomb at a police Naka which was around 18 km away. This created a situation, wherein available resources with Air Force, Army and BSF were deployed to prevent any untoward incident during visit. Air Force Station, Udhampur had a GPS Jammer with ranges up to 40 km. Later from the intelligence sources it was learned that a drone from the other side of international border took off, came up to the border and then malfunctioned due to its GPS navigation got blocked. Since then a lot of water has flown into the river as far as drone and counter drone technology is concerned.

Key Takeaways/Recommendations

63. Across the China border, in the past 5 years, there around 70 transgressions of unmanned aerial systems took place into Indian territory and the record of neutralizing them do not instill confidence. Deploying counter drone system at High Altitude area, especially at places like Arunachal Pradesh with poor road connectivity, is a challenge. In the region, there are border outposts which are 90 km away from the road-head. In addition, expecting every border patrol to go out with a man pack and counter drone solution is also not

practical. In addition, at high altitude the battery life is limited so unless we have fuel based counter drone system its efficacy will be restricted. As per experts, for every 1,000 meter increase in the altitude, the battery performance goes down by approximately by 10%.

64. For an acoustic detection system, the background noise from high winds will limit its performance.

65. In 2019, Ministry of Civil Aviation released 'National Counter Rogue Drone Guidelines' to lay out guidelines assessing drone threat. To strengthen the national Roadmap for drones operations Draft of National Counter Rogue Drone Policy (NCRDP) has been prepared and is under submission for approval.

66. The Anti- Rogue Drone Technical Committee (ARDTC) was constituted in July 2022 to assess the effectiveness of the developed systems and to certify them. The ARDTC under supervision of DG BSF, with mandate to evaluate the technology available to counter rogue drone and certify its effectiveness in dealing with rouge drones, is an important step for C-UAS.

Presented by: Mr Navneet Singh, CEO, Kepler Aerospace

Title: Comprehensive Counter-UAS Grid Technological Solutions

Introduction

69. The comprehensive counter UA solutions in a grid architecture are more effective and potent rather than a singular one-off system. A single system remains less effective in a contested and environmentally variable region. A networked approach to anti-drone systems ensures that some things may work against some drones while others work against other type of drones. The drone systems are being developed that can work in actively denied environments and have been used effectively in Russia- Ukraine war even under intense Electronic Warfare environments. Today, battlefield is a pure Darwinism environment in which the best and the adaptable survives. The early evolution of Drones was based on mission and battlefield needs. The modular, switchable, and adaptable designs are the outcomes of this evolution. The technology adoption strategy for drones is based on its relevance, rapid prototyping and Quick intelligence deployment.

Key Takeaways/Recommendations

70. Fiber-optic drones, drones operating at low frequencies, use of Controlled reception pattern antennas (CRPA) to protect drones GPS receivers from jamming are some of the technologies used which challenge the effectiveness of an Anti-drone system.

71. To focus on a networked approach with multi-sensor and multi-affecter capabilities. In place of passive detection, adoption to active detection systems in the layered defence configuration will offer improved capability to a counter drone system.

72. The detection systems to adopt multi-sensor approach using active detections with Radar and EOIR, passive detection with ELINT/SIGINT systems, cameras and LRF for detection and ranging. Infield innovations are key to countering new threats.

Presented by: Maj Gen CS Mann, AVSM, VSM, ADG ADB

Title: Counter UAS Support Requirements in TBA

Introduction

73 As a counter UAS measure, the Initial Response includes Visual detection, Small Arms fire neutralization and concealment. The progressive measures include camouflage, protective nets & cope cages and handheld jammers.

74. An effective C-UAS system to have short reaction time, passive AD measures, Soft Kill & DEW capability, autonomous systems for swarm drones and indigenous supply chains.

75. The emergence of C-UAS systems include EO, acoustic, active sensors, jammers, remote controlled gun arrays, net guns, fragmentation ammunition, interdiction drones and directed energy weapons. Drone identification and interdiction involve detecting, tracking, and neutralizing unauthorized or malicious drones using various technologies like radar, radio frequency (RF) detection, and acoustic sensors, with the aim of ensuring airspace safety and security.

