

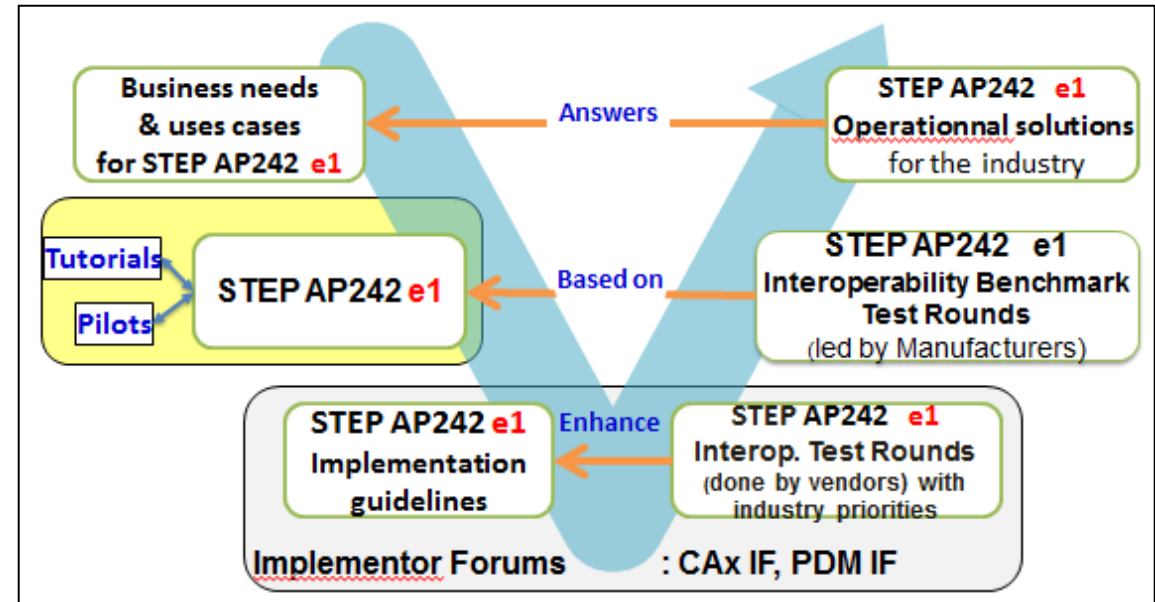


# Status of use of STEP AP242 ed1 for PDM and 3D MBD interop, new capabilities of AP242 edition 2

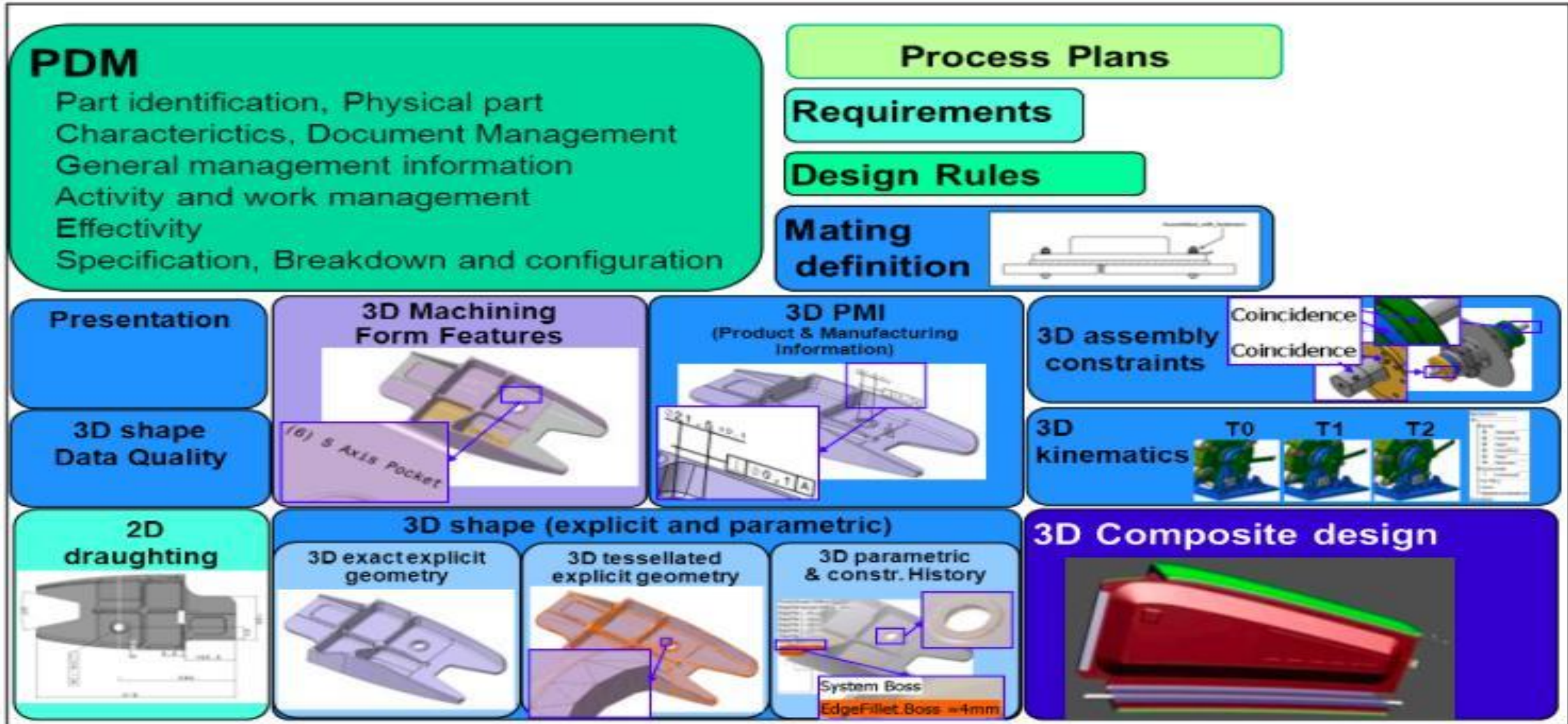
By Jean-Yves Delaunay (Airbus)

# Content

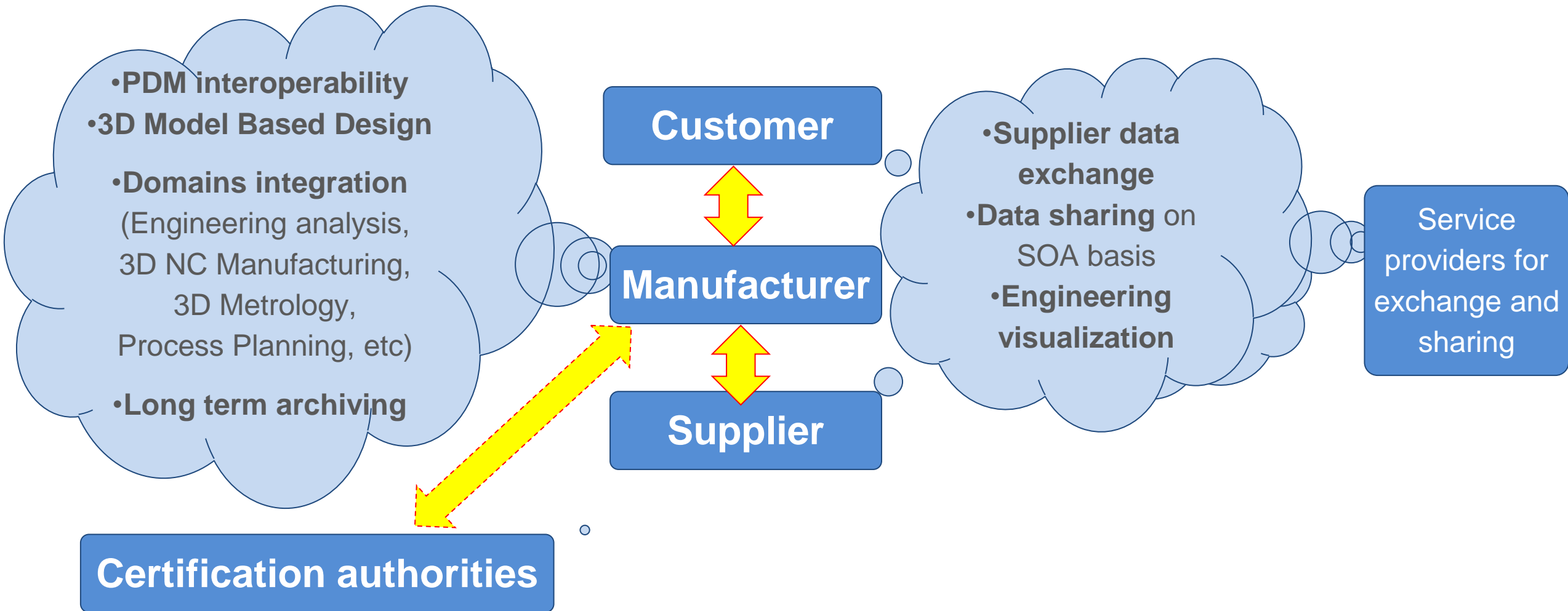
- A&D business needs for 3D MBD interoperability
- STEP AP242 [edition 1](#)
  - AFNeT – prostep iViP 2017 benchmark
  - CAx IF Recommended Practices
  - Use in the industry
- STEP AP242 [edition 2](#) development project
- New needs and new challenges: preparation of STEP AP242 [edition 3](#) project
- Summary



