Benefiting of Digitalization for Spacecraft Engineering

SESP2017

DEFENCE AND SPACE

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What is Digitalization?

Digitization = converting analogic information into computer bits (photos, PDF documents, …)

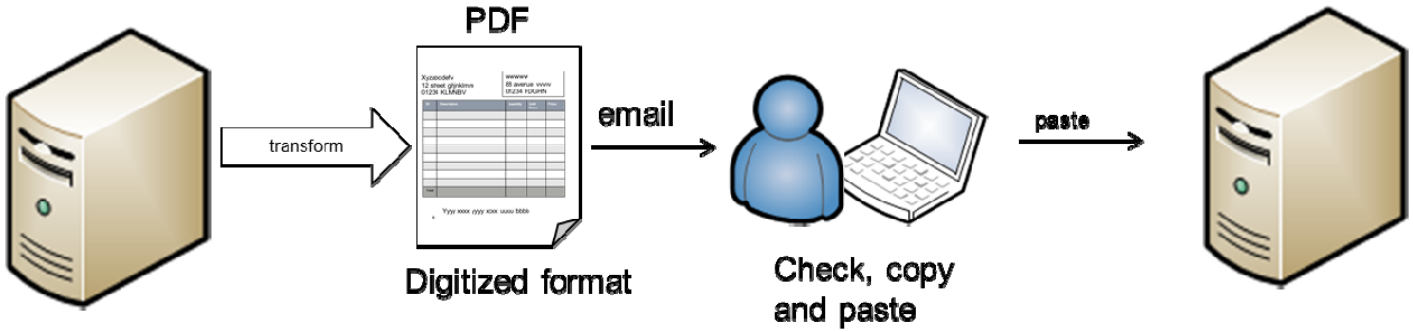
Digitalization = automatic data exchange (at digit level) without human interaction thanks to shared data structures definition

Typical example : remove various copy/paste actions from documents to tools and/or vice versa

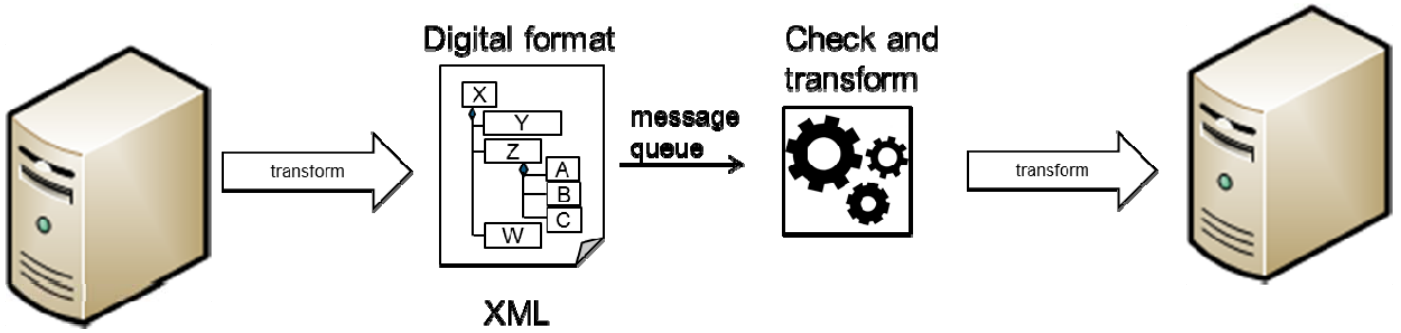
The famous Industry 4.0, considered as the fourth industrial revolution, is based on digitalization

Invoice example (simplified)

Today



Tomorrow



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Digitalization at AIRBUS Defence and Space

Extends previous multidisciplinary approach (e.g. as covered by Virtual Spacecraft Design) to the system complete life cycle

