SHIFTING FOCUS IN MODEL-BASED METHODS FOR MULTIDISCIPLINARY SPACE SYSTEMS DESIGN

From Tool-Centric to Data-Centric Approaches

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DLR

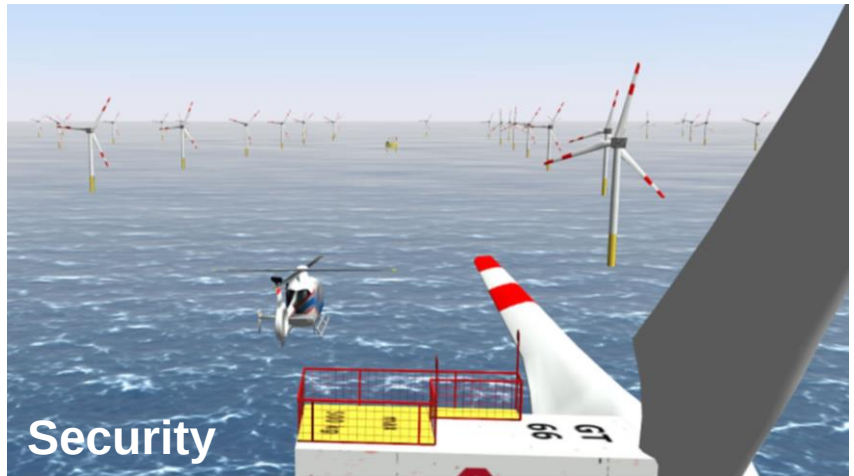
Areas

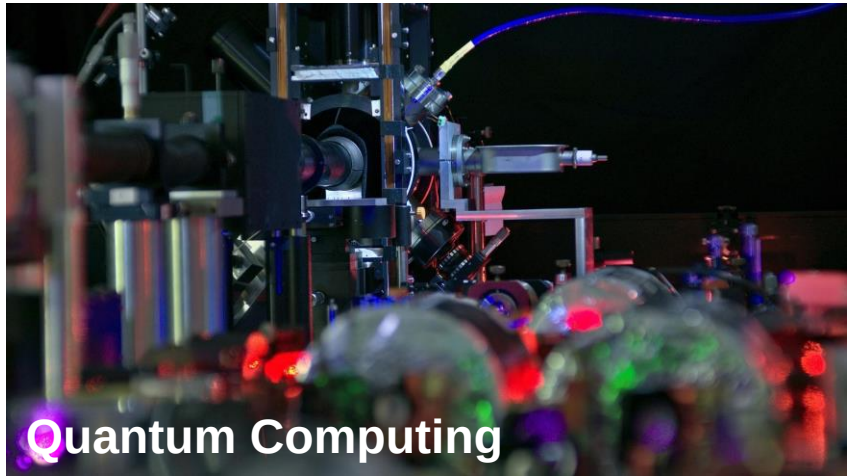

Space


Aeronautics


Energy


Transportation


Security


Quantum Computing

DLR in Numbers

