LOTAR

LONG TERM ARCHIVING AND RETRIEVAL

Long Term archiving and retrieval of aerospace product data : Overview of EN9300 LOTAR, status of use, 5 years roadmap

AFNeT Standardization Days
19 - 20 April 2017

Jean-Yves DELAUNAY: Airbus

AIA AEROSPACE INDUSTRIES ASSOCIATION ASD-STAN Standardization

ProSTEP iViP PDES, Inc.

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LOTAR – Goal

- The project goal is to *develop, publish and maintain standards* designed to provide the capability ***to archive and retrieve*** **digital product and technical information**, including 3D CAD and PDM data, in *a standard neutral form*
  - that can be read and reused throughout the product lifecycle, independent of changes in the IT application environment originally used for creation.

- The standards are published as EN/NAS(*) 9300 series and cover both the information content as well as the processes required to ingest, store, administer, manage and access the information.

(*): EN – European Standard (Norm); NAS – National Aerospace Standard

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The LOTAR project: To support the **longevity** of Aerospace & Defense 3 D Model based definition

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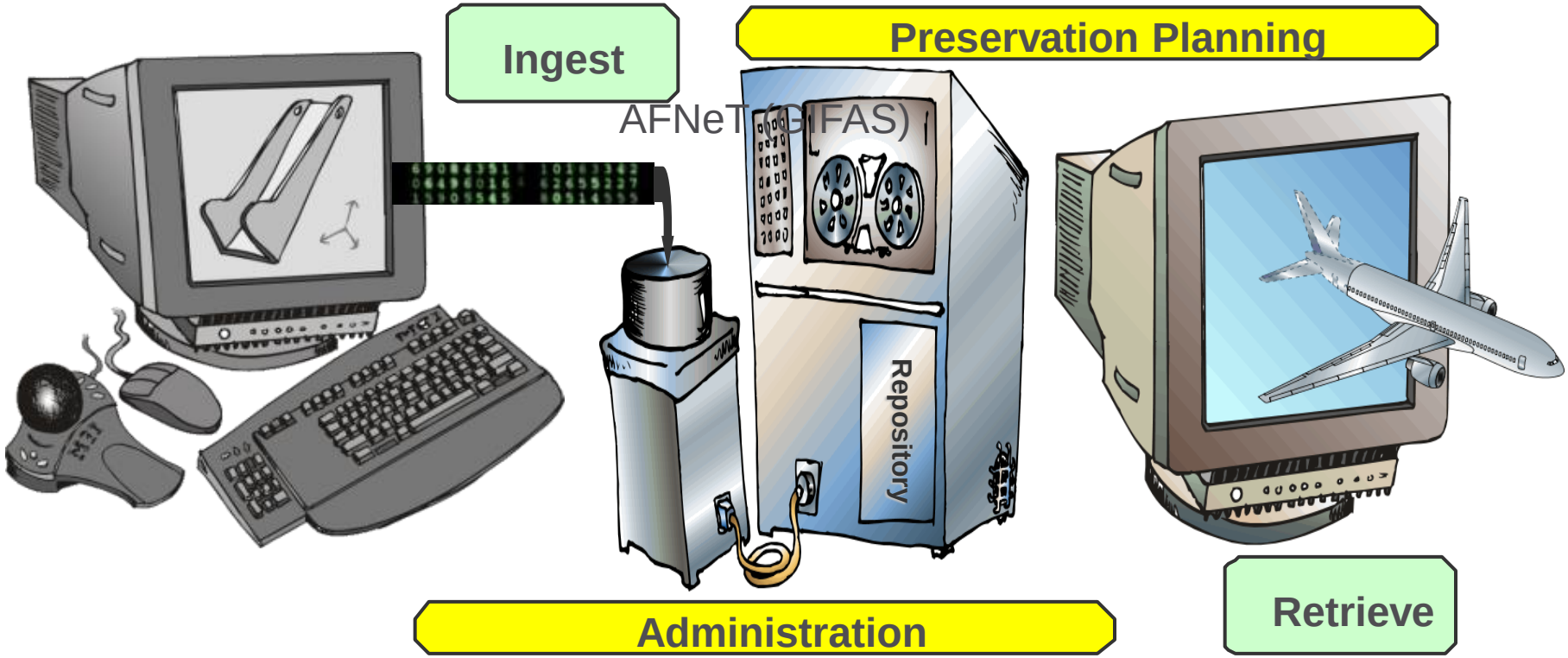
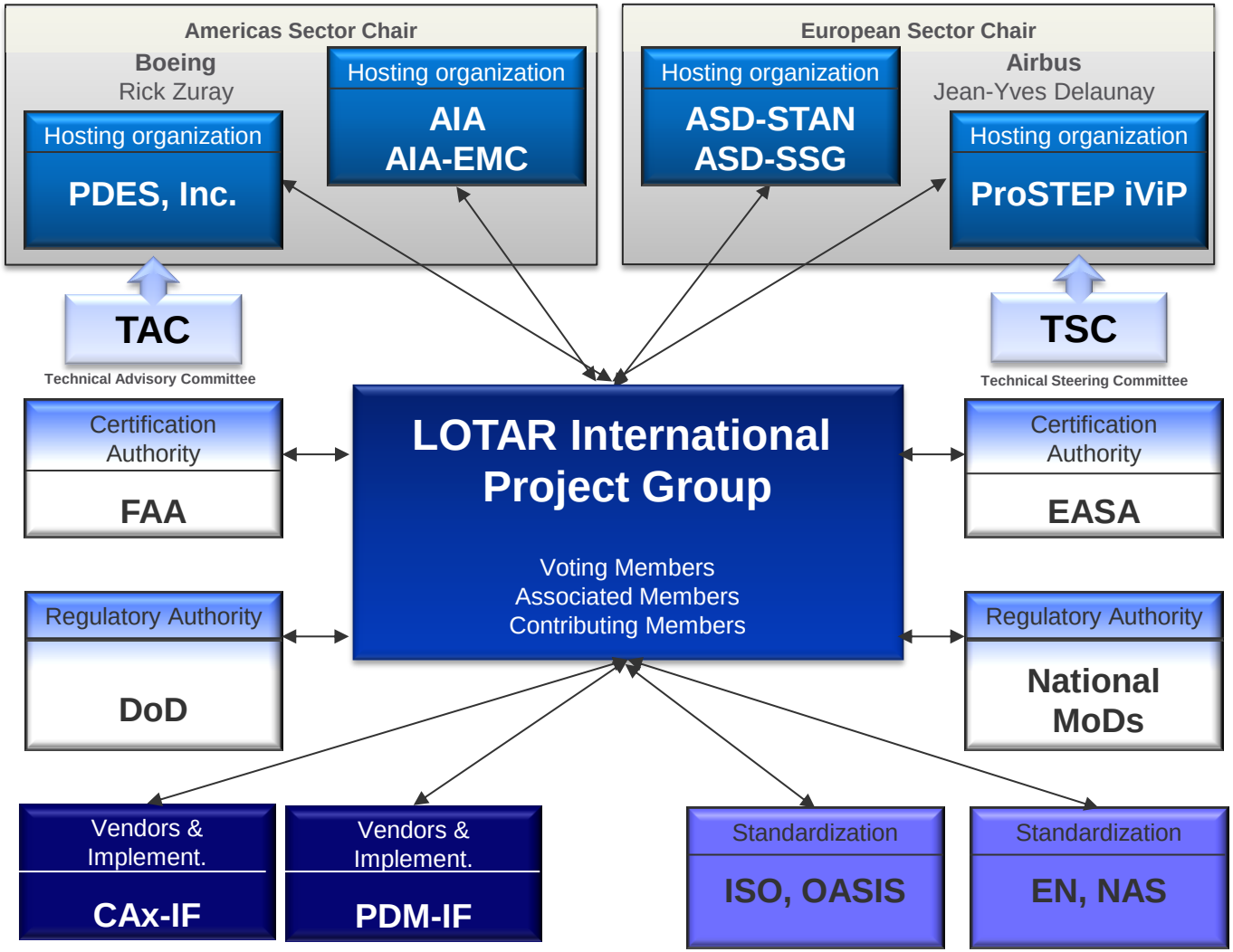
- CAD S/W versions change every **6 to 12 months**, CAD generations change every **10 years**.
- Aircraft lifecycle of **70+ years**
- The Lifecycle of software & hardware is short compared to the lifecycle of an aircraft or a defence system (nuclear missile, ...)



LOTAR Organization – External View



LOTAR Member Companies in 2017

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Europe

- Airbus Commercial Aircraft
- Airbus Helicopter
- Airbus Defence & Space
- AFNeT (GIFAS)
- SAFRAN

Americas

- BAE Systems
- Boeing
- Embraer
- GE
- Goodrich
- Gulfstream
- Honeywell
- Lockheed Martin
- Sandia National Labs

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Motivation for LOTAR

- Meeting the **legal and business requirements** of the aerospace and defense industry:

- EN/NAS 9300 considers requirements coming from:
  - Legal and certification rules
  - Regulations on long term archiving of technical documentation
  - Reuse
  - Support in operation
- Additional to legal demands, there are industry established standards, company specific rules and recommendations.
- The standard defines architecture, processes and data formats to fulfill these requirements.

