



Centre for Aerospace Power and Strategic Studies

Report on CAPS-IMR Seminar and Exhibition

on

'Surveillance & Electro-Optics India 2025'

11 June 2025

SESSION 1 – INAUGURAL SESSION

The CAPS-IMR seminar and exhibition on 'Surveillance & Electro-Optics India 2025' was held on June 11, 2025, at the Air Force Auditorium, Subroto Park. With a focus on advancing surveillance & electro-optics, the seminar brought together key representatives of the Indian Defence Forces, the Ministry of Defence, the Defence Research and Development Organisation, and industry leaders to discuss the challenges, opportunities, and actionable strategies for expeditiously achieving the aim.

Welcome Address

Air Vice Marshal Anil Golani (Retd), Director General, Centre for Air Power Studies

The session opened with AVM Anil Golani acknowledging the importance of surveillance in military operations. He highlighted that surveillance for military operations encompasses a broad spectrum of activities aimed at gathering, monitoring, and analysing information to enhance situational awareness and support decision-making. AVM Golani further stated that this multifaceted approach is crucial in modern warfare, where timely and accurate intelligence can significantly impact the success or failure of the missions. He also said that electro-optical systems have become indispensable components of modern military operations, fundamentally altering the conduct of surveillance, reconnaissance, targeting, and threat detection. He also mentioned that the EO/IR systems market, valued at \$13.87 billion in 2025, is projected to experience substantial growth through 2035, driven by escalating defence budgets and the increasing complexity of modern battlefields. AVM Golani also mentioned that EO systems have transformed targeting capabilities, enabling precision-guided munitions to achieve remarkable accuracy even in complex urban environments. This has helped to reduce collateral damage and civilian casualties, a critical consideration in contemporary conflicts where the legitimacy of military operations is increasingly scrutinised. AVM Golani stated that from enhancing precision strike capabilities to enabling network-centric warfare, EO systems stand at the forefront of military innovation, offering both opportunities and challenges for defence establishments worldwide.

Inaugural Address

Air Marshal Ashutosh Dixit AVSM VM VSM, Chief of Integrated Defence Staff,

in his inaugural address, stated that traditional battlefield concepts, such as frontlines, depth areas, and rear zones, are no longer relevant in an era defined by long-range precision strikes and real-time surveillance. He argued that when weapons can strike targets hundreds of kilometres away with pinpoint accuracy, the classical ideas of front, rear, and flanks become irrelevant. He argued that what we call the front and the theatre merge into one. He further stated that this new reality demands that we extend our surveillance envelope far beyond what previous generations could have imagined. He emphasised that modern surveillance capabilities must facilitate the military to detect, track, and identify threats while they are still in staging areas, airfields, or bases deep within adversary territory. This concept existed earlier, but today we have the means to realise it, the Air Marshal pointed out. Remarking on



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the achievements of Operation Sindoor, he said, the operation had demonstrated that indigenous innovation, when properly harnessed, can match and even exceed international benchmarks. He added that at the core of the success was IAF's Integrated Air Command and Control System (IACCS), which was also synced and integrated with the Army's Akashteer system, providing a joint and integrated approach to the air defence of the nation. He remarked that in modern warfare, information without the ability to act upon it rapidly is of limited value. IACCS compressed our sensor-to-shooter timelines dramatically, enabling responses that outpaced adversary decision cycles. Looking at the future, he stated that India's existing MALE (Medium Altitude Long Endurance) and HALE (High Altitude Long Endurance) platforms, and MQ-9, Rustom and TAPAS unmanned aerial vehicles, must evolve with modular payloads, advanced sensor fusion and artificial intelligence-assisted analysis to provide battlefield commanders with timely, actionable intelligence.