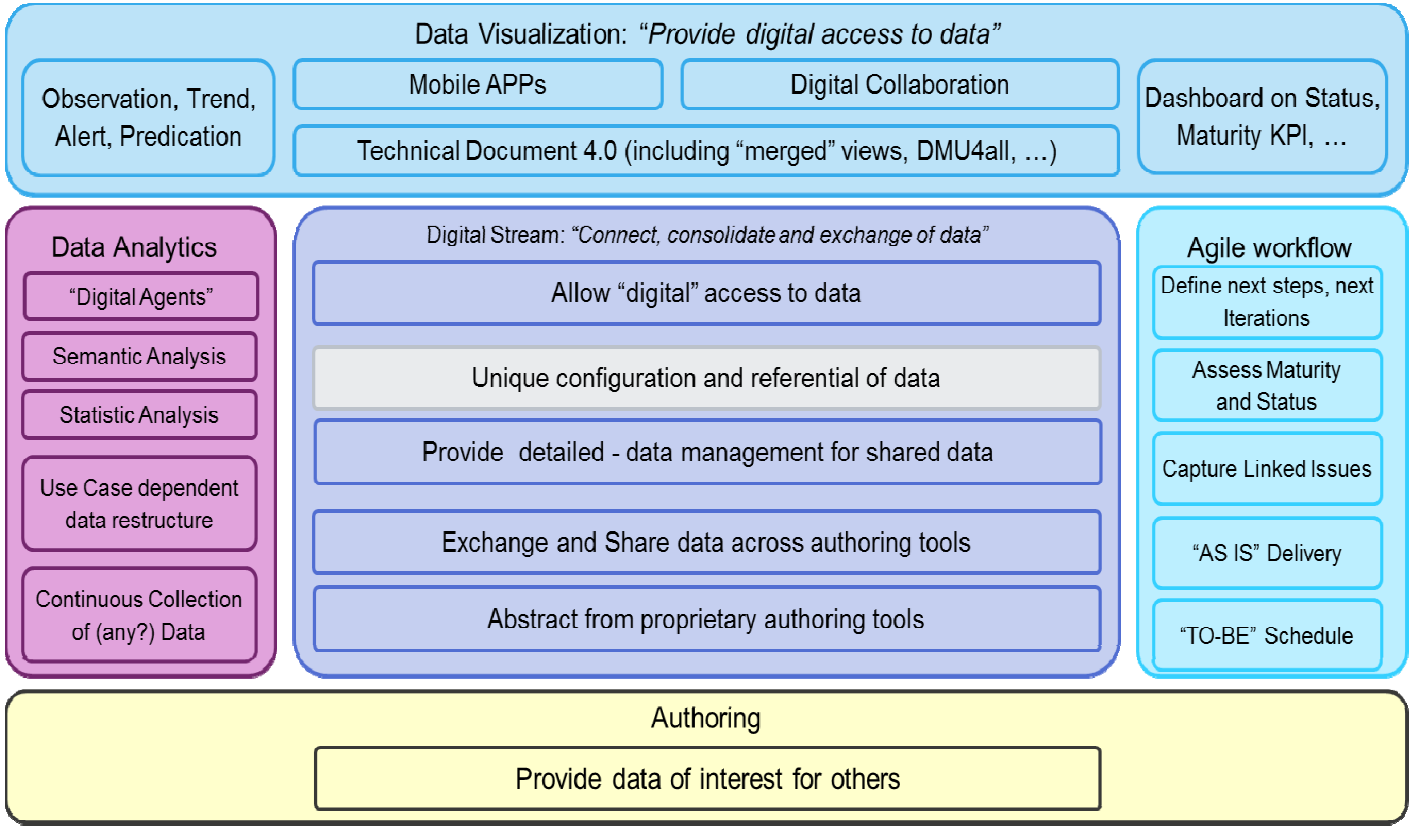
- From proposal phase
- To operational phase
- Including functional design, detailed design in various functional domains, mechanical design, manufacturing, validation, …

Supports the selection of the right product and configuration, with an effective “flow” of data from the product repository, to the individual design tools

Enables:

- processes improvement, lean and agile methodology
- cross disciplines optimization technics

