REALITY, TECHNOLOGIES, PERILS, AND OPPORTUNITIES

4-TH INTERNATIONAL NUCLEAR CONFERENCE - SMR AND ADVANCED WORLD NUCLEAR TECHNOLOGY FOR INDUSTRIAL APPLICATIONS 10-11 APRIL 2025 SOFIA

What is DISCOVERER

Sofia Petascale Supercomputer

- **Discoverer** is a Petascale supercomputer can execute:
  - 4,6 PetaFlops Rmax
  - 6,0 PetaFlops Rpeak

  [1 PetaFlops= 10^{15} Flops = 10^{6} Flops x 10^{9} Flops]
- **In** in oct 2021 **Discoverer** was ranked at 91st place among the worlds top 500 supercomputers (in oct 2023 it is 166th)
- Discoverer's infrastructure is **co-funded by EuroHPC JU (35%) and by PetaSC** and the Bulgarian government (65%).
- **PetaSC Bulgaria** is a legal consortium combining the knowledge and 15 years of expertise of the National Center for Supercomputing Applications, the Strategic Center for Artificial Intelligence and **Sofia Tech Park** (where it is hosted)
- **Discoverer's mission & vision:**
  - **T**o foster better science for society
  - **T**o facilitate innovations by establishing deeper collaborations between academic institutions and the business
  - **T**o help training the next generation IT talent

166th (91st)

TOP 500 The List.

NCSA NATIONAL CENTRE FOR SUPERCOMPUTING APPLICATIONS

Discoverer Upgrade 1/2

DISCOVERER
Sofia Petascale Supercomputer

- Lot1 - GPU (Eviden)
  - 4 NVIDIA GDX H100 (32 H100 GPUs, 640 GB GPU mem)
    - 8x H100 GPU & 8x 80GB of GPU HBM2e 8x 3.84TB NVMe
    - 2TB system memory / 2x 1.92TB NVMe / 4x IB 400Gb/s
    - 2x Racks with **cooling doors** and IB cables

- Lot2 – Storage (A1/HPE) [expanding current 4PB DDN to 10PB]
  - Cray ClusterStor E1000 (**Lustre**) (5.5PB HDD + 0.5PBNVMe Flash)
    - **5.5PB physical storage capacity on HDD drives** AND
    - **500 TB physical storage capacity on NVMe drives flash**
    - The system is able to handle 1 million IOPS and Read/Write throughput of over 40 GB/s on the flash pool.
    - Network 8 x InfiniBand HDR 200 Gb/s ports for storage data traffic
    - Racks and cables

  - HPE WEKA (**WekaFS)**
    - **usable capacity is 430TB (NVMe drives**) after data protection against two hardware failures at the same time (N + 2)
    - **WekaFS high-performance parallel file system** providing **multiprotocol access to a global namespace** hosted on **cluster of 11 HPE ProLiant DL325 storage nodes (11xU1)**.
    - WekaFS supports shared **POSIX access to single global namespace**.
    - WekaFS supports NFS v3&4, SMB v3, supports Container Storage Interface (CSI), GPUDirect Storage protocols AND access to the stored files via these protocols
    - Every storage node in the cluster has 2 x InfiniBand 200Gb/s HDR ports each one located on a separate InfiniBand adapter, and 4 x 1Gb/s Ethernet ports
    - Racks and cables

  - Lot 3- UPS (A1)
    - **Delta UPS Modulon DPH 300kVA** with battery backup solution Delta UBR
    - **Source Transfer Switch MGE Upsilon STS 400A**

