How to make your Data as durable as your Products

Bernd Feldvoss, Airbus
Jochen Boy, PROSTEP AG

prostep ivip Symposium
Stuttgart, 3 May 2023

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How to make your Data as durable as your Products

1. Requirements & Processes
2. EN9300: The LOTAR Standard
3. Preservation Planning
4. Auditing

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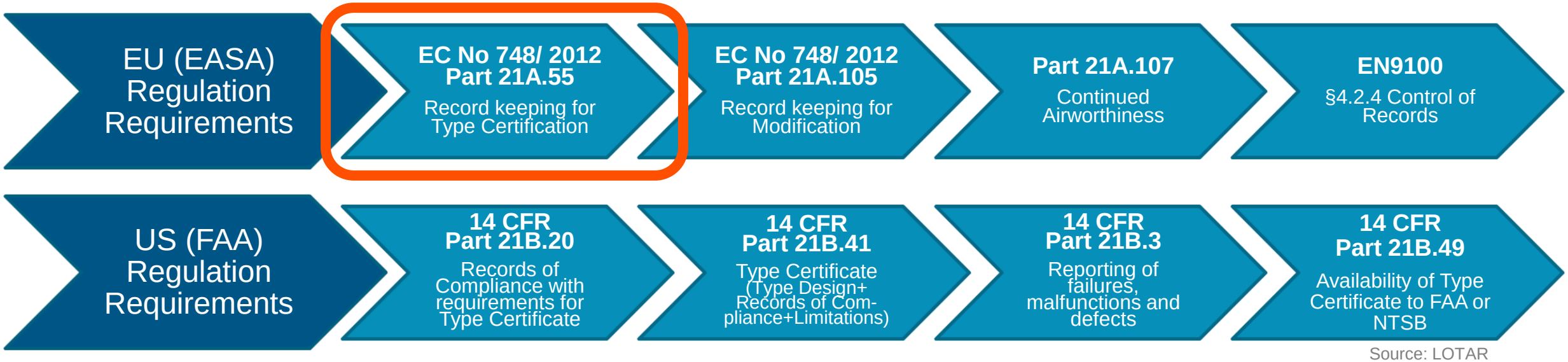
Regulatory Requirements for Long-Term Archiving regarding Aircraft Certification and Safety

Document & Data Archiving is a legal obligation defined by external requirements and by internal company policies.



Source: LOTAR

The FAA and EASA have promoted efforts to harmonize the regulations, so there are many similarities between them.

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What EASA requests for long-term archiving…

The **EASA Part-21** (Certification of aircraft and related products, parts and appliances, and of design and production organisation) also contains the requirements for archiving:

21.A.5 Record-keeping

Regulation (EU) 2021/699

All relevant design information, drawings and test reports, including inspection records for the product or article tested for the purpose of certification, shall be held by the holder of a type-certificate, restricted type-certificate, supplemental type-certificate, design change or repair design approval or of an ETSO authorisation at the disposal of the Agency and shall be retained in order to provide the information necessary to ensure the continued airworthiness, continued validity of the operational suitability data and the compliance with the applicable environmental protection requirements of the product or the article.

[applicable from 18 May 2022]

GM1 21.A.5 Repair designs and record keeping

ED Decision 2021/007/R

For repair designs, the record-keeping requirement of point 21.A.5 applies to the data described in AMC 21.A.433(a).

[applicable from 18 May 2022]

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…and how Airbus put it into action for the A350 program

In 2009, a CRI was signed in order to agree on the rules for archiving of 3D data. Just a few of them…

European Aviation Safety Agency	Airbus A350 CERTIFICATION REVIEW ITEM	Ref.:	A-02
		Issue:	2
		Status:	Closed
		Date:	13.10.2009
		Page:	1 of 4
		Next Action:	

Subject:	**Digital three-dimensional data for Type Design definition**
Category:	**Interpretative Material**
Requirements:	Part 21A.4, 21A.31(a)(1) and (a)(2), 21A.55, 21A.133

Authorities shall have **access to these data** when required. For practicability reasons it might be the case that this access can only be provided in the Airbus facilities.

For distribution purpose, it must be possible to derive the visualization format from the 3D CAD design data, which **must not alter the content and must be fully consistent with the original 3D CAD design** definition

For every 3D CAD design data change, the 3D visualization record must be **replaced upon official release of the design data** (automatic update of such 3D visualization record is preferred)

The 3D design data must be **archived with a reliable and harmonized process** so that the **original content is preserved**. The IT obsolescence shall not endanger these data.

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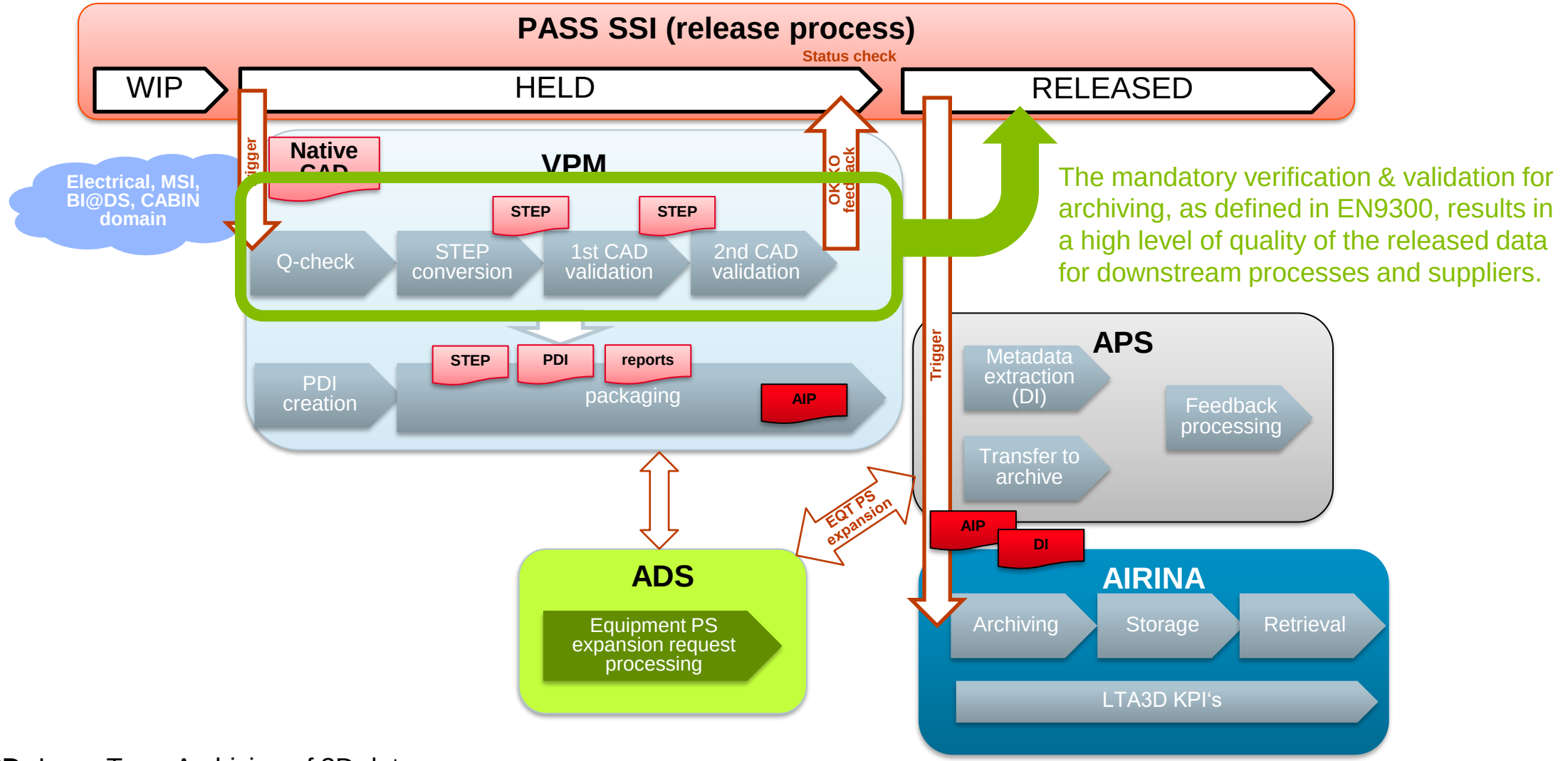
LTA3D A350: Archiving process is integral part of release process



