Digital Transformation in Aerospace Industry

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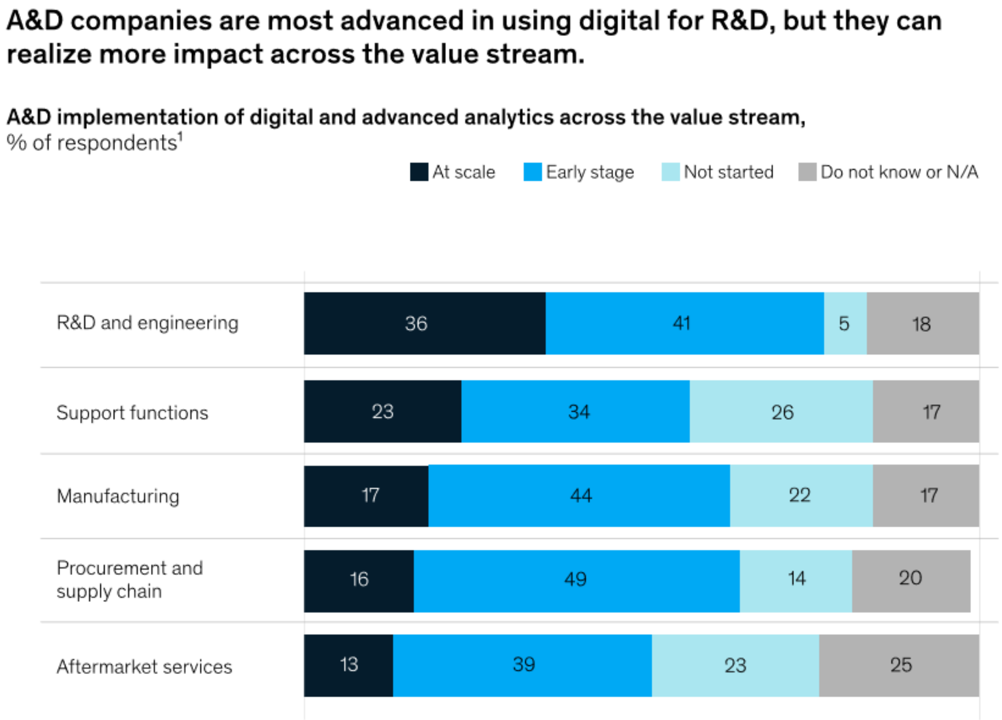
Agenda

- The Aerospace and Defence scenario
- Key digital technologies in A&D
- Application examples
- Focus on the Space Economy

The Aerospace and Defence scenario

Aeronautics and Space are highly technological and strategic domains. Together with Defence, they are critical assets in the international context and global driver of innovations and technological solutions required to bring forward the worldwide and EU twin **green digital** transition, capable of addressing today's global challenges as the achievement of the UN 2030 Agenda, as well as EU Green Deal, EU Digital Compass.



