GENERAL STUDIES IV

C-DAC Indigenous GPU 2028: India's AI Compute Mission

Faculty/Author: Faculty Editorial Board
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The Centre for Development of Advanced Computing (C-DAC) is reportedly targeting the development of an indigenous Graphics Processing Unit (GPU) by around mid-2028 through potential private-sector partnerships. This initiative could strengthen India's artificial intelligence infrastructure, semiconductor ecosystem, technological self-reliance and strategic autonomy. Civil Service Gurukul examines GPU technology, semiconductor manufacturing, AI compute sovereignty, economic opportunities, implementation challenges and India's technological roadmap from the UPSC Prelims and Mains perspective.

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Current Affairs – Executive Summary

C-DAC is reportedly targeting the development of an indigenous Graphics Processing Unit (GPU) by around mid-2028 while exploring private-sector partnerships. The proposed initiative could contribute to India's artificial intelligence infrastructure, semiconductor ecosystem and technological self-reliance. However, achieving AI compute sovereignty requires capabilities extending beyond processor design, including fabrication, packaging, memory, software ecosystems and energy-efficient data centres.

Mid-2028

C-DAC

GPU

GS III

1. Why Is C-DAC's Indigenous GPU Roadmap in the News?

According to developments reported in the newspaper edition of 27 November 2026, the Centre for Development of Advanced Computing is targeting the development of an indigenous GPU by around mid-2028 and exploring collaboration with private-sector organisations.

The proposed roadmap assumes significance because advanced computing hardware has become a critical foundation for artificial intelligence, scientific research, supercomputing and digital infrastructure.

> **Important Current Affairs Clarification:**
> Mid-2028 represents a reported development target, not a confirmed commercial launch date. The available information does not establish that the GPU has already been manufactured, commercially deployed or independently benchmarked.

2. What Is a Graphics Processing Unit (GPU)?

A Graphics Processing Unit is a specialised electronic processor designed to execute numerous computational operations in parallel.

Originally developed for graphics rendering, GPUs have become increasingly important for artificial intelligence, machine learning, scientific simulations and high-performance computing.

Major Applications of GPUs

- Artificial intelligence and machine learning.
- Training large language models.
- AI inference and deployment.
- Scientific simulations and research.
- Weather forecasting and climate modelling.
- Medical imaging and computational biology.
- Computer graphics and visualisation.
- High-performance computing.

3. Difference Between CPU, GPU and NPU

Parameter	CPU	GPU	NPU

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Full Form	Central Processing Unit	Graphics Processing Unit	Neural Processing Unit
Primary Purpose	General-purpose computing	Highly parallel computing	Neural network acceleration
Architecture	Typically fewer complex cores	Many parallel execution units	Specialised AI acceleration units
Major Applications	Operating systems and general applications	Graphics, AI and scientific computing	AI workloads and efficient inference
Flexibility	High general-purpose flexibility	Optimised for parallel workloads	Optimised for supported AI operations

UPSC Prelims Memory Trick:

CPU ? General-purpose processing

GPU ? Parallel processing

NPU ? Neural network acceleration

These categories describe typical architectural strengths rather than absolute limitations.

4. Why Are GPUs Important for Artificial Intelligence?

Artificial intelligence models frequently involve mathematical operations on large matrices and tensors. GPUs can accelerate many such operations by distributing computations across parallel execution units.

AI Training

AI training involves adjusting a model's parameters using data and computational optimisation. Large-scale training may require substantial computing resources.

AI Inference

AI inference refers to using a trained model to generate predictions, classifications, recommendations or responses.

AI Training	AI Inference
Develops or improves model parameters.	Uses an already trained model.
Often computationally intensive.	Computational requirements depend on the model and workload.
Example: Training a language model.	Example: Generating an answer using a language model.

5. What Is C-DAC?

The Centre for Development of Advanced Computing (C-DAC) is an autonomous scientific society under the Ministry of Electronics and Information Technology (MeitY), Government of India.

