इलेक्ट्रॉनिकी एवं
सूचना प्रौद्योगिकी मंत्रालय
MINISTRY OF
ELECTRONICS AND
INFORMATION TECHNOLOGY

सत्यमेव जयते

भारत सरकार की एक पहल
राष्ट्रीय सुपरकम्प्यूटिंग मिशन
NSM
NATIONAL SUPERCOMPUTING MISSION
An Initiative of Government of India

विज्ञान एवं प्रौद्योगिकी विभाग
DEPARTMENT OF
SCIENCE & TECHNOLOGY

सत्यमेव जयते

प्रगत संगणन विकास केंद्र
सी-डैक
CDAC
ज्ञानदेव तु केवलम्
CENTRE FOR DEVELOPMENT OF ADVANCED COMPUTING

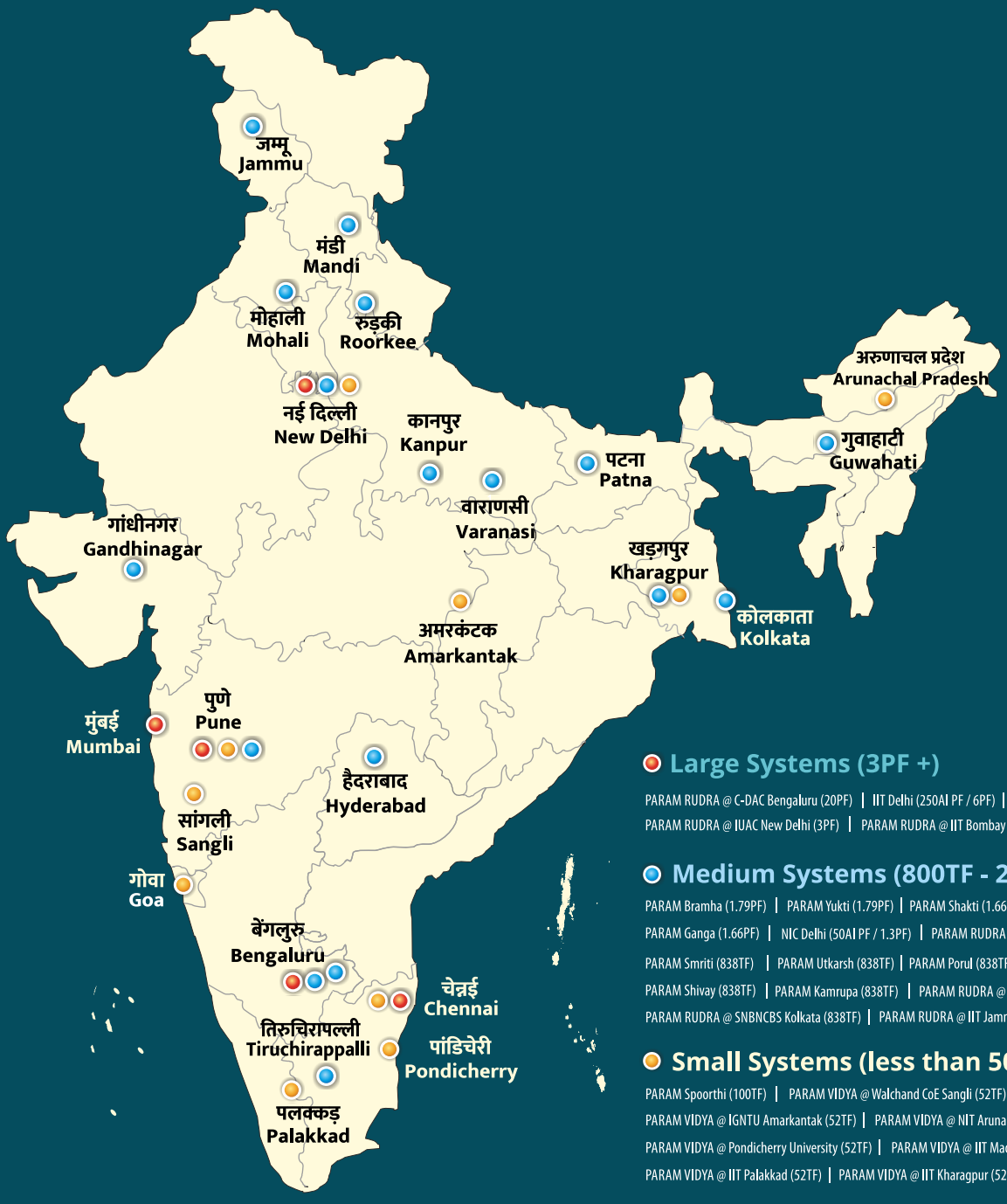
INDIAN INSTITUTE OF SCIENCE
भारतीय विज्ञान संस्थान

NATIONAL SUPERCOMPUTING MISSION

ACHIEVEMENTS

https://nsmindia.in

Equipping India with Supercomputers under NSM



Map not to Scale

Large Systems (3PF +)

PARAM RUDRA @ C-DAC Bengaluru (20PF) | IIT Delhi (250AI PF / 6PF) | PARAM Siddhi AI (5.26PF) | PARAM Pravega (3.3PF)
PARAM RUDRA @ IUAC New Delhi (3PF) | PARAM RUDRA @ IIT Bombay (3PF) | PARAM RUDRA @ IIT Madras (3PF)

Medium Systems (800TF - 2PF)

PARAM Bramha (1.79PF) | PARAM Yukti (1.79PF) | PARAM Shakti (1.66PF) | PARAM Sanganak (1.66PF) |
PARAM Ganga (1.66PF) | NIC Delhi (50AI PF / 1.3PF) | PARAM RUDRA @ GMRT/NCRA Pune (1PF) | PARAM Seva (838TF)
PARAM Smriti (838TF) | PARAM Utkarsh (838TF) | PARAM Porul (838TF) | PARAM Himalaya (838TF)
PARAM Shivay (838TF) | PARAM Kamrupa (838TF) | PARAM RUDRA @ IIT Patna (838TF) | PARAM Ananta (838TF)
PARAM RUDRA @ SNBNCBS Kolkata (838TF) | PARAM RUDRA @ IIT Jammu (838TF)

Small Systems (less than 500TF)

PARAM Spoorthi (100TF) | PARAM VIDYA @ Walchand CoE Sangli (52TF) | PARAM VIDYA @ DTU New Delhi (52TF)
PARAM VIDYA @ IGNTU Amarkantak (52TF) | PARAM VIDYA @ NIT Arunachal Pradesh (52TF) | PARAM VIDYA @ IIT Goa (52TF)
PARAM VIDYA @ Pondicherry University (52TF) | PARAM VIDYA @ IIT Madras (52TF) | PARAM VIDYA @ C-DAC Pune (52TF)
PARAM VIDYA @ IIT Palakkad (52TF) | PARAM VIDYA @ IIT Kharagpur (52TF)

Executive Summary

Following the approval of CCEA in 2015, the National Supercomputing Mission (NSM) has been steered by the Department of Science and Technology (DST) and the Ministry of Electronics and IT (MeitY) and implemented by the Centre for Development of Advanced Computing (C-DAC), Pune and the Indian Institute of Science (IISc), Bengaluru. The mission is driven to achieve the following goals:

a) Attain self-reliance in supercomputing;

b) Build a culture of using supercomputing for carrying out R&D and problem-solving in various domains of scientific and technological endeavours and designing solutions for societal applications; and

c) Position the supercomputing ecosystem in the country at a globally competitive level.

