



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

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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

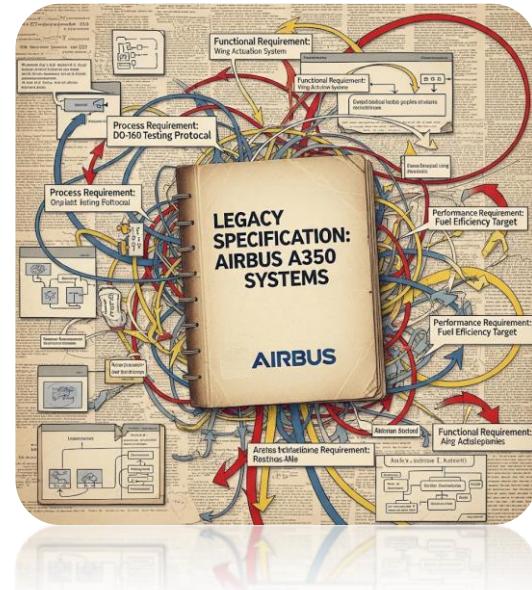


Introduction and Challenges

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 - Requirements sometimes not intelligible, outdated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

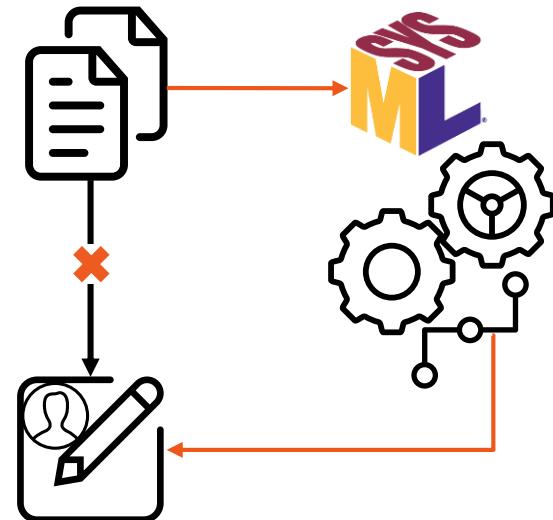
Model-Based Solution

The Foundation

Transforming Specifications

From Documents to Models

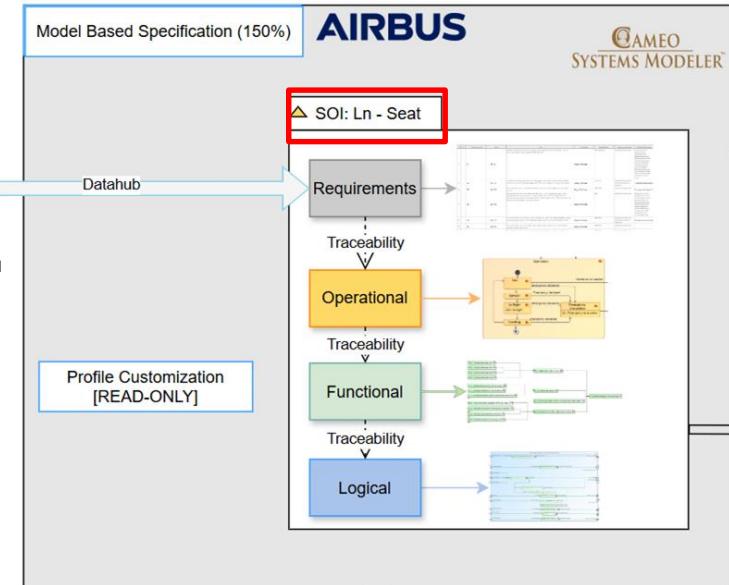
- Replace all the specification documents for Seats
 - Provide more context and traceability than traditional textual requirements
- Leverage and improve the existing Requirement management tool database
 - Rewriting, and deleting Requirements
 - Following the Guide to Writing Requirements (INCOSE/ISO 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