LTA3D: Long-Term Archiving of 3D data

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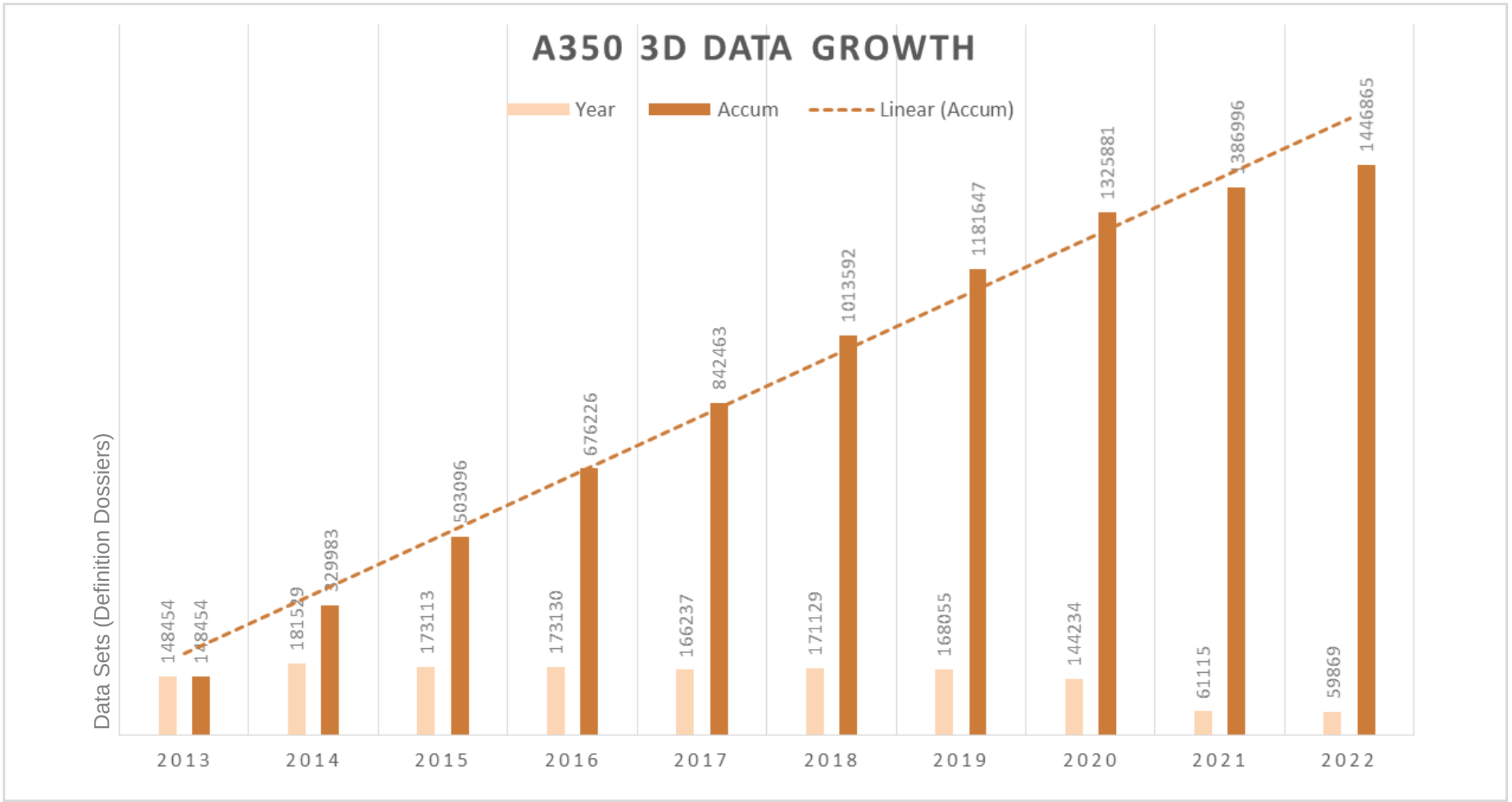
LTA3D Archival Growth (A350)



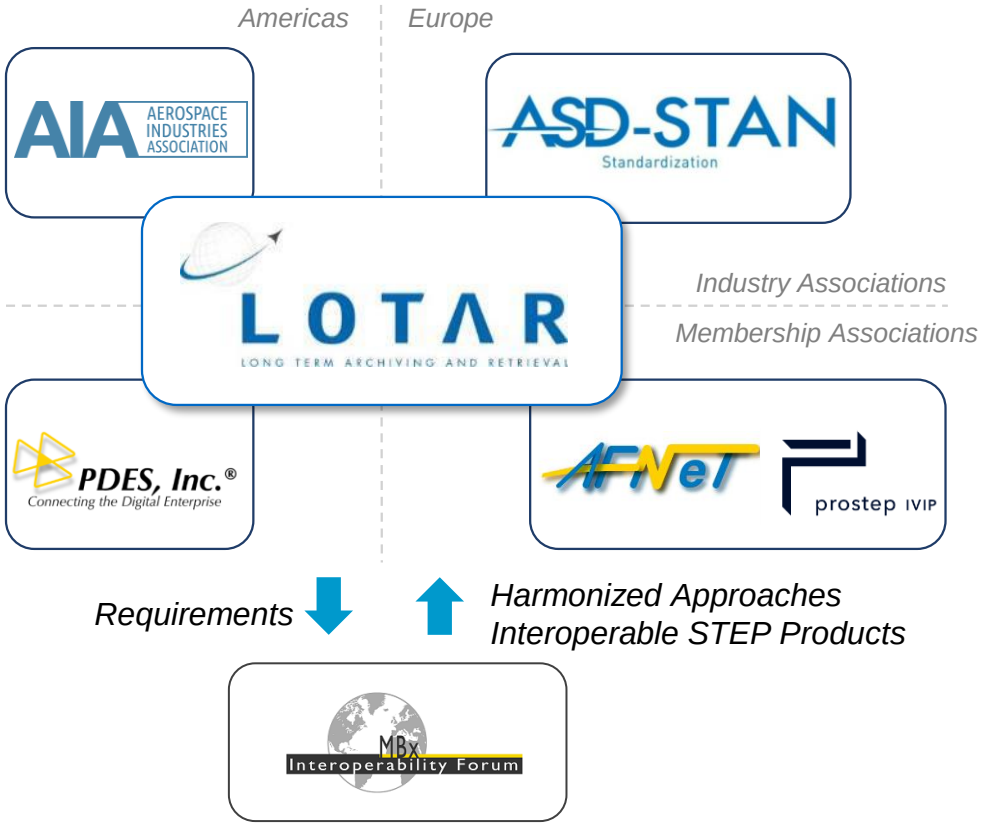
LOTAR Overview

www.lotar-international.org

- Long Term Arching and Retrieval (LOTAR) is an international consortium of Aerospace manufacturers
- Prime objective is creation and deployment of the **EN/NAS 9300 series of standards** for long-term archiving and retrieval of digital data, based on standardized approaches and solutions.
- Integration of LOTAR requirements in software tools ensured by close cooperation with the

