LEONARDO

Corporate Research Laboratories
Chief Technology & Innovation Office

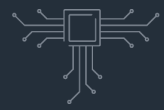
Leonardo Labs

Annamaria Scotto

PMO @ Leonardo Labs

La Laurea in Azienda

21/04/2023


Electronics


Helicopters


Aircraft


Cyber & Security


Space


Unmanned Systems


Aerostructures

The Leonardo Labs – Mission

The Leonardo Labs are **technology incubators** intended to support **Leonardo's long-term research** and its **development of cutting-edge technologies**, particularly in the digital sphere. They stem from the desire, not just to remain on the frontline of innovation, but to anticipate it, thereby **improving the products and services** offered to customers and boosting the Group's long-term growth prospects. The goal is to be **the driver of national technology** to direct and support the entire ecosystem of customers, industrial partners and universities

The technological areas of the laboratories are defined within the "**Masterplan 2030 for Innovation**", one of the pillars on which the strategic plan "**Be Tomorrow - Leonardo 2030**" is based, an ambitious and far-sighted vision, which aims to contribute to progress sustainable, safety and a more hospitable future.

Leonardo's laboratories will also allow to feed a continuous **flow of talents** and to ensure flexibility and renewal of professional skills, based on a model according to which young research fellows and doctoral students of international origin work together with experts and internal researchers at Leonardo's Divisions.

