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STRENGTHENING INDIA'S AI DEFENCE CHIP ECOSYSTEM

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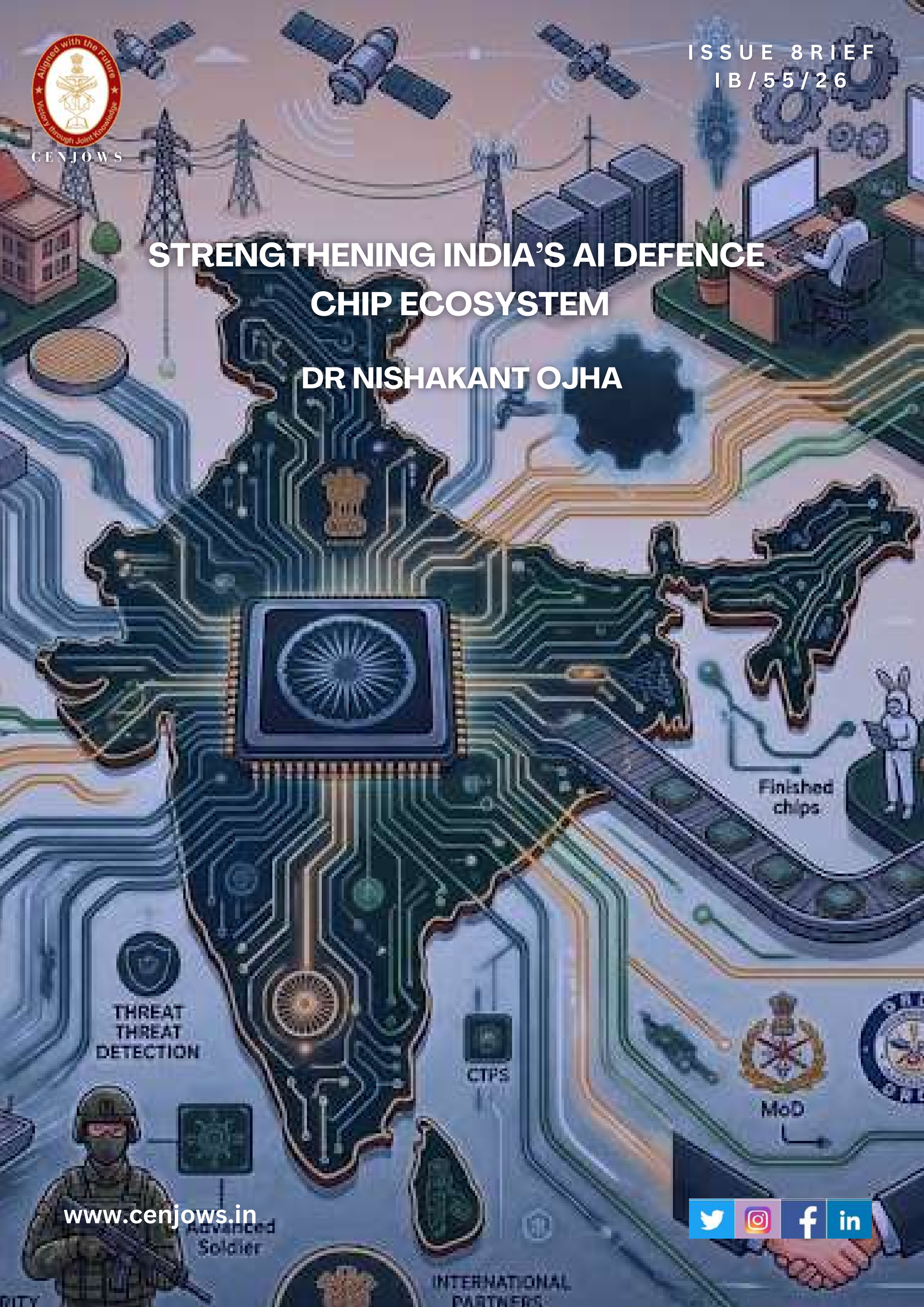

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STRENGTHENING INDIA'S AI DEFENCE CHIP ECOSYSTEM

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Abstract

Semiconductors & Strategic Compute for Battlefield AI confronted one of the most structurally consequential vulnerabilities in India's defence modernisation agenda: the near-total dependence of every AI-enabled military system on foreign-manufactured semiconductor chips.[1] In an era where artificial intelligence governs everything from autonomous drone navigation to real-time battlefield intelligence fusion, the chip is the foundation upon which all operational capability rests. A nation that does not control its semiconductor supply chain does not truly control its weapons systems.[2]

