- Use of ISO 10303 STEP AP242 edition 1 for configured MBD interoperability
- Enhancements of AP242 ed2;
- Related Interoperability Forums.

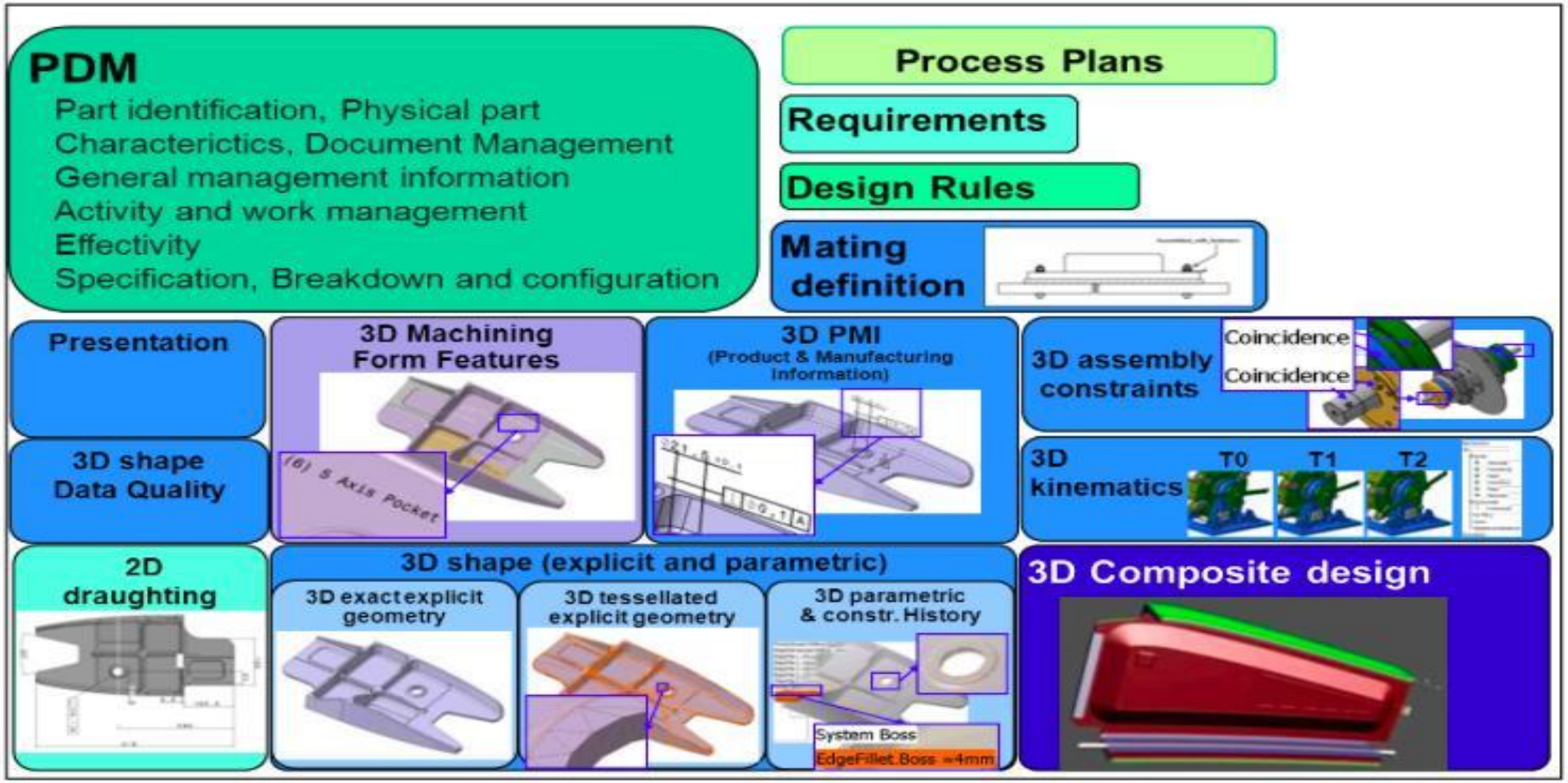
Jean-Yves DELAUNAY
Airbus Operations

- **Jean-Yves Delaunay**
  Airbus Engineering,
  PLM Interoperability expert
  Based in Toulouse, France
  Joined Airbus in 1990
- Before Airbus:
  - Automotive: Peugeot SA (1985 – 1987)
  - Ship Building: DCN (1987 – 1989)
  - Engineer diplomas in Mechanical Engineering (HEI) and in Computer Aided Design (ENSIMAG)
- 3 great daughters
- Hobbies: walking, swimming, history and cinemas.

Table

- Summary of implementation and use of ISO 10303 AP242 edition 1
- Enhancements and new capabilities developed in AP242 edition 2
- Speeding up of solutions deployment with Interoperability Forums
- Preparation of AP242 enhancements using Agile methods (ed3, etc)
- AP242 links with other PLM standards to support the digital thread

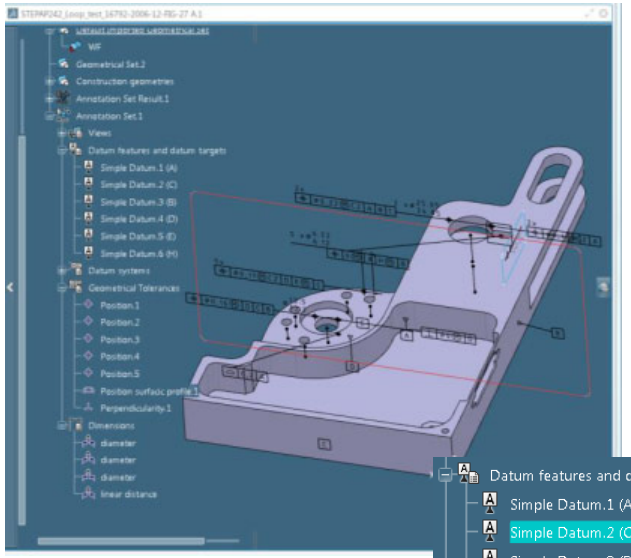
ISO 10303 AP242: the recognized Aerospace & Defense standard for 3D Model Based Definition interoperability



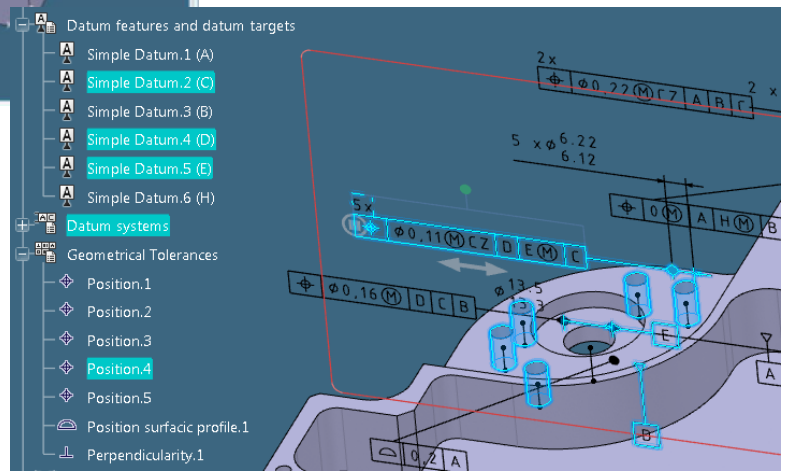
Scope of STEP AP242 ed1

(International Standard in 2015)

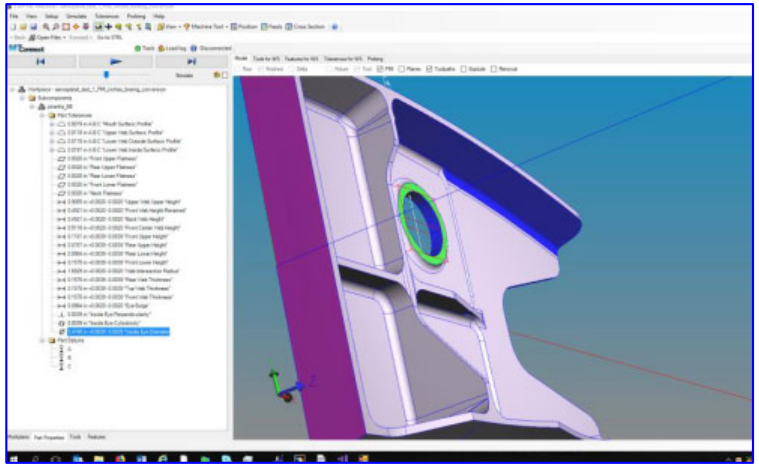
Example of implementation of AP242 ed1 for CAD exchange



CAD to CAD data exchange using AP242 ed1 (3D with PMI)

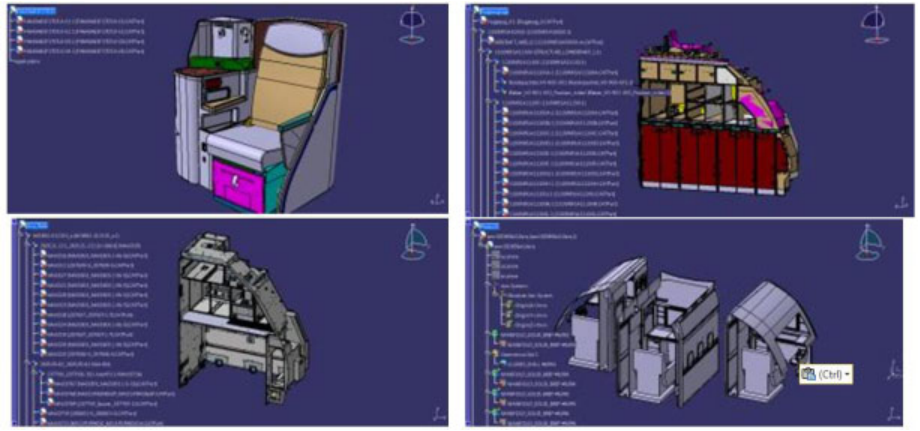


Exemple of STEP file imported in 3DExperience



CAD to CAM data exchange using STEP AP242 ed 1

3D DMU data exchange with cabin equipment suppliers in AP214 / AP242 (Airbus)



