International Council on Systems Engineering
A better world through a systems approach

Towards a greater understanding of Systems Design and Interoperability between Airbus Commercial and its Suppliers

Maxime Varoqui

Paper #146

Maxime Varoqui

Systems Engineer

Professional Experience

3 Years at AIRBUS in Mobile, AL as a Systems Engineer

- MBSE Lead for the “MBSE for Seats” project
- Version Engineer for Cabin Attendant Seats
- Version Engineer for Passenger Seats

2 Years at the Aerospace Systems Design Laboratory (ASDL) at Georgia Tech

- MDAO
- Design of Experiments
- Sensitivity Analysis

Today's Agenda

- Introduction and Challenges
- A Model-Based Solution
- Collaborative Modeling
- Enhancing Design Reviews
- Limitations and Outlook

Introduction and Challenges

Passenger Seats are **Buyer's Furnished Equipment** (BFE)

- Supplier designs seats
- Airbus oversees and integrates the Seats inside the aircraft
- Airbus requirements shared with the seat suppliers as PDF documents

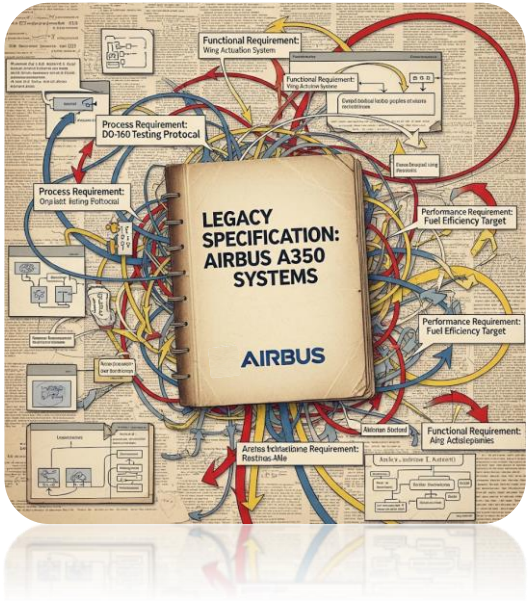
→ Airbus owns the specification, supplier owns the design, shared V&V activities

Introduction and Challenges

Legacy **Specification**

- Specification comes as a 1000+ page document
  - Cross-Program requirements, difficult to determine their applicability
  - Requirements sometimes not intelligible, outdated
  - Gathers different types of requirements: Process, Functional, Performance…

→ Challenge for Airbus to update the specification and for the supplier to understand the impact on their designs



Introduction and Challenges

V&V Activities

- V&V and testing activities carried by the supplier, incrementally approved by Airbus during Design Reviews
- Quantity and Quality of Requirements:
  - Tedious and error-prone manual compliance checks
  - Relies on experts' knowledge

→ Risk of subjectivity and bias while checking compliance

Objective

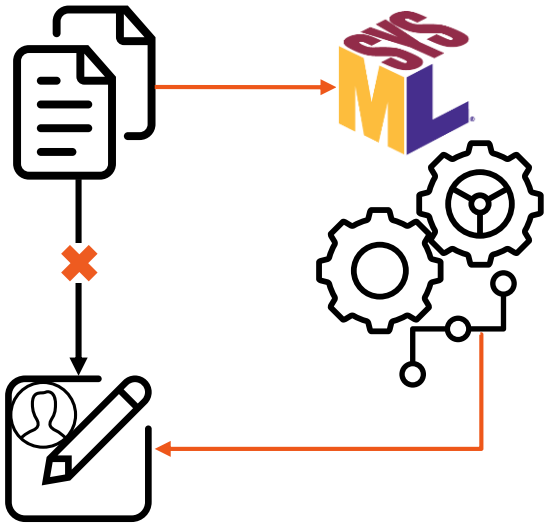
Improve the understanding of the Specification and of the Supplier's Design, anticipate design changes' impact, and facilitate Design Review activities

Model-Based Solution
The Foundation

Transforming Specifications

From Documents to Models

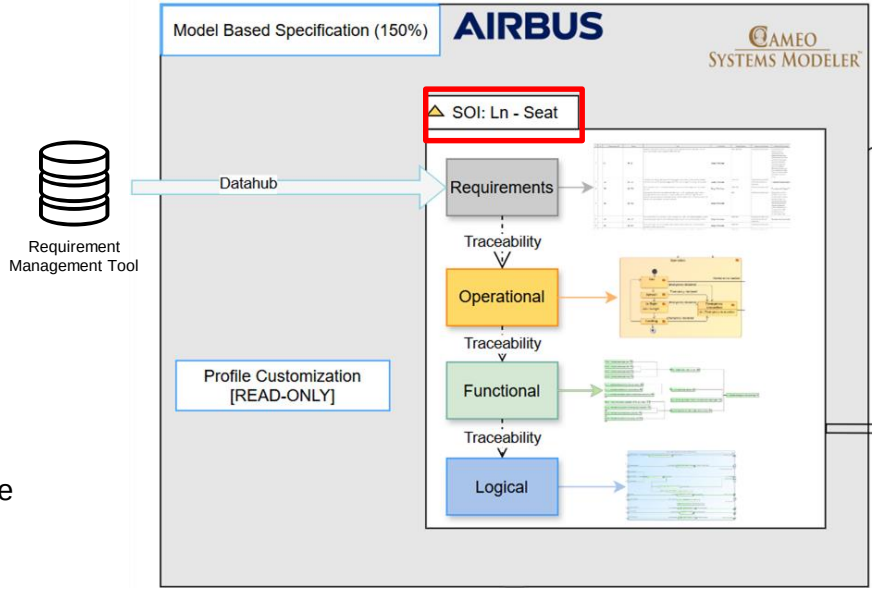
- Replace all the specification documents for Seats
  - Provide more context and traceability than traditional textual requirements
- Leverage and improve the existing Requirement management tool database
  - Rewriting, and deleting Requirements
  - Following the Guide to Writing Requirements (INCOSE/ISO 15288)
  - Requirements made unique, verifiable, complete
- Synchronization of Requirements to modeling tool
  - Customization of Requirement Stereotype with additional attributes: Stakeholder, rationale, MoC, Design Review, etc.



