MeluXina: Your Supercomputer for Earth Observation Applications

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About Us

90.000 HPC CPU Cores

5.120 Cloud vCPUs

800 GPU-AI accelerators

Infiniband HDR 200 Gb/s

20 Petabytes high performance storage

300+ Tailored software packages

Luxembourg's national supercomputer Meluxina

has been built to serve a large variety of complex, data-driven computational workloads. Its design is forward-looking, responding to the convergence of simulation, modeling, data analytics and artificial intelligence. This enables predictive analytics simulations.

Performance

Compute
18 FP64 PetaFlops
500 AI PetaFlops

Data
500+ GB/s Scratch storage
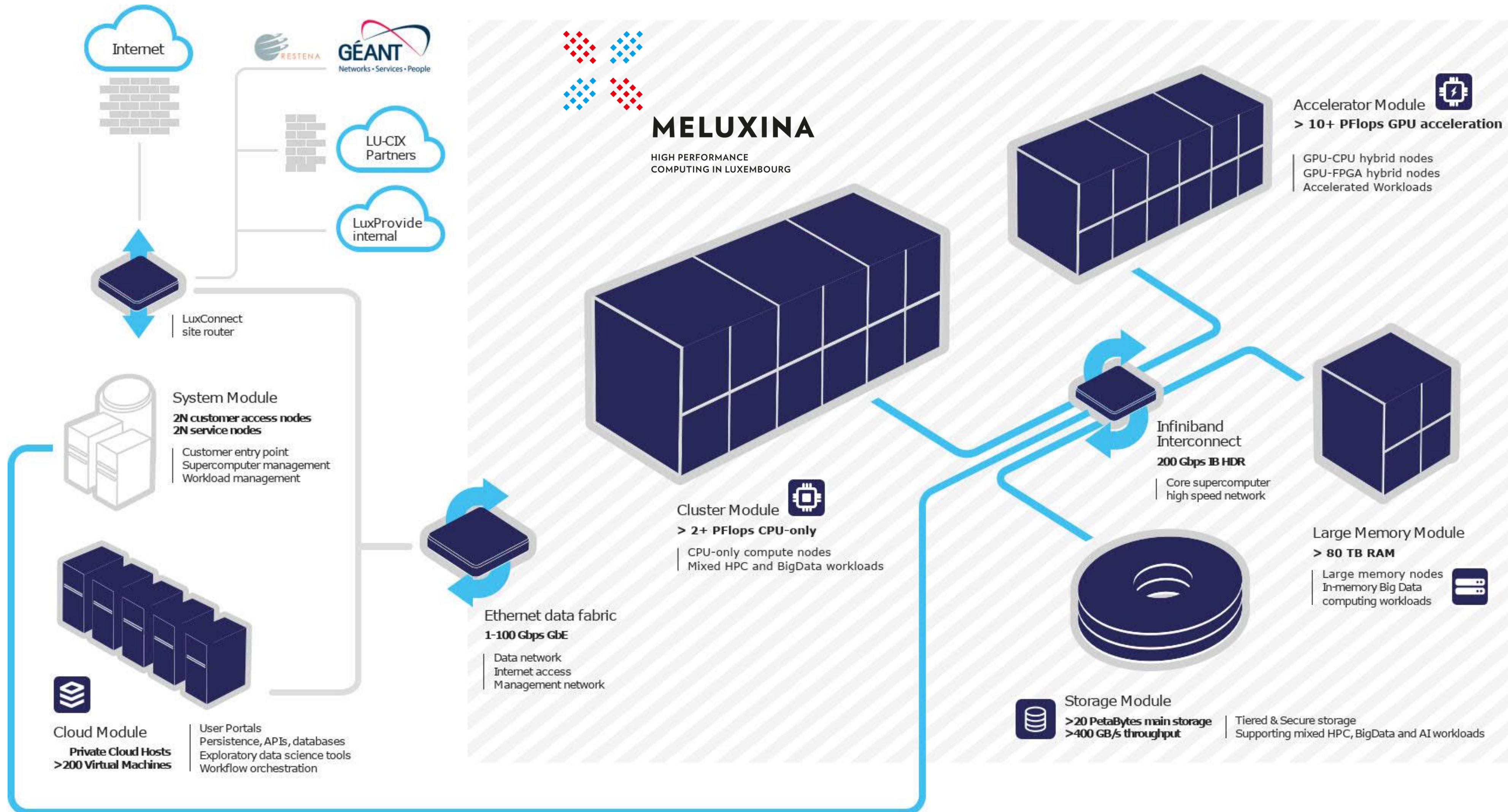**190+** GB/s Project storage

