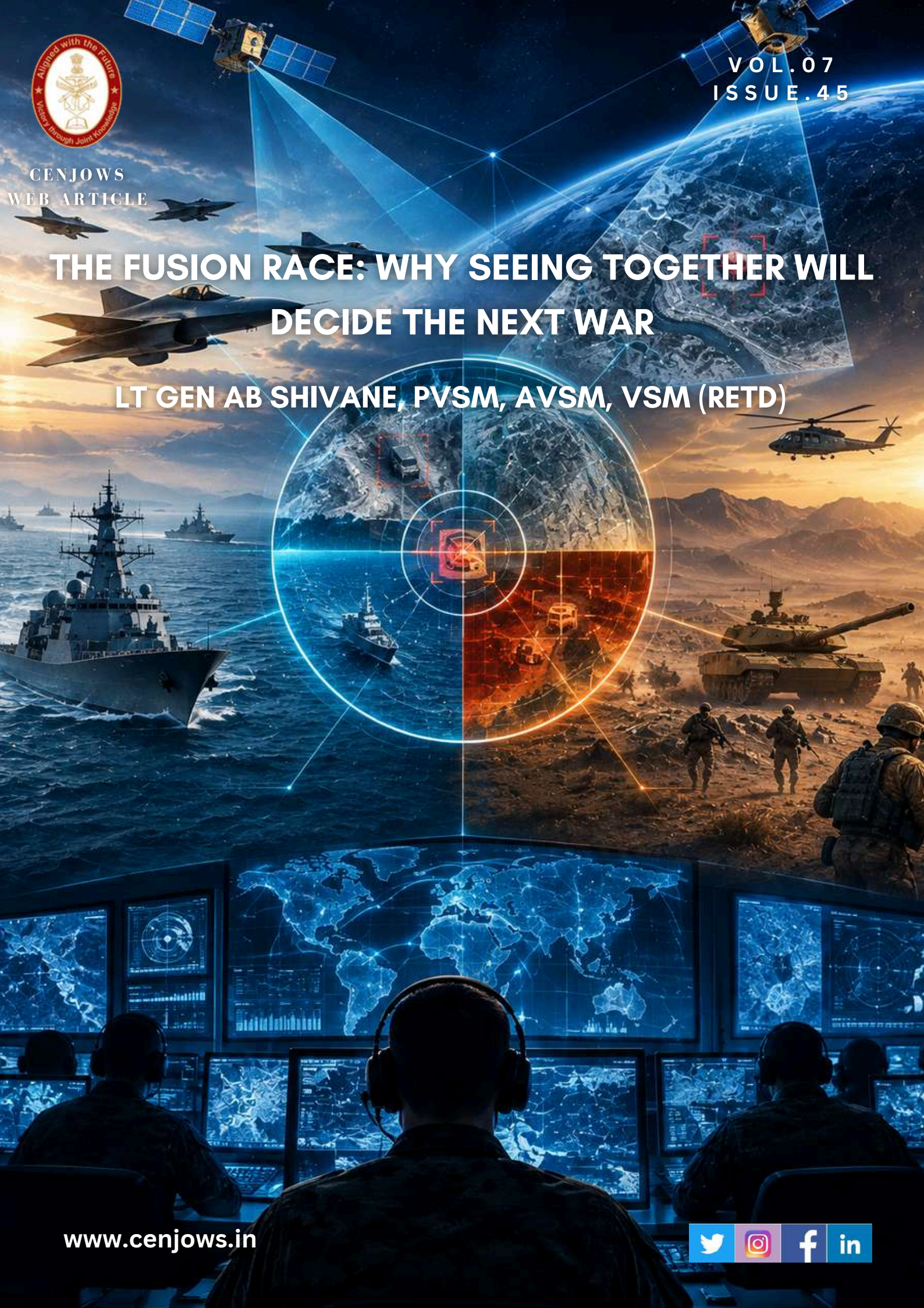

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THE FUSION RACE: WHY SEEING TOGETHER WILL DECIDE THE NEXT WAR

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THE FUSION RACE: WHY SEEING TOGETHER WILL DECIDE THE NEXT WAR

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CENJOWS

The Fusion Race: Why Seeing Together Will Decide the Next War

Lt Gen AB Shivane, PVSM, AVSM, VSM (Retd) is a former Strike Corps Commander and Director General of Mechanised Forces.

Abstract

Sensor fusion, not sensor count, has become the real battleground of modern war. This article traces how "seeing the enemy" has evolved into a fight to combine hundreds of inputs from land, sea, air, space and cyberspace into a single trusted picture. It compares America's CJADC2 push to link every sensor and shooter into a single kill chain, China's Multi-Domain Precision Warfare built on a fast-growing satellite fleet, and India's uneven progress through the Integrated Air Command and Control System, Akashteer, Trigun and Project Sanjay. India's core weakness lies not in any single service but in the seams between them, especially below brigade level. The article also highlights the issue of a contested operational environment in which spoofing, jamming, and disruption require focus at the acquisition stage and in joint doctrines.