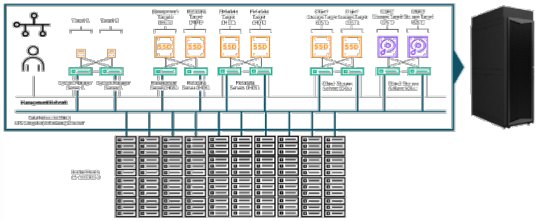


Figure 1 Cray ClusterStor E1000: An engineered parallel HPC storage system

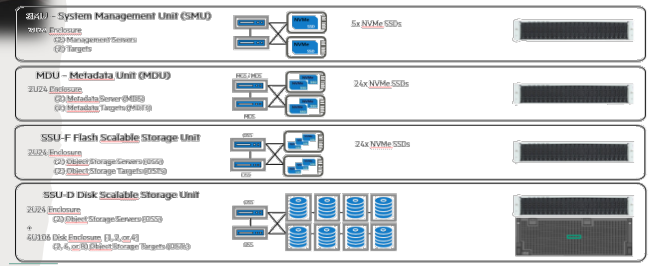


Figure 2 Cray ClusterStor E1000 storage components

Figure 3: WekaFS combines NVMe flash with cloud object storage in a single global namespace

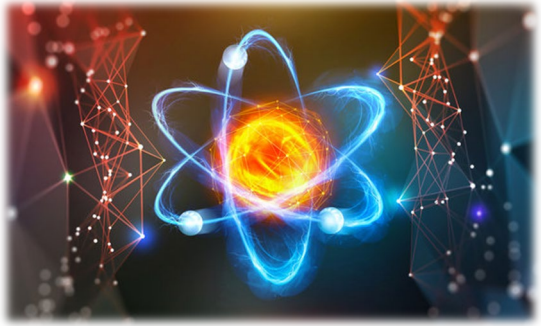
DISCOVERER
Sofia Petascale Supercomputer

Projects by field (2024)

Discoverer spearheaded projects across Europe and Bulgaria, contributing to advancements in diverse fields such as biomedicine, meteorology, physics, products engineering and more.

What the fields include:

1. **Physical Sciences**: Condensed Matter Physics, Universe Science, Nanophysics, Chemical Sciences
2. **Life Sciences**: Molecular and Structural Biology, Genetics, Genomics, Bioinformatics, Fundamental Constituents of Matter, Biomedicine, Biomedical Engineering
3. **Engineering**: Computer Science and Informatics, Products and Processes Engineering, Systems and Communication Engineering
4. **Meteorology**: Weather Forecasting



EuroHPC
Joint Undertaking

Introduction

- Data centres are energy-intensive, especially with AI-driven growth.
- SMRs offer scalable, low-carbon alternatives to meet surging demand.
- Presentation covers: current reality, enabling technologies, costs, advantages, and risks.

The Reality of SMR Adoption

- Current Projects: TVA, OPG, and Pennsylvania's 960 MW campus.
- Co-location Model: Building data centers near nuclear facilities.
- Regulatory Progress: NRC approvals for population-adjacent deployment (2023).
- Demand Surge: AI centres need 2.5x power of traditional centres.

SMR Technologies Enabling Integration

- Modular Design: Scalable from <10 MW to 300+ MW.
- Advanced Cooling: Molten salt/gas systems for safety & flexibility.
- Microgrid Compatibility: Uptime >99.999%, reduced transmission losses.
- Power Matching Models:
  - Energy Hub – Shared grid for industry cluster.
  - Micro Modular – Tailored SMRs for individual centres.

Core Advantages of SMRs in Data Centres

- Reliability: Baseload power, grid independence.
- Scalability: Modular growth with demand.
- Sustainability: Near-zero carbon, compact footprint.
- Security: Reduced exposure to cyber or grid threats.
- Operational Efficiency: Long refuelling cycles, low maintenance.

Implementation Challenges

- Technology Readiness: Limited data on advanced designs.
- Infrastructure Needs: Microgrids and waste disposal systems.
- Public Engagement: Education required to overcome safety fears.
- Cost Parity: Must compete with rapidly dropping renewable prices.

Conclusions

- SMRs offer transformative energy potential for data centres.
- Still high-risk, but aligned with future sustainability and reliability goals.
- A strategic bet worth considering as AI and digital services expand.

DC - HPC - AI - SMR

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