Particulars	Details

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Full Form	Centre for Development of Advanced Computing
Established	1988
Headquarters	Pune, Maharashtra
Administrative Ministry	Ministry of Electronics and Information Technology
Institutional Status	Autonomous scientific society
Major Areas	Advanced computing, supercomputing, cybersecurity, electronics and information technology.
Notable Contribution	PARAM series of supercomputers.

6. What Is AI Compute Sovereignty?

AI compute sovereignty refers to a country's ability to develop, access, manage and secure the computing resources required for artificial intelligence according to its strategic, economic and developmental priorities.

It does not necessarily mean complete technological isolation or domestic production of every component. Rather, it involves reducing critical vulnerabilities and developing meaningful domestic capabilities across the computing ecosystem.

Major Components of AI Compute Sovereignty

- Domestic processor architecture and chip design.
- Access to semiconductor fabrication facilities.
- Advanced packaging and testing capabilities.
- Reliable access to high-performance memory.
- Secure hardware and software supply chains.
- Domestic intellectual property development.
- Affordable and reliable computing infrastructure.
- Energy-efficient data centres.
- Skilled semiconductor and AI professionals.

7. Semiconductor Value Chain: From Design to Deployment

Semiconductor Development Process

Architecture Design ? Circuit Design ? Verification ? Wafer Fabrication ? Packaging ? Testing ? Software Integration ? Commercial Deployment

Stage	Meaning
Architecture Design	Determining the processor's computational structure and capabilities.
Chip Design	Developing the electronic circuits and physical layout.

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Stage	Meaning
Verification	Checking whether the proposed design functions as intended.
Fabrication	Manufacturing semiconductor circuits on wafers.
Packaging	Protecting and electrically connecting the semiconductor die.
Testing	Evaluating functionality, reliability and performance.
Software Integration	Developing drivers, compilers, libraries and framework compatibility.
Commercial Deployment	Supplying and operating the processor in practical computing systems.

Important UPSC Concept:

Indigenous chip design does not automatically guarantee indigenous semiconductor fabrication. A processor designed in India may still require overseas manufacturing facilities, imported memory or foreign equipment.

8. Why Does India Need Indigenous GPU Capabilities?

Strategic Autonomy

Domestic computing capabilities could reduce vulnerability to concentrated international technology supply chains and external restrictions.

Economic Development

Semiconductor design and advanced computing can support high-value manufacturing, research, entrepreneurship and skilled employment.

Affordable AI Infrastructure

A commercially competitive domestic GPU ecosystem could expand computing access for startups, universities and research institutions.

Scientific Research

Advanced computing infrastructure can support climate research, biotechnology, engineering simulations and other computationally intensive scientific applications.

Digital and National Security

Greater domestic control over critical hardware and software may improve supply-chain assurance, subject to independent security testing and effective governance.

9. Major Government Initiatives Supporting India's Technology Ecosystem

Initiative	Major Objective

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IndiaAI Mission	Development of India's AI ecosystem, computing access, innovation, skills and responsible AI.
India Semiconductor Mission	Development of semiconductor and display manufacturing and related ecosystems.
National Supercomputing Mission	Expansion of India's high-performance computing infrastructure and capabilities.
Design Linked Incentive Scheme	Support for eligible semiconductor design activities and deployment.
Chips to Startup Programme	Development of semiconductor design talent and innovation capabilities.
Digital India	Digital infrastructure, digital services and citizen empowerment.
Atmanirbhar Bharat	Strengthening domestic economic and technological capabilities.

These initiatives provide broader policy context. Their inclusion does not establish that each initiative directly finances the reported C-DAC GPU roadmap.

10. IndiaAI Mission and Indigenous Computing

The IndiaAI Mission, approved in March 2024 with an initial outlay of approximately Rs. 10,372 crore, seeks to strengthen India's artificial intelligence ecosystem.

Seven Major Pillars of the IndiaAI Mission

1. IndiaAI Compute Capacity.
2. IndiaAI Innovation Centre.
3. IndiaAI Datasets Platform.
4. IndiaAI Application Development Initiative.
5. IndiaAI FutureSkills.
6. IndiaAI Startup Financing.
7. Safe and Trusted AI.

Indigenous computing hardware could complement broader efforts to expand access to AI infrastructure, provided the hardware achieves commercially viable performance, reliability and software compatibility.