Keynote Address

Lt. Gen. Vineet Gaur, DG (Capability Development), Army HQ

Lt. Gen. Vineet Gaur, DG (Capability Development), in his keynote address, stated that electro-optics has emerged not just as an enabler of surveillance but as an indispensable backbone of intelligence gathering, decision-making, and precision engagement across all domains. He further stated that in an era where access to cutting-edge defence technologies can be constrained by geopolitical shifts, export controls, or supply chain issues, relying on foreign vendors for critical technologies and surveillance capabilities will create inherent vulnerabilities and will limit India's strategic flexibility. He also highlighted that of the 52 spy satellites India is expected to launch in the coming years, 31 will be built by private sector firms. He stated that this marks a shift in our approach to defence modernisation, one that is faster, more agile, and more collaborative with the private industry. He further argued that these satellites will be equipped with cutting-edge camera lenses, advanced sensors, and a suite of modern technologies to enhance India's situational awareness and defence preparedness. He also emphasised the prioritisation of underwater surveillance, especially in light of Chinese naval activity in the Indian Ocean Region (IOR). At the end of his keynote address, Lt Gen Gaur remarked that our electro-optical platforms must be all-weather and all-domain. Cyber resilience and a common data language are also key for interoperability.

Special Address

Air Vice Marshal Tejpal Singh, Assistant Chief of Air Staff (Plans), delivered a special address, emphasising the critical role of advanced surveillance and technology in modern warfare. He stated that this contested battlefield transparency has always been a contest of ISR capabilities as well as denial and counter capabilities. It is like a cat-and-mouse game. However, the notion of battlefield transparency, extending beyond the theoretical construct, is an absolute necessity for forward operations on the battlefield in any domain. He further noted that enhanced battlefield imagery and robust monitoring systems have become essential to operational effectiveness. We need to integrate our surveillance systems in the same way our air defence systems are integrated. This will result in synergy and interoperability, he said.

EY-IMR Knowledge Paper on Surveillance & Electro-optic Devices was realised by CISC, DCOAS, ACAS (Plans), and DG CAPS



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Session II - Surveillance and Electro-Optics

Chairperson: Air Vice Marshal Rahul Bhasin, VM, ACAS Ops (Space), Air HQ

AVM Bhasin commenced the session by underscoring the critical role of surveillance in ensuring the success of military operations, remarking that its importance cannot be overstated, even if one tries. He highlighted a key operational principle: effective surveillance requires going higher in altitude, which, in turn, demands more advanced and sophisticated sensors. Following this, the chair provided a brief overview of the session structure and introduced the speakers.

Latest Developments and Requirements for Tactical Recce (EO, SAR, IR Search):

Group Captain Shailendra Singh, CO, CPRU, Air Force Station Palam

The speaker began by introducing the OODA Loop - Observe, Orient, Decide and Act - noting its relevance not just in the battlefield, but also in everyday human decision-making, as individuals are continually engaged in this cycle. Tactical Recce primarily pertains to the "Observe" phase and is non-kinetic. He also referred to Warden's five Ring Model, which includes: Fielded Military, Population, Infrastructure, System Essentials, and Leadership. In the context of Tactical Recce within operations, the speaker outlined several core components: (i) The operational chain: *Platform – Sensor – Network – Data Analysis and Distribution*; (ii) Use of Stand-off or Stand-in approaches based on the spectrum of conflict (Peace, No War No Peace, War) and the desired outcome; (iii) The time-sensitive nature of tactical reconnaissance; (iv) Integration with both manned and unmanned platforms; (v) A fully integrated recce-strike system (ISR-T); (vi) Multi-domain applicability, spanning air, land, and maritime environments.

He described the Electro-Optical (EO) based recce systems, which include high-resolution optical sensors, multispectral and hyperspectral sensors, gimballed pods, distributed aperture systems, AI-enhanced target recognition, and can be integrated with passive detection systems. However, they face challenges such as dependency on weather and lighting conditions, as well as vulnerability to optical jamming and other countermeasures. Synthetic Aperture Radar (SAR)-based systems, by contrast, offer *all-weather, day-night capability* and *Ground Moving Target Indication (GMTI)*. Emerging capabilities include advanced waveform processing for improved resolution, lightweight SAR systems suitable for HALE/MALE UAVs, and techniques such as amplitude change and coherent change detection. Key limitations here are high power requirements and complex processing needs. The speaker concluded by highlighting key requirements for future systems: achieving NIIRS 7 or better imagery, maintaining standoff ranges exceeding 250 km, enabling multi-sensor fusion, adopting modular open-systems architectures, and fostering indigenous R&D with an eye towards export potential.

