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CURRENT AFFAIRS

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ISRO DEVELOPS PRAVAHA SOFTWARE

THIS ARTICLE COVERS 'DAILY CURRENT AFFAIRS' AND THE TOPIC DETAILS OF **"ISRO DEVELOPS PRAVAHA SOFTWARE".** THIS TOPIC IS RELEVANT IN THE "**SCIENCE AND TECHNOLOGY**" SECTION OF THE UPSC CSE EXAM.

Why in the News?

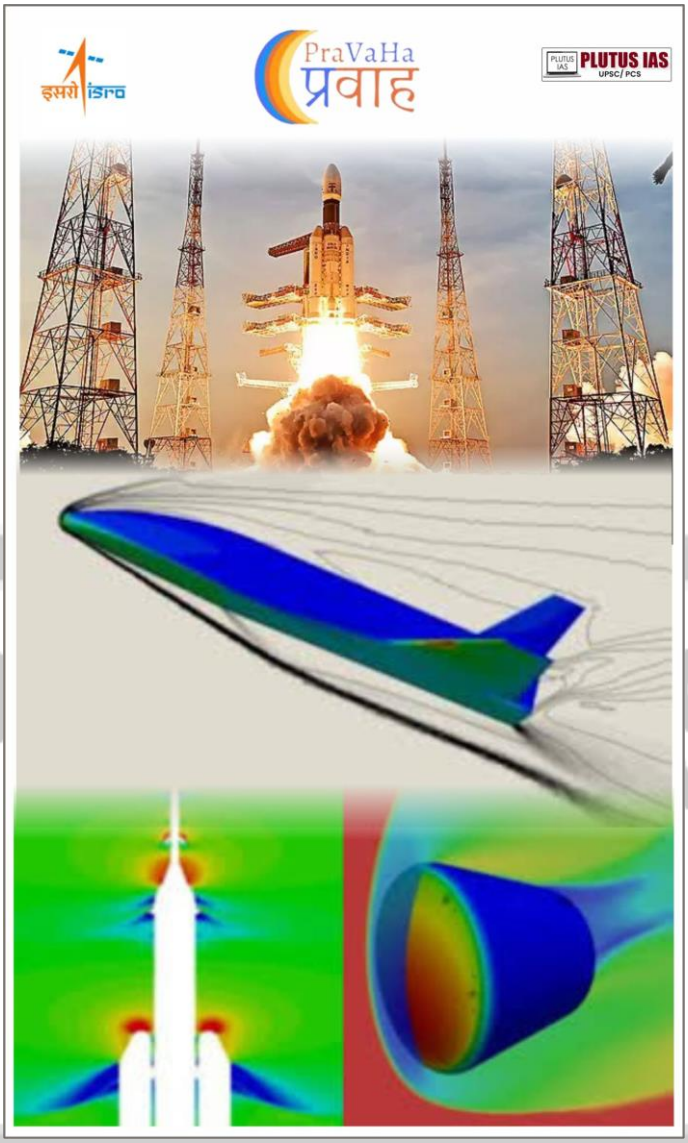
The Indian Space Research Organisation has developed a Computational Fluid Dynamics (CFD) software called **Parallel RANS Solver for Aerospace Vehicle Aero-thermo-dynamic Analysis, also known as PraVaHa.**
Developed at ISRO's Vikram Sarabhai Space Centre (VSSC), PraVaHa simulates external and internal flows on various launch vehicles, including winged and non-winged re-entry vehicles. It is capable of precisely predicting complex aerodynamic flows and aerothermal loads, making it an ideal tool for designing and characterising aerospace vehicles.

ABOUT COMPUTATIONAL FLUID DYNAMICS (CFD) SOFTWARE

Computational Fluid Dynamics (CFD) software is a specialized tool used for simulating fluid flow, heat transfer, and related phenomena. This software is critical in various fields, including aerospace, automotive, civil engineering, and energy.

KEY BENEFITS OF CFD SOFTWARE

- **Accurate Predictions:** CFD software can model complex fluid behaviours, providing detailed insights into flow patterns, heat transfer, and chemical reactions.
- **Cost-Effective:** CFD software reduces the need for physical prototypes and experiments, saving time and resources.
- **Optimization:** Helps in optimizing designs by allowing for the evaluation of multiple configurations and scenarios.
- **Safety:** Enhances safety by predicting potential issues and mitigating risks in the design phase.
- **Multiphysics Capabilities:** Integrates fluid dynamics with other physical phenomena, offering comprehensive analysis for complex engineering problems.



MAJOR BENEFITS OF PRAVAHA

- **Accurate Prediction Capability:** PraVaHa excels in precisely predicting complex aerodynamic flows and aerothermal loads, which is essential for designing and characterizing aerospace vehicles.
- **Faster Simulation Turnaround Time: The software can rapidly perform simulations on high-performance computing clusters, enabling the evaluation of multiple configurations and aiding** in selecting optimal designs.
- **Flexibility and Collaborative Development:** Designed to leverage both CPU and GPU architectures, PraVaHa is adaptable for collaborative projects with academic institutions and government laboratories.
- **Simulation of Various Conditions:** The software can simulate airflow under both perfect gas and real gas conditions. It is also validated for simulating chemical reactions during Earth re-entry and combustion in scramjet vehicles.
- **Replacement of Commercial Software:** PraVaHa aims to replace many commercial CFD software applications currently used for aerodynamic characterization, offering a cost-effective, indigenous solution for aerospace design.