Expected benefits of the use of LOTAR standards

- Process security achieved through implementation of archival systems compliant to international accepted standards
- Aerospace and Defense authorities accept workflow due to intense collaboration during standards creation
- Applicable archiving workflow supported by STEP interfaces & functionalities
- By solving the challenges of long term data retention, issues of data exchange are addressed

The development and the use of LOTAR standards by the A&D industries allow decreasing the cost and the risks of LT archiving of aerospace product data

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Status of use of NAS/EN 9300 by LOTAR members

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			NAS / EN 9300 LOTAR parts (CAD)					
A&D company	**Area of application**	**Scope**	CAD 3D exact geometry	CAD 3D tessellated geometry	CAD 3D PMI	CAD Assembly structure	**ISO formats**	**Project status**
			Part 110	**Part 100**	**Part 120**	**Part P115**	**ISO 10303 "STEP"**	
Airbus	A350	3D electrical harness installation	Yes	Yes	Yes	Yes	AP 214 ed3 (*) + AP 242 ed1	PROD
EADS		"Full 3D" model based	Yes	Yes	Yes	Yes	AP 242 ed1	PROD
Dassault-Aviation	Falcon 7X	complete definition of the aircraft (airframe, brackets, pipes, harness)	Yes	No	Yes	Yes	AP 214 ed3 (*)	PROD
Snecma	New parts of engines	3D definition with PMI of new mechanical part	Yes	No	Yes	No	AP 214 ed3 (*)	PROD
Boeing	787	3D definition with PMI with assemblies	Yes	Yes	Yes	Yes	AP 203 ed2 (*) + U3D PDF	DEV
Gulfstream	G650	3D mBD mechanical, electrical and composite	Yes	No	Yes		AP 203 ed2 (*)	PROD
Lockheed-Martin	F35	3D mBD mechanical, electrical and composite	Yes	No	Yes	Yes	AP 203 ed2 + AP242 ed1	DEV
EMBRAER	Legacy 450 & Legacy 500	complete definition of the aircraft	Yes	No	Yes	Yes	AP 242 ed1	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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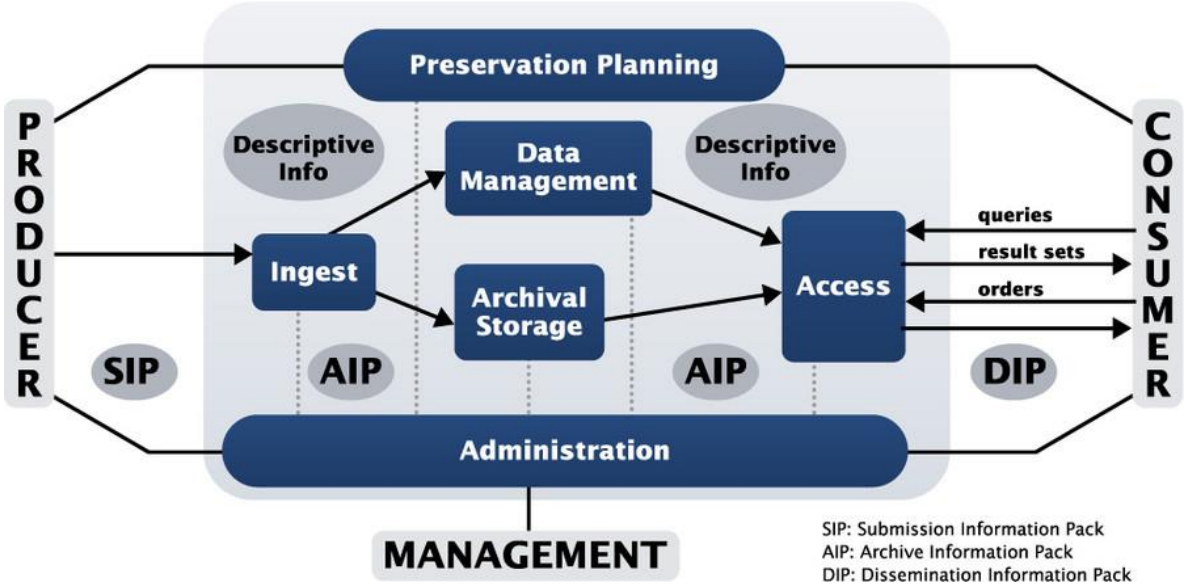
LOTAR Standard Foundation
ISO 14721:2003 (OAIS)

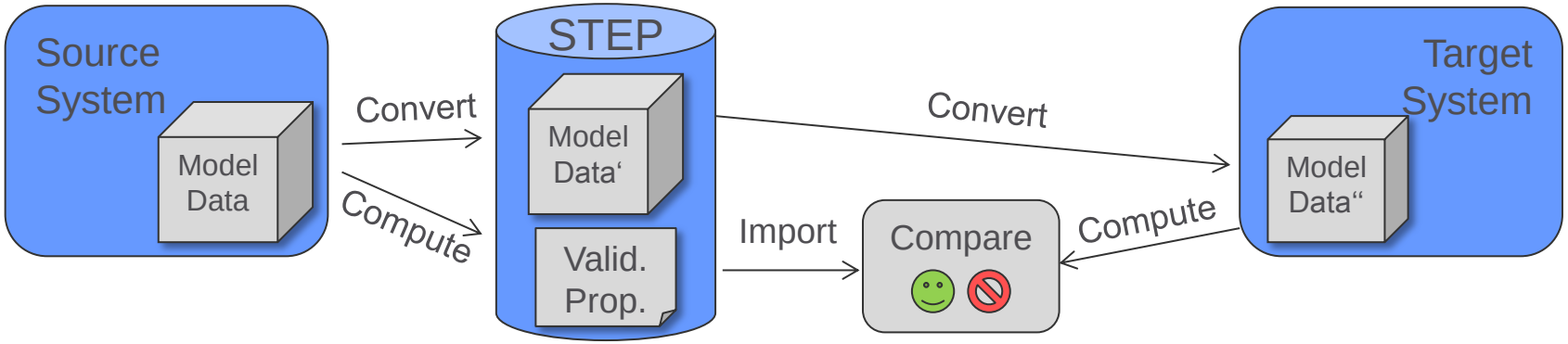
- „Open Archive Information System“ (OAIS) Reference Model is basis for LOTAR processes
- Developed by Aerospace and Defense Industry
- Extended to meet the specific requirements of LOTAR



- As neutral data format for the archives, ISO 10303 (STEP) has been chosen since it is the most advanced open format.

Validation of LOTAR STEP Data

- A distinctive feature of the combined use of LOTAR and STEP is the use of Validation Properties
- Validation Properties are key characteristics of a digital model that help to ensure consistency of the data



- They are computed by the exporting system and included as key-value pairs in the STEP file
- Any importing system will compare its import results with these properties and thus determine success of the data transfer.