11. Importance of Public-Private Partnerships

Advanced processor development requires coordination between scientific institutions, semiconductor companies, universities, startups and manufacturing partners.

Stakeholder	Potential Contribution
C-DAC and Research Institutions	Advanced computing research and processor development.
Private Semiconductor Companies	Engineering, manufacturing expertise and commercialisation.

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Stakeholder	Potential Contribution
Foundries	Semiconductor wafer fabrication.
Universities and IITs	Research, innovation and skilled manpower development.
AI Startups	Practical applications and workload testing.
Government	Policy support, research funding and procurement frameworks.
Independent Testing Institutions	Performance, reliability and security evaluation.

12. Major Challenges in Developing Indigenous GPUs

- **Technological Complexity:** Advanced processor architecture requires specialised expertise and extensive verification.
- **Fabrication Dependence:** Domestic design may continue to depend on overseas semiconductor manufacturing.
- **Memory and Interconnects:** High-performance computing requires suitable memory bandwidth and communication technologies.
- **Software Ecosystem:** Drivers, compilers, libraries and AI frameworks must support the processor.
- **Capital Requirements:** Research, manufacturing and testing involve substantial investment.
- **Skilled Manpower:** Semiconductor design requires specialised engineering and research talent.
- **Commercial Viability:** Domestic hardware must compete on cost, performance and reliability.
- **Energy Consumption:** Large-scale AI infrastructure can impose significant electricity and cooling requirements.
- **Intellectual Property:** Partnerships must clearly define ownership, licensing and technology-transfer arrangements.

13. How Should Indigenous GPU Performance Be Evaluated?

The success of a domestic GPU cannot be determined merely by the number of processing cores or promotional claims. Evaluation should use transparent and reproducible benchmarks.

Performance Indicator	Importance
Computational Throughput	Measures the amount of computation performed over time.
Memory Bandwidth	Measures the rate at which data can move to and from memory.
Energy Efficiency	Evaluates useful computation relative to power consumption.
Software Compatibility	Determines support for relevant applications and AI frameworks.
Reliability	Assesses stable operation under practical workloads.
Security	Evaluates hardware and software vulnerabilities.
Total Cost of Ownership	Considers acquisition, electricity, cooling, maintenance and operational expenses.
Scalability	Assesses performance when multiple processors operate together.

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14. Illustrative Example: Why Energy Efficiency Matters

Consider two hypothetical GPU systems completing an identical computational workload.

Particulars	System A	System B
Average Power Consumption	400 Watts	300 Watts
Processing Time	10 Hours	10 Hours
Electricity Consumption	4 kWh	3 kWh
Relative Energy Saving	Baseline	25%

If both systems achieve identical output quality and processing time, System B consumes 25% less electricity. At data-centre scale, such efficiency differences may influence operational costs and environmental performance.

These figures are hypothetical and do not represent actual performance specifications of C-DAC's proposed GPU.

15. Ethical and Environmental Dimensions

Technological self-reliance should be accompanied by responsible governance, equitable access and environmental sustainability.

- Fair access to publicly supported computing infrastructure.
- Transparent allocation of research funding.
- Responsible procurement and avoidance of conflicts of interest.
- Protection of intellectual property rights.
- Independent verification of technological claims.
- Energy efficient computing and responsible water consumption.
- Electronic waste management and recycling.
- Cybersecurity and responsible AI development.

> **GS Paper IV – Ethics Perspective:**
> Publicly funded technological development must reflect transparency, accountability, scientific integrity, environmental responsibility and equitable access to innovation.

16. Way Forward for India's AI Compute Sovereignty

Develop a Complete Semiconductor Ecosystem

Coordinate investments in processor design, fabrication access, advanced packaging, memory, testing and supporting infrastructure.

Strengthen Research and Development

Encourage collaboration between scientific institutions, universities, semiconductor companies and technology startups.

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Build Open Developer Ecosystems

Invest in accessible developer tools, compilers, software libraries and compatibility with widely used AI frameworks.

Promote Transparent Benchmarking

Establish independently reviewed, workload-specific benchmarks covering performance, cost, reliability and energy efficiency.