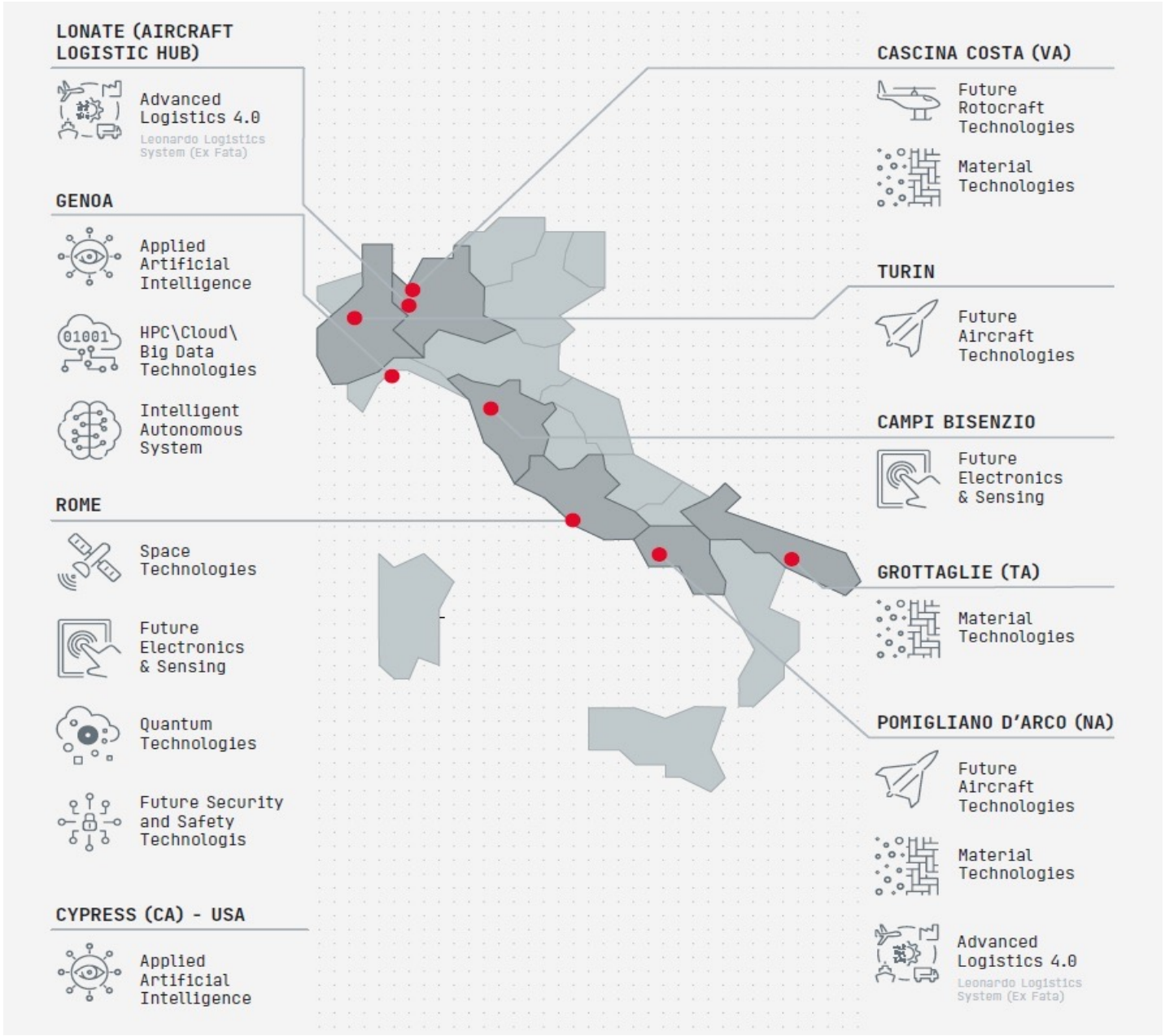
The Leonardo Labs – Numbers

The main Leonardo Labs numbers are:

- **11** Leonardo Labs (in 6 regions in Italy and 1 in the USA)
- **9** Research areas
- **38** Research units
- **4** Joint external laboratories
- **200** Research fellows at end 2023

In the support at the activities of Leonardo Labs is available the newborn supercomputer Davinci-1. These are the main numbers of Davinci-1:

- **4th** in the aerospace sector behind only to NASA JAXA, DLR agencies;
- **24th** in the private company supercomputers;
- **150th** in the top 500 worldwide supercomputers;
- **5** Pflops of computing power;
- **20** PByte of cumulative storage capacity.



Leonardo Labs – “L2 in 4D”

Divisions & Companies

Research Areas

- Digital Twin and Advanced Simulation
- Artificial Intelligence
- Big Data
- HPC\Cloud
- Unmanned & Robotics
- Quantum
- Electrification
- Materials
- Optoelectronics

38 Research Units + 4 Joint Labs

Leonardo Labs

- Future Rotorcraft Technologies
- Future Aircraft Technologies
- Material Technologies
- Space Technologies
- Future Electronic and Sensing
- Quantum Technologies
- Applied Artificial intelligence
- HPC\Cloud\Big Data Technologies
- Intelligence Autonomous System
- Future Safety & Security Technologies
- Advanced Logistics 4.0

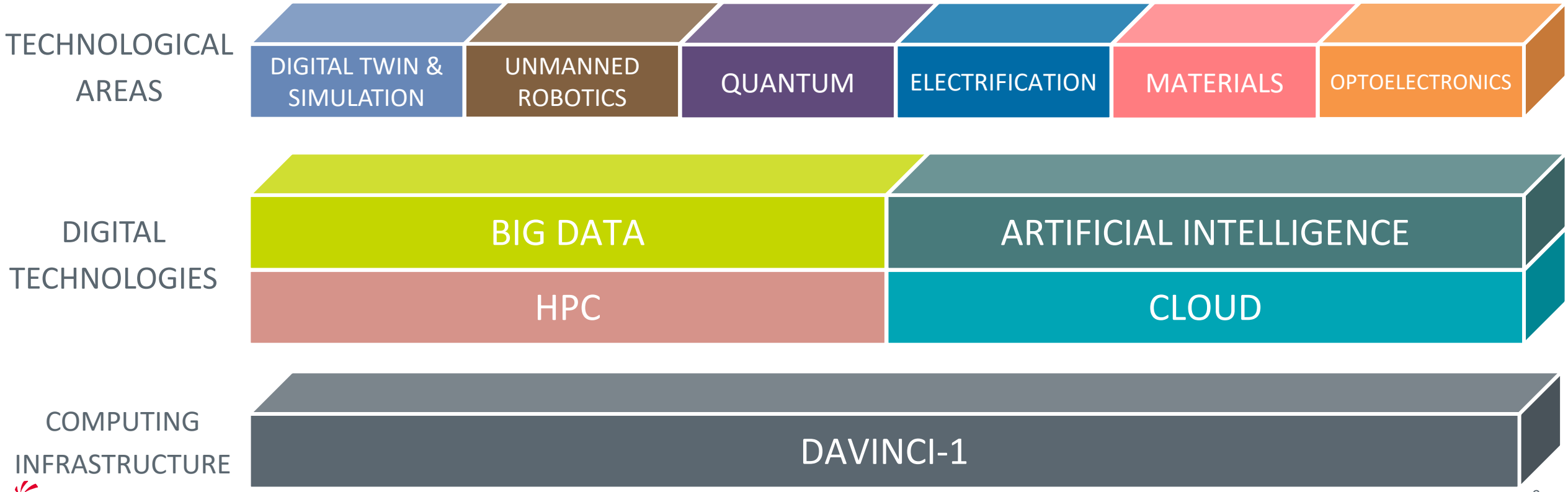
Leonardo Labs – “L2 in Vertical Dimension”