10,000 Employees

55 Institutes and Facilities

35 Locations and Offices

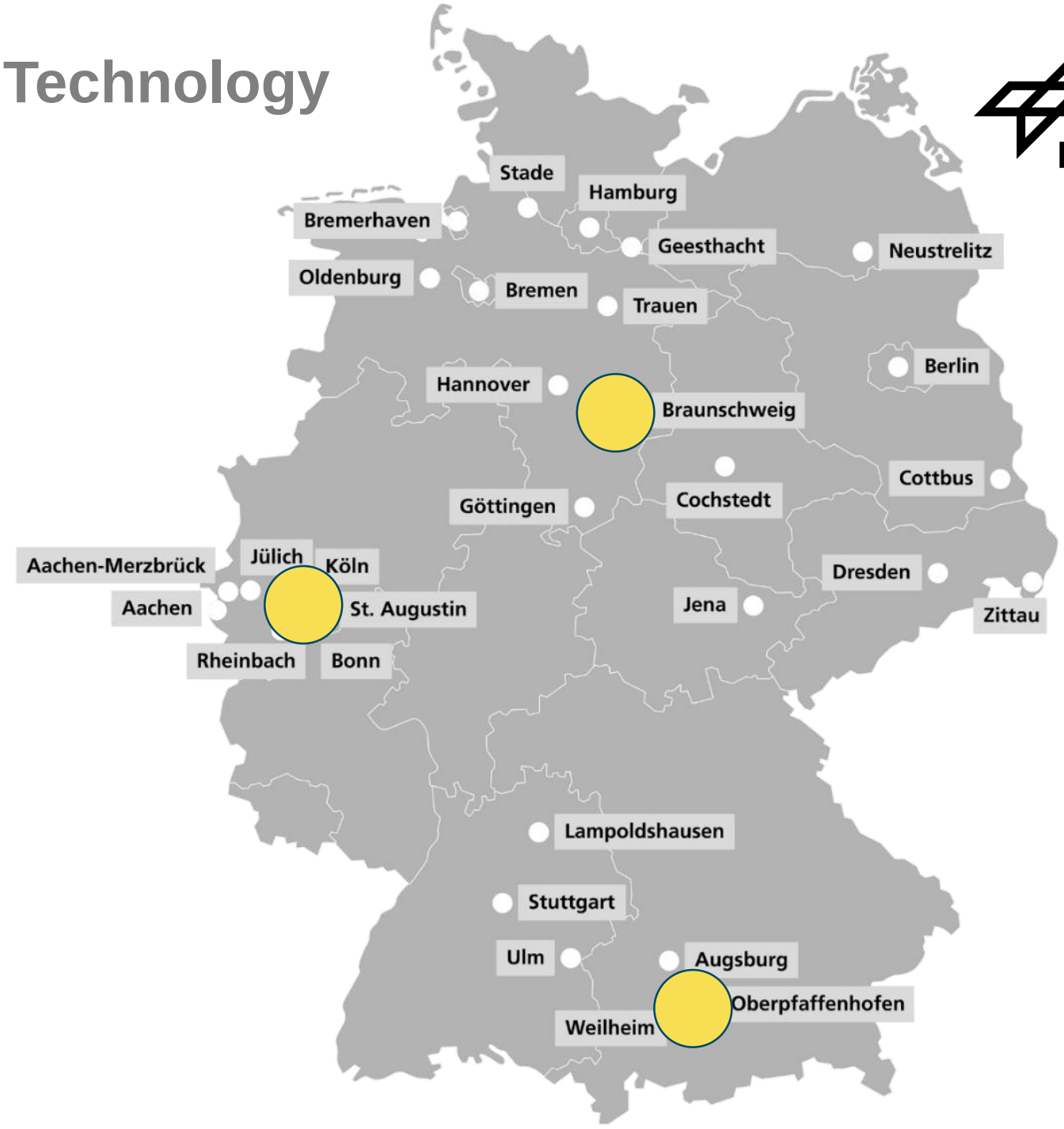
DLR Institute of Software Technology

200 Employees

4 Departments

3 Main Locations

https://www.dlr.de/sc/



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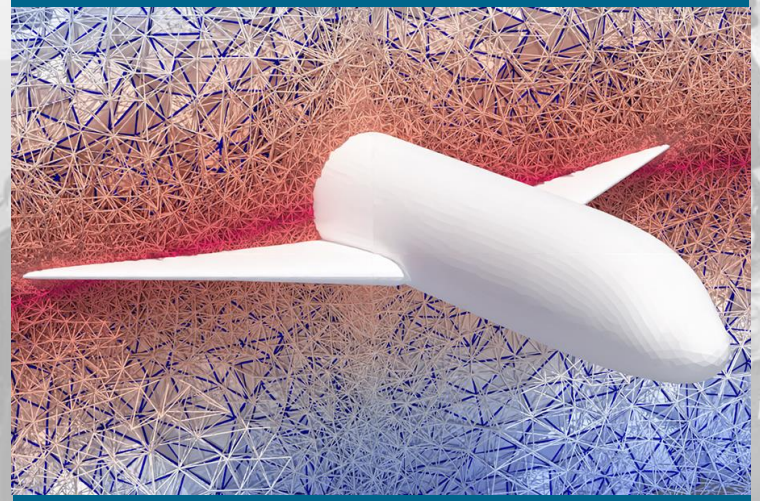
Software for Aeronautics and Space