Transforming Specifications

MOFLT Modeling

- Airbus Generic MBSE Framework MOFLT (Mission, Operational, Functional, Logical, Technical).
- Seat as System of Interest
- Development of the Seat specification
  - **Requirements** synchronized from database
  - **Use Cases**, Seat **Life Cycle**
  - High-Level **Functional architecture**
  - Primary **Logical Architecture** of the Seat's main components
  - No Technical Layer developed within the specification to preserve supplier innovation

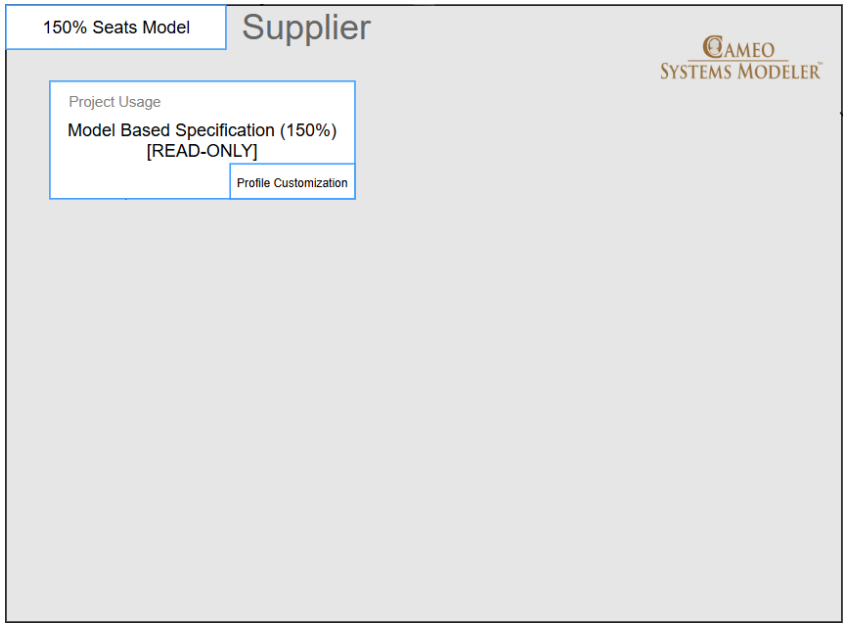


→ Model-Based Specification (MBS) is sent to seats suppliers alongside the traditional PDF documents

Collaborative Modeling
Bridging Airbus and Suppliers' Designs

Collaborative Modeling

Systems Model MOFLT Structure



- Seat System of Interest (SOI) started by Airbus
- Interface between Airbus and Supplier, between the specification and the design
  - Supplier builds their **Functional**, **Logical** layers refining Airbus Functional, and Logical specification
  - Supplier is responsible for building the **Technical** Layer

Collaborative Modeling

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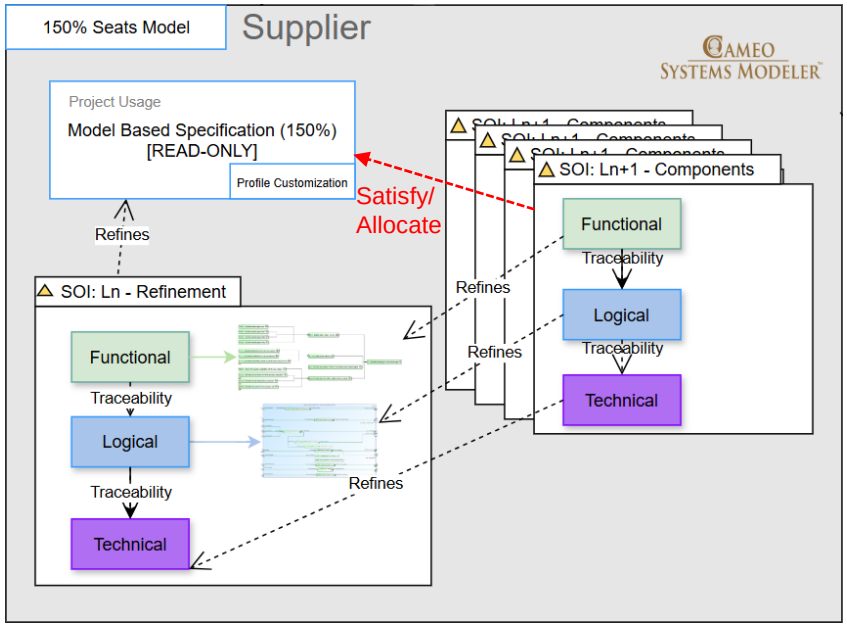

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- Interface between Airbus and Supplier, between the specification and the design
  - Supplier builds their **Functional**, **Logical** layers refining Airbus Functional, and Logical specification
  - Supplier is responsible for building the **Technical** Layer
- Development of Components' Viewpoints (new Systems of Interests) by the Supplier refining the Seat
  - **F**, **L**, and **T** layers applied recursively
  - Traceability links to Model-Based Specification

Collaborative Modeling

Model-Based Product Line Engineering (**MBPLE**) approach

150%

- Model contains the entire specification, **all possible Seats features**

120%

- Represents a platform seat and contains a reduced specification, with supplier's offered features

100%

- Represents a platform seat to be integrated in an aircraft and contains and even more reduced specification with the specific **features selected by the airline**