Key Takeaways/Recommendations

76. The Key components of C-UAS include effective surveillance and detection, timely identification, combined approach for interdiction, robust Command & Control system with decentralized control. The sensors include AESA (Active electronically scanned array) radars, Electro Optical Devices and Passive/ Acoustic Sys. The Soft Kill techniques Jammers, GPS Spoofers and Cyber Takeover. The Hard Kill techniques includes Remote controlled weapon station (RCWS), Anti-Drone ammonization, Interceptor Drones, VSHORADS (IR), VSHORADS (LBR), DEW and Net Guns.

77. As no single technology can effectively handle the drone threat, a combined approach is required. The Command and Control system also needs to be decentralised for quick and prompt response. There is a need for inherent and organic C-Drone Capability at multiple levels. C-UAS system to include Man-portable, vehicle based, platform based and integrated C-UAS System configurations.

SESSION 4
COUNTER-UAS POLICY

Presented by Lt Gen Manish Erry, Director General Strategic Planning

Title: WHOLE OF NATION APCH TO C-UAS POLICY

Introduction

78. The increasing proliferation of Unmanned Aerial Systems (UAS) has brought significant advantages in sectors such as surveillance, logistics, and disaster management. However, these benefits come with serious security challenges, particularly the risk posed by rogue drones. The rapid evolution of drone technology has led to their use for malicious activities, including espionage, smuggling, and even potential attacks on critical infrastructure. The threat landscape has expanded beyond conventional warfare, necessitating a robust Counter-Unmanned Aerial System (C-UAS) policy to safeguard national security.

79. In response to these emerging threats, the Directorate General of Civil Aviation (DGCA), the Ministry of Civil Aviation (MoCA), and the Indian Armed Forces have implemented various regulatory frameworks and counter-drone measures. The presentation on the "Whole of Nation Approach to C-UAS Policy" underscores the need for a coordinated strategy involving government agencies, industry stakeholders, and the private sector. Existing policies, such as the Drone Rules 2021 and the National Counter Rogue Drone Guidelines, have laid the groundwork for managing drone-related threats. However, evolving threats, including drone swarms and AI-enabled autonomous UAS, require an integrated national response.

80. Lt Gen Erry explored key takeaways from the presentation, highlighting the challenges in framing and implementing counter-UAS policies. It also provides strategic recommendations to enhance India’s counter-drone capabilities while ensuring that security measures do not hinder commercial drone innovation.

Key Takeaways

81. **Evolution of Regulatory Framework for Drone Management.** The regulatory landscape for drone operations in India has evolved significantly since the introduction of civil aviation requirements for Remotely Piloted Aircraft (RPA) in 2018. The DGCA categorized drones, outlined regulatory guidelines for their operation, and established ceiling heights and no-fly zones. The Drone Rules 2021, along with subsequent amendments, introduced a simplified regulatory framework, liberalized remote pilot

licensing requirements, and mandated safety features for drone operations. These regulations have encouraged commercial drone applications while ensuring compliance with national security concerns. Additionally, penalties for violations have been established to enforce accountability among drone operators.

82. **National Counter Rogue Drone Guidelines.** Recognizing the threat posed by unauthorized drones, the Ministry of Civil Aviation (MoCA) issued the National Counter Rogue Drone Guidelines, which outline detection, identification, and neutralization measures. These guidelines aim to protect critical infrastructure, public spaces, and national assets from potential drone threats. The framework emphasizes a risk-based approach, integrating technological solutions with regulatory oversight to ensure robust counter-drone mechanisms.

83. **Military Implementation of Counter-Drone Systems.** The **Indian Air Force (IAF)** has implemented counter-drone systems at its bases to mitigate risks posed by unauthorized UASs. These systems are designed to detect, track, and neutralize potential threats, ensuring the security of military installations. The Indian Army has also revised its policy guidelines on counter-UAS operations and capability development, focusing on categorizing threats, delineating responsibilities, and enhancing command and control (C2) aspects. These measures highlight the military's proactive approach to counter-drone strategies, reinforcing the need for national-level coordination.