LOTAR standards overview organized per technical disciplines

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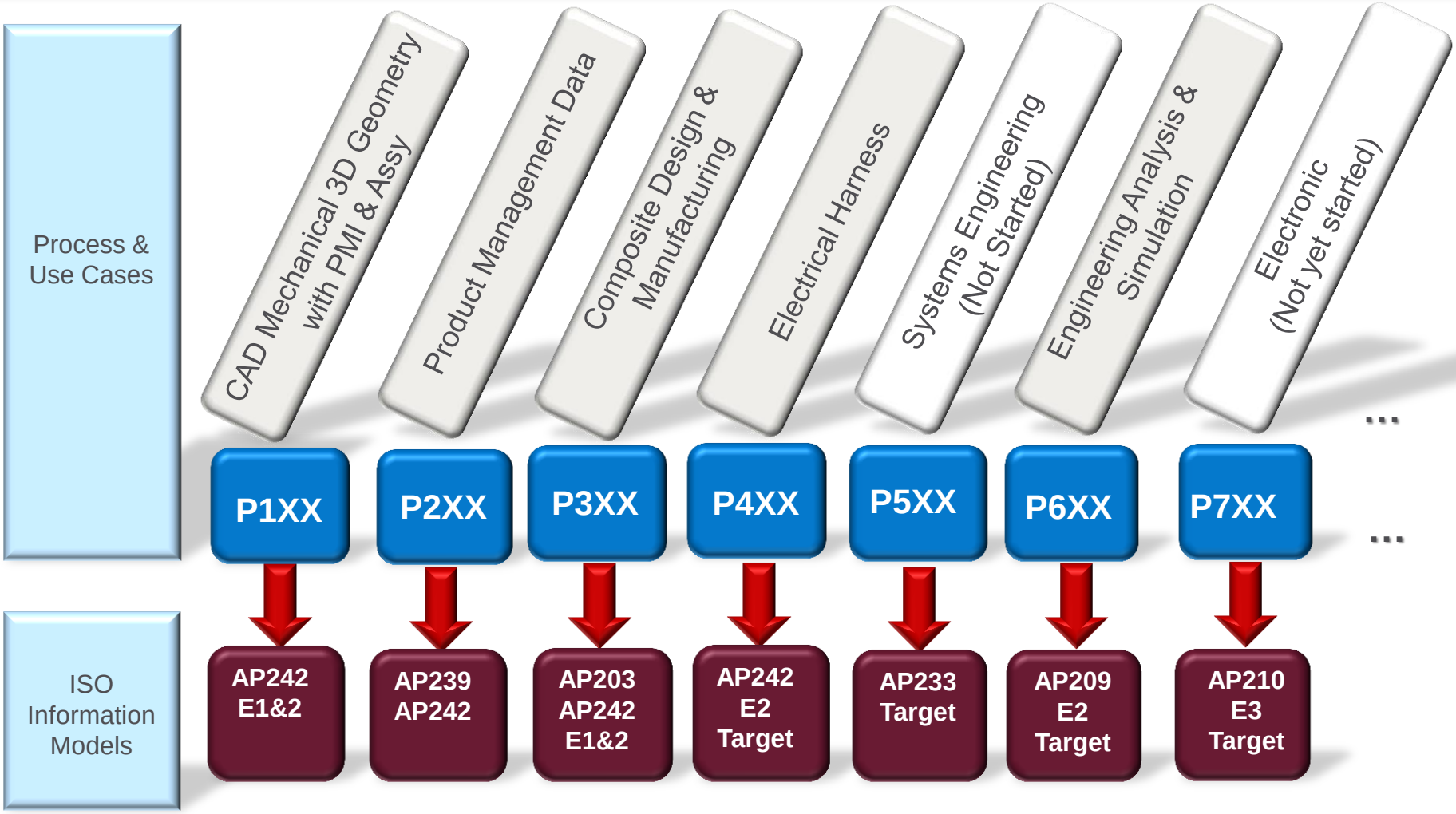
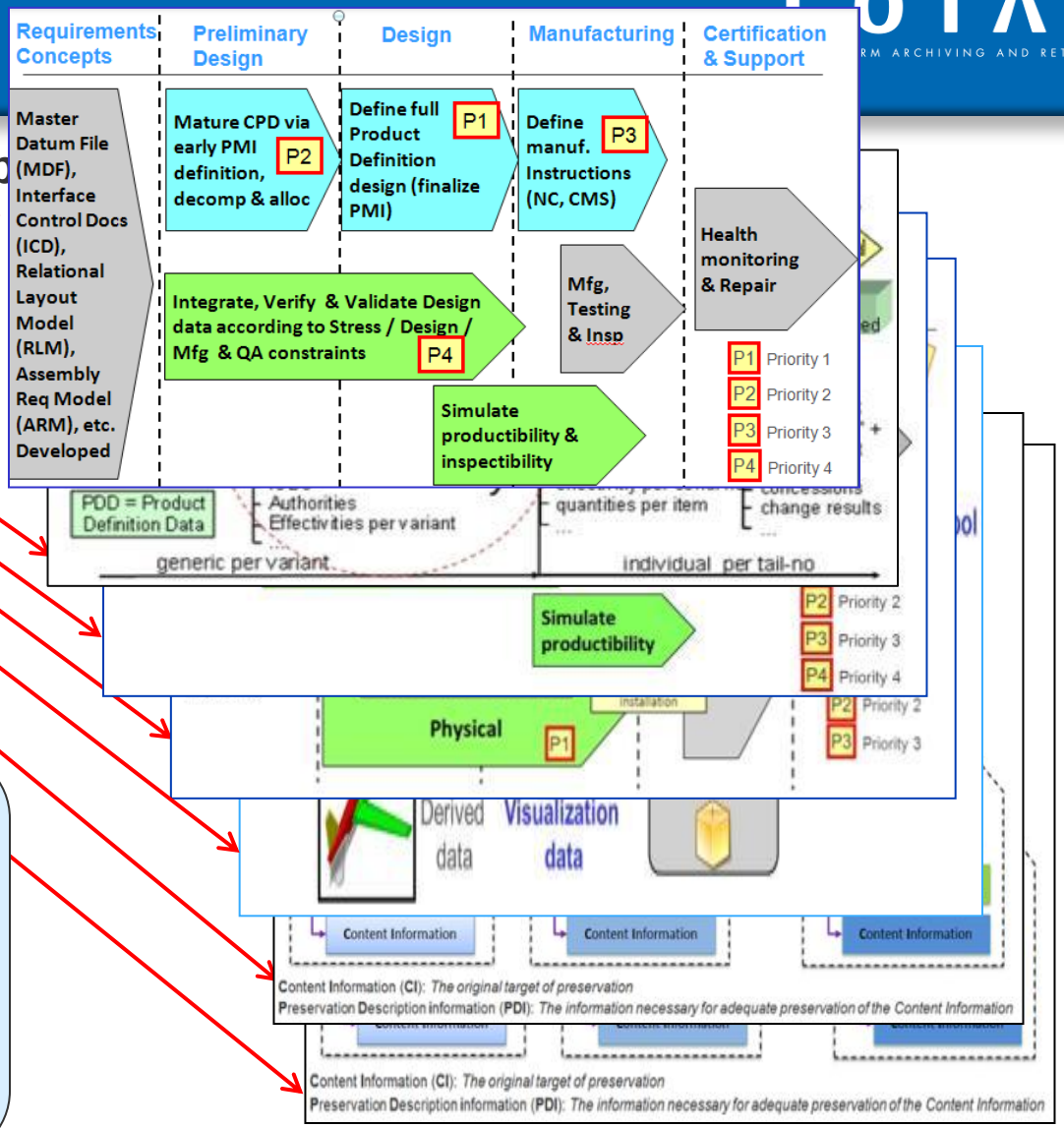


LOTAR International

- 7 Technical Working Groups
  - 3D Mechanical / PMI
  - PDM / PLM
  - Adv. Mfg & Composite
  - Electrical
  - 3D Visualization
  - Meta data for archive packages
  - Engineering Analysis & Simulation



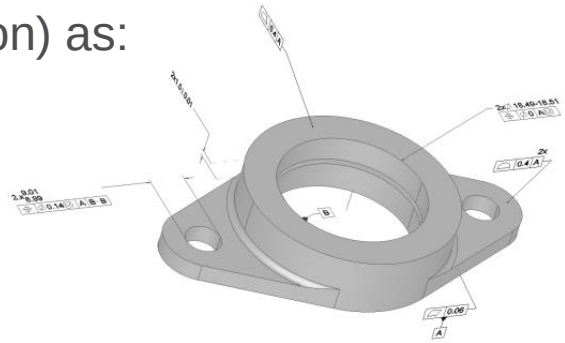
Description of a LOTAR WG web page

- Goals and Objectives
- Associated LOTAR use cases
- LOTAR Family of Standards
- Associated ISO 10303 Information Models
- Meetings & teleconferences
- Accomplishments
- Related standardization projects

http://www.lotar-international.org/lotar-workgroups.html

LOTAR WG: 3D Mechanical CAD with PMI (EN/NAS 9300-1xx)

- Scope:
  - Exchange and archiving of 3D Geometry via STEP
  - Provision of Validation Properties and User Defined Attributes
  - Transfer of PMI (Product & Manufacturing Information) as:
    - Representation (machine-consumable, reusable)
    - Graphic Presentation (human-readable)



- Deliverables(*):
  - Parts:
    - 100 (Common Concepts)
    - 110 (Explicit 3D Geometry),
    - 115 (CAD Assembly Structure),
    - 120 (PMI Graphic Presentation),
    - 121 (PMI Semantic Representation),
    - 122 (Machining Features),
    - 125 (Assembly PMI Graphic Pres.)
    - 126 (Assembly PMI Semantic Representation
  - Comprehensive suite of test models
  - Numerous pilot projects in cooperation with the CAx-IF
  - Support of STEP AP242 development and associated Recommended Practices

(*): Accomplished or in work; more planned

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LOTAR Mechanical / Product & Manufacturing Information Workgroup and Related Entities

End Users

Producers create requirements for archiving Mechanical, Product & Manufacturing information.
Consumers retrieve data with the associated methods, tools, and standards which are verified and validated prior to being disseminated.