MBx Interoperability Forum (MBx-IF):

- Facilitated by AFNeT, PDES Inc. and prostep ivip
- Consists of CAD, PDM, and Electrical Wiring Interconnection System (EWIS) STEP Translator & Validation Tool vendors
- Supports STEP AP242 “Managed Model-Based 3D Engineering”



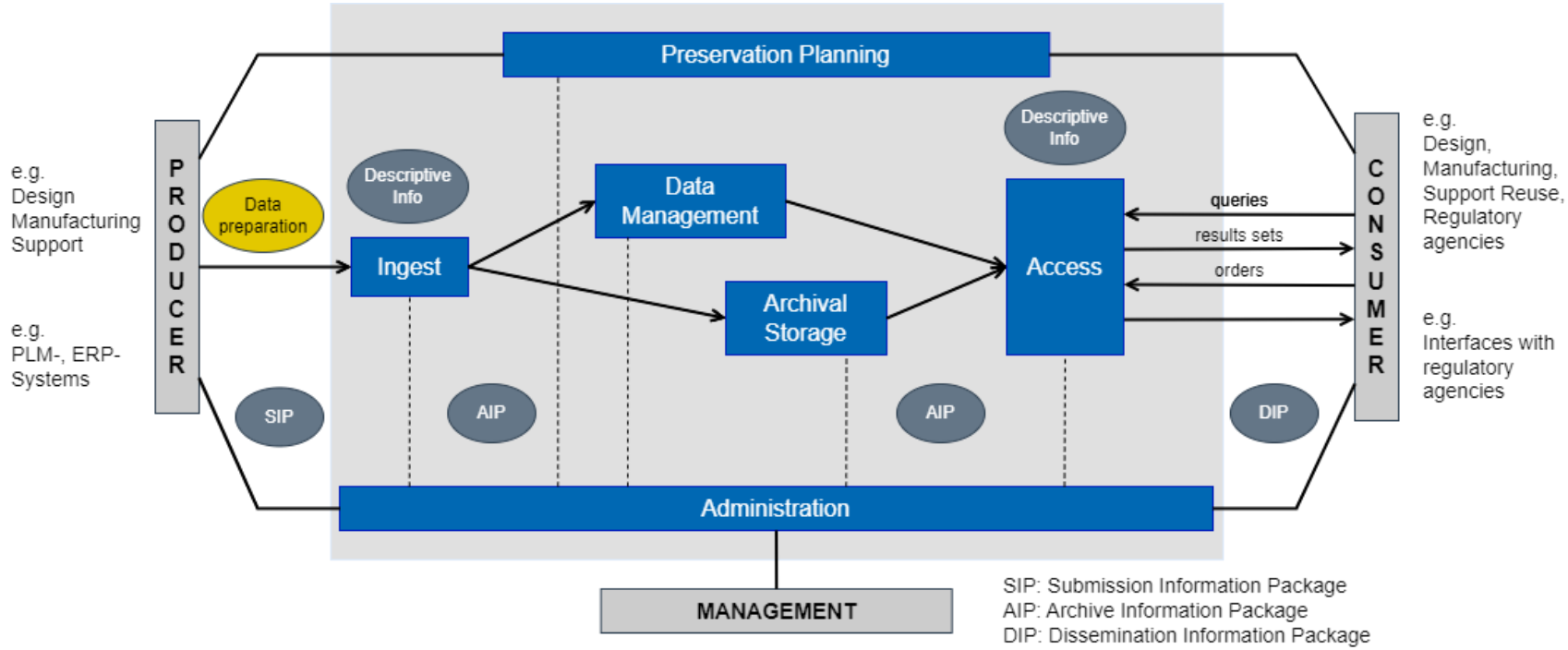
EN = European Norm (Standard) - ASD-STAN
NAS = National Aerospace Standard - AIA
MBx = Mobel-Based “x” (Design, Engineering…)

LOTAR Member Companies

2023

LOTAR Standard Foundation
ISO 14721:2012 (OAIS)

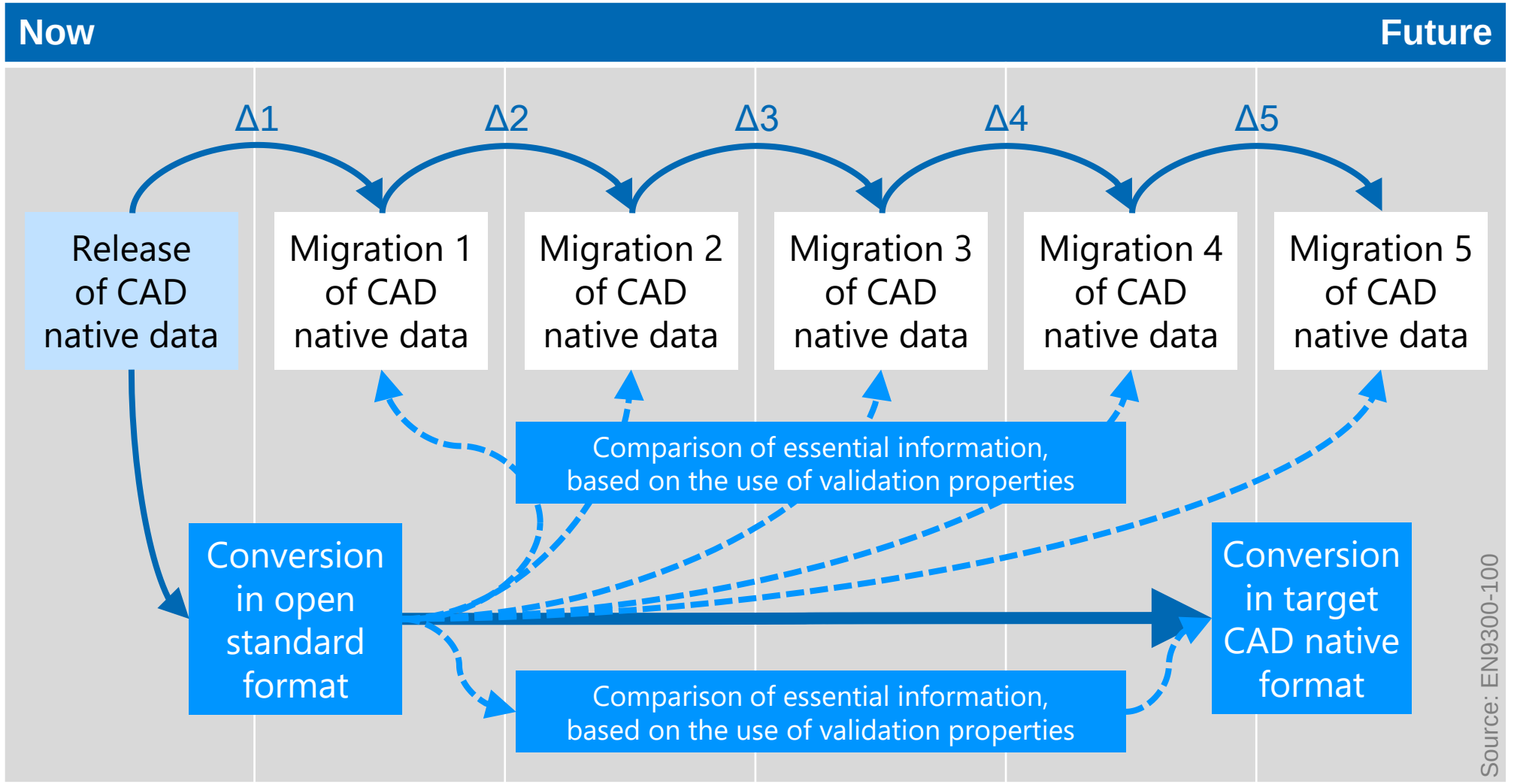
- "Open Archive Information System" (OAIS) Reference Model provides basis for LOTAR processes
- LOTAR is jointly developed by the Aerospace and Defence Industry
- Extends OAIS to meet the industry-specific requirements as defined by EASA and FAA