Holistic End 2 End Product Lifecycle Management Vision



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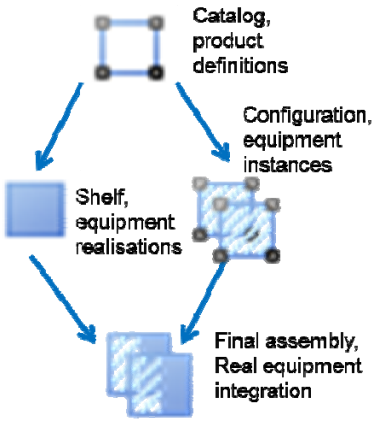
Approach taken for Space

3 key building blocks:

- Spacecraft Product Lifecycle Management (PLM) program, named **CONNECT**, dealing with mechanical design, configuration control, procurement and manufacturing. It relies on COST product such as:
  - Dassault 3D experience (Mechanical design suite)
  - PTC Windchill (Product Data Management)
  - SAP (ERP)
  - Solumina (Manufacturing engineering)

- System Engineering Database (SEDB), **RangeDB**, using a data model initially draft in ECSS-E-TM-10-23, was previously designed to cover the System Reference Database use case, it covers the complete functional engineering and verification

- Satellite Sizing Tool, **SST**, for Telecom spacecraft design, from bid phase (costing, pre sizing, …) to design including detailed aspects such as preliminary accommodation, harness routing optimization, …



RangeDB

Following a preliminary analysis program, named E2EPLM, the operational program, called Factory 4.0, has started in 2017 and will run until 2019 to deliver a complete digitalization solution for spacecraft engineering, manufacturing and operations.

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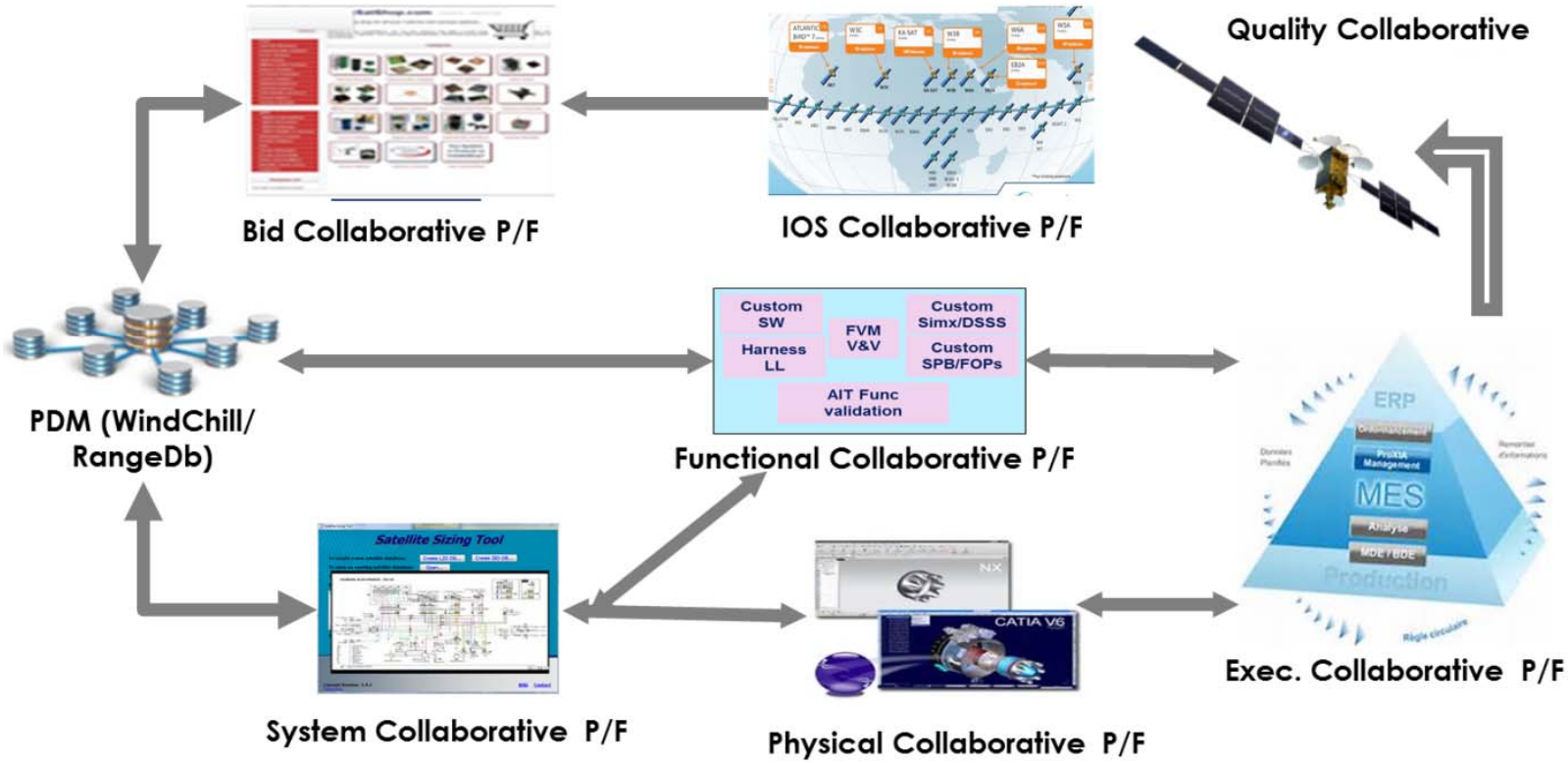
Factory 4.0 scope