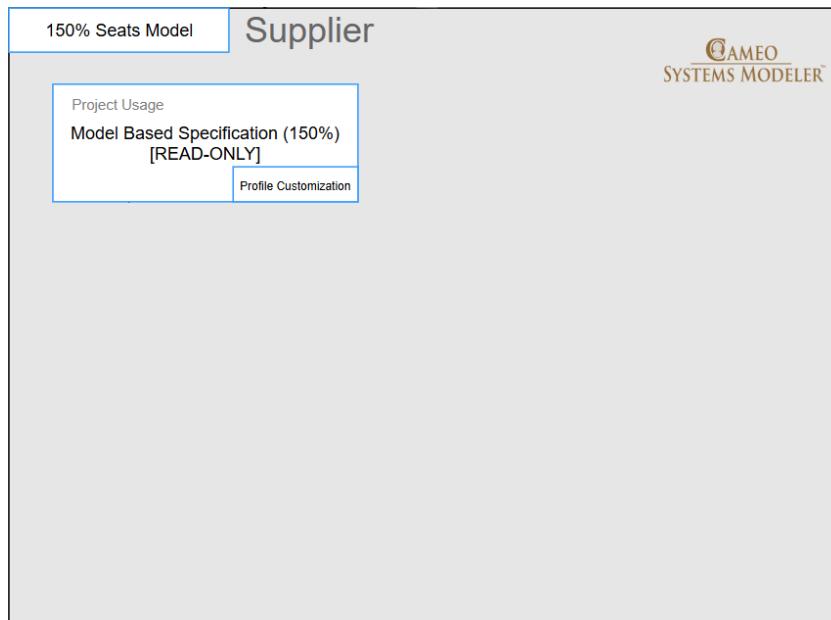
→ Model-Based Specification (MBS) is sent to seats suppliers alongside the traditional PDF documents

Collaborative Modeling

Bridging Airbus and Suppliers' Designs

Collaborative Modeling

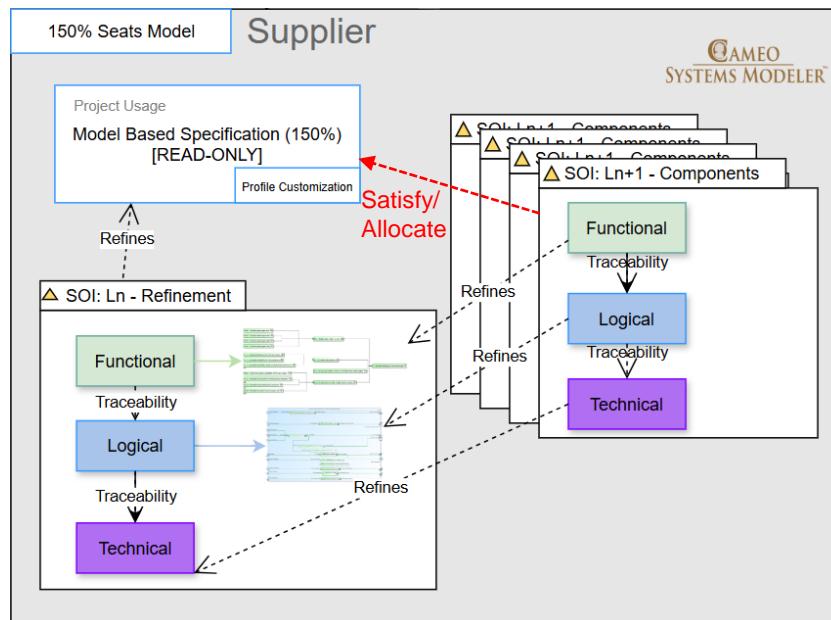
Systems Model MOFLT Structure



- 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

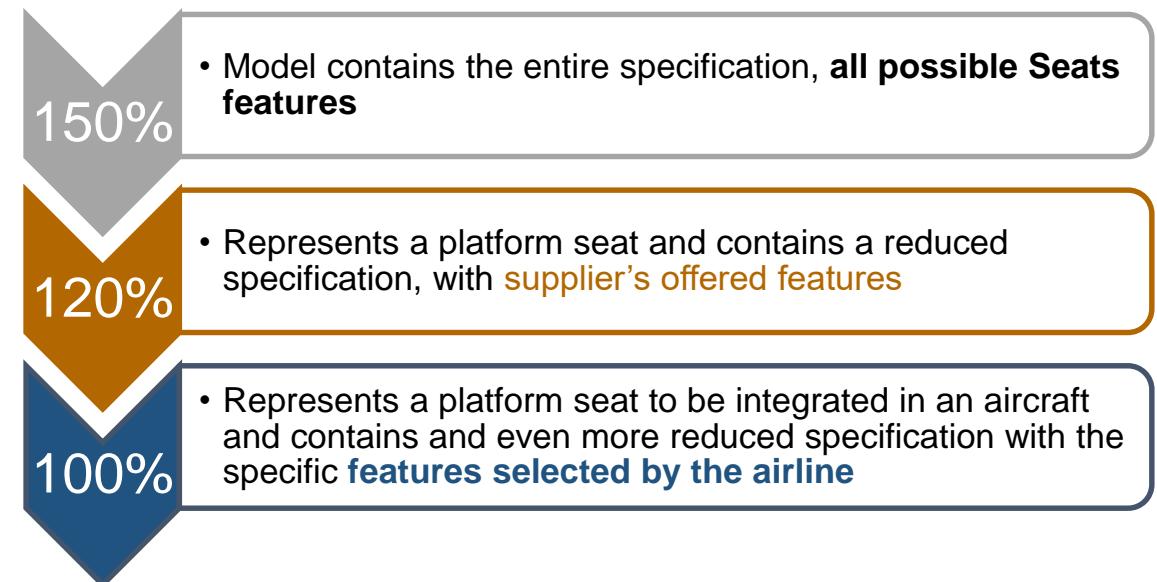
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 - Supplier builds their **Functional**, **Logical** layers refining Airbus Functional, and Logical specification
 - Supplier is responsible for building the **Technical** Layer
- Development of Components' Viewpoints (new Systems of Interests) by 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