# Remind of the scope of ISO STEP AP242 edition 1 (ISO International Standard in 2014)



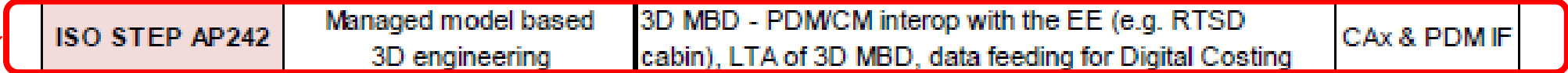
# AP242 ed1: the answer to key A&D business requirements for 3D Model Based Definition interoperability



- STEP AP242: Convergence of AP203ed2 and AP214ed3

# List of main PLM interoperability standards for Airbus Engineering V1 (\*)

Standards	Standard name	Main Airbus use cases - business value	Implementer Forum
<b>Priority 1</b>			
EN9300 LOTAR	A&D PLM LTA & Retrieval	LT Archiving for 3D MBD, Analysis & PDM/CM	CAx & PDM IF
ISO STEP AP242	Managed model based 3D engineering	3D MBD - PDM/CM interop with the EE (e.g. RTSD cabin), LTA of 3D MBD, data feeding for Digital Costing	CAx & PDM IF
ISO STEP AP209	Multi Disciplinary Analysis & Design	input for the Multi-Physics Master Data Model definition	CAx IF (& SDM IF)
ISO STEP AP235	Engineering properties for product design & verification	E2D single Material data base	(xDM IF)
ISO STEP AP239	Product Life Cycle Support	input for the def. of the MDM for E2E PDM-CM & Req., V&V	(xDM IF)
OMG SysML	System Modeling Language	System architecture, system modeling, IT design	?
FMI / FMU	Functional Model Interface / Functional Model Unit	Interoperability for systems simulation within Airbus and with its EE, for virtual systems simulation	?
ISO STEP MoSSEC	Modelling & Simul. Info. in a collaborative SE Context	Traceability of modelling and simulation process based on linked data	(xDM IF)
ISO JT	JT file format specification for 3D visualization	Only for visualization of 3D tessellated BREP Data with different levels of details	JT IF
<b>Priority 2</b>			
ISO 8000	Data quality	principles, requirements and quality rules for product digital master data	
ISO PLIB	Parts Library	Input for interop. & LT archiving of standards parts library (Airbus internal and external catalogs)	

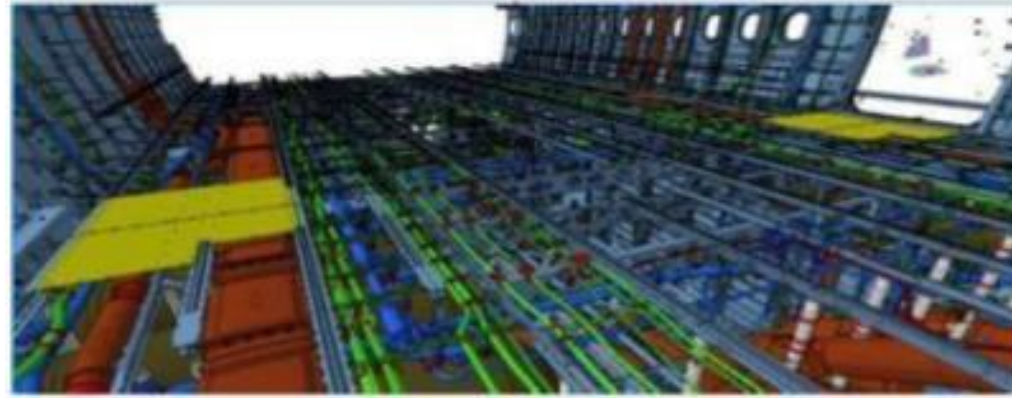


Scope of the presentation

(\*) No exhaustive list

# Examples of use of STEP AP 242 (and AP214) from Airbus

- Past (still in use)
  - STEP AP 214 for the conversion of legacy 3D CAD models to CatiaV5
  - STEP AP 214 for exchange of PDM product structure

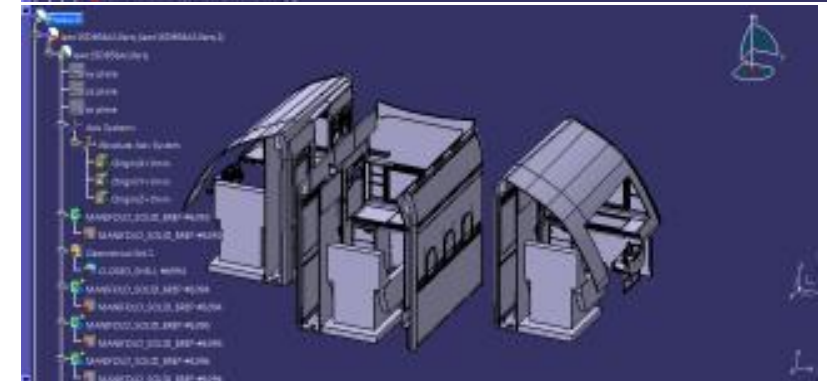
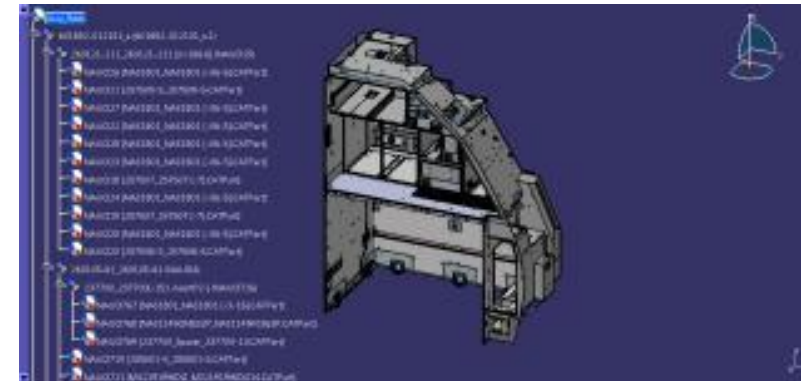


- Present

## 3D DMU data exchange with cabin equipment suppliers

### 3D MBD Long Term Archiving

of A350 “Full 3D” definition  
in STEP AP 242 / AP214



# Results of AFNeT – prostep iViP [PDM Implementor Forum](http://www.pdm-if.org/) in 2017

## → Dev. of STEP AP242 BO Model XML recommended practices

### • **Product & Assembly Structure**

- Joint document with CAx IF, JT-IF
- Version 1.2 for AP242 IS published June 30, 2017
- Version 1.99 for AP242 TC in final development; target public release as v2.0 Jan. 2018
- Discussed proposed implementation change for AP242 Ed.2


### • **Configuration Management (resolved configuration)**

- PDM-IF specific document, based on PAS Rec. Practices
- Current working draft v0.43; ongoing development
- v0.5 planned for end of 2017 / early 2018;  
further versions depend of progress of work
- Public release as v1.0: scope and date not yet determined

