LOTAR

LONG TERM ARCHIVING AND RETRIEVAL

Teaming to achieve a robust LOTAR capability for Engineering Analysis & Simulation data

September 13, 2016

St. Simons Island, GA (USA) *and via WebEx*

AIA AEROSPACE INDUSTRIES ASSOCIATION ASD-STAN Standardization

ProSTEP iViP PDES, Inc.

Objectives

- Introduce the LOTAR Engineering Analysis & Simulation (EAS) Working Group
- Team with (Computer Aided Engineering) CAE vendors to implement ISO STEP AP209 edition 2 in commercial tools for Structural Analysis first
- Achieve LOTAR capability for EAS data

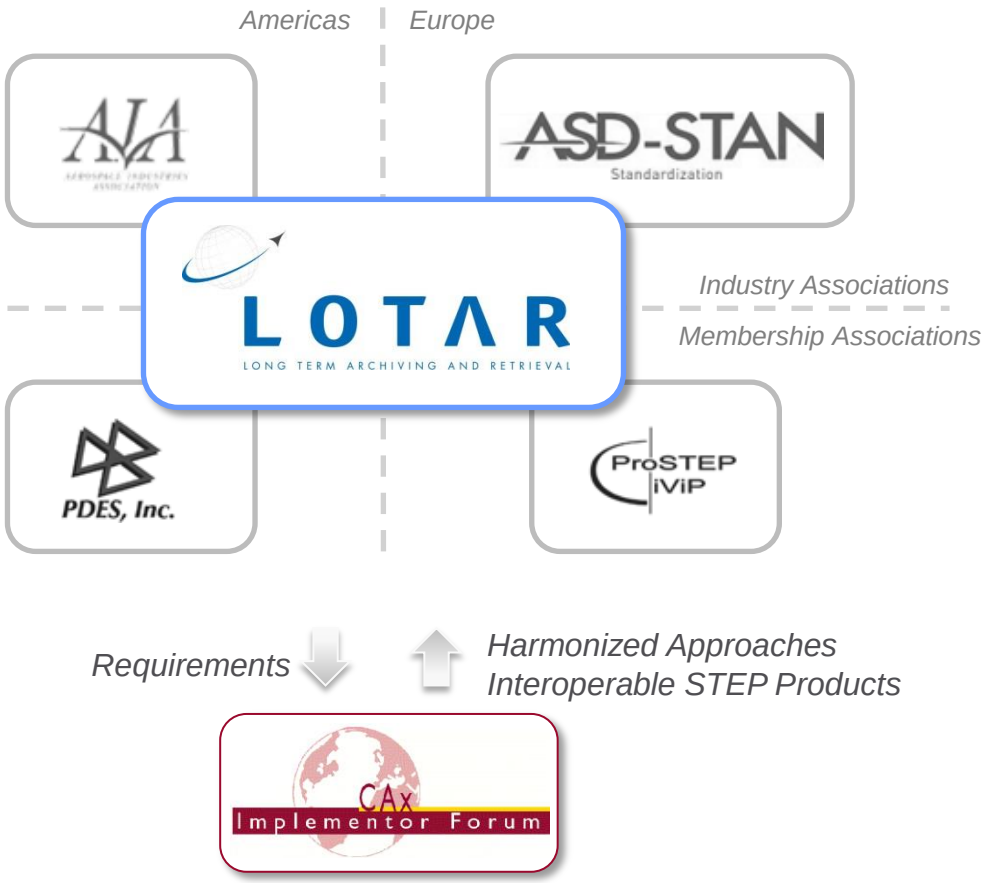
Content

- Introduction to LOTAR
- The Engineering Analysis & Simulation (EAS) Working Group
- Technical approach
- Teaming to achieve the goal
- Development and testing of software supporting LOTAR EAS standards based on STEP AP209 ed2
- Resources provided
- Summary & next actions
- Backup

Introducing LOTAR

LOTAR "On A Page"
Details at www.lotar-international.org

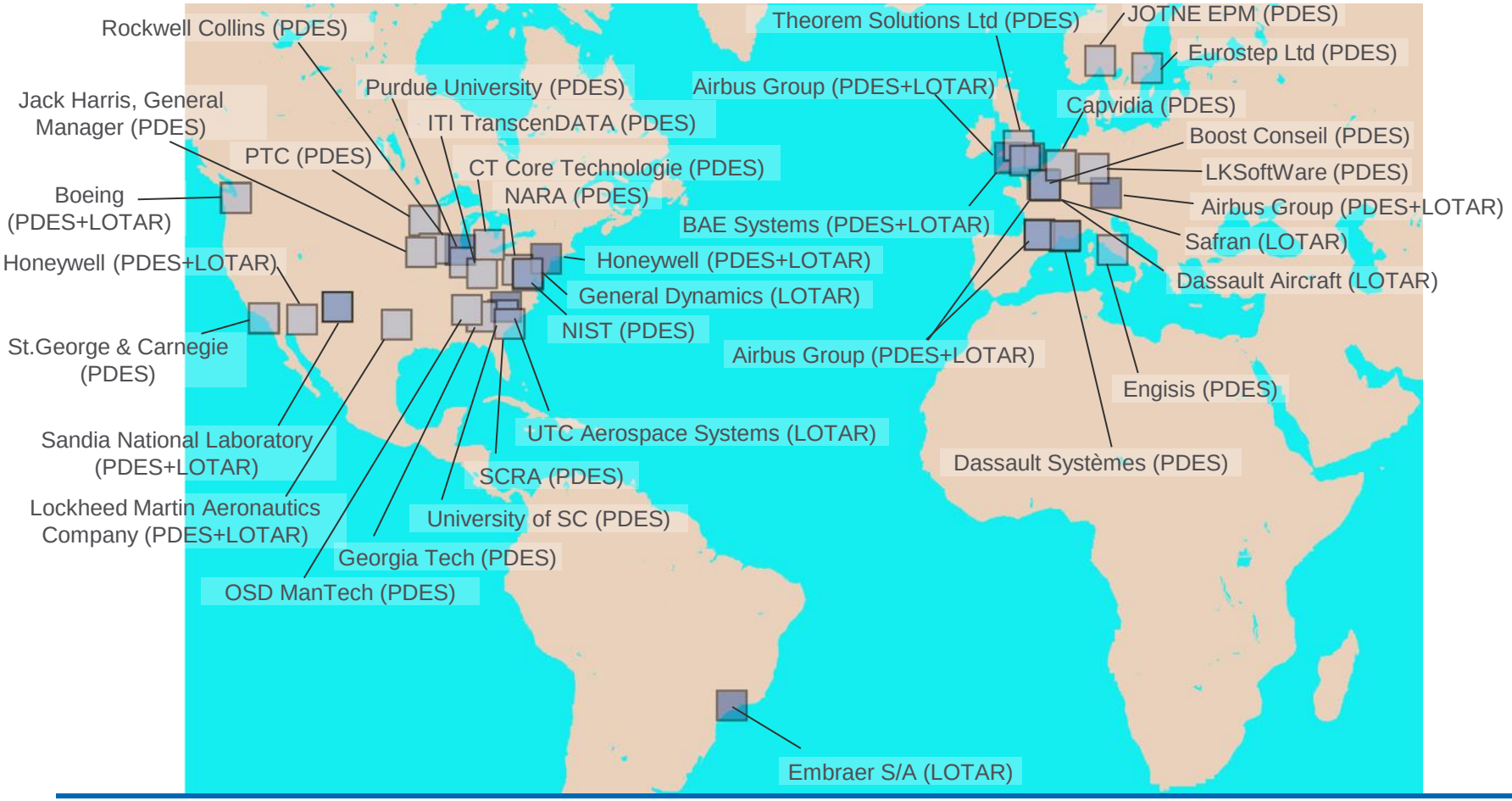
- LOTAR is an international consortium of Aerospace manufacturers
- Prime objective is creation and deployment of the **EN/NAS 9300 series standard** for long-term archiving and retrieval of digital data, based on standardized approaches and solutions.
- Integration of LOTAR requirements in software tools ensured by close cooperation with the **CAx Implementor Forum (CAx-IF):**
  - Facilitated by PDES, Inc. and ProSTEP iViP
  - Consists of CAD, STEP Translator, and Validation Tool vendors
  - Supports AP203, AP209, AP214, AP242
- Similar PDM-IF:
  - Facilitated by AFNeT and ProSTEP iViP
  - Consists of PDM and STEP Translator vendors
  - Supports AP242 BO Model XML