Develop Skilled Human Resources

Expand training in semiconductor engineering, computer architecture, embedded systems and high-performance computing.

Encourage Sustainable Computing

Promote energy-efficient processors, renewable electricity, responsible cooling systems and environmentally sustainable data centres.

Ensure Strategic International Cooperation

Combine domestic capability development with diversified international partnerships, secure supply chains and access to specialised technologies.

17. UPSC Prelims Quick Revision Capsule

Keyword	Remarks
GPU	Graphics Processing Unit
CPU	Central Processing Unit
NPU	Neural Processing Unit
C-DAC	Centre for Development of Advanced Computing
C-DAC Ministry	Ministry of Electronics and Information Technology
C-DAC Headquarters	Pune, Maharashtra
PARAM	Indian supercomputer series
AI Training	Development or optimisation of model parameters
AI Inference	Application of a trained model
Foundry	Semiconductor fabrication facility
Fabless Company	Chip design company outsourcing fabrication
Compiler	Translates code into another executable or intermediate form
Memory Bandwidth	Rate of data transfer to and from memory
Compute Sovereignty	Strategic control and reliable access to computing capabilities
Mid-2028	Reported C-DAC GPU development target, not confirmed launch

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18. UPSC Prelims Practice MCQs

Question 1

With reference to Graphics Processing Units, consider the following statements:

1. GPUs are particularly useful for parallel computational operations.
2. GPUs can accelerate artificial intelligence training.
3. GPUs can be used only for graphics rendering.

Which of the statements given above are correct?

A. 1 and 2 only
B. 2 and 3 only
C. 1 and 3 only
D. 1, 2 and 3

Reveal Answer and Explanation

Correct Answer: A – 1 and 2 only
GPUs support highly parallel computations and can accelerate AI training. Their applications extend beyond graphics rendering.

Question 2

C-DAC functions as an autonomous scientific society under which ministry?

A. Ministry of Finance
B. Ministry of Electronics and Information Technology
C. Ministry of Commerce and Industry
D. Ministry of Education

Reveal Answer and Explanation

Correct Answer: B
C-DAC is an autonomous scientific society under the Ministry of Electronics and Information Technology.

Question 3

Which of the following statements correctly describes indigenous semiconductor design?

A. Domestic chip design guarantees domestic wafer fabrication.

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B. Semiconductor manufacturing does not require testing.

C. Chip design and wafer fabrication are distinct stages.

D. All indigenous processors must use exclusively domestic components.

Reveal Answer and Explanation

Correct Answer: C

Semiconductor architecture and design can be developed domestically while fabrication may take place at an overseas foundry.

Question 4

Consider the following pairs:

1. GPU – Parallel processing.
2. Foundry – Semiconductor fabrication.
3. AI inference – Application of a trained model.

How many of the above pairs are correctly matched?

A. Only one

B. Only two

C. None

D. All three

Reveal Answer and Explanation

Correct Answer: D – All three

GPUs accelerate parallel workloads, foundries manufacture semiconductor wafers, and inference uses trained AI models.

Question 5

Which of the following can contribute to India's AI compute sovereignty?

1. Domestic processor design capabilities.
2. Secure semiconductor supply chains.
3. Development of software libraries and compilers.
4. Energy-efficient computing infrastructure.

A. 1 and 2 only

B. 2 and 3 only

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C. 1, 3 and 4 only

D. 1, 2, 3 and 4

Reveal Answer and Explanation

Correct Answer: D – All four

Compute sovereignty requires an integrated ecosystem of hardware, software, secure supply chains and sustainable infrastructure.

19. UPSC Mains Practice Question

GS Paper III – Science and Technology

Question: Discuss the significance of indigenous AI computing hardware in achieving India's technological self-reliance. Examine the major challenges associated with developing indigenous GPUs and suggest suitable policy measures.

Marks: 15 | **Word Limit:** 250 words

Reveal Model Answer

Introduction

Artificial intelligence has emerged as a strategic technology influencing economic development, scientific research and national security. C-DAC's reported indigenous GPU development roadmap highlights India's ambition to strengthen domestic advanced computing capabilities.