<http://www.pdm-if.org/>



Back up  
slide



**Recommended Practices**  
For  
**STEP AP242 Business Object Model XML**  
**Configuration Management**

Release 0.4.3  
- Working Document -

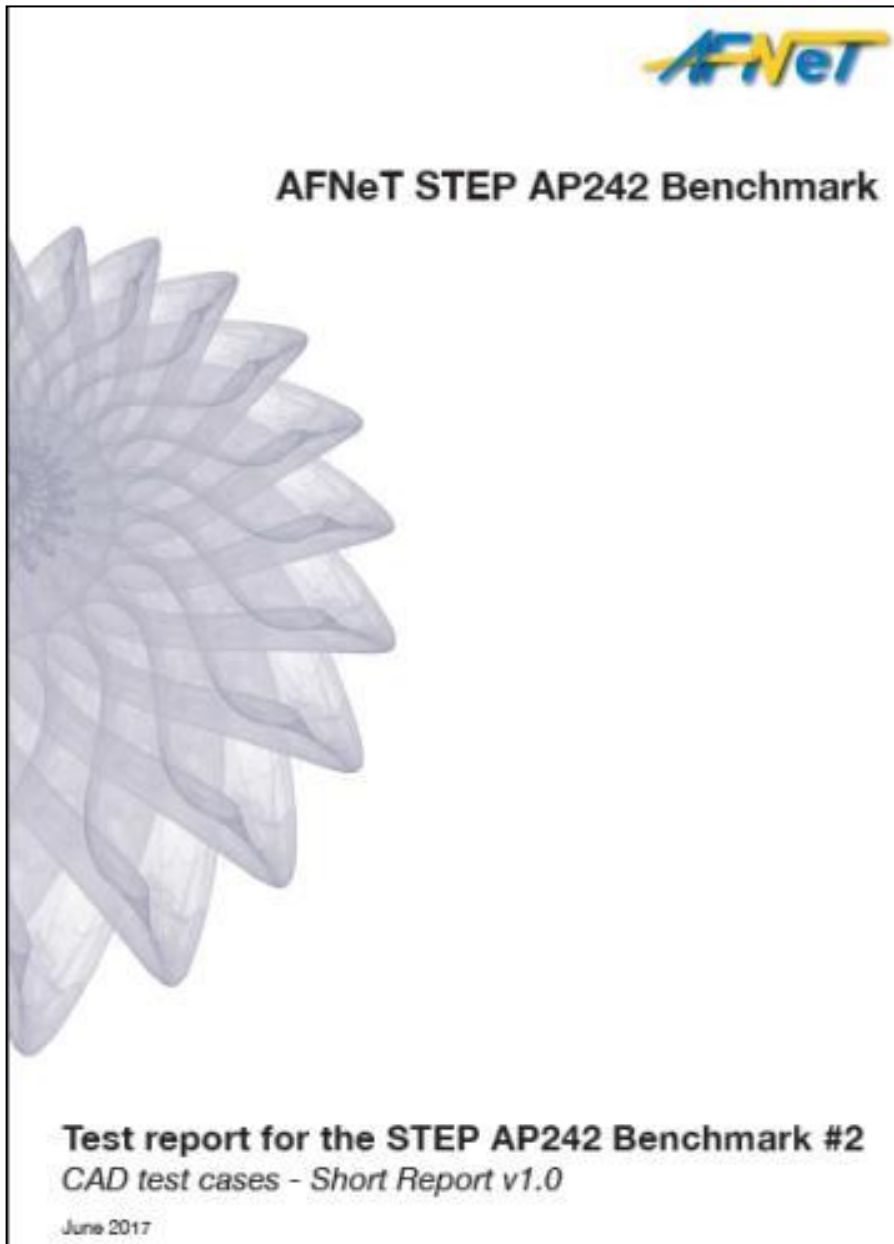
September 27, 2017

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# Summary of AFNeT STEP AP242 benchmark #2 (2017): [CAD Work Package](http://benchmark.ap242.org/)



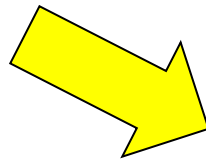
<http://benchmark.ap242.org/>

- 1 Introduction
- 2 Terms and definitions
- 3 Test methodology
- 4 Test results for each tool
- 5 Test results for each test case
- 6 Summary
- 7 Publication of the long report
- 8 Acknowledgements

**Table of content  
of the public test report**



Test cases  
overview



type	Source format	Target format	Solution name	TC1 3D exact geometry	TC2 3D Translated geometry	TC6c assembly BO model XML + translated geo.	TC6d CAD assembly (P21 & nested ) + exact geometry
import	STEP AP242	3DEXPERIENCE	3DEXPERIENCE R2016x	●	●	●	●
import	STEP AP242	3D PDF	Tetra4D Reviewer 2016.1.0	●	●		●
import	STEP AP242	3D PDF	CrossManager 16.2	●	●		●
import	STEP AP242	CATIA V5	3DEvolution v4.0 SP2	●	●	●	●
import	STEP AP242	CATIA V5	CATIA V5-6R2016	●	●	●	●
import	STEP AP242	CATIA V5	CrossManager 16.2	●	●		●
import	STEP AP242	CATIA V5	ASFALIS	●		●	
import	STEP AP242	Creo	3DEvolution v4.0 SP2	●	●	●	●
import	STEP AP242	Creo	ASFALIS	●		●	
import	STEP AP242	Inventor	Inventor Professional 2017	●	●		●
import	STEP AP242	Inventor	3DEvolution v4.0 SP2	●	●	●	●
import	STEP AP242	Inventor	ASFALIS	●			
import	STEP AP242	NX	3DEvolution v4.0 SP2	●	●	●	●
import	STEP AP242	NX	CrossManager 16.2	●			
import	STEP AP242	NX	ASFALIS	●		●	
import	STEP AP242	SOLIDWORKS	3DEvolution v4.0 SP2	●	●	●	●
import	STEP AP242	SOLIDWORKS	ASFALIS	●		●	
viewer	STEP AP242	Viewer	3DAnalyzer	●	●	●	●
viewer	STEP AP242	Viewer	Tetra4D Reviewer 2016.1.0	●	●		●

**BUS**



# STEP AP242 Benchmark n°2 – [PDM WP](#)



## Tests of COTS interfaces by independent specialists



AFNet & ProSTEP iVIP STEP AP242 Benchmark



Test report for the STEP AP242 Benchmark #2  
PDM test case - Short Report

March 2017

### Content

- 1 Introduction
- 2 References and terms
  - 2.1 Reference documents
  - 2.2 Terms
- 3 Test methodology
  - 3.1 Functionalities tested in this Benchmark
  - 3.2 Testing Strategy
  - 3.3 Synthetic Test Case Specifications
    - : PDM Assembly with 3D Geometry
  - 3.4 List of tested applications
  - 3.5 STEP file selected as reference for phase 3
- 4 Test Results
  - 4.1 Overview of the Test Results
  - 4.2 Overall Test Results
- 5 Summary
- 6 Publication of the Long Report of PDM test case
- 7 Acknowledgements

- The results show a **good level of STEP AP242 BO XML implementation for PDM product structure exchange.**

- Most of in-scope PDM functionalities are robustly supported, except for the transfer of the benchmarked assembly validation properties.

Access to the short report:

<http://benchmark.ap242.org/>



Illustration of  
test cases

**AIRBUS**

# STEP AP242 ed1 Benchmark 2017 : [PDM results](#)

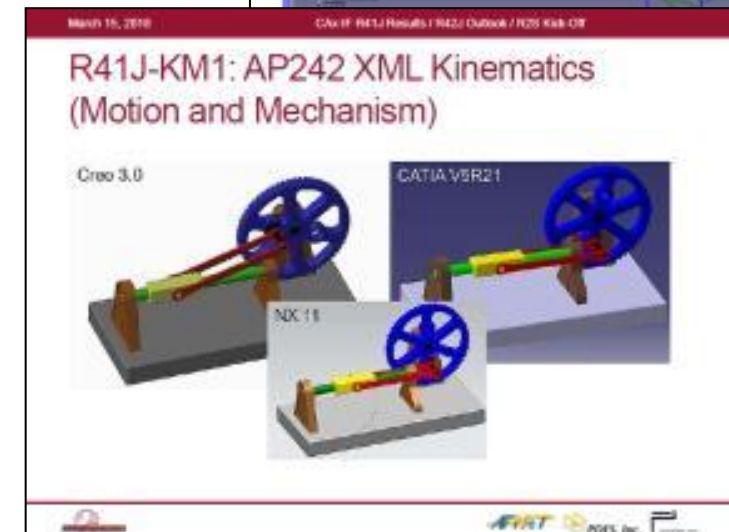
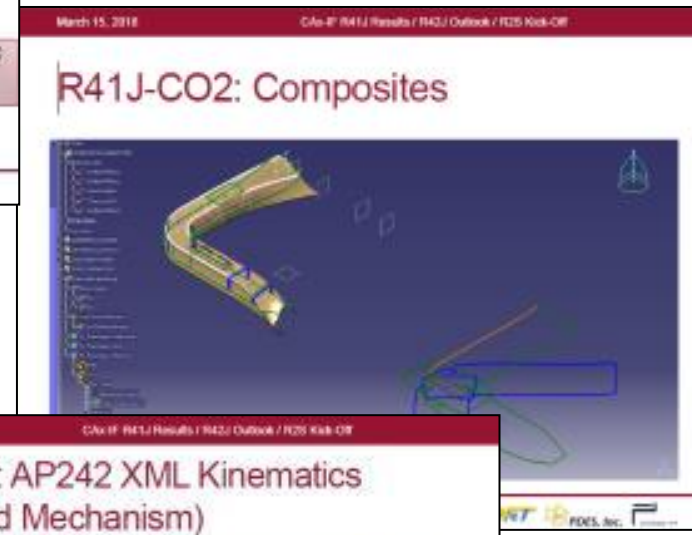


		Dassault Systèmes 3DEXPERIENCE R2017x	Elysium ASFALIS	PROSTEP AG OpenPDM	PTC Windchill 11	T-Systems COMPDM 2	CoreTechnologie 3DEvolution 4.0
See 3.2	STEP AP242 PDM Test case Criteria	PDM system	STEP interface for Aras Innovator	STEP interface for TeamCenter	PDM system	STEP interface for Aras Innovator	CAD and Converter system
Phase 1: STEP import from sample file							
1	STEP IMPORT	●	●	◐	●	●	●
1	STEP IMPORT Assembly Validation Properties	■	●	■	■	●	●
2	STEP RE-IMPORT same sample file	●	●	●	●	●	●
Phase 2: STEP export and check							
3	STEP EXPORT	●	●	◐	●	●	●
3	STEP EXPORT Assembly Validation Properties	●	●	◐	●	●	●
4	STEP file conformity	◐	●	●	◐	◐	◐
6	STEP EXPORT with changes	●	●	◐	●	●	
7	STEP EXPORT Assembly Validation Properties with changes	●	●	◐	●	●	
7	STEP file with changes conformity	◐	●	●	◐	◐	
Phase 3: STEP import from selected files							
5	STEP IMPORT	●	●	◐	●	●	
5	STEP IMPORT Assembly Validation Properties	■	●	■	■	●	
6	STEP IMPORT with changes	●	●	◐	●	●	
6	STEP IMPORT Assembly Validation Properties with changes	■	●	■	■	●	