EN = European Norm (Standard)
NAS = National Aerospace Standard
CAx = Computer Aided "x" (Design, Engineering…)
PDM = Product Data Management

LOTAR Participants

International consortium of Aerospace manufactures and user companies from around the world.



Seven LOTAR Working Groups at present

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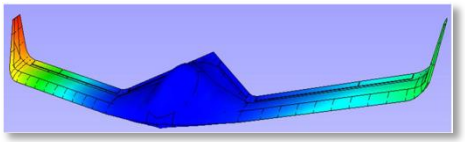
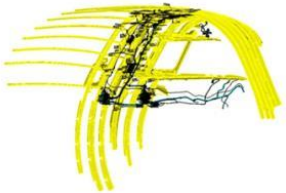


Engineering Analysis and Simulation

EN/NAS 9300-6xx series

ISO STEP AP209 ed2

2014 launch

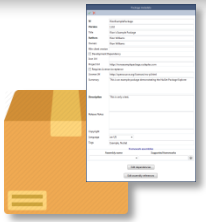


Wiring Harness

EN/NAS 9300-4xx series

STEP AP242 ed2

2012 launch

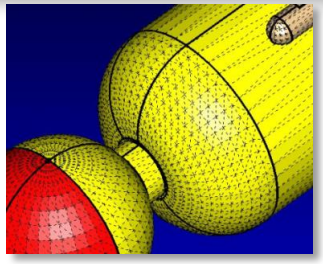


Meta Data for Archive Packages

EN/NAS 9300-21

STEP AP239 ed3
STEP AP 242 ed2

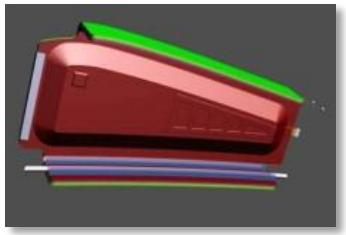
2012 launch



3D Visualization

Requirements and Compliance Documents

2012 launch

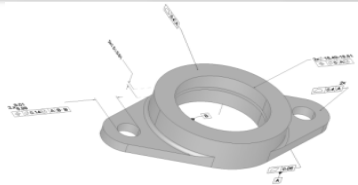


Composites and Advanced Manufacturing

EN/NAS 9300-3xx series

STEP AP203 ed2
STEP AP242 ed1

2009 launch

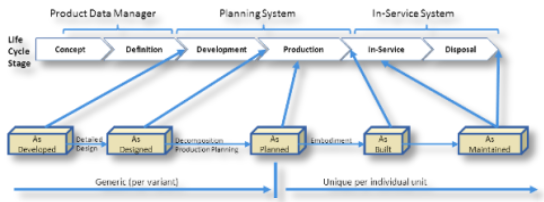


Mechanical 3D CAD with Product and Manufacturing Information (PMI)

EN/NAS 9300-1xx series

STEP AP203 ed2
STEP AP214 ed3
STEP AP242 ed1

2004 launch



Product Data Management (PDM)

EN/NAS 9300-2xx series

STEP AP239
STEP AP242 ed1

2004 launch

The Engineering Analysis & Simulation (EAS) Working Group

Creation of a LOTAR WG for engineering analysis and simulation data

- The LOTAR Engineering Analysis & Simulation Working Group was created in Dec. 2014
- Team Members and LOTAR Member companies involved in the activities of this WG:

