GLOBAL PRODUCT DATA INTEROPERABILITY SUMMIT 2024

Data Integrity as a Key Digital Thread Enabler

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Presenters’ Bios

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Systems Engineer
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Systems Engineer and Supply Chain Digital Engineering Product Owner. As a Systems Engineer, he works closely with BR&T’s Integrated Technology Teams to develop structured technical requirements for projects ranging from fundamental university research (low TRL) to prototype aircraft (high TRL). As a Product Owner, he leads research activities guiding the development of capabilities to enable digital engineering and collaboration with suppliers and other external stakeholders. Brendan holds a Bachelor of Science degree in Mechanical Engineering from Bradley University and a Master of Science degree in Aerospace Engineering from Washington University in St. Louis. Prior to working at Boeing, he worked as a Systems Engineer in the natural gas power industry managing the design and execution of capital improvement projects.

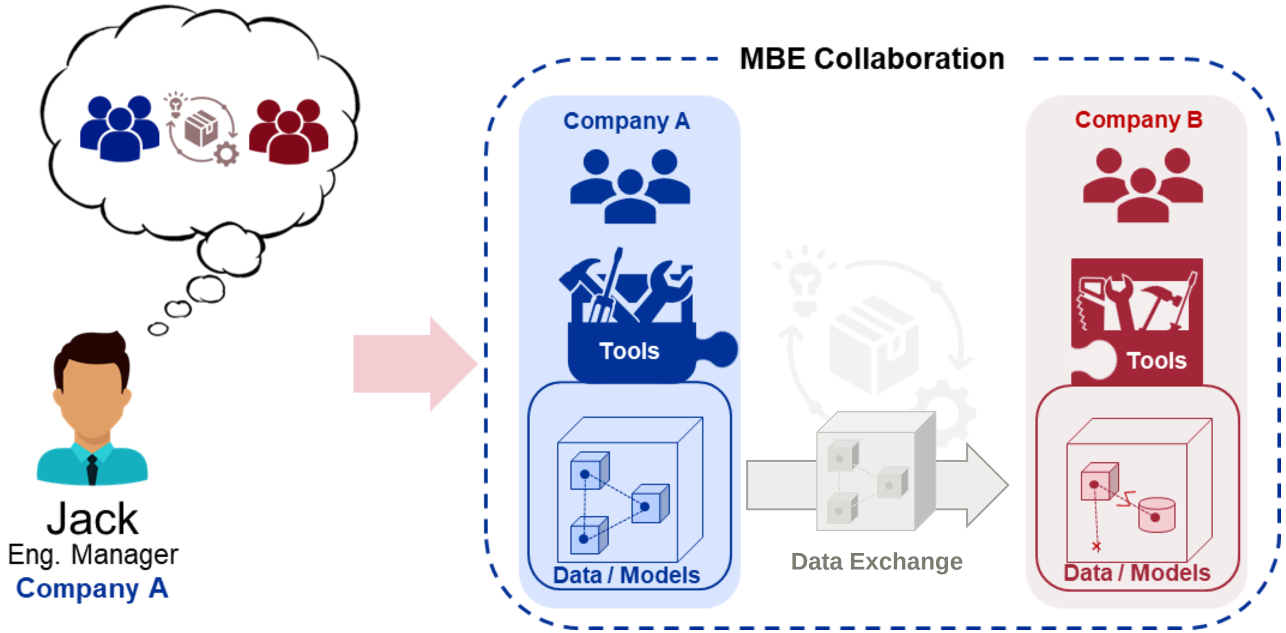
Antonio García-Salcedo
Systems Engineer
Capgemini Engineering

MBSE Systems Engineer and Team Lead. He works integrated within the BR&T team architecting the Digital Thread and developing solutions to assess and improve digital capabilities for Supply Chain collaboration in MBE. As a Team Lead, he coordinates the efforts between the involved parties. Antonio holds a Bachelor of Science degree in Aerospace Engineering from University of Seville, a Master of Science (MSc) degree in Space Engineering from Polytechnic University of Milan in Italy and a MSc in Aeronautical Engineering from University of Seville in Spain. Prior to working at Capgemini, he worked as an Orbital Dynamics Engineer for a startup in the new space industry and participated as a systems engineer and project manager in the UNOOSA’s DropTES research program involving the DLR (German Aerospace Center) and Polytechnic University of Milan.

Outline

- **Introduction**
  - Scenario – Interoperability challenges during model-based collaborations
- **Data Integrity Challenges**
  - Overview of digital thread challenges
  - Complexities of data exchange with external stakeholders
  - Data integrity as a strategy to address these challenges
- **Preserving Data Integrity**
  - Interoperability vs. data integrity
  - Gaps in tools, standards, collaboration methods, and quality processes
  - Methods for preserving data integrity
  - Data integrity requirements and compliant exchanges
- **Data Integrity Guidelines**
  - Proposal for addressing data integrity during model-based collaborations
  - Takeaways and next steps
- **Q&A**

Interoperability Deficits Exist within Model-Based Collaborations



Jack is an Engineering manager who wants to collaborate using models in a Digital Environment with another company:

- He is experienced in product lifecycle development and has heard about **interoperability limitations** of tools when several teams perform concurrent work
- He is concerned about the efficiency of the collaboration and the **risk** of **losing data** while maintaining the **Digital Thread** when **exchanging digital models** with external stakeholders
- He knows some **standards** but may not be not be fully aware about how they are implemented or if they are current

How should Jack proceed knowing these risks exist?

Data Integrity as a Key Enabler for the Digital Thread

But first…

What does a digital thread do?

- Establishes <u>traceability</u> of product information (~75%)
- Facilitates the handoff of data from stakeholder to stakeholder downstream (~45%)
- [Extends data to] customers and supply chain (~38%)

What is a digital thread?