84. **Challenges in Framing and Implementing Counter-UAS Policies.** Despite the existing regulatory frameworks, several challenges remain in effectively implementing a comprehensive counter-UAS policy. One of the primary obstacles is the large number of drone users with conflicting requirements, as security agencies prioritize threat mitigation while the private sector focuses on commercial innovation. Legal and regulatory constraints further complicate counter-drone operations, particularly regarding the use of kinetic and electronic countermeasures within civilian airspace. Additionally, coordination gaps between central, state, and private entities create inefficiencies in addressing emerging drone threats. The rapid advancement of drone technology has introduced new security risks, including drone swarms, autonomous systems, and AI-enabled UAS. These evolving threats necessitate dynamic policy adaptations to ensure that counter-drone strategies remain effective. A significant challenge is balancing security needs with innovation, as overly stringent regulations could stifle the growth of India's commercial drone ecosystem.

Recommendations

85. **Establishment of a National Counter-UAS Authority (NCUA).** To streamline counter-drone efforts across multiple stakeholders, India should establish a National Counter-UAS Authority (NCUA). This centralized body would oversee all counter-drone policies, ensuring better coordination between the military, civil aviation authorities, law enforcement agencies, and private industry. The NCUA should also facilitate real-time intelligence sharing, enhancing national preparedness against drone-related threats.

86. **Integration of Counter-Drone Technologies.** India must invest in advanced counter-drone technologies, including radar-based tracking, radio frequency (RF) detection, and artificial intelligence (AI)-driven threat assessment systems. The deployment of directed energy weapons (DEWs) and electronic warfare (EW) capabilities should be prioritized for high-security zones. Integrating these technologies with Unmanned Traffic Management (UTM) systems will allow for real-time monitoring and neutralization of unauthorized drones.

87. **Private Sector and Industry Collaboration.** Public-private partnerships are crucial in strengthening India's counter-drone capabilities. Engaging private industry and startups in the development of indigenous C-UAS solutions will reduce dependency on foreign technology and foster self-reliance in drone defence. The government should provide research and development (R&D) incentives to encourage innovation in counter-drone measures while maintaining strict regulatory oversight.

88. **Legal and Policy Reforms.** To address regulatory challenges, India should redefine legal provisions for counter-drone operations. This includes clarifying the legal authority for neutralizing rogue drones, particularly in civilian airspace, and introducing amendments to drone-related legislation to accommodate emerging threats. Regulatory reforms should also focus on establishing clear guidelines for drone swarm mitigation, considering the increasing use of coordinated autonomous drones in security breaches.

89. **Strengthening Public Awareness and Training Programs.** Building a national security culture around drone operations requires comprehensive public awareness campaigns. Educating drone operators, law enforcement agencies, and local communities about drone regulations and security threats will enhance compliance and improve response mechanisms. Additionally, capacity-building programs should be developed for law enforcement personnel, providing specialized training in counter-drone detection and response strategies.

90. **Enhancing International Cooperation.** Given the global nature of drone threats, India should strengthen international collaborations on counter-drone research and policy development. Partnerships with countries experienced in C-UAS strategies, such as the United States, Israel, and European nations, can help India adopt best practices and acquire advanced counter-drone technologies. Establishing bilateral agreements on drone security will facilitate the exchange of intelligence and technological expertise.

Presented by Air Vice Marshal PV Shivanand, ACAS AD, IAF

Topic CMF CHALLENGES FOR NATIONAL CUAS GRID

Introduction

91. The rapid evolution of drone technology has significantly altered the landscape of airspace management and national security. Initially developed for military applications, drones have expanded into various civilian sectors, including commercial, industrial, and recreational uses. This expansion, however, has introduced significant challenges in managing airspace, particularly in detecting, tracking, and mitigating unauthorized or rogue drone activities.

92. India's air defence ecosystem is grappling with the complexities of integrating drone operations into a structured framework while ensuring security and operational efficiency. The presentation by AVM Shivanand also highlights the need for a comprehensive national Counter-Unmanned Aerial System (CUAS) grid. This involves a multi-stakeholder approach that includes the Indian Air Force (IAF), the Ministry of Civil Aviation (MoCA), the Ministry of Home Affairs (MHA), and other regulatory bodies.