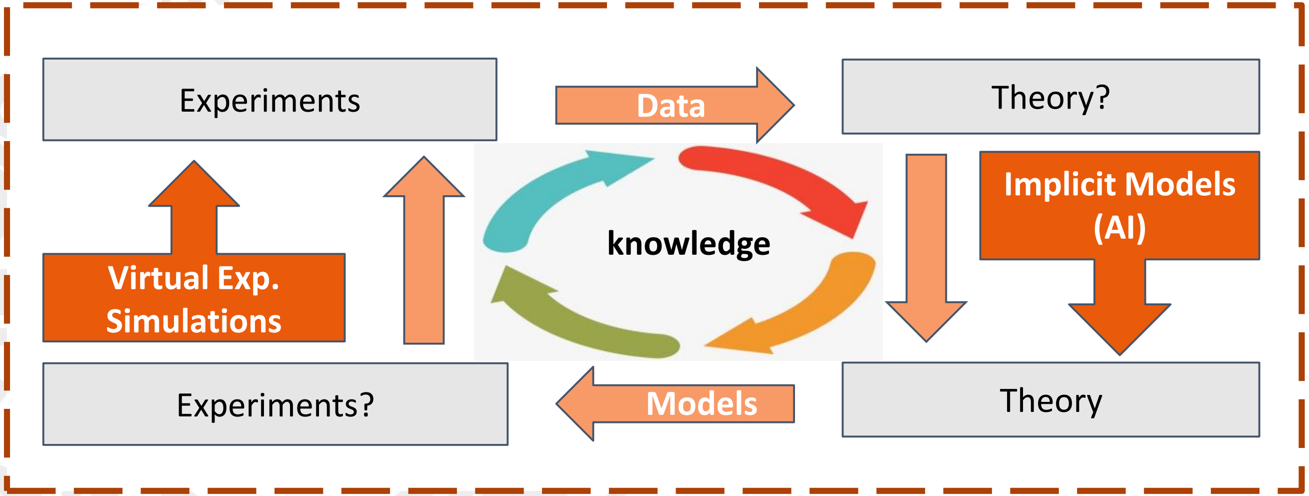
McKinsey - Digital: The next horizon for global aerospace and defense (2021)

Digital Technologies: key enablers for A&D

1. *HIGH PERFORMANCE COMPUTING*
2. *ADVANCED MANUFACTURING*
3. *AUTONOMOUS TECHNOLOGIES*
4. *AR/VR METAVERSE*
5. *CLOUD, EDGE, IOT, CONTINUUM PARADIGM*
6. *BIG DATA*
7. *5G*
8. *DIGITAL TWIN*
9. *COLLABORATIVE ROBOTS*
10. *ARTIFICIAL INTELLIGENCE*
11. *QUANTUM COMPUTING*
12. *CYBER*

How Digitalisation can help the Aerospace industry

Scientific Progress With Computers

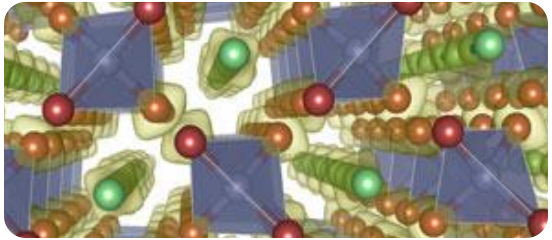


Time depends on computational resources

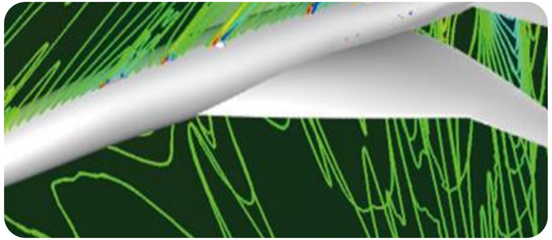
HPC & Data Processing are a knowledge accelerator: the more the better!
The progress of modern scientific research itself leads to an ever-increasing need for computational capacity as an inevitable consequence

High Performance Computing for Aerospace

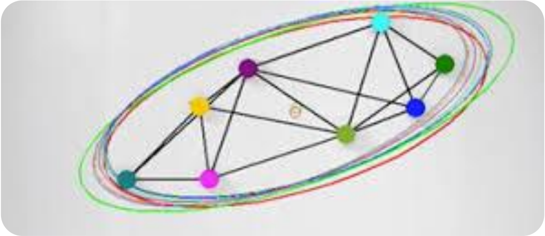
Enable and validate innovative and faster investigation strategies for the design and optimization of aircraft and spacecraft



Materials science simulations to design new materials, e.g. for more lightweight and robust aerostructures, fuel containers, heat exchangers, more efficient solar cells, etc.