Test result	Symbol
Success	●
Partial success fail	◐
Total Fail	●
Not supported	■
Not tested	

		DATAKIT CrossManager 17.1
		CAD converter
See 3.2	Phase 3bis: STEP import from selected files to CAD-viewer format	
5bis	Assembly and geometry presentation	●
5bis	AVP, PDM attributes and product structure presentation	●
5bis	AVP checks	●

➔ Availability of STEP AP242 XML interfaces for exchange of PDM product structure for all the main PDM systems



- **Continuation of tests of AP242 ed1 functionalities:**

- 3D PMI semantic
- Composite
- Kinematics

- **Presentation of status of STEP AP242 interfaces by the main PLM editors:**

- NIST tools update (STEP 3D PMI analyser, STEP AP209 analyser)
- Dassault Systèmes (Catia V5, 3DEXPERIENCE, SolidWorks, etc.)
- Siemens PLM (NX, NJT2GO, Femap, SolidEdge, TCVis, etc.)
- CT CoreTechnologie (3D\_Evolution, 3D\_Analyzer)
- Datakit (CrossCAD converter)
- Elysium (Asfalis converter)
- Jotne EPM (EXPRESS Data Manager, status of AP242 and AP209 IFs)
- International TechneGroup - ITI (PDE Lib, CAD IQ, CAD Fix, etc.)

# AFNeT – prostep iViP PDM Impl. Forum: Implementor Group 2018 scope

- **CONF3: Bicycle test case**

- Specifications
- Occurrence Effectivities and Revision Effectivities

- **BMW Data Set**

- See discussions in the morning (TOP 3)

- **Full-loop Test**

- CAD A -> AP242 XML -> CAD B -> AP242 XML -> CAD A
- Management of supplier IDs at OEM
- Covered by VDA Test Case; need to check Rec. Practices are sufficient

- **CUST Test Case**

- With PDM Properties as defined by the UG

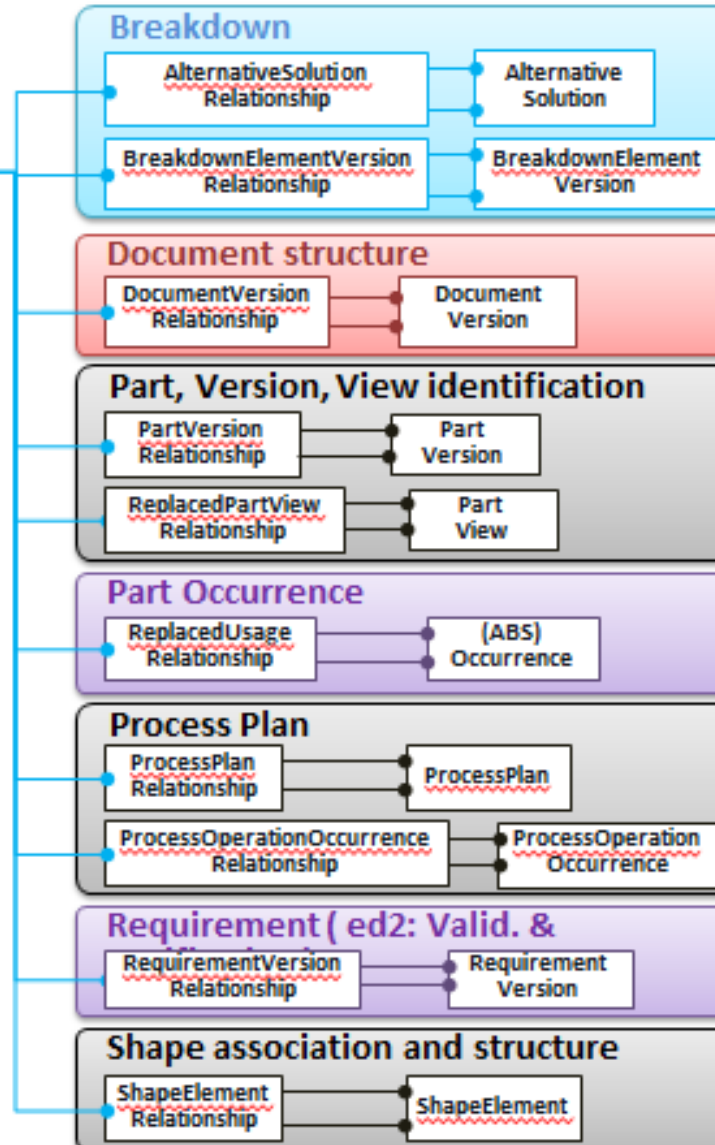
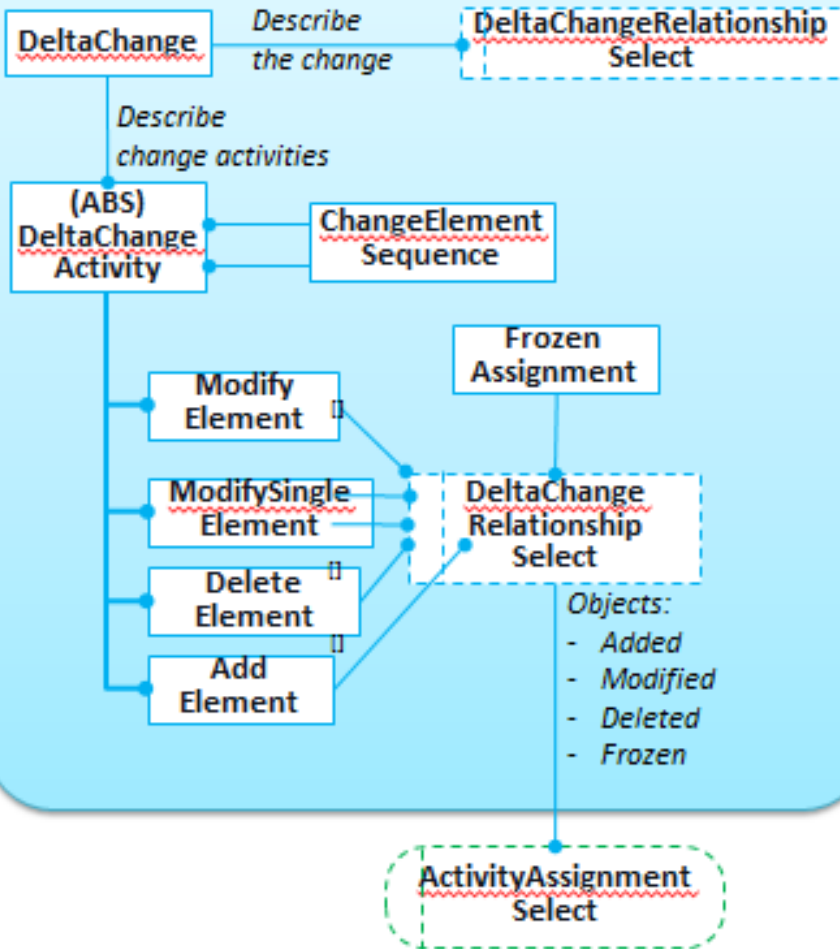
- **Additional Topics & Ideas**

- Using several different geometric representations for same part (e.g., native & neutral)
- Several versions of one part in same file
- Sending of partial structures



Next opportunities for powerful “**Delta change**” capability,  
 : to exchange differences with respect to a set of data previously sent.