93. He outlined the evolution of drones, the challenges associated with airspace management, and the necessary policy measures to counter potential threats. Key topics include the regulatory framework under Drone Rules 2021, emerging threats posed by Beyond Visual Line of Sight (BVLOS) operations, and the importance of a coordinated response involving government, military, and civil aviation authorities. The way forward emphasises proactive policy shaping, training measures, and technological advancements to mitigate airspace vulnerabilities.

Key Takeaways

94. The evolution of drones has led to their transition from military applications to widespread civilian use in industries such as agriculture, logistics, surveillance, and disaster management. Their market potential continues to expand due to their cost-effectiveness and varied applications. However, the emergence of small, slow, and low-flying drones presents significant challenges in detection and tracking, making them a concern for national security.

95. Managing airspace has become increasingly difficult as traditional air defence systems, which were originally designed to counter large, high-speed aerial threats, are often ineffective against smaller and low-flying drones. Detection and tracking are further complicated due to the absence of transponders, allowing drones to operate autonomously with minimal skill requirements. Additionally, drones have the potential for both legitimate and disruptive activities, posing risks for security agencies and air traffic management authorities alike.

96. To address these concerns, the Drone Rules 2021 were introduced, establishing a legal framework for drone operations. These rules cover various aspects such as drone categorization, registration, licensing, and mandatory safety measures. Simultaneously, the Counter Rogue Drone National Policy (MHA**)** was implemented to mitigate security threats posed by unauthorized drones. The Indian Air Force plays a crucial role as a lead policy consultant, ensuring a coordinated approach towards counter-drone strategies and training of the Central Armed Police Forces (CAPFs).

97. Emerging challenges in drone management include the authorization and regulation of Beyond Visual Line of Sight (BVLOS) drone operations, which require robust tracking mechanisms. Real-time coordination between Unmanned Traffic Management (UTM) and Air Traffic Management (ATM) is essential to ensure seamless integration, particularly as drone usage expands in both commercial and military sectors. These issues are currently being discussed among key stakeholders, including MoCA, IAF, Airports Authority of India (AAI), and the Quality Council of India (QCI).

98. To counter drone threats effectively, the IAF is actively engaged with the Government of India to shape policies related to airspace management. In addition to policy advocacy, significant efforts are being made in training CAPFs, air defence personnel, and other security agencies to tackle rogue drone activities. Furthermore, the national role alignment

ensures better coordination between air defence and air traffic services (ATS), thereby enhancing overall airspace security.

Recommendations

99. A stronger focus on counter-drone measures is essential, requiring investments in cutting-edge detection and mitigation technologies. These should include radar, radio frequency (RF) sensors, artificial intelligence (AI)-driven threat analysis, and both kinetic and non-kinetic countermeasures.

100. Deploying electronic warfare (EW) systems and directed energy weapons (DEWs) will further strengthen India's defence against potential drone threats. Additionally, the establishment of dedicated drone defence units within the IAF and CAPFs will ensure a rapid and coordinated response to drone incursions in sensitive locations.

101. The regulatory framework needs to be further enhanced to address the evolving nature of drone threats. While the Drone Rules 2021 provide a strong foundation, refinements are needed to enforce stricter compliance and monitoring. A real-time drone tracking and geofencing system should be developed to prevent unauthorized drone activity in restricted airspace. Stricter penalties should also be imposed on drone operators violating airspace regulations to ensure deterrence.

102. Expanding the National CUAS Grid is necessary for seamless airspace management. A unified airspace management system should be implemented, integrating both civilian and military drone operations. Improved inter-agency coordination among MoCA, MHA, IAF, and law enforcement agencies will ensure a synchronized approach to drone monitoring and response. Additionally, setting up regional drone monitoring centers across critical locations such as border areas and urban centers will enhance surveillance capabilities and security preparedness.

103. Training and capacity building must be prioritized to strengthen national defence mechanisms. The IAF should take a leading role in training CAPFs and security forces in counter-drone strategies. Regular training programs should be conducted for air traffic services (ATS) personnel and law enforcement agencies to enhance their understanding of drone threats and response protocols. Furthermore, the development of standard operating procedures (SOPs) for counter-drone operations, including rapid response measures, will ensure a coordinated and effective defence strategy.