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Design rules

Single source for data, stored and configured in a single place, shared by everyone

Two categories of data

- Engineering data with configuration control needs to enable data exchange between engineers
- Archiving of analysis results, tests and operations data, store everything automatically and then provide retrieval mechanisms

For engineering data, use of SEDB with accurate modelling of the data is required to enable data sharing between engineering activities. Two approaches are proposed:

- A Conceptual Data Model (CDM) covering all domains needs, not only TM/TC data but also:
  - equipment connectors detailed descriptions (EICD)
  - mechanical bounding box and connector locations
  - and many others
- A user defined Data Model based on ETM10-23 Categories and Value Properties
  - Flexible enough to define equipment properties that are domain specific (no or few relationship with others)

For analysis results, tests and operations data, use of big data system well connected with the SEDB, to retrieve all data stored automatically at execution time together with its definition at engineering level.

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SOME DATA CONTINUITY EXAMPLES

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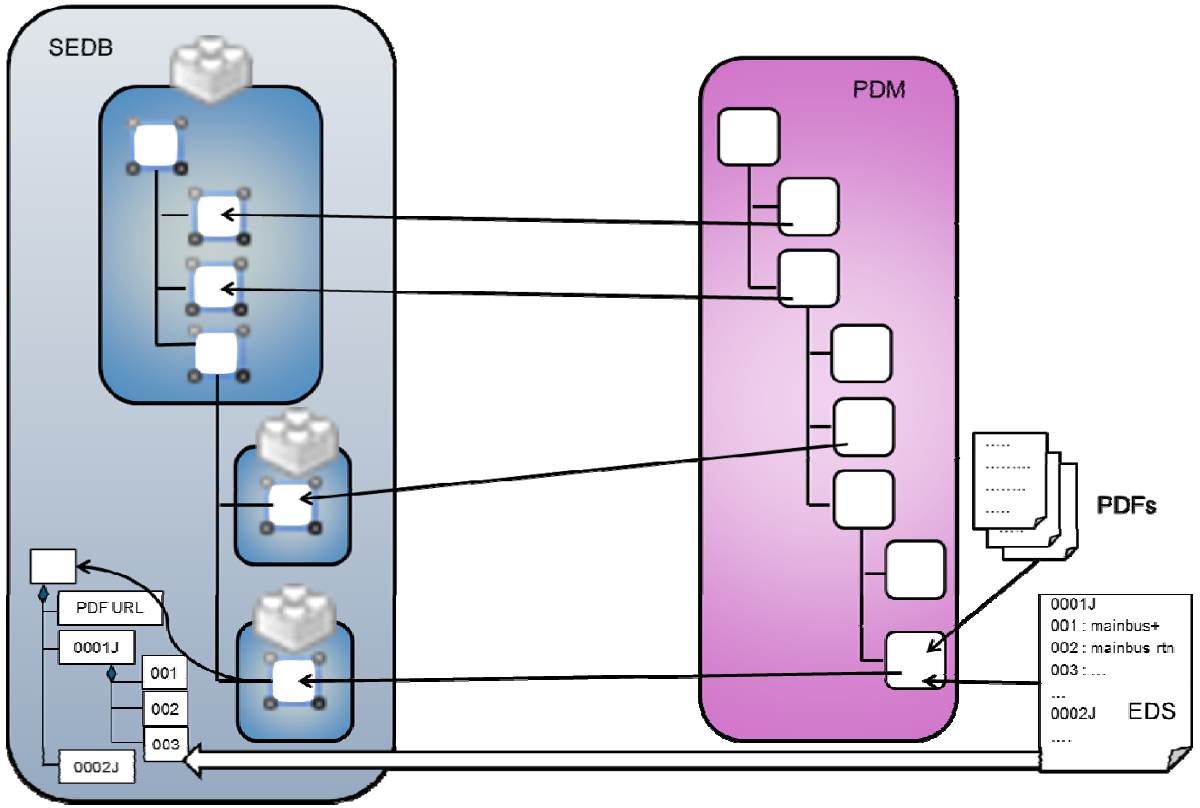
Product Data Management and System Engineering DataBase

Use of SEDB, a data centric data management approach together with classical Product Data Management (Windchill)

Both product trees are automatically synchronized:

- Equipment suppliers documents are made accessible from the SEDB (URL access)
- Equipment Electronic Data Sheet (EDS) are automatically imported into SEDB to provide fine grain access to the data in a shared manner, as the unique source of such information for engineering activities. For instance Electrical ICD provides:
  - Functional interfaces
  - Connectors and contacts definitions



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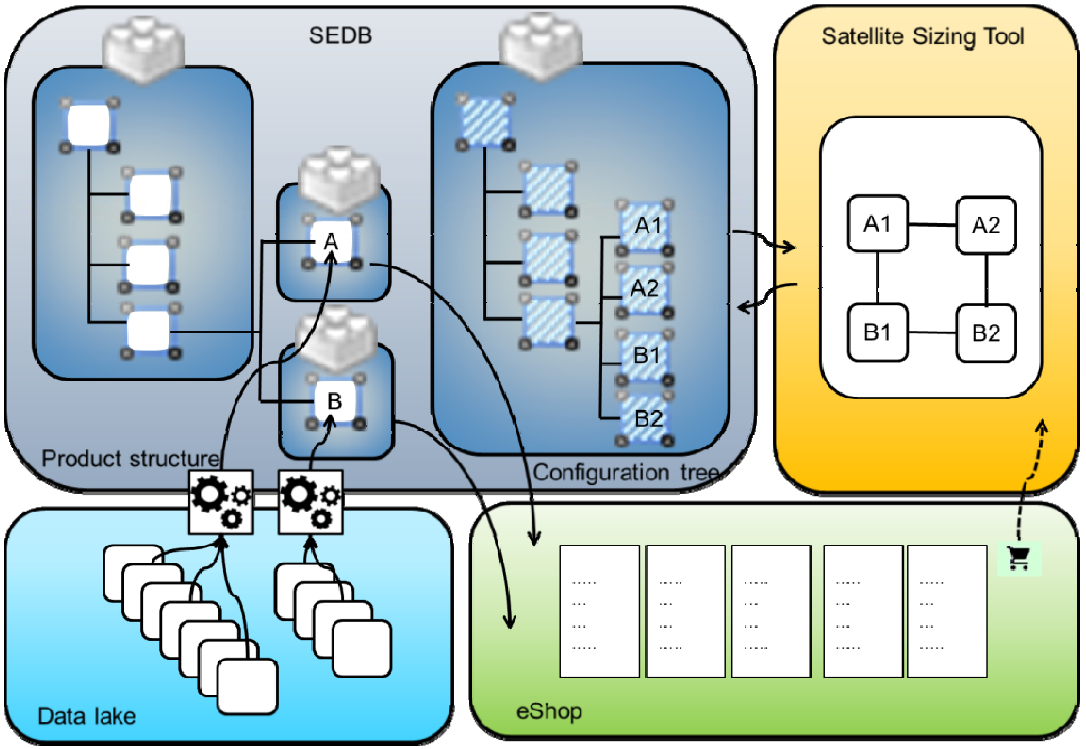
Proposal phase to design phase