- <u>Linkage and traceability</u> between data elements at the meta data level (~68%)
- <u>Interoperability</u> between data elements for interpretation of one by the other (~45%)
- Combination of model and technology to facilitate the data model (45%)

From: 2023 – A&D PLM Action Group Digital Thread Collaborative Research Report. Release 1.0

Preserving <u>Data Integrity</u> can help enable these features

Lack of Compatibility within a Digital Collaboration Environment

What inhibits digital threads:

Principal inhibitors to formulating and executing a digital strategy withing respondents' companies:

- Lack of interoperability between different vendors' tools and systems
- Lack of knowledge or confidence in technology
- Lack of information traceability between different vendors' tools and systems

Notable examples of gaps in capabilities offered by respondent's chosen PLM solution providers:

- Incompatibility between tools & systems from different vendors
- Securing and controlling access of data originating from multiple application is challenging

From: 2023 – A&D PLM Action Group Digital Thread Collaborative Research Report. Release 1.0

***Data standards** can address these gaps/inhibitors, but….*

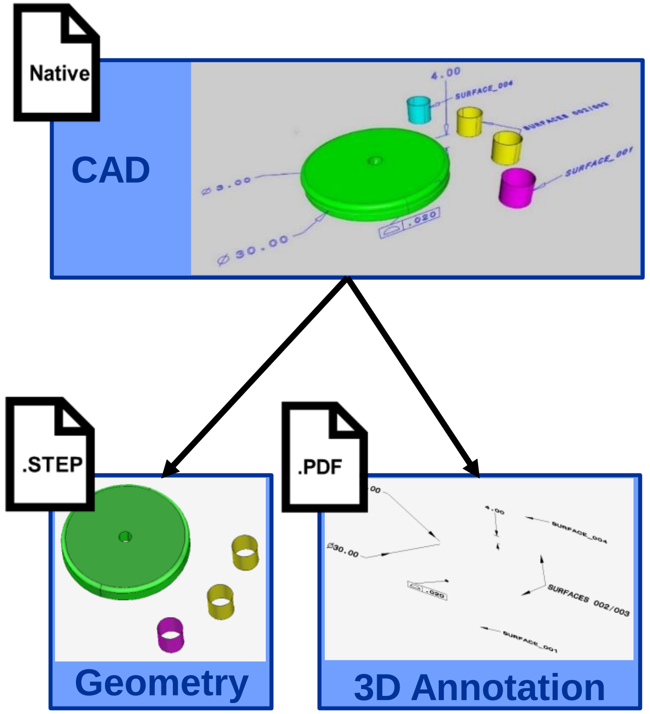
Inefficient Standardization within Industry

… the quality of data may still be compromised during transactions

- Some common issues:
  - – Data standards may not be fully or correctly implemented within a tool
  - – Data standards may not be mature
  - – Data standards my not exist in highly specialized areas
  - – People may not be aware of all standards that could be applied
  - – Data standards may be difficult to digest/consume
- Interoperability applied to the engineering data is a key enabler for data exchange with external stakeholders
- Interoperability is closely related to data integrity – <u>the ability of preserving the original information of the model</u>

Example Scenario

Two files were needed to convey part information due to a tool's lack of standard implementation



Time consuming!

Complexities of Data Exchange with External Stakeholders

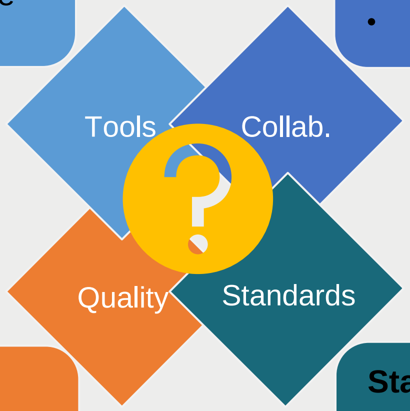
Guidelines are needed to strengthen aspects of data exchange

Tools Challenges

- Tools tend to prioritize native formats
- Tool versioning creates issues
- Lack of cross domain linkages

Tools
- Authoring
- Exchange
- PLM

Collaboration
- Exchange Method
- Digital Thread



Quality
- Product
- Data

Standards
- Data formats
- Processes

Collaboration Challenges

- Optimization of collaboration activities:
  - Translation
  - Validation
  - Export
  - Exchange

Quality Challenges

- Quality processes are not addressed between tools
- Quality checks are static

Standards Challenges

- Standards are not fully utilized/realized
- Standard usage may differ between organizations

These challenges create a disconnect between OEMs and external stakeholders

Data Integrity – “What gets measured gets managed”

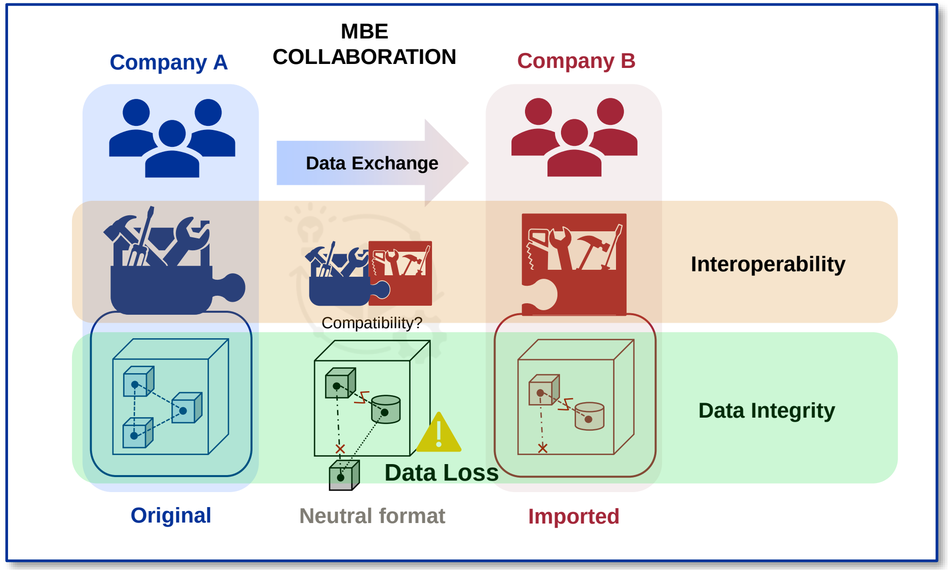
Data integrity solutions could be a strategy to address these challenges

Proposed Definition:

<u>Data Integrity (DI):</u> The state of being whole and undivided. When a model is manipulated, for either exchange or translation purposes, a loss of quality can occur.