Interconnect
200 Gb/s on Cluster nodes
400 Gb/s on Accelerator and large memory nodes

In June 2021, the **MeluXina** accelerator module has been ranked **36th in the Top500** World ranking of supercomputers, **4th greenest in the world** and **greenest in the EU**.

Internet

RESTENA

GÉANT
Networks · Services · People

LU-CIX
Partners

LuxProvide
internal

LuxConnect
site router

System Module

2N customer access nodes
2N service nodes

Customer entry point
Supercomputer management
Workload management

Cloud Module

Private Cloud Hosts
>200 Virtual Machines

User Portals
Persistence, APIs, databases
Exploratory data science tools
Workflow orchestration

MELUXINA

HIGH PERFORMANCE
COMPUTING IN LUXEMBOURG

Accelerator Module

> 10+ PFlops GPU acceleration

GPU-CPU hybrid nodes
GPU-FPGA hybrid nodes
Accelerated Workloads

Cluster Module

> 2+ PFlops CPU-only

CPU-only compute nodes
Mixed HPC and BigData workloads

**Infiniband
Interconnect**

200 Gbps IB HDR

Core supercomputer
high speed network

Large Memory Module

> 80 TB RAM

Large memory nodes
In-memory Big Data
computing workloads

Ethernet data fabric

1-100 Gbps GbE

Data network
Internet access
Management network

Storage Module

>20 PetaBytes main storage
>400 GB/s throughput

Tiered & Secure storage
Supporting mixed HPC, BigData and AI workloads

Green Supercomputing

1 TOWARDS A CARBON NEUTRAL DATA CENTER

Data Centers are large energy consumers but the one that hosts MeluXina is cutting edge when it comes to sustainability and social responsibility.

- Certified 100% **Green Electricity** supplied from hydroelectric power sources
- Optimised use of **Free Cooling**
- **Biomass** recycling representing a yearly reduction in CO_2 in excess of 27,000 metric tons
- **PUE** of the Data Centers constantly measured and monitored
- Continuous improvement plan for **Energy Efficiency** supervised by the government agency Klima-Agence
- **Waste heat** from servers used to heat office space and preheat diesel generators

2 MELUXINA'S ENERGY EFFICIENCY

In the greater supercomputing world, sustainability refers to **sustained output in terms of floating-point operations per second per watt (FLOPS/W)**.

In June 2021, MeluXina's GPU AI Accelerator module has been ranked 4th greenest in the world and greenest in the EU.