eMarket approach to select equipment in product tree catalog (eShop)
Comparison of equipment according to target system
Selected basket is sent to SST design tool for costing and pre sizing activities.
In both cases all the data are coming from the SEDB
For some data like performance data, measurement coming either from testing phases or on orbit is used to define a more accurate definition of these values:

- A data lake, a big data infrastructure is used to feed back the SEDB



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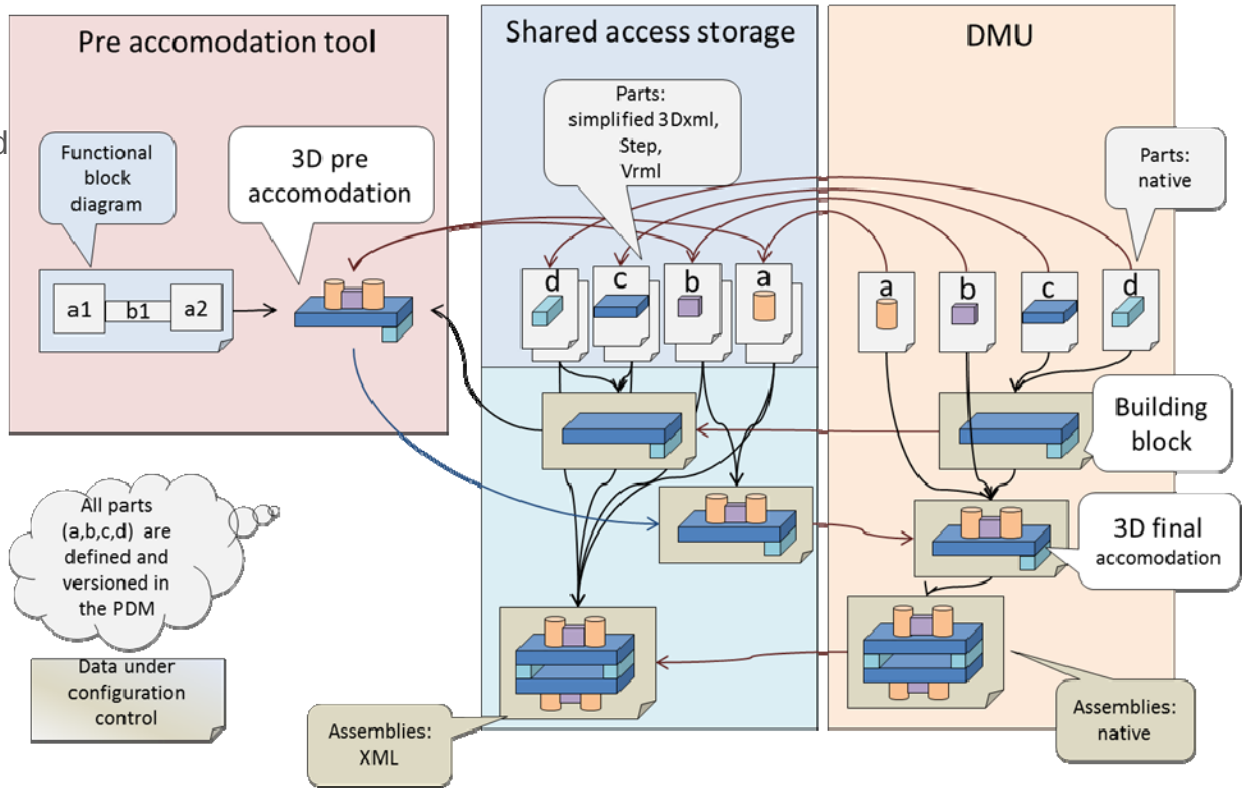
Design phase to accommodation