Keywords: sensor fusion, multi-domain operations, CJADC2, Multi-Domain Precision Warfare, Project Sanjay, decision superiority, kill chain

Introduction: The Changing Meaning of "Seeing"

The traditional Col John Boyd’s OODA loop (observe, orient, decide, and act) has long been a competitive military principle for gaining an advantage in battle. However, the definition of "observing" has evolved significantly. It's no longer about a solitary radar operator peering at a screen or a forward observer using binoculars. Instead, it involves a multitude of sensors, even hundreds, deployed across land, air, sea, space, and cyberspace. These sensors feed into a unified system that makes sense of the resulting data overload in mere seconds. This is the core of multi-platform, multi-sensor fusion, and it has subtly emerged as the pivotal technical challenge in contemporary warfare.

The Fusion Problem

The concept itself appears straightforward: integrate data from a warship's radar, a drone's infrared camera, an aircraft's signal intercept, satellite imagery, and a ground soldier's report into a single, reliable, and precise picture that a commander can use to make decisions. Making that happen in real time is one of the most difficult problems in modern defence engineering.

Different sensors rarely tell exactly the same story. They may locate the same target at slightly different positions, report at different times, or produce information that is incomplete, degraded or contradictory. The system must therefore determine which reports are credible, which should be given less weight and which need human verification. It must do this quickly, often at machine speed, while an adversary is actively attempting to deceive the network with false or manipulated information.

For much of the history of warfare, advantage came from having better sensors. That remains a factor, but it is no longer enough. The key to winning is increasingly about the capacity to integrate multiple information sources, synthesise the information they provide, and present it to the commander without sacrificing time, context, or accuracy.

The American Model: CJADC2

The challenge of making sense of multiple sensor inputs is often explained through the Joint Directors of Laboratories (JDL) model, a framework developed by US

defence laboratories several decades ago. It describes fusion as a series of increasingly sophisticated layers.

At the bottom, raw information from individual sensors is cleaned, aligned and processed. The next layer seeks to establish tracks by correlating reports from different sources. Three sensors detecting the same moving object, for example, should produce one coherent contact rather than three separate blips. At the higher levels, the system attempts to understand what that contact means in the wider operational picture, assess whether it represents a threat and determine how available sensors should be tasked to reduce uncertainty.

Most modern combat systems have become reasonably capable at the lower levels of fusion. The harder challenge lies above them. Determining significance, assessing intent and deciding how limited sensing and processing resources should be allocated require a level of machine judgement that remains difficult to achieve reliably.

That is the frontier of modern battlespace fusion. The competition is no longer just about how much data you have. It's increasingly about who can transform imperfect, disparate data into faster, trusted understanding.

The United States calls its version of this effort Combined Joint All-Domain Command and Control, usually shortened to CJADC2.[i] The goal is to link every sensor and every weapon, American and allied, across all domains into a single network that lets a commander in one theatre see and act on information gathered in another. Recent American exercises show where the real emphasis has shifted. It is no longer about building better individual sensors. It is about closing what planners call the kill chain, turning detection into a strike decision in the shortest possible time, using data from military, intelligence, and even commercial sources. Field trials in Europe through 2026 have shown acoustic sensors cueing drones for visual confirmation before a strike is authorised, with the same data pushed simultaneously to commanders watching different theatres at once.

The Chinese Model: Multi-Domain Precision Warfare

China has developed its own answer, called Multi-Domain Precision Warfare.[ii] Chinese military writing describes this as systems confrontation, the idea that rather than destroying enemy forces one platform at a time, a military should identify and

disable the critical nodes that hold an opposing force together, such as its command posts, sensors, and logistics chains. To do this, Beijing has invested heavily in space. Its fleet of intelligence and reconnaissance satellites has grown from a few dozen in 2010 to well over 300 by the middle of this decade, feeding artificial intelligence systems designed to find weaknesses in an adversary's network and guide precision strikes against it.[iii] Western analysts have been blunt about the resemblance between this concept and the American one. China appears to be pursuing a comparable objective, although the precise maturity and architecture of its system remain difficult to assess from open sources.

India's Fusion Architecture

India occupies an interesting and somewhat exposed position in this contest. It has real capability. The Air Force's Integrated Air Command and Control System is an air picture system that combines ground radar, airborne radar and satellite links. It played a key role in Operation Sindoor 2025, where it identified and intercepted drone and missile attacks on the western border.[iv] The Army's Akashteer system and the Navy's Trigun network were also seamlessly integrated into this picture under a joint command structure for integrated Air Control and Reporting.

Exercises such as Amogh Jwala in 2026 have shown Indian forces integrating drones, attack helicopters, artillery, and electronic warfare into a common sensor-to-shooter chain.[v] The Army's Project Sanjay is taking this effort further by creating a shared surveillance and battlefield picture for commanders at the brigade, division, and corps levels.[vi] The challenge for India is not just to deploy more sensors in the field. It is to ensure that information output can flow between organisations, to the commander who requires it, and at the right time, enabling decision superiority. The seam between systems may prove more dangerous than the weakness of any individual system.