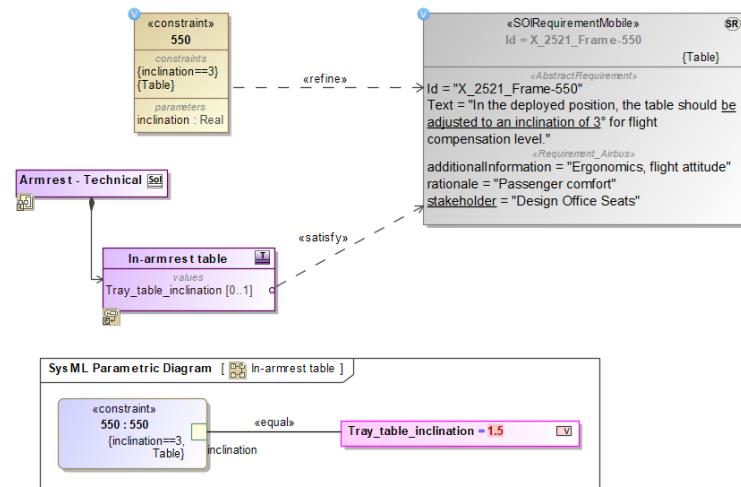
Collaborative Modeling

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%)

Original Live Model

Model Copy

AIRBUS

Teamwork Cloud

Trunk

Profile Customization

Project Usage

Model Based Specification (150%)

Update from Local

Update from Local

Trunk

Profile Customization

Project Usage

Model Based Specification (150%)

Supplier Teamwork Cloud

Original Live Model

Model Copy

AIRBUS

Teamwork Cloud

Trunk

Profile Customization

Project Usage

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Update from Local

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Model Based Specification (150%)

Project Usage

150% Seat Model

Supplier

 Teamwork Cloud

Original Live Model

Model Copy

AIRBUS

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Profile Customization

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Model Based Specification (150%)

Project Usage

150% Seat Model

Update from Local

Update from Local

Update from Local

Trunk

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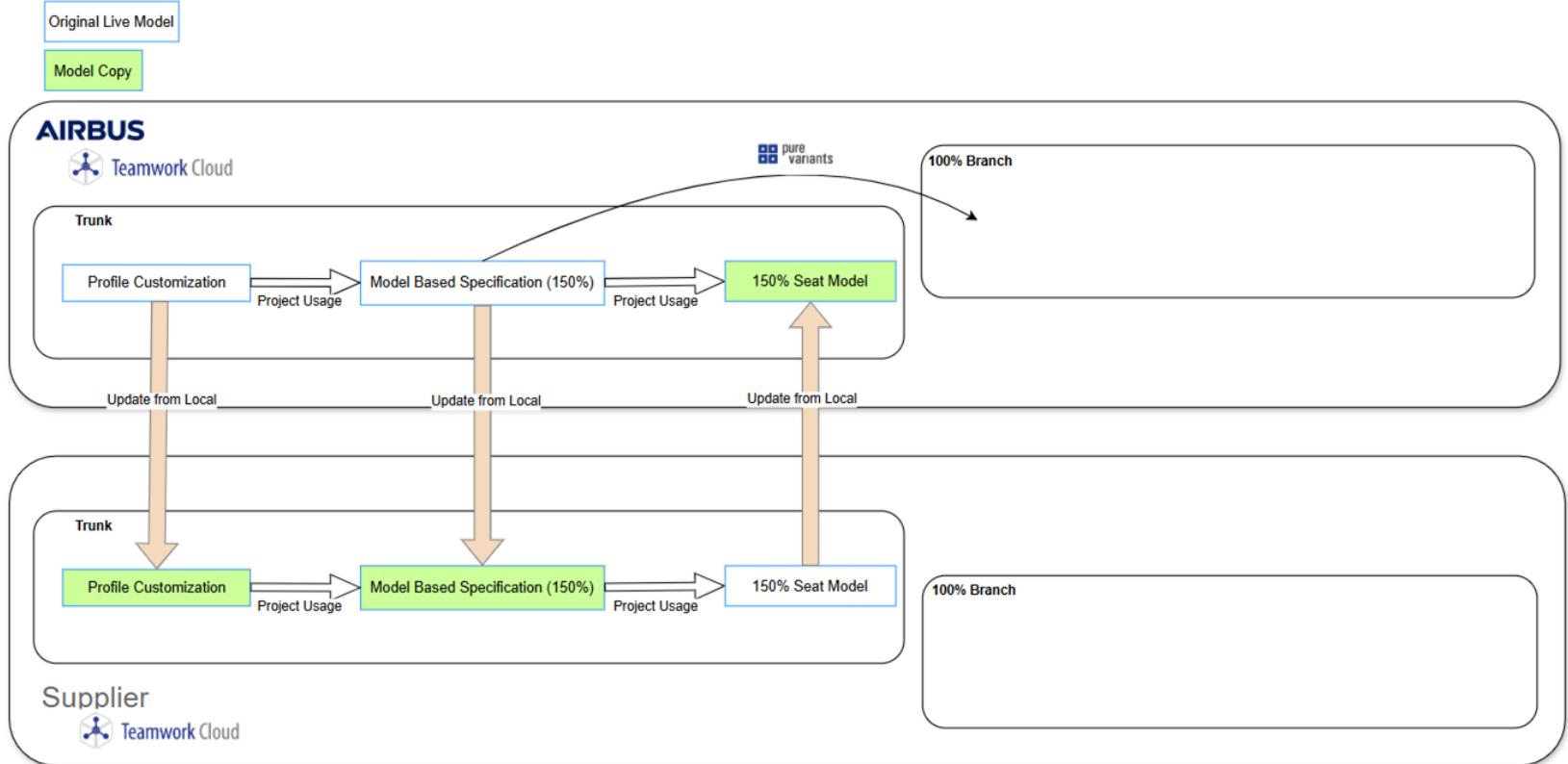
Model Based Specification (150%)