Software and Systems Engineering

Visualisation in VR and AR

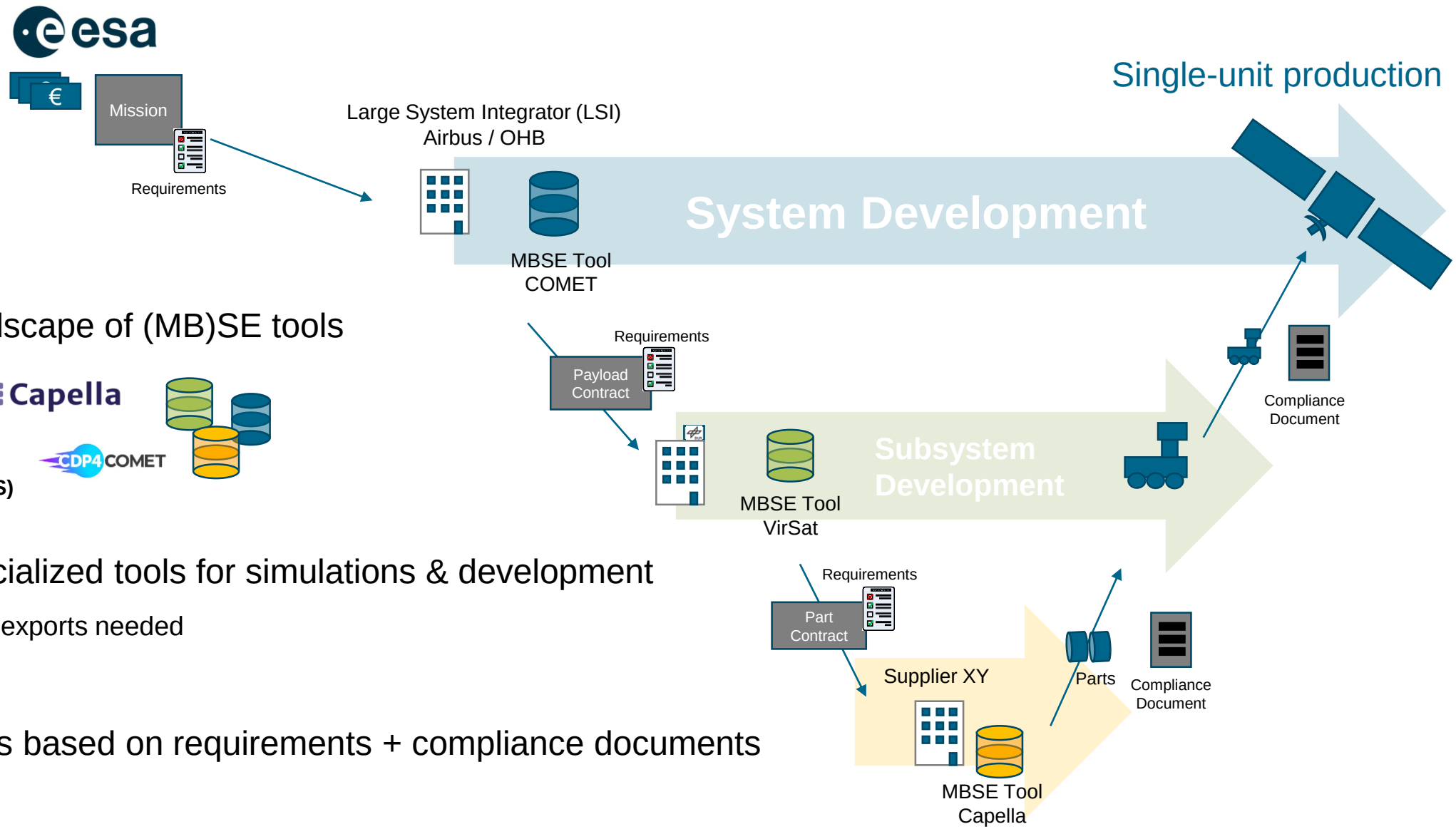
Artificial Intelligence

Quantum Software and Algorithms

High-Performance Computing

- Research on dependable software systems and algorithms with a focus on aeronautics, space, energy, transport and security
- Designing and transferring efficient development processes and sustainable digital solutions through the use of state-of-the-art software technologies