TECHNOLOGY READINESS LEVEL		LEONARDO LABS	DIVISIONS
TRL 1	Observation of the fundamental principles	Explore, select and develop new enabling technologies.	
TRL 2	Formulation of the concept of technology		
TRL 3	Experimental tests		
TRL 4	Validated Laboratory Technology	Share, co-develop, adapt and optimize the newtechnologies, with Divisions. Facilitate transfer to Divisions’ product.	
TRL 5	Technology Validated in an industrially relevant environmental		
TRL 6	Technology demonstrated in an industrially relevant environment		
TRL 7	Demonstration of the product prototype in an operational environmental	Sell Technology/IP if unused or try to startup	Finalize development and ensure implementation into the technology and product portfolio
TRL 8	Complete and qualified product		
TRL 9	Product tested in an operational environment – production and marketing		

TRL

Leonardo Labs – Integrated approach to technological innovation

Leonardo Labs are based on an **integrated innovation approach in which all technological areas are interconnected and interact synergistically, making the most of common points**. At the base lies the davinci-1 with its computing and storage capabilities that are exploited by **HPC and Cloud technologies**, used by all the technologies and domains of the upper level. The third level is composed of **Big Data and AI** technologies which are both independent research areas and a founding element for the other research areas. An example is the convergence of the AI, Big Data, HPC technology domains in the creation of the Digital Twin platform for design, validation and support operations of our platforms.



Ipotesi/spunti/tematiche di tesi

- **Artificial Intelligence**:
  - Trustworthy AI per garantire proprietà di robustezza dei modelli basati su machine learning (reti neurali ecc..)
  - Continual Learning per addestrare reti che imparano in maniera continua da nuovi dati senza scordare la conoscenza appresa dai dati precedenti
  - Parallelizzazione del training di reti neurali tramite tecniche distribuite (ci servirebbe particolarmente)
- **HPC**:
  - HPC software evaluation and optimization
- **Post Quantum Cryptography**:
  - Problemi matematici computationally hard per algoritmi asimmetrici PQ. Analisi di varie classi di primitive e loro vulnerabilità, anche con riferimento alla call NIST. Proposte di candidati originali e/o di nuovi percorsi di cripto analisi su candidati noti.
- **Robotics**:
  - Locomotion and navigation on uneven terrains using quadrupeds
  - Autonomous Mobile grasp and manipulation of generic objects
  - Semantic mapping
  - Low-level control of quasi-direct-drive actuators