Rod Dreisbach
Boeing (BCA) - retired

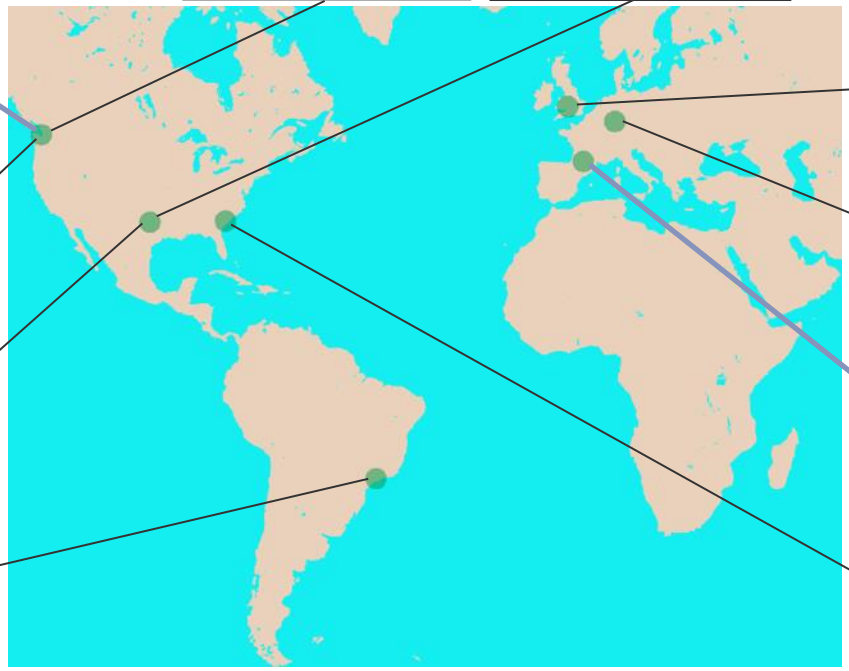
Keith Hunten
Lockheed Martin - retired

Joe Draper
Americas Co-leader
Boeing (BCA)
Everett, WA USA

Randy Cigel
Boeing (R&T)
Seattle, WA USA

Chris Johnson
Lockheed Martin Aeronautics Company
Fort Worth, TX USA

Rodrigo Britto
Embraer S/A
São José dos Campos, BR



Gerrit Rollema
Airbus Operations Ltd
Filton, UK

Jochen Boy
PROSTEP AG
Darmstadt, DE

Albert Lévy
EU Co-leader
CIMPA S.A.S.
(on behalf of Airbus)
Blagnac, FR

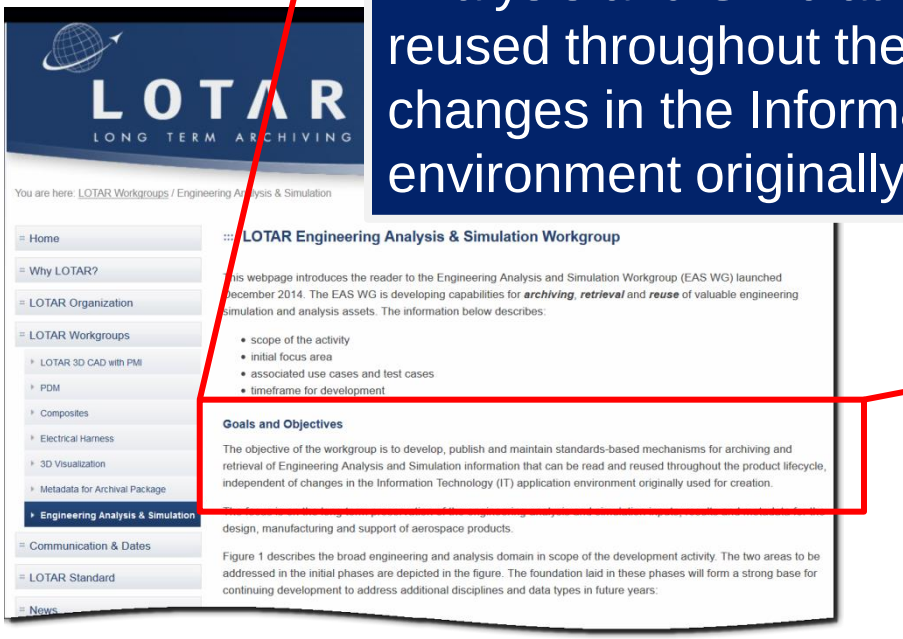
Phil Rosche
ACCR, LCC
Summerville, SC USA

Objective of LOTAR EAS

http://www.lotar-international.org/lotar-workgroups/engineering-analysis-simulation.html

Goals and Objectives

…to develop, publish and maintain standards-based mechanisms for archiving and retrieval of Engineering Analysis and Simulation information that can be read and reused throughout the product lifecycle, independent of changes in the Information Technology (IT) application environment originally used for creation.



Needs for LOTAR of EAS data

The general requirements include legal and business (engineering) needs:

Legal needs

- Certification
- Litigation
- Accident investigation

Business needs

- Evaluate changes
- Evaluate damage
- Address customer questions
- Evaluate new conditions and mission requirements
- Engineer modifications
- Engineer derivatives
- Capture knowledge
- Exchange data

An archive information package must be created to support these items, used for 2 main purposes:

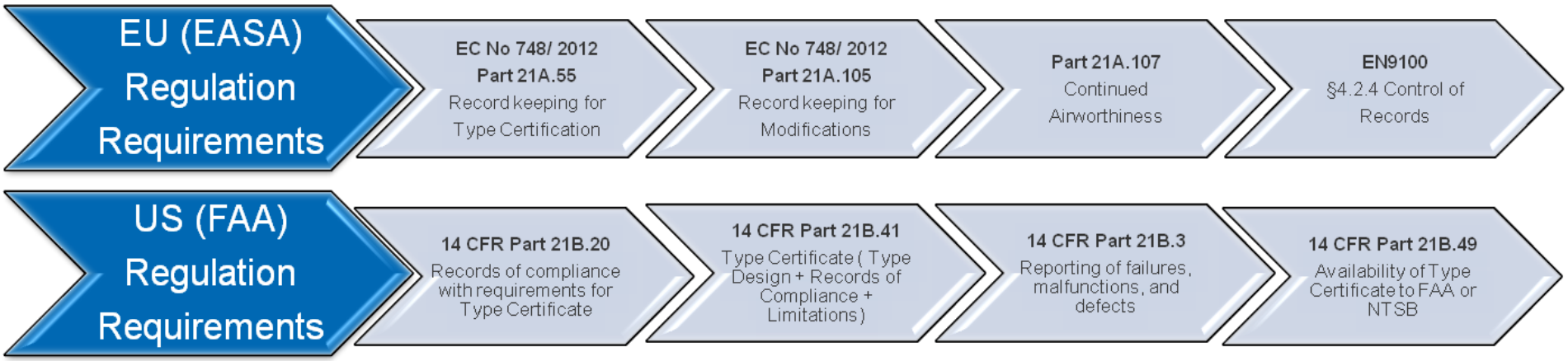
- **retrieve**
- **reuse**

} analysis and simulation data.

LOTAR supports the needs by providing an enduring data archive.

Regulatory requirements for LOTAR aircraft certification and safety

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



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

A diverse "world" is a business reality and effective data exchange is necessary and important to LOTAR

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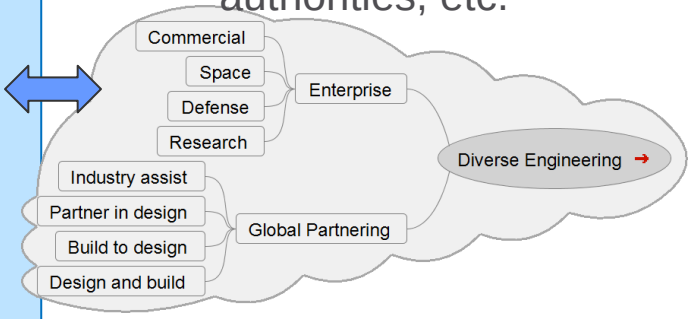
Diverse Geography (sites extend across multiple time zones & cultures)

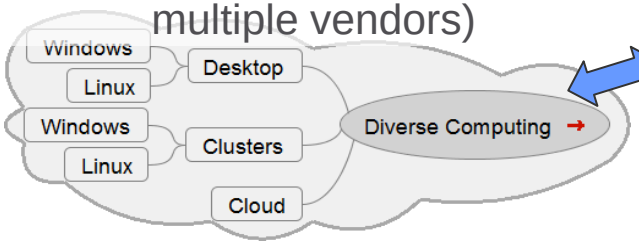
Analysis data is shared between many different systems and authors during each phase of aerospace and defense product development.

The benefit of ISO STEP standards for effective LOTAR is obvious.

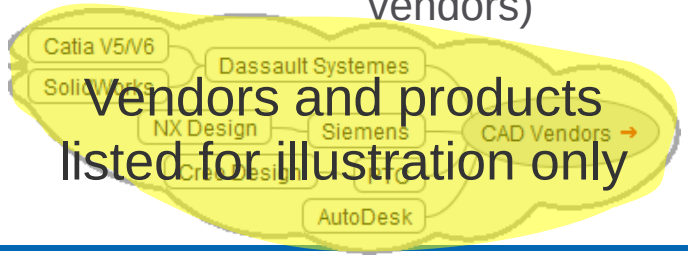
Diverse Engineering (multiple sites, companies, design authorities, etc.