Significance

- Reduces vulnerability to concentrated international hardware supply chains.
- Supports technological self-reliance and strategic autonomy.
- Promotes semiconductor innovation and skilled employment.
- May improve access to AI infrastructure for researchers and startups.
- Strengthens scientific research and high-performance computing.

Major Challenges

- Dependence on advanced semiconductor fabrication facilities.
- High research and capital investment requirements.
- Shortage of specialised semiconductor design talent.
- Software compatibility and commercial competitiveness.
- Energy consumption, cooling and environmental costs.

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- Intellectual property and supply-chain security concerns.

Way Forward

- Develop transparent public-private research partnerships.
- Strengthen semiconductor design, fabrication access and packaging capabilities.
- Invest in developer tools and software ecosystems.
- Establish independent performance and security benchmarks.
- Promote sustainable computing and specialised skill development.
- Maintain diversified international technology partnerships.

Conclusion

Indigenous GPU development can become an important component of India's technological self-reliance. However, genuine compute sovereignty requires a competitive, secure and sustainable ecosystem rather than domestic chip design alone. A coordinated approach combining research, industrial development, international cooperation and responsible governance is essential.

20. UPSC Syllabus Mapping

UPSC Paper	Relevant Topic
Prelims GS Paper I	General Science, Computers, Artificial Intelligence and Semiconductor Technology.
Mains GS Paper II	Government policies, institutional development and international technological cooperation.
Mains GS Paper III	Indigenisation of technology, IT, computers, economic development and infrastructure.
Mains GS Paper IV	Scientific integrity, accountability, technology ethics and environmental responsibility.
Essay	Technological self-reliance, innovation and sustainable development.
Interview	India's AI strategy, semiconductor ecosystem and strategic autonomy.

21. Frequently Asked Questions

What is the C-DAC indigenous GPU roadmap?

It refers to C-DAC's reported effort to develop an indigenous Graphics Processing Unit by around mid-2028 while exploring private-sector partnerships.

Has C-DAC already launched its indigenous GPU?

The reported development target does not establish that a commercial GPU has already been launched.

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What is the full form of GPU?

Graphics Processing Unit.

What is the full form of C-DAC?

Centre for Development of Advanced Computing.

Which ministry administers C-DAC?

Ministry of Electronics and Information Technology, Government of India.

Why are GPUs important for AI?

GPUs can accelerate many parallel mathematical operations required for AI training, inference and scientific computing.

What is AI compute sovereignty?

It refers to a country's ability to develop, access, manage and secure computing resources according to its strategic and developmental requirements.

Does indigenous GPU design guarantee domestic manufacturing?

No. Processor design and semiconductor fabrication are separate stages. Domestic designs may depend on foreign manufacturing facilities.

What is the difference between AI training and inference?

Training develops or optimises model parameters, while inference uses a trained model to produce outputs.

Why is software compatibility important for GPUs?

Drivers, compilers, libraries and AI frameworks enable applications to use the computational capabilities of a GPU effectively.

Why is indigenous GPU development important for UPSC?

The topic connects artificial intelligence, semiconductor technology, indigenisation, economic development, strategic autonomy and responsible technological governance.

22. Conclusion

C-DAC's reported indigenous GPU roadmap represents a potential step towards strengthening India's advanced computing capabilities and technological self-reliance.

However, achieving meaningful AI compute sovereignty requires more than designing a processor. It demands a comprehensive ecosystem involving semiconductor manufacturing, advanced packaging, software development, skilled manpower, secure supply chains and sustainable computing infrastructure.

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Through transparent public-private partnerships, independent performance evaluation and sustained investment in research and innovation, India can work towards becoming a competitive and responsible participant in the global artificial intelligence ecosystem.

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Editorial Disclaimer: This article is prepared for educational and UPSC examination purposes. The reported mid-2028 indigenous GPU development target is not a confirmed commercial launch date. Technical specifications, commercial availability, project funding and manufacturing arrangements require independent verification. Numerical examples are hypothetical and are not actual C-DAC GPU performance benchmarks.

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+91 9911020626

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