Space-based ISR for Early Warning

Wing Commander Sanjeev Babu, Defence Space Agency

The second speaker of the session highlighted the relevance of ISR (Intelligence, Surveillance, and Reconnaissance), with a focus on space-based early warning systems. Highlighting their strategic advantages, he outlined key objectives such as supporting nuclear deterrence, detecting launches, enabling rapid response, and tracking full-scale threats. He discussed various orbital strategies for early warning, such as Geosynchronous Earth Orbit



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(GEO), Low Earth Orbit (LEO), and Highly Elliptical Orbit (HEO), emphasising that space-based ISR represents a game-changer in early warning capabilities. The speaker continued by mapping the evolution of space-based ISR early warning systems and referenced developments in the U.S., Russia, and China, while noting Europe's ongoing technology demonstration efforts. The U.S. Space-Based Infrared System (SBIRS) was cited as a key example, capable of missile launch detection, as well as assessing the threat level to civilians. Wing Commander Babu pointed to the recent developments in the field, most notably the burgeoning public-private partnerships, with private industry playing an increasingly vital role. In this area, India is also seeing growing engagement, as reflected by the representation of industry participants in the seminar. Other developments include Cruise Missile Defence coverage, overhead persistent infrared satellite programs, and stratospheric-based early warning systems. The speaker noted that while the U.S. Strategic Defence Initiative has not yet materialised, recent official statements suggest renewed momentum. He concluded by asserting that integrated deterrence begins in space.

INDUSTRY REPRESENTATIVES:

Application Considerations for Suitable IR Detector Integration

Ram Biron, SCD, Israel, began with three challenges to modern warfare, starting with coastal defence, particularly relevant for India given its extensive coastline. He noted the difficulties posed by asymmetric threats, including swimmers and small vessels, and stressed the need for effective day-and-night surveillance. The speaker continued by highlighting the second focus area - UAV detection and validation - where challenges include the growing threat landscape, the small footprint of UAVs, and high false alarm rates. To address these, the speaker highlighted the benefits of using, inter alia, shorter wavelengths for enhanced recognition and atmospheric penetration. The speaker discussed the third challenge, which involves long-range visual surveillance extending beyond 50 km, as well as the atmospheric constraints involved. One of the proposed solutions to this, the speaker brought to the fore, was sensors operating at wavelengths up to 4.2 microns. He concluded by underscoring IR-based technologies to meet the evolving demands of modern warfare.

Gideon Nahshoni, Rafael Advanced Defence Systems, began his talk by introducing *Microlite*, which is a lightweight, high-performance, multi-mode optical airborne radar system designed for day and night operations. He elaborated on its operational versatility, detailing its applications in both air-to-air and air-to-ground scenarios, where it offers advanced surveillance and targeting capabilities.

Vinod Yadav, Tata Advanced Systems Ltd, began by showcasing some of Tata's defence products. He shared that Tata established its Optronics facility over a decade ago and now can manufacture thousands of systems annually. Emphasising Tata's commitment to indigenous development, he noted their close collaboration with DRDO. Mr. Yadav said that the latest development in the field has been the integration of AI in Tata's systems, such as automated image enhancement features. Tata's focus areas in Optronics include reducing size, weight, and power requirements; improving range and resolution through high-definition and multispectral sensors; using AI/ML for real-time image processing and increased autonomy; enhancing power efficiency for continuous 24/7 operations; upgrading legacy platforms with night-vision capabilities, and high-volume manufacturing.