AP242 Semantic GD&T interop. capability is implemented in the recent CAD applications

Overview of STEP AP242 ed1 COTS interfaces capabilities for PDM – CM data exchange

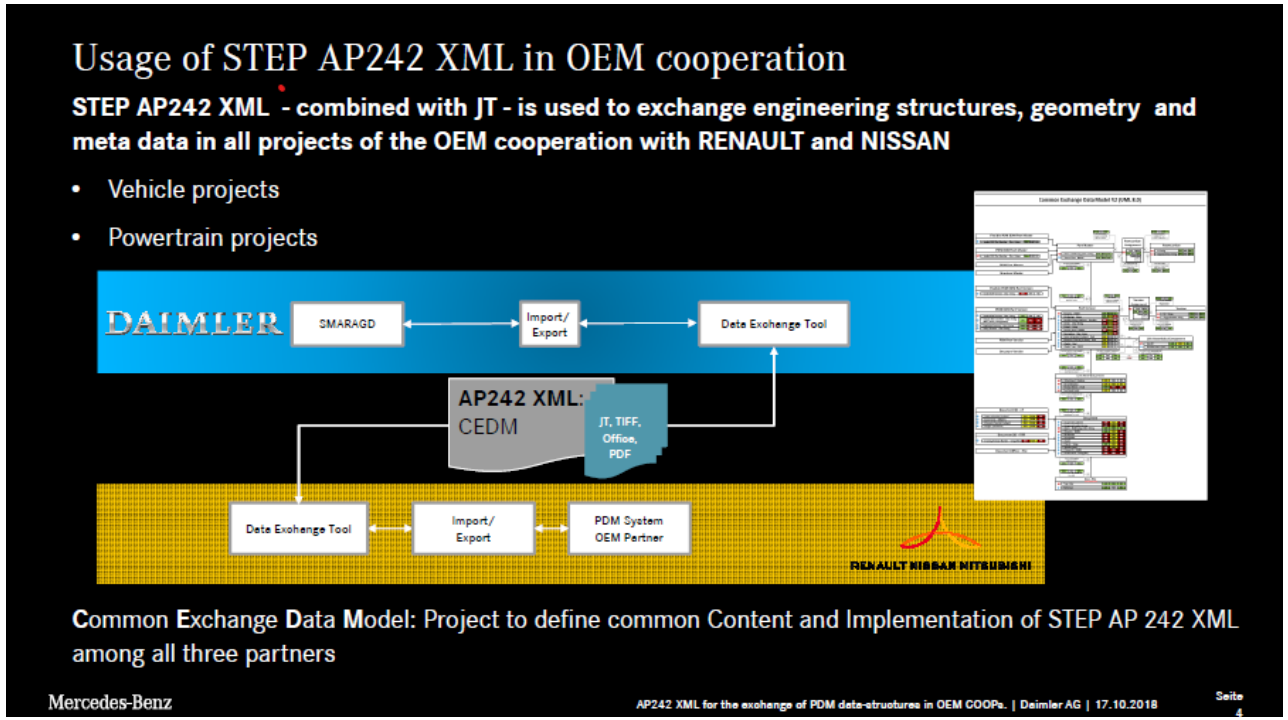
	Siemens PLM		Dassault Syst.		Tsystem		JOTNE		Datakit	
	TeamCentre		3DEXPERIENCE		COMPDM		XML BO M.		XML BO M.	
PDM information	Function	Status	Function	Status	Function	Status	Function	Status	Function	Status
"As Design" product structure	Yes	COTS	Yes	COTS	Yes	COTS	Yes	COTS	Yes (R)	COTS
Nested PDM product structure	Yes	COTS	Yes	COTS	Yes	COTS	Yes	COTS	Yes (R)	COTS
Assembly validation properties	Yes	Pilot	Yes	COTS	Part.	COTS	Yes	COTS	Y (R)	COTS
Life cycle management	Yes	Pilot	Yes	COTS	Yes	COTS	Yes	COTS	Y (R)	COTS
Document structure	Yes	COTS	Yes	COTS	No	No	Yes	COTS	Y (R)	COTS
Person and organization	Yes	COTS	Yes	COTS	Yes	COTS	Yes	COTS	Y (R)	COTS
Date and time	Yes	COTS	Yes	COTS	Yes	COTS	Yes	COTS	Y (R)	COTS
Classification	Yes	COTS	Yes	COTS	Yes	COTS	Yes	COTS	future	future
Material properties	Yes	COTS	Yes	No	No	No			future	future
Customized PDM properties	Yes	COTS	Yes	COTS	Yes	COTS	Yes	COTS	Y (R)	E2 IS?
Config. Mngt - based on effectivities	Yes	Pilot	Yes	PDM IF	N1	COTS			future	COTS
Config. Mngt - based on specifications	Yes	Pilot	Yes	PDM IF	N1	COTS			future	E2 IS?
Config. Mngt - based on combination of effectivities & specifs.					N1	COTS				
Config. Mngt - based on specifications					N1	COTS				
N1: Occurrence effectivities										

From AFNeT 2019 Standardizay Days

Major PDM systems have several COTS AP242 interfaces for PDM "As designed" data exchange, either developed by their editors or by third party integrators

Examples of use of STEP AP242 XML for PDM exchange

- **AP242 XML for the exchange of PDM data structures in OEM COOPs**
  (Daimler AG, AFNeT - prostep ivip AP242 Day, 17 Oct. 2018)

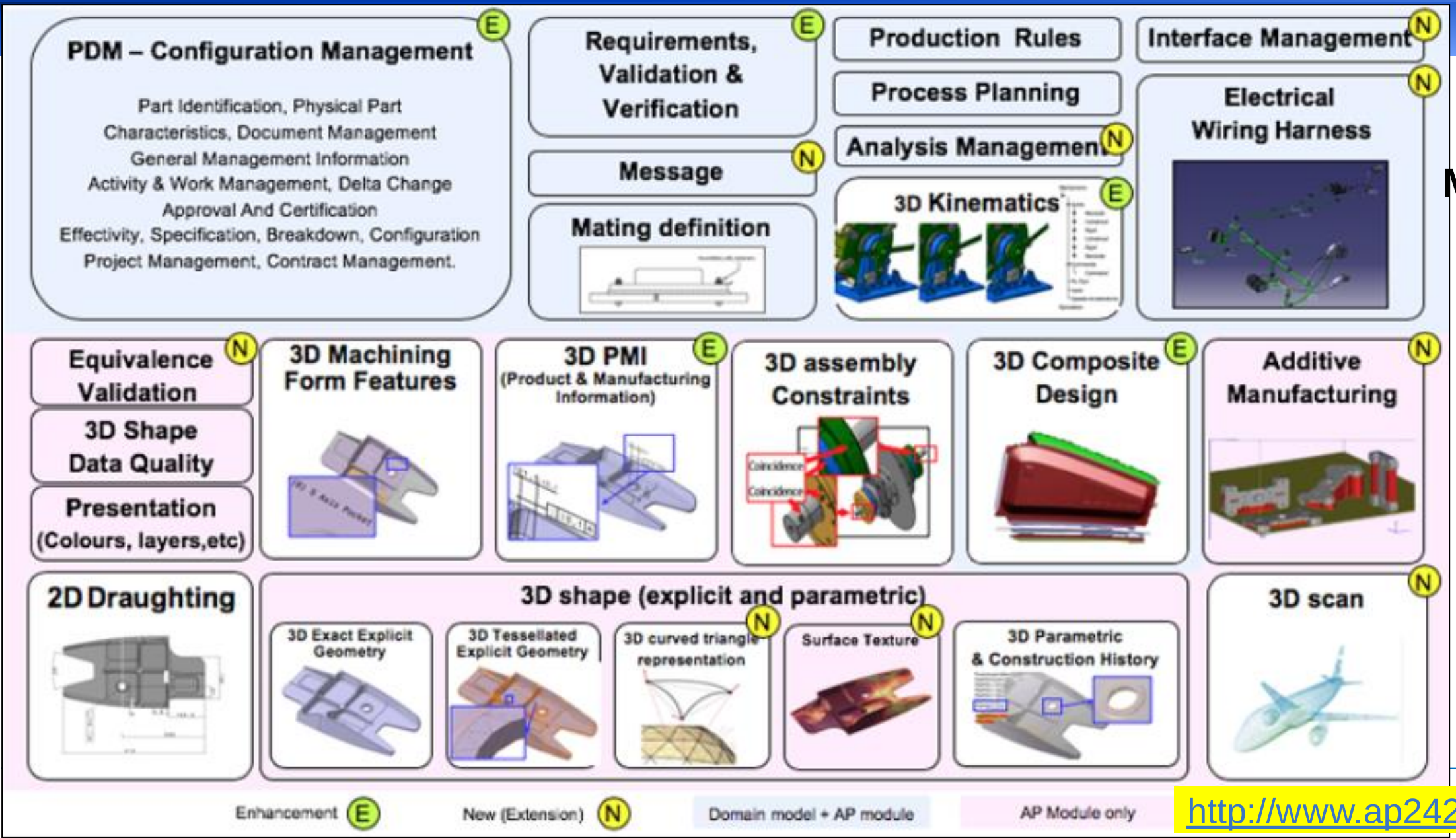


- **Planned use of PDM data exchange based on STEP AP242 by Airbus**
  - Principle: 3D Experience technical compatibility with STEP AP242
  - Heterogeneous exchange for general usage
  - Specific Aircraft program deployment in case by case usage
  - Long Term Archiving