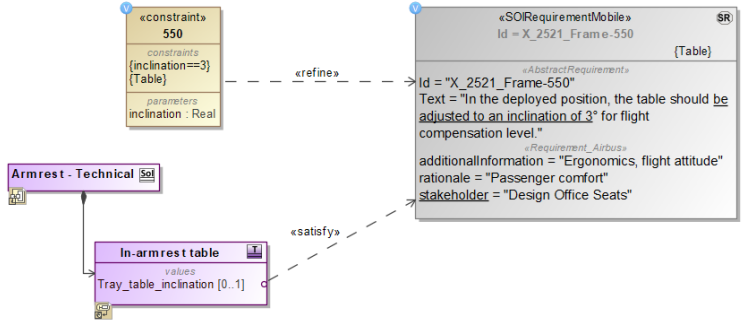
Collaborative Modeling

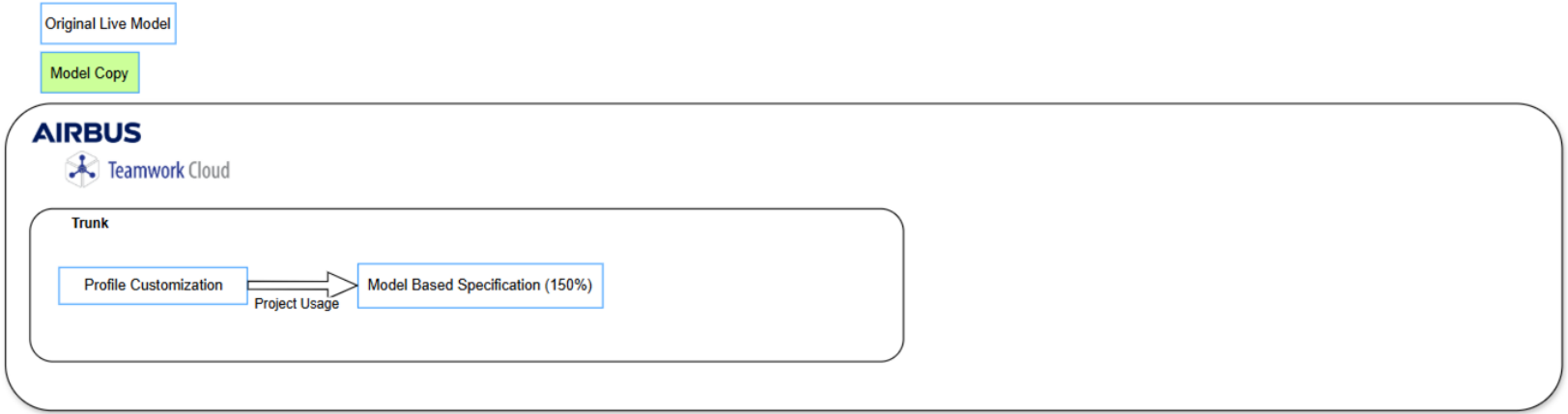
Verification and Model Opinion

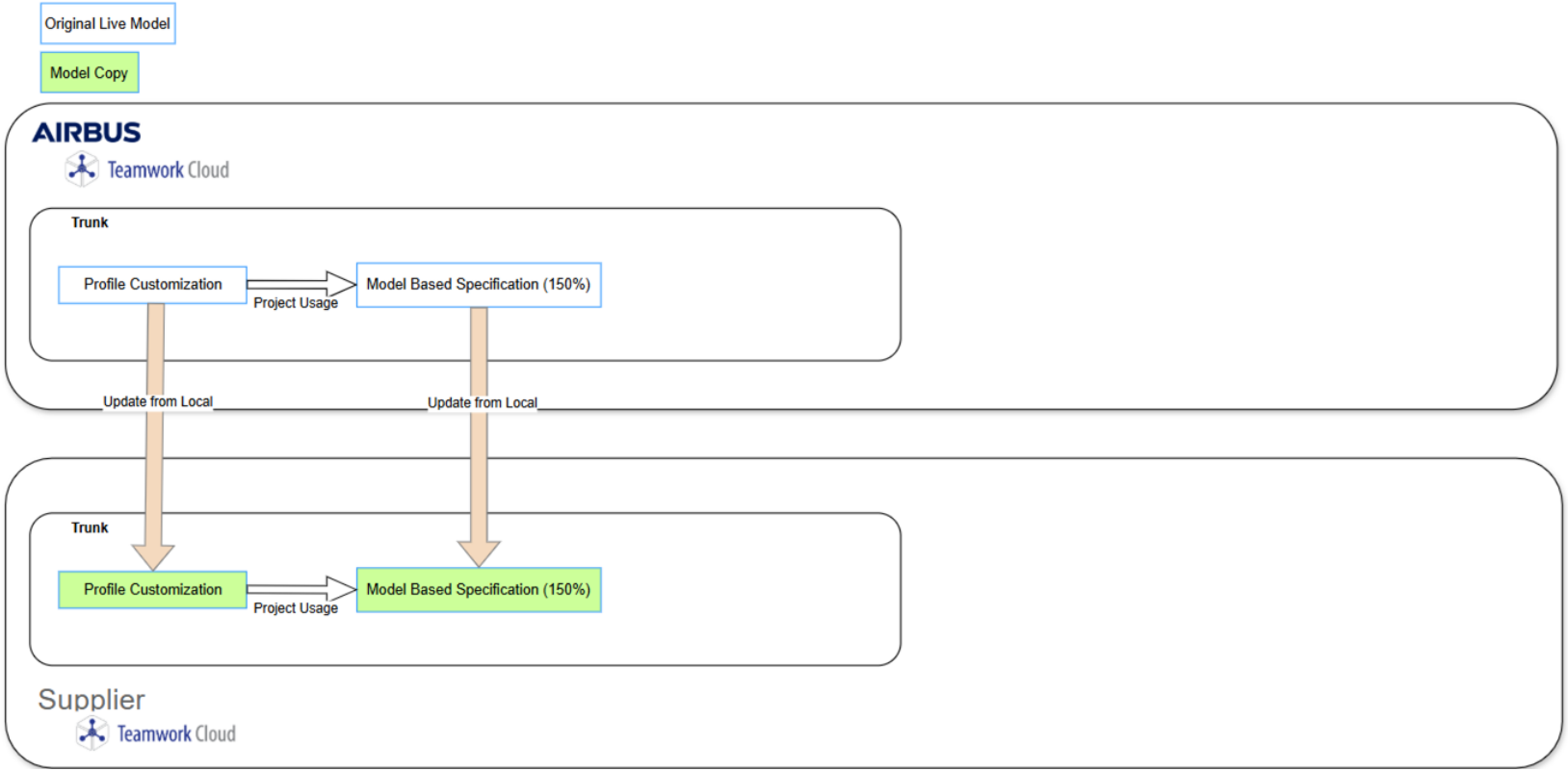
- Development of Modeling rules and common ontology to support early verification

  Unit Conversion, Satisfaction Rules

- Leveraging simulation capabilities of the Cameo Simulation toolkit
  - Compare Value Properties against requirements/constraints
  - Export results to instances and slots