## Delta Change



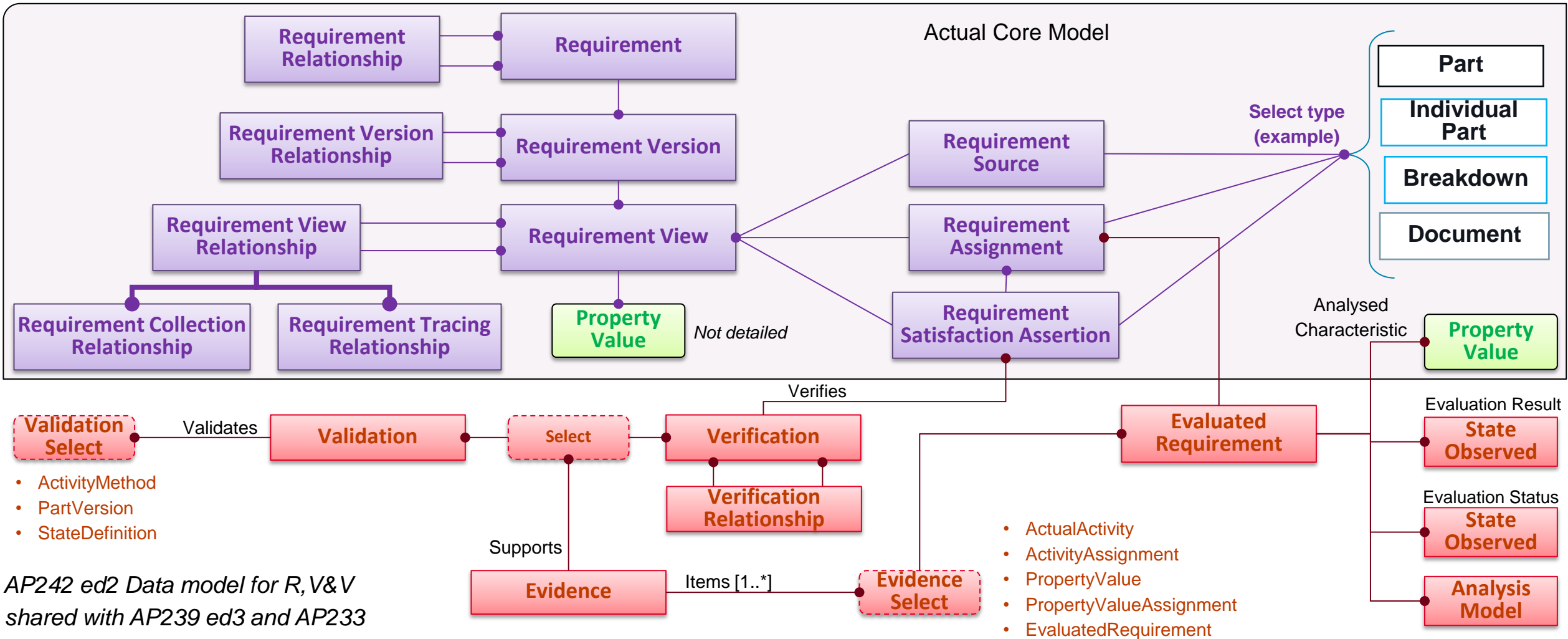
This capability specifies the information needed to describe the association between:

- **ORIGINAL** product or engineering information
- and **CHANGED** product or engineering information.

EXAMPLE: Typical activities are:

- "**ADD** component 3 and 4 to an assembly"
- "**REMOVE** document xyz from the set of describing documents of a part",
- "**MODIFY** requirement x".

# Overview of “Requirement Mngt. with Valid. & Verification” capabilities defined in AP242 ed2 : “text based” and “property based”



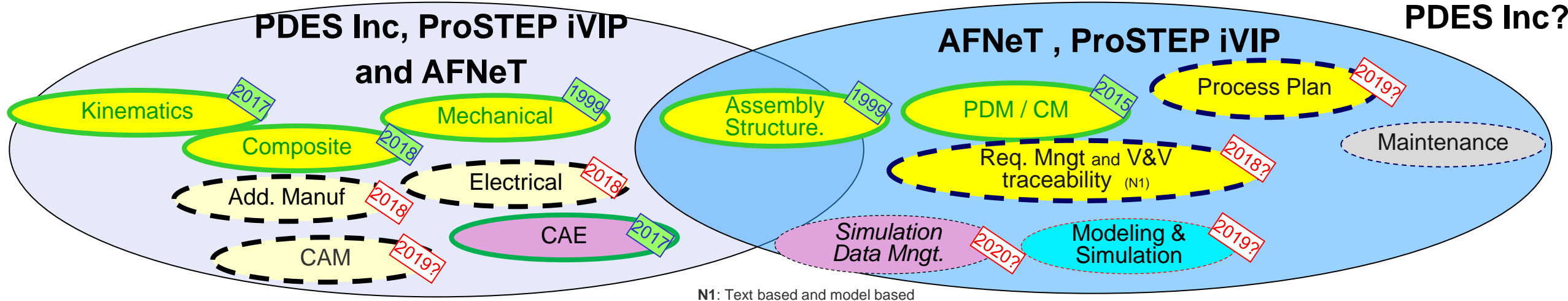
- STEP AP242 ed1 covers already the Requirement Management interop. capability
- Preparation of the launch of the STEP R,V&V Implementer Forum: Users + Vendors!



# Importance of CAx-IF and xDM-IF to run Interoperability test rounds to speed up the deployment of STEP AP242 interfaces

## CAx IF

## xDM IF



N1: Text based and model based

Functionality covered / tested by the Implementer Forum as a specific Working Group

Related ISO STEP standards (AP = Application Protocols)

covered

Planned Extension

AP242 e1

IS in 2014 (IS = International Standard)

AP242 e2

In development - Planned IS in 2019

AP209 e2

IS in 2014

AP239 e3

In development - Planned IS end of 2019

MoSSEC e1

In development - Planned IS end of 2019

**Importance of the involvement of the Manufacturers in the CAx and PDM IF**

**In 2019: extension of the CAx IF with the Electrical WG + new business model for prostep iViP & AFNeT + extension of the xDM-IF to R, V&V domain, Process Plan, etc**



# Summary of status of development of AP242 edition 2

- Status of development
  - AP242 ed2 Draft International Standard sent to ISO Secretary **end of Feb. 2018**
  - Expected start of the national AP242 ed2 DIS ballot: **mid of June 2018**
  - Preparation of the Final DIS in Q3 2018: FDIS ballot in **Q4 2018**
  - **Planned AP242 ed2 “International Standard” in Q2 – Q3 2019**
- Close coordination with ISO /TC 184 /SC 4 /WG 12
- Project supported by the PDES Inc and AFNeT STEP associations
- Co lead by A&D industries: Boeing and Airbus

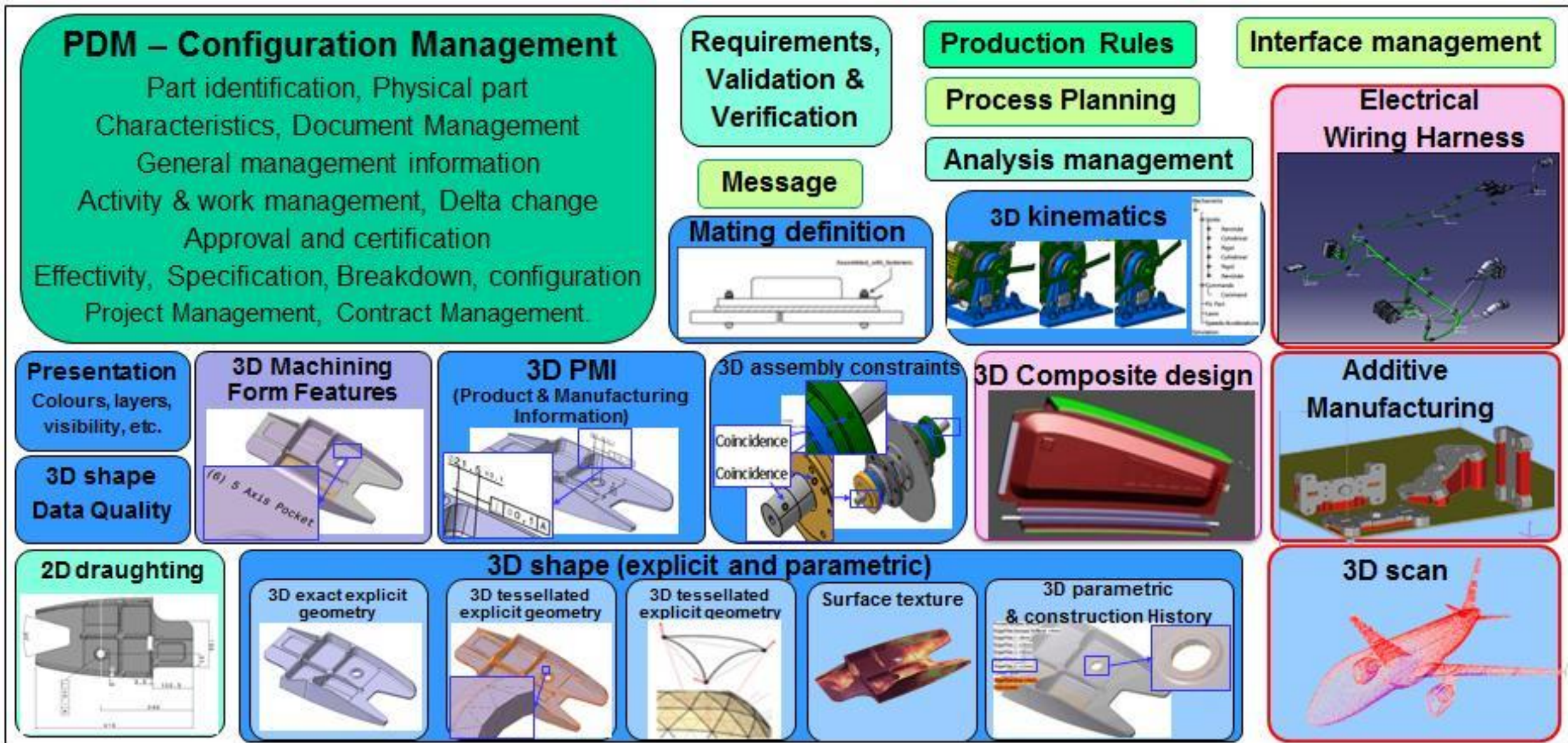
- For more information:

<http://www.ap242.org/edition-2>



# Overview of ISO 10303 STEP AP242 edition 2

## “Managed Model Based 3D Engineering”



# Key objective for the A&D industry:

To enable the digital thread: Design / Simulation  $\Leftrightarrow$  Manufacturing  $\Leftrightarrow$  Support

## The Digital Thread for Aerospace & Defense

### Project Activities

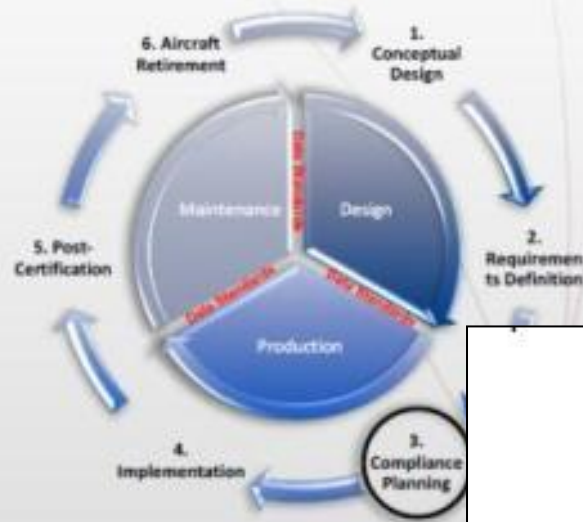
- What is the **minimum MBD** content to support the **digital thread** for the industry?

- Design
- Manufacture
- Certification

- Interoperability based on **industry data standards** is a key to the **digital thread**.

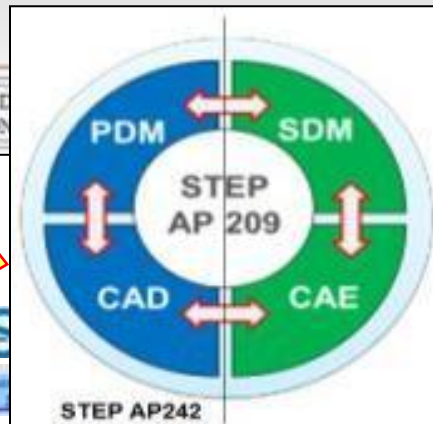
- AP242 is the recognized majority direction for enabling this interoperability.

CIMdata PLM roadmap  
17 Oct. 2017



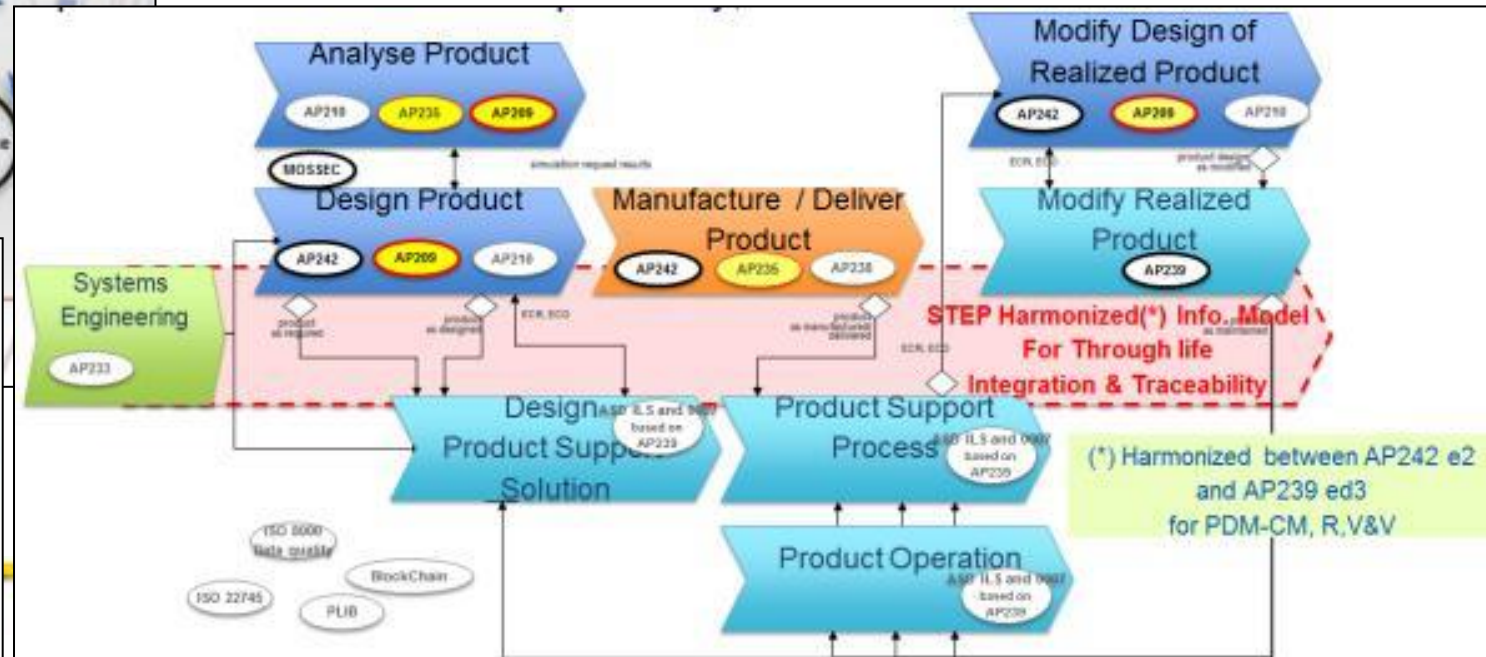
Administered by CIMdata

AEROSPACE & DEFENSE  
PLM ACTION



Close consistency of STEP AP242 and AP209 for MBD  $\Leftrightarrow$  MB Simulation associativity

Strong opportunity to set up the **STEP PLM backbone across the life cycle** with the finalization of the **PDM-CM and Req. ,V&V harmonization** in the STEP modular architecture with **AP242 edition 2 and AP239 edition 3**



(\*) Harmonized between AP242 e2 and AP239 ed3 for PDM-CM, R,V&V

Prep. in 2018 of [STEP AP242 edition 3](#) project, planned to start in 2019

- Needs of the A&D industries for interoperability capabilities covering [all the Digital Technological Processes used for the 3D Model Based Engineering](#):
  - Enhancements: PMI semantic, Composite design, mechanical features, holes and fastener, additive manufacturing, electrical, etc
  - Extensions to new domains: Tubing, Sheet Metal, etc.
- Preparation of a shared vision of the industry for the AP242 extensions
  - scope, capabilities, implementations technologies (e.g., web services, analytics, etc),
- Start of identification of gaps and enhancements, to be incorporated in the project plan for the STEP AP242 e3 project
  - ➔ **Needs for the industries to identify their priorities and plan the resources for the development of AP242 e3**
    - Deliverable : White paper (draft in July, final September)
    - Face to Face 2018 sessions: PDES Inc March Offsite, AFNeT June, PDES Inc Sept. offsite
- Target: whitepaper as input for AP242 e3 New Work Item, planned for Q1 2019
  - ➔ anticipated start of AP242 e3 project in Semester 1 2019.

# Process for dev. of AP242 5 years roadmap

Governance

Communication

STEP AP242 5 years roadmap  
Version (X)

Requirements & uses cases  
for STEP AP242 edition (N)

Tutorials  
Pilots  
Development of  
STEP AP242 edition (N)

STEP Architecture  
and infrastructure  
STEP  
Libraries

STEP AP242 edition (N)  
Interoperability Benchmark  
Test Rounds (led by Manufacturers)

Based on

AP242 ed(N)  
Implementation  
guidelines

Enhance

STEP AP242 ed(N)  
Interop. Test Rounds  
done by vendors with industry priorities

Implementor Forum

Governance		
Managed Industry requirements	Library	Implementor Forums, Pilots & Recom. practices
Application Protocol	Communication	Infrastructure and architecture