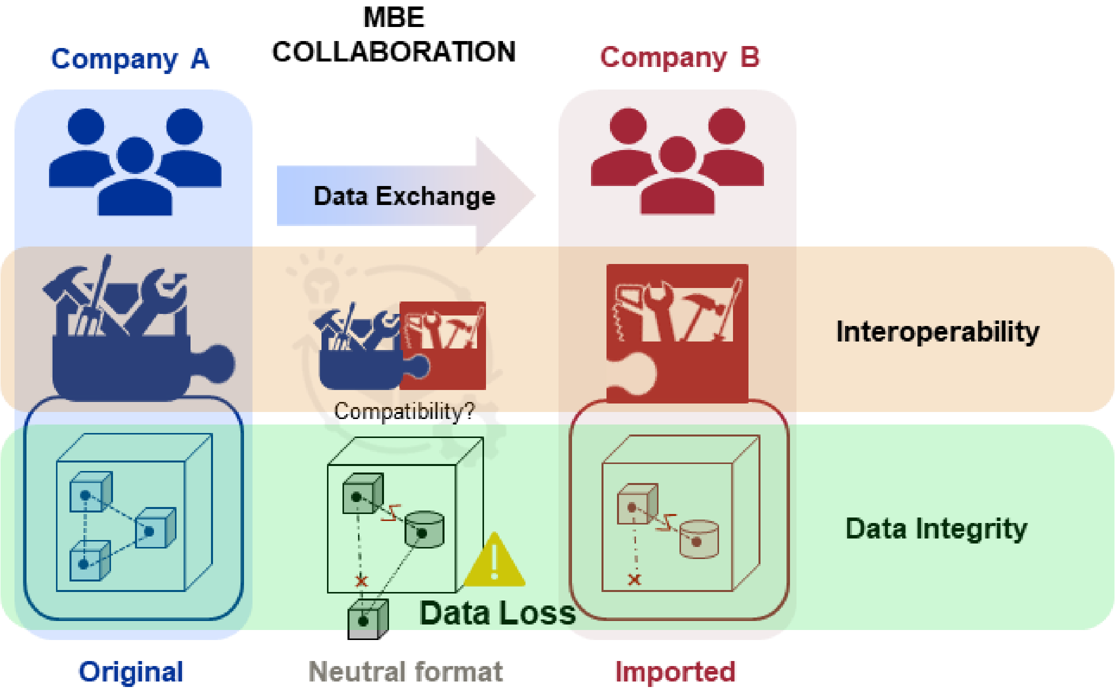
This presentation introduces the “Data Integrity” concept as a key enabler for the DTh:

1. To raise awareness for the need for processes to execute interoperability at scale (manage travelled risk from data loss)
2. To promote the use of industry data quality standards (such as ISO 8000, NAS9300-LOTAR, ISO10303-STEP, etc.) to standardize its definition and associated terms

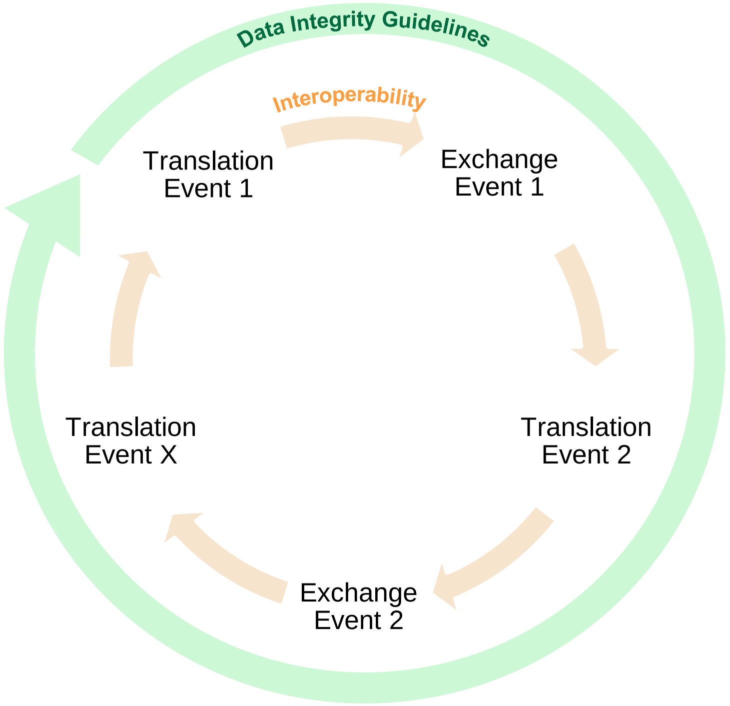


Interoperability vs Data Integrity

Tools Perspective vs Data Quality Perspective



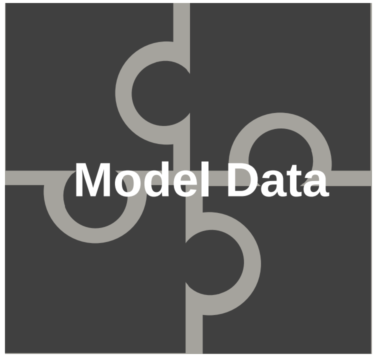
Event vs Lifecycle Perspective

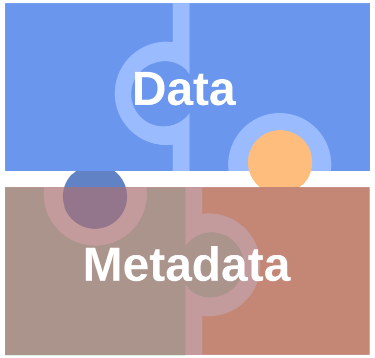


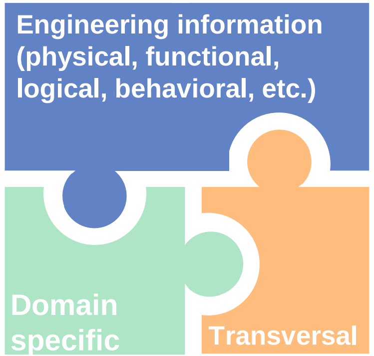
DI Guidelines: High level guidelines to measure and manage DI throughout the MBE Collaboration process

Data Integrity Challenges – Complex Data

What type of data is integrated within a model?