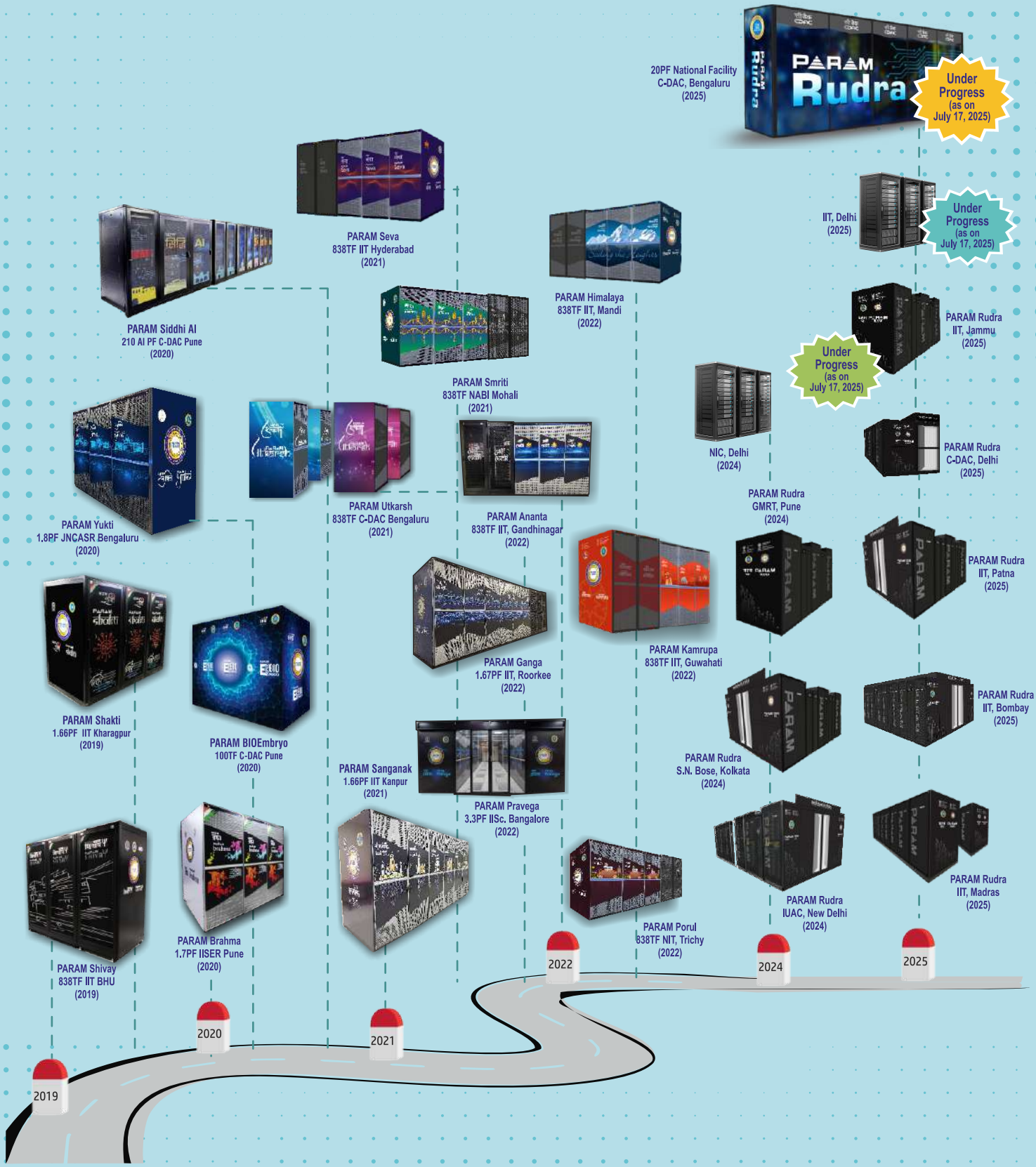
Under NSM, 40 supercomputing systems with cumulative capacity of more than 64 PF is planned to be built and commissioned. Thirty-seven supercomputers with cumulative capacity of 39 PF are commissioned at various academic institutions, organizations and Research and Development (R&D) labs including IISc, IITs, C-DAC etc. Three more systems with compute capacity of approximately 27 PF are expected to be developed and commissioned by December 2025.

With the design, development, manufacturing and operationalization of indigenous supercomputing systems, the local components in the supercomputers have drastically increased to more than 50%. These include: Indigenous High-Performance Computing Servers "Rudra", High-Performance Computing Network "Trinetra", Rudra based SSD Storage Server "MK" and C-DAC's HPC Software stack. PARAM Rudra Systems under Phase III are built using these indigenous technologies.

Currently, over 12,000 researchers, including 1,700+ PhD scholars from 250+ institutes (IISc, IITs, IISERs, NITs, etc.), are utilizing NSM's HPC systems across various research area like drug discovery, disaster management, study climate change and associated impacts, astronomy, computational chemistry, research on new materials, analyze aircraft engines and hypersonic flight vehicles, simulate turbulent flows for green energy technologies and many other research activities. Together, they have completed more than 100+lakh compute jobs and published over 1,650 research papers in top journals worldwide. Additionally, more than 27,000 individuals have been trained in HPC and AI skills. Startups and MSMEs are also leveraging these systems for HPC-driven projects.

A national-level HPC applications are being developed and operationalized by C-DAC, R&D and Academic Institutions under NSM.

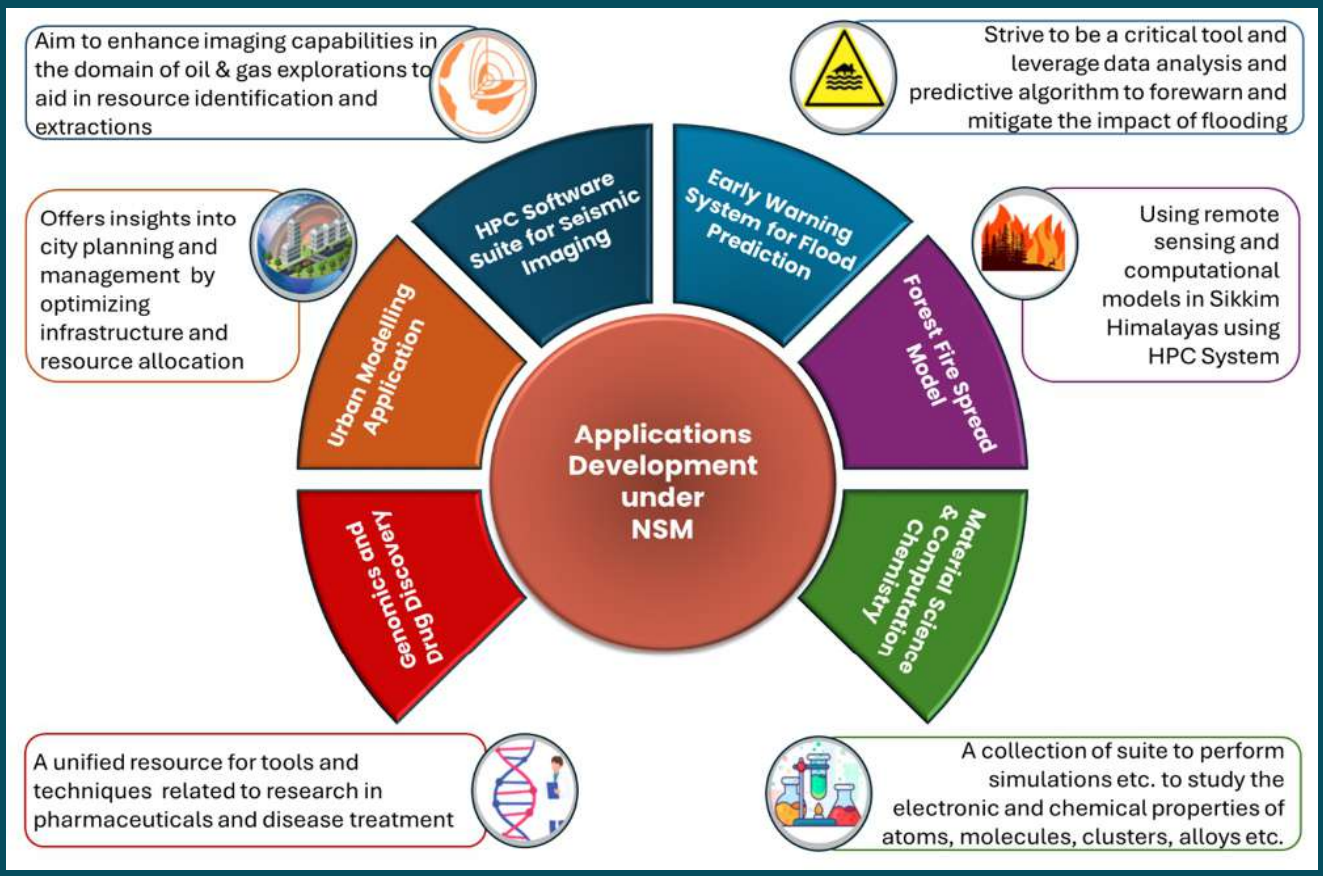
Installing Supercomputers under NSM from 2019 Onwards