Diverse Computing (from multiple vendors)



Diverse CAD (systems from multiple vendors)



Vendors and products listed for illustration only

Diverse CAE (systems from multiple vendors)

Vendors and products listed for illustration only

STEP AP209 ed2 translators permit CAE diversity while mitigating the risk of losing valuable investments in analysis

Business value of ISO STEP AP209 ed2 translators for LOTAR at Aerospace & Defense companies

- **Situation**
  - Aerospace & Defense companies and their suppliers buy software from multiple CAE vendors
  - Analysis, substantiated by test, is the evidence that aerospace products conform to customer and regulatory requirements
  - For many reasons, LOTAR of analysis data is a business requirement
  - Loss of analysis data results in costly rework to reproduce it
- **Target** – ISO STEP AP209 ed2 translators enable the preservation of value in the analysis models and results without dependence on a single CAE tool
- **Business Proposition**
  - Buy CAE software that supports ISO STEP AP209 ed2 translators and phase out CAE software that doesn't

Business value of ISO STEP AP209 ed2 translators for CAE vendors

- **Situation**
  - Most of your customers already use CAE products from your competitors
  - You must evolve or you will not sell new products
  - Customers tend to use a version of your product for long periods of time due to the cost of migration (upgrade, validate, verify, educate, etc.)
- **Target** – satisfied customers who see the value in your newest software will buy it and migrate to it
- **Business Proposition**
  - Seek to understand your customers needs for LOTAR of engineering analysis data
  - Offer solutions that ease the process of migration to new software
  - Offer solutions that preserve the value of their existing analysis models and results for the long term by supporting ISO STEP AP209 ed2 translators

Technical Approach

Driving questions for designing LOTAR EAS use cases

Vehicle Level Finite Element Analysis (VLFEA) is at the tip of the structural analysis "iceberg"

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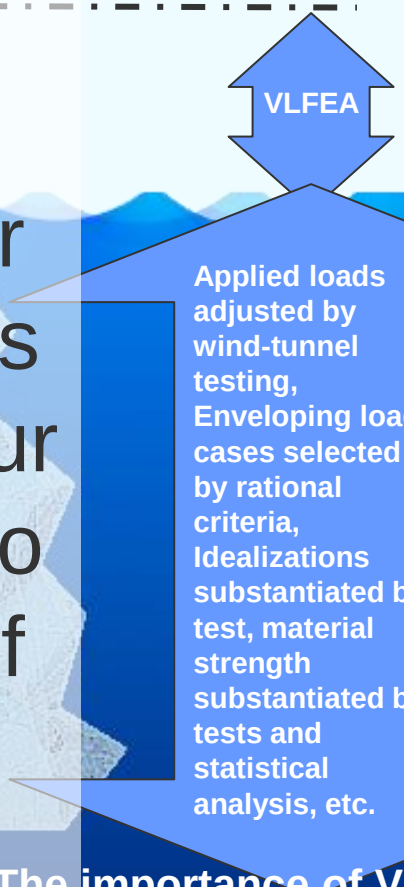
VLFEA, substantiated by test, is the basis for analysis that serves as evidence that our products conform to the requirements of our customers and regulatory authorities.



The importance of VLFEA is common to all A&D companies in the EAS WG

It is the culmination of a large volume of analytical data that supports it and represents a significant investment.

Domain of engineering analysis and simulation, with initial development phase

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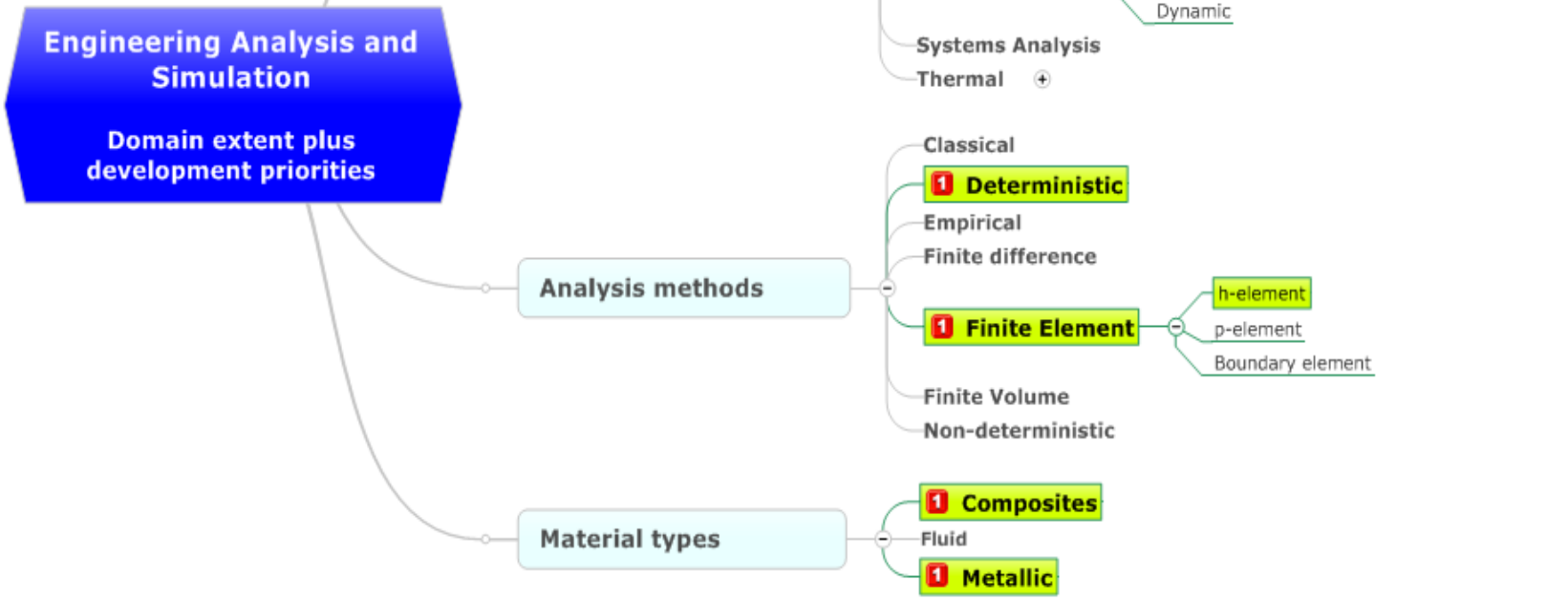
Phase 1 Scope

- Structural Analysis
- Linear, Static, Deterministic
- Finite element method (h-formulation)
- Metallic and composite materials

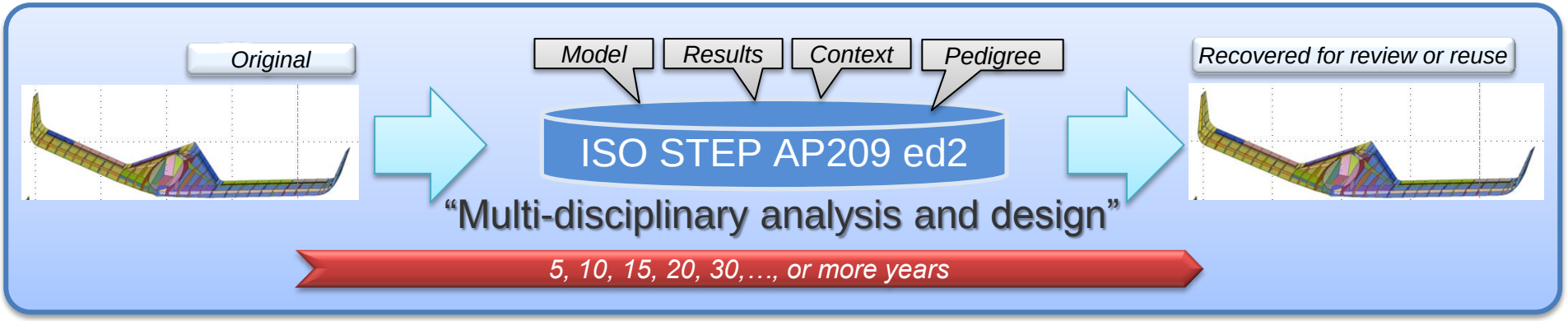
Phase 1 Focus

- Internal loads
- Total vehicle
- Retrieve and reuse previous analysis



Primary technology for data exchange – ISO STEP AP209 ed2

Primary Technical Approach



The primary technical approach is based on using a **vendor-neutral ISO STEP AP209 ed2 data model**.