104. The adoption of emerging technologies should be encouraged to enhance drone security. AI-driven drone traffic management systems should be developed to enable better tracking and classification of drones. Standards for BVLOS operations should be defined to ensure safer commercial drone applications. Additionally, the government should encourage private sector participation and support startups that are working on indigenous CUAS technologies to drive innovation and self-reliance in the field.

105. Public awareness and community involvement also play a vital role in ensuring drone security. Awareness campaigns should be launched to educate drone users about regulations, security risks, and responsible usage. A structured reporting mechanism should be established, enabling citizens to report suspicious drone activities to law enforcement agencies. Finally, international cooperation should be strengthened to facilitate the exchange of best practices in drone airspace management and counter-drone technologies, ensuring India remains at the forefront of global security initiatives.

Conclusion

106. The increasing use of drones in both civilian and military domains presents significant challenges for national security and airspace management. While regulations such as the Drone Rules 2021 and the Counter Rogue Drone National Policyprovide a structured approach to governance, there is an urgent need for a more robust and technologically advanced counter-drone strategy. A whole-of-government approach involving the IAF, MoCA, MHA, and other key stakeholders is essential for establishing a national CUAS grid that ensures safe and secure airspace operations.

107. To move forward, India must invest in cutting-edge counter-drone technologies, strengthen its regulatory framework, leverage AI-based tracking mechanisms, and improve training programs for security forces. The establishment of a unified drone defence system that integrates both military and civilian airspace management will further strengthen national security.

108. By adopting a proactive and technology-driven approach, India can effectively balance the benefits of drone technology with the necessity of national defence and airspace protection. Ensuring strategic policy interventions, regulatory refinements, and public awareness initiatives will be key to safeguarding India’s airspace from emerging drone threats while fostering the responsible and innovative use of this rapidly advancing technology.

Presented by Mr Ashok Wadhwan

Title: Advancements in Electronic Warfare in a Drone Warfare.

Introduction

109. The speaker highlighted the significance of counter UAS technology in recent times as his initial remark. He laid down that in the modern era, unmanned systems are reshaping battlefields worldwide, redefining asymmetry in warfare. Recent conflicts, such as the Russia-Ukraine and Israel-Palestine conflicts, highlight this shift. For India, the threat landscape is rapidly evolving, with the threat spectrum expanding every passing day.

Key Takeaways

110. He stressed that the most critical assets on the battlefield today are not fighter jets; they are Electronic Warfare (EW) systems.

(a) **Evolution of Drone Warfare.** Drones have transitioned from surveillance tools to armed systems capable of precision strikes.

(b) **Detection vs Destruction.** Detection technologies are now just as critical as destruction, with new entrants like FPVs & Kamikaze Drones playing a key role.

(c) **Challenging Traditional Concepts.** The idea of "big is beautiful" is being challenged, as large tanks are increasingly destroyed by smaller, agile drones like MERS Drones.

(d) **Emerging Tactics.** Strategies such as swarm drones, hunter-killer tactics, and kamikaze drones targeting pre-determined sites are emphasising quantity and cost-effectiveness over traditional military power.

111. He presented the new techniques to counter the emerging threats:

(a) **AI-powered countermeasures.** AI-driven jammers and neural networks enable automatic detection, frequency selection, and precise disruption of drone communications.

(b) **Mobile and Portable Platforms.** Vehicle-mounted mobile platforms and man-portable jammer guns provide swift mobility and adaptability in countering drone threats on the move.

(c) **Advanced Drone Warfare.** Autonomous drone-to-drone combat with proximity fuses and killer drones equipped with smart munitions enhance precision and effectiveness in neutralizing adversarial drones.

(d) **Multi-Sensor Fusion and Smart Targeting.** Integration of multiple sensors and AI-enabled Command and Control (C2) systems improves drone identification and targeting capabilities.

(e) **Cost-Effective Solutions for Swarm Drones**. The use of small, guided munitions offers an efficient and affordable solution for countering drone swarms in modern warfare.

112. Highlighting the features of a comprehensive Counter UAS such as Immediate Detection / Classification / accurate direction/location/tracking of Drones and Operators, soft and hard kill measures, quick installation and easy operation, he also highlighted the gaps in India's counter UAS capabilities.