- **Support for Academia and Industry:** By making PraVaHa available to academic institutions and other entities, ISRO supports the design of missiles, aircraft, and rockets, fostering self-reliance in India.
- **Enhanced Thermal Protection System Design:** The software aids in designing the shape, structure, and thermal protection systems necessary for aerospace vehicles during launch and re-entry, ensuring crew and vehicle safety.
- **Improved Aerodynamic Analysis:** PraVaHa can simulate both external and internal flows on launch vehicles and re-entry vehicles, whether winged or non-winged, allowing for comprehensive aerodynamic and aerothermal load analysis.
- **Reduced Simulation Time:** Its ability to quickly simulate complex aerodynamic flows reduces the time required for simulation and analysis, making design and testing processes more efficient.
- **Support for Human Spaceflight Missions:** PraVaHa is extensively used in the Gaganyaan program for aerodynamic analysis of human-rated launch vehicles, crew escape systems, and crew modules, making it an essential tool for future human spaceflight missions.

HOW WILL PRAVAHA CONTRIBUTE TO THE SUCCESS OF THE HUMAN SPACEFLIGHT MISSION?

- **Aerodynamic Analysis of Launch Vehicles and Crew Modules:** PraVaHa is extensively utilized in the Gaganyaan program to analyze the aerodynamics of human-rated launch vehicles, crew escape systems, and crew modules, ensuring spacecraft safety and stability during launch, ascent, and re-entry.
- **Thermal Protection System Design:** The software aids in designing the shape, structure, and thermal protection systems necessary for aerospace vehicles during launch and re-entry, safeguarding both the crew and the vehicle.
- **Simulation of Complex Aerodynamic Flows:** PraVaHa can accurately predict complex aerodynamic flows and aerothermal loads, making it an essential tool for designing and characterizing the Gaganyaan spacecraft.
- **Faster Simulation Turnaround:** PraVaHa can perform rapid simulations on high-performance computing clusters, allowing for the evaluation of multiple configurations and the selection of optimal designs for the Gaganyaan mission.
- **Replacement of Commercial Software:** PraVaHa offers a cost-effective, indigenous solution for the Gaganyaan program, expected to replace most commercial CFD software currently used for aerodynamic characterization.

FUTURE SPACE DEVELOPMENTAL PROGRAMMES OF ISRO

Gaganyaan Mission:

- **Human Spaceflight:** ISRO's Gaganyaan mission aims to send Indian astronauts into space. The mission includes developing human-rated launch vehicles, crew modules, and life support systems. The first crewed mission is planned for the near future, following the successful completion of uncrewed test missions.

Chandrayaan-3:

- **Lunar Exploration:** Following the success of Chandrayaan-2, ISRO is planning Chandrayaan-3, which will include a lander and a rover to explore the lunar surface further, particularly focusing on the south pole region of the Moon.

Aditya-L1 Mission:

- **Solar Observation: T**he Aditya-L1 mission aims to study the Sun's corona and its impact on space weather. The mission will place a satellite in a halo orbit around the L1 point of the Sun-Earth system.

Mangalyaan-2 (Mars Orbiter Mission 2):

- **Mars Exploration:** Building on the success of the first Mars Orbiter Mission (Mangalyaan), ISRO plans to launch a second mission to Mars to explore the Martian atmosphere and surface further.

Reusable Launch Vehicle (RLV):

- **Cost-Effective Access to Space:** ISRO is developing an RLV technology to reduce the cost of access to space. This involves designing a vehicle that can return to Earth and be reused for multiple missions.

Small Satellite Launch Vehicle (SSLV):

- **Commercial Launch Services:** The SSLV is being developed to cater to the growing small satellite market. It will provide on-demand launch services for small satellites, offering a cost-effective and flexible launch solution.

Space Station:

- **Orbital Habitat:** ISRO has plans to develop its own space station. This long-term project aims to support scientific research and serve as a platform for international collaboration in space.

Next-Generation Launch Vehicles:

- **Advanced Rocket Technologies:** ISRO is developing more advanced launch vehicles, including the Unified Launch Vehicle (ULV) and heavy-lift rockets, to increase payload capacities and improve mission versatility.

Satellite Constellations:

- **Communication and Earth Observation:** ISRO plans to deploy constellations of satellites for enhanced communication services, global internet coverage, and comprehensive Earth observation capabilities.

Prelims Based Question

Q. Recently seen in the news, "PraVaHa" is related to:

A. PraVaHa is designed exclusively for marine engineering applications, focusing solely on simulating underwater fluid dynamics.
B.PraVaHa software was developed by a private space company for a space simulation programme.

C. The Ministry of Jal Shakti launched the PraVaHa scheme to ensure a round-the-clock water supply for every household.
D.PraVaHa is a Computational Fluid Dynamics software developed by ISRO.

ANSWER: D

Mains Based Question

Q. Discuss the key benefits of Computational Fluid Dynamics (CFD) software developed by ISRO and explain how PraVaHa exemplifies these advantages in aerospace applications and human space flight programmes.

Vikas Agarwal