Leveraging NSM Systems for Application Development

The NSM has been steadfast in addressing the grand challenge problems through high-performance computing (HPC), driving advancements crucial for India's growth and steering it toward achieving sustainable development goals (SDG) adopted by the United Nations in 2015 to end poverty, provide good health and affordable energy, equip citizens with high-end skills for quality job opportunities, protect the planet from the after-effects of disasters, and ensure that by 2030 all people enjoy peace and prosperity.

It remained focused on developing applications of national importance for operational use to tackle pressing issues such as disaster management, resource optimization, healthcare innovation, and sustainable urban planning.



By prioritizing areas such as Early Warning Systems for Flood Prediction, Forest Fire-spread Prediction, Seismic Imaging for Oil & Gas Exploration, Urban Modeling for Resource Allocation, Genomics and Drug Discovery for Disease Treatment, Materials Science, and Computational Chemistry at C-DAC, NSM not only met global standards but also enhanced India's scientific and technological capabilities. These efforts at C-DAC along with many more efforts at the collaborating institutions (R&D and Academic) spread across the country contribute to national progress and security, empowering the nation to effectively respond to and overcome its most critical challenges.

Development of Applications of National Interest under NSM:

- Genomics and Drug Discovery Platform: It serves as a unified resource for various tools and techniques related to research in pharmaceuticals and disease treatment. Carried out Drug Repurposing for SARS-CoV-2 (Covid-19) through docking for Ayurveda Compounds from Giloy, Pimpli. Developed HPC tools Tango and used simulations expertise for Cardio-toxicity predictions of probable drug molecules given by Pharma Industries - Lupin ltd.

- Science-based decision support framework to address urban environment: It offers high-resolution urban environmental modeling and forecasting that aids in city planning and management during extreme weather events, such as heavy rainfall, urban flooding, and air pollution, potentially reducing the economic and social losses associated with these events.
- Seismic Imaging Suite: It aims to enhance imaging capabilities in the domain of oil and gas exploration through advanced algorithms that aid in subsurface structural imaging. Results of SeisRTM found to be compatible with their commercial counterparts
- Early Warning System for Flood Prediction for River Basins: It leverages data analysis and predictive algorithms to forewarn and mitigate the impact of flooding in the river basins of India by safeguarding communities. Currently, it is used to simulate floods (upto 2 days in advance) in Mahanadi River basin during monsoon.
- Development of Forest Fire Spread Model: It uses satellite remote sensing and computational models including in Sikkim Himalayas using a HPC System.
- Materials Science and Computational Chemistry Applications: It provides a suite to conduct computations by undertaking simulations etc. to study chemical properties of atoms, molecules, clusters, alloys etc.,

Usage of NSM Infrastructure by End Users/ Researchers for their Scientific Problems:

- C-DOT leveraged PARAM Siddhi AI to identify issuance of 2.25 lakh benami SIM cards in Gujarat, 12.34 lakh in WB, 5.24 lakh in Haryana, 3.27 lakh in Bihar & Jharkhand together, 2.28 lakh in MP and 2.04 lakh in UP-East
- NLTM/ Bhashini used PARAM Siddhi AI to develop India specific Language Models for ASR, TTS, STS etc.

- NCRA-TIFR uses PARAM Rudra to assist in detection and precise location of signals across a wide radio range (300 to 1460 MHz) for the Square Kilometre Array (SKA) (Ongoing)
- Used PARAM Pravega for high-resolution simulations for hydrodynamic jets interacting with a smooth interstellar and Circumgalactic medium (ISM & CGM) of Milky Way
- Used PARAM Pravega for sensitivity analysis to select sensitive parameters of the hydrological model SUMMA (Structure for Unifying Multiple Modelling Alternatives)
- Used PARAM Pravega for pseudo-spectral direct numerical simulations to solve the 3D Hall–Vinen–Bekharevich–Khalatnikov (HVBK) model of superfluid helium

- Used PARAM Pravega to combine quantum- & classical-mechanical simulations at molecular level to develop structure-property relationships governing use of nanomaterials in (electro) catalysis and membrane separation applications. These include CO2 reduction to valuable chemicals, electrochemical water splitting to oxygen/ hydrogen, and seawater desalination to produce drinking water
- Used PARAM Pravega to design new materials for energy storage and energy harvesting applications using DFT and ML tools to predict accurate material properties
- Used PARAM Seva to develop efficient Li-CO2Mars batteries for interplanetary missions to Mars and balance the CO2 emissions on Earth using a nanoalloy catalyst RuNi anchored on candle soot carbon
- Used PARAM Brahma for first-principles density functional theory-based calculations to study systems that are of relevant to (a) carbon dioxide and methane capture and conversion, (b) thermoelectric materials and (c) H-bonded systems
- Used PARAM Brahma for discrete element simulations to study flow & clogging behavior of cylindrical particles in presence of spherical tracer particles added in small content
- Used PARAM Yukti to improve hole mobility in semiconducting p-type scandium nitride (ScN) using the state-of-the-art Boltzmann transport formalism from first-principles to develop high-efficiency devices with semiconducting ScN and nitride heterostructures
- Used PARAM Utkarsh for coupled quantum mechanics molecular mechanics-based simulations with path integral MD to study tunnelling effect in hydrogen bonded systems
- Used PARAM Sanganak for high fidelity crystal plasticity finite element simulations to study the deformation behavior of Ni-based superalloys
- Used PARAM Ananta to simulate flow scenarios, from low Reynolds number sub-critical laminar flow to supercritical turbulent flow and investigate phenomena such as Taylor vortices, spiral, and wavy modes of instability using contour analyses
- Used PARAM Shivay for theoretical predictions for enhancement of out-of-plane piezoelectricity in the van der Waals heterostructures
- Used PARAM Smriti for DNA methylation analysis in adipose cells to define DNA methylation pattern in differentiation and dedifferentiation of adipose cells
- Used PARAM Shakti to conduct a comprehensive screening of small molecules against a range of cancer-specific receptors, including ER-alpha, EGFR, HER2, and DDI2
- Used PARAM Shakti to optimize problem related to theoretical research in macro-economics to assist in taking better policy responses (both fiscal and monetary) in future.
- Used PARAM Smriti to perform docking & MD simulation and predicted Paroxetine as potential candidate to be repurposed for 1st line epileptic seizure medication
- Used PARAM Ganga for research on multi-nucleon transfer mechanism (MNT) in the vicinity of Coulomb barrier within heavy-ion nuclear reactions, with a particular emphasis on interpreting MNT cross-sections with existing literature experimental data
- Studied increased frequency of cloud bursts/ extreme rainfall events in Uttarakhand
- Explored alternative solid electrolytes to advance lithium batteries with better thermal and chemical stability

Aligning with Sustainable Development Goals (SDGs)

SDG 1: No Poverty

- **Socio-Economic Development:** By supporting startups and MSMEs, NSM contributes to economic growth and job creation, which can help alleviate poverty by fostering entrepreneurship and providing new opportunities for economic participation.

SDG 4: Quality Education

- **Training and Capacity Building:** The NSM has trained over 22,000 individuals in HPC skills, surpassing initial targets and contributing to the Skill India Mission. This effort not only enhances educational outcomes but also equips a skilled workforce essential for technological advancement and research.