The complete archive of analysis and simulation data will be based on fulfilling the requirements of the member companies. ISO STEP AP209 ed2 is an enabling technology for preserving FEA input and results for the long-term.

STEP AP209 edition 2: Multidisciplinary analysis and design

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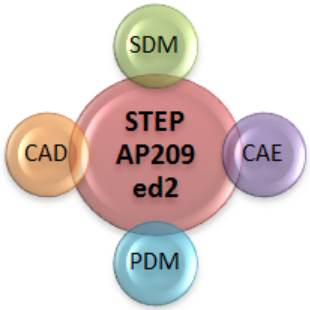
- **STEP AP209 ed2** is the target data model for simulation data long term archiving (LOTAR)
- STEP AP209 public web site: www.ap209.org
- Governance by ISO Technical Committee 184 for Industrial Automation Systems and Integration, Subcommittee 4 for Industrial Data



AP209 integrates 4 domains: CAD, CAE, SDM and PDM

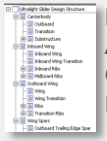
SDM : Simulation Data Management
CAD : Computer Aided Design
CAE : Computer Aided Engineering
PDM : Product Data Management

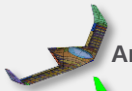
Development History

- AP209 ed1 published in 2001
- AP209 ed2 became an ISO International Standard Dec. 1st 2014
- Builds upon the full capabilities of STEP AP242 ed1 (*Managed Model Based 3D Engineering*)
- Edition 2 scope now includes:
  - *Product definition (product structure and 3D shapes)*
  - *Configuration control information*
  - *Finite element data (linear statics and modes)*
  - *Material specifications & properties*
  - *Computational Fluid Dynamics (based on CGNS Std.)*
  - *Generic structured and unstructured analysis mesh*
  - *Meshless numerical analysis*
  - *Discrete/continuous field representation*
  - *Kinematics analysis*

Computer Aided Design
3D Solids
Surface Lofts
Structural Layouts

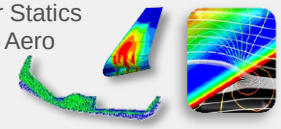
Product Data and Metadata
Product Structure
Analysis Structure
Configuration Data
Material Specification



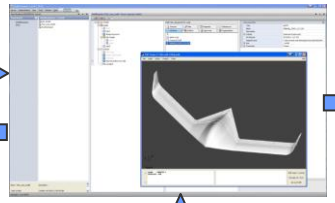


Analysis Geometry
Idealized for Loads
Idealized for Structures
Idealized for Aero

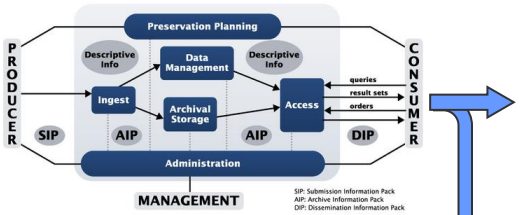
Finite Element Models and Analysis
Linear Statics
Panel Aero
CFD



Simulation Data Management



Long Term Archival and Retrieval (LOTAR)



Examples of essential information to preserve for LOTAR of FEA data

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Metadata

- Descriptive text
- Pedigree
- Software used to produce original FEA and results
- Finite element analysis plan (purpose, assumptions, etc.)

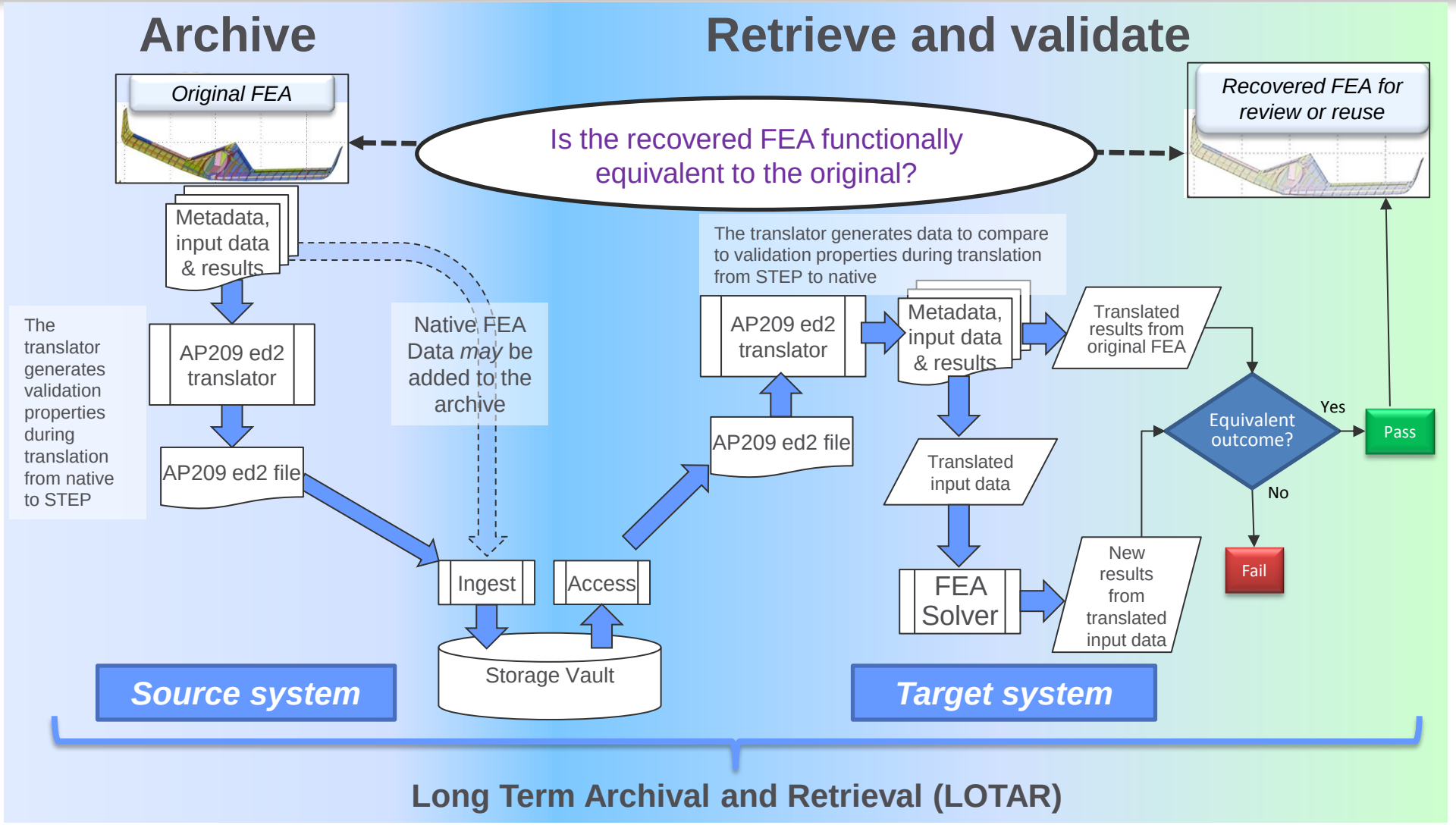
Input data

- Units
- Nodes
- Elements
- Properties
- Loads and Boundary Conditions

Results

- Solution diagnostics (element and solution quality metrics)
- Displacements
- Reactions
- Internal Forces
- Node/Element Corner Forces

The “round-trip” of an EAS archive to/from long-term storage



Teaming to achieve the goal

LOTAR engineering analysis and simulation (EAS) working group (WG) and related entities

End Users

Producers of requirements for archiving and recovering engineering analysis and simulation data, and consumers of the associated methods, tools, and standards.