- Neutral data formats have been chosen for the archives (ISO 10303 STEP and other standards)

CAD Migration Strategies

Process to demonstrate the equivalence of aerospace product models,
based on preservation of essential information, with validation & verification rules.



LOTAR Standards Overview

Data Domain Specific Parts

3D Mechanical CAD & PMI	Product Management Data & Configured Product Structure	Composite Design & Advanced Manufacturing	Electric Wiring Harness	Model-Based Systems Engineering	Engineering Analysis and Simulation	Electronics *(not started)*
P1xx	**P2xx**	**P3xx**	**P4xx**	**P5xx**	**P6xx**	**P7xx**

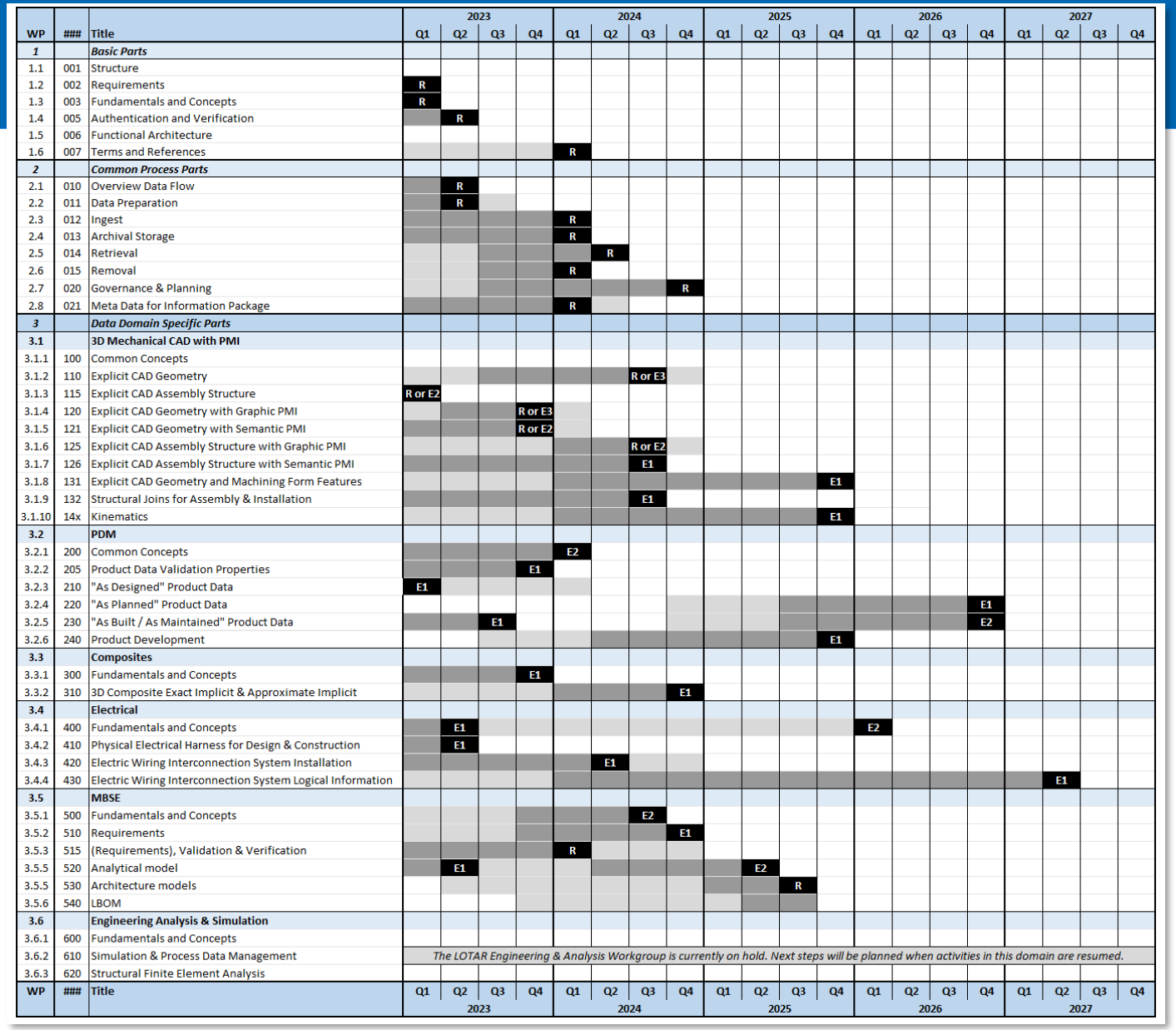
Common Process Parts

(Common Process, Data Preparation, Ingest, Archival Storage, Retrieval, ...)

Basic Parts

(Overview, Requirements, Fundamentals, Methods, ...)