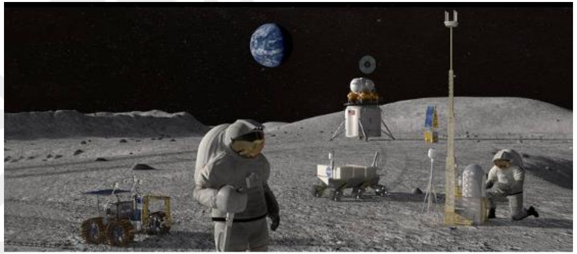
Aerodynamics and propulsion, including Computational Fluid Dynamics, wind turbine aerodynamics, parachute drag prediction, aircraft design and optimization, etc.



Flight Control systems, including networked and adaptive control, control of unmanned aerial systems & spacecraft, pilot assistance, etc.

Edge Computing for Aerospace

For some applications, High Performance Computing must be available directly on board the aircraft or spacecraft



Jun 29, 2022

High Performance Spaceflight Computing (HPSC)

NASA's High Performance Spaceflight Computing (HPSC) project is developing a flight computer to provide at least 100x current computational capacity using the same power. Main uses include extreme terrain landing, managing vehicle's health, automated guidance, navigation and control, autonomous and teleoperated robotics

Other Examples: computing system that will give Earth observation satellites the ability to process images onboard. This has the potential to increase the capacity of an Earth observation satellites by more than 20x

Artificial Intelligence

Machine learning technologies such as AI are employed to increase production efficiency, reduce costs of operations and deliver a safer and better service. In the learning phase, data are collected from both machine-to-machine and machine-to-human interfaces

SOME EXAMPLES
Optimization algorithms in structural engineering for the design of aerospace structures
Predictive maintenance systems to reduce failures and downtime
Streamlined design processes using digital tools, AI simulators, and virtual reality testing when prototyping, budgeting, and manufacturing
AI-driven performance evaluation to reduce fuel consumption and environmental impact
Improved safety and advanced threat detection through AI-enabled facial recognition in airport cameras and cabin sensors
Chatbots that resolve customer issues swiftly, contributing to satisfaction and loyalty
ML/AI algorithms for UAV operations

The problem of malicious AI

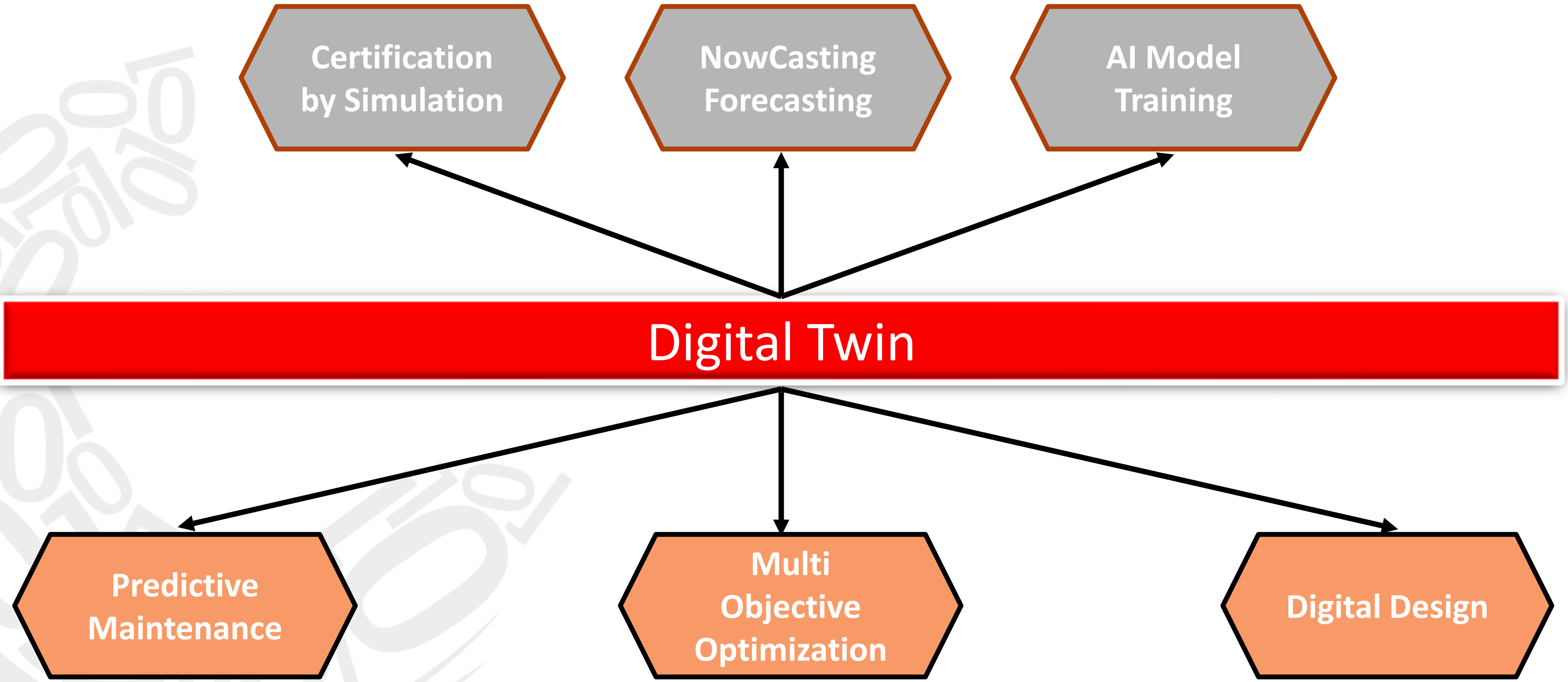
- AI algorithms applied to satellite imaging need a long and expensive training process. With synthetic data the training can be done faster and cheaper