This issue brief examines three interlocking imperatives emerging: building an indigenous AI defence chip ecosystem anchored in the RISC-V open architecture; developing secure processors for tactical edge computing in contested operational environments; and advancing indigenous design capabilities for next-generation battlefield AI platforms.[3] Together, these imperatives constitute the strategic agenda

for India's semiconductor sovereignty in defence, a sovereignty that is not merely an industrial aspiration but a national security imperative of the first order.[4]

The Chip at the Heart of Modern Warfare

Modern warfare is, at its deepest level, a competition in computation. Every weapons system that confers decisive advantage in the contemporary battlespace, autonomous aerial vehicles, AI-guided precision munitions, electronic warfare platforms, satellite-based intelligence systems, and hypersonic glide vehicles depend on advanced semiconductor chips for their guidance, control, and lethal effect.[5] The nation that commands the most capable chips, and that can produce and protect those chips under conditions of strategic competition and conflict, commands a structural military advantage that compounds across every domain of warfare.[6]

India's current position in this competition is one of acute vulnerability. Despite possessing world-class software engineering talent, a growing deep-tech startup ecosystem, and a credible space and missile programme, India remains almost entirely dependent on imported semiconductors for both its civilian and defence electronics needs.[7] The chips that power India's military drones, communications systems, radar platforms, and command networks are overwhelmingly sourced from foundries in Taiwan, South Korea, and the United States supply chains that are geographically exposed, subject to foreign export controls, and vulnerable to disruption precisely in the scenarios of strategic competition for which India is preparing.[8]

Why Semiconductor Sovereignty Matters for Defence

The strategic stakes of semiconductor dependency are not hypothetical. The global semiconductor crisis of 2020-2022 demonstrated the fragility of chip supply chains under even peacetime stress conditions, with production disruptions cascading across automotive, consumer electronics, and defence industrial sectors worldwide.[9] In a conflict scenario involving a technologically sophisticated adversary, the deliberate targeting of semiconductor supply chains through export controls, cyberattacks on foundries, or physical interdiction of maritime logistics routes represents a potent instrument of strategic coercion that could degrade India's military operational capability without a single kinetic exchange.[10]

China's experience provides both a cautionary tale and a strategic roadmap. Having faced increasingly severe US export controls on advanced semiconductor technology since 2018, China has accelerated a multi-hundred-billion-dollar programme of domestic semiconductor development, with the explicit strategic objective of achieving self-sufficiency in chip production by 2030.[11] While China's progress has been uneven, particularly in the most advanced logic chips below 7 nanometres, its investment in domestic chip design tools, materials, and manufacturing equipment demonstrates the seriousness with which Beijing treats semiconductor sovereignty as a national security imperative.[12]

For India, the calculus is different, but the imperative is no less urgent. India does not need to replicate Taiwan Semiconductor Manufacturing Company's entire production capability overnight. What India does need is a focused, defence-centric semiconductor programme that achieves indigenous capability in the specific chip categories that are most operationally critical and most strategically exposed: processors for autonomous vehicles and UAVs, secure processing units for battlefield command systems, and application-specific integrated circuits for AI inference at the tactical edge.

RISC-V Architecture: The Foundation for Indigenous Military Chip Design

The most significant architectural opportunity for India's indigenous military semiconductor programme is the RISC-V instruction set architecture (ISA). RISC-V is an open-source, royalty-free chip architecture that any institution, company, or government can use to design processors without paying licensing fees to foreign corporations or operating under export control restrictions.[13] This makes it uniquely suited to India's defence semiconductor ambitions: a RISC-V-based chip design programme is legally unencumbered, technically capable, and critically immune to the kind of supply chain weaponisation that the United States has deployed against China's chip industry.[14]

There are three specific priority areas for RISC-V deployment in India's defence AI chip ecosystem. First, RISC-V processors for UAVs: unmanned aerial vehicles are the most rapidly proliferating platform in modern warfare, and the processing unit at the heart of a military drone governing its navigation, target recognition, and autonomous decision-making is precisely the kind of chip that India cannot afford to source from foreign suppliers in a contested operational environment.[15] DRDO's existing UAV programmes, including the Rustom series and the TAPAS BH-201, provide a ready-made platform ecosystem into which indigenously designed RISC-V processors can be integrated, creating a fully sovereign autonomous aerial vehicle capability from chip to airframe.[16]

Second, RISC-V for embedded military systems: the Indian Armed Forces operate a vast inventory of electronic systems, radio communications, radar signal processors, encrypted data links, and electronic warfare modules, each of which contains microcontrollers and processors that are currently sourced from foreign suppliers. A systematic programme of RISC-V-based re-indigenisation of these embedded systems, prioritising those with the highest operational criticality and greatest strategic exposure, would progressively reduce India's semiconductor dependency across the military electronics inventory.