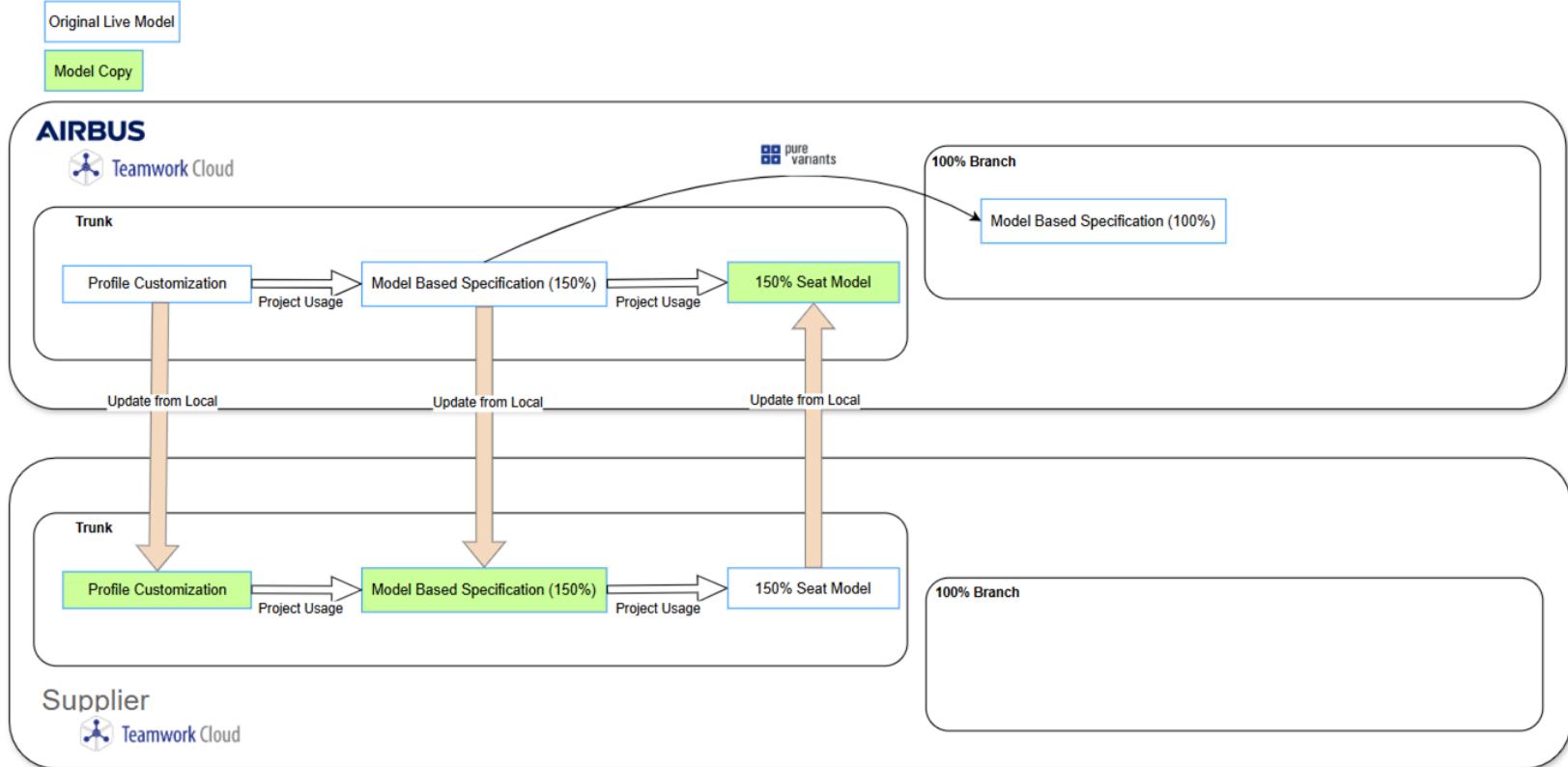
Project Usage

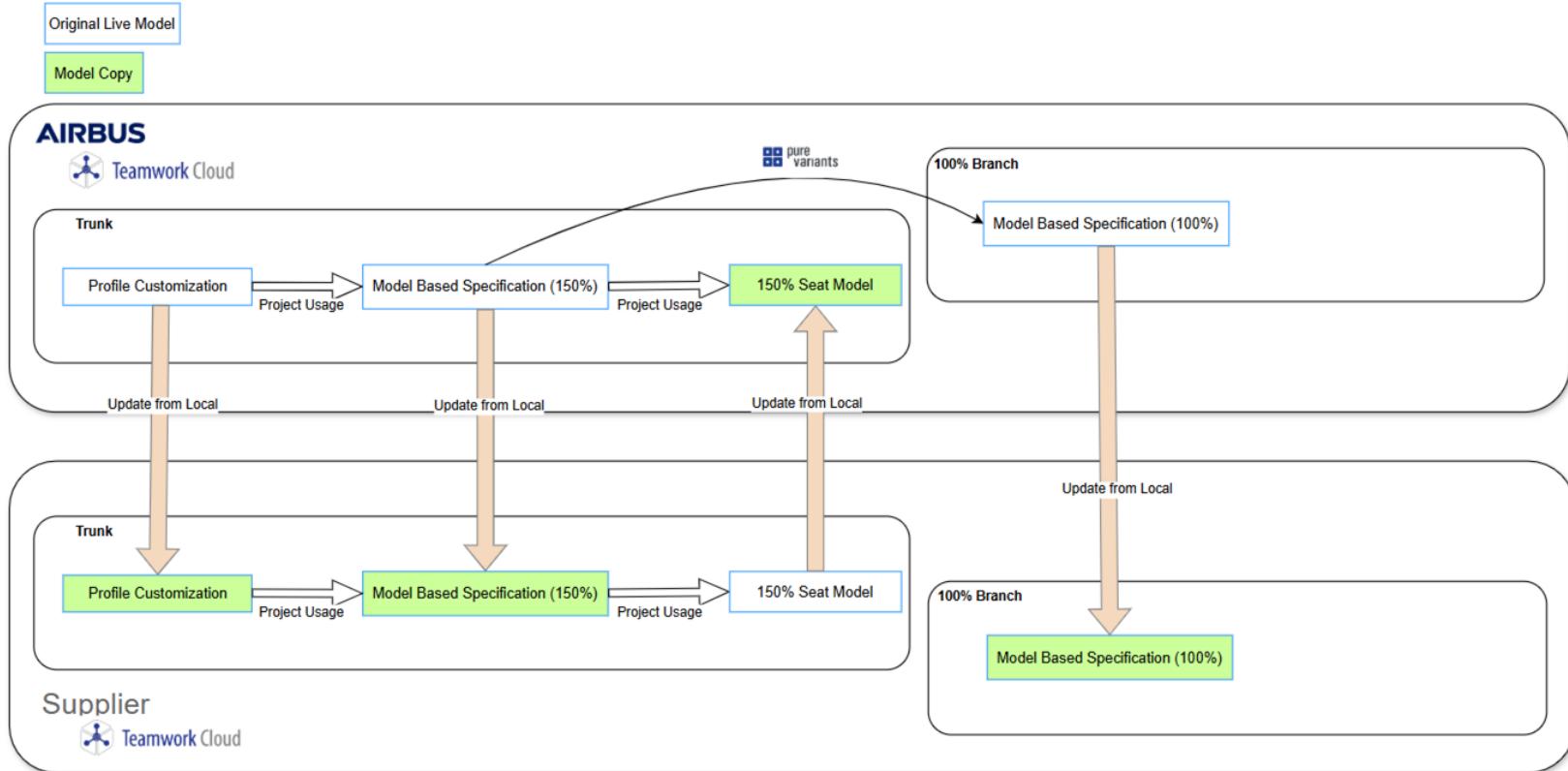
150% Seat Model

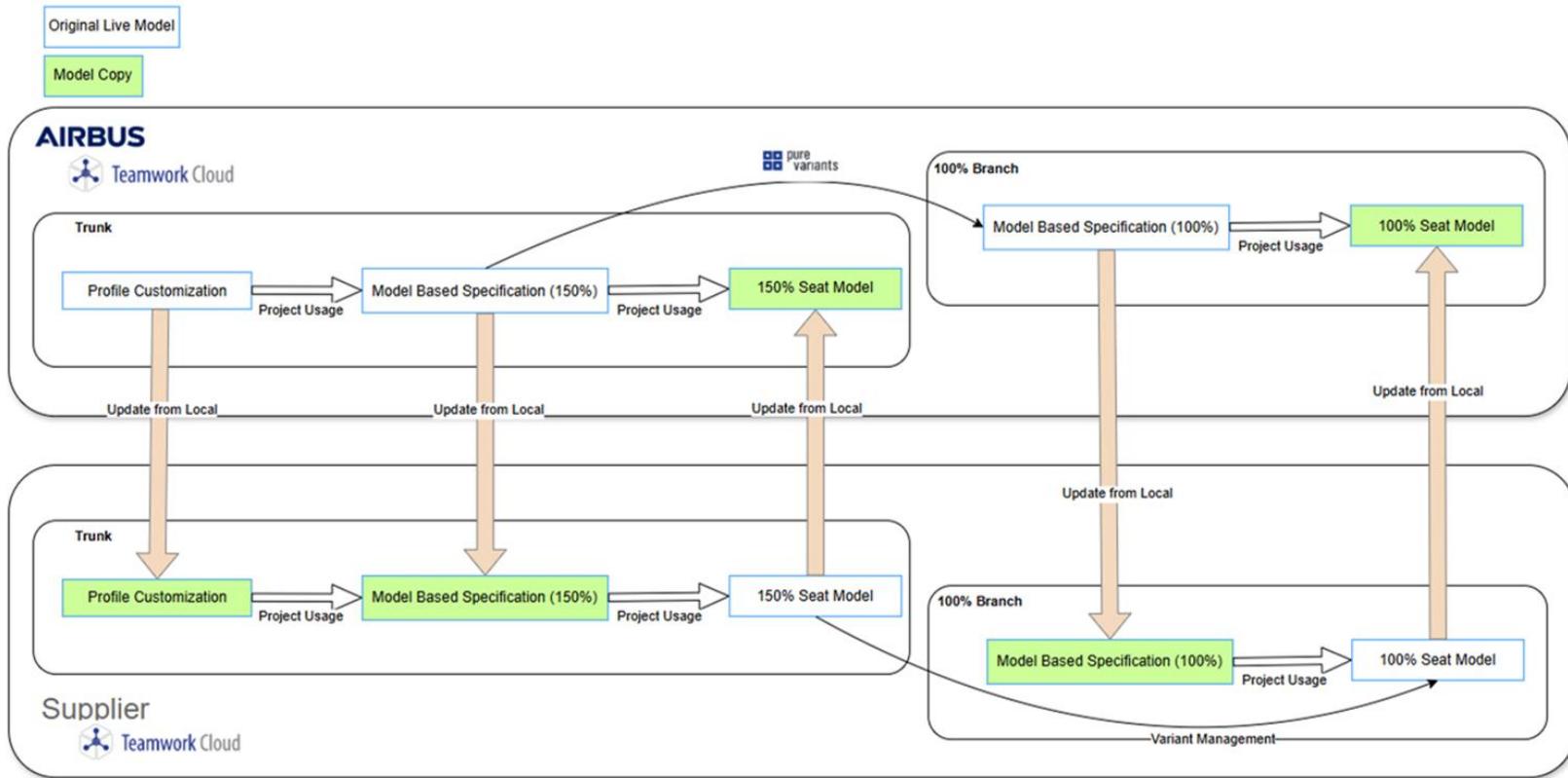
Supplier

 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

```
    "_2021x_2_ae00251_1725998105020_104885_4446": "X_2521_Frame-5326",
    "_2021x_2_ae00251_1685711989264_728890_1918": "If there is more than one impact, for the final impact that is above the severity at which the ILD is intended to deploy, the maximum protection of the ILD must be provided.\n",
    "_2021x_2_ae00251_1694791489279_326642_124": "For ensurance of protection during secondary impacts.\n",
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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

DDR DesignReview - [00193]										Download SCM	Sync VT3	Mark as complete	Print	
Text Search	Category	MBSE Compliance Opinion	Previous Compliance	Compliance	Requested Evidence	Provided Evidence	Acceptance							
x_2521_fram...	S...	Any	Any	Any	S...	Select P...	Select Acceptance							
Requirement ID	Description			Stake holders	Category	Applicable Design Reviews	MBSE Compliance Opinion	Previous Compliance	Compliance	Requested Evidence	Provided Evidence	Trace Graph	Final Comment	
X_2521_fram-001	The seat must accommodate occupants encompassing the 2 year old child to the 95th percentile male.			Design Office Seats	A	PDF CDR CEIR	Full	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Not A
X_2521_fram-111	The Weight Recruit shall be delivered in the standard Airbus format provided in X32M12540 by the Airbus Mass Properties Department, Engineering, submitted as PDF (signed) and valve file via the VT3.			Mass Properties	C	CDR CEIR PDF	Full	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Not A