Original Live Model
Model Copy
AIRBUS
Teamwork Cloud
Trunk
Profile Customization
Project Usage
Model Based Specification (150%)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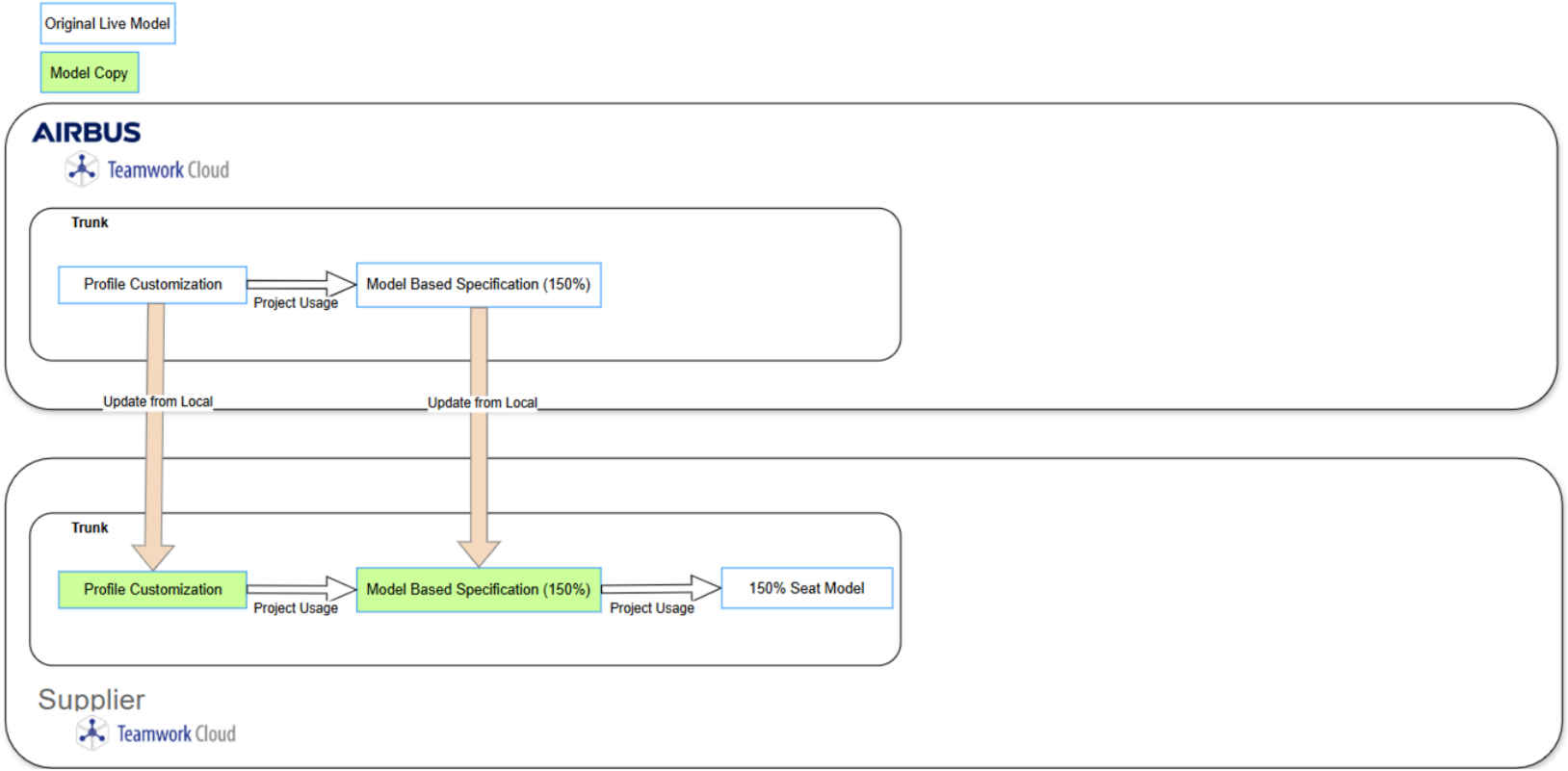
Teamwork