NAFEMS

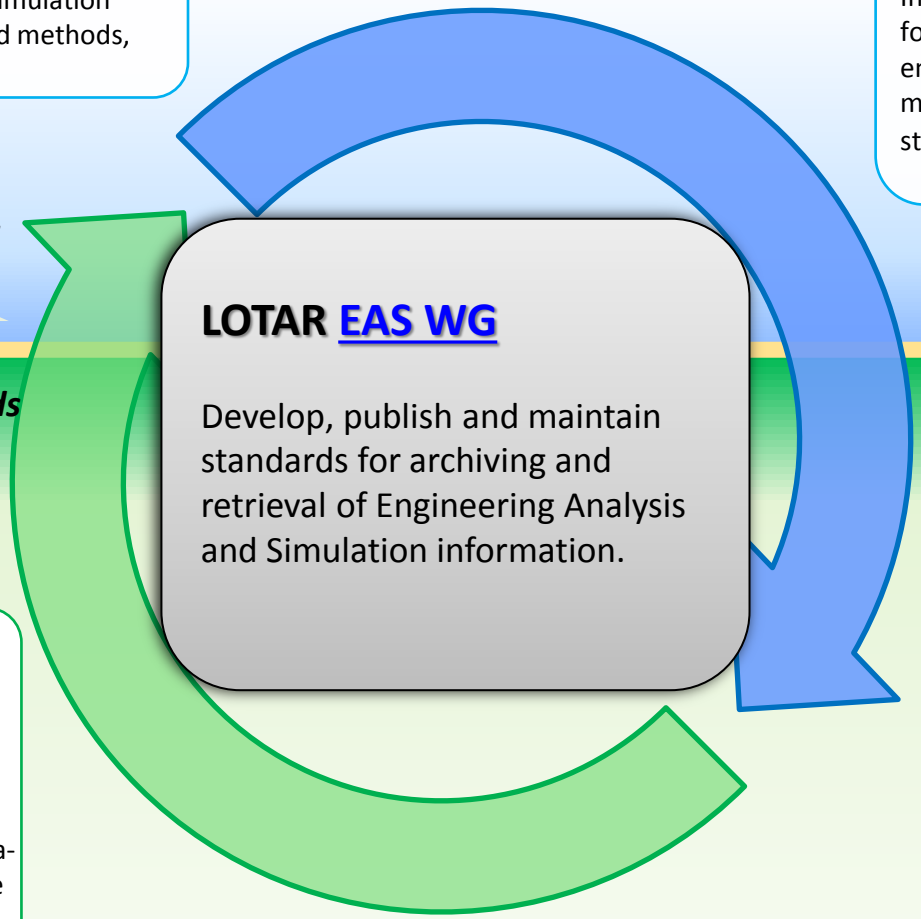
International non-profit organization for advancing and promoting engineering analysis and simulation methods, data management, standards and education.

Users

Requirements & Use Cases

Standards, Software & Methods

Providers



LOTAR EAS WG

Develop, publish and maintain standards for archiving and retrieval of Engineering Analysis and Simulation information.

National Institute of Standards and Technology (NIST)

Promote the use of standards.

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

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

Modeling and Simulation information in a collaborative Systems Engineering Context (MoSSEC)

Develop methods for organizing and sharing Modeling and Simulation meta-data and information in a collaborative system, and for capturing context to enable traceability.

International Organization for Standardization (ISO)

Develop and publish international standards, in particular

- ISO 10303 STEP
- ISO 14721 OAIS (Open Archival Information System)

PDES, Inc., ProSTEP iViP and AFNeT

Develop data models, standard data representations, including AP209 ed2, and common approaches through standards.

ASD-STAN and AIA

Sponsoring the LOTAR NAS / EN 9300-xxx development.

V3 - Sept 2016

Memoranda of Understanding (MoU) have enabled collaboration

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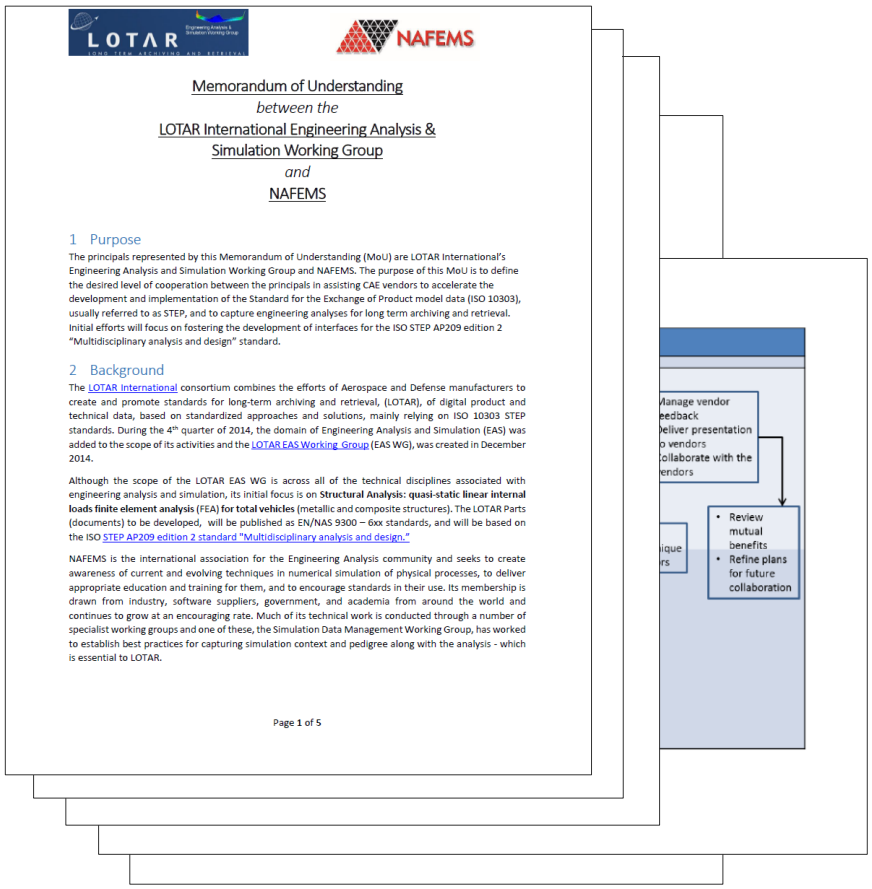
MoU between LOTAR EAS WG and NAFEMS



LOTAR NAFEMS

Memorandum of Understanding
between the
LOTAR International Engineering Analysis & Simulation Working Group
and
NAFEMS

1 Purpose

The principals represented by this Memorandum of Understanding (MoU) are LOTAR International's Engineering Analysis and Simulation Working Group and NAFEMS. The purpose of this MoU is to define the desired level of cooperation between the principals in assisting CAE vendors to accelerate the development and implementation of the Standard for the Exchange of Product model data (ISO 10303), usually referred to as STEP, and to capture engineering analyses for long term archiving and retrieval. Initial efforts will focus on fostering the development of interfaces for the ISO STEP AP209 edition 2 "Multidisciplinary analysis and design" standard.