Examples of metadata transversal to the domains

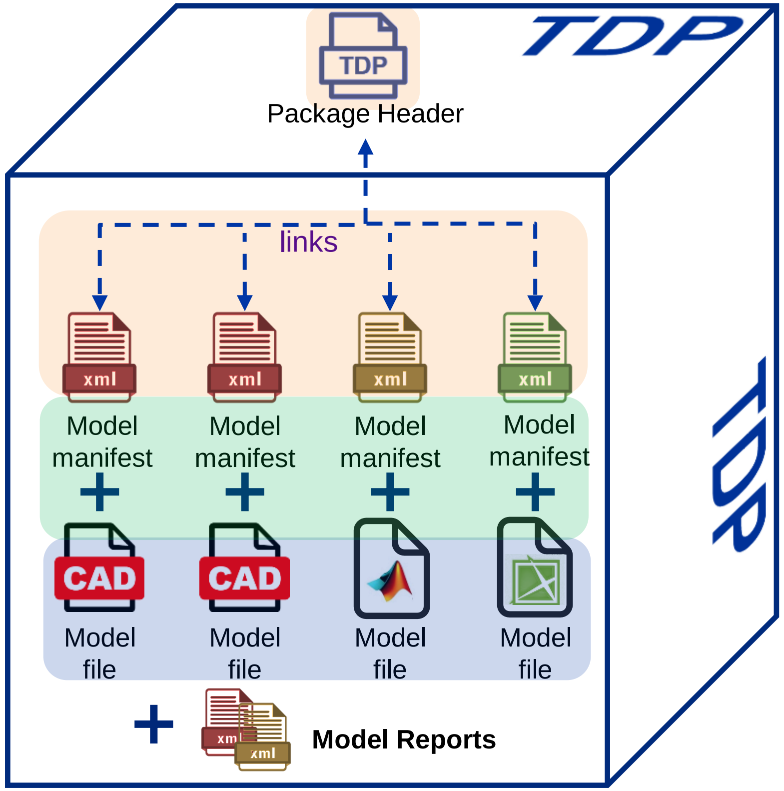
Traceability, Change Management, Configuration Management, etc.

Export control tag	Last modification date
Author	Model linkage
Creation date	Authoring tool

Digital Thread Enabler

Examples of metadata items for different domains

Spatial	Architecture	Requirements	SysMBD
Length units	Element ID	Language	Compiler
Mass units	Model plugins	Specified by	Key parameters
Density units	Dev language	Specification level	Time scale



Technical Data Package (TDP) Representation

- **Package Header**
- **Model Manifests & Reports**
- **Models**

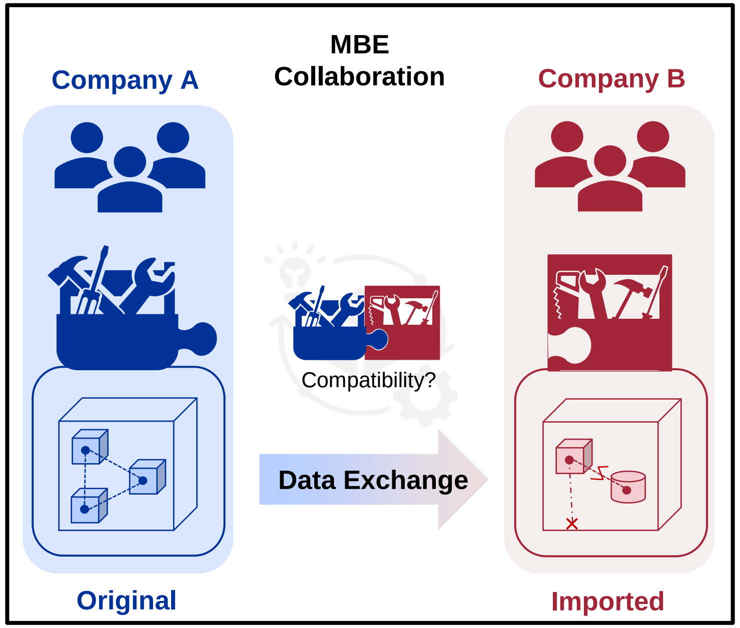
Data Integrity Challenges – Tools & Standards

Tools

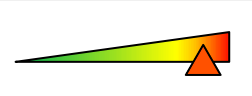
Incompatible Tools, Native Formats

Toolboxes incompatibility:

- Domain Tool (e.g. Vendor A Tool – Vendor B Tool)
- Tool's version (e.g. Tool R22– Tool R23)
- Cross-domain tool (e.g. 3DMBD – Requirements)