SDG 7: Affordable and Clean Energy

- **Energy-Efficient Technologies:** The development of power-efficient AUM HPC processors and dense server designs contributes to optimizing energy use in HPC, aligning with goals for sustainable and efficient energy consumption.
- Efficient liquid chip cooling in the data centres in NSM optimizes the energy use.

SDG 8: Decent Work and Economic Growth

- **Job Creation and Economic Impact:** The NSM's initiatives, including the manufacturing of 6,000 Rudra servers and support for MSMEs and startups, contribute to direct and indirect job creation. The focus on local manufacturing and technology transfer boosts the domestic high-tech manufacturing sector and stimulates economic growth.

SDG 9: Industry, Innovation, and Infrastructure

- **Technological Innovation:** The development of indigenous technologies such as the Rudra Server and Trinetra interconnect demonstrates significant innovation in HPC. By transitioning from "Buy to Build," NSM promotes industrial growth and technological self-reliance.
- **Infrastructure Development:** The deployment of advanced supercomputing systems across multiple states and the expansion of computational capacity reflects the strengthening of infrastructure and support for R&D.

SDG 10: Reduced Inequality

- **Inclusive Approach:** NSM emphasizes inclusivity by training individuals from underrepresented groups, including women and SC/ST communities. This commitment helps address systemic disparities and fosters a diverse and equitable workforce.

SDG 11: Sustainable Cities and Communities

- **Strategic Geographic Deployment:** The strategic placement of systems in various states, including underserved regions like Jammu and Kashmir, supports regional research and innovation. This approach ensures more equitable access to advanced computational resources.

SDG 12: Responsible Consumption and Production

- **Eco-Friendly HPC Innovations:** Contribution towards the advancements in computational efficiency and resource optimization within HPC environments through the creation of indigenous hardware and software solutions, such as energy-efficient HPC systems and sophisticated optimization tools, NSM strategically reduces energy consumption and minimizes the carbon footprint associated with computing operations. These initiatives align with global imperatives to uphold sustainable industrial practices, ensuring that technological progress is achieved without compromising environmental sustainability.

SDG 13: Climate Action

- **Research Applications:** The development of applications for early warning system for flood prediction, forest fire management, and climate modelling supports efforts to address and mitigate climate-related challenges. These initiatives contribute to enhancing resilience and preparedness for climate impacts.

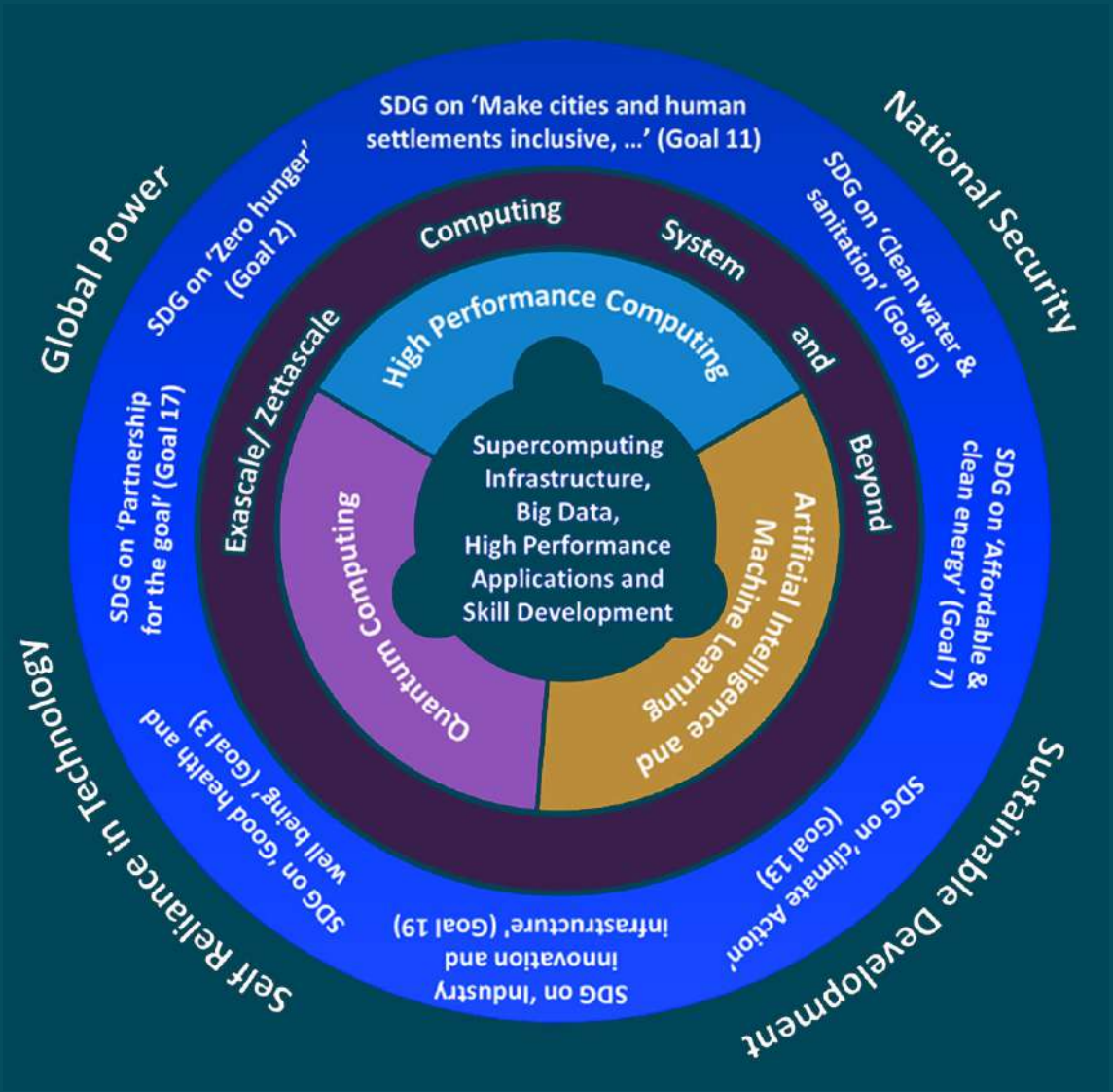
SDG 15: Life on Land

- **Enhanced Wildfire Management:** The forest fire application project employs sophisticated computational models to predict, monitor, and mitigate wildfires, safeguarding biodiversity and ecosystem integrity. This initiative enhances ecosystem resilience, reduces habitat loss, and supports the sustainable management of terrestrial resources.
- **Accurate Timely Warning For Action on Ground:** The early warning system for flood prediction employs scalable HPC to simulate inundated areas with early inputs on precipitation, discharge and tidal data. It assists in curtailing loss of lives during flooding by timely evacuation of people and animals.

SDG 17: Partnerships for the Goals

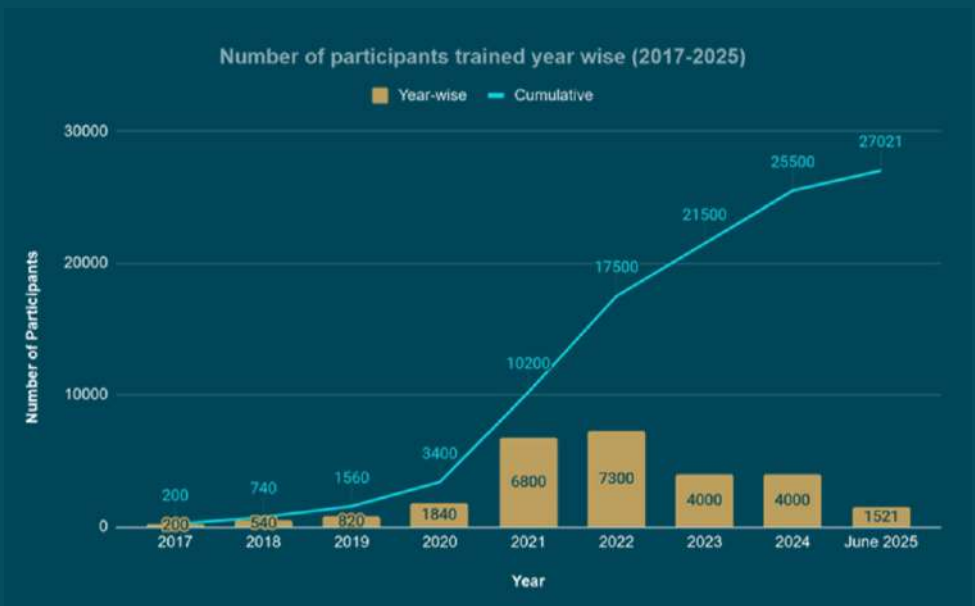
- **Collaborations and Technology Transfer:** The NSM's collaborations with industry leaders (Intel, Nvidia, AMD), academic institutions (IITs, IISc), and international organizations (ADAC, HPSF) exemplify a commitment to building partnerships that drive innovation and progress.