Third, RISC-V as the foundation for India's military AI accelerator chips: the most computationally demanding task in battlefield AI is neural network inference, the process by which a trained AI model analyses sensor data and generates actionable outputs in real time. Dedicated AI inference accelerator chips, designed on a RISC-V base with custom neural processing unit (NPU) extensions, can deliver the processing performance required for real-time battlefield AI at a fraction of the power consumption of general-purpose processors, a critical advantage for battery-powered UAVs and soldier-carried systems operating in remote, high-altitude environments. [17]

Secure Processors for Tactical Edge Computing

The concept of tactical edge computing reflects a fundamental architectural shift in military AI systems: rather than relying on centralised cloud or data centre processing, which requires reliable, high-bandwidth communication links back to rear-area servers, tactical edge computing deploys AI processing capability directly at the point of action, embedded in the platform or carried by the soldier.[18]

This architectural shift is not a convenience; it is an operational necessity. Modern contested environments are characterised by deliberate electromagnetic spectrum denial: adversaries jam communications, disrupt GPS signals, and attack data links precisely to blind and slow opposing command systems. An AI system that cannot function when its connection to a rear-area server is severed is not a reliable military capability; it is a liability that an adversary can neutralise by simply degrading the communications environment.[19] Tactical edge AI processing, embedded in autonomous platforms and soldier systems, eliminates this single point of failure by ensuring that AI-enabled capability persists even in fully disconnected, denied, or degraded communication environments.

The security dimension of tactical edge processors is equally critical. A battlefield AI chip processes some of the most sensitive data in the military information environment: real-time ISR imagery, identification friend-or-foe algorithms, targeting parameters, encryption keys, and command authentication codes. A chip with embedded hardware vulnerabilities, whether intentional backdoors or unintentional design flaws, represents a catastrophic intelligence compromise. The only reliable way to ensure the security of a military edge processor is to design and manufacture it indigenously, with full visibility into every stage of the chip's design, fabrication, and testing.[20]

There are three specific security requirements for India's tactical edge processors. First, hardware security enclaves: trusted execution environments (TEEs) that isolate the most sensitive processing operations from the rest of the chip, ensuring that encryption keys and authentication codes cannot be extracted even if an adversary gains physical possession of the device. Second, anti-tamper mechanisms: physical design features that destroy sensitive data and disable the chip if unauthorised access is attempted, preventing reverse engineering of India's military AI algorithms by adversary technical intelligence teams.[21] Third, supply chain verification: cryptographic attestation mechanisms that allow a platform operator to verify that a chip is genuine and unmodified, a critical capability in an era of counterfeit electronics and hardware supply chain attacks.

India's Centre for Development of Advanced Computing (C-DAC), with its established expertise in high-performance computing and its existing SHAKTI processor programme itself built on the RISC-V architecture, provides the most credible institutional foundation for developing India's defence-grade tactical edge processor. The February 2026 seminar called for a dedicated defence spin-off from the SHAKTI programme, with DRDO co-leadership and MoD funding, to develop a family of secure tactical edge processors optimised for battlefield AI applications. [22]

Indigenous Design for Next-Generation Battlefield AI

The indigenous design capability for next-generation battlefield AI chips is a more ambitious objective than the near-term RISC-V processor programme: it envisions India developing the full stack of chip design expertise architecture, logic design, physical design, verification, and design for manufacture required to produce purpose-designed AI chips for military applications that will emerge over the next decade.