CONTACTS

Annamaria Scotto

Head of Leonardo Labs and Cloud Computing Project Management

annamaria.scotto@leonardo.com

Leonardo Labs

Corporate Research Laboratories
Chief Technology & Innovation Office

Enrico Mingo Hoffman

P.I. Robotics @ Leonardo Labs

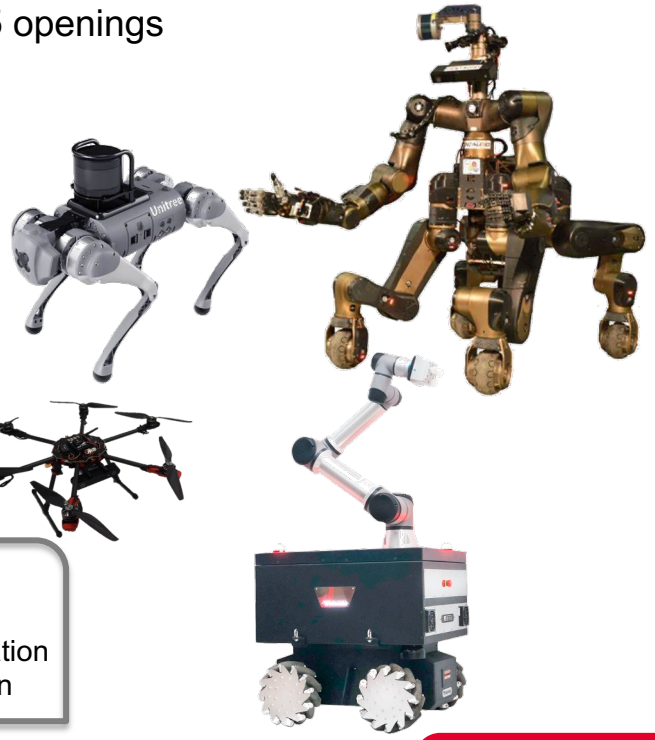
La Laurea in Azienda

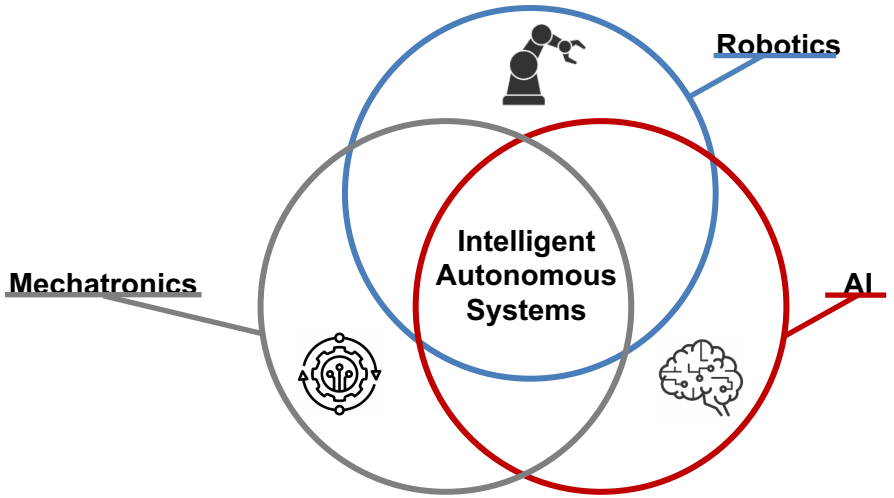
21 Apr 2023

Unmanned Systems & Robotics Group

PI: Enrico Mingo Hoffman

- 21 Researchers (Ms., Ph.D.) + 15 openings
- Turin, Milan, Genoa, and Rome
- Divisional & Founded Projects





PLATFORMS

Unmanned **G**round **V**ehicles (**UGV**)
- Quadrupeds (**Q-UGV**)
- Mobile Manipulators

Unmanned **A**erial **V**ehicles (**UAV**)
- QuadRotors
- HexaRotors

SYSTEM

Unmanned **R**obotics **S**ystems (**URS**)
- Command & Control
- Shared Autonomy/Tele-Operation
- Indoor/Outdoor communication


Defense & Security Support


Logistics & Manufacturing

Unstructured Robotics Lab. PI: Nikos G. Tsagarakis

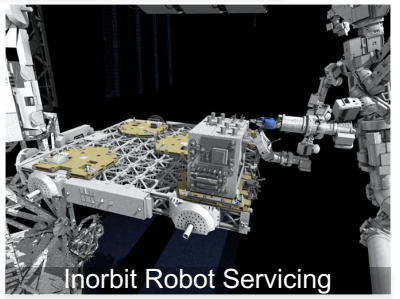
Humanoids & Human Centered Mechatronics

Robotics for Manufacturing Lab. PI: Arash Ajoudani

Human-Robot Interfaces and physical Interaction

Portfolio of various sized autonomous systems, for specific environments with proprietary mechatronics, software stack, and control framework.


Inspection & Maintenance


Inorbit Robot Servicing

CONTACTS

Enrico Mingo Hoffman

Robotics Principal Investigator

enrico.mingohoffman@leonardo.com

Leonardo Labs

Corporate Research Laboratories
Chief Technology & Innovation Office

Antonio Sciarappa

P.I. HPC/Cloud Area @ Leonardo Labs

HPC Specialist @ Cloud Computing Unit

La Laurea in Azienda

21 Apr 2023

About me

My studies and research career:

- ❑ Bachelor’s, Master’s (UniTO) + PhD in Theoretical Physics (SISSA)
- ❑ Postdoctoral Researcher – String Theory (KIAS, Seoul)
- ❑ Master in High Performance Computing (SISSA/ICTP)
- ❑ Researcher in Industrial and Applied Mathematics (MathLab)

My career at **Leonardo Labs** – Genova Torre Fiumara:

- ❑ Researcher in the **HPC/Cloud** Area, Jan 2021 - Oct 2022
- ❑ HPC Specialist and P.I. **HPC/Cloud** Area, Nov 2022 - onwards