Probability for Data Loss



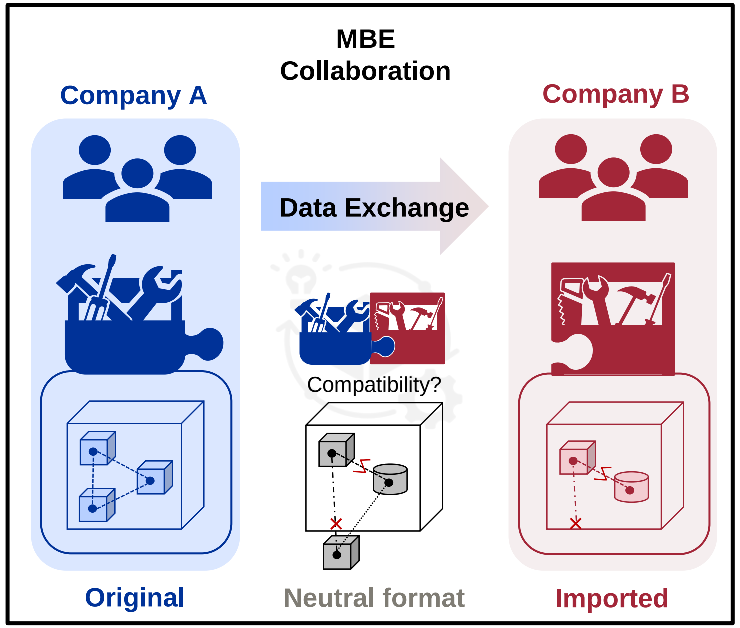
Use neutral data format for exchange

Standards

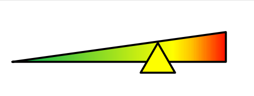
Incompatible Tools, Neutral Formats

Data Format Translation

- Needed when tools are not or partially compatible with a data format
- Change the way the information is structured and packaged



Probability for Data Loss



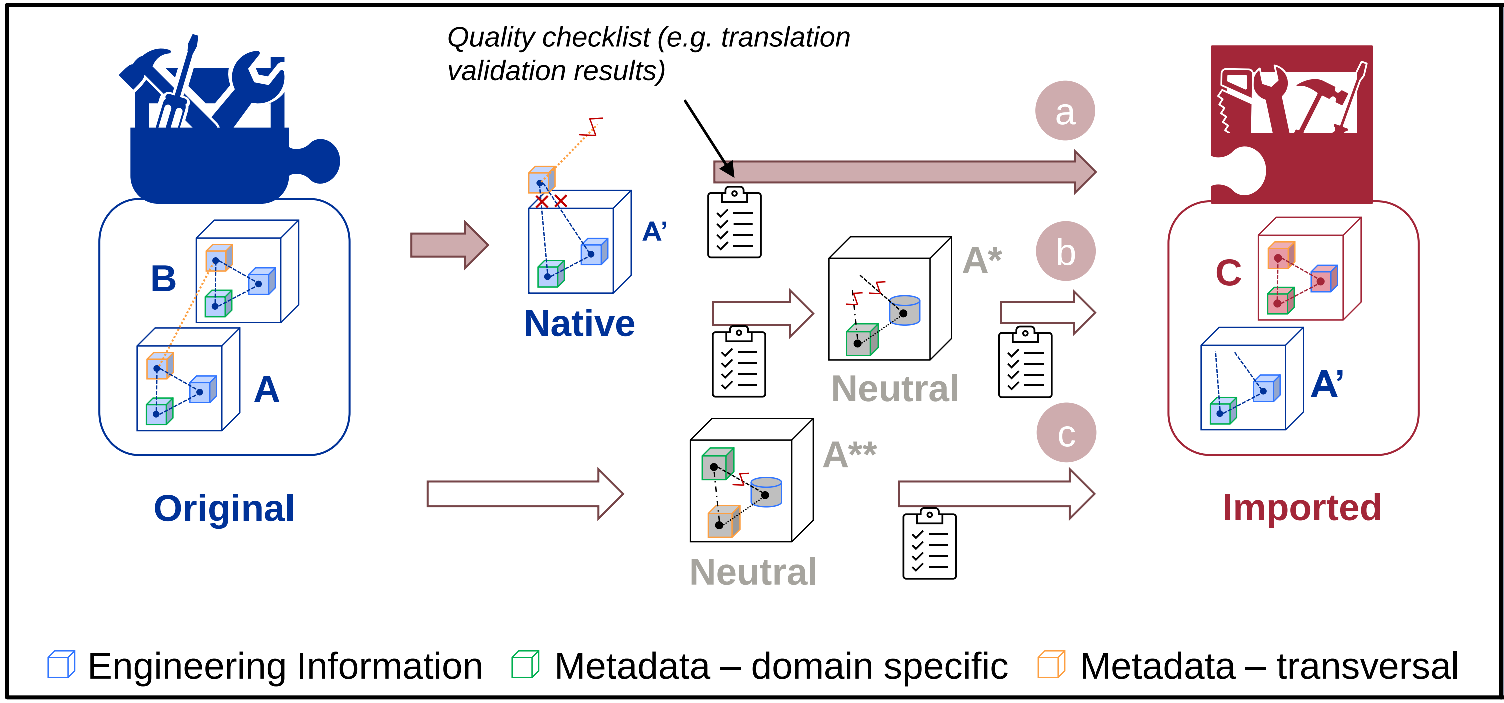
Data Integrity Challenges – Collaboration & Quality

Collab.

Quality

Various activities can introduce data loss during collaboration

- Data format translation (export / import)
- Extraction from the original toolbox
- Distribution / exchange



Data Integrity is Path Dependent

- There are different pathways (a, b or c) to perform the exchange
- The risk for data loss (eng. Information, domain specific, or transversal metadata) is dependent on the activities of each path
- Processes are to preserve the quality of the data throughout the exchange

Methods for Preserving Data Integrity

Model Metadata & Manifests

(e.g. xml, STEP AP239, MoSSEC/AP243)

- Embedded in the model or attached as an additional .xml
- Contain domain specific and transversal information
- Various standards define which metadata shall be placed within the manifest (e.g. MoSSEC/AP243)
- If a data loss risk is foreseen during the exchange, the information can be manually added in the manifest to ensure it is preserved

Model Reports

(e.g. LOTAR EN/NAS 9300 - 500 series)

- A compilation of results/metrics of the model's execution in a specific test case
- It can be used to verify that different versions of a model (model in different data formats) behave the same

How does this help preserve DI?