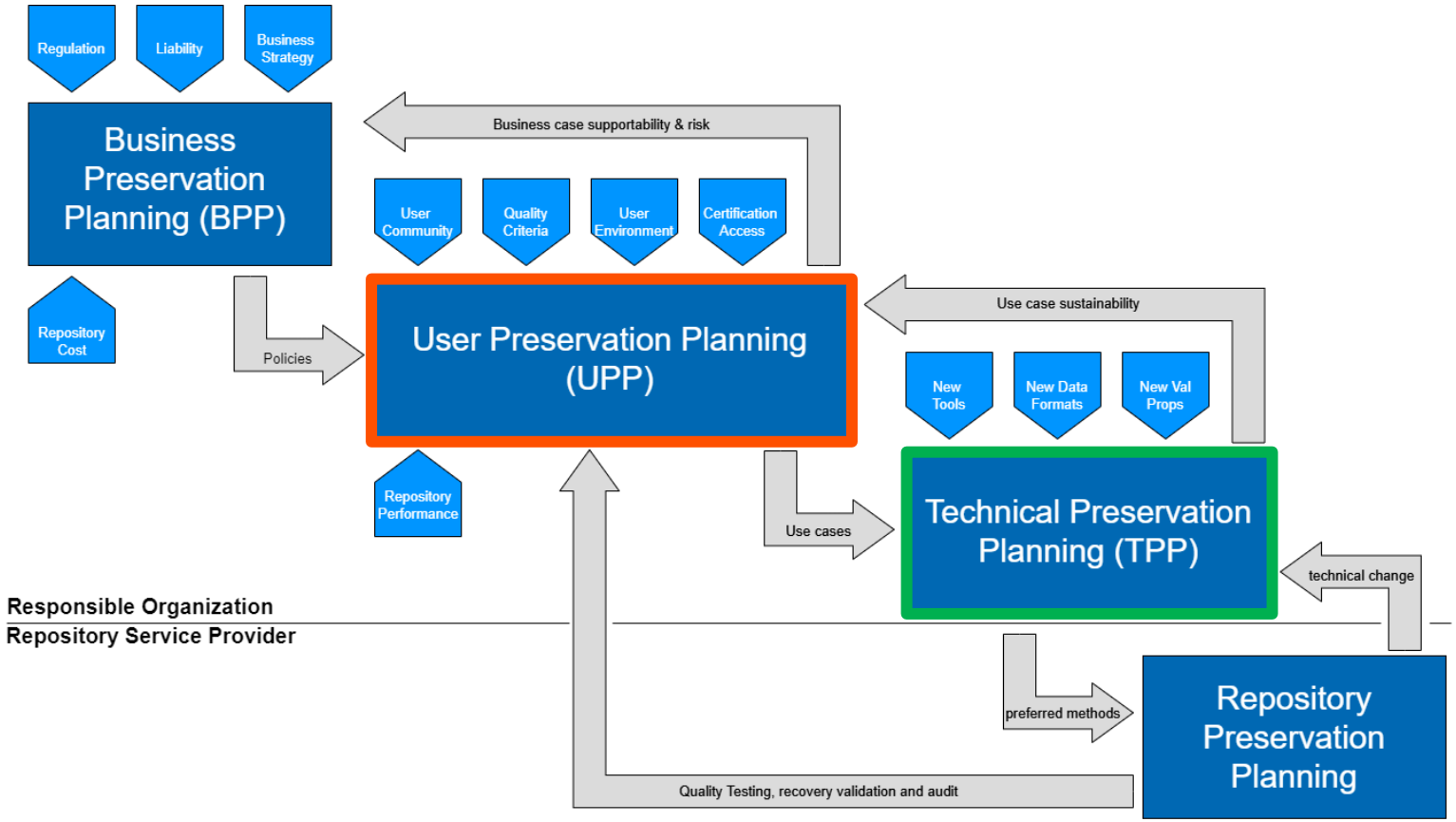
LOTAR 5-Year Roadmap



WP	###	Title	2023 Q1	2023 Q2	2023 Q3	2023 Q4	2024 Q1	2024 Q2	2024 Q3	2024 Q4	2025 Q1	2025 Q2	2025 Q3	2025 Q4	2026 Q1	2026 Q2	2026 Q3	2026 Q4	2027 Q1	2027 Q2	2027 Q3	2027 Q4
1		***Basic Parts***																				
1.1	001	Structure																				
1.2	002	Requirements	R																			
1.3	003	Fundamentals and Concepts	R																			
1.4	005	Authentication and Verification		R																		
1.5	006	Functional Architecture																				
1.6	007	Terms and References					R															
2		***Common Process Parts***																				
2.1	010	Overview Data Flow		R																		
2.2	011	Data Preparation		R																		
2.3	012	Ingest					R															
2.4	013	Archival Storage					R															
2.5	014	Retrieval						R														
2.6	015	Removal					R															
2.7	020	Governance & Planning								R												
2.8	021	Meta Data for Information Package					R															
3		***Data Domain Specific Parts***																				
3.1		**3D Mechanical CAD with PMI**																				
3.1.1	100	Common Concepts																				
3.1.2	110	Explicit CAD Geometry							R or E3													
3.1.3	115	Explicit CAD Assembly Structure	R or E2																			
3.1.4	120	Explicit CAD Geometry with Graphic PMI				R or E3																
3.1.5	121	Explicit CAD Geometry with Semantic PMI				R or E2																
3.1.6	125	Explicit CAD Assembly Structure with Graphic PMI							R or E2													
3.1.7	126	Explicit CAD Assembly Structure with Semantic PMI							E1													
3.1.8	131	Explicit CAD Geometry and Machining Form Features												E1								
3.1.9	132	Structural Joins for Assembly & Installation							E1													
3.1.10	14x	Kinematics												E1								
3.2		**PDM**																				
3.2.1	200	Common Concepts					E2															
3.2.2	205	Product Data Validation Properties				E1																
3.2.3	210	"As Designed" Product Data	E1																			
3.2.4	220	"As Planned" Product Data																E1				
3.2.5	230	"As Built / As Maintained" Product Data			E1													E2				
3.2.6	240	Product Development												E1								
3.3		**Composites**																				
3.3.1	300	Fundamentals and Concepts				E1																
3.3.2	310	3D Composite Exact Implicit & Approximate Implicit								E1												
3.4		**Electrical**																				
3.4.1	400	Fundamentals and Concepts		E1											E2							
3.4.2	410	Physical Electrical Harness for Design & Construction		E1																		
3.4.3	420	Electric Wiring Interconnection System Installation						E1														
3.4.4	430	Electric Wiring Interconnection System Logical Information																		E1		
3.5		**MBSE**																				
3.5.1	500	Fundamentals and Concepts							E2													
3.5.2	510	Requirements								E1												
3.5.3	515	(Requirements), Validation & Verification					R															
3.5.5	520	Analytical model		E1								E2										
3.5.5	530	Architecture models											R									
3.5.6	540	LBOM																				
3.6		**Engineering Analysis & Simulation**																				
3.6.1	600	Fundamentals and Concepts																				
3.6.2	610	Simulation & Process Data Management	*The LOTAR Engineering & Analysis Workgroup is currently on hold. Next steps will be planned when activities in this domain are resumed.*																			
3.6.3	620	Structural Finite Element Analysis																				
WP	###	Title	2023 Q1	2023 Q2	2023 Q3	2023 Q4	2024 Q1	2024 Q2	2024 Q3	2024 Q4	2025 Q1	2025 Q2	2025 Q3	2025 Q4	2026 Q1	2026 Q2	2026 Q3	2026 Q4	2027 Q1	2027 Q2	2027 Q3	2027 Q4

Source: LOTAR Homepage

Different Levels of Preservation Planning



Preservation planning based on EN9300 Part 020 [LOTAR-2012]

- **Business Preservation Planning (BPP)** develops and documents the long-term data **retention strategy** of the responsible organization.

- **User Preservation Planning (UPP)** ensures that BPP retention **policies are implemented**.

- **Technical Preservation Planning (TPP)** provides expertise in the way that product information is **develop**ed, both in terms of **how processes use software** to represent aspects of the product, and the way in which information is represented when being transferred between different software products.

- **Repository Preservation Planning (RPP)** is concerned with minimizing the costs and risks associated with the way that data is held in the **archive**.