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The speaker presented a wide range of products, such as the *Rajak Portable* and *Rajak Long-Range Observation Systems*. He then spoke on Situational Awareness Systems (SAS), See-Through Armour, gimballed EO payloads, sighting systems for armoured vehicles, and fire control systems for IFV turrets. The speaker concluded by affirming Tata's continued focus on innovation and large-scale manufacturing in this domain.

Enabling Next Generation Surveillance Systems with Ansys Digital Engineering

Prem Andrade, Distinguished Engineer, Ansys Inc. highlighted the increasingly congested, contested, and constricted nature of the modern battlefield, which poses significant challenges to safe, accurate, and effective operations. He remarked that after advanced technologies have been acquired, they must be meaningfully used, an objective that can be guided through simulation. By simulating diverse threat scenarios, decision-makers can better understand and educate themselves on the technological requirements necessary for mission success. The speaker noted Ansys Aerospace and Defence's extensive footprint in this space, showcasing examples such as a synthetic aperture radar (SAR) simulation of Karachi Harbour and simulations for electronic warfare systems focused on RF interference and mitigation. He concluded by noting the critical role of simulation in enhancing surveillance capabilities and operational readiness.

Strengthening Indian Defence Industry by Self Reliance, HFCL Defence and Aerospace

Sampathkumaran ST

The speaker began his talk by outlining the key strategic focus areas for achieving industry self-reliance in the defence sector. He noted that central to this effort is the emphasis on indigenous design and development, with DRDO, DPSUs, and private industry working collaboratively to innovate and deliver cutting-edge systems. He also highlighted the importance of the Make in India initiative and the broader vision of Atmanirbhar Bharat in driving domestic defence manufacturing. The speaker further focused on defence start-ups and MSMEs, highlighting platforms such as iDEX and defence innovation hubs, as well as the need to promote exports by targeting new markets with high-quality Indian defence products. The speaker also highlighted HFCL's investment in Research & Development (R&D), a component considered critical for developing future-ready innovative solutions, for different battlefield challenges. The speaker concluded by noting some of HFCL's value propositions, stating that as a key player in the ecosystem, it recognises the limitations but views them as opportunities for transformation and indigenous innovation to ensure self-reliance above all.

Session 3: Terrestrial, Maritime, and Underwater Surveillance

Chairperson: Cmde Sudhir K. Singh, Cmde (SR), Naval HQ

The speaker began by discussing the evolving nature of surveillance in national security, highlighting its transformation from a tactical issue to a strategic imperative. What we see, how quickly we see it, and how accurately we interpret it define how we respond to a situation. The modern conflict is not just fought on the battlefield but fought on all fronts, land, air, and water. Surveillance radars and optical systems are maritime assets for the 7,600 km coastline. The surveillance begins even before they leave the port. Main awareness is



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around satellite-based surveillance, with numerous partnerships established across various organisations on multiple platforms, including those for surface and sub-surface operations at sea, all of which incorporate surveillance features for our use. The speaker highlighted that even as the surveillance architecture is maturing, there are real challenges, signal overload and sensor integration. Signal overload has become a significant challenge, necessitating a proper system for data sensing and cybersecurity, as the entire maritime surveillance network falls under cybersecurity. We are a regional network security provider; therefore, we must understand the region and have pan-regional surveillance capabilities.

Shivang Anirudh Mishra, Marketing Manager, Optimised Electrotech,

focused on Augmented Intelligence in surveillance and the utilisation of AI with conventional approaches, and said it isn't tactical anymore, but a strategic imperative. The speaker discussed the rise in non-linear, multi-domain threats and highlighted the inadequacy of legacy surveillance systems. Emphasising further, he further emphasised the need for a dynamic, self-learning, multi-sensor system. Augmented Intelligence offers data from multiple sources, including visual, sonar, radar, and others. He mentioned that Augmented AI provides faster threat detection, longer pre-emptive window, fewer false positive and enables predictive behaviour.