Cloud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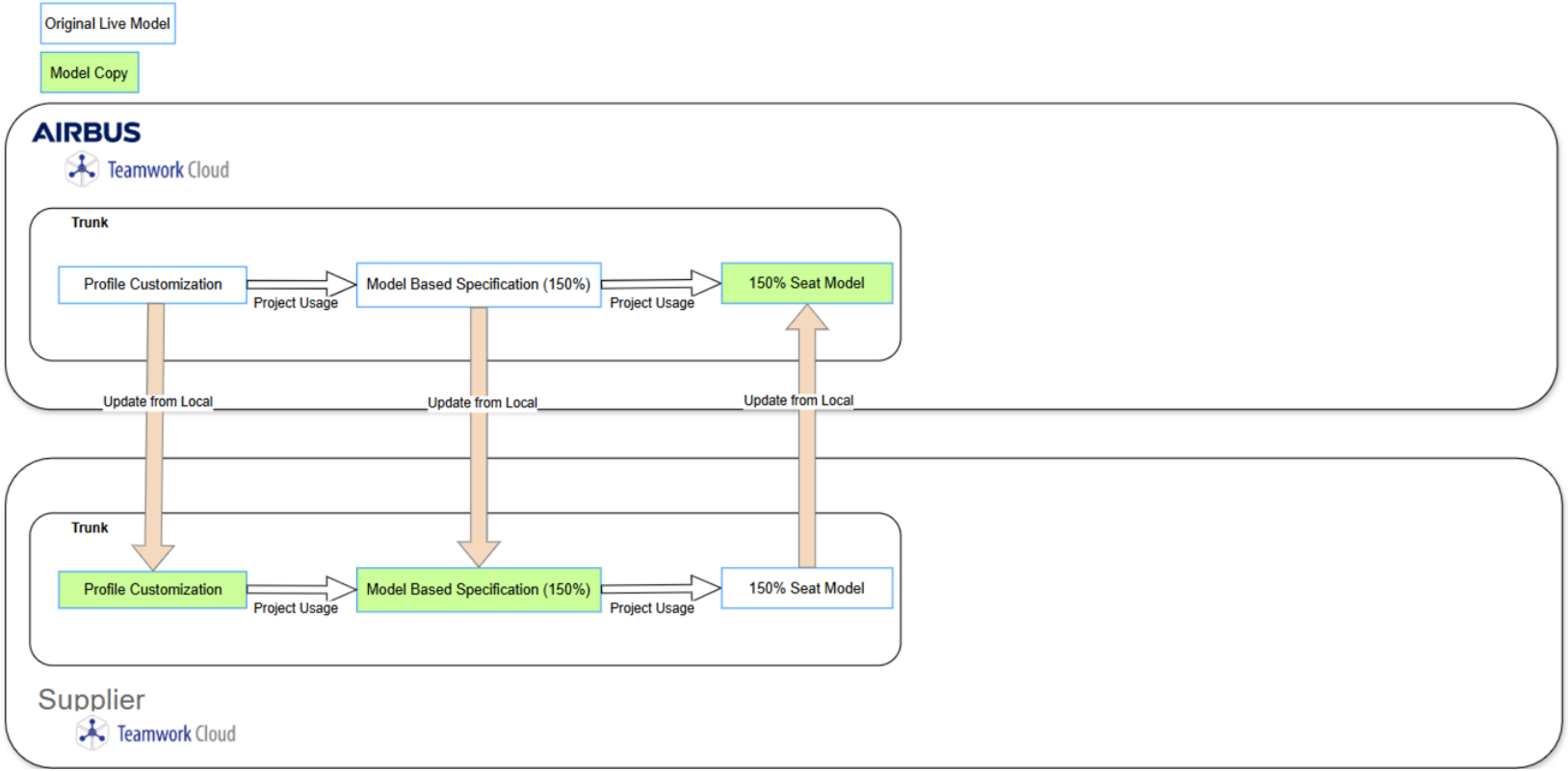
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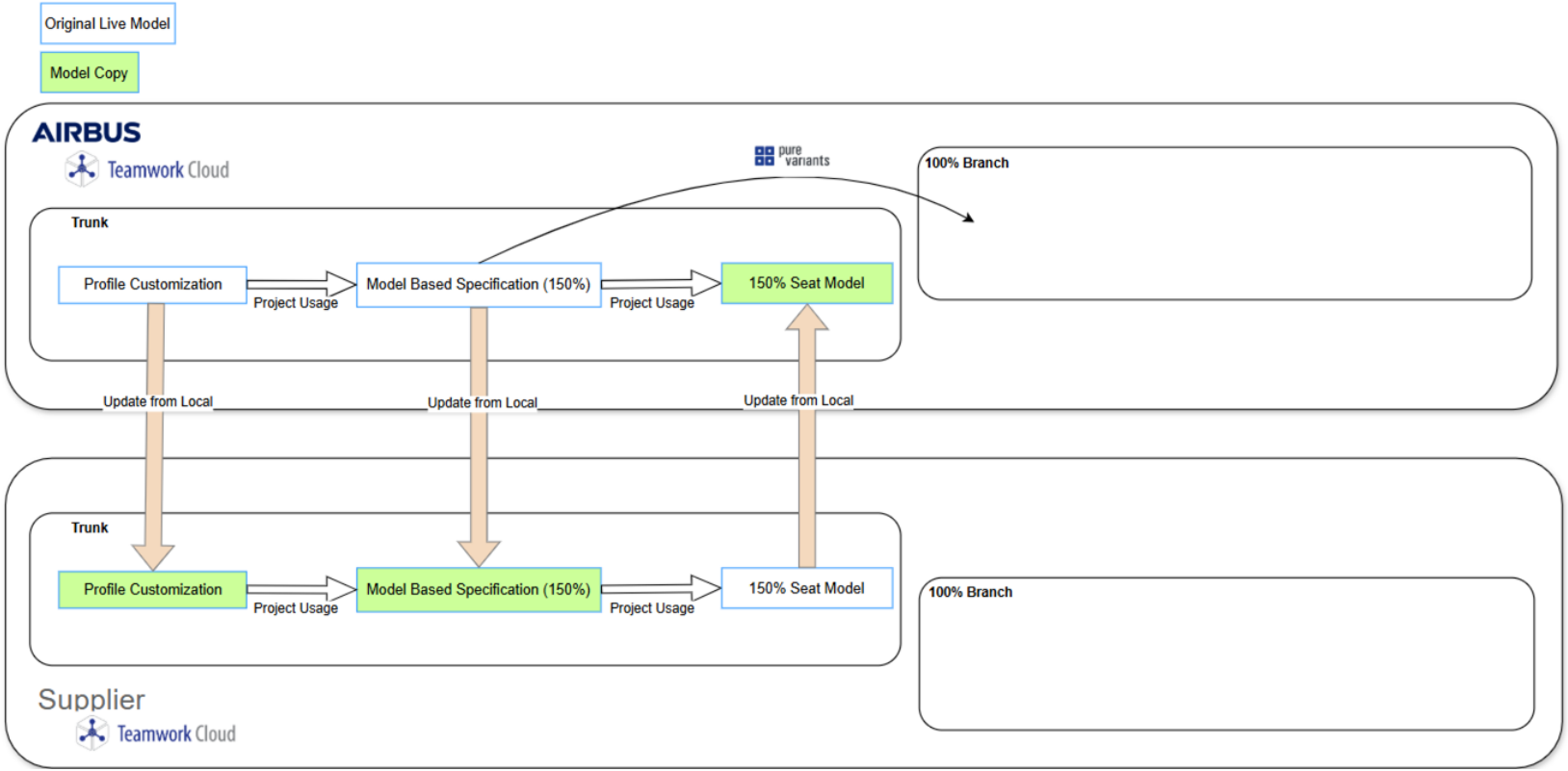
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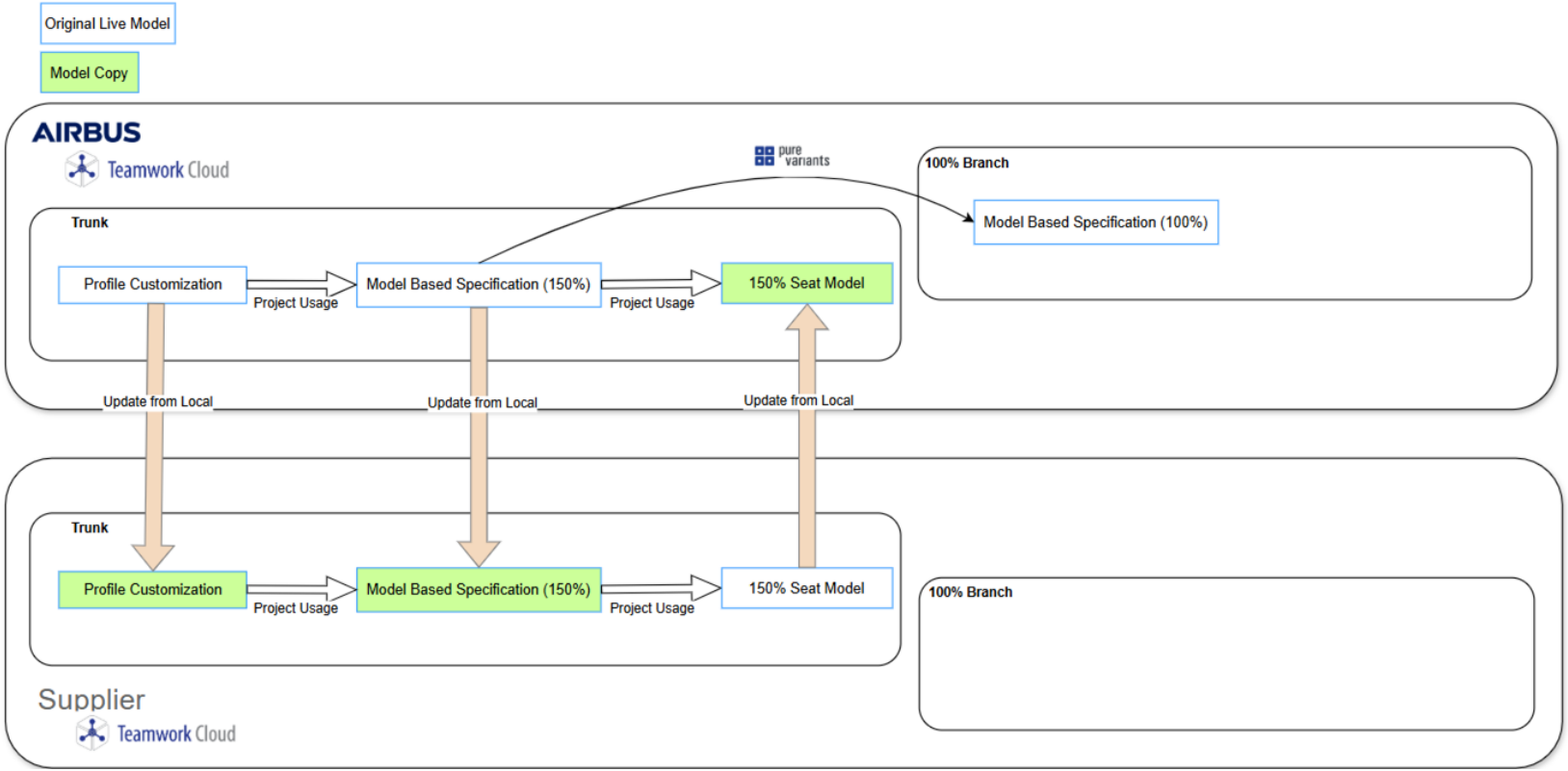