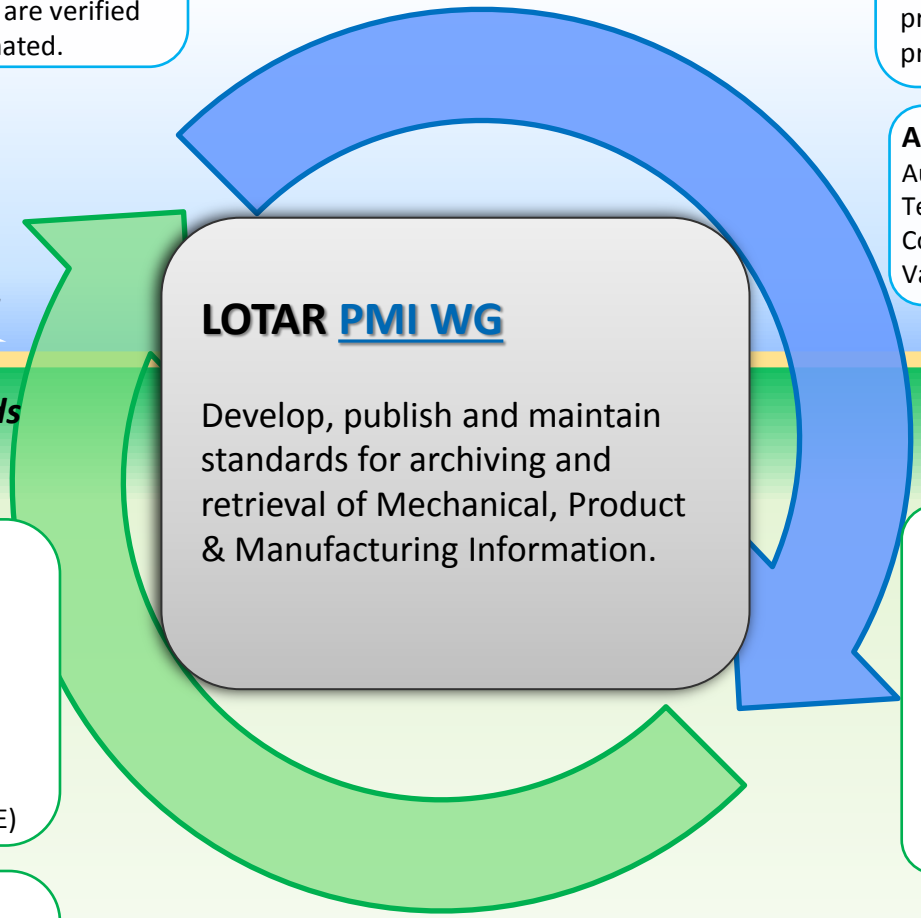
User Standards
ISO TC 213, TC 10 (e.g. 1101, 16792)
ASME Y14,5, ASME Y14.41,.
AS9100, ISO 8000, ISO PAS 26183

Users

Requirements & Use Cases

Standards, Software & Methods

Providers



LOTAR PMI WG

Develop, publish and maintain standards for archiving and retrieval of Mechanical, Product & Manufacturing Information.

IMS

The Intelligent Manufacturing Systems Program is an industry-led, global, collaborative business innovation program focused on manufacturing processes..

AIAG LTDR
Automotive Industries Action Group Long Term Data Retention project.
Collaborative effort with Equivalent Validation activity.

International Organization for Standardization (ISO)

Develop and publish international standards, in particular
- ISO 10303 STEP
- ISO 14721 OAIS (Open Archival Information System)
- ISO 14739 (PRC); ISO 24517 (PDF-E)

Quality Information Framework (QIF)

Developing the digital product verification package with initial emphasis on dimensional metrology; from product design to inspection planning, planning to programming, and inspection execution to results.

PDES, Inc., ProSTEP iViP & AFNeT

Develop data models, standard data representations, including AP242 ed2, and common approaches through standards.

CAx-Implementers Forum (CAx-IF) & CAM vendors

Develop software capabilities and recommended practices by implementing standards and validating them through testing the associated codes.

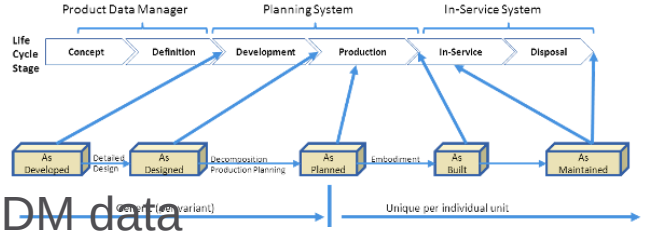
National Institute of Standards and Technology (NIST)

Promote the use of standards.
Support various Working Groups.

V2 Oct 2015

LOTAR WG: PDM (EN/NAS 9300-2xx)

- Scope:
  - Archive and retrieve Product Data Management information in a standard neutral form that can be read and reused throughout the product lifecycle
  - Preservation of digital PDM information along the product lifecycle: in development, as designed, as planned, as delivered and as maintained.



- Deliverables(*):
  - Part 200 fundamentals and concepts for LTA of PDM data
  - Part 210 as designed (ed. 2 incl. effectivities)
  - Part 220 as planned (cancelled)
  - Part 230 as built (dependency on Part 210)
  - Part 240 Product Management Data In-development (including prelim design review, critical design review, FAI, etc.),
  - Part 250 Change documentation

(*): Accomplished or in work; more planned

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LOTAR WG: Advanced Manufacturing
(Composite Design, Additive Manufacturing, etc) (EN/NAS 9300-3xx)

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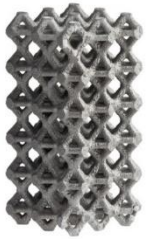
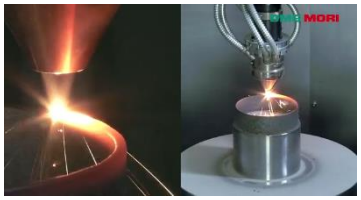
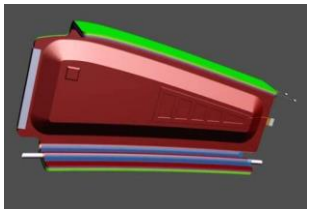
- **Scope:**
  - Preservation of New information required in STEP data model for Composite design and Additive manufacturing:
- **Organic Shapes and Surface Models**
  - **Design Tools –**
  - **Representation Formats**
  - **Preservation of CAD 3D tessellated solids**
  - **3D composite structures information such as Sequences, Plies, Cores, Material properties, Rosette, Orientation…**
  - **Preservation of CAD 3D tessellated solids**

Full shape freedom



➔ Cost independent from shape





- **Deliverables(*):**
  - Parts 300 (Common Concepts), 310 Ed.1 (“exact implicit” – Ply Definition), 310 Ed.2 (“approximate explicit” – 3D Tess. Solid)
  - Support of STEP AP242 Development and associated Recommended Practices
  - Prototype part developed to anticipate future structures in order to demonstrate concepts
  - Independent tests of CAD tools for the purpose of interoperability

(*): Accomplished or in work; more planned

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LOTAR WG: Electric Harness (EN/NAS 9300-4xx)

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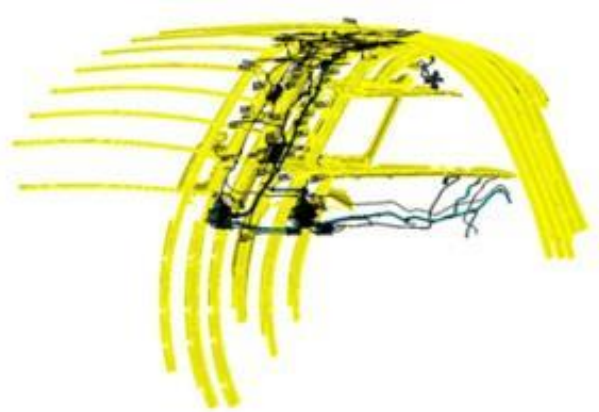
- Scope:
  - Preservation of digital electrical harness models
    - Design
    - Certification
    - Manufacturing
    - Support



- Deliverables(*):
  - Part 400 (Common Concepts),
  - Part 410 (Physical harness definition for design & construction)
  - Preparation of test cases for physical electrical harness definition
  - Preparation of business requirements and use cases for extension of STEP AP 242 ED2 to include Electrical Harness Data
  - Coordination with other standardization projects related to electrical harness (STEP AP 210, AP239, VDA VEC specification, ...)

(*): Accomplished or in work; more planned

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LOTAR Electrical Harness Information Workgroup and Related Entities

End Users

Producers create requirements for archiving Electrical harness information.
Consumers retrieve data with the associated methods, tools, and standards which are verified and validated prior to being disseminated.

Users

Requirements & Use Cases

IMS

The Intelligent Manufacturing Systems Program is an industry-led, global, collaborative business innovation program focused on manufacturing processes..

LOTAR Elec. Harness WG

Develop, publish and maintain standards for archiving and retrieval of Electrical harness Information.

Standards, Software & Methods

Providers

International Organization for Standardization (ISO)

Develop and publish international standards, in particular
- ISO 10303 STEP, ISO 14721 OAIS
- ISO /TC20 /SC1: Aerospace electrical requirements

National Institute of Standards and Technology (NIST)

Promote the use of standards. Develop STEP file checker and analyzer to assess the maturity of implementation of STEP standards by PLM application vendors

International Electrotechnical Commission(IEC)

Develop and publish international standards, for electrical, electronic, and related technologies
Define glossary for electrical terms

PDES, Inc., ProSTEP iViP & AFNeT

Develop data models, standard data representations, including STEP AP242 ed2, and common approaches through standards.
Support implementer forums: CAx IF, etc.

CAx-Implementers Forum (CAx-IF)

Develop CAD software capabilities and recommended practices by implementing standards and validating them through testing the associated codes.
WG for electrical planned in 2017

PDM-Implementers Forum PDM-IF)

Develop PDM software capabilities and recommended practices by implementing standards and validating them through testing the associated codes.