- ➢ Metadata provides the capability to include information that might not be included within the engineering information (model)
- ➢ Metadata placed in the manifest can be kept with the model, even if tools lack capability to consume it
- ➢ Model reports support data quality since they ensure two different models have the same behavior

IDEA

Both, **Model Manifests**, and **Model Reports** are included in the Technical Data Package to preserve data integrity

Methods for Preserving Data Integrity

Exchange Methodology

Summation of all the steps needed to exchange or modify a model between stakeholders:

- Includes methods used for data translation (within a tool or via third party tools) which impact downstream interoperability of the data
- Could be standardized to define best practices for creating model manifests and the required metadata
- Should define ways to preserve the DTh by avoiding duplicities or data divergence

Interoperability Database *(Needed)*

- Contains lessons learned from data exchange reports (tools and standards)
- Guides users to different standards that can be employed for interoperability
- Increases visibility, reusability, and DI maturation within a company

How does this help preserve DI?

- Standardized exchange methods (including the necessary checks to ensure quality and address data loss risk) could be deployed as part of a program wide DI strategy
- Companies could utilize an interoperability database to support the development of program DI strategies

Data Integrity Guidelines

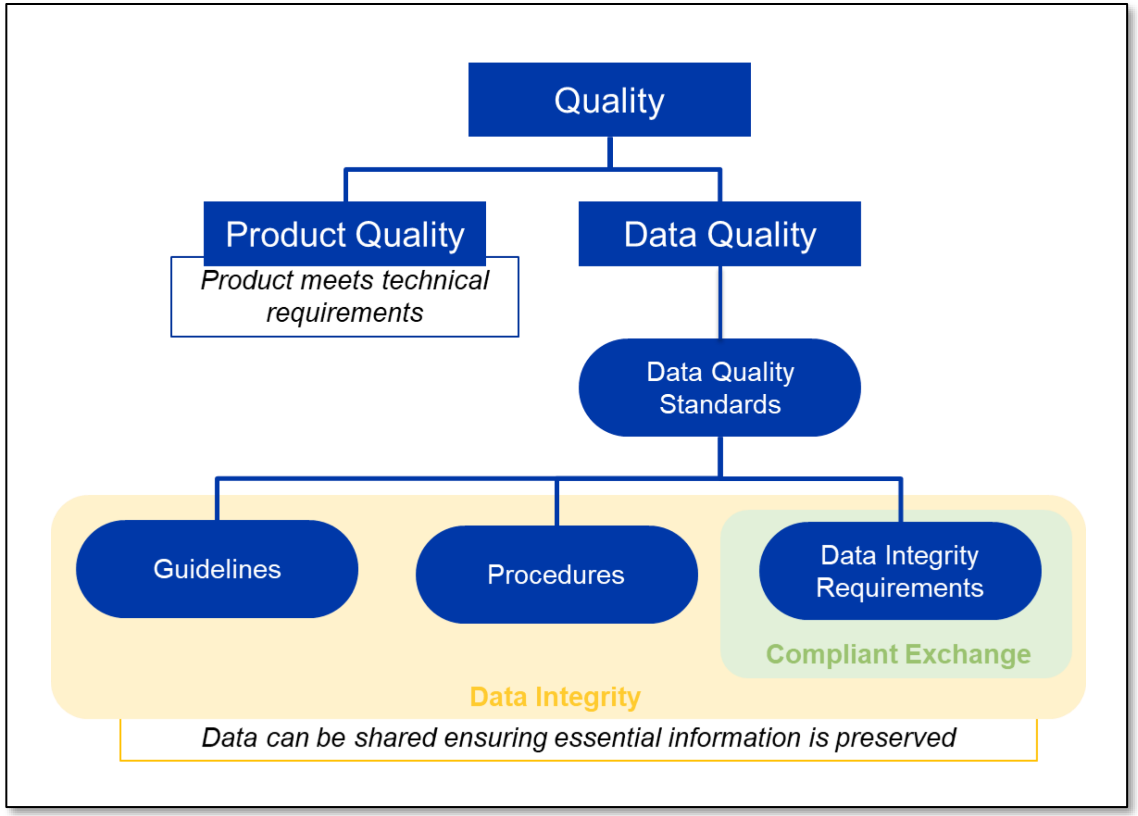
Data Integrity for Achieving Quality

- Data quality (ISO 8000) includes many aspects of the data (accessibility, accuracy, completeness, consistency, etc.)
- DI refers to the requirements of the data quality, which needs to be preserved in the **model data** when **exchange** is required for collaboration.