2 Background

The LOTAR International consortium combines the efforts of Aerospace and Defense manufacturers to create and promote standards for long-term archiving and retrieval, (LOTAR), of digital product and technical data, based on standardized approaches and solutions, mainly relying on ISO 10303 STEP standards. During the 4th quarter of 2014, the domain of Engineering Analysis and Simulation (EAS) was added to the scope of its activities and the LOTAR EAS Working Group (EAS WG), was created in December 2014.

Although the scope of the LOTAR EAS WG is across all of the technical disciplines associated with engineering analysis and simulation, its initial focus is on **Structural Analysis: quasi-static linear internal loads finite element analysis** (FEA) **for total vehicles** (metallic and composite structures). The LOTAR Parts (documents) to be developed, will be published as EN/NAS 9300 – 6xx standards, and will be based on the ISO STEP AP209 edition 2 standard "Multidisciplinary analysis and design."

NAFEMS is the international association for the Engineering Analysis community and seeks to create awareness of current and evolving techniques in numerical simulation of physical processes, to deliver appropriate education and training for them, and to encourage standards in their use. Its membership is drawn from industry, software suppliers, government, and academia from around the world and continues to grow at an encouraging rate. Much of its technical work is conducted through a number of specialist working groups and one of these, the Simulation Data Management Working Group, has worked to establish best practices for capturing simulation context and pedigree along with the analysis - which is essential to LOTAR.

Page 1 of 5

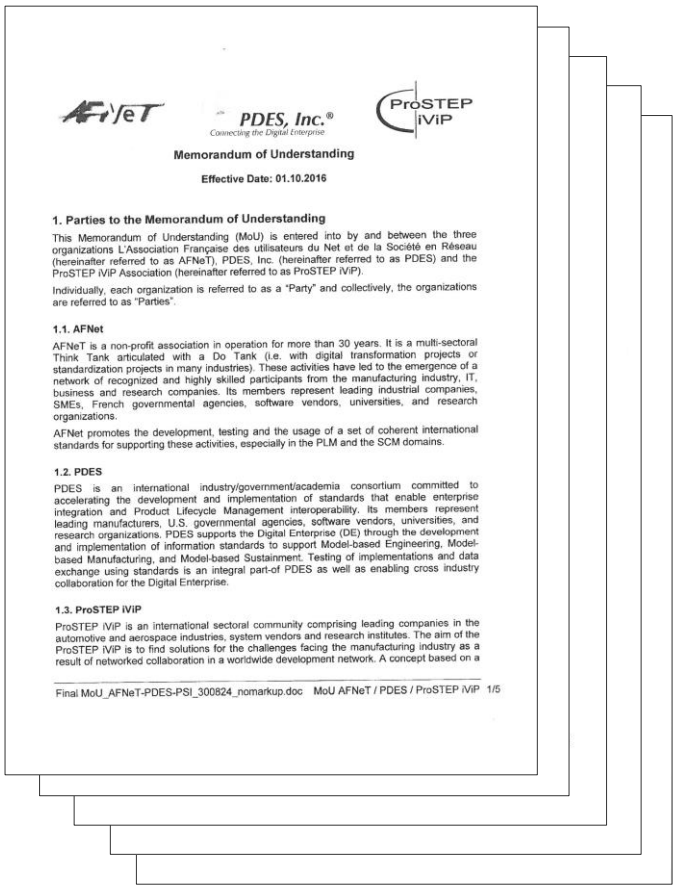
Manage vendor
eedback
eliver presentation
o vendors
ollaborate with the
endors

- Review mutual benefits
- Refine plans for future collaboration

ique
rs

Signed 23 June 2016

MoU between AFNet, PDES and ProSTEP iViP



AFNeT PDES, Inc.® Connecting the Digital Enterprise ProSTEP iViP

Memorandum of Understanding

Effective Date: 01.10.2016

1. Parties to the Memorandum of Understanding

This Memorandum of Understanding (MoU) is entered into by and between the three organizations L'Association Française des utilisateurs du Net et de la Société en Réseau (hereinafter referred to as AFNeT), PDES, Inc. (hereinafter referred to as PDES) and the ProSTEP iViP Association (hereinafter referred to as ProSTEP iViP).

Individually, each organization is referred to as a "Party" and collectively, the organizations are referred to as "Parties".

1.1. AFNet

AFNeT is a non-profit association in operation for more than 30 years. It is a multi-sectoral Think Tank articulated with a Do Tank (i.e. with digital transformation projects or standardization projects in many industries). These activities have led to the emergence of a network of recognized and highly skilled participants from the manufacturing industry, IT, business and research companies. Its members represent leading industrial companies, SMEs, French governmental agencies, software vendors, universities, and research organizations.

AFNet promotes the development, testing and the usage of a set of coherent international standards for supporting these activities, especially in the PLM and the SCM domains.

1.2. PDES

PDES is an international industry/government/academia consortium committed to accelerating the development and implementation of standards that enable enterprise integration and Product Lifecycle Management interoperability. Its members represent leading manufacturers, U.S. governmental agencies, software vendors, universities, and research organizations. PDES supports the Digital Enterprise (DE) through the development and implementation of information standards to support Model-based Engineering, Model-based Manufacturing, and Model-based Sustainment. Testing of implementations and data exchange using standards is an integral part-of PDES as well as enabling cross industry collaboration for the Digital Enterprise.