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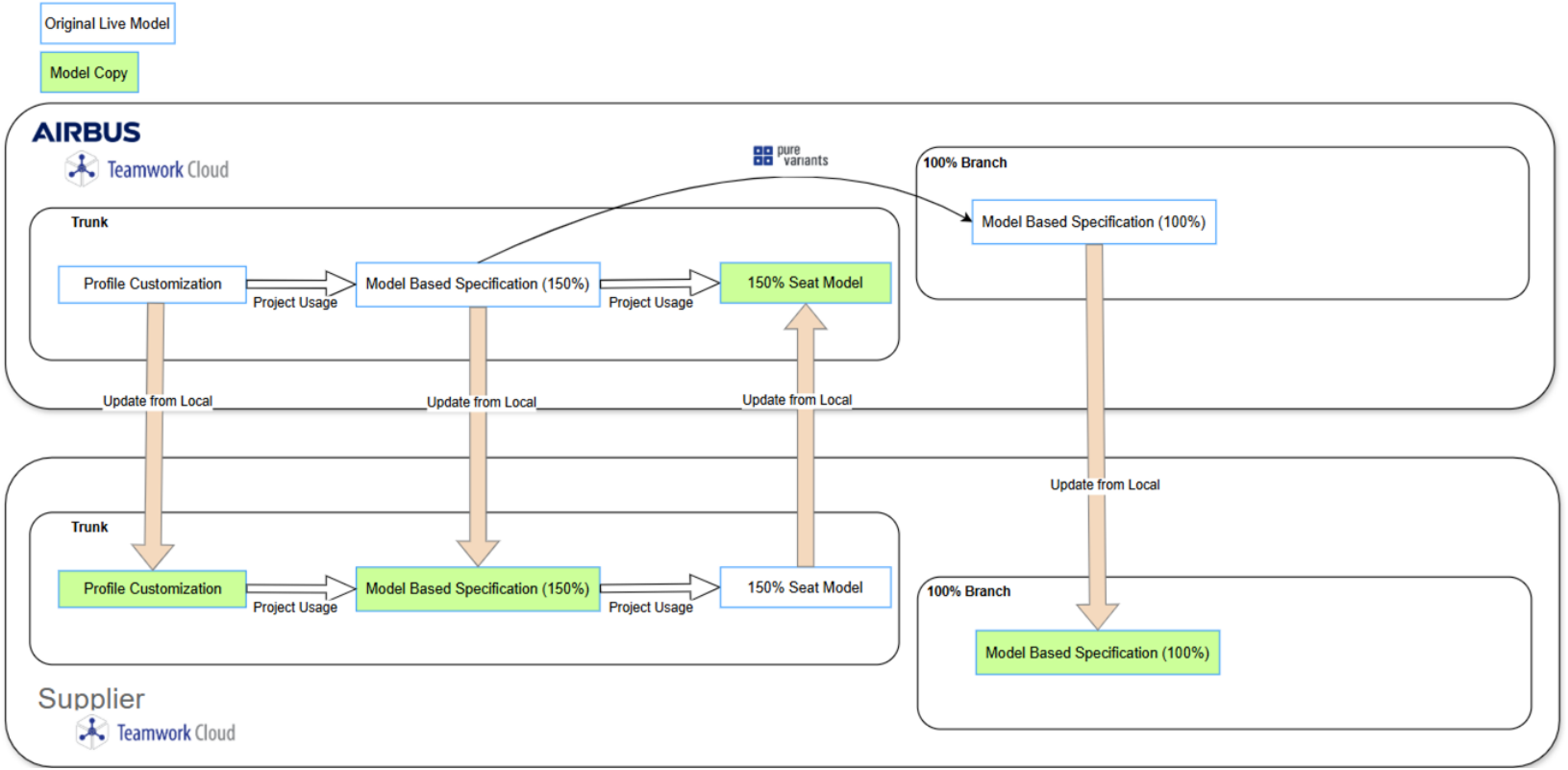
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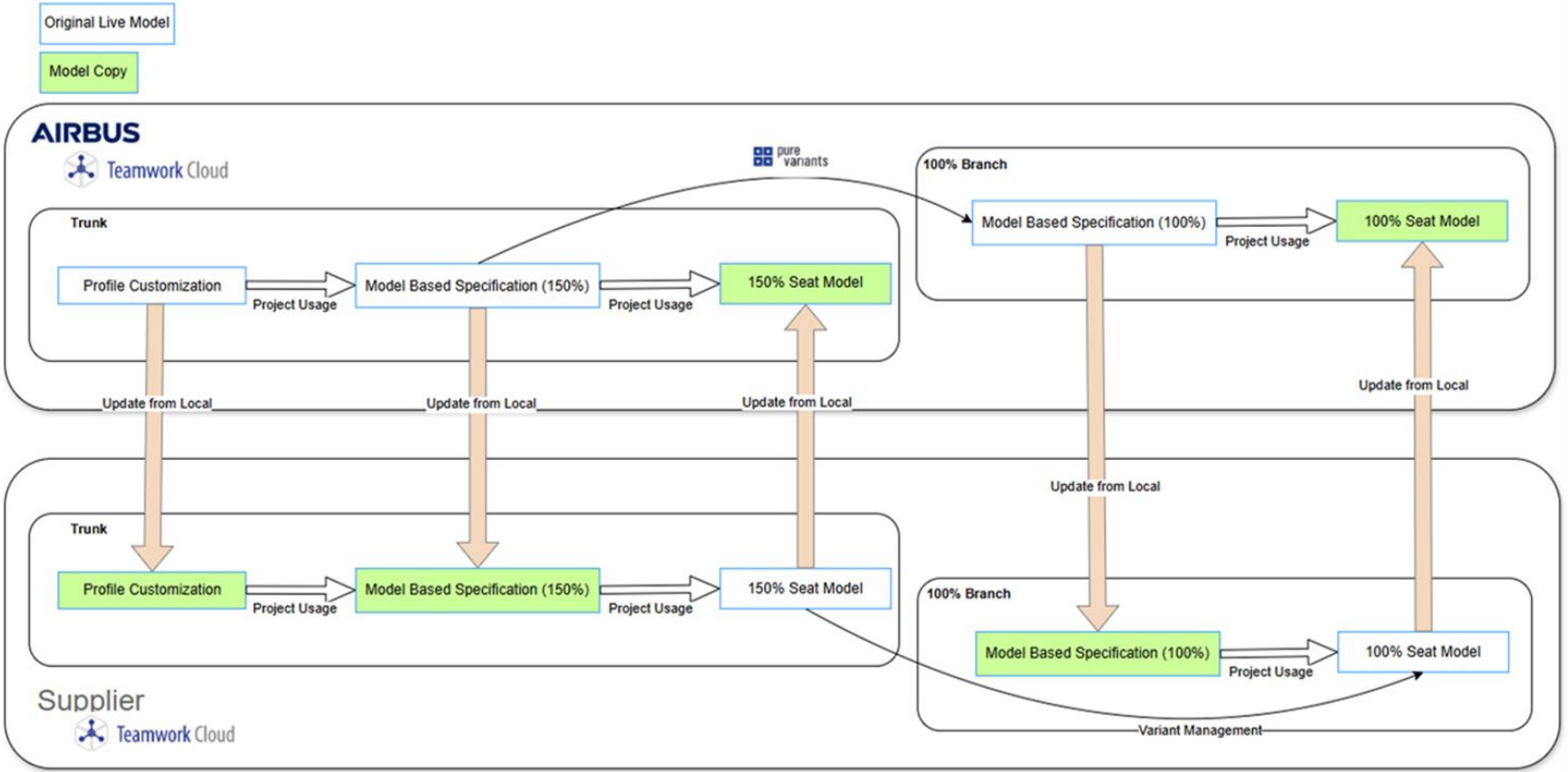
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Variant Management
Supplier
Teamwork Cloud