113. In the Indian context, gaps in Counter-UAS (C-UAS) capabilities include the lack of long-range integrated C-UAS systems, limited deployment of kinetic solutions, insufficient use of long-range lasers, challenges in detecting low-flying, high-speed FPVs, reliance on static or semi-mobile C-UAS, absence of standard C-UAS for armored vehicles, lack of inter-agency coordination, inadequate fusion of data between the military and MHA, and the absence of a unified anti-drone policy.

Recommendations

114. **Develop Long-Range Detection & Neutralisation.** Enhance capabilities for detecting and neutralising drones at extended ranges.

115. **Low-Cost Kinetic Solutions.** Use cost-effective solutions like 40mm rockets and 7.62mm ammunition for effective drone neutralisation.

116. **Develop High-Energy Lasers.** Focus on the development of high-energy laser systems with a range of over 5 km to intercept drones.

117. **AI-Based FPV Signature Recognition.** Implement AI technology to accurately recognise and target FPVs based on their unique signatures.

118. **Ruggedised Vehicle-Mounted System.** Create robust vehicle-mounted C-UAS systems with softkill, hardkill, and kinetic capabilities for dynamic operations.

119. **Mobile C-UAS for Armored Vehicles & IFVs.** Develop mobile counter-UAS systems tailored for armored vehicles and Infantry Fighting Vehicles (IFVs).

120. **Centralised AI-Driven Counter-Drone Command Network**. Establish a centralised, AI-powered command network for better coordination and response to drone threats.

121. **Real-Time Drone Threat Intelligence Sharing Platform.** Implement a platform for the real-time sharing of drone threat intelligence across agencies.

122. **Early Implementation in Key Areas.** Prioritise the deployment of C-UAS systems in critical areas like VAS, VPS, ports, airports, and strategic assets to enhance security.

Presented by DIG Jamal Taha, Rep DG, Indian Coast Guard

Title: Maritime Threat & Policy parameters – Multi-Domain UVs- UAS, USVs, UUVs & Unmanned Boats.

Introduction

123. Shri Taha Jamal, DIG of the Indian Coast Guard, delivered a talk focused on how these technologies are reshaping maritime security, particularly in the context of India's vast coastline and the emerging challenges from modern threats.

Key Takeaways

124. He highlighted India's maritime landscape and growing threats and the capabilities possessed by the Coast Guard. Currently, the Indian Coast Guard is experimenting with drone technology, looking into their potential for surveillance, reconnaissance, and even strike capabilities. The key challenge remains figuring out how to best integrate drones into existing defence strategies.

125. He highlighted how drones have been used in recent conflicts like the Russia-Ukraine war and the Israel- Gaza conflict for target identification and precision strikes, marking a significant shift in drone warfare capabilities.

Key Recommendations

126. **Addressing Organisational Gaps.** One of the biggest hurdles to efficient maritime security in India is the compartmentalised approach between agencies. He emphasised the need for a centralised command centre where information can flow seamlessly, ensuring better coordination and quicker response times.

127. **Establishing Drone Stations.** Another recommendation was to establish dedicated drone stations to manage various types of drones, including swarm drones and kamikaze drones. These drones could be used not just for surveillance but also for offensive operations, making them a valuable tool in maritime defence.

128. **Mission Planning for Drones.** Every operational drone should be part of a structured mission-planning centre. This would ensure effective planning and real-time execution while maintaining flexibility to adapt to changing threats. A continuous loop of action, reaction, and counteraction would ensure that the response to drone threats is always evolving.

129. **Innovation and Adaptation.** Shri Jamal stressed the importance of innovation and adaptation in countering emerging maritime threats. The key to staying ahead of adversaries is to continuously innovate and adapt to new technologies and tactics.

Q&A SESSION

130. The Q&A session covered key questions regarding India's current counter-drone capabilities and policies. It was noted that while there is no formal, comprehensive counter-drone testing and certification policy yet, efforts are underway to develop guidelines for the effective testing and certification of counter-drone systems. Additionally, challenges in counter-drone deployment were addressed, particularly in terms of detecting and neutralising small swarm drones, with ongoing advancements in technology. The importance of indigenous development of drones and related equipment was emphasised, with discussions around setting up meetings with manufacturers to better understand the demand and focus areas for development. Finally, directions were given by the VCAS to the ADG ADB to take up these issues, indicating a focused approach towards strengthening India's counter-drone capabilities.