- However, synthetic data can also generate deep fakes and misinformation

- The risk of malicious AI increases security concerns about Aerospace and Defence companies

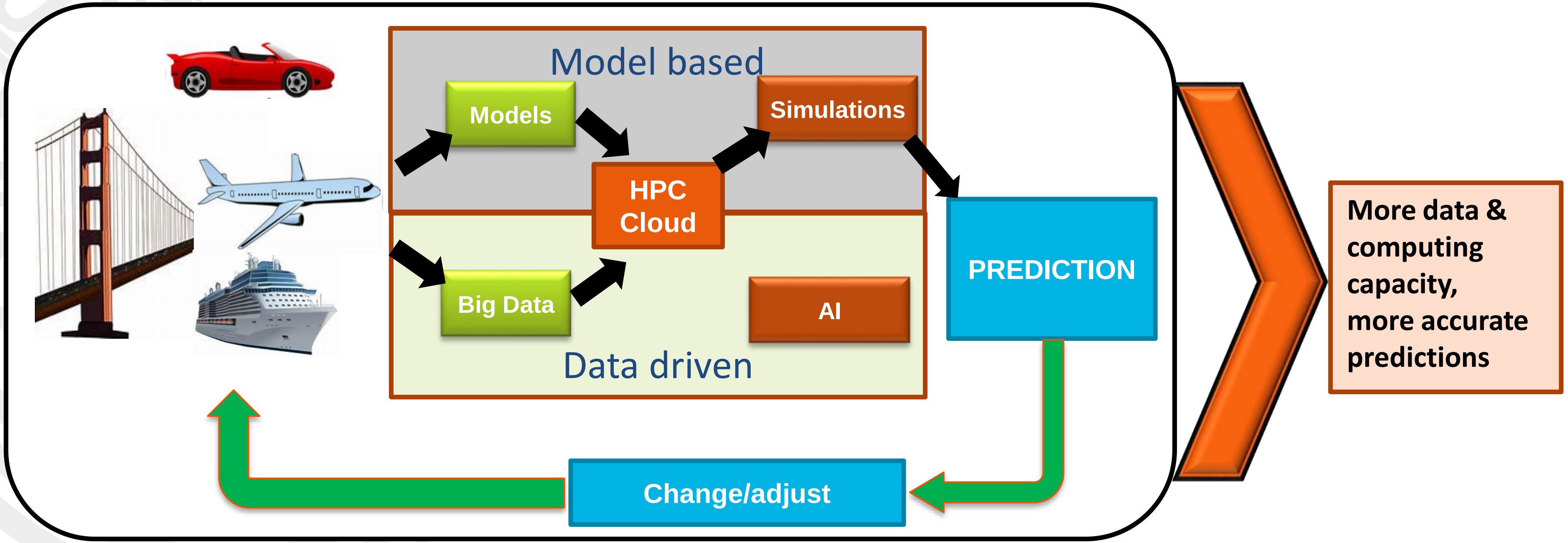
- Technologies for secure, trustable and explainable AI will be key to verify its content and identity – thus proving authenticity