The Engineering Landscape of Space Missions



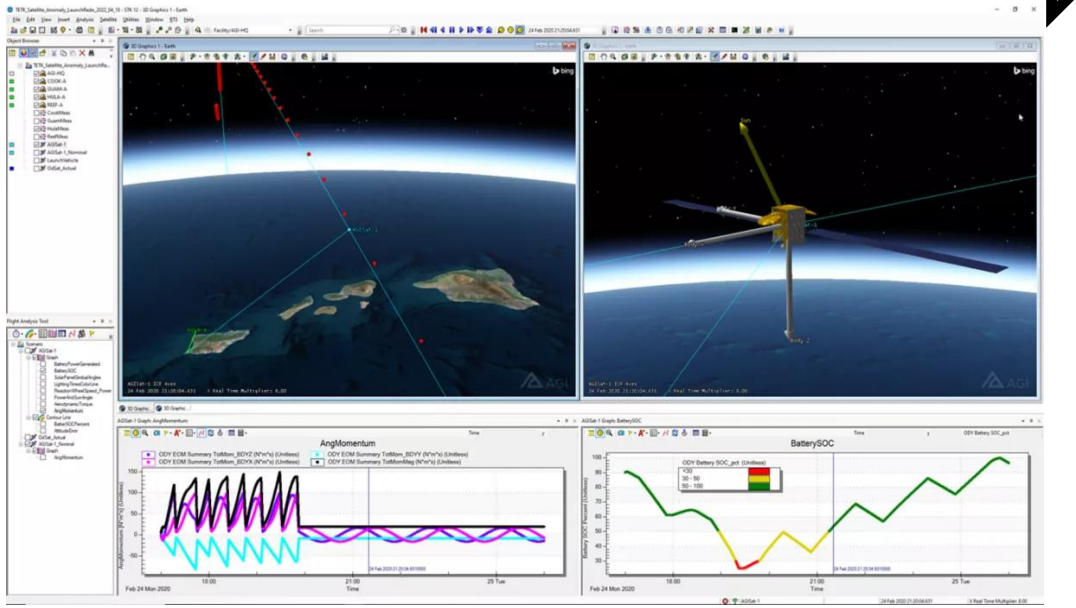
- Diverse landscape of (MB)SE tools

CAMEO SYSTEMS MODELER™ Capella CDP4COMET **RangDB (AribusDS)**

- Heavily specialized tools for simulations & development
  - Imports + exports needed
- Subcontracts based on requirements + compliance documents

Tool-Centric Model-Based Design: Benefits and Challenges

- Highly specialized tools in engineering landscape
  - domain expertise, precision, and efficiency



Source: https://images.ansys.com/is/image/ansys/agi-tetk-satellite-overview.png?wid=1200

But:

- Siloed data due to tool-specific formats
- Time-consuming integration between different disciplines (import / export functionality)
- Difficulty in scaling to more complex missions involving multi-organization collaboration
- Challenges coming from global context:
  - System complexity explodes
  - Systems are interconnected