V1 June 2016

LOTAR WG "Engineering Analysis & Simulation" (EN/NAS 9300-5xx)

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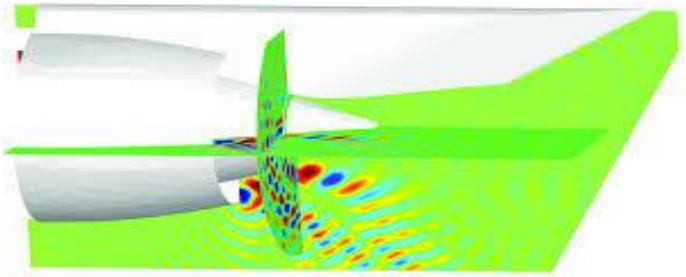
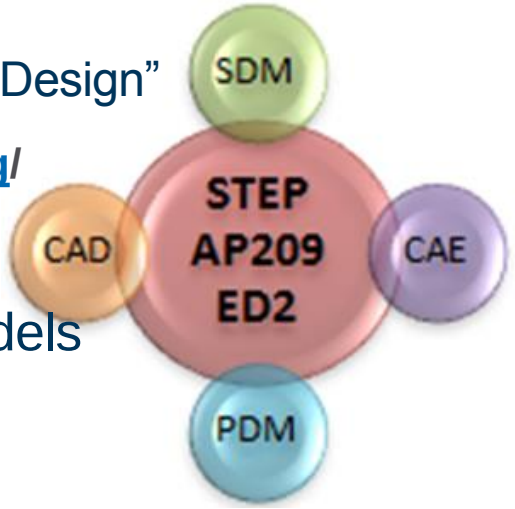
- Start of the LOTAR working group for "Engineering Analysis and Simulation" in 2014
  - Scope: Preservation of Simulation and Analysis information
  - Deliverables(*):
    - Parts 600 (Fund. & Concepts),
    - Part 610 "LTA & R. of "Simulation Data Management"
    - Part 620 "LTA & R. of Structural Analysis information"
  - Coordination with other standardization projects related to S & A (ISO STEP AP209)



- Scope of ISO STEP AP 209 ed2 "Multi-Disciplinary Analysis and Design"
  - Structural analysis
  - Computational Fluid Dynamic

http://www.ap209.org/



- Start of pilots for exchange / LTA of structural analysis models
- Preparation of the launch of the CAE IF in Q3 2017, part of the CAx Implementer Forum

- Preparation of a permanent MoU with NAFEMS (USA, Europe)

LOTAR "Engineering Analysis and Simulation" Overview on a page

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Why: Business Need

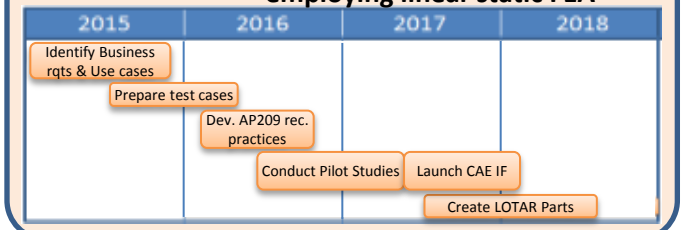
In an environment of rapidly changing software and hardware, a general requirement exists for access to and viability of digitally formatted engineering assets over the life of the product

- **Legal drivers**
  - Cover certification needs
  - Support litigation
  - Support accident investigations
- **Engineering, design & customer support drivers**
  - Evaluate changes/improvements
  - Engineer derivatives/conversions
  - Extend payload/range/performance
  - Address customer questions
  - Evaluate damage
  - Capture knowledge
  - Increase business capability

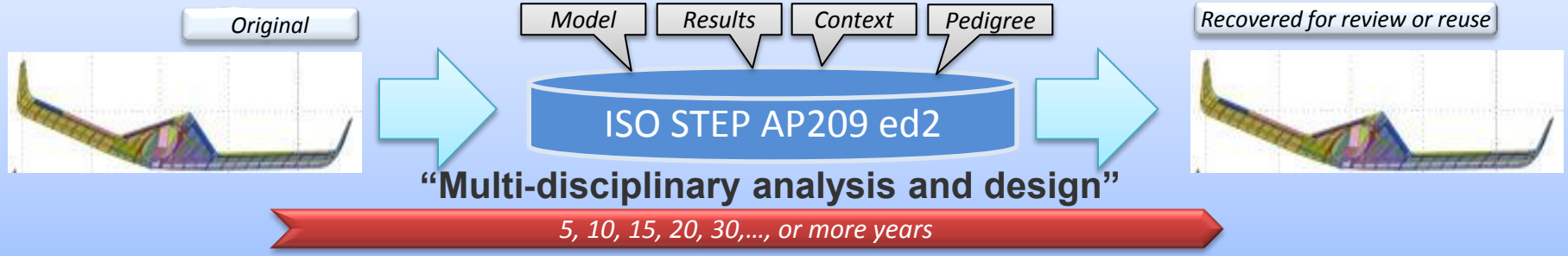
When & What*:

Phase 1 Schedule: 2015-2018

Phase 1 Scope: **Vehicle-level model & loads employing linear static FEA**



How: Primary Technical Approach



Who: Players & Roles

Users & Member companies	PDES, Inc., ProSTEP iViP, AFNeT	CAx-IF & CAE vendors	NAFEMS, NIST, more
Requirements	*AP209 ed2 development*	*Translator development & testing*	*Additional collaboration*

LOTAR International EAS Working Group

Overall project orchestration; User requirements; Test models; LOTAR EAS standard development (NAS/EN 9300-6xx)

*EAS scope is broad. Other analysis types and disciplines to be addressed in subsequent phases

Preparation of the launch of the LOTAR MBSE WG in 2018

- In 2017, bi weekly confcal of the PDES inc MBSE WG, covering the overall MBSE interoperability picture
- Start to take into account the specific activities to prepare the LOTAR MBSE WG
- Target to prepare the NWI for June or Sept. 2017
  - To allow the start of the LOTAR MBSE WG in 2018
  - Prerequisite: Target ISO standard supporting the MBSE information for exchange and long term archiving:
    - AP233 ed2 as candidate
    - Closely related to other STEP modular APs: AP239, AP209, AP242, AP210, etc
  - Project Mngt.: conf. American and European LOTAR MBSE co-leaders
  - Define a roadmap and structure of the LOTAR P5XX
    - P500: Fundamental and concepts, P510, P520
  - Contribute to the roadmap of STEP standards for MBSE

Objectives of the LOTAR 5 years roadmap

- To identify the main « standards components » to be taken into account for planning of LOTAR capabilities with a target date of delivery and main associated dependancies.

- The LOTAR 5 years roadmap has to take into account:
  - the **priorities of the A&D LOTAR members**
    - business requirements, use cases
  - The **LOTAR domains / technical disciplines to be covered:**
    - P1XX, P2XX, P3XX, P4XX, P5XX (in prep.), P6XX
    - Their associated **product life cycles:**
      - Conceptual design, simulation, design, manufacturing
  - The underlying standardization projects (« V » model):
    - Dev. of ISO information models (STEP APs, etc)
    - Dev. of Rec. Practices, Interoperability test rounds - Implementer Forums
    - The STEP infrastructure to be maintained

« V cycle » for development and validation of LOTAR standards

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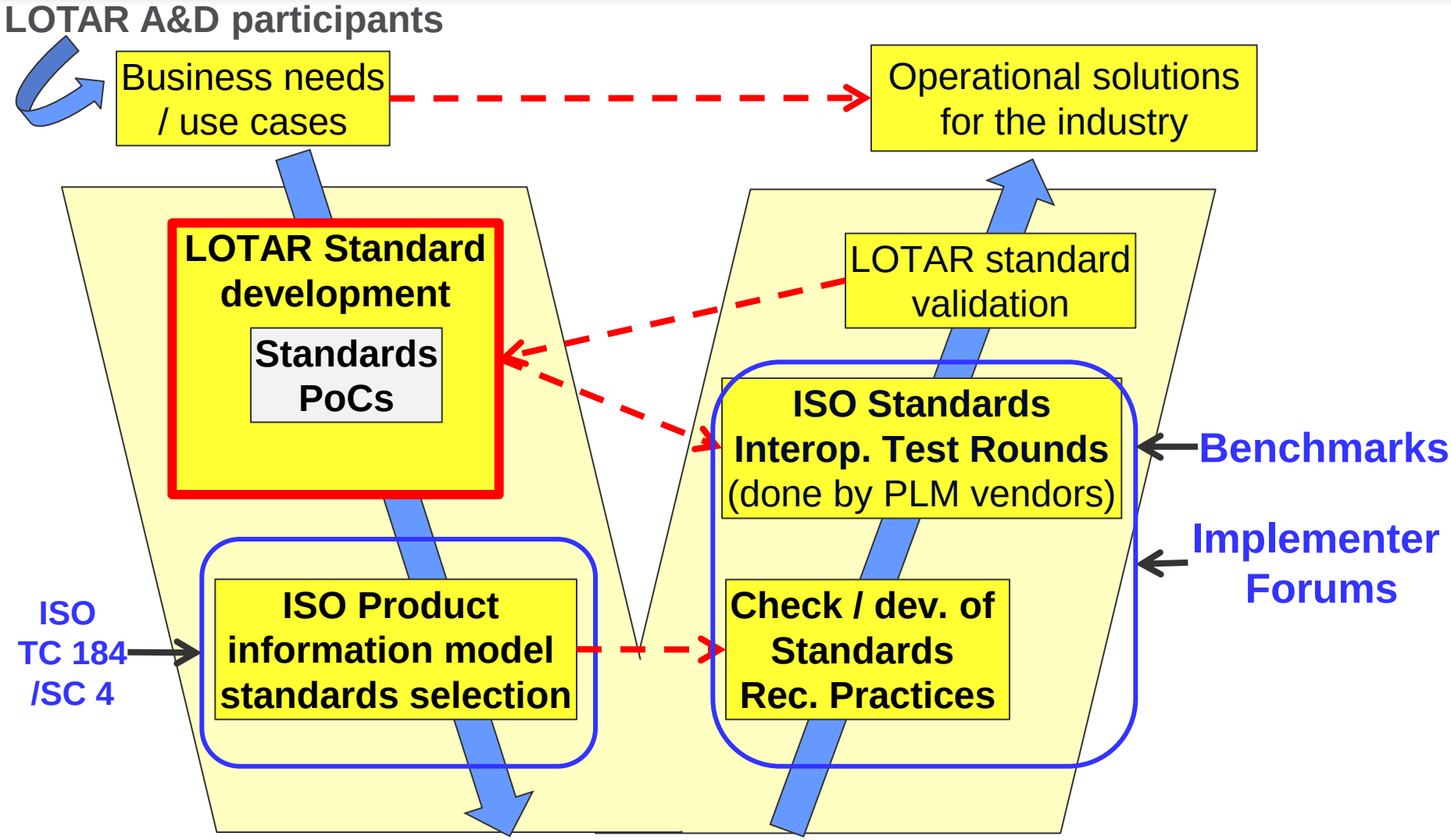