Next-generation battlefield AI will make qualitatively different demands on its underlying computer hardware than current systems. Autonomous swarm coordination, the ability of multiple unmanned platforms to communicate, share sensor data, and collectively plan and execute tactical manoeuvres, requires ultra-low-latency, ultra-low-power inter-node communication and distributed inference processing that no existing commercial chip architecture is optimised for.[23] Hypersonic weapon guidance, which must execute complex aerodynamic computations and update trajectory plans in milliseconds under extreme thermal and vibration conditions, requires radiation-hardened processors with deterministic real-time performance guarantees that commercial chips cannot provide. Electronic warfare AI, which must analyse and respond to adversary electromagnetic emissions in real time across wide frequency ranges, requires specialised signal processing architectures with hardware-accelerated fast Fourier transform and machine learning inference pipelines. [24]

Building the indigenous design capability to address these requirements demands investment at multiple levels simultaneously. At the talent level, India must dramatically expand the number of chip design engineers produced by its universities and technical institutions, with a dedicated defence semiconductor fellowship programme to attract and retain the best talent in defence-relevant specialisations.[25] At the tools level, India must develop or acquire domestic electronic design automation (EDA) tools, the software used to design chips, to reduce dependence on foreign EDA tool vendors whose export licences could be restricted under geopolitical pressure. At the fabrication level, while India cannot immediately replicate leadingedge foundry capability, it can develop and operate domestic fabrication capacity for the legacy process nodes (28nm to 90nm) that are adequate for many military applications, including microcontrollers, radar signal processors, and secure communications chips.[26]

The India Semiconductor Mission, launched in 2021 with a budget of ₹76,000 crore, provides the macro-level investment framework for India's semiconductor ambitions. However, the Mission's current focus on attracting commercial foundry investment, typified by the Tata Electronics-Powerchip joint venture announced in 2024, does not adequately address the specific requirements of military-grade chip design and production.[27] A dedicated defence semiconductor sub-programme within the India Semiconductor Mission, with ring-fenced funding, DRDO technical leadership, and security-cleared design and fabrication facilities, is essential to ensure that India's semiconductor investment produces the defence-specific capabilities the strategic situation demands.[28]

The Ecosystem Imperative: Startups, Academia, and Public-Private Collaboration

No government programme alone can build the semiconductor ecosystem that India's defence needs require. The most dynamic chip design innovation globally emerges from a dense ecosystem of startups, university research groups, and established companies working in close collaboration with government and defence customers.[29] India already has the foundational elements of such an ecosystem: a world-class IIT and IISc research base with growing chip design programmes; a cluster of semiconductor design startups in Bengaluru, Hyderabad, and Pune; and the iDEX framework providing a channel for startup engagement with defence procurement.[30]

There are several specific measures required to catalyse this ecosystem for defence semiconductor development. First, a Defence Semiconductor Challenge under the iDEX framework, inviting Indian startups to develop RISC-V-based processor designs for specific military applications, such as UAV navigation, secure communications, and AI inference, with guaranteed procurement commitments for successful designs.[31] Second, a DRDO-IIT joint chip design programme, embedding IIT chip design teams within DRDO laboratory programmes, creating the kind of defence-academia collaboration that has produced breakthrough semiconductor capabilities in Israel and the United States.[32]

Third, a Military Fabless Design Centre, established as a joint venture between DRDO and Indian private sector chip design companies, that operates as a dedicated design house for military-specific chips under appropriate security classification. Fourth, a defence electronics components indigenisation mandate, requiring that all new MoD procurement programmes above a specified value include a minimum percentage of indigenously designed semiconductor components, creating a guaranteed domestic market that incentivises private sector investment in defence chip design capability.[33]

Implications for India's Broader AI Defence Strategy

The semiconductor is not an isolated industrial policy initiative; it is the enabling foundation for every other element of India's AI-enabled military modernisation programme. The autonomous systems, cognitive warfare tools, battlefield healthcare AI, smart logistics platforms, and cyber deterrence capabilities envisioned across the CENJOWS research programme all depend on a reliable, secure, and sovereign supply of the chips that make them function.[34]

This interdependency has a direct bearing on the pace at which India can realise its broader AI defence ambitions. A delay in semiconductor indigenisation is not merely an industrial setback; it is a delay in every AI-enabled capability that depends on those chips. Conversely, an accelerated semiconductor sovereignty programme creates a multiplier effect across the entire AI defence modernisation agenda: indigenous chips enable indigenous AI systems, which enable indigenous doctrine, which enables genuine strategic autonomy.