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LTA3D Preservation Assessments (due to EN9300)

Periodic Assessment
Non-Recursive / Native CAD
All domains: Electrical, BI@DS, MSI, Cabin

Purpose – Check data can be retrieved and converted to Native CAD without loss of quality

Litigation Assessment
Recursive / STEP
All domains

Purpose – Check system performance, robustness and completeness in case of legal request against a pre-defined list of expected retrieval results

Technical Assessment
Recursive / STEP & Native CAD

- R18
- R21
- R27

Purpose – Check full product structure can be retrieved in both Native CAD and STEP

Large file Assessment
Non-Recursive / Native CAD
Top 10 largest archived data files

Purpose – Check system performance when processing very large TAR packages

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Preservation Planning Assessments – A350 Periodic

Output from this step:

			PA Preparation		PA Overall Results		PA Detailed Results			
							Conversion		Validation	
AIP Category	Source CAD System	Content Information Standard	PoP Size	Sample Size	PA OK or Warning	PA Succ Rate	Conv OK	Conv Succ Rate	Val OK	Val Succ Rate
CAD 3D Exact Geometry	CATIA V5R18 SP2	AP214 ISO Edition 3	28283	648	648	100.00%	648	100.00%	648	100.00%
CAD 3D Assembly Structure	CATIA V5R18 SP2	AP214 ISO Edition 3	33034	650	650	100.00%	650	100.00%	650	100.00%
CAD 3D Annotation	CATIA V5R18 SP2	AP214 ISO Edition 3	12611	630	630	100.00%	630	100.00%	630	100.00%
CAD 3D Tessellated Geometry	CATIA V5R18 SP2	AP242 ISO	50510	654	654	100.00%	654	100.00%	653	99.85%
CAD 3D Exact Geometry	CATIA V5R21 SP2	AP214 ISO Edition 3	306233	662	662	100.00%	662	100.00%	654	98.79%
CAD 3D Assembly Structure	CATIA V5R21 SP2	AP214 ISO Edition 3	241837	661	661	100.00%	661	100.00%	661	100.00%
CAD 3D Annotation	CATIA V5R21 SP2	AP214 ISO Edition 3	651	328	328	100.00%	328	100.00%	320	97.56%
CAD 3D Tessellated Geometry	CATIA V5R21 SP2	AP242 ISO	276754	661	661	100.00%	661	100.00%	661	100.00%
CAD 3D Exact Geometry	CATIA V5-6R2017 SP2	AP242 ISO Edition 1	80928	658	656	99.70%	656	99.70%	654	99.39%
CAD 3D Assembly Structure	CATIA V5-6R2017 SP2	AP242 ISO Edition 1	64429	656	656	100.00%	656	100.00%	656	100.00%
CAD 3D Annotation	CATIA V5-6R2017 SP2	AP242 ISO Edition 1	106870	659	659	100.00%	659	100.00%	659	100.00%
CAD 3D Tessellated Geometry	CATIA V5-6R2017 SP2	AP242 ISO Edition 1	75684	657	657	100.00%	657	100.00%	657	100.00%
			1277824	7524	7522	99.97%	7522	99.97%	7503	99.72%

Summary

Only 2 retrieval errors:

2 Exact Geometry Errors already during ingest: Design defect - Flexible equipment - bad solid non-manifold (edge shared with more than 3 faces) - Tightener

In addition we faced only a few retrieval warnings (validation KO) because of minor design defects and because accuracy of CatiaV5R27 improvements in comparison with CatiaV5R21 used during ingestion

Action plan: 2 models to be re-designed.

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Audit and EN9300 Compliance

To prove to EASA that the record keeping requirements are met, AIRBUS undergoes an external audit every two years

Carried out by TÜV IT

with support by PROSTEP

TÜV IT:

- Leads the audit and issues the certificate
- Covers all general archiving requirements and 2D content (i.e., Office documents, 2D Drawings (TIFF),…)
- Based on **AC-DMS** (Audit Criteria for Document Management Solutions)

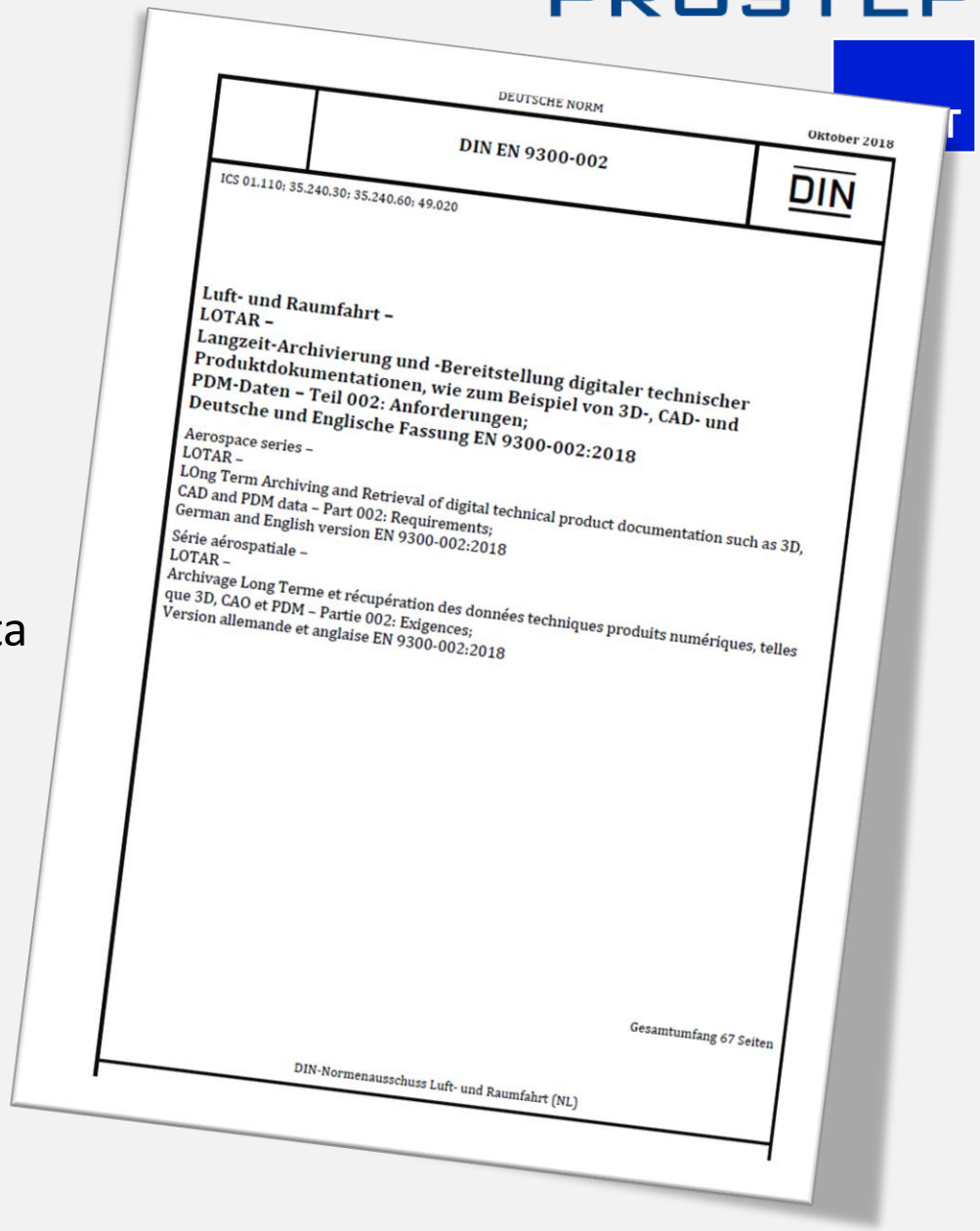
  = PK-DML (Prüfkriterien für Dokumenten-Management-Lösungen)