Digital Twin: Applications Areas



Digital Twin, HPC, Mixed reality

Integrated Data Driven and Model Driven digital twins to be used along the whole product lifecycle to save time, money and energy in developing the models and testing them in multiple conditions to find the most appropriate solutions for different or conflicting needs



Metaverse

WHAT IT IS

A **virtual** world connecting users through their **avatars.** Closer to the real world than a game, thanks scalability allowing constant **expansion of the range of experiences and features available**

DOUBTS

"Build an airplane in the metaverse" is still **unclear**. Most manufacturers have been using the **Digital Twin** for years

PROS

The **digitalization** *reduces* design and development **costs** and introduces tools and practices such as **predictive maintenance** and **fuel cost management**

DIFFERENCES

Not just creating a virtual replica of the product, but **placing the virtual production activity in a broader geographical and interactive framework**

GOALS

Building a **single integrated digital ecosystem** in the metaverse up to prototyping, to test customer preferences

The secure Metaverse in the Defense World and its possible applications

- Host multinational or joint meetings, interact more closely with each other
- Share mission data remotely while VR helps participants visualizing the battlespace
- Soldiers training in synthetic environment
- Virtual attacks into opponent's metaverse or targeting their digital infrastructure

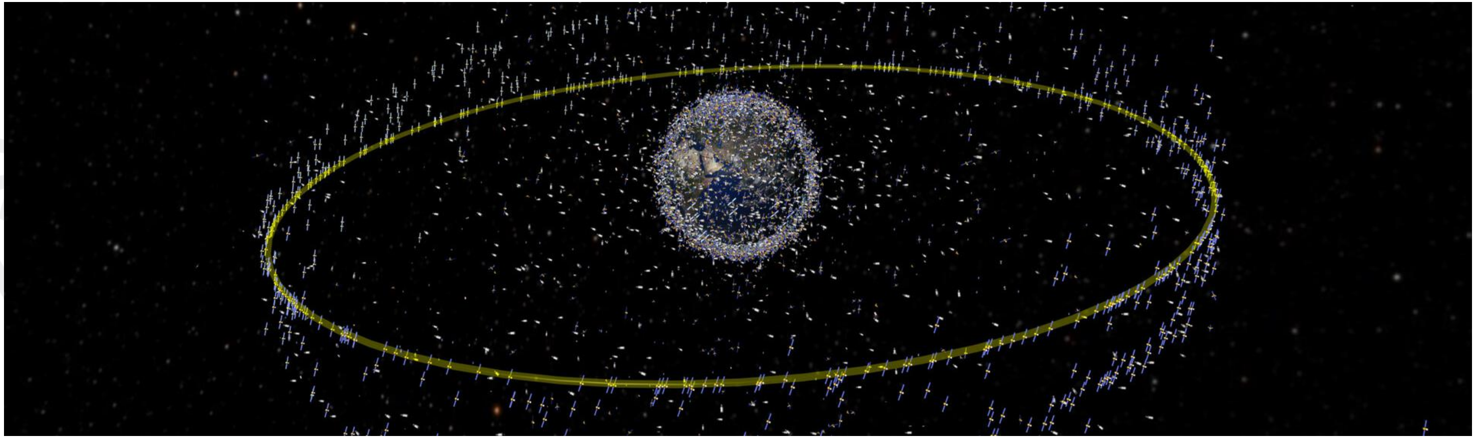
Destination Earth

- An initiative by EC, ESA, ECMWF and Eumetsat to **create a digital model of Earth** to monitor the effects of natural and human activity on our planet, anticipate extreme events and adapt policies to climate-related challenges
- To enable the continuous and accurate **monitoring** of the health of the planet by focusing on the effects of climate change, for example on the oceans, water, Earth's ice caps, land use etc.
- To allow better understanding of the **socio-economic effects** of climate change and the occurrence of extreme natural disasters.

Cobots for industrial manufacturing

- Unlike industrial robots, which work in isolation and can be dangerous, collaborative robots are designed to **safely operate in the same workspace of humans**
- Useful as part of processes **that cannot be completely automated.**
- In aerospace manufacturing they can be employed in tasks requiring coordinated work of two or more operators
- Widely adaptable and **reconfigurable** on different jobs, e.g. manipulation, inspection or to operate task-specific tools.

Space Situational Awareness



- **Earth orbits are crowded**! NASA estimates around 23.000 large objects of “junk” in LEO, with another 7.000 untracked objects of significant size and over 900.000 objects from 1 to 10 cm. All potentially with very high relative speeds
- SSA is the **current and predictive knowledge** of the space environment. It is fundamental for conducting safe operations in space