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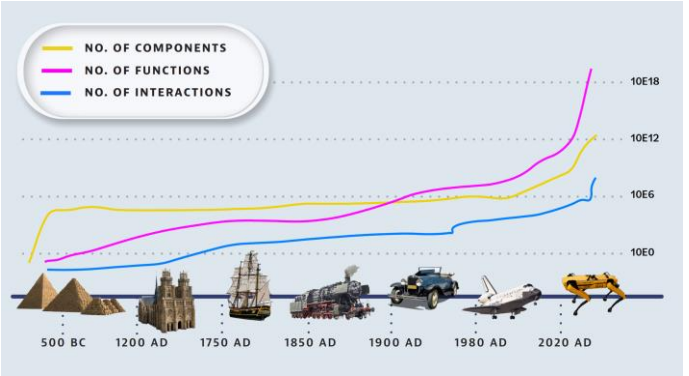
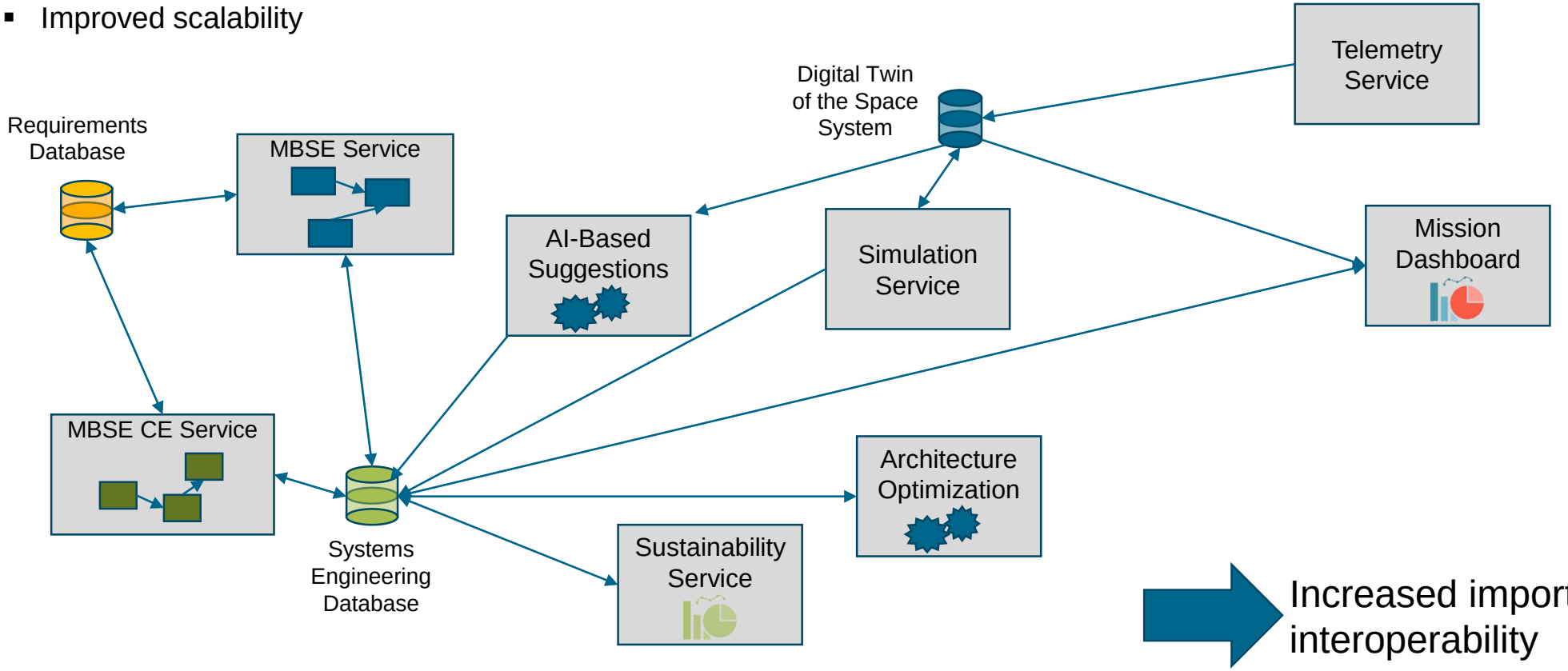