Table

- Summary of implementation and use of ISO 10303 AP242 edition 1
- Enhancements and new capabilities developed in AP242 edition 2
- Speeding up of solutions deployment with Interoperability Forums
- Preparation of AP242 enhancements using Agile methods (ed3, etc)
- AP242 links with other PLM standards to support the digital thread

Overview of ISO 10303-242 edition 2 (STEP AP242 ed2)



Managed Model Based 3D Engineering

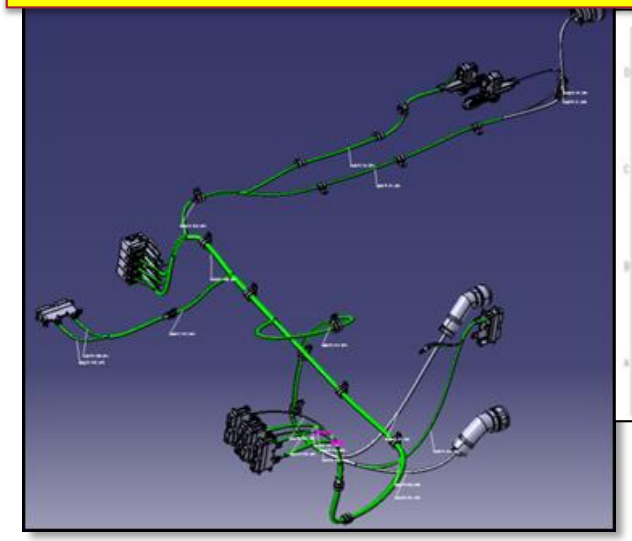
AP242 ed2 project supported by
- AFNeT
- PDES Inc

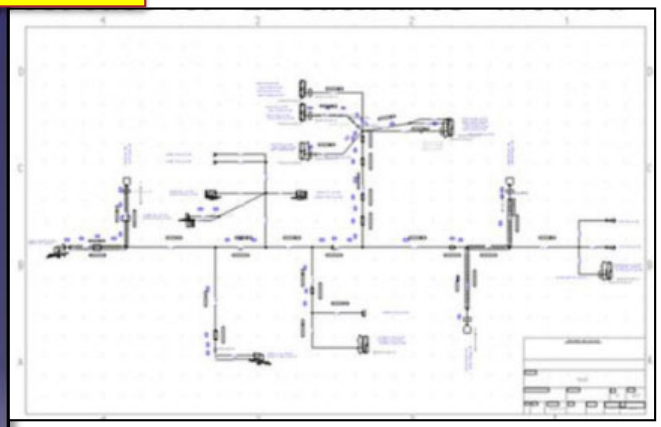
AP242 DIS2 ballot in progress (closure: end Oct. 2019)

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

AP242 ed2 new capability for Electrical Wiring Harness

Electrical harness design (2D, 3D…)





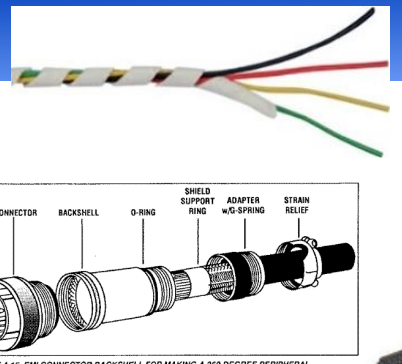


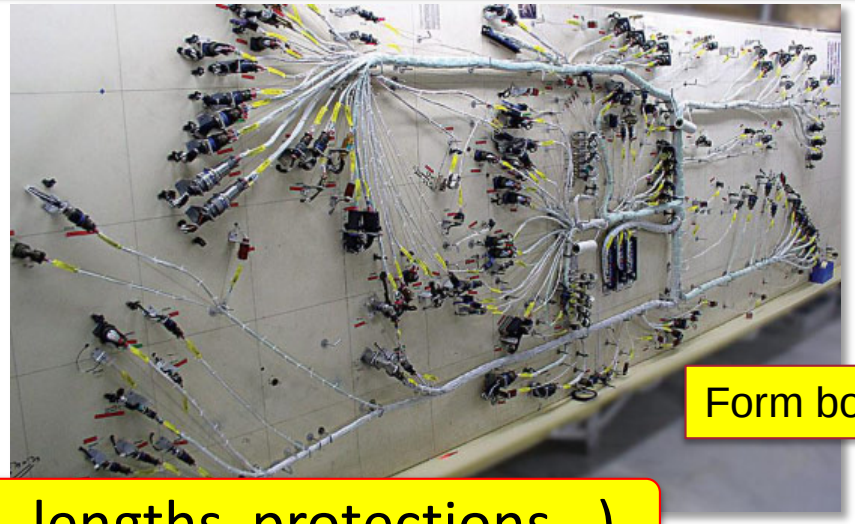
FIGURE 4-15. EMI CONNECTOR BACKSHELL FOR MAKING A 360 DEGREE PERIPHERAL TERMINATION OF CABLE SHIELDS

Electrical devices: connectors, backshelves, splices, braid, wrap, terminals…

Connectivity information: Wire List…

Wire List Data.csv

	A	B	C	D	E	F
1	///Wire_ID	Part Name	Refdes 1	Pin 1	Refdes 2	Pin 2
2	10011	3252-VIO	P4	8	J2	1
3	10012	3050/1-BLU	J1	9	P4	10
4	10013	3053/1-GRN	J1	2	P4	7
5	10014	3055-BLK	P4	2	J2	8
6	10015	3050-BLU	J1	4	J2	3
7	10016	3047-YEL	J2	4	J1	7
8	10017	3047-ORG	J1	3	P4	6
9	10018	3047-YEL	P4	5	J2	5



Form board

http://www.ap242.org/electrical-harness

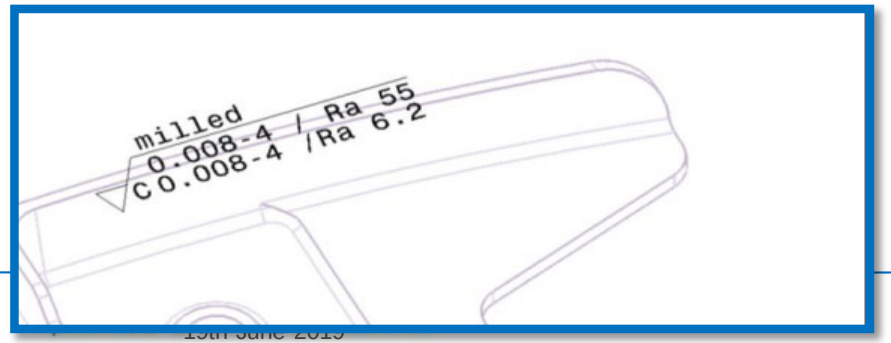
Scope: focus on physical electrical harness (topology, wires, lengths, protections…)

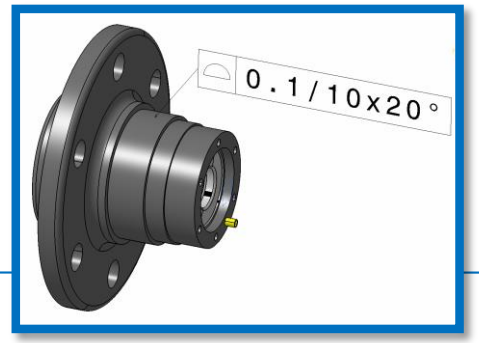
AP242 ed2 mechanical: enhancements for 3D geometry and 3D PMI

	AP242 Ed. 1 (2014)	AP242 ed.2
3D exact geometry	Yes	Yes
3D tessellated geometry	Yes	Yes + enhancement
Graphic PMI/annotation	Yes	Yes + enhancement
Semantic PMI/annotation	Yes	Yes + enhancement
Composite	Yes	Yes + enhancement
Additive manufacturing	No	Yes (NEW)

New semantic PMI supported in AP242 Edition 2

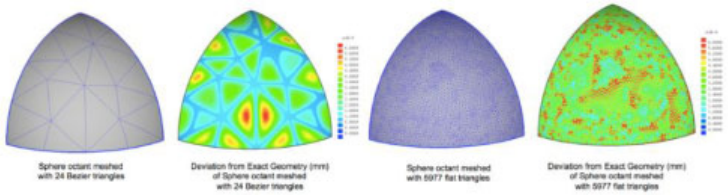
- Surface texture parameters, ISO 1302
- ISO 1101 Intersection plane / orientation plane, new modifiers , Geometric tolerances with a Restrictive specifications
- Spotface dimension / countersunk / counterbore / hole depth





Enhancements for Geometry

- 3D scan
- Advanced tessellation (cubic bézier triangle)



- Persistent ID
- Surface visual texture

- Vertex colors for tessellated geometry

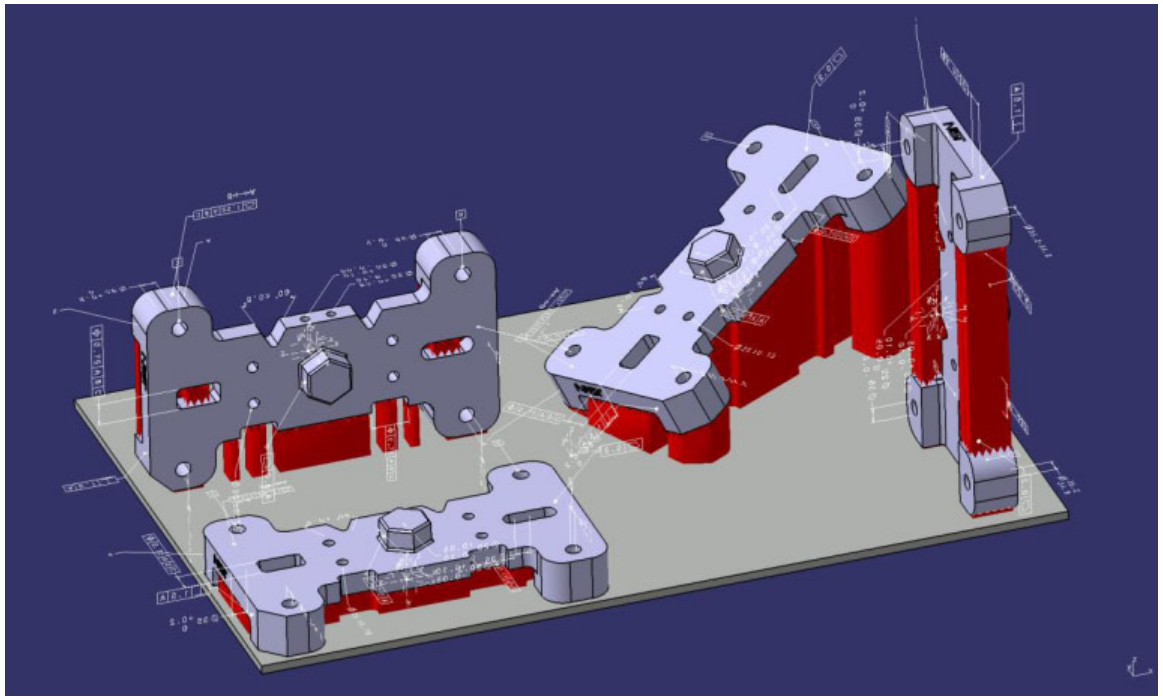
http://www.ap242.org/ed2-3d-cad-interoperability