The export dimension of India's defence semiconductor programme is credible. Indigenous military chip capability would not only serve India's own strategic needs but would position India as a potential supplier of trusted, non-Chinese semiconductor solutions to partner nations in the Indo-Pacific, Africa, and the Global South.[35] In an era of deepening semiconductor geopolitics, in which the United States, Europe, Japan, and South Korea are actively seeking to reduce dependence on Chinese and Taiwanese chips, an India-made trusted military semiconductor ecosystem carries significant strategic and economic value as an instrument of defence diplomacy.[36]

Policy Recommendations

The following are the recommendations for the Ministry of Defence and the Government of India on Semiconductors & Strategic Compute for Battlefield AI advances:

- **Establish a Defence Semiconductor Sub-Programme within the India Semiconductor Mission**

  A ring-fenced defence semiconductor programme, co-led by DRDO and the Ministry of Electronics and Information Technology, should be established with dedicated funding for military-grade chip design, security certification infrastructure, and a classified fabrication facility for legacy process nodes. This programme should be insulated from commercial considerations and governed by national security priorities.

- **Launch a RISC-V Military Processor Initiative**

  DRDO, in collaboration with C-DAC and Indian semiconductor design startups, should launch a structured programme to develop a family of RISC-V-based processors for priority military applications: UAV navigation and autonomy, encrypted tactical communications, battlefield AI inference, and radar signal processing. Each chip family should be designed to MIL-SPEC standards for temperature, vibration, and radiation tolerance.

- **Establish a Secure Tactical Edge Processor Programme**

  A dedicated programme to develop India's military tactical edge processor, building on C-DAC's SHAKTI RISC-V heritage, should be launched with DRDO co-leadership, targeting deployment in next-generation infantry systems, autonomous platforms, and encrypted command terminals. The programme should incorporate hardware security enclaves, anti-tamper mechanisms, and cryptographic supply chain verification as non-negotiable design requirements.

- **Create a Defence Semiconductor Challenge under iDEX**

  The iDEX framework should be expanded to include a dedicated Defence Semiconductor Challenge, inviting Indian chip design startups to compete for development contracts and guaranteed procurement commitments in specific military chip categories. Challenge briefs should be developed by DRDO with

MoD procurement backing, ensuring market certainty for successful participants.

- **Mandate Semiconductor Indigenisation in Defence Procurement**

  All new MoD capital procurement programmes above ₹500 crore should require a minimum indigenisation plan for semiconductor components, with a target of 30 per cent indigenous semiconductor content by value within five years of contract award. This mandate should be incorporated into the Defence Acquisition Procedure and monitored by a new Semiconductor Indigenisation Cell within the MoD.

- **Invest in Chip Design Talent at Scale**

  A national Defence Semiconductor Fellowship programme should be established, funding 500 postgraduate students per year at IITs, IISc, and NITs in chip design, hardware security, and semiconductor materials science, with mandatory internship rotations in DRDO laboratories and defence electronics companies. This pipeline is the single most important long-term investment in India's semiconductor sovereignty.

- **Pursue Quad Semiconductor Cooperation for Defence Applications**

  India should actively pursue semiconductor cooperation under the Quadrilateral Security Dialogue framework, seeking access to advanced chip design tools, fabrication technology, and joint development programmes for defence-specific semiconductor applications. Such cooperation should be structured to enhance rather than replace India's indigenous capability, with technology transfer and joint design provisions that build domestic expertise over time.

Conclusion

The Semiconductors & Strategic Compute for Battlefield AI delivered a message of strategic clarity: India cannot achieve genuine AI-enabled military modernisation without semiconductor sovereignty. Every drone, every autonomous platform, every battlefield AI system, every encrypted communications network that India seeks to field in defence of its national security interests runs on chips and today, those chips are made elsewhere, by others, under conditions that India cannot fully control.

The path to semiconductor sovereignty in defence is neither quick nor cheap. It demands sustained investment in chip design talent, in design tools, in fabrication infrastructure, and in the institutional frameworks that connect DRDO, academia, industry, and the Armed Forces around a shared programme of military semiconductor development. But the cost of inaction is higher still: a continued dependence on foreign chips is a structural vulnerability that an adversary could exploit to neutralise India's entire AI defence investment at a moment of strategic crisis.

The semiconductor is the new frontier of India's strategic autonomy. The deliberations provide the intellectual and policy foundation for India to advance that frontier with urgency, purpose, and the full institutional weight of a nation that understands what is at stake.

DISCLAIMER

The paper is the author's individual scholastic articulation and does not necessarily reflect the views of CENJOWS, the Defence forces or the Government of India. The author certifies that the article is original in content, unpublished, and it has not been submitted for publication/ web upload elsewhere and that the facts and figures quoted are duly referenced, as needed and are believed to be correct.

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