X_2521_fram-111	It shall be demonstrated by test and/or appropriate static strength analysis for all components and loadings considered that the seat-in-flight seat/seat fixture combination will withstand the ultimate load factors of 10.0 and 10.5 for the X32M12540 and X32M12541 respectively. The ultimate load factors for the X32M12540 and X32M12541 shall be 1.5 times the static load factors for the X32M12540 and X32M12541 respectively.			Stress	B	PDF CDR CEIR PDF	Full	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Not A
X_2521_fram-111	All parts incl. consumables (e.g. paint, sealant, surface protection etc.) shall be considered in the Weight Recruit (estimated or measured).			Mass Properties	C	PDF CDR CEIR	Not	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	N/A

Design Review Assistant

AIRBUS | DRA

Design Review Assistant 0.2.43

DDR DesignReview - [9E991]
Based on model run: d36d007b-0e06-4af5-9c36-49f6228034ce

Download SCM Sync VT3 Mark as complete

Text Search Category MBSE Compliance Opinion Previous Compliance Compliance Requested Evidence Provided Evidence Acceptance

x_2521_frame S... Any Any Any Any Select Pr... Select Acceptance

Requirement ID Description Stake holders Category Applicable Design Reviews MBSE Compliance Opinion Previous Compliance Compliance Requested Evidence Provided Evidences Trace Graph Final Comment Acceptance