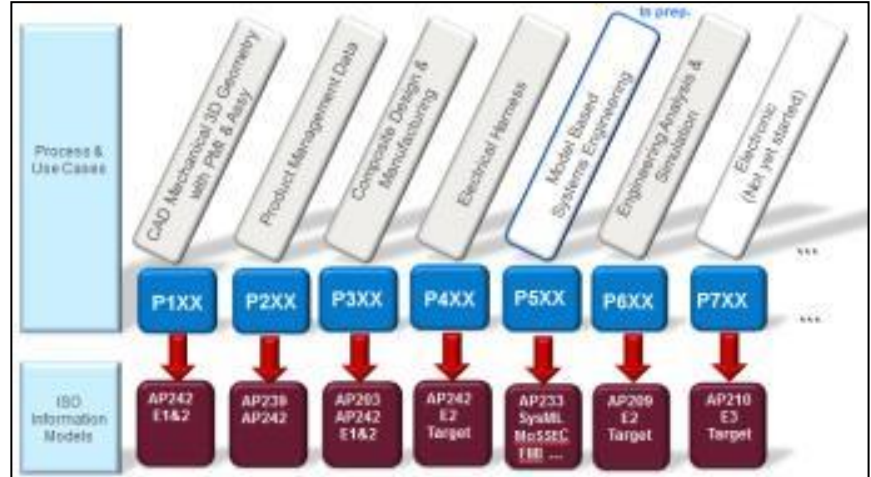
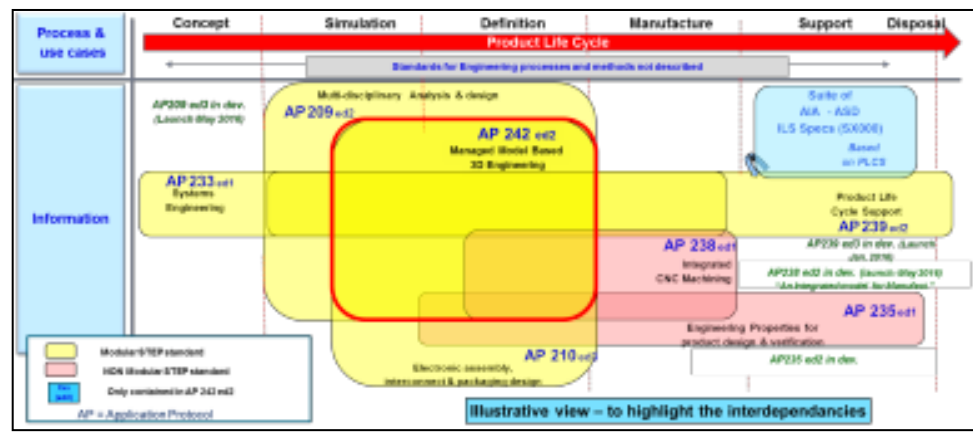
PDES, Inc.



# STEP AP242 interoperability capabilities associated to other standards

- Other modular STEP APs
- NAS / EN 9300 LOTAR
- QIF
- 3D PDF
- ISO 13584 “Part Libraries”
- ISO 8000 “Data quality”
- AutomationML

(Non exhaustive list)



For more details, ref. presentation “Model-Based Enterprise (MBE) & Model-based Manufacturing (MBM) standards : AP209, AP242, AP238, QIF, Step Extended Architecture



# Next actions: **2018 October STEP AP242 Day**

- Prostep iViP STEP AP242 Day:  
October 2017 , Hamburg, ZAL Zentrum



<http://www.prostep.org/en/events/events/step-ap242-day/>

- Preparation of AFNeT - prostep iViP STEP AP242 Day – **18<sup>th</sup> of October 2018**, Toulouse, hosted by Airbus
- Draft agenda to be finalized:
  - Success stories for use of STEP AP242 in the industries
  - Use cases – demos on specific disciplines, e.g.
    - 3D MB Definition : 3D semantic PMI – GD&T
    - Composite design, Kinematics
    - PDM
  - Presentation by PLM software providers : PTC, Dassault Systems, Siemens PLM, Autodesk, etc
  - Status of the CAx IF and PDM IF
  - Status of the 2018 AP242 benchmark
  - Summary of STEP AP242 edition 2
  - Summary of preparation of STEP AP242 edition 3
  - Etc.

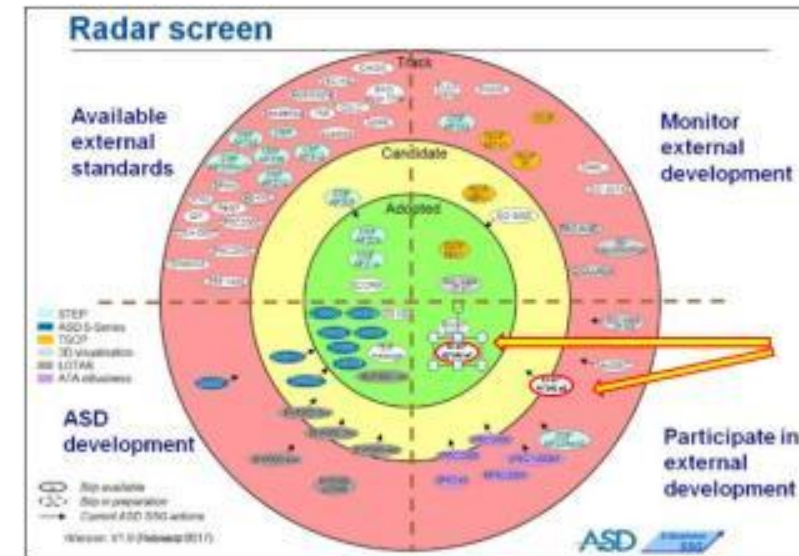
# Summary: Recommendations of the Aerospace & Defense industry to use STEP AP242 for 3D Model Based Definition exchange & LT Archiving

## • European A&D industry association (ASD SSG)

### Statement on STEP AP242 for CAD/PDM exchange and long term archiving - Feb. 2015

ASD recommends the use of STEP AP242 for the **exchange, long term archiving and transfer to downstream processes of CAD data** (mechanical design, incl. composite) and associated **configuration (PDM) data**. The most recent editions of the standards should be used wherever possible.

[ASD SSG statement for the use of STEP AP242](#)



<http://www.asd-ssg.org/radar-chart>

## • Aerospace and Defence PLM Action Group Product Data Exchange Standards - Direction Statement

3. The A&D PLM Action Group requests that PLM software providers ensure that the following standards are implemented to sufficient conformance levels, including relevant industry Recommended Practices, in the next functional release of their PLM solution. We expect these solutions to be validated within the appropriate ISO working groups.

- ISO 10303 AP<sup>1</sup> 242 "Managed model based 3D engineering"
- ISO 10303 AP209 edition 2 "Multidisciplinary Analysis and Design"
- ISO 10303 AP239 "Product Life Cycle Support"
- ISO 10303 AP238 "Application interpreted model for computerized numerical controllers"

Product data exchange standards  
Direction Statement  
<https://www.cimdata.com/en/aerospace-and-defense>

**AIRBUS**



# Synthesis: AP242, as the cornerstone standard of the A&D industries for 3D model based design interoperability


- European A&D companies have started to use STEP AP242 in operation for 3D DMU exchange and 3D MBD Long Term Archiving
- ASD SSG recommendation: STEP AP 242 is the cornerstone standard for interoperability of core 3D engineering design models
- Certification of new aircrafts based on semantic 3D MBD and the introduction of the digital twins require a consistent set of ISO standards to support this digital thread:
  - specification, definition, simulation, manufacturing, quality control, etc
- Next actions:
  - To **extend the scope of COTS AP242 operational interfaces** by PLM providers
    - To **contribute to the CAx IF**, with extension to new domains in 2019: new funding model
    - To **support the extension of PDM IF to xDM IF** : Req., V&V, SDM, Process Plan, etc
    - To **prepare the launch of AP242 e3 in 2019**, part of AP242 5 years roadmap

**The involvement of the European industries to develop & use AP242 standard is crucial to support the worldwide digital continuity for 3D MB Definition**

Back up  
slides

# PDM IF Recommended Practices for STEP AP242 Business Object Model XML Configuration Management: Table of Contents

- 1 Introduction**
- 2 Reference to Recommended Practices**
  - 2.1 Reference to Core Document [242BO-PAS]
  - 2.2 Listing of Recommended Practices Version in Exchange Files
- 3 Fundamentals and Concepts**
  - 3.1 Big Picture
  - 3.2 Configuration Management (ConfM)
  - 3.3 Use Cases
  - 3.4 Definitions in ISO 10303-3001
  - 3.5 Product Configuration
- 4 Configuration and Effectivity Information**
  - 4.1 Configuration Identification
  - 4.2 Configuration Composition Management
    - 4.2.1 Configuration effectivity
  - 4.3 Product Specification
    - 4.3.1 Template „Specification”
    - 4.3.2 Template „SpecificationAssignment”
    - 4.3.3 Template „SpecificationConditionAssignment”
  - 4.4 Usage of Option Pool (Dictionary)
- 5 Supported Configuration Management for PDM Systems**
  - 5.1 Managing Effectivities
  - 5.2 Managing the Product Context
    - 5.2.1 Managing the Option Pool
  - 5.3 Managing Configuration



**Draft**

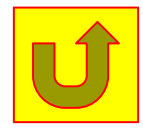
**Recommended Practices**  
For  
**STEP AP242 Business Object Model XML**  
**Configuration Management**