Design Review Assistant
The User Interface

Model Export

- Export to JSON-LD/OWL format based on ontology entities built within Cameo
- The ontology used for the export is independent from the stereotype and framework used


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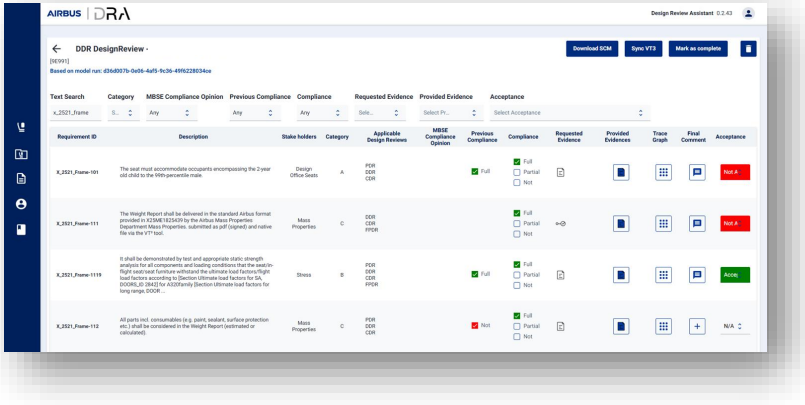
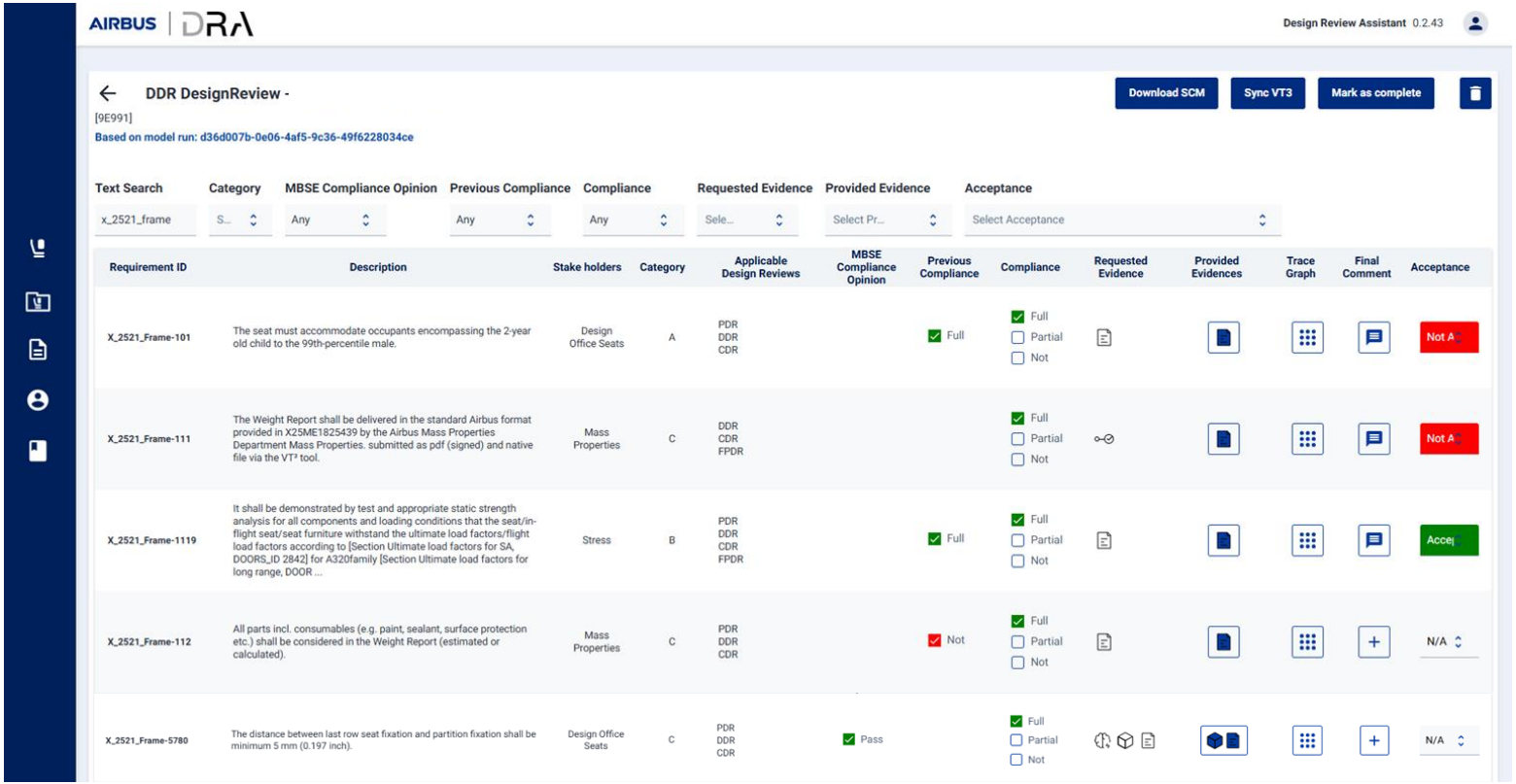
Design Review Assistant

- **Bridges the gap** between systems models and seats engineers
- Independent tool **enhanced by System Models**
- **Assists engineers** during Design Reviews by providing **applicable requirements** to be reviewed
- Integrates **Test Report Results** from Airbus database
- **Stores history** of System Development throughout Design Process
- **Exports results** to traditional certification format



Design Review Assistant

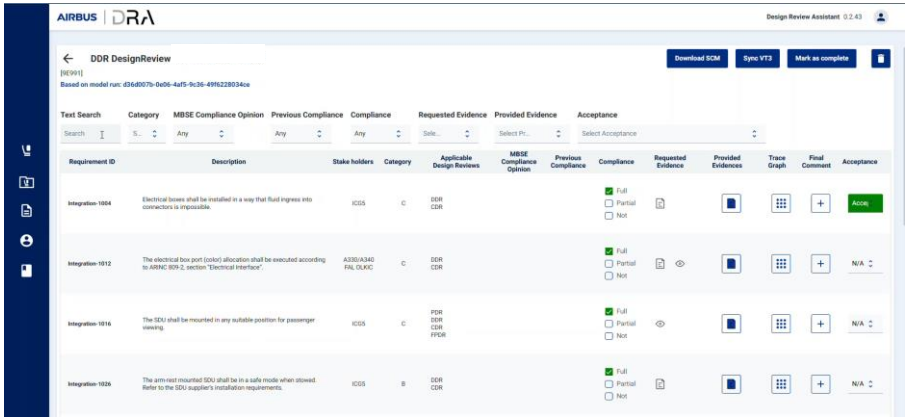


Design Review Assistant

System Model Enhancement

- Glimpse of the model provided through traceability explorer
- Enriches compliance statement with traceability, early verification insights, systems architecture
- Nodes are navigable and contain stereotype relevant information

ID, type, stereotype, relationship to other elements, value, unit, etc.