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LOTAR 3D Mechanical / PMI Work Group Five Year Road Map

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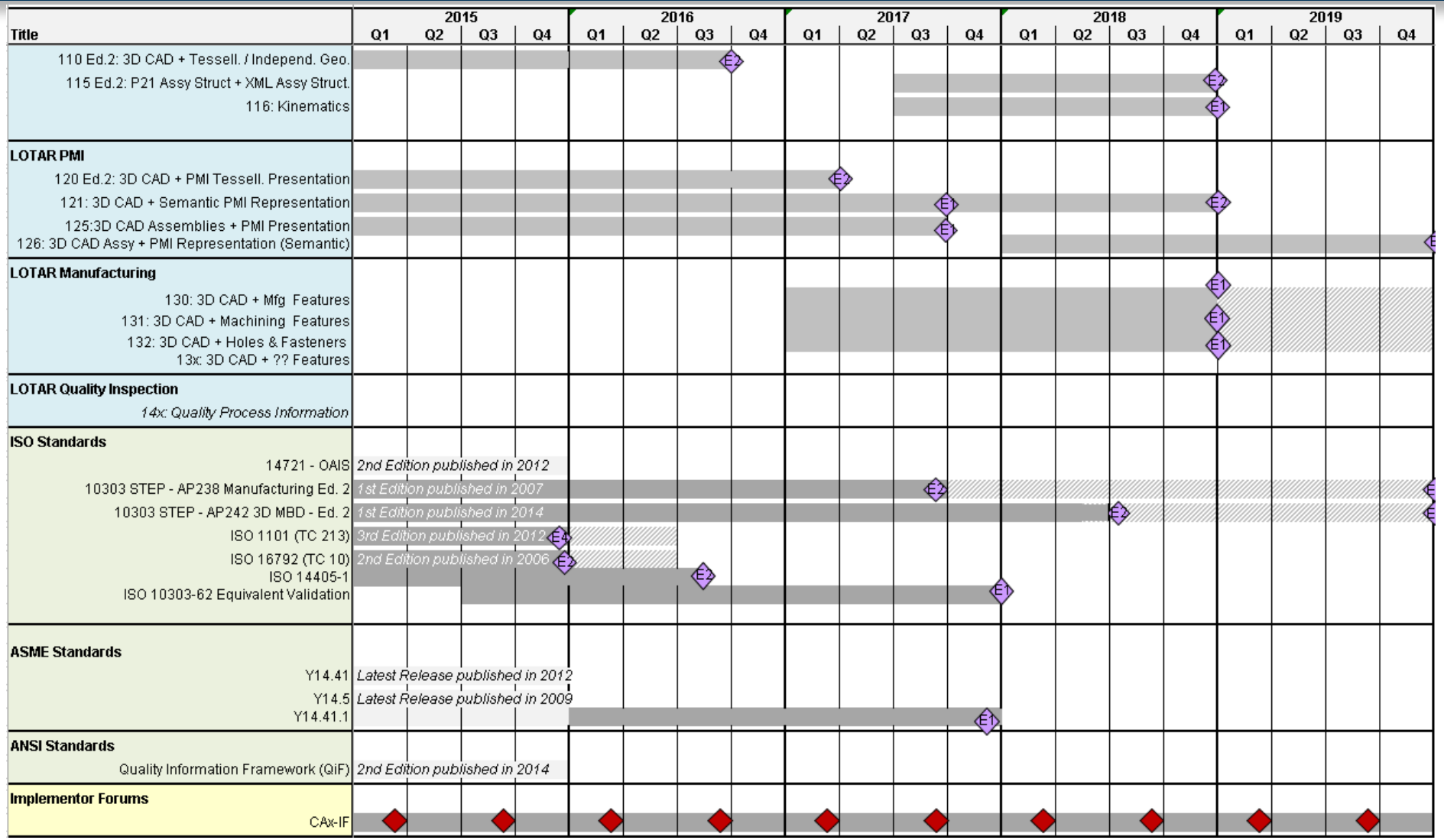

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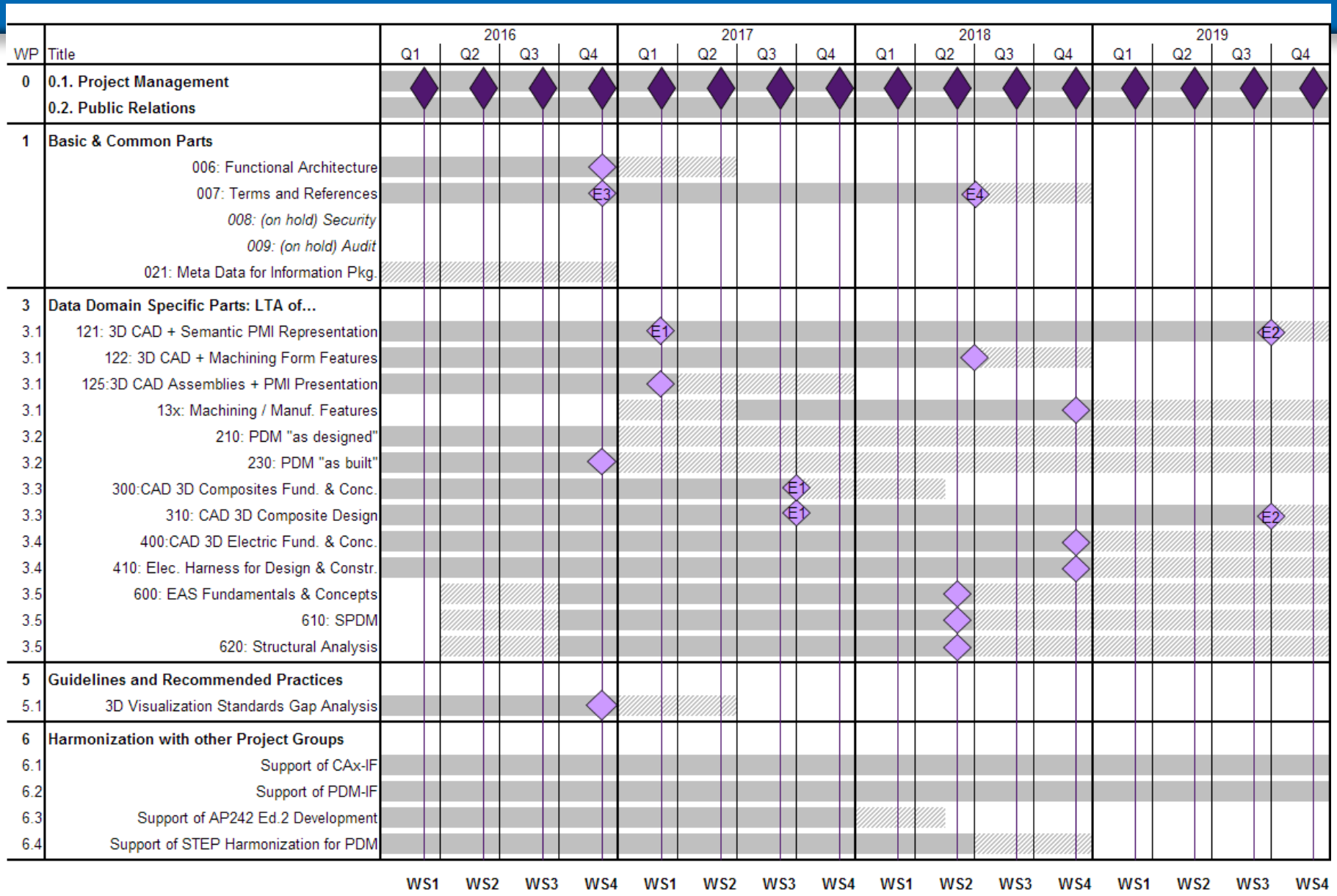
LOTAR Electrical WG
5 years roadmap