Data & Services as the Foundation of Next-Generation Space Systems Design

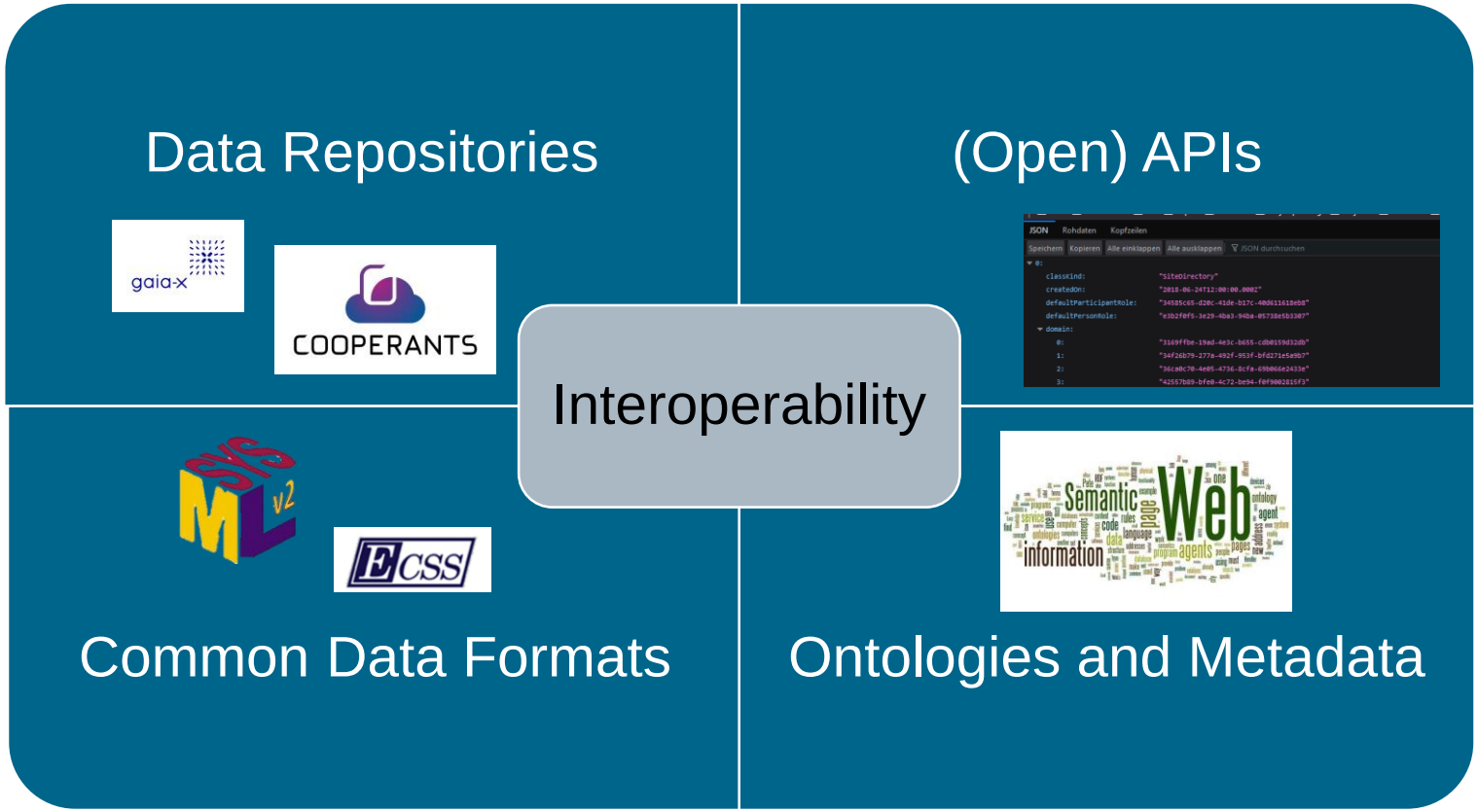
- Global trend of digital transformation highlights importance of data
  - Data enable emerging technologies like AI, machine learning, and digital twins
  - Services can be independent from data management
  - Improved scalability



Enabling Data Interoperability

Data interoperability: the ability of different systems and tools to share, understand, and use data seamlessly.

- *„Room“ for collaboration*
- Providers for data spaces and services
- IPR and data regulation regimes



- *„Speaking“ with each other*
- Foundation for accessing and sharing data via world wide web / network

- *„Speaking“ the same language*
- Data exchange between tools and services

- *„Understanding”*
- Data transformations
- Machine-readability

The Promise of SysMLv2

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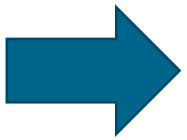
- One general purpose language that can be customized to most applications
- Specification of API
- In theory: all problems we have are solved by always using SysML!