X_2521_Frame-101 The seat must accommodate occupants encompassing the 2-year old child to the 99th-percentile male. Design Office Seats A PDR DDR CDR Full Partial Not     

X_2521_Frame-111 The Weight Report shall be delivered in the standard Airbus format provided in X25ME1825439 by the Airbus Mass Properties Department Mass Properties. submitted as pdf (signed) and native file via the VT* tool. Mass Properties C DDR CDR FPDR Full Partial Not     

X_2521_Frame-1119 It shall be demonstrated by test and appropriate static strength analysis for all components and loading conditions that the seat/in-flight seat/seat furniture withstand the ultimate load factors/flight load factors according to [Section Ultimate load factors for SA, DOORS_ID 2842] for A320family [Section Ultimate load factors for long range, DOOR ... Stress B PDR DDR CDR FPDR Full Partial Not     

X_2521_Frame-112 All parts incl. consumables (e.g. paint, sealant, surface protection etc.) shall be considered in the Weight Report (estimated or calculated). Mass Properties C PDR DDR CDR Not Full Partial Not      

X_2521_Frame-5780 The distance between last row seat fixation and partition fixation shall be minimum 5 mm (0.197 inch). Design Office Seats C PDR DDR CDR Pass Full Partial Not      

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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.

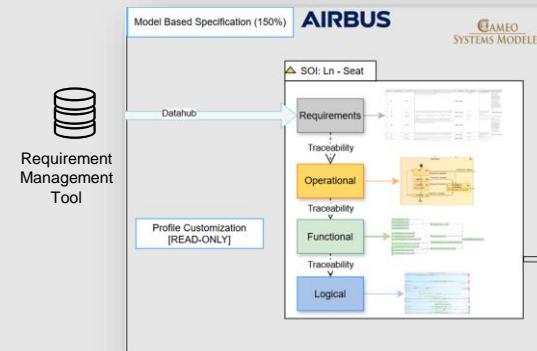
Requirement ID	Description	Stakeholders	Category	Applicable Design Reviews	MBSE Compliance Opinion	Previous Compliance	Requested Evidence	Provided Evidence	Acceptance