The NSM's initiatives align with several SDGs by enhancing educational outcomes, driving economic growth, fostering innovation, promoting inclusivity, supporting climate action, and building strategic partnerships. They underscore mission's role in advancing India's sustainable development agenda.



Activities for HPC Skill Development under NSM:

- **Proliferate HPC/ DL awareness:** In collaboration with NSM institutes, focused on expanding HPC/ DL knowledge through awareness workshops across India emphasizing on the latest technologies ensuring the participants stay informed about emerging trends and advancements in the field
- **Hackathons and Bootcamps:** Conducted specialized HPC/ DL hackathon at IIT Madras and IIT Guwahati and HPC Awareness Bootcamps at NIT Trichy, IIT Mandi and IIT Roorkee aimed at optimizing and upscaling users' codes and fostering a hands-on, problem-solving environment. Collaborated with Intel and NVidia for conducting NSM DLI and GenAI hackathon
- **Domain-specific training, Faculty Development Programs (FDP) and Quality Improvement Programs (QIP):** Provided domain-specific trainings for faculty members with programs like AICTE and QIP designed for non-CS faculties to equip them with skills in HPC, AI, ML, and DL
- **Teachers visits:** Facilitated faculty visits to C-DAC to promote academic-industry interaction, to expose to HPC infrastructure, and encourage adoption of HPC technologies in curriculum
- **EduHiPC Workshop:** An annual program offering comprehensive HPC training to faculties across India
- **High Performance Scientific Computing Course:** Developed and hosted course on High Performance Scientific Computing on SWAYAM (under NPTEL) to enable learners to gain structured knowledge in HPC
- **HPC Shiksha Portal (http://hpcshiksha.cdac.in):** Provided access to HPC resources, recorded sessions, including materials for hands-on works & assignments, fostering a rich learning environment for both educators & students
- **NSM Users Forum (https://nsm-cdac.community.forum/):** Developed and setup dedicated forum for users across all NSM sites for technical discussions, query resolution, and knowledge sharing on topics related to HPC
- **NSM India Website (https://nsmindia.in/):** Developed a website to serve as official information gateway for the NSM. It includes overview of NSM, updates on supercomputing infrastructure and deployments, training activities, information about partner institutions and future plans
- **JupyterHub Portal:** Developed a JupyterHub-based portal to support training and educational activities, offering users an interactive platform to write, run, and test code efficiently.
- **Self-paced Learning Portal:** Currently developing self-paced learning portal for hosting HPC courses and related content. It aims to empower learners to progress at their own pace while tracking performance and reinforcing concepts through hands-on practice



Indigenous HPC Products Developed Under NSM:

PARAM RUDRA Supercomputing System

The PARAM RUDRA is a fully integrated HPC platform built on indigenously developed RUDRA servers, designed by C-DAC and manufactured in India by leading Indian EMS partners such as M/s VVDN and M/s Kaynes.

Aligned with the Government of India's visionary 'Make in India' and 'Atmanirbhar Bharat' initiatives, PARAM RUDRA is a significant leap towards self-reliant supercomputing infrastructure.

50% plus Local Content Value Addition: Major components are manufactured and assembled within India, reducing import dependency and boosting domestic capability.

Built for Performance & Flexibility; Supports multiple server configurations with:

- Scalable from hundreds of TeraFLOPs to tens of PetaFLOPs
- Intel® or AMD® CPUs
- NVIDIA® or AMD® GPUs
- High-speed interconnect (≥ 200 Gbps) with low latency

OCP-Compliant Architecture

- Modular design based on Open Compute Project (OCP) standards
- Centralized DC power distribution for energy efficiency
- Available in liquid-cooled or air-cooled CPU variants

Infrastructure Made in India

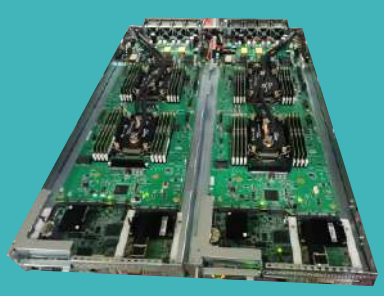
- Beyond computing, PARAM RUDRA's supporting infrastructure - server racks, UPS systems, and cooling equipment - is also manufactured in India, further contributing to the Atmanirbhar Bharat initiative.

Rudra series of Servers :

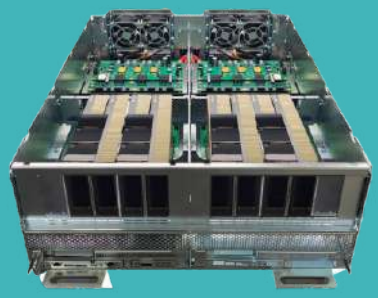
Rudra 1: Built on Intel® 2nd Gen Xeon® Scalable processors (Cascade Lake), Rudra 1 supports up to 1.2 TB DDR4 memory and includes two expansion slots for GPU/accelerator cards. A dedicated Baseboard Management Controller (BMC) enables remote access and monitoring via IPMI 2.0, Intel Node Manager, and Redfish/ REST API.

Rudra-SPX: Buit on Intel® 4th and 5th Gen Xeon® Scalable processors (Sapphire and Emerald Rapids) with up to 64 cores, Rudra-SPX supports up to 350W TDP processors. It supports four PCIe Gen 5.0 (32GT/s)x16CEM ports, enabling seamless integration with GPUs for higher performance.

Rudra-I - CPU-CPU 1-RU



Rudra-SPX CPU-CPU 1-OU



Rudra-SPX CPU-GPU 5-OU Liquid/Air Cooled

Rudra-GN: Powered by AMD 4th Gen EPYC 9004 'Genoa' processors and 8× AMD Instinct MI300X OAMs, Rudra-GN supports DDR5, PCIe 5.0, and is ORv3 (21") rack compatible. It is available in two air-cooled variants—2OU for HPC and 8OU for advanced AI workloads.

Rudra-GN: AI Server with 8OU form factor

Rudra-GN: HPC Server with 2OU form factor

Rudra based SSD storage server

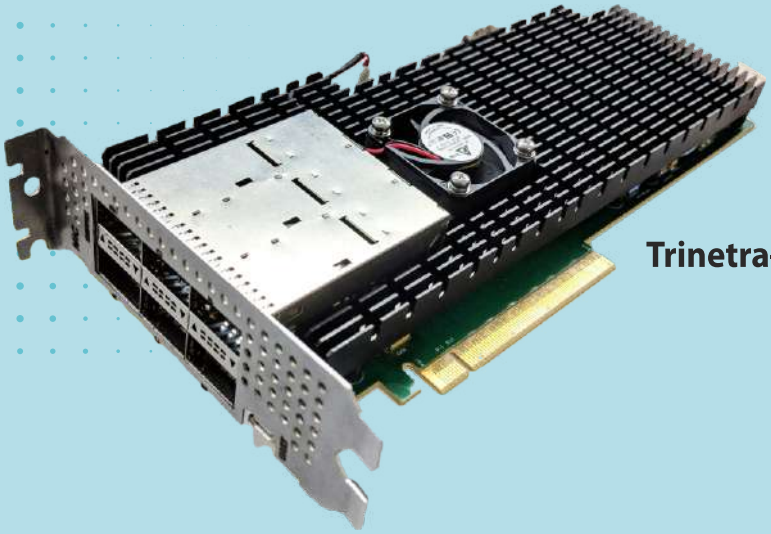
Based on Rudra 1 server, SSD storage server MK1 is designed to provide the perfect combination of flash performance and capacity. The dual processor provides maximum SSD performance, while the remote DMA feature enhances throughput. A redundant power supply ensures high availability.