AP242 ed2 Mechanical domain: extension to Additive Manufacturing

Support of new entities for:

- Build orientation
- Build plate size
- Build volume
- Build plate placement

//http://www.ap242.org/additive-manufacturing



Planned extensions for STEP AP242 ed3 and following editions (according to resources)

- Heterogeneous materials
- Representation Lattice structures:.
- Semantic representation of PMI for Additive manufacturing

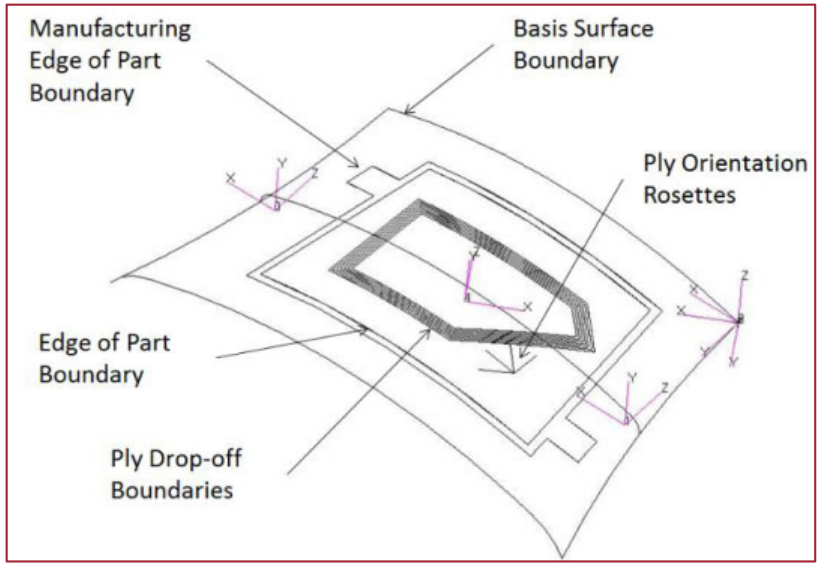
In consistency with ISO 14649 part 17 « Process data for additive manufacturing" and STEP AP238 ed2

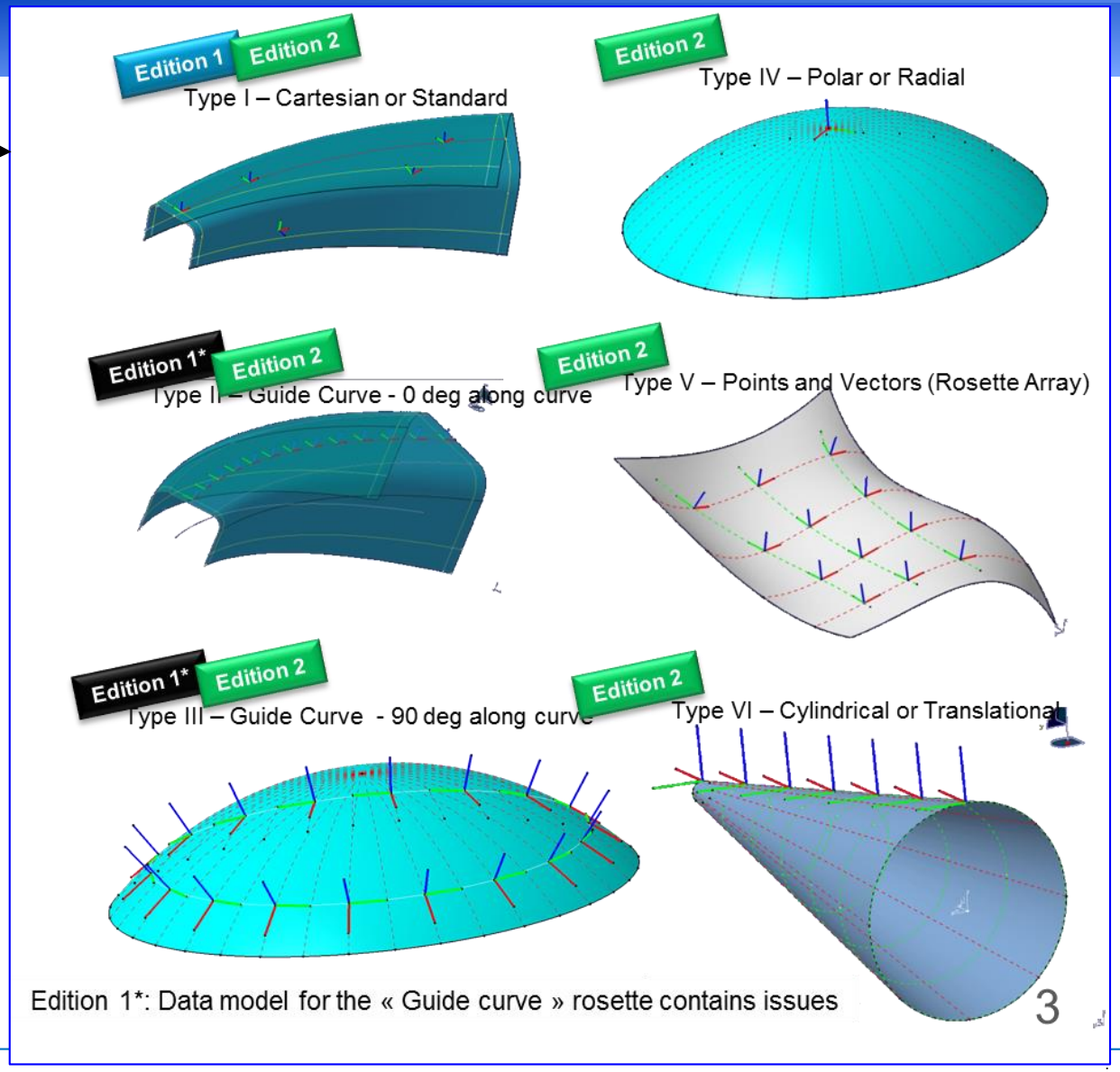
Enhancements of AP242 ed2 for Composite design

Definition of new types of Rosette

Description of:

- the Engineering End of Ply (EEoP)
- the Manufacturing End of Ply (MEoP)





http://www.ap242.org/ed2-composite-design-interoperability

Harmonization of AP242 ed2 and STEP AP239 ed3 PLCS for PDM and Requirement, Validation & Verification management

AP239 ed3 specific capabilities

- Planning, scheduling
- Risk
- Probability
- Task description
- Resources
- Slot
- Observation

Capabilities shared by AP239 ed3 and AP242 ed2

- Common resources Incl.: Classification, Date & Time Effectivity, Property, Condition, State, Identification, name & description
- Management resources Incl.: Person, organization and Address, Approval/Certification, Information rights, Contract and project
- Message
- Delta change
- Document Management
- Breakdown
- Analysis
- Activity
- Individual Part
- Work Management
- Planned and evaluated characteristics
- Requirement Management, V&V
- Representation and external element reference
- Product Specification and Configuration
- Product Data Management
- Interface