Integration-1004	Electrical boxes shall be installed in a way that fluid ingress into connectors is impossible.	ICDS	C	DDR CDR	<input checked="" type="checkbox"/> Full <input type="checkbox"/> Partial <input type="checkbox"/> Not	<input type="checkbox"/> Full <input type="checkbox"/> Partial <input type="checkbox"/> Not	<input type="checkbox"/> Full <input type="checkbox"/> Partial <input type="checkbox"/> Not	<input checked="" type="checkbox"/> Full <input type="checkbox"/> Partial <input type="checkbox"/> Not	Done
Integration-1012	The electrical box port (color) allocation shall be executed according to ARINC 809-2, section "Electrical Interface".	A330/A340 ML-DLXC	C	DDR CDR	<input checked="" type="checkbox"/> Full <input type="checkbox"/> Partial <input type="checkbox"/> Not	<input type="checkbox"/> Full <input type="checkbox"/> Partial <input type="checkbox"/> Not	<input type="checkbox"/> Full <input type="checkbox"/> Partial <input type="checkbox"/> Not	<input checked="" type="checkbox"/> Full <input type="checkbox"/> Partial <input type="checkbox"/> Not	N/A
Integration-1016	The SDU shall be mounted in any suitable position for passenger viewing.	ICDS	C	DDR CDR PDR	<input checked="" type="checkbox"/> Full <input type="checkbox"/> Partial <input type="checkbox"/> Not	<input type="checkbox"/> Full <input type="checkbox"/> Partial <input type="checkbox"/> Not	<input type="checkbox"/> Full <input type="checkbox"/> Partial <input type="checkbox"/> Not	<input checked="" type="checkbox"/> Full <input type="checkbox"/> Partial <input type="checkbox"/> Not	N/A