"Trinetra" Network: Powering Indigenous Supercomputing Solutions

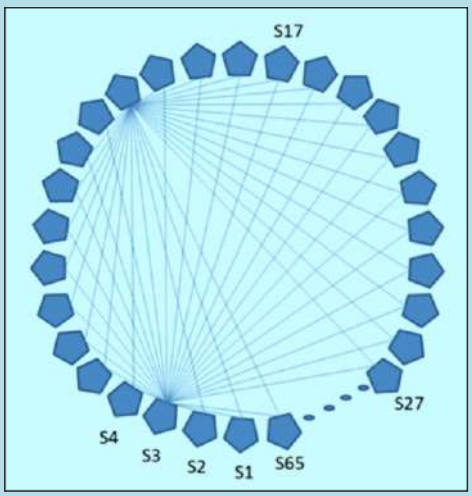
Trinetra is the latest in series of high-performance networks. Along with Rudra server platform, it allows for realization of indigenous high-performance systems which is a major step towards realizing 'Atmanirbhar Bharat' in the area of contemporary hardware system design.

This cutting-edge HPC network is a key component of the PARAM systems, and its progress spans multiple stages:

- **Trinetra-PoC:** The proof-of-concept phase focused on understanding the architectural concepts of switchless networks and 3D Torus topology.
- **Trinetra-A:** This phase saw the development of a 100Gbps network, successfully deployed in the PARAM Rudra system at C-DAC Pune, and validated with multiple scientific applications. Performance results showed it was on par with industry-standard InfiniBand systems.
- **Trinetra-B:** The latest iteration, which uses 200Gbps links, will be deployed in the upcoming PARAM 20PF system, bringing further improvements in scalability and network performance.



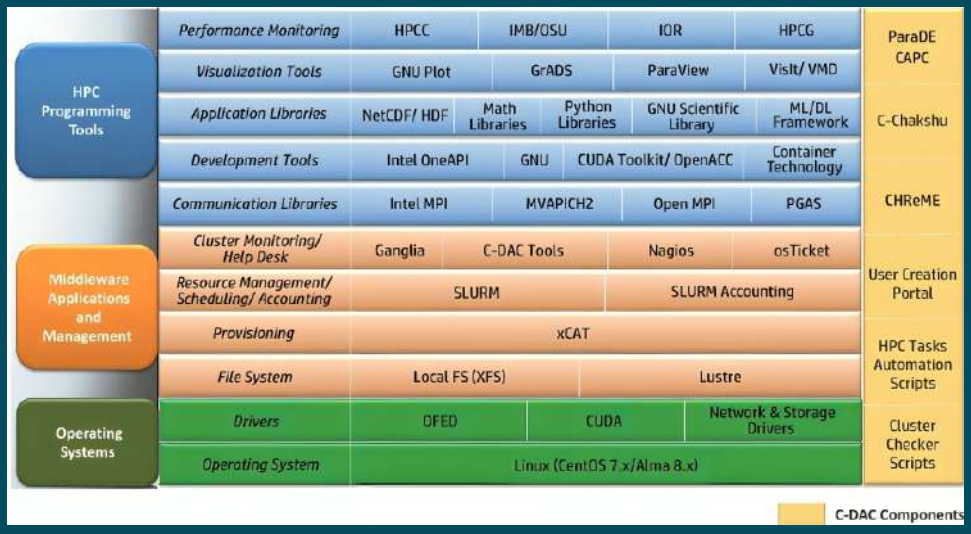
Trinetra-A Network Interface Card(NIC)



Sx: 32-server Supernode

Trinetra-B Network Interface Card(NIC)

C-DAC's HPC Cluster Suite (CHCS)



CHCS was engineered to meet the diverse requirements of NSM systems, enhancing performance and ensuring seamless integration across HPC environments. Core Components of the NSM HPC Software Stack are:

- **Operating System:** CentOS/Alma is selected to provide a stable and robust platform for HPC operations.
- **Drivers:** Critical drivers such as CUDA for GPU acceleration, alongside network and storage drivers, are included to facilitate efficient data management and connectivity.
- **File Systems:** A high-performance distributed file system is integrated to manage extensive data volumes effectively.
- **Provisioning:** The xCAT (Extreme Cluster Administration Toolkit) is employed for provisioning, automating the deployment and configuration of cluster resources.
- **Resource Management:** SLURM (Simple Linux Utility for Resource Management) is utilized for job scheduling and resource management, optimizing the allocation and use of resources.
- **Cluster Management:** It is achieved through tools such as Ganglia and Nagios, supplemented by C-DAC tools and Osticket for efficient issue tracking and support.
- **Communication Libraries:** Essential communication libraries, including MPI, Intel MPI, MVAPICH, and PGAS (Partitioned Global Address Space), are integrated to enable effective parallel communication and data exchange.
- **Development Tools:** The suite features GNU Compiler & Intel oneAPI Compilers to support a broad spectrum of programming languages and optimizing computational performance.
- **Application Libraries:** Key libraries such as NetCDF for network data, mathematical libraries for numerical computations, GNU libraries, and DL/ML libraries are included to support a wide range of application needs.
- **Visualization Tools:** Scientific visualization and data analysis are facilitated through tools like GNU Plot, ParaView, and VMD (Visual Molecular Dynamics), enabling detailed examination and interpretation of simulation results.
- **Performance Monitoring:** The software stack incorporates performance monitoring tools and benchmarks to continuously evaluate and enhance system performance.

CHCS ensures optimal performance and compatibility with NSM systems. It also aligns with India's strategic goals of fostering technological self-reliance. By leveraging open-source technologies, the stack provides a flexible and cost-effective solution, driving innovation and bolstering capabilities within the national research and academic communities.

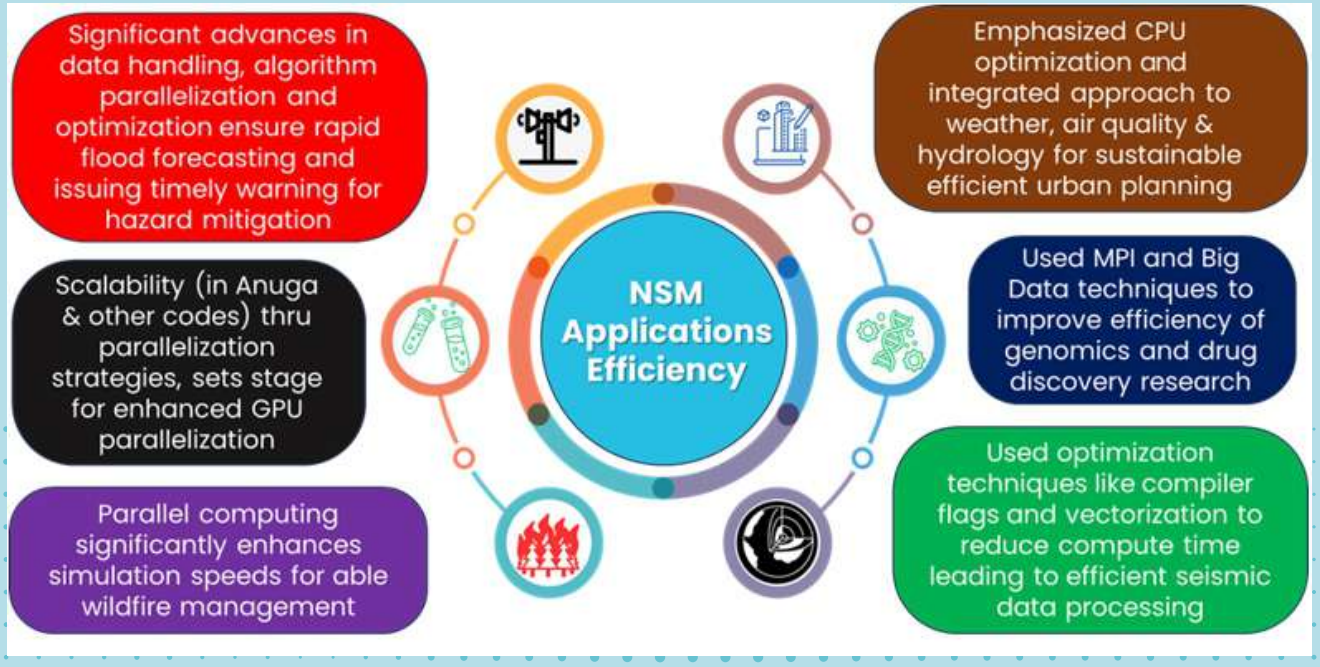
The deployment of CHCS significantly enhanced the computational capabilities of NSM systems, empowering researchers to conduct high-impact research and achieve advancements across various scientific and engineering disciplines.