Satellite Sizing Tool provides the functional design based on equipment definitions from SEDB
SEDB thanks to connections with PDM (Windchill) and DMU (Dassault 3D Experience) provides access to:

- Simplified geometry files, generated from the DMU with different quality levels:
  - Bounding boxes in XML format
  - Open 3D standards
- Mechanical assemblies
  - XML file with equipment physical locations
  - Bi-directional exchange pre accommodation and final accommodations



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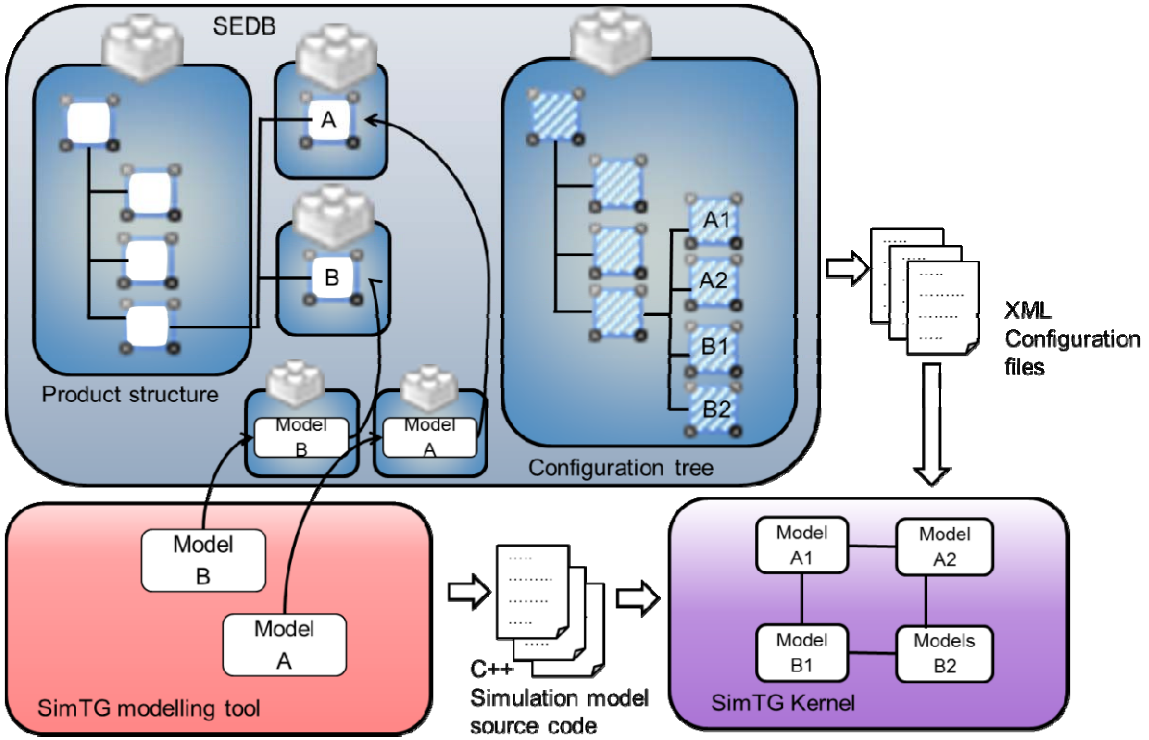
Design to verification: simulation

SimConf provides automatic generation of the simulator configuration:

- SimTG (Airbus simulation framework) simulation models are imported (using the same CDM) in SEDB for what concerns their structure:
  - system interfaces (see SMP2 presentations)
  - configuration parameters
- System interfaces are mapped with equipment functional interfaces
- Configuration parameters are mapped with equipment properties
- According to Configuration tree, XML files are generated to feed the simulation kernel



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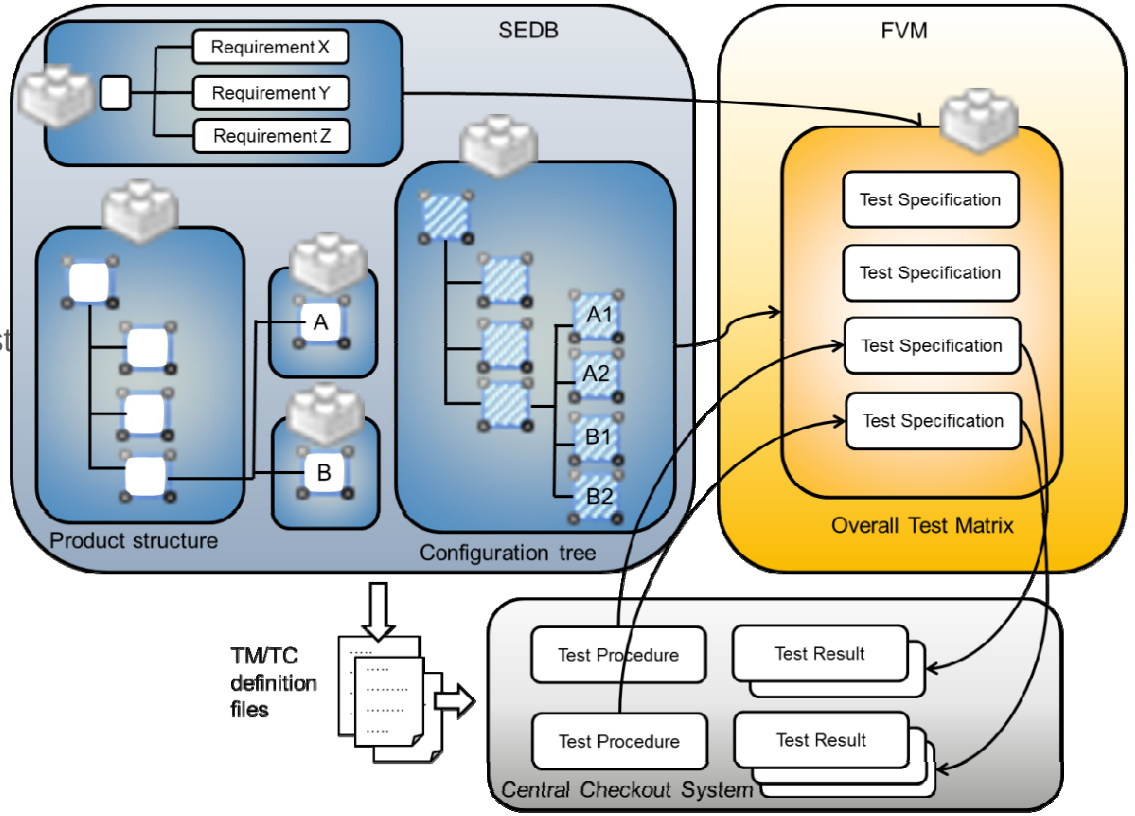
Design to verification: verification management

Functional Verification Manager (FVM), based on RangeDB framework, extends CDM to define tests specification including:

- Test requirements and traceability towards system requirements
- Equipment under test (as defined in the SEDB)
- Configuration of the system used to perform the test
- Test phases and resources
- Links towards the actual test procedure on the checkout system
- Links towards test results for test execution assessments (sign off process)
- Overall test matrix for both preparation and execution



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Conclusion

A major change in our industry

A top level improvement program for our company:

- Covering all technical domains and all phases (from bid phase to on orbit)
- Dedicated and significant resources involvement
- Big expectations in terms of costs and planning reduction

Main challenge is not only technical but rather to ensure the buy-in of all stakeholders!

Thank you