The Seam Problem

The trouble is that this capability is uneven. India is strong within each service but weak across the seams between them. A study of the Army's own networking programmes highlights the most pressing gap, the space below brigade level, where individual units and forward posts still lack the digital integration needed to share targeting data in real time. A battlefield communications programme meant to solve

this problem, first planned around the year 2000, only produced its first working vehicle-mounted prototype in 2025. That kind of delay is not a technical failure so much as an institutional one. Each service has historically bought its own equipment from various foreign and domestic vendors, resulting in excellent individual platforms that struggle to communicate with one another. A mixed fleet built on Russian, French, Israeli, and increasingly indigenous technology makes this worse, since every vendor brings its own protocols and is reluctant to open them up.

The Vulnerability of Trust

Fusion also introduces a trust angle across the systems and the services. A system that trusts its sensors can be fooled by those same sensors. Researchers have shown that a cheap adversarial sticker on a vehicle can trick an expensive automated targeting system into misclassifying a tank as harmless. Jamming and spoofing of satellite navigation signals are now routine in contested airspace. The data used to train these systems can be quietly poisoned long before a shot is fired. Any nation building a fused sensor network has to assume that the network itself will be a target, not just a tool.

Recommendations for India

For India, the way forward must begin with acquisition policy, not more hardware. Every future purchase for the Army, Navy, and Air Force should make open architecture and shared data standards a contractual requirement, not an afterthought bolted on years later. The most urgent investment is not another satellite or radar; it is closing the digital gap at the battalion and company levels, where slow decisions cost lives. India should build its own indigenous data backbone and fusion engine under its self-reliance programme, both to reduce dependence on foreign vendors and to avoid being locked into systems that cannot be freely modified.

Finally, no fused picture should ever rest on a single sensor. Cross-checking data from radar, infrared, and other sensors before making a strike decision is not a luxury; it is the only real defence against an adversary trying to blind or deceive the network.

For India, the next step should be to treat sensor fusion as an operational capability rather than a networking project. Exercises should routinely test whether information

from space, air, land, maritime, electronic, and cyber sources can be integrated at the decision-making level. The test should not be how much data the network can carry. It should be how much decision advantage it can create.

Conclusion: From Seeing to Understanding

The nations that master this problem first will not necessarily have the best individual weapons. The side that can fuse these disparate sources more effectively gains something more valuable than a clearer picture. It gains a better chance of understanding the battlefield before its opponent does. This also creates an asymmetric opportunity. A force does not necessarily need more sensors than its adversary if it can extract greater value from the information, it already possesses. Better fusion can allow a smaller force to compensate, at least in part, for disadvantages in numbers, range or platform density.

The next contest will therefore not be between platforms alone. It will be between decision systems. The real contest is no longer about seeing more. It is about understanding more from what is seen. The force that can connect its sensors, make sense of conflicting information, identify what matters, and act before the opportunity closes will hold the advantage. In the battlespace of the future, seeing will remain essential. But seeing together, understanding faster, and deciding better may determine who prevails.

Declaration

I declare that this manuscript is being submitted exclusively to CENJOWS for publication consideration, is original, and has not been published or submitted elsewhere. I further certify that it contains no classified, restricted, or sensitive information and is based entirely on open-source material suitable for publication in the public domain.

ENDNOTES

[i] U.S. Government Accountability Office, Defense Command and Control: Further Progress Hinges on Establishing a Comprehensive Framework, GAO-25-106454 (Washington, DC: GAO, 2025), https://www.gao.gov/products/gao-25-106454.

[ii] "Pentagon Report Highlights China's Space Advancements and AI-Driven 'Precision Warfare,'" SpaceNews, December 18, 2024, https://spacenews.com/pentagon-report-highlights-chinas-space-advancements-and-ai-driven-precision-warfare/.

[iii] "DoD Report: China's ISR Fleet Swells to 510+ Satellites, 'Informatized' Warfare Accelerates," SatNews, December 24, 2025, https://satnews.com/2025/12/24/dod-report-chinas-isr-fleet-swells-to-510-satellites-informatized-warfare-accelerates/.

[iv] "A Year after Operation Sindoor, Integrated Air Command and Control System Sees Accelerated Modernisation," Tribune India, May 6, 2026, https://www.tribuneindia.com/news/defence/a-year-after-operation-sindoor-integrated-air-command-and-control-system-sees-accelerated-modernisation/.

[v] "Indian Army Conducts Exercise Amogh Jwala at Babina Field Firing Ranges," All India Radio News, March 19, 2026, https://www.newsonair.gov.in/indian-army-conducts-exercise-amogh-jwala-at-babina-field-firing-ranges.

[vi] Press Information Bureau, Government of India, Ministry of Defence, "Raksha Mantri Shri Rajnath Singh Flags-off 'SANJAY – The Battlefield Surveillance System,'" January 24, 2025, https://www.pib.gov.in/PressReleaseIframePage.aspx?PRID=2095712.