*Release 0.4.3*  
*- Working Document -*

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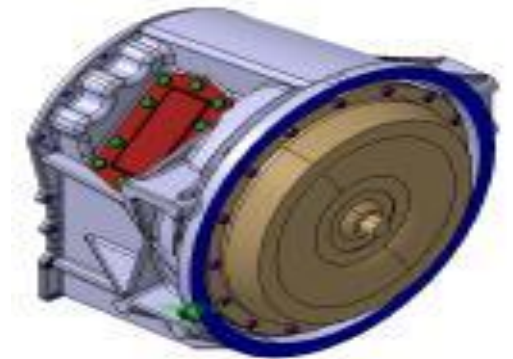
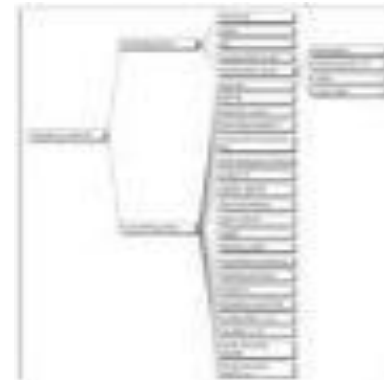
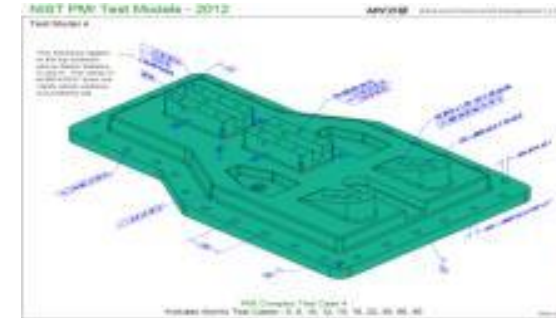
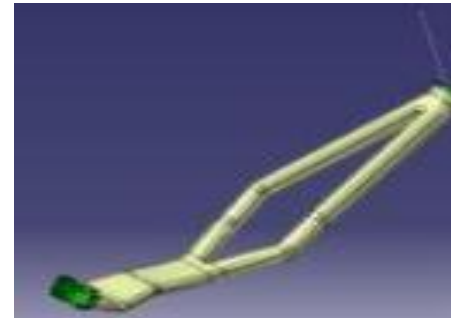


# AFNeT – ProSTEP iViP STEP AP242 Benchmark n°2 – [CAD geometry WP](#)

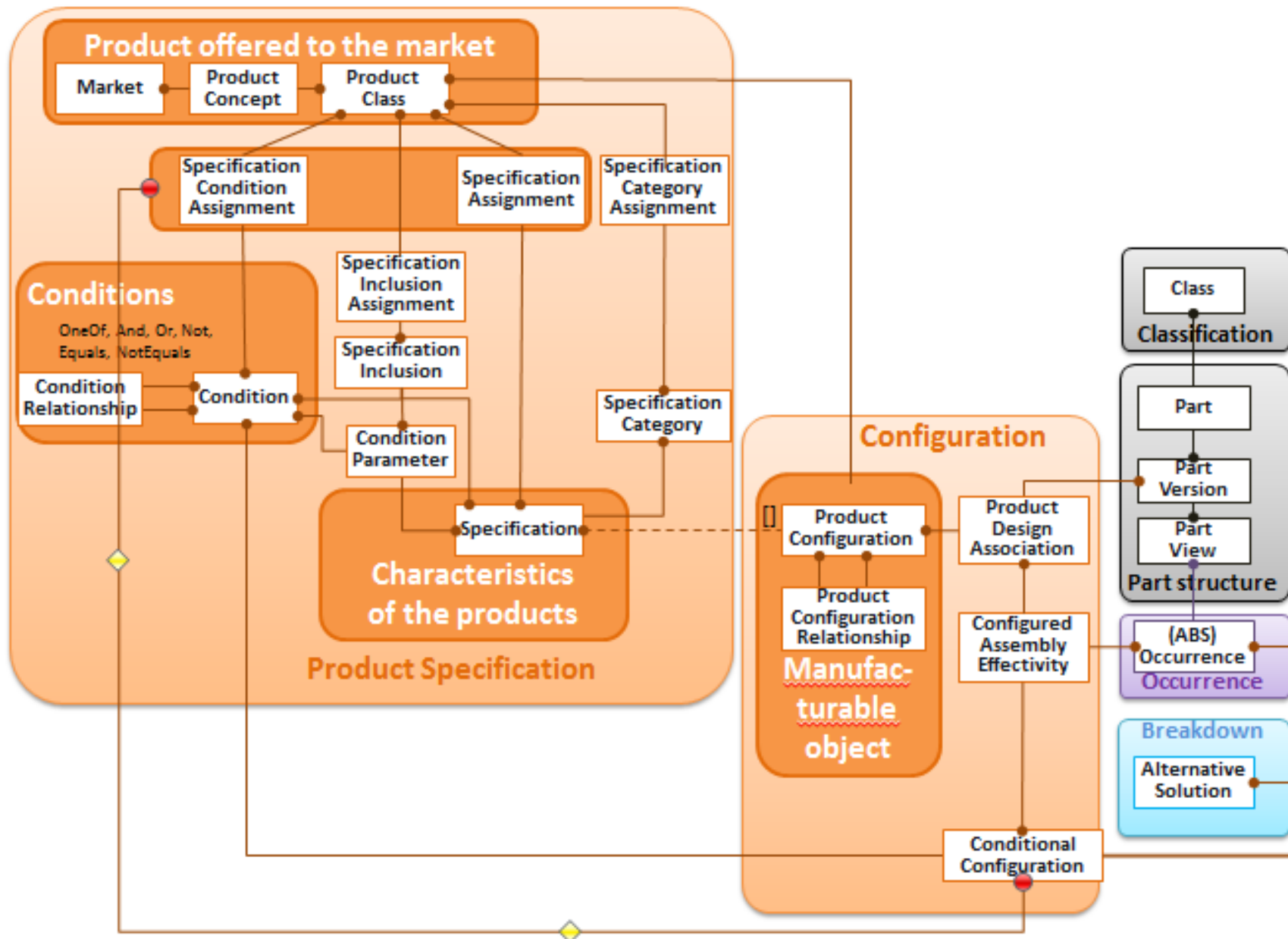
## Tests of COTS interfaces by independent specialists

- Planning: Start in June 2016; report in June 2017
- Use cases: data exchange of:
  - 3D exact geometry,
  - 3D tessellated geometry,
  - 3D PMI representation and graphic presentation,
  - assembly structure,
  - associated validation properties
- Applications tested:
  - Autodesk (Inventor Professional 2017),
  - CoreTechnologie (3DEvolution, 3DAnalyzer),
  - Datakit (CrossManager),
  - Elysium (ASFALIS)
  - Dassault Systèmes (CATIAV5-6R2016, 3DEXPERIENCE 2016x),
  - Theorem (CADVerter),
  - TechSoft3D (Tetra 4D Converter),
  - Kisters (Kisters 3DViewStation 2016),

- Test cases:



# Product specifications, to describe large variants of products



Main concepts used to handle large number of variants:

- **product classes**  
: used to identify sets of similar products to be offered to the market;
- **specifications**  
: used to describe characteristics of the products (b.e.: “options”);
- **specification categories**  
: used to group similar characteristics of the products;
- **specification expressions**  
: used to control the usage of a part within a product and to represent conditions for product classes;

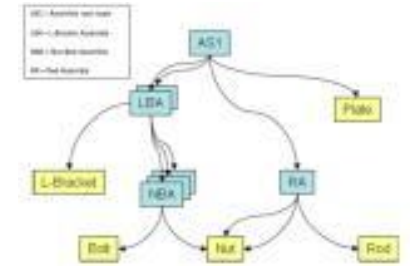
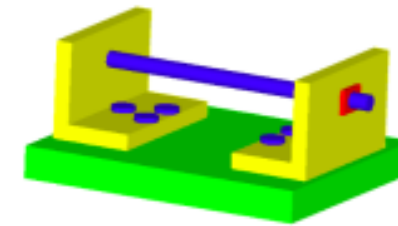
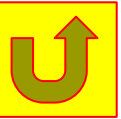
# STEP AP242 ed1 Benchmark 2017

## : [PDM Work Package results](#)



### Vendors & interfaces tested

### Test descriptions



### Exchange of PDM Information using AP242 BO Model XML

- Part number, Version, Life cycle status
- Document management information
- Assembly Validation Properties
- References to geometry (STEP Part 21 files / CAD models)
- References to non-CAD documents (PDF, JPG)
- Management of changes (new versions, updated life cycle status)

Company	Solution	Target PDM system	DateDescription for this Benchmark
DASSAULT SYSTEMES	3DEXPERIENCE R2017x	3DEXPERIENCE R2017x	3DEXPERIENCE STEP AP242 import and export native interface
ELYSIUM	ASFALIS EX7.1.12	Aras Innovator 11	STEP AP242 interface for Aras Innovator by Elysium
PROSTEP	OpenPDM 8	TeamCenter 10	STEP AP242 interface for TeamCenter by PROSTEP AG
ptc	Windchill 11.0 M020	Windchill 11.0 M020	Windchill STEP AP242 import and export native interface
T-Systems	COMPDM 2.0	Aras Innovator 11	STEP AP242 interface for Aras Innovator by T-Systems International GmbH
COBIT TECHNOLOGY	3D_Evolution 4.1	*	CAD & Converter system with STEP AP242 interface
datakit	CrossManager 17.1	*	Converter system supporting STEP AP242 conversions

**Good participation of the main PDM software editors.** Siemens PLM does not commercialize a STEP AP242 PDM XML interface

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Thank you