HPC Infrastructure – davinci-1

davinci-1: Leonardo supercomputing infrastructure

https://www.leonardo.com/it/innovation-technology/davinci-1

- Rank 150th worldwide (88th on Nov. 2020)
- Rank 16th as industry (10th on Nov. 2020)
- Rank 4th in Aerospace (3th on Nov. 2020)

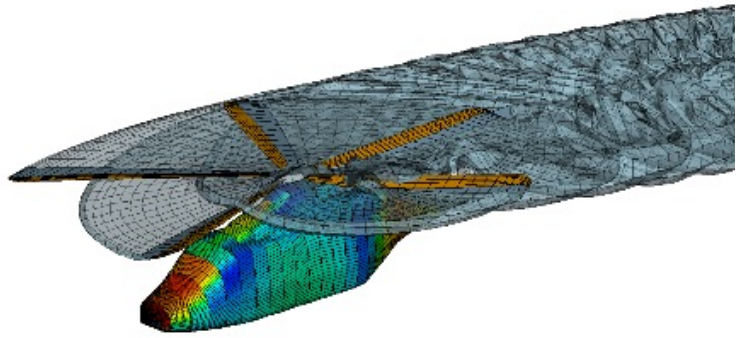
Some technical detail:

- 56 Intel + 80 AMD w/ 4 NVIDIA A100 GPU nodes
- 5 Pflops peak performance + 20 PB storage
- Internal Cloud Infrastructure (OpenStack)

Work at Leonardo Labs

HPC/Cloud Lab activities:

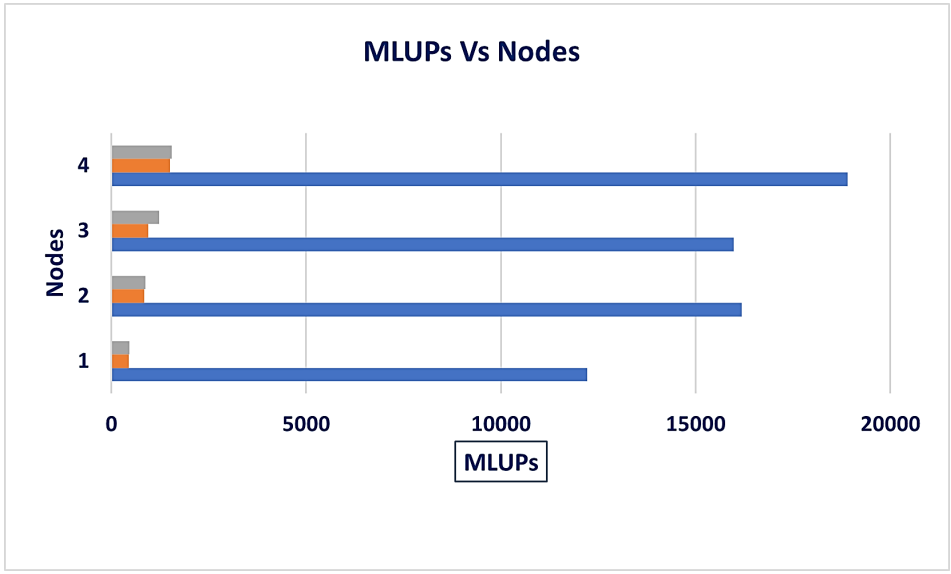
- ❑ Optimization of in-house Leonardo simulation codes and multi-CPU, multi-GPU acceleration on davinci-1 cluster
- ❑ Research of new algorithms (e.g. Lattice Boltzmann method)
- ❑ Co-design and evaluation of new hardware technologies and open-source software of potential industrial interests
- ❑ Performance analysis of new programming paradigms
- ❑ Study containerization tools, Federated Learning, security
- ❑ Research on Quantum Algorithms and Quantum Emulators