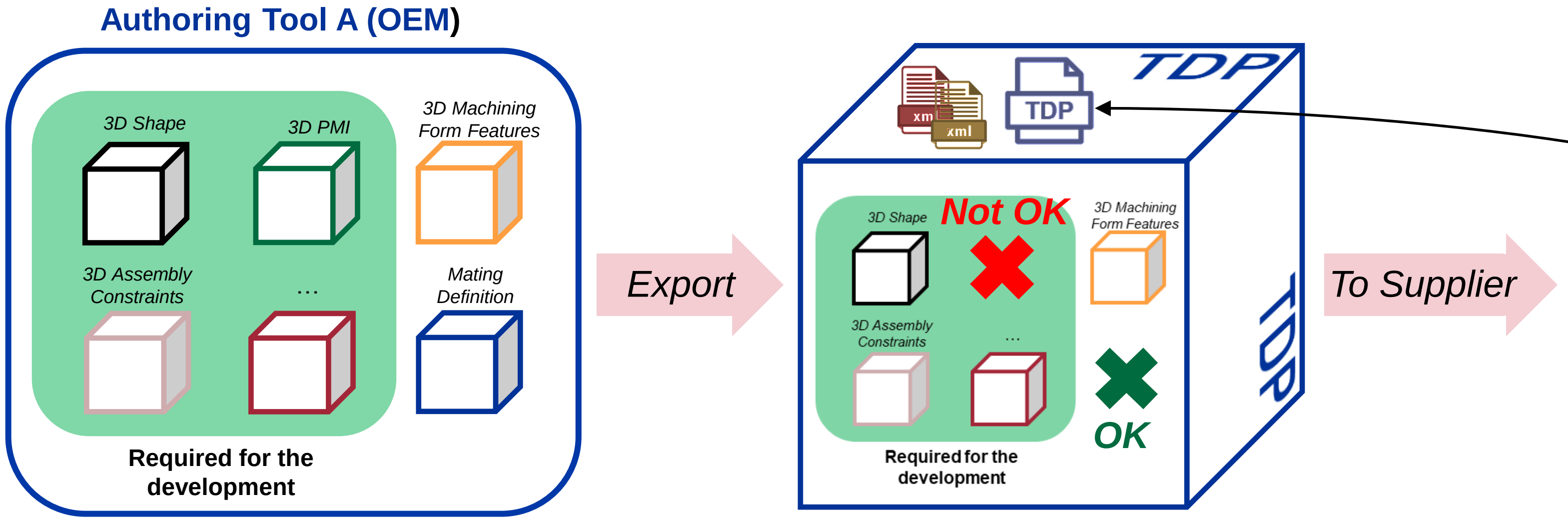
Data Integrity Requirements

- Information the model must have (functionalities of the data that will enable the development of the process)
- DI requirements ensure the model data serves its purpose and the data can be manipulated, consumed, and/or developed

A **Compliant Exchange** is when Data Integrity requirements are satisfied and there is minimal to no risk of losing essential information during the exchange process



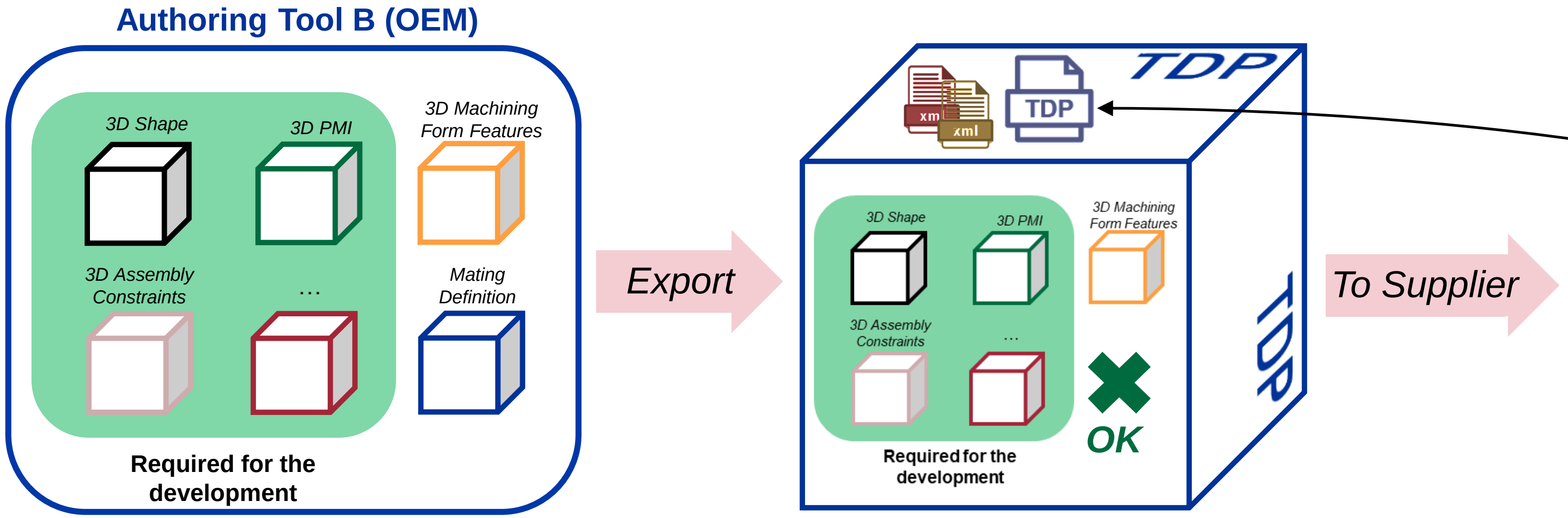
Compliant Exchange Example using STEP AP242



Non-Compliant Exchange
Model contains 75% required data

Model Manifest Proposal:

- Include the addition of the of Data Integrity history
- Maintain DI requirements for the data Aligned to collaboration objectives



Compliant Exchange
Model contains 100% required data

Proposal for Addressing Data Integrity for a Collaboration

A. Data needs Identification

- **A1** Identify collaboration domain
- **A2** Determine data requirements and Data Integrity needs
- **A3** Identify tools and data standards

B. Interoperability and risk assessment

- **B1** Study interoperability between tools and standards
- **B2** Identify risks and gaps between interoperability and data requirements
- **B3** Identify alternatives to close the gaps

C. Data Integrity Req. Definition

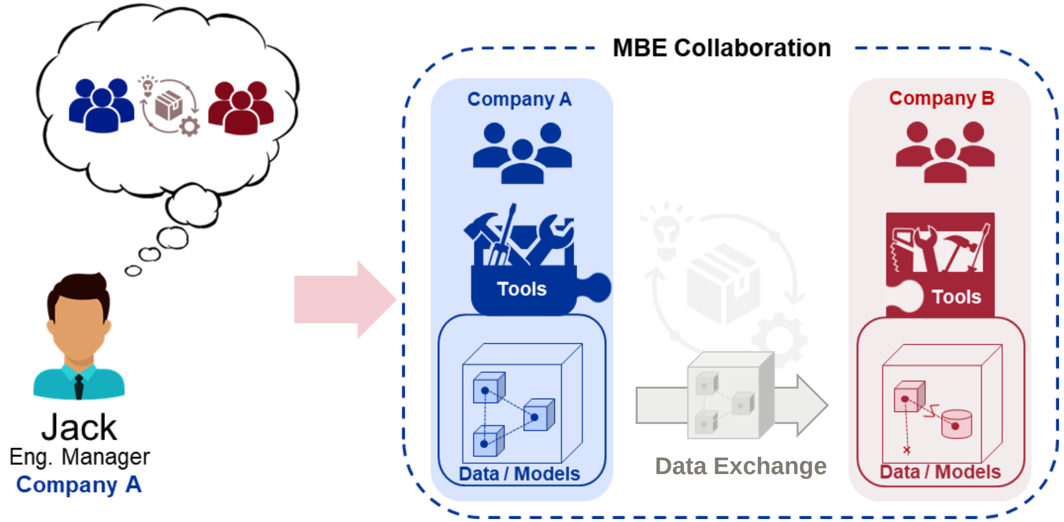
- **C1** Asses open gaps and spot potential risks of the exchange methodology
- **C2** Define DI requirements for compliant exchange
- **C3** Define processes for exchange methodology