The GREEN 500

The list measures **performance in FLOPS/W** using the TOP 500 measure of high performance LINPACK benchmarks at double-precision floating-point format.
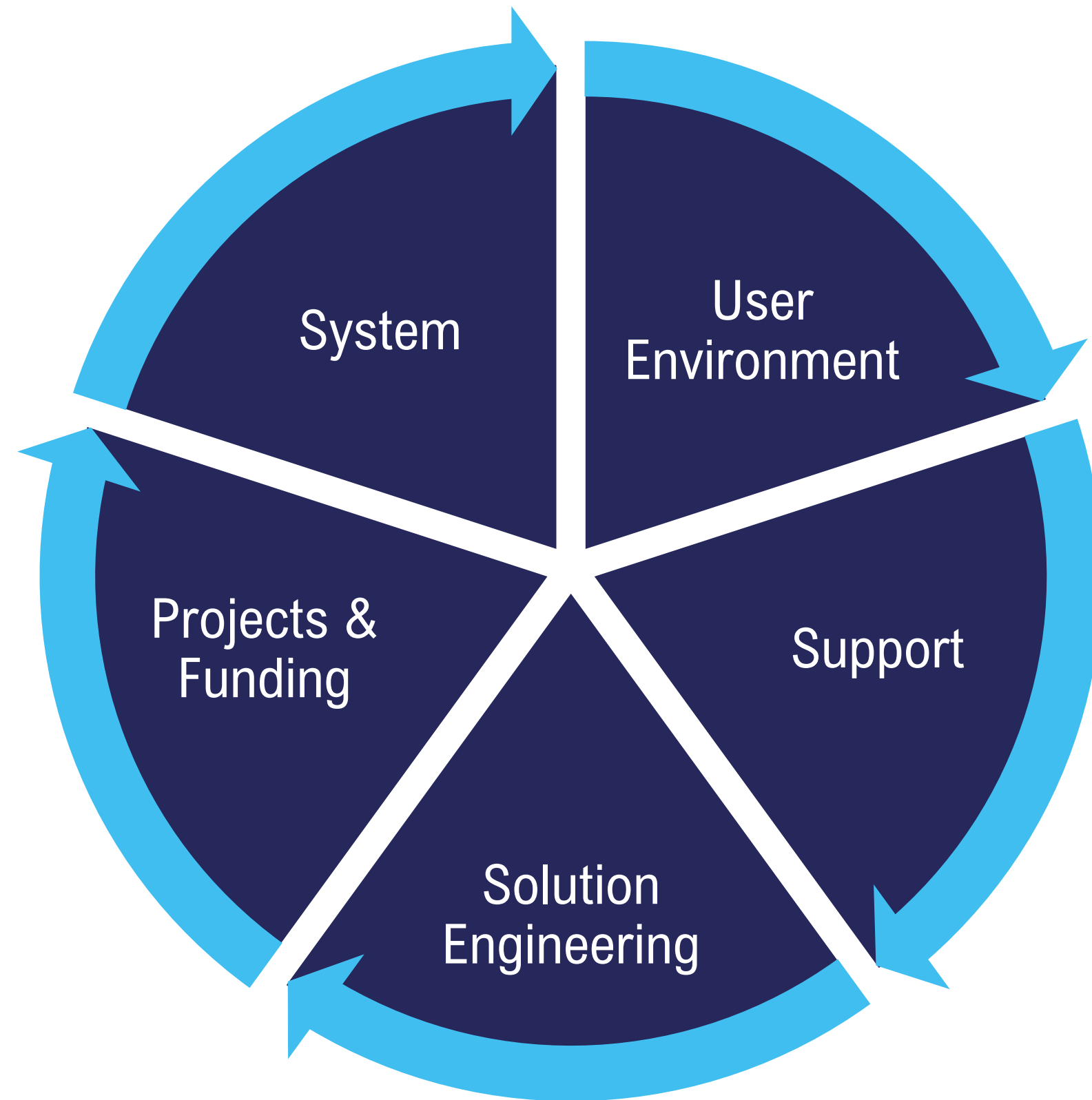
3 ENVIRONMENTAL SOCIAL AND GOVERNANCE IMPACT

In the context of **ESG solutions**, however, sustainability means the efficient utilization of resources. Better utilization of resources, coupled with shorter timeframes, means improved environmental sustainability.