Audit and EN9300 Compliance

PROSTEP is responsible for auditing all 3D content

Based on:

- EN9300-002: LOTAR Requirements
- EN9300-003: LOTAR Fundamentals and Concepts
- EN9300-100: Common Concepts for LTA&R of 3D MCAD Data
- EN9300-110: CAD Mechanical 3D Explicit Geometry
- EN9300-115: Explicit CAD Assembly Structure
- EN9300-120: CAD 3D Explicit Geometry with Graphic PMI



DEUTSCHE NORM

Oktober 2018

DIN EN 9300-002

DIN

ICS 01.110; 35.240.30; 35.240.60; 49.020

Luft- und Raumfahrt –
LOTAR –
Langzeit-Archivierung und -Bereitstellung digitaler technischer Produktdokumentationen, wie zum Beispiel von 3D-, CAD- und PDM-Daten – Teil 002: Anforderungen;
Deutsche und Englische Fassung EN 9300-002:2018

Aerospace series –
LOTAR –
LOng Term Archiving and Retrieval of digital technical product documentation such as 3D, CAD and PDM data – Part 002: Requirements;
German and English version EN 9300-002:2018

Série aérospatiale –
LOTAR –
Archivage Long Terme et récupération des données techniques produits numériques, telles que 3D, CAO et PDM – Partie 002: Exigences;
Version allemande et anglaise EN 9300-002:2018

Gesamtumfang 67 Seiten

DIN-Normenausschuss Luft- und Raumfahrt (NL)

LTA&R: Long-Term Archiving & Retrieval
MCAD: Mechanical Computer Aided Design
PMI: Product & Manufacturing Information

Example Requirement: Validation Information

From EN9300-002: LOTAR Fundamentals & Processes

7.3.1 Data Preparation

Data preparation covers the phase of preparation for submission, and is outside the scope of the OAIS model. This has the following detailed requirements:

3) **Preparation of the validation[2] information associated to each source product information**: When technically feasible, the Producer shall check the quality control criteria (e.g., validation properties) of the information to be preserved. The validation report of each source product information has to be created, as associated input to the Ingestion process of the Archive.

Source: EN9300-002

Example Requirement: Validation Information

Corresponding AIRBUS Process Definition

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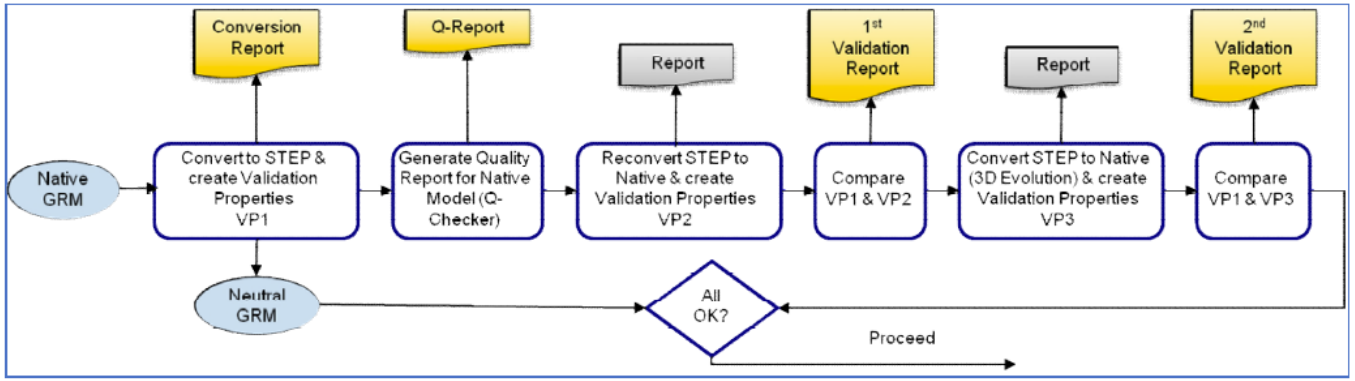

Figure 2-5: Conversion/validation process overview

The CATIA STEP converter generates the STEP file that contains CAD entities with Validation Properties (VP) computed in the original CAD system. Then the STEP file is imported in two validation tools CATIA (loop validation) and 3D Evolution (second validation) that compute the VP deviation (difference between computed and read VP from STEP).

- Both CAD validation tools are using different algorithms for VP calculation and additionally some of them are not customizable. That's why there can be differences in each validation report.
- Airbus uses the thresholds advised by the CAx Implementor Forum **[CAx-IF]**
- The same thresholds are applicable for both Ingest and Retrieval.

Source: AIRBUS Procedural Documentation AIRINA v1.2

Example Requirement: Validation Information

Documentation of fulfilled requirement in Audit Report

4.12 EN9300-002: Data Preparation

Data preparation covers the phase of preparation for submission, and is outside the scope of the OAIS model.

DP-3	**Preparation of the validation information associated to each source product information**					
Documentation	Audit	Operator	Evidence	Recommend.	Constr.	Fulfilled
☑	☐	☐	☐	0	0	yes

D: Validation Level 1 is used. [VDoc, 2.18.4, Figure 2-5] gives an overview on the process, which includes generation of the STEP file including validation properties, and then validation of the STEP and the included properties by import into two different CAD applications, CATIA V5 and 3D_Evolution.

Validation properties can be interger counts, these have to match exactly, or values calculated from the model geometry. [VDoc, 2.18.4, Figure 2-4] lists the applicable thresholds. See also GR-5.

Source: AIRINA Audit Report 2021, Draft Version

Example Requirement: Validation Information

Inclusion of Validation Reports in Archive Package

6.1.2.4 **AIP: The Archival Information Package**

An AIP represents the information package which is actually preserved in the archive, i.e. in AIRINA/LTA3D the package which is delivered by the Airbus LTA PLM Systems as the final step of ingestion. It provides a set of information that has all qualities needed for the permanent preservation containing content information (CI), i.e. the neutral STEP file, and preservation descriptive information (PDI), i.e. quality, conversion and validation reports.