AP242 ed2 specific capabilities

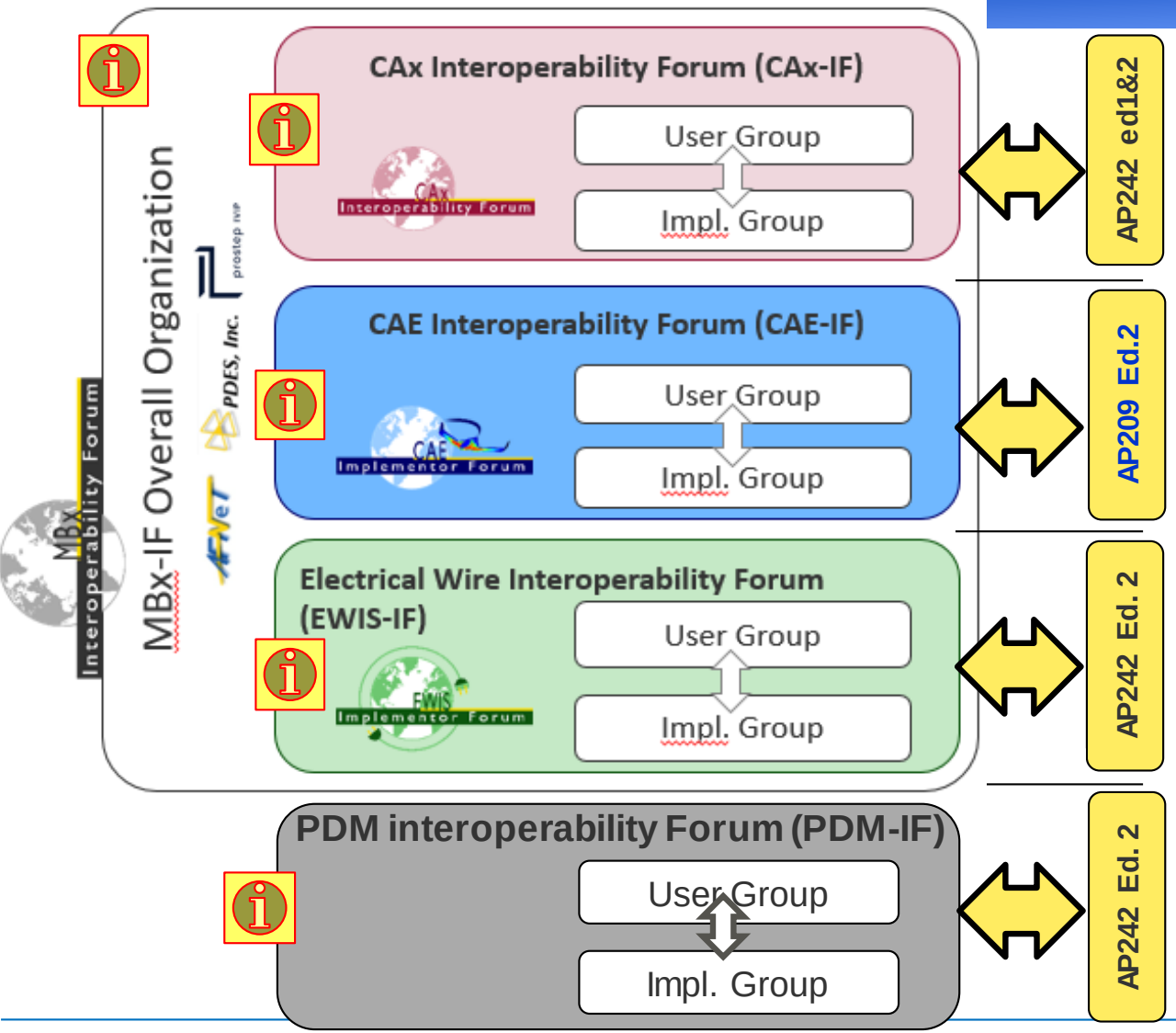
- Material
- Mating
- Kinematics
- Process Plan
- Electrical Harness
- Composite Structural Shape and Structure
- Shape Association and Structure
- 3D geometry

Target: harmonization of AP242 ed2 – AP239 ed3 for PDM – CM finalized in Q4 2019

Table

- Summary of implementation and use of ISO 10303 AP242 edition 1
- Enhancements and new capabilities developed in AP242 edition 2
- Speeding up of solutions deployment with Interoperability Forums
- Preparation of AP242 enhancements using Agile methods (ed3, etc)
- AP242 links with other PLM standards to support the digital thread

Overview of Interoperability Forums (IF) speeding up the deployment of AP242 and AP209 solutions



An Interoperability Forum consists of

- a **User Group**, and
- an **Implementor Group**

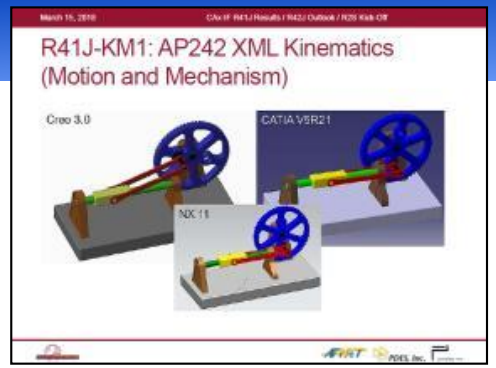
focused on a specific capabilities of a named standard; in this case: AP242

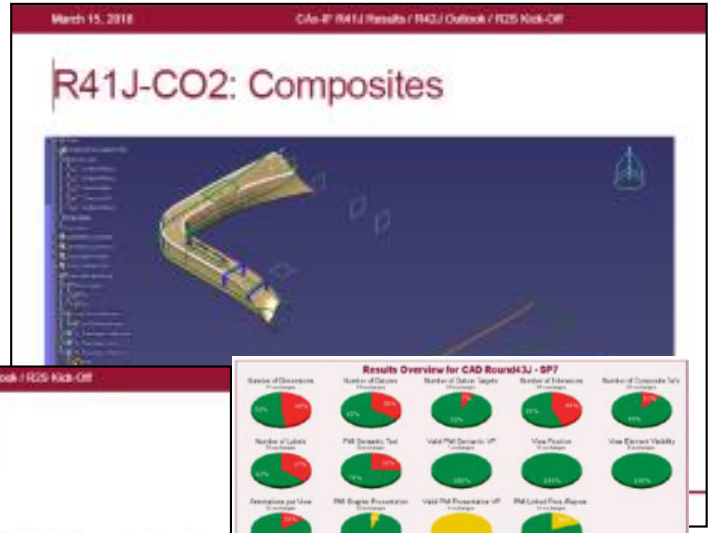
It enables **testing of interoperable implementations** of a standard through regular test rounds and recommended practices based on **prioritized industry use cases** and **public test cases**

Note: **STEP AP209**: "Multidisciplinary Analysis and Design »
http://www.ap209.org/welcome

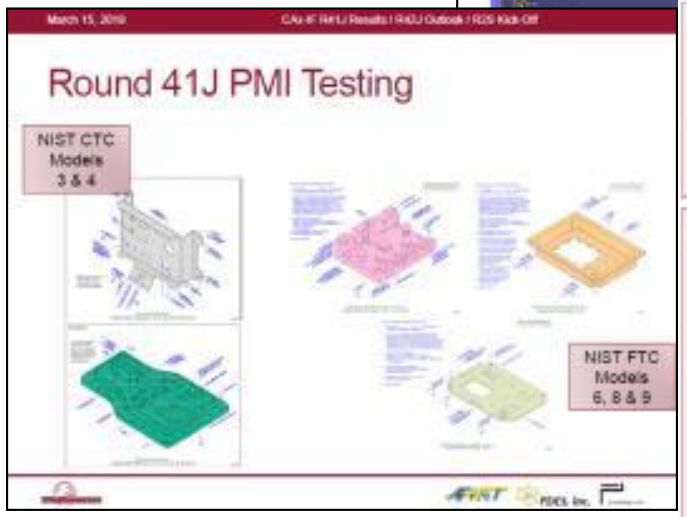
AFNeT – prostep ivip – PDES Inc CAx Implementer Forum: March and Sept. 2019 Round Tables (PDES Inc. offsites)

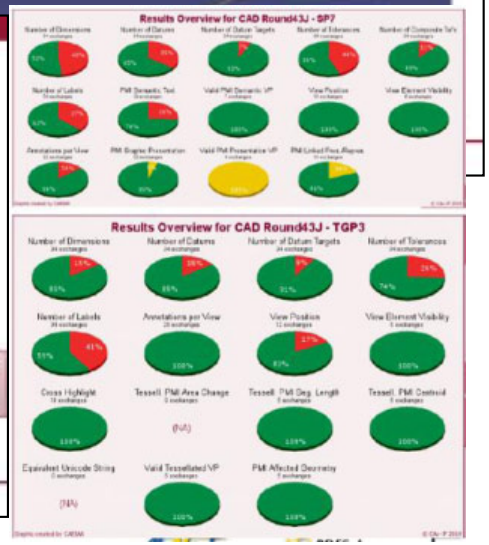
CAx Interoperability Forum





- Continuation of tests of AP242 ed1 and AP242 ed2 DIS functionalities:
  - 3D PMI semantic
  - Composite
  - Kinematics
  - etc
- Status of STEP AP242 interfaces by the main PLM editors:
  - **NIST tools update** (STEP 3D PMI analyser, STEP AP209 analyser)
  - **Autodesk (AutoCAD**
  - **Dassault Systèmes** (Catia V5, 3DEXPERIENCE, SolidWorks, etc.)
  - **Siemens PLM** (NX, NJT2GO, Femap, SolidEdge, TCVis, etc.)
  - **PTC** (CREO)
  - **CT CoreTechnologie** (3D_Evolution, 3D_Analyzer)
  - **Datakit** (CrossCAD converter)
  - **Elysium** (Asfalis converter)
  - **EPM Jotne** (EDMOpenSimDM)
  - **Mitutoyo (**MiCAT Planner)
  - **International TechneGroup - ITI** (PDE Lib, CAD IQ, CAD Fix)
  - **Techsoft 3D** (HOOPS, Tetra4D)
  - **STEP Tools** (ST-Developer)





https://www.cax-if.de/cax/cax_user_group.php

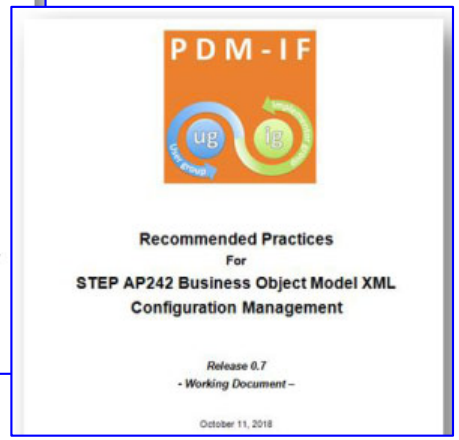
Launch of the CAx IF "User Group" in Q4 2019 to define industry use cases

AFNet - protep ivip PDM Implementor Forum, based on AP242

Member / Vendor Benefits

- Testing in a closed, trusted environment
- Early detection of errors leads to **faster development cycles**
- Beta-testing with other systems **enhances product interoperability & robustness**
- Prioritized User requirements, and **common implementation approaches** agreed.