Integration-1024	The armrest mounted SDU shall be in a safe mode when stowed. Refer to the SDU supplier's installation requirements.	ICDS	B	DDR CDR	<input checked="" type="checkbox"/> Full <input type="checkbox"/> Partial <input type="checkbox"/> Not	<input type="checkbox"/> Full <input type="checkbox"/> Partial <input type="checkbox"/> Not	<input type="checkbox"/> Full <input type="checkbox"/> Partial <input type="checkbox"/> Not	<input checked="" type="checkbox"/> Full <input type="checkbox"/> Partial <input type="checkbox"/> Not	N/A

Objective

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

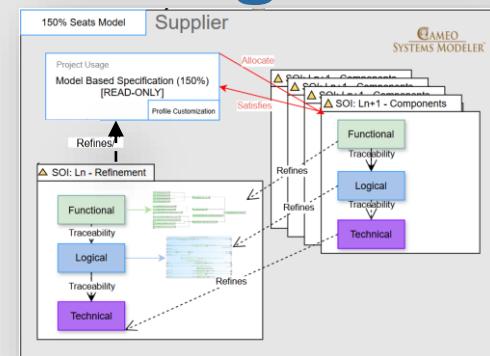
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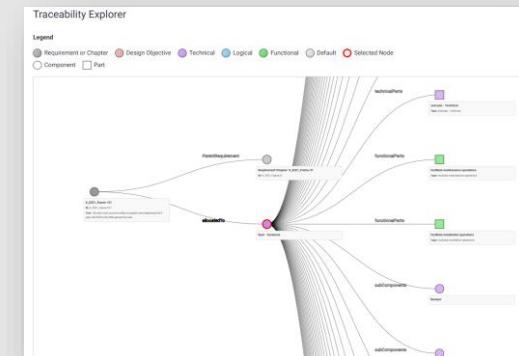
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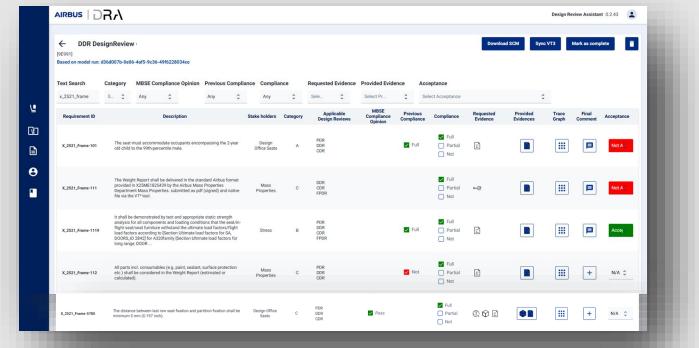
Objective

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Objective

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



The screenshot shows the AIRBUS DRA software interface for Design Review Assistant. The main view displays a table of requirements with columns for Requirement ID, Description, Stakeholders, Category, Applicable Design Norms, Previous Compliance, Requested Evidence, Provided Evidence, and Acceptance. Each requirement row includes a detailed description and a status summary for each column. The interface is designed for tracking and managing design review activities across multiple phases and stakeholders.

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

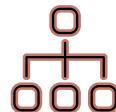
Benefits

- **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!



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