

## NCC success stories - Collaboration with industrial (end) users

### 1. Title

HPC as Industry Enabler

### 2. NCC presenting the success story

Leonardo is a third party in the Italian National Competence Centre EuroCC Italy, established by the EuroCC project. Leonardo experts employ their HPC competences, acquired through experience on the Davinci-1 supercomputer, to provide the Italian companies, in particular from the Liguria region, with technical support and training in HPC/AI/HPDA field.

The HPC is indeed a central infrastructure in supporting companies to innovate and improve their competitiveness in the respective business sector. Actually, there are many companies that may profit from HPC technologies and methodologies: from the SMEs that could change and speed up their algorithms, to the large companies that could upgrade existing processes and create fertile ground for the creation of completely innovative solutions.

### 3. Leonardo as HPC User

Considering the wide portfolio of products and services built and developed by Leonardo, HPC has proven to be useful in different scenarios and sectors. Those, HPC has a dual function: on one hand, it provides a large proprietary computing power, by removing limits on the processing power used by the internal algorithms and codes; on the other, it allows centralized computing capacity for the company which lead to optimize the expertise of engineers and researchers. Within the company, HPC and cloud computing resulted in designing and developing innovative solutions in the fields of Big Data, Artificial Intelligence, Simulation of complex systems and Optimization of parallel code. More, “**Digital Twin**” will be one of the main reality for future Leonardo HPC -related activities.

The term 'Digital Twin' arised from the the engineering field, and stands for a computer program, fed with data collected from a real system, and able to represent in a synthetic but accurate way (often through visualizations with 3D models, graphs, curves and dashboards) the overall status of the real twin. Simplifying, we could say that the digital twin is the equivalent of a control unit of the real twin, implemented within a software and that can work even without the controlled system. Recently, the concept of Digital Twin is taking on new meanings in the sense of a holistic digital model of a real system, or a virtual representation of it (always within a computer program) that replicates the state and changes in

state, thanks to the combined use of data, simulations and artificial intelligence. The holistic model as an extension of the Digital Twin is an incredibly powerful tool since it allows for predictive capability. It is largely enabled by the computing and data analysis power now available in supercomputers or in the cloud. The power is such to be able to calculate very complex but accurate numerical models, able to meet the increasing need to predict the behavior of a system under different operating conditions, be it a car an airplane, a ship, an industrial plant up to the human body and the whole earth (in the latter two cases we are still talking about research projects). The availability of an accurate and predictive virtual twin of the processes within Leonardo is also essential to predict the effect of a change of state, intended or unintended (e.g. due to altered environmental conditions), to avoid malfunctions, to reduce production and operating costs, by virtue of preventive actions, to make «what-if», evaluations, to train operators, etc...

The key element in developing a digital twin is the **software**. Software is not a single program; conversely, it implements complex multi-component (engine, structure, air, water, etc...) and multi-scale models (metal, metal components, complete aircraft, a fleet of airplanes, etc... ), which are evaluated in a coupled fashion, i.e., whose values affect each other. Hence, a special function describing the internal state of the system and keeping all components synchronized, is strongly required. To properly define a Digital Twin, this function must maintain synchronization also with the values of the sensors within the real twin.

There are the other two elements very relevant for digital twin: the **data**, which may be collected from sensors or simulated, and the **numerical models** needed to simulate the behavior of the various system components. The models can be based on the first principles, i.e. the constitutive equations that describe the behavior of the subsystem/component, or can be 'data driven', when data collected by the sensors are used to define an implicit model of the system behavior, through procedures ranging from simple interpolation to artificial intelligence. In this way, procedures computationally very expensive are able to faithfully replicate the states of a subsystem when the input data change (in this case, the AI model reproduces the load curve without any equation!).

Therefore, the realization of a Digital Twin is a very complex work and requires many elements, as a large amount of data, an **adequate computational infrastructure**, specific software and, above all, **transversal competences**, ranging from experts in real systems, to process and design engineers, to computer scientists for software writing and data management, to mathematicians or physicist for models, to computational infrastructure experts.

Leonardo experiments this innovation improvement thanks to HPC- activities on the **Davinci-1 supercomputer**, which ensured the computational power needed to develop and execute the software, manage and process the massive amount of data, and compute the solutions to the various mathematical and artificial intelligence models needed to create the digital twin.



#### 4. Leonardo as EuroCC Competence Center

Leonardo is a third party in the Italian National Competence Centre EuroCC Italy, established by the EuroCC project and aims to provide SMEs with technical support and expertise by Leonardo's HPC - researchers and experts.

As a leading technology company in Italy, Leonardo supports the national ecosystem trying to enable and encourage local companies with the adoption of HPC technologies to gain a competitive advantage in the business sector. Thanks to the collaboration with the technological hub of SIIT in Genoa, many training courses focusing on HPC have been delivered and targeted to local SMEs willing to gain closer collaboration with the National Competence Center. The training courses range from the management of HPC infrastructure, to modeling and parallelization of code with GPUs, to the creation of Big Data systems based on Cloud Computing, to the development and training of Artificial Intelligence models using HPC.

Leonardo is strongly supported by CINECA, with its long-standing experience in HPC technology transfer and leader of EuroCC Italy, for disseminating HPC technologies and offering specialized courses.

#### **Success story # Highlights:**

- **Aeronautics**
- **Digital Twin**
- **Industry Enabler**
- **Defence and Security**
- **Industrial Processes**



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## 1-2 Images:



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