However:

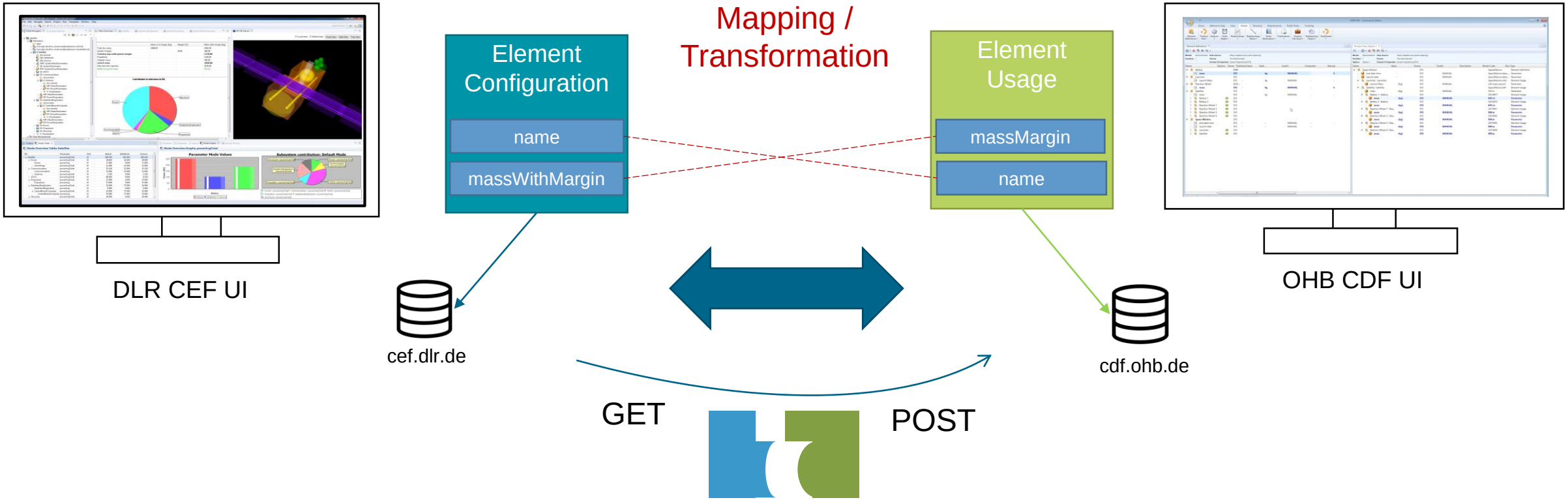
- Tools might only implement a subset of SysMLv2
- Integration of non systems engineering related data
- One standard for everything is not realistic
  - SysMLv2
  - ORM (ESA)
  - OpenCAESAR (NASA)