5 years roadmap for LTA&R of Electrical Harness				2016	2017	2018	2019	2020	2021
LOTAR	Elec. Harness	P400	Fundamental concepts			E1			E1
LOTAR	Elec. Harness	P410	Harness for design & construction			E1			
LOTAR	Elec. Harness	P420	Harness installation definition (?)					E1	
LOTAR	Elec. Harness	P430	Harness System design?						
LOTAR	Elec. Harness	P440	Harness installation connexion test?						...
Data model	Elec. Harness		STEP AP242 **ed2**	CD	Dis	IS			
Data model	Elec. Systems		STEP AP242 **ed3**	Prep. AP242 E3 White Paper			CD		Dis
Impl. Forum	CAx IF (Elec.)		Test Rounds AP242 **ed2**	(Pilot)		ed2 DIS	ed2 IS	ed2 IS	
Impl. Forum	CAx IF (Elec.)		Test Rounds AP242 **ed3**						ed3 DIS

Title of the LOTAR “electrical” WG may change and become “Electrical systems” WG

LOTAR Overall Project Plan (2016 – 2019)



Summary – next actions

- Planned increasing use of LOTAR standards in the A&D industries
  - New A&D products developed on 3D Model Based Definition
    - ➔ Use of 3D PMI – no more drawing !
- Need to set up a 5 years roadmap according to each company business needs
- Strong momentum for LT Archiving of Engineering Analysis and Simulation in 2017
- Opportunities for new European A&D members to join the LOTAR project
  - Next activities planned in 2018
    - Restart of PDM WG, based on AP239 ed3 – AP242 ed2 harmonized models
    - Start of LOTAR MBSE
  - Following years: LOTAR mechanical WG: holes and fasteners, 3D metrology, etc.

The development and the use of LOTAR standards by the A&D industries aim at decreasing the cost and the risks of Long Term Archiving and Retrieval of aerospace digital product information

Any questions?

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Back up slides

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LOTAR International public web site : Overview

Why Lotar?
- ►Mission, Objectives & Scope
- ►Hosting Organizations
- ►Legal & Business Motivation

LOTAR organization
- ►External View
- ►Internal View
- ►Working together

LOTAR Workgroups
- ►3D CAD with PMI
- ►PDM
- ►Composite
- ►Electrical Harness
- ►Engineering Analysis & Simulation
- ►3D visualization
- ►(Meta data for archive packages)

Communication
- ►Public presentations
- ►Progress Reports
- ►Dates

LOTAR standards
- ►Overview on parts
- ►Industry use
- ►Next steps

News

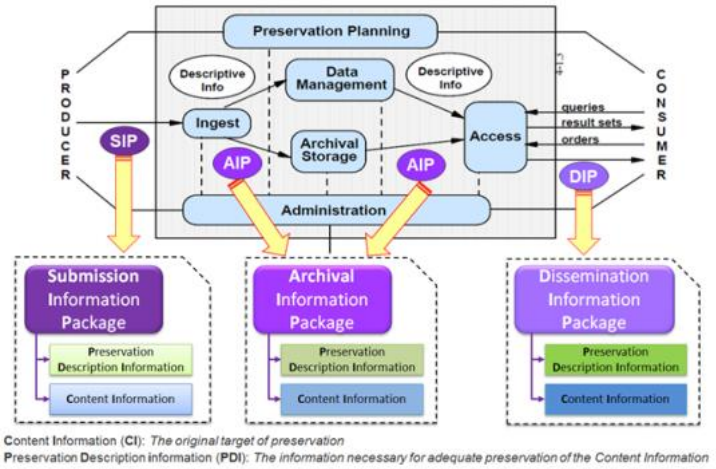
Links

Contact

http://www.lotar-international.org

LOTAR WG: Meta-Data for Archiving (Technical Specification/Rec Practice)

- Scope:
  - Define processes, UCs and standard information model to manage meta-data for:
    - Submission Information Package
    - Archival Information Package
    - Dissemination Information Package
    - Define processes, UCs and standard information model to manage meta-data for:
  - Define the information model and the corresponding STEP AP 239 PLCS subset



- Deliverables(*):
  - Parts 021 (Meta-data for Archiving),
  - Processes, use cases and test cases
  - STEP AP 239 information model subset
  - STEP AP 239 LOTAR DEX / Rec. Practices for meta data for AP
  - Test round reports and prototypes of PLM vendors

(*): Accomplished or in work; more planned

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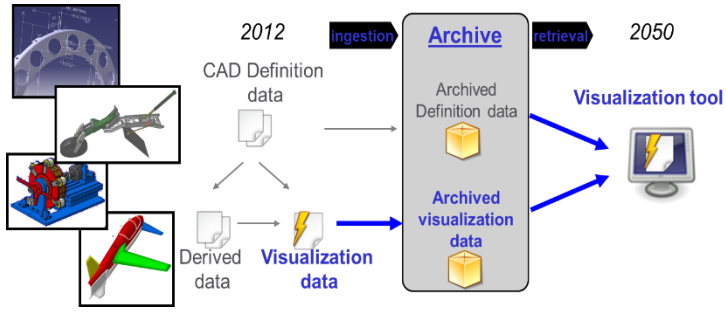
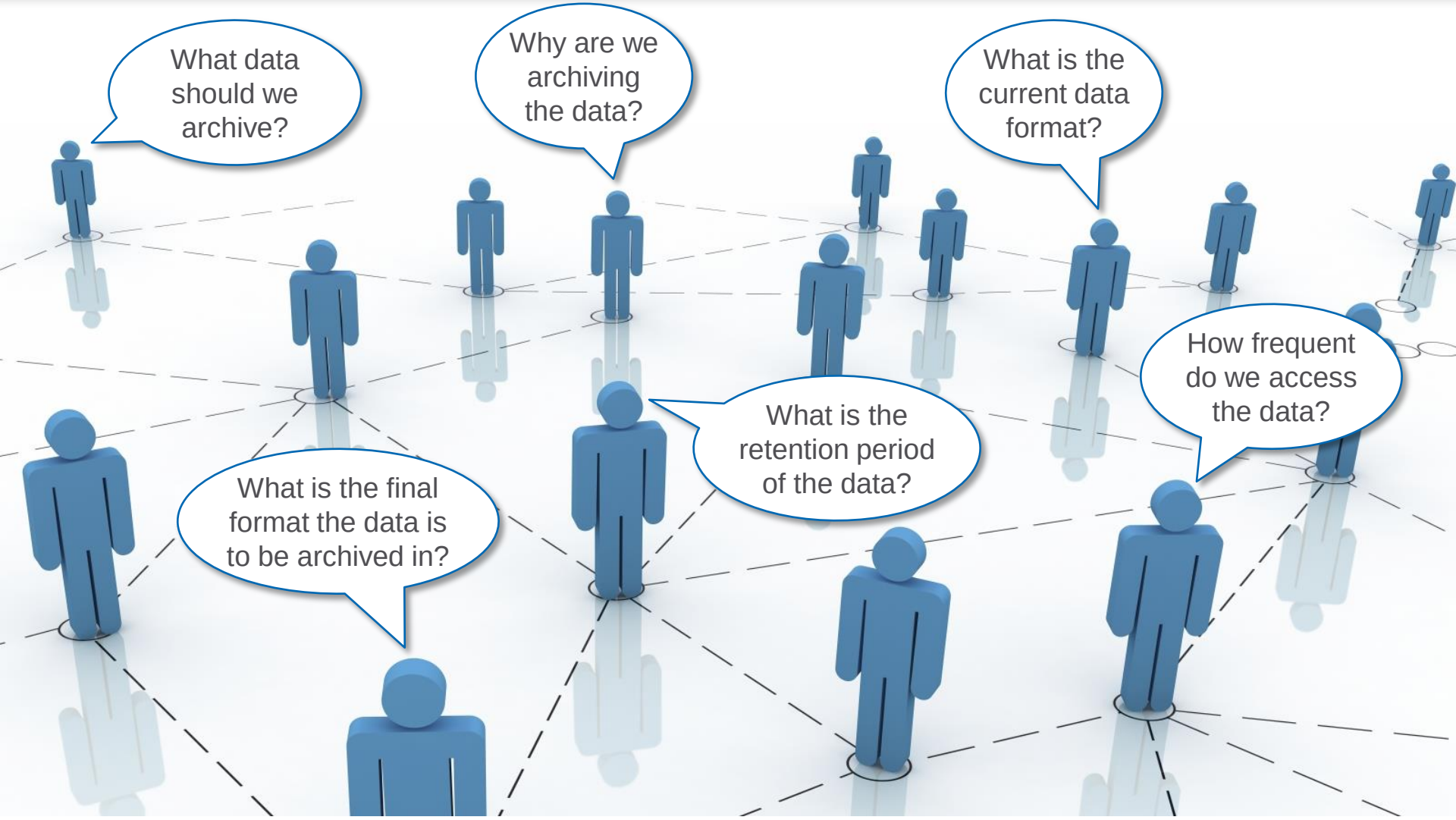
LOTAR WG: 3D Visualization (Technical Specification/Rec Practice)