Remarks from the Chairperson, Lt Gen NS Raja Subramani

131. As we refine the road framework for counter-drone solutions, it is imperative to convene a meeting with the Drone Federation of India to further deliberate on this critical subject. A key focus must be on identifying essential components for counter-drone systems that can be manufactured within India. This aligns with our broader objective of fostering indigenous capabilities under the Make in India initiative.

132. A comprehensive policy on both drones and counter-drone technologies is expected to be introduced within the next three months. While we may not have all the answers at this stage, we can assure the active involvement of all three services, the Ministry of Home Affairs, and paramilitary forces in collectively working towards viable solutions. Effective solutions and best practices will emerge only when end-users—including the Armed Forces, paramilitary organizations, industry stakeholders, and academia—collaborate in shaping policies that genuinely incentivize domestic manufacturing.

133. The success of Make in India depends not just on policy formulation but on concrete steps toward implementation. We must strive to develop our own indigenous drone and counter-drone technologies, given their immense potential in both military and civilian applications. These systems represent the future of warfare and security, and it is imperative that we take decisive steps to establish self-reliance in this domain.

Concluding Remarks

134. In his concluding remarks, Maj Gen (Dr.) Ashok Kumar, VSM (Retd), DG CENJOWS, emphasised the importance of strengthening the relationship between the industry, forces, and academia to elevate India's defence capabilities to new heights. He expressed heartfelt gratitude to all the speakers who generously shared their time and insights, as well as to the seminar attendees for their participation.

MAJOR INSIGHTS

135. **Future Conflicts Will Be Drone-Intensive.** AI-enabled drone swarms will dominate future battlefields, with ISR (Intelligence, Surveillance, Reconnaissance) and precision strike capabilities integrated across multiple domains.

136. **China's Unmanned Revolution is a Regional Challenge.** China's PLA has developed an extensive, multi-tiered unmanned warfare system, including kamikaze drones, swarm tactics, and coordinated man-unmanned operations.

137. **India's Capability Gap Needs to be Bridged.** India's indigenous drone production ecosystem is still nascent and heavily reliant on foreign-made components, especially from adversarial sources, posing strategic vulnerabilities.

138. **Counter-UAS Must Be Multi-Layered and Adaptive.** There is no one-size-fits-all solution; counter-drone systems need to combine passive and active sensors, AI-enabled jamming, hard/soft kill options, and modular scalability.

MAJOR RECOMMENDATIONS

139. **Establish a National Counter-UAS Authority (NCUA):** A central agency should oversee and coordinate all C-UAS policies and capabilities across military, civil, and industrial sectors for seamless integration.

140. **Invest in Long-Range and AI-Driven Detection & Neutralization.** Prioritise development of real-time radar systems, DEWs, RF analytics, and AI algorithms for drone identification, especially for swarm and FPV drones.

141. **Create Unified Unmanned Forces and Training Infrastructure.** Form a tri-service Unmanned Systems Force (USF) and develop dedicated training programs for soldiers, paramilitary, and police in drone and C-UAS warfare.

142. **Strengthen Indigenous Manufacturing and Public-Private Collaboration.** Promote "Make in India" initiatives with incentives for startups, field testing frameworks, and joint R&D with academia and DRDO to ensure self-reliance.

CONCLUSION

The seminar on UAS Warfare highlighted a pivotal inflection point in India's defence modernization, where technological transformation is not just an option but a necessity. Drones have already become the new rifles of the battlefield—versatile, decentralized, and intelligent. However, while adversaries like China rapidly scale their unmanned warfare capabilities, India still grapples with institutional silos, fragmented production ecosystems, and foreign dependency. The insights from this seminar clearly point to the need for an integrated, agile, and indigenous approach to both UAS deployment and counter-UAS development. With drone warfare no longer confined to future predictions but defining the present battlespace, India must move swiftly to institutionalize strategic reforms, leverage AI and emerging technologies, and operationalize a whole-of-nation response. Only then can India secure its skies and dominate in tomorrow's intelligent, multi-domain wars.