Col. Manoj Joshi, Col (C&R), Army AD Dte, Army HQ

Tracking Threats and C&R for Air Defence

Col. Manoj Joshi, Col (C&R), Army AD Dte, Army HQ, started his talk by introducing the tracking threats and C&R for Air Defence. In the last decade, there has been an exponential growth in both the number of users of airspace and the counter airspace mechanisms. Regarding air threats, he explained that they can manifest through the air and cause damage to lives and property in various ways. Further elaborating on the issue, he highlighted that manned platforms, such as planes and helicopters, and unmanned platforms, including projectiles and unmanned aerial systems are changing the warfare. The manned platforms are diminishing in comparison to unmanned platforms as the stand-off range is changing, stealth is different, and force multiplication is higher. Unmanned aerial platforms offer superior threat manufacturing capabilities, are highly versatile, require specialised skills, are larger, and have a wide range of employability, spanning from peace to war. A better unmanned platform for tactical employment can also have strategic ramifications and have a better pace of development. He emphasised the need of having multiple channels of detection, including radars, passive systems, electro-optical systems, and echo sticks. This ensures that even if one system fails, another can detect the threat and prevent it from manifesting.

Cdr M. Ravikant, Cdr (AW)-MR, Naval HQ

Augmentation of Maritime Surveillance by the Indian Navy

Cdr. M. Ravikant Cdr (AW), ACNS (Dire) from Naval HQ, spoke on the relevance of the augmentation of maritime surveillance. He brought the focus on India's significance as a Maritime nation, emphasising the need for the government to reimagine India's role in the Indian Ocean Region. Talking of the Indian Navy's position, the speaker accentuated that the Indian Navy was the first responder in any crisis, especially about the geographical realities of the time. He underlined the vast area of surveillance that falls under the Indian Navy's



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exclusive surveillance zones. Breaking down the magnitude of it, he pointed to the nearly 2,000 sq. kms area in the sea that falls under India, and around 15,000-17,000 large, registered vessels that cross the area, and hundreds of thousands of smaller, individual boats all of whom fall under the vessel tracking and monitoring system used by the Indian Navy for surveillance. Indian Navy has a massive responsibility in the region, with a significant number of cargo shipments and other vessels passing through this route. Submarines also play a significant role by engaging in surface and subsurface dominance awareness. He further mentioned the Information Fusion Centre Indian Ocean Region (IFC IOR), set up by the Indian Navy at Gurugram, to address the need to promote collaboration for maritime safety and security. The centre aims to build a coherent maritime situation picture and act as a maritime information hub. Considering the realities of the Indian Navy's responsibility in the IOR, he talked of collaborative efforts to maximise cooperation regarding satellite surveillance. He discussed the India-France agreement, formalised in 2019, for 10 low-orbit satellites equipped with space-based AI technology to monitor all the vessels in the Indian Ocean, highlighting how they enhance our situational awareness.

SESSION 4 – ELECTRO-OPTICS FOR TARGET ACQUISITION AND ENGAGEMENT

Chairperson: Air Vice Marshal AP Saraph VSM, ACAS (Wpns), Air HQ

The session brought together leading experts from the Indian Armed Forces and DRDO to discuss the critical role of Electro-Optical and Infrared (EO/IR) systems in modern warfare. Air Vice Marshal Saraph opened the discussion by emphasising the significance of EO/IR technology, particularly in aerial platforms such as the Su-30 and Rafale aircraft. These sensors play a pivotal role in scenarios where radar systems are inactive, enabling passive detection and targeting. He highlighted that EO/IR systems are now widely used across all three services, integrated not only into aircraft but also into drones, ground-based platforms, and soldier-carried equipment. With the increasing importance of real-time data processing and battlefield transparency, the AVM underlined the role of advanced computing technologies such as AI, ML, and edge computing in enhancing EO capabilities. He discussed recent technological advancements that have led to the development of lighter, smaller, and more power-efficient sensors. He pointed out that while India is assembling EO systems, core components like IR detectors and focal plane arrays remain heavily reliant on foreign sources. Stressing the need for indigenous development, he called for stronger industry-academia collaboration. Furthermore, he spoke about the integration of EO/IR with other sensor systems such as radar, GPS, IMUs, and acoustic sensors, advocating for a synergistic approach to ensure better target identification in complex environments. The future lies in hyperspectral and multispectral sensors, meta-optics, and revolutionary packaging and integration techniques that will miniaturise and optimise EO payloads for diverse platforms.