D. Quality Planning

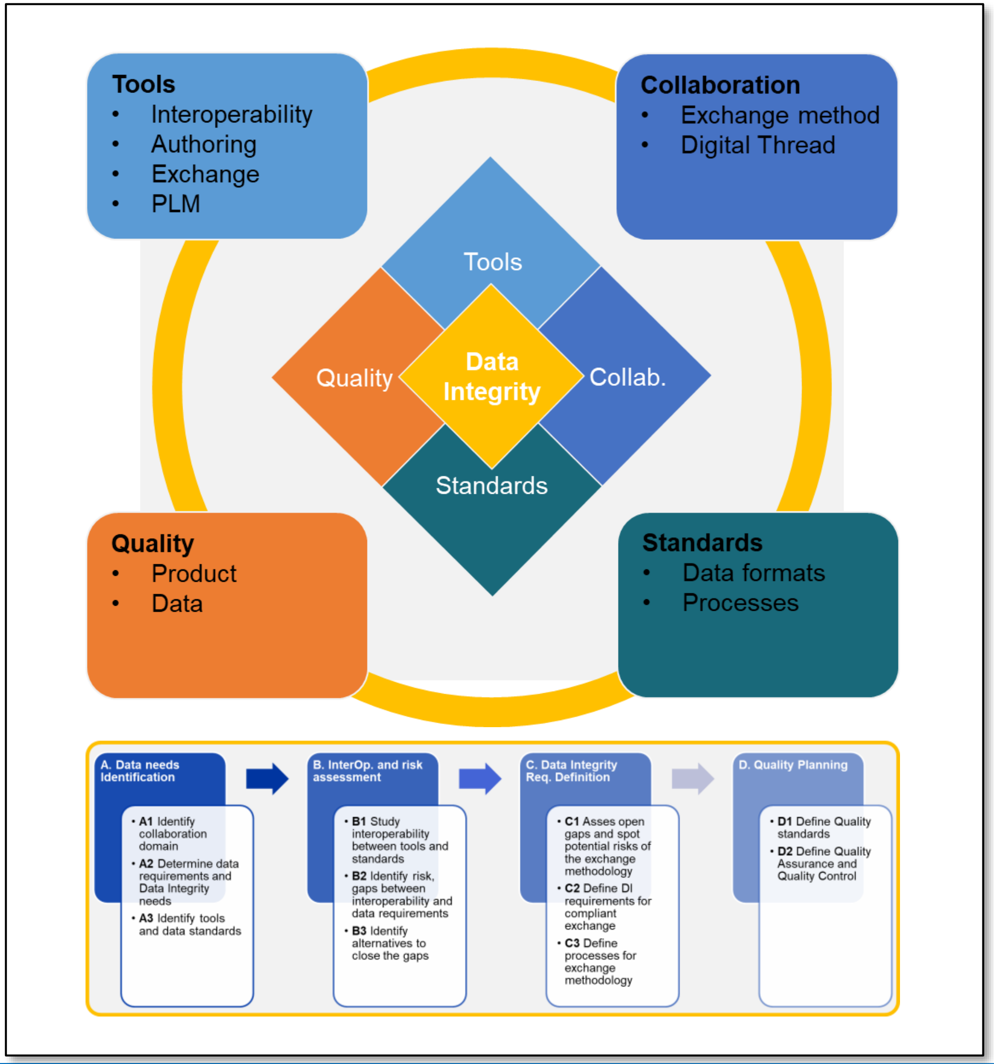
- **D1** Define Quality standards
- **D2** Define Quality Assurance and Quality Control

Data Integrity as a Process

How should Jack address risks for an MBE collaboration?



1. **Identify data needs**
2. **Perform an interoperability risk assessment**
3. **Define data integrity requirements**
4. **Perform quality planning**



Takeaways

- There are challenges with preserving the digital thread through various aspects of supplier data exchange (associated with the loss of data)
- Explicitly measuring and monitoring data integrity is a proposed methodology for controlling data loss
- Resources, such as standards and model artifacts (model manifests and reports) can be leveraged to help preserve data integrity (including guidelines)
- Data quality is addressed by data integrity requirements, which can be used to define compliant exchanges for digital models
- High level guidelines are proposed to connect the aspects of supplier data exchange – tools collaboration, quality, and standards

Next Steps

1. Increase awareness for data integrity
   - Further define/refine the concept of data integrity through position paper(s), industry conferences, and forums

2. Understand the feasibility of an interoperability database
   - Ongoing work to develop translation reports, interoperability between tools, etc. happens in isolation in industry or even within a company.
   - What is the need for an interoperability database? How it should be coordinated? What will be the requirements?

3. Develop guidance to properly define data integrity requirements and compliant exchange
   - Address the challenges by providing standardized requirements for tools, translation reports, and other steps associated with the collaboration process.

4. Provide input to Standardization bodies and Industry Workgroups
   - LOTAR MBSE Working Group, INCOSE Quality management Working Group, and OMG

Questions & Answers

Q & A

(or feedback)

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