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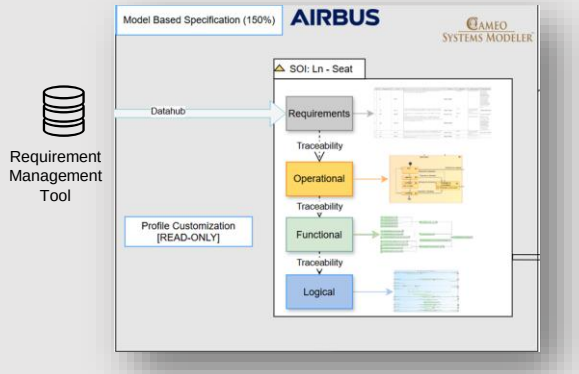

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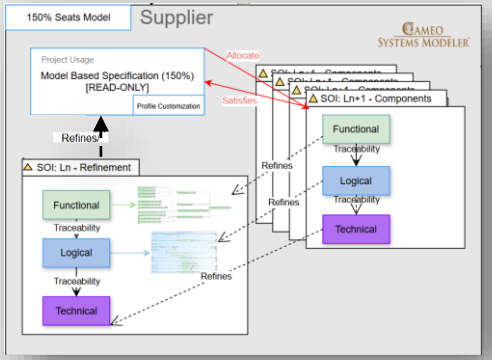

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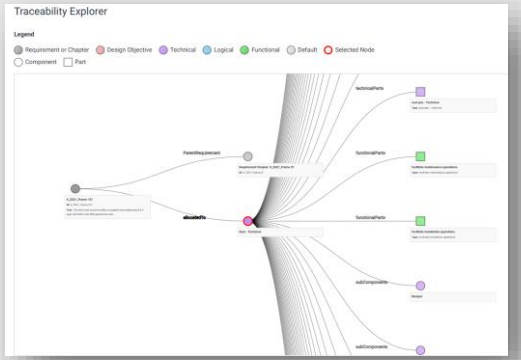

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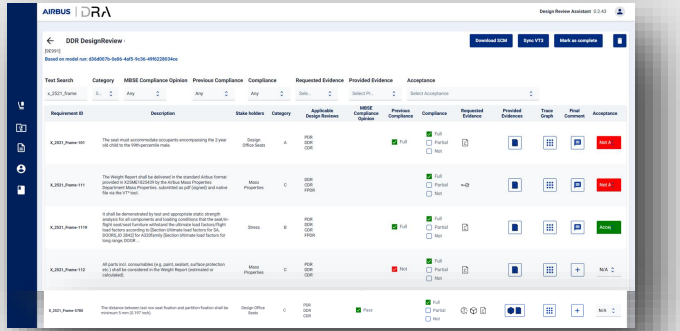


Conclusion and Outlook

Limitations and Future Considerations

- **Initial Investment**

  Time consuming upfront (process development, training, iterations)

- Relies on Airbus and supplier using the **same toolset**

  Working on solutions to translate frameworks or collaborate with different tools

- Model spans across **Airbus and Supplier IP**

  Clear definition of responsibilities and ownership required

- **Export Control** Classification

  Working with Classification experts from Europe and the USA

- Cameo limitations for direct **integration of V&V tools**

  Exploring use of ecosystems

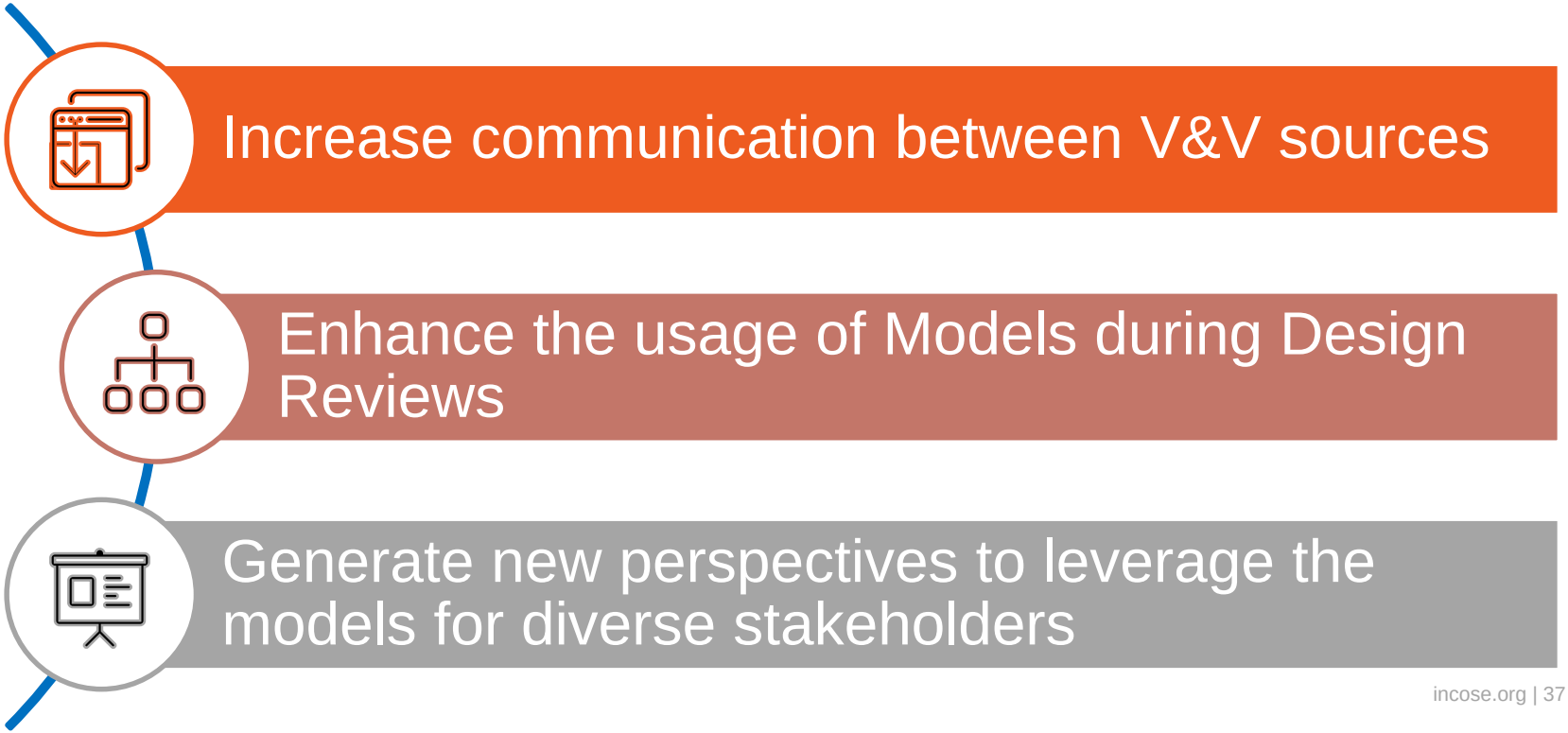
- **Significant number** of models expected

  Requires strong infrastructures and robust Product Life Cycle Management (PLM) strategy

Benefits

- **Improved requirements**
- Applicable **requirements narrowed down** with variation points setup (**MBPLE**)
- End to End **traceability** of Requirements and Model Elements across layers and levels
- **Early verification** of requirements
- **High reusability** of models thanks to 150%/120%/100% configurations
- User interface allows non-modelers to **understand the Systems Model**
- **Informed compliance checks** performed in the Design Review Assistant

Outlook


Increase communication between V&V sources
Enhance the usage of Models during Design Reviews
Generate new perspectives to leverage the models for diverse stakeholders

Thank you!

Maxime Varoqui

Maxime.Varoqui@airbus.com

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+1 251 434 7492