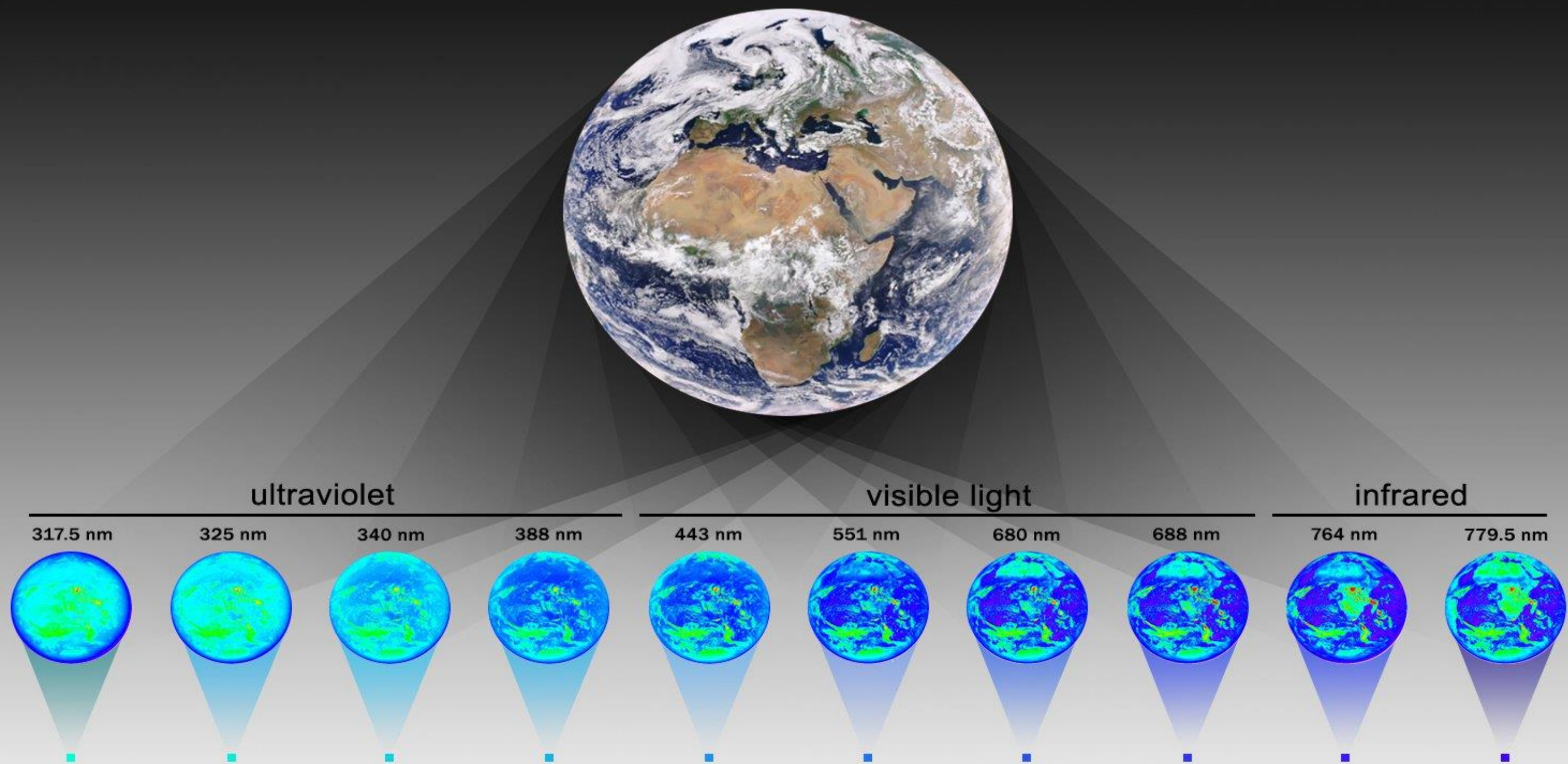HPC can deliver on that goal as demonstrated through a variety of use cases.

- **Weather prediction and climate change**: Timely and more precise weather forecasting with a better understanding of climate change adaptation for optimised scheduling and impact.
- **Energy and utilities**: Developing real-time wind and solar maps for energy optimisation and improved photovoltaic efficiency.
- **Drug development**: Accelerating drug discovery and developing personalised healthcare.
- **Discrete manufacturing**: Reducing or eliminating the need for physical testing, predictive and prescriptive maintenance, automation of product lifecycle management, and shortened design cycles.