- SSA has a dual civil-military aspect, as it looks for both **unintentional** (e.g. solar storms or debris) and **intentional** (e.g. kinetic, electronic warfare and cyber-attacks) threats to space systems

Digital certification

- For a typical commercial aircraft, the cost of certification (proof of compliance with safety standards) can be **over € 100 million** and several years to be completed.
- This makes for a strong industry demand for a virtual certification process, employing accurate **simulations run on digital twin models** of the aircraft.
- Simulation does not only help to prove use cases at a fraction of the cost of traditional testing: it can be used in **situations that are practically impossible to test physically**.

Space Democratization and Space Economy

- This fast transformation of the space industry is largely driven by **new services** and **applications** made possible through innovations in launch and satellite manufacturing technology

- “NewSpace” industry is based onto **rapid inventions and developments, lower costs, commercially available parts** and incremental development

- The **sharing economy** in space, a double-digit B$ industry, is one of the key running transformations. It relates to the shift from large players, governments and big corporations, who operate satellites, distribute data and supply services, towards opening of the market to **startups** that not only deploy new technologies to support traditional applications, but also develop new applications

COMAC

SPACEX

BLUE ORIGIN

Google

Technological enablers

The main reasons for this explosion can be summarized by the progress in the following main technologies:

- Constellations/Mega Constellations
- Nanosatellites
- Additive Manufacturing
- Cloud-based data processing
- Big data for processing / advanced analytics functions to support information driven products
- AI & deep learning for predictive and prescriptive request patterns
- Robotics

Demand for high qualified competencies

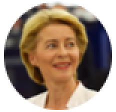
- Finding and retaining **STEM Top Talents**, is one of the challenges. Aerospace industry needs to find and engage with the right potential applicants and improve employee experience through the use of new technologies and marketing strategies.

- **Training, upskilling** and **reskilling** is an essential key element for the digital transformation of the whole industrial ecosystem. which EU actions are focusing on

European Commission

Pact for Skills

How Europe Can help Aerospace Industry?



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"We are connecting our satellites, drones, high performance computing. For real-time knowledge and long-term predictions on the impact of climate change."
[https://twitter.com/vonderleyen/status/1492086222436589571]

EuroHPC Joint Undertaking

CLEAN AVIATION

sesar JOINT UNDERTAKING

PNRR
19/07/22
Centro Nazionale di Ricerca in High Performance Computing, Big Data e Quantum Computing

LEONARDO SUPERCOMPUTER PRE-EXASCALE