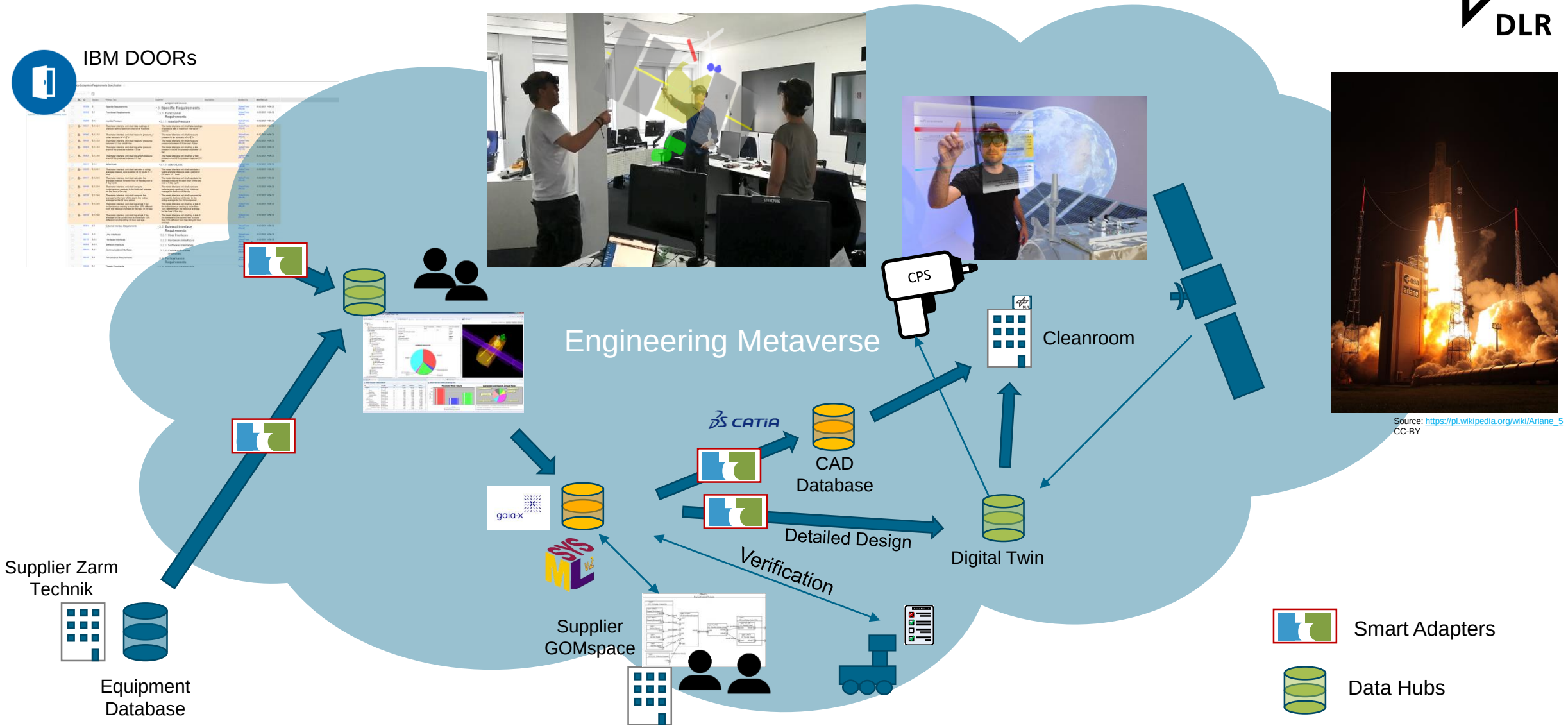
We need smart adapters!

API-Adapters for Similar Data of Different Types

- Data models of e.g. early phase / concurrent design facilities are similar but of different types in different backends
- To exchange data, adapters will need to get, transform and push data to the target



Case Study: A Data-Centric Approach to a Space Mission



Source: https://pl.wikipedia.org/wiki/Ariane_5
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Tools in the New Paradigm: Enablers of Data Exchange

- Tools are no longer isolated silos but **enablers of data exchange**

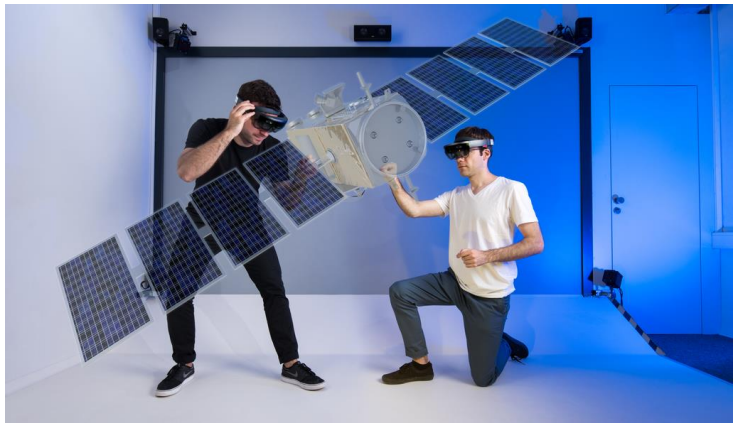
Benefits:

- **AI and Machine Learning**: Integration of smart services such as for e.g. design suggestions, automated verification…
- **Digital Twins**: Collect and abstract data in digital twins of space systems for e.g. simulation and testing in virtual environments
- **Cloud-Based Design**: Leveraging cloud infrastructure for real-time collaboration and data-sharing across global teams

From Tools to Data: Are You Ready for the Shift?

Tools are temporary, data are long-lasting assets!

- Still building MBSE desktop tools?
- The challenge of tomorrow:
  - Integrate (& share) as much data as possible!
- Solutions?
  - Open APIs
  - Standards: SysMLv2, …
  - Smart semantic adapter functionalities



Do you have further solutions to achieve interoperability in mind? Let us know!

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