LuxProvide: Luxembourg's One-Stop shop for HPC & HPDA

Credits: NASA/JPL-Caltech

ultraviolet   visible light   infrared

317.5 nm   325 nm   340 nm   388 nm   443 nm   551 nm   680 nm   688 nm   764 nm   779.5 nm

Credit: NASA/NOAA/JPL-Caltech

The Earth Observation ecosystem

Sensing	Collection	ETL	Processing	Showcase

Iterative (Virtual) Design

Faster time to market

Accurate physical models
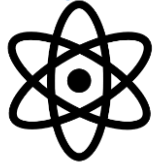
High-Resolution simulation
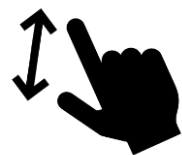
Telecommunication Emulation

The Earth Observation ecosystem

Sensing → **Collection** → ETL → Processing → Showcase

Big Storage Capacity

Redundant system backup

Snapshot technology

Hardware Encryption

Open Source Solutions

The Earth Observation ecosystem

Sensing > Collection > **ETL** > Processing > Showcase

Distributed Computing
Frameworks
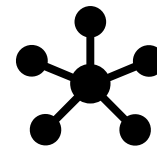
Capacity for Scale-Up and
Scale-Out

High IO-speed

The Earth Observation ecosystem
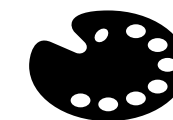
Sensing > Collection > ETL > **Processing** > Showcase

Latest Generation Acceleration
Hardware

High-Speed Interconnect
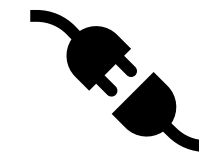
AI-enhanced physical engines

Fast Visualisation

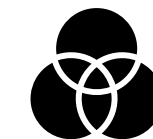# The Earth Observation ecosystem

Sensing → Collection → ETL → Processing → Showcase

Dedicated VMs

Platforms for data and algorithms

IoT data streaming

User Portal

DS-friendly AI/ML/DL platforms

Use Cases

| Sensing | Collection | ETL | Processing | Showcase |

Advanced Modelling and Testing for Next-generation Satellites Operations

MeluXina enables modelling of real-time satcom scenarios

➤ Efficiency: complex bandwidth and power allocation - simultaneously and for multiple beams - to avoid satellite service interruption

➤ Computational power: **twice as fast as typical cloud computer** resources

➤ Reliability: secure environment for sensitive customer data

➤ Flexibility: scalable to large network sizes

➤ Access: Europe-based, accessible on short notice

SES

Use Case

Sensing ▶ Collection ▶ ETL ▶ Processing ▶ Showcase

HPC compatible & working well
Current status

➢ Onboarding process done: Running models on MeluXina

➢ Troubleshooting remaining: Model setup problems & benchmarking CPU and GPU with HPC mentor Farouk Mansouri

➢ Obtained 10x speed up: Using CPU model on MeluXina GPU nodes

➢ **CPU runs: Production runs already submitted on MeluXina**

➢ **GPU runs: Model test confirmed to run**

➢ **Production phase: Started in June**

Use Case

| Sensing | Collection | ETL | Processing | Showcase |

Cloud Platform for Earth Observation Services

Partners with WASDI (ESA project)

➢ Services: Web APIs, Web GUI, and Web Platform

➢ Partnership: Applying together to ESA project

➢ Performance: High bandwidth and redundant links to WAN.

➢ Flexibility: scalable to large network sizes

➢ Easy Access: Ingress and Egress free of charge

The Value Proposition: Trust

Sensing > Collection > ETL > Processing > Showcase

Tier IV DataCenter

Hardware Encryption

Luxembourg Law:
No Patriot Act

ISO Certifications:
27001 & 27002

The Value Proposition: Team

Sensing > Collection > ETL > Processing > Showcase

Solutions Engineering:

➤ Tech solutions for identified needs

➤ Computational Expertise (HPC, HPDA)
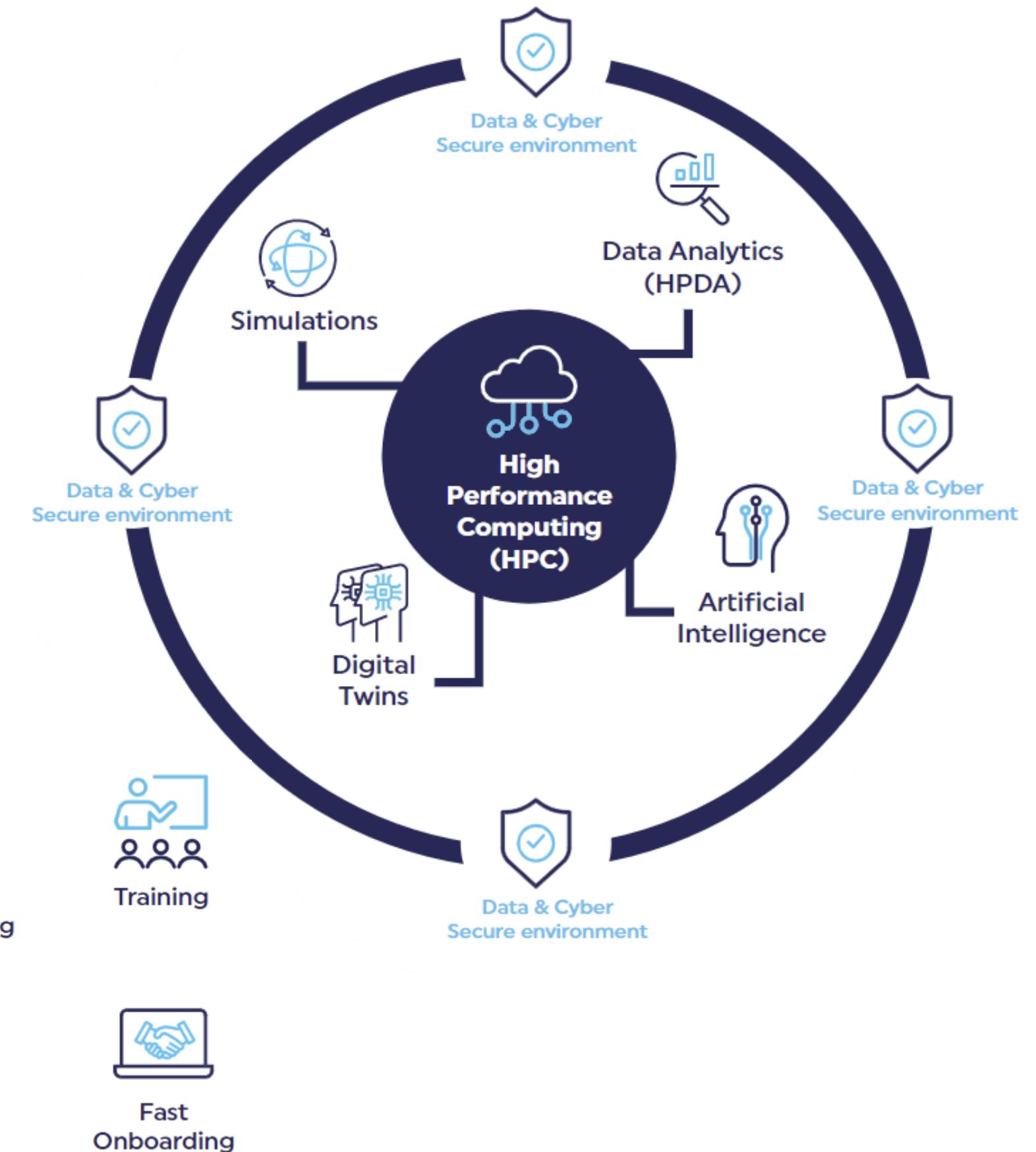
➤ Domain Expertise

Software Engineering:

➤ Performance Expertise

➤ Optimization, Profiling and Parallelization

"In a nutshell"

➤ **One stop shop for HPC & HPDA** in Luxembourg and Europe

➤ State of the art infrastructure and hardware

➤ High performance and high availability

➤ Focus on security and GDPR compliance

➤ Domain and technical expertise

➤ Complete industry-oriented packages

➤ Specialized support for SMEs

Thank you