Enabling Applications, Tools, Programming Models along with Optimization and Scaling on NSM PARAM Systems

HPC Applications	Bio-informatics	MUMmer, HMMER, MEME, PHYLIP, mpiBLAST, ClustalW	Visualization Programs: GrADS, ParaView, VisIt, VMD
	Molecular Dynamics	NAMD, LAMMPS, GROMACS (CPU & GPU)	Libraries: Scientific and Mathematical Libraries, NetCDF, PNETCDF, Jasper, HDF5, Tcl, Boost, FFTW
	Material Modelling, Quantum Chemistry	Quantum-Espresso, Abinit, CP2K, NWChem	Programming Models: MPI, OpenMP, OpenACC, CUDA, SYCL, Julia, Pthreads
	CFD, Aerospace	OpenFOAM, FDS, SU2	**Benchmarks Performed on Latest Architectures**
	Weather, Ocean, Climate	WRF, RegCM, MOM, ROMS	
	Disaster Management	ANUGA Hydro, SpeckFEM3D	
AI/ ML/ DL Tools/ Technologies/ Libraries	**DL Framework:** TensorFlow , keras, theano, pytorch, scikit-learn, scipy, cuDNN		Architecture: Intel, AMD, IBM, Nvidia, ARM, Graphcore
	Data Science: Numpy , RAPIDS		Key Application Areas: Atmospheric Sciences, Molecular Dynamics, Computational Fluid Dynamics, Deep Learning
	Dist. DL Framework: TensorFlow and Pytorch with Horovod		
	Container Technology: enroot		Open Source Applications: WRF, LAMMPS, NAMD, GROMACS, OpenFOAM
	DL App. Dev. Platform, web based IDE: JupyterHub		
Installed additional applications, libraries, tools on different NSM systems as per requirements from users of respective systems			

Leveraging Parallel Computing (MPI) and Big Data technologies in genomics, CPU optimization in urban modeling, seismic imaging, flood forecasting, and scalability optimizations in wildfire management enhanced the capabilities of the applications. These examples highlight the mission's direct impact on societal welfare and scientific advancement. They demonstrate NSM's role in facilitating high-impact research and providing innovative solutions to global challenge problems.

The optimization and scaling services for applications underscore NSM's commitment to maximizing the performance and accessibility of supercomputing resources, thereby extending their benefits to a wider array of scientific communities and industries.



PARAM Supercomputers - NSM in News

क्या है 'परम रुद्र' सुपर कंप्यूटर्स, क्यों ये हैं भारत के लिए बेहद खास, जानें इसकी विशेषताएं

टेक्नोलॉजी की दुनिया में भारत के लिए आज बेहद खास दिन है। प्रधानमंत्री नरेंद्र मोदी ने देश को तीन सुपर कंप्यूटर्स दिए। इन सुपर कंप्यूटर्स का नाम परम रुद्र रखा गया है। इन्हें देश के 3 अलग-अलग शहरों में स्थापित किया जाएगा। आपको बता दें कि ये सुपर कंप्यूटर्स कई हजार कंप्यूटर्स का एक साथ काम करेंगे।

Param Rudra Super Computer: भारत आज टेक्नोलॉजी के क्षेत्र में तेजी से शोध कर रहा है। इस दिशा में आज देश ने एक बड़ी उपलब्धि हासिल की। प्रधानमंत्री नरेंद्र मोदी ने आज देश को सुपर कंप्यूटर समर्पित किए। इन सुपर कंप्यूटर का नाम परम रुद्र रखा गया है। गहने की तो ये एक कंप्यूटर सी हैं लेकिन ये साधारण कंप्यूटर से पूरी तरह से अलग हैं। पीएम मोदी ने आज शाम 5:30 बजे वीडियो कॉन्फ्रेंसिंग के जरिए इन 3 सुपर कंप्यूटर समर्पित किए।

देश को मिले ये 3 परम रुद्र सुपर कंप्यूटर पर्यावरण, जलवायु समेत दूसरे कई सारे क्षेत्रों में बड़े मददगार साबित होने वाले हैं। सुपर कंप्यूटर साधारण कंप्यूटर से हजारों गुना तेज काम करते हैं। देश को मिले इन तीनों सुपर कंप्यूटर की खासत और परफॉर्मेंस का अंदाजा आप इसी बात से लगा सकते हैं कि जो काम साधारण कंप्यूटर 500 साल में कर सकते हैं वही काम ये परम रुद्र सुपर कंप्यूटर मिनटों में कर सकते हैं।

हजारों कंप्यूटर्स का काम करेगा परम रुद्र

आपको बता दें कि ये परम रुद्र सुपर कंप्यूटर एक साथ इतनी बड़ी मात्रा में डेटा को प्रॉसेस कर साधारण कंप्यूटर मिलकर भी नहीं कर सकते। इन सुपर कंप्यूटर का काम साधारण तौर पर देश

संपादक की पसंद




PM launches 3 desi supercomps to boost scientific research

TIMES NEWS NETWORK

New Delhi: India's Gaganyaan mission is not just about reaching space but about achieving "limitless heights of our scientific dreams," said Prime Minister Narendra Modi on Thursday, as he virtually inaugurated three indigenously developed Param Rudra supercomputing systems to facilitate pioneering scientific research, along with two high-performance computing (HPC) systems—'Arka' and 'Arunika'—designed for weather and climate research, as well as predictions.

The PM also flagged products made by the semiconductor industries within a short period of time and mentioned 'India Mission' to ...or. He emphasised building ...osystem, ...al role in ...n.

"India has become a significant power in the space sector," Modi said, noting that the country's scientists achieved the same feat with limited resources where other nations spent billions of dollars on their success.

The three Param Rudra supercomputers, worth around Rs 130 crore, were developed under National Supercomputing Mission (NSM). These supercomputers have been deployed in Pune, Delhi and Kolkata to facilitate pioneering and advanced scientific research in areas such as physics, cosmology and earth sciences.

"In the era of digital revolution, computing capacity is becoming synonymous with national capability," the PM said, noting the direct dependence on science and technology and computing capabilities for opportunities in research, economic growth, disaster management, ease of living and ease of doing business.

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NEWS BRIEF

India's New PARAM Rudra Supercomputers To Power Next-Gen Scientific Research — What You Need To Know

KULDEEP NEGI

Sep 27, 2024, 09:26 AM | Updated 09:26 AM IST

PARAM Supercomputers - NSM in News

NSM User's Feedback

PARAM Seva has helped me immensely in guiding my Ph.D. students. This helped the students to explore a wide range of research problems. We are still trying to enhance our knowledge by solving different problems in our field. We owe the deepest debt of gratitude to C-DAC-Pune and the support team of PARAM Seva.