Intelligence Gathering with EO Sensors for Today's Missions. Mr. Nitin Agarwal, Scientist G at the Instruments Research and Development Establishment (IRDE), DRDO, explained the technical aspect of intelligence gathering with EO sensors. With over two decades of experience in electro-optical systems, Mr. Agarwal provided insights into the challenges faced in EO payload development, especially for airborne platforms. He emphasised the growing demands from users for high-resolution, all-weather, passive surveillance capabilities. Stabilisation requirements for EO systems, particularly in moving



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platforms, demand accuracy down to micro-radian levels, which necessitates advanced gyro systems and responsive actuators. He elaborated on various EO applications across domains, including submarine periscopes, naval fire control systems, land-based night sights, UAV surveillance payloads, and airborne targeting systems likeIRST and LEOF. Mr. Agarwal discussed how EO systems have evolved from simple night-vision devices to sophisticated multispectral and hyperspectral imaging systems capable of detecting, tracking, and classifying targets. He emphasised the importance of passive imaging technologies over active ones like SAR and LIDAR to maintain stealth. He also noted the critical role of post-processing, image enhancement, and tracking algorithms in converting raw imagery into actionable intelligence. Further, he highlighted the dependence on foreign sources for critical optical materials like germanium and indium arsenide, stressing the urgency for domestic research in sensor-grade material development. He concluded by outlining the need for enhanced geo-pointing accuracy, automatic target queuing, and cyber-secure solutions to counter modern threats.

Surveillance and Target Acquisition.

Brigadier Anurag Asthana, Brig Ops, Artillery Directorate, Army_HQ representing the Artillery Directorate at Army HQ, offered an operational perspective on EOIR technology. He underlined the importance of integrating EO systems at the tactical level for real-time surveillance and target acquisition. His presentation focused on the application of EO sensors in artillery fire correction, threat detection, and battlefield awareness. Brigadier Asthana called for the development of modular EO payloads that can be quickly adapted to various platforms and operational environments. He also advocated for faster development cycles and closer coordination between users and designers to ensure that technological solutions meet the dynamic requirements of the field.

Closing Address

Air Vice Mshl Anil Golani (Retd), Director General, CAPS

In his closing address, Air Vice Marshal Anil Golani (Retd), Director General of CAPS, expressed appreciation for the engaging discussions and valuable insights shared throughout the session on Electro-Optics for Target Acquisition and Engagement. While acknowledging that it would be difficult to encapsulate every point raised, he highlighted a few critical themes. One significant takeaway was the growing operational need for longer-range vision systems due to the increasing deployment of stand-off weapon systems. He remarked that the seminar was both timely and relevant, especially in light of the consensus that sensor technology remains a weak link within India's indigenous defence capabilities. This gap presents a clear opportunity for increased collaboration between government, industry, and research institutions to develop innovative and self-reliant solutions. He further emphasised the importance of thinking innovatively and learning from global examples, such as the Russia-Ukraine conflict, where technological superiority in targeting played a decisive role.

AVM Golani thanked the chair, speakers, and industry representatives for their meaningful contributions and acknowledged the significant presence of delegates from across the defence spectrum. He reflected on the success of past CAPS events—such as the session on unmanned systems that saw a large turnout—as evidence of the strong engagement from all



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stakeholders. He concluded with a call for ongoing dialogue, support, and collaborative research efforts to bridge capability gaps and strengthen India's strategic edge.