- Scope:
  - To define common recommendations for LT Archiving and Retrieval of 3D Visualization information being consistent with LT Archiving and Retrieval of information concerning CAD models and related information, throughout the full product life cycle.
- Deliverables(*):
  - To define the characteristics of the Visualization information to be archived.
  - To prepare recommended practices for implementing available 3D Visualization standards by the LOTAR community.
  - To describe to the recommended processes to ensure the consistency between the archived CAD 3D (authoring) data and the archived 3D Visualization (derived) data



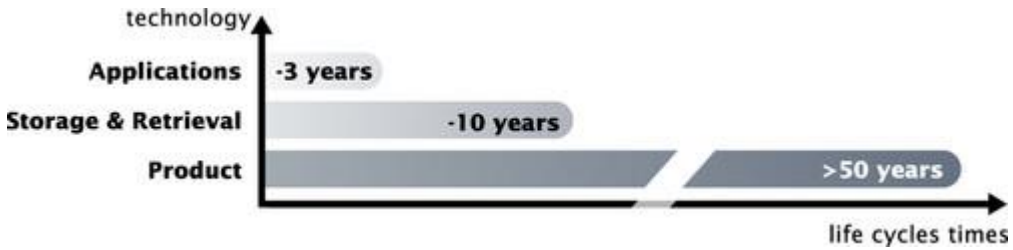
(*): Accomplished or in work; more planned

Information Lifecycle Planning
Driving Questions



Technical and IT Background

- The life cycle of applications and storage technologies has to be considered by setting up a long term archiving and retrieval standard:



- Continuous development of technical product documentation leads to a change of methods and tools, which are used for design, manufacturing, customer support and archiving.
  - New releases of CAD / CAM / CAE / PDM / … systems offering new functionalities
  - After each migration, the data shall be checked for consistency and completeness.

  → A conversion of the native product data into a more stable format is essential.

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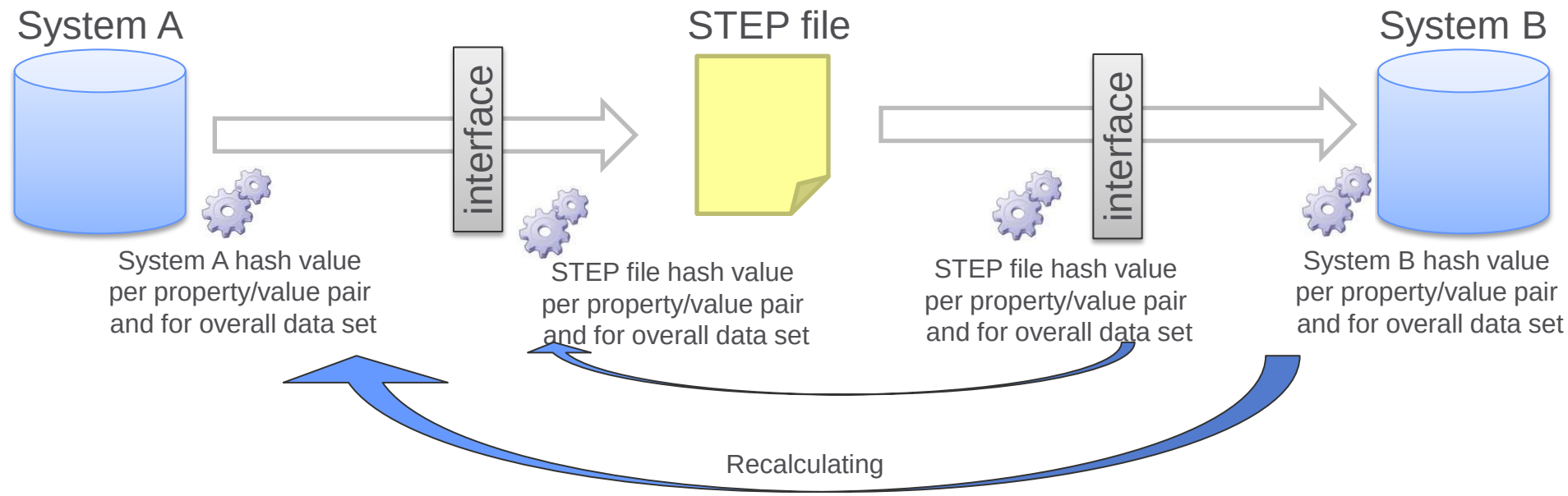
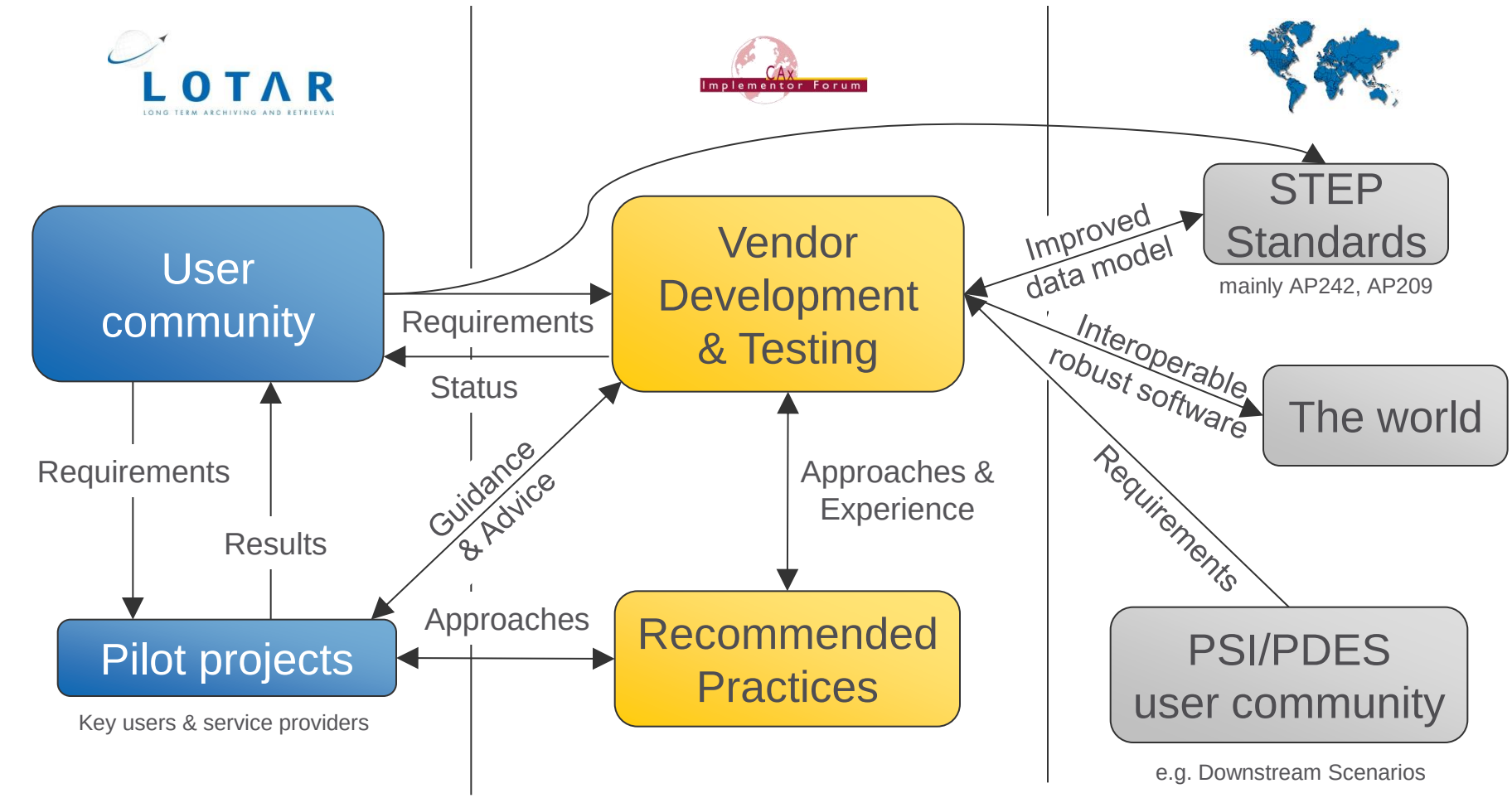
System requirements

- Proposal to use the LOTAR technical specification TS-9300-200-1 on « Product Structure Validation » using hash code to check consistency of the data between the systems.



- Need at least two versions of the same systems in order to reflect the change of versions over the years
- The control of the test bed itself have to be defined to avoid uncontrolled modification / change during a test period

LOTAR / CAx Implementor Forum Coordination