Dr. Mukhtyar Singh
Assistant Professor
DTU Delhi, PARAM Seva User

"The NSM's SPOTLIGHT system, built on C-DAC's indigenously designed PRAM RUDRA servers, started an unprecedented journey into the transient universe with the GMRT, commencing full science operations in April 2025. This AI-driven, big-data platform for time-domain astronomy—deployed on indigenously developed hardware—is designed to detect astrophysical phenomena such as Fast Radio Bursts (cosmic flashlights) and Pulsars (cosmic clocks), while simultaneously fostering a skilled technological and scientific workforce to support cutting-edge research in India."

Prof. Jayanta Roy
Associate Professor, NCRA-TIFR

PARAM Brahma supercomputing facility by C-DAC, Pune has been of great help to my research group. Our group primarily attempts to solve chemical problems using wavefunction-based methods such as coupled-cluster (CC) theory. Computational calculations with wavefunction-based techniques are notorious for their large disk and memory requirements. The PARAM Brahma supercomputer is equipped with a higher number of cores and memory per node. We were able to meet our computational needs after the facility was available to us. Also, the support team at C-DAC very efficiently provides the necessary assistance regarding any issues. We express our sincere gratitude to C-DAC, Pune and the team behind PARAM Brahma.

Sudipta Chakraborty
IIT Bombay, PARAM Brahma User

"As a user of Param Rudra, I can confidently say it is the best HPC system I have used in my research career. It performs large-scale quantum mechanical calculations with high accuracy and efficiency. We use GPU nodes for Li-ion battery cathode simulations and descriptor development from DFT, while CPU nodes handle over 900 catalyst systems for CO_2 electroreduction."

Prof. Ranjit Thapa
Professor, Department of
Physics SRM University-AP

PARAM Shivay has played a crucial role in advancing our research by providing high-performance computing (HPC) capabilities essential for grids of stellar evolution model calculations, large-scale data analysis, and computational modelling. Its robust infrastructure has significantly accelerated our scientific computations, enabling us to tackle challenging research problems efficiently. The prompt and highly supportive helpdesk team has been instrumental in installing necessary software, resolving technical issues, and ensuring an uninterrupted research workflow. We express our deepest gratitude to C-DAC, Pune and the entire local support team for their unwavering assistance.

Dr. Kuldeep Verma
Assistant Professor, Indian Institute of
Technology (BHU), Varanasi PARAM Shivay User

NSM User's Feedback

PARAM Ganga has been instrumental in developing the Transdimensional Bayesian inversion for 2D anisotropic media. Given the high computational demands of the developed algorithm-where runtimes can extend to days depending on the problem size - PARAM Ganga is a suitable platform for handling such complex computations. Additionally, the helpdesk has been highly supportive in installing the necessary programs and modules.

Arun Singh
IIT Roorkee, PARAM Ganga User

PARAM Brahma has helped our computational studies immensely. The system on which we are working has a large size (~390 atoms and ~3700 electrons). Thus the calculations are heavy and time consuming. However, PARAM Brahma provides faster solutions due to its advanced hardware architecture.

Dr. T. Raja
Sr. Principal Scientist,CSIR National Chemical Laboratory

The work focused on different stages of diseases on which each class incorporates 1000 above 3D images, so have to process a large data-set and high memory usage in 2D and 3D perspective. The PARAM Himalaya helps us in the time efficient execution of high complex models which incorporate large feature sets and have to handle more parameters which is time consuming and can't be implemented with normal CPU, GPU platforms.

Jismi K
APJ Abdul Kalam Technological University, Thiruvananthapuram, PARAM Himalaya User

"Our Plasma Theory Group at IISc Bangalore has greatly benefited from the high-performance computing capabilities of PARAM Pravega and PARAM Rudra. These cutting-edge platforms have played a pivotal role in the development and scaling of our indigenous fusion simulation code, G2C3. We are grateful to C-DAC Pune for their continuous support and world-class infrastructure, which has been instrumental in advancing India's domestic fusion program.

Prof. Animesh Kuley
Associate Professor of Physics IISc Bangalore

PARAM Yukti has been instrumental in the successful completion of my project, particularly in handling large-scale systems efficiently. Its computational capabilities have significantly facilitated simulations of complex structures. Recently, the use of GPUs has further enhanced performance, improving computational speed and efficiency. Additionally, the support team provided valuable assistance, particularly with software installation.

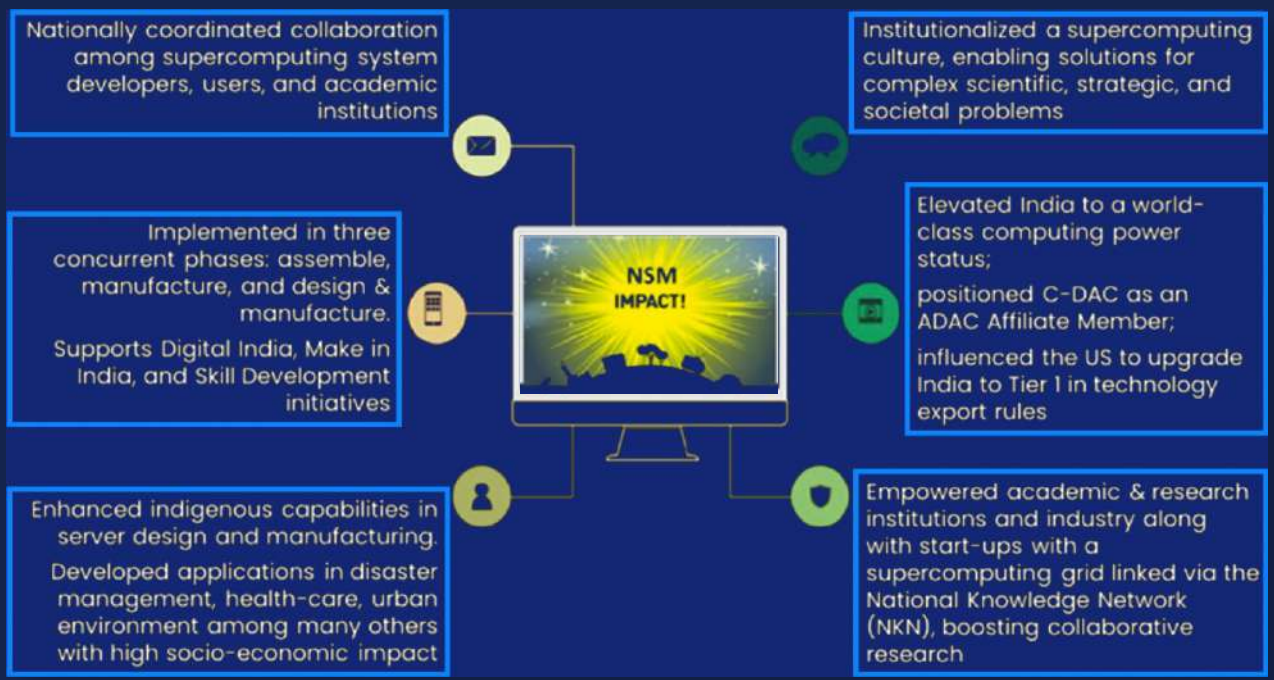
Surabhi Menon, Integrated Ph.D. Student
Jawaharlal Nehru Centre for Advanced Scientific Research, Bengaluru, PARAM Yukti User

UNION MINISTER OF JAL SHAKTI SHRI C R PATIL INAUGURATED C-FLOOD, A UNIFIED INUNDATION FORECASTING SYSTEM ON JULY 02, 2025

C-FLOOD is a web-based platform that provides two-days advance inundation forecasts up to village level in the form of flood inundation maps and water level predictions. It uses 2-D hydrodynamic modelling to simulate flood scenarios on infrastructure developed under NSM

It marks a transformative step towards strengthening India's flood management and disaster response framework

NSM IMPACT



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Branding and Communication/NSM/2025