One AIP represents a single node of a 3D structure. These content units together represent an AIP containing the following files:

Filename Suffix	Description
.stp	STEP file (from initial CATIA export of the 3D data set)
pdi.xml	PDI header file (from PDI header generation plug-in)
rpt_report01.txt	Quality check report (from Q-Checker)
rpt_report02.txt	Conversion report (from CATIA)
rpt_report03.txt	First validation report (from “loop test”, i.e. CATIA validation)
rpt_report04.txt	Second validation report (from validation tool “3D Evolution”)

Table 6-2: Content of an incoming AIP

Source: AIRBUS Procedural Documentation AIRINA v1.2

Audit and EN9300 Compliance

AIRINA Re-Certification Audit will take place in June 2023

AIRBUS A350 is not the only example of the LOTAR standard being actively used in industry:

			NAS / EN 9300 LOTAR parts (CAD)					
A&D company	Area of application	Scope	CAD 3D Exact Geometry	CAD 3D Tessellated Geometry	CAD 3D PMI Present.	CAD Assembly structure	ISO formats	Project status
			Part 110	Part 110	Part 120	Part P115	ISO 10303 "STEP"	
Airbus Commercial	A350	Electrical Harnes, Mechanical System & Bracket Installation, Cabin	Yes	Yes	Yes	Yes	AP214 Ed.3 (*) + AP242 Ed.1	PROD
Airbus Commercial	BelugaXL	Electrical Harnes, Mechanical System & Bracket Installation, Cabin	Yes	Yes	Yes	Yes	AP242 Ed.1	PROD
Airbus Defence & Space		"Full 3D" model based	Yes	Yes	Yes	Yes	AP242 Ed.1	DEV
Dassault-Aviation	Falcon 7X	complete definition of the aircraft (airframe, brackets, pipes, harness)	Yes	No	Yes	Yes	AP214 Ed.3 (*)	PROD
Snecma	New parts of engines	3D definition with PMI of new mechanical part	Yes	No	Yes	No	AP214 Ed.3 (*)	PROD
Boeing	787	3D definition with PMI with assemblies	Yes	No	Yes	Yes	AP203 Ed.2 (*) + U3D PDF	PROD
Gulfstream	G500, G600, G650	3D mBD mechanical, electrical and composite	Yes	No	Yes	No	AP203 Ed.2 (*)	PROD
Lockheed-Martin	F35	3D mBD mechanical, electrical and composite	Yes	No	Yes	Yes	AP203 Ed.2 + AP242 Ed.1	PLANNED
EMBRAER	Legacy 450 & Legacy 500	complete definition of the aircraft	Yes	No	Yes	Yes	AP242 Ed.1	DEV
MTU Aero Engines	New parts of engines	3D definition without PMI of new mechanical part	Yes	No	No	In Prep.	AP214 Ed.3	PROD

PLANNED	: project planned
DEV	: project in development
PROD	: project on production

(*): Plan to migrate to STEP AP 242 ed1 when possible

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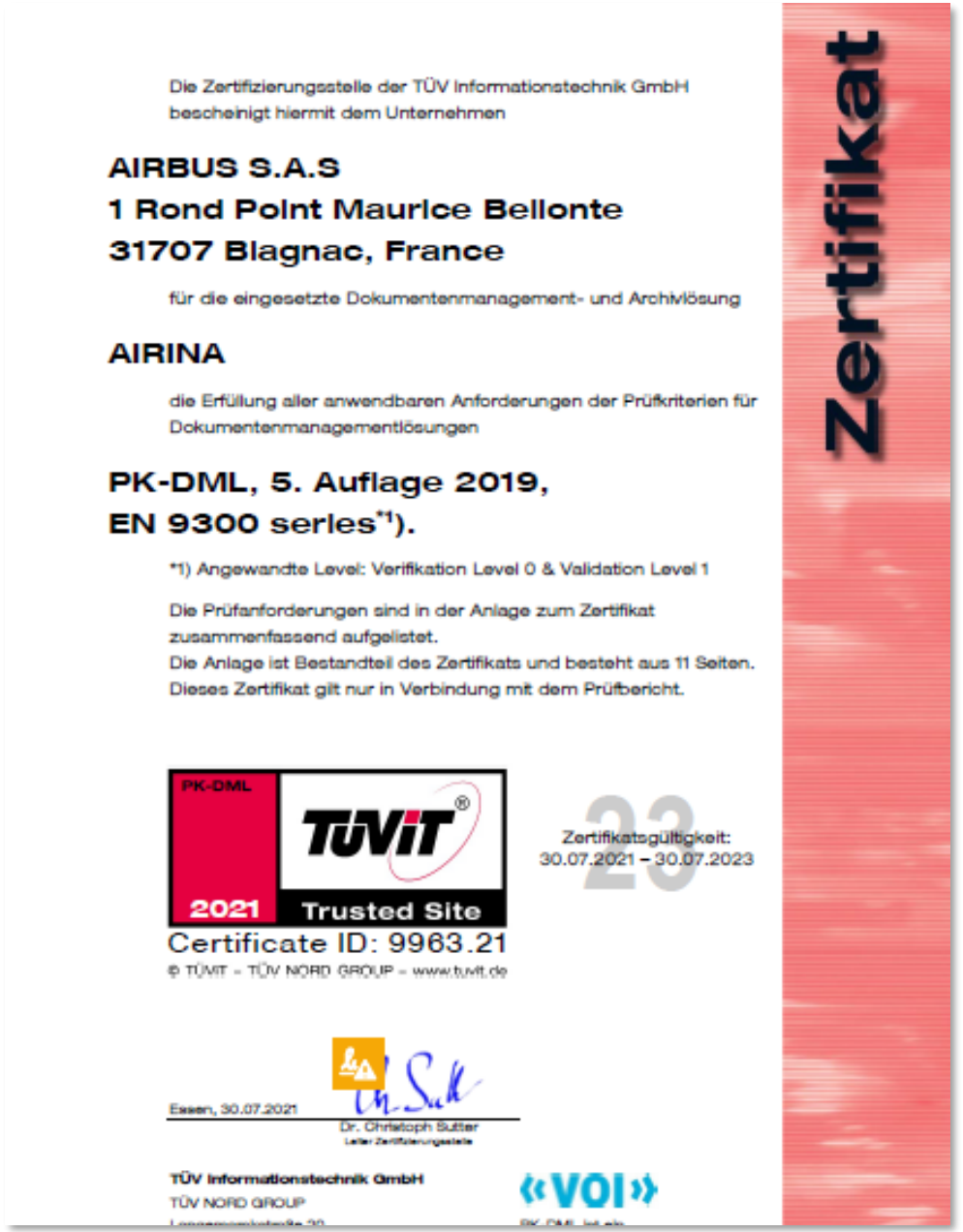
Zertifikat

Die Zertifizierungsstelle der TÜV Informationstechnik GmbH
bescheinigt hiermit dem Unternehmen

AIRBUS S.A.S
1 Rond Point Maurice Bellonte
31707 Blagnac, France

für die eingesetzte Dokumentenmanagement- und Archivlösung

AIRINA

die Erfüllung aller anwendbaren Anforderungen der Prüfkriterien für Dokumentenmanagementlösungen

PK-DML, 5. Auflage 2019,
EN 9300 series*1).

*1) Angewandte Level: Verifikation Level 0 & Validation Level 1

Die Prüfanforderungen sind in der Anlage zum Zertifikat zusammenfassend aufgelistet.
Die Anlage ist Bestandteil des Zertifikats und besteht aus 11 Seiten.
Dieses Zertifikat gilt nur in Verbindung mit dem Prüfbericht.

PK-DML 2021 TÜVIT Trusted Site
Certificate ID: 9963.21
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Zertifikatsgültigkeit:
30.07.2021 – 30.07.2023

Essen, 30.07.2021
Dr. Christoph Sutter

TÜV Informationstechnik GmbH
TÜV NORD GROUP

«VOI»

AIRBUS

THANK YOU FOR YOUR PARTICIPATION

You will never archive alone

AIRBUS