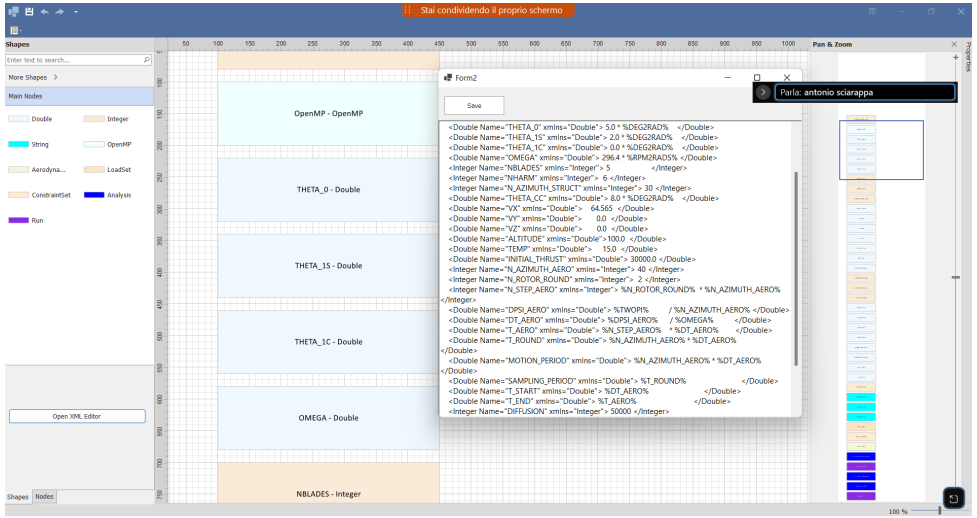


Collaborations

Involvment with Universities and Research Instituties:

- ❑ Two **Joint Labs** with IIT – Istituto Italiano di Tecnologia (Quantum Computing and Scientific Computing)
- ❑ Industrial **PhD** Fellowships with various Universities
- ❑ **Supervision** of UniGE Bachelor, Master **Thesis** students:
  - GUI for Leonardo simulation codes (D'Agostino - DIBRIS)
  - Lattice Boltzmann libraries evaluation (D'Agostino - DIBRIS)
  - HPC monitoring data analysis (Riccomagno - DIMA)
- ❑ **Lectures** and **presentations** to UniGE students





CONTACTS

Antonio Sciarappa

HPC/Cloud Principal Investigator

antonio.sciarappa@leonardo.com

LEONARDO

THANK **YOU**
FOR YOUR ATTENTION

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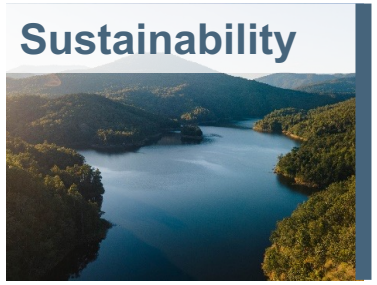
Leonardo Labs – “L2 in Horizontal Dimension”

RESEARCH AREAS	LEONARDO LABS										
	Future Rotorcraft Technologies	Future Aircraft Technologies	Materials	Space Technologies	Future Security & Safety	Future Electronics & Sensing	Quantum Technologies	Applied AI	HPC\Cloud Big Data Technologies	Autonomous Intelligent Systems	Advanced Logistic 4.0
Digital Twin and Advanced Simulation	✓	✓	✓					✓	✓	✓	✓
Artificial Intelligence	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Big Data	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
HPC/Cloud	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Unmanned and Robotics	✓	✓		✓		✓		✓	✓	✓	✓
Quantum							✓	✓	✓		
Electrification	✓	✓									
Materials	✓	✓	✓								
Optoelectronics	✓	✓	✓			✓					

Leonardo Labs – “New Research Areas 2023”

	Ambition/ Goals	Main Research lines	Note
	• Capture the **rapid growth in the Space industry** by researching **new technologies** for next-gen products • Contribute to create a **System Integration approach** on Space Systems.	• Robotics for Space • Future Solar Generators • Future optical instruments • SSA/SDA	**New Area in Corporate site** **Main sites Genoa, Nerviano** **Cooperation with some Divisions / Companies**
	• Develop solutions to increase the **environmental sustainability** of Company’s products/ services • Embed **sustainability aspects** when adopting and integrating **specific technologies** within product design	• Decarbonization of Products and Activities • Life Cycle & Circularity • Reduction of Environmental Impact of Industrial Processes • Digital Technologies for Sustainability	**New Area in Corporate site** **Main site Rome** **Cooperation with all Divisions / Companies**
	• Research, develop and deploy **Cyber Security tools and systems** in full cooperation with C&S Division • **Evolving current Lab** within C&S from its focus on physical shield to an **integrated cyber approach**	• Trusted and Secure Computing • Intrusion detection • Data security • Cryptography	**Expansion of Lab located in C&S division** **Main sites Chieti, Rome, Catania** **Increased direct CTIO support to Lab in C&S**