AP242 PDM Recommended Practices



USERS

- Airbus Group
- Boeing
- BMW
- Daher
- Daimler
- Dassault Aviation
- GIFAS
- Liebherr
- LOTAR
- MBDA
- PFA
- Prostep ivip
- Volkswagen
- Zodiac Aerospace

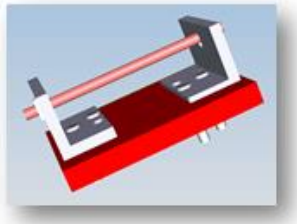
PDM systems editor

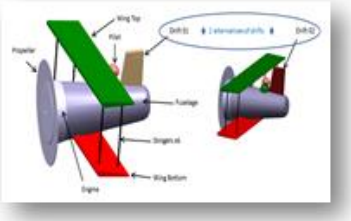
- Beta CAE
- CoreTechnologie
- Dassault Systèmes
- Datakit
- Elysium
- Jotne EPM
- Prostep AG
- PTC
- T-Systems

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

Examples of AP242 XML test cases used

Simple effectivities (Serial number, date ...)



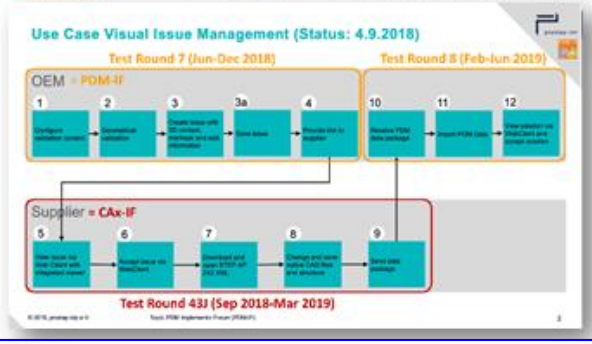


Complex effectivities and options

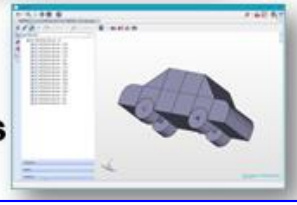
Interoperability of customized attributes

```
<Class uid = "C--6">
    <Id id="customized PDM type"/>
</Class>
<Class uid="C--7">
    <Id>
        <Identifier uid = "I--60" id = "CustomA_Part" idRoleRef = "C--6" idContextRef = "0--3"/>
    </Id>
</Class>
```

Cax-IF – PDM-IF Interoperability

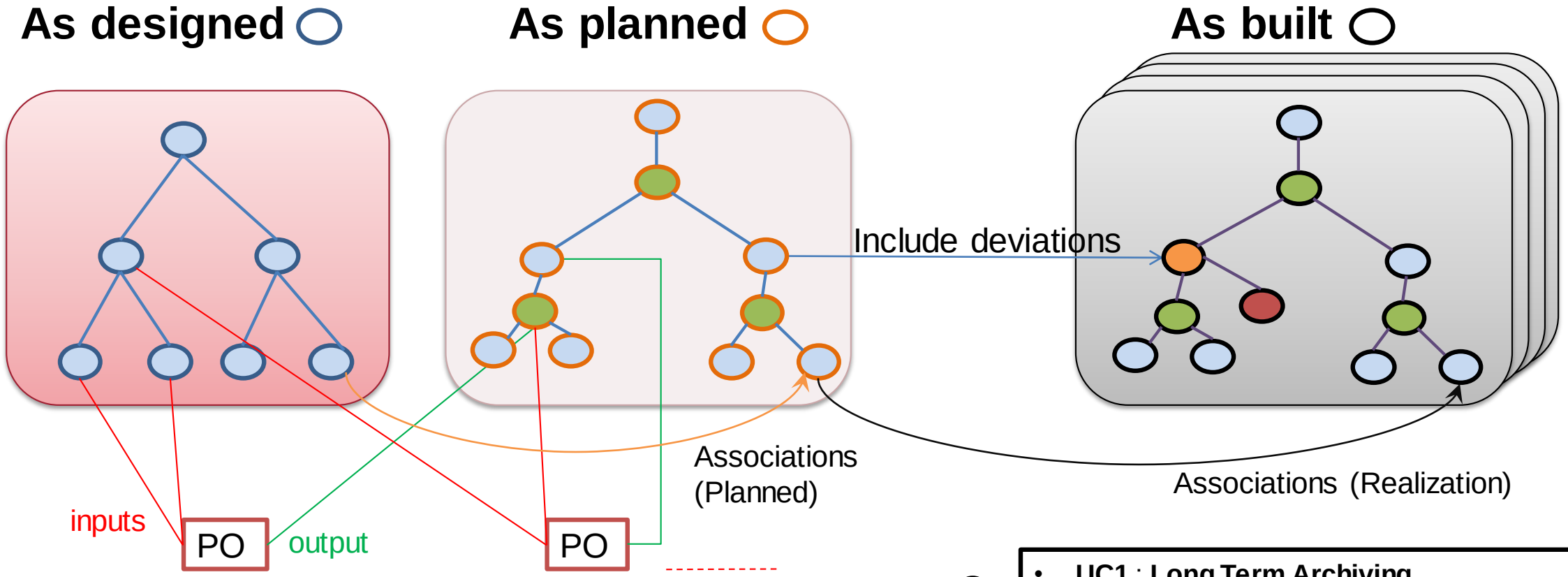


Interoperability of multiple Ids and Multi-language strings



June 19 2019

PDM IF Use case under preparation : exchange of As designed, As planned, As built product structures



Assembly node or leaf part

PO Process Operation

As planned intermediate node

As built intermediate node

Deviations

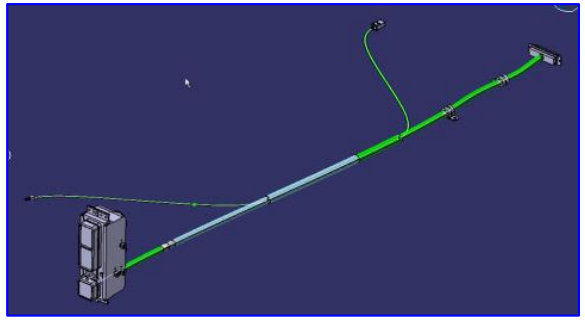
As built node including deviations

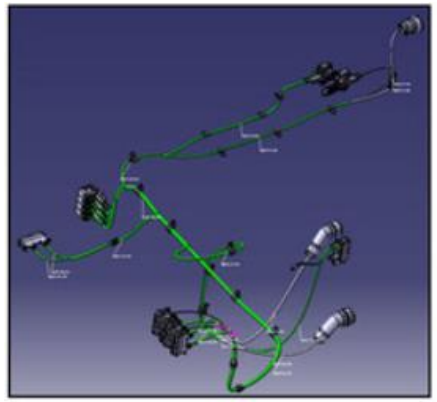
- **UC1** : **Long Term Archiving**
- **UC2** : Exchange **within the company** between **two different systems.**
- **UC3** : Exchange between an **OEM and a supplier** of the "**As designed and As planned**".
- **UC4** : Exchange between an **OEM and a supplier** of the "**As designed**".

AFNet – PDES Inc. EWIS Interoperability Forum based on AP242 ed2

Global Product Data Interoperability Summit | **2019**

- Launch of the EWIS-IF User Group in April 2019
- Presentation of EWIS-IF goal & objectives to electrical vendors in June 2019
- AP242 ed2 Elec. conference call training to interested vendors in Aug. 2019
- Launch of the 1st test round in Sept. 2019 with 2 test cases:
  - Electrical wiring harness assembly
  - Electrical harness topology





USERS

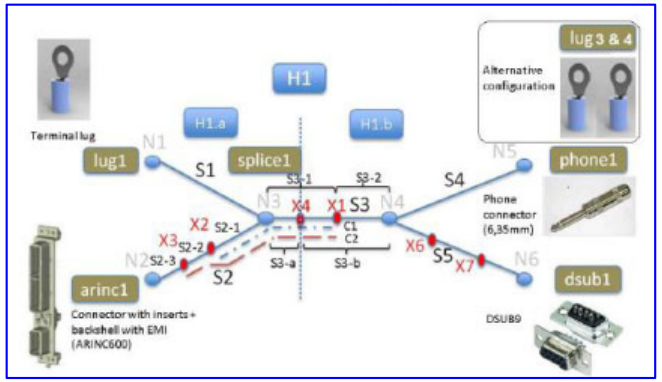
- **Gulfstream**
- **Airbus Group**
- **Boeing**
- **Safran**
- **Fokker**

Electrival vendors

- **EMCos**
- **CoreTechnologie**
- **Datakit**

Planned or in progress

- **Dassault Systemes**
- **Siemens**
- **Aucotec**



LOTAR

LONG TERM ARCHIVING AND RETRIEVAL

STEP AP 242 Electrical Harness XML Tutorial

Version: pre 1.2
Date: 2019-02-22
Status: Update for AP242 ed2 pre-DIS2, BO-Model and XML-Schema as of 2018-11-30
some re-namings going on ... see Bug 7331

Lothar Klein
LKSoftWare GmbH
Steinweg 1
36093 Künzell, Germany

This document contains SysML data models and XML Examples and is based on an XML schema (XSD file) provided by:

Sophie HERAIL
CIMPA S.A.S.
Subcontractor for AIRBUS Operations SAS - EZMA
Centreda 1
4, Avenue Didier Daurat
31700 Blagnac

Links:
http://www.lotar-international.org/
http://www.ap242.org/
https://en.wikipedia.org/wiki/ISO_10303
http://www.iso.org

AP242 Electrical Harness tutorial (draft recommended practices)

https://www.cax-if.de/ewis/ewis_introduction.php

Table

- Summary of implementation and use of ISO 10303 AP242 edition 1
- Enhancements and new capabilities developed in AP242 edition 2
- Speeding up of solutions deployment with Interoperability Forums
- Preparation of AP242 enhancements using Agile methods (ed3, etc)
- AP242 links with other PLM standards to support the digital thread
-

Target development of next versions of AP242 using Agile method
Planned development of AP242 ed3 in 2 years, starting in 2020

- The industry needs quicker availability of PLM interoperability standards in order to enable the seamless digital thread.
  - Objective supported by the ISO /TC 184/ SC4 “Industrial data” chair
- New standarization procedures in development based on Agile principles
  - Development of new capabilities with associated ballots, managed by SC 4/ WG11

  ➔ **Target publication of next versions of AP242 every 2 years (ed3, etc)**
    - Will Include the individual capabilities already succesfully balloted
  - Based on AP242 5 years roadmap, gathering industry requirements

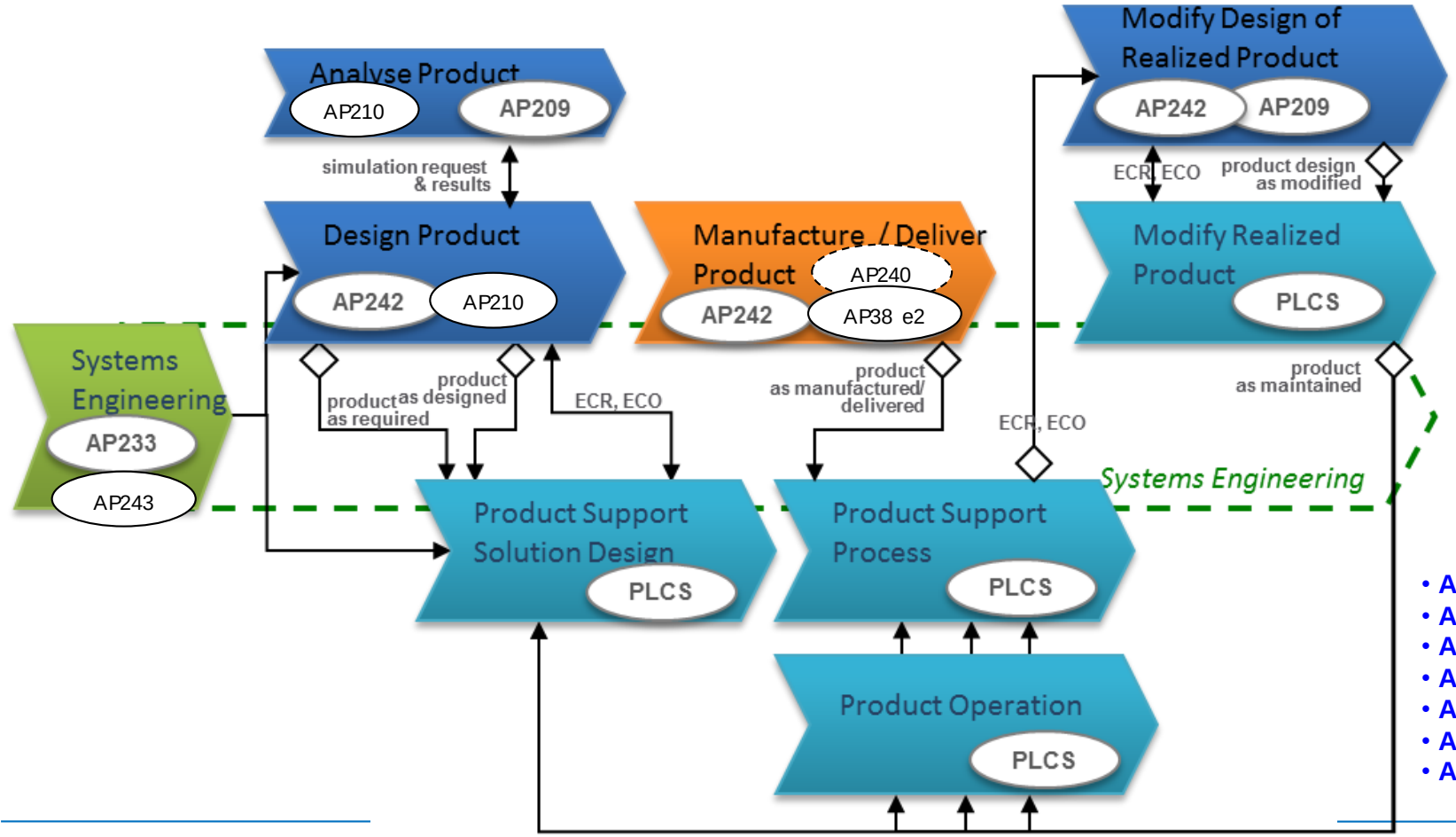
- Examples of new business requirements of the AP242 5 years roadmap:
  - Extension of electrical wiring harness to functional design, signals, etc
  - Extension for additive manufactuing, tubing, 3D PMI semantic at the assembly level, fasteners, etc
  - PDM: derogations, generic REST web services, etc

Table

- Summary of implementation and use of ISO 10303 AP242 edition 1
- Enhancements and new capabilities developed in AP242 edition 2
- Speeding up of solutions deployment with Interoperability Forums
- Preparation of AP242 enhancements using Agile methods (ed3, etc)
- AP242 links with other PLM standards to support the digital thread

AP242 is part of a suite of STEP modular Application Protocols, related to other complementary standards

- The A&D industry relies on a set on complementary PLM interoperability standards covering the full life cycle, ISO 10303 'STEP", complemented by other standards

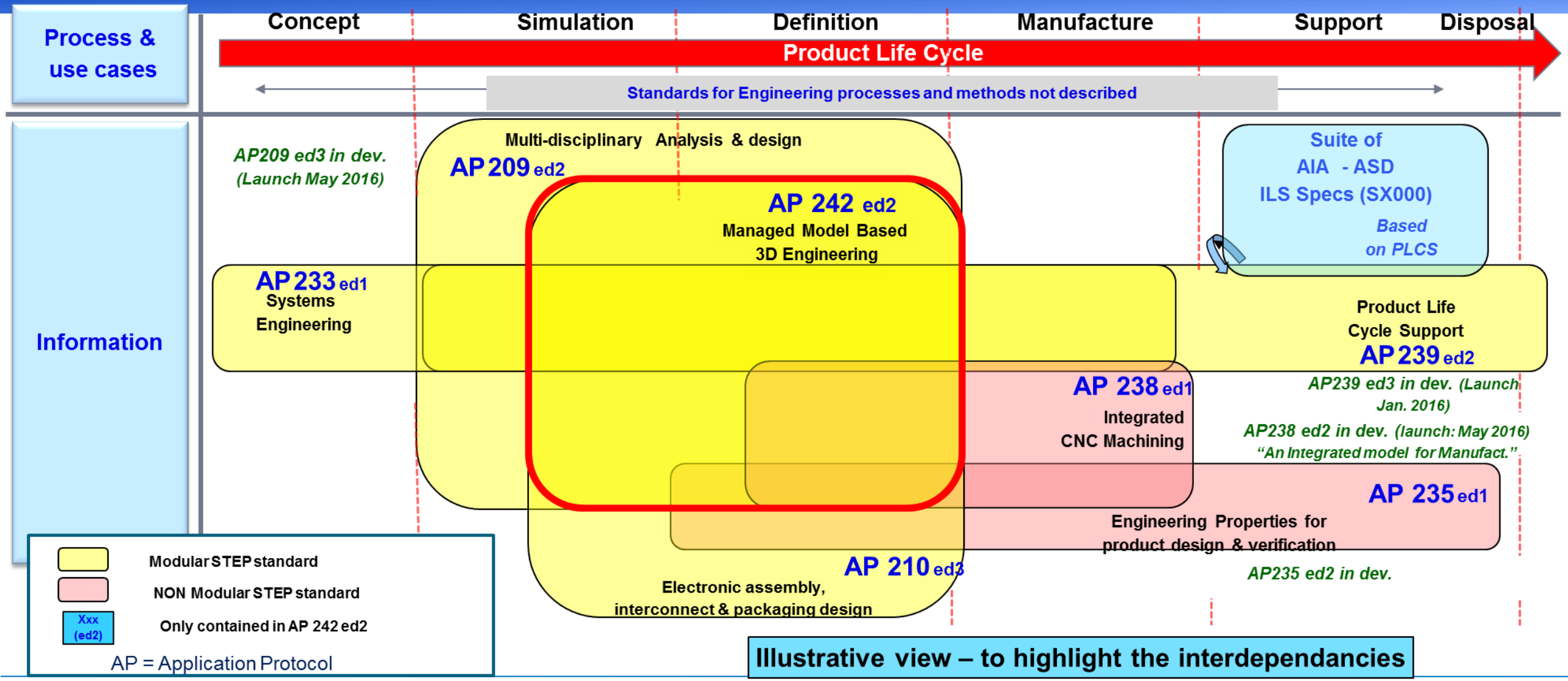


High level activity model identifying:
- the domain of usage
- and the data flows between the main STEP APs
(Application Protocols)

- **AP209 ed2**: "Multidisciplinary Analysis and Design"
- **AP210 ed3**: "Electronic assembly, interconnect, & packaging design"
- **AP238 ed2**: "Model Based Integrated Manufacturing » (STEP-NC)
- **AP233** "Systems Engineering"
- **AP239 ed3**: "Product Life Cycle Support" (PLCS)
- **AP242** "Managed Model Based 3D Engineering »
- **AP243** "Model. & Sim. Info. in a collab. SE Context" (MoSSEC)