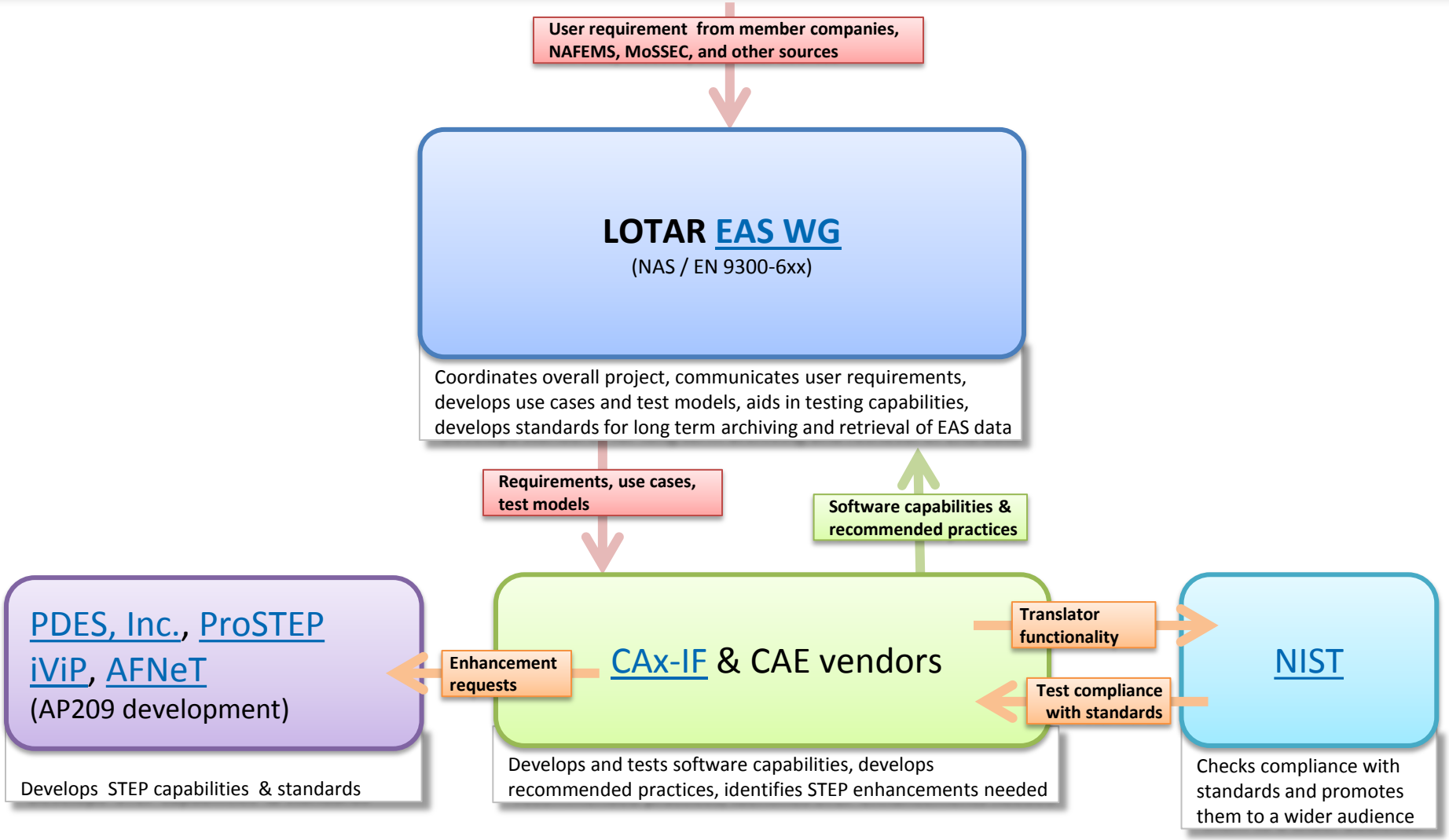
1.3. ProSTEP iViP

ProSTEP iViP is an international sectoral community comprising leading companies in the automotive and aerospace industries, system vendors and research institutes. The aim of the ProSTEP iViP is to find solutions for the challenges facing the manufacturing industry as a result of networked collaboration in a worldwide development network. A concept based on a

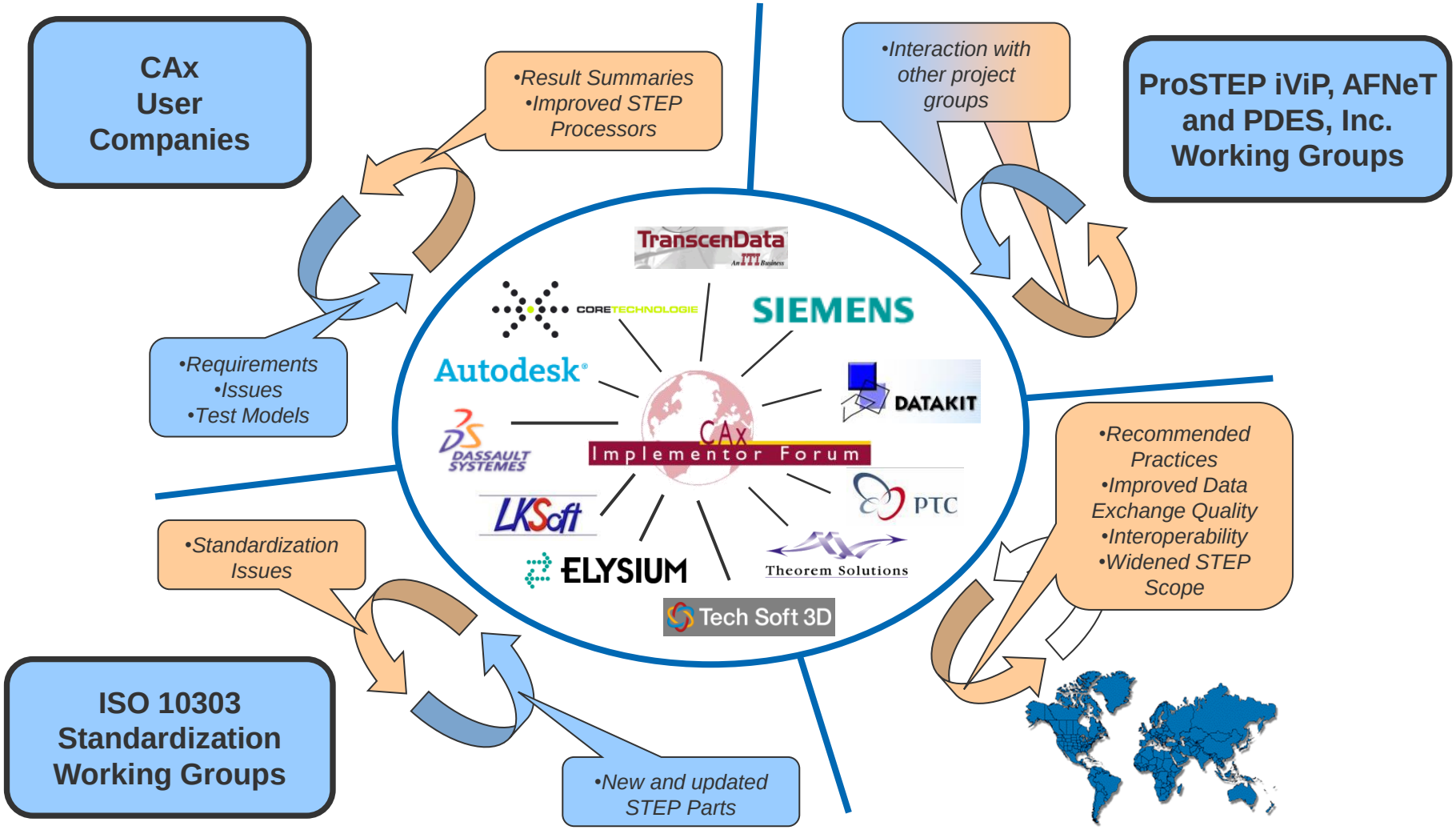
Final MoU_AFNeT-PDES-PSI_300824_nomarkup.doc MoU AFNeT / PDES / ProSTEP iViP 1/5

Signed 7 September 2016

Collaborative development space for LOTAR EAS



CAx implementor forum (CAx-IF)



CAx-IF participation requirements

Formal:

- Either be a PDES, Inc. member, AFNeT member OR be a ProSTEP iViP member
- Sign a NDA (non-disclosure agreement)
  - Basis for the trusted atmosphere and unprecedented cooperation among the vendors in the forum
- Have at least a prototype STEP processor
  - Export and/or Import
  - Based on AP242 or AP209