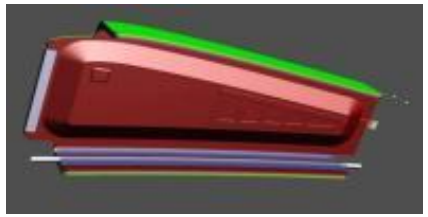
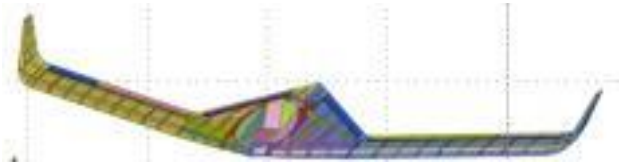
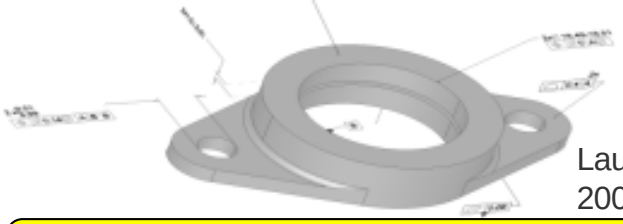
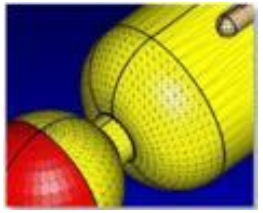
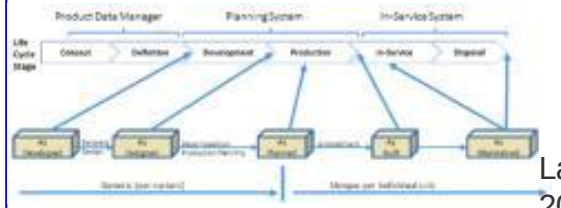
Overview of the key ISO 10303 STEP standards for the A&D industries

Global Product Data Interoperability Summit | **2019**



Illustrative view – to highlight the interdependancies

LOTAR and the link to ISO STEP AP242

Advanced Manufacturing : composite (Additive Manuf.)	Wiring Harness	Engineering Analysis and Simulation	Model Based Systems Engineering
NAS/EN 9300 3XX Information model (ISO AP242)  Launch 2009	**NAS/EN 9300 4XX** (ISO AP242 ed2)  Launch 2012	**NAS/EN 9300 6XX** (ISO AP209 ed2)  Launch 2014	**NAS/EN 9300 5XX** (ISO AP233 – AP239 / AP242 AP243 "MoSSEC", SysML, FMI / Modelica, etc) Planned launch 2018
Mechanical CAD 3D with PMI Product & Manufacturing Information)	**3D visualization**	**Product Data Management (PDM)**	**Meta data for archive package**
NAS/EN 9300 1XX Information model (ISO AP242)  Launch 2004	**LOTAR recommendations** (ISO AP242 ed2)  Launch 2012	**NAS/EN 9300 2XX** (ISO AP242 ed2 – AP239 ed3)  Launch 2004	**NAS/EN 9300 4XX** (ISO AP242 ed2 – AP239 ed3)  Launch 2012

The LOTAR standards rely mainly on ISO 10303 product data exchange standard, which includes AP242

Summary

- **STEP AP242 is the cornerstone ISO standard for configured Model Based Design**
  - consistent with other STEP standards: AP209 “Analysis”, AP239 PLCS, AP243 MoSSEC, AP238, etc
  - Integration in progress in 3D PDF,
  - Foundation for NAS / EN 9300 LOTAR standards,

- **Several Interoperability Forums support the deployment of STEP AP242 solutions** with the testing of COTS beta solutions in trusted environments
  - **CAx IF** (Mechanical), **EWIS IF** (Electrical Wiring Harness), **PDM IF** (PDM – CM), etc
    ➔Benefits for the manufacturers & PLM providers to participate in these Interoperability Forums

- **Need to extend the sharing of success stories and best practices of AP242 ed1** and to prepare the implementation of solutions based on AP242 ed2

- **Value for trade associations to support the deployment of PLM standards** : ISO 10303, FMI/Modelica, SysML, UAF, Industry 4.0, etc
  ➔ benefit for the entire eco system

27 Nov. 2019: AFNeT – prostep ivip STEP AP42 Day Hamburg, Center of Applied Aeronautical Research (ZAL)

High level agenda

- 08H00 : Coffee – Exhibition
- 09H00 : Welcome & Introduction
- 09H10 : Keynote from Airbus
- 09H30 : Status of AP242 CAx-IF, PDM-IF and 2019 AFNeT-prostep ivip AP242 Benchmark
- 10H15 : Status of AP242 CAD and PDM implementation matrix based on vendors response
- 10H35 : Coffee break
- 10H50 : Presentation by industry of AP242 in production with vendors solutions
- 12H20 : Lunch break
- 13H20 : Presentation by industry of AP242 future deployment scenarios (Holes and fasteners, Electrical Harness, PMI semantic, PDM -incl. multiview, kinematics)
- 14H50 : Coffee break
- 15H05 : Overview of AP242 edition 2 scope: extensions and main enhancements
- 15H25 : Overview of main interdependencies between AP242 and other standards
- 15H55 : Industry requirements for AP242 5 years Roadmap including AP242 ed3
- 16H15 : Closing remarks
- 16H30 : End of the event

Access to web pages for registration

- AFNeT
- Prostep ivip

Access to AFNeT – prostep ivip STEP AP242 presentations of **October 2018,** held in Airbus Toulouse,

- **BACK UP SLIDES**

Preparation of STEP AP242 edition 3 project in Q4 2019 : Expected to start in 2020

ISO /TC184 /SC 4 governance

STEP AP242 5 years roadmap ⟷ **ISO 10303 Roadmap**

Requirements & uses cases for STEP AP242 edition 3

Tutorials ⟷ **Pilots** ⟷ **Development of STEP AP242 edition 3**

STEP Architecture and infrastructure | **STEP Librairies**

Governance

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

STEP AP242 Interop. Benchmark Test Rounds (led by Manufacturers)

Based on

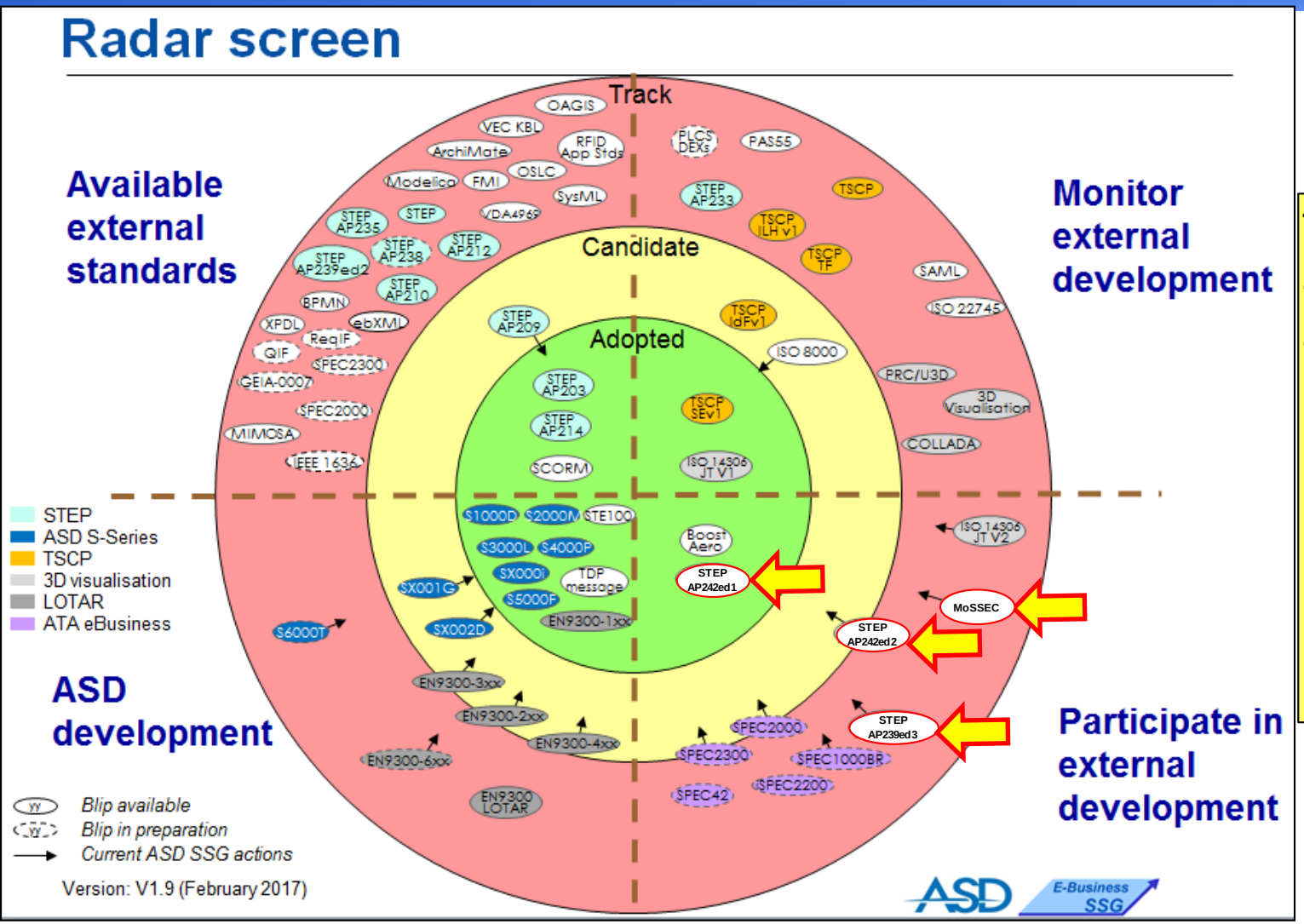
AP242 ed3 Implementation guidelines ← Enhance ← **STEP AP242 ed3** Interop. Test Rounds done by vendors with industry priorities

Implementor Forum

Needs for the industries to identify their priorities and plan resources for the development of PLM interoperability capabilities to be part of AP242 e3

Recommendations of the European A&D industry association for adoption of AP242 ed1, dev. of AP242 e2, AP239 e3 and MoSSEC

Radar screen



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

Extracts of ASD SSG statements

The ASD SSG supports:

- the adoption of STEP AP242 e1,
- the development of:
  - ➢AP242 e2, +
  - ➢AP239 e3 PLCS, +
  - ➢AP243 MoSSEC,
  - ➢A consistent AP239 ed3 and AP242 ed2 based on common core technical capabilities and STEP resources.

Coordination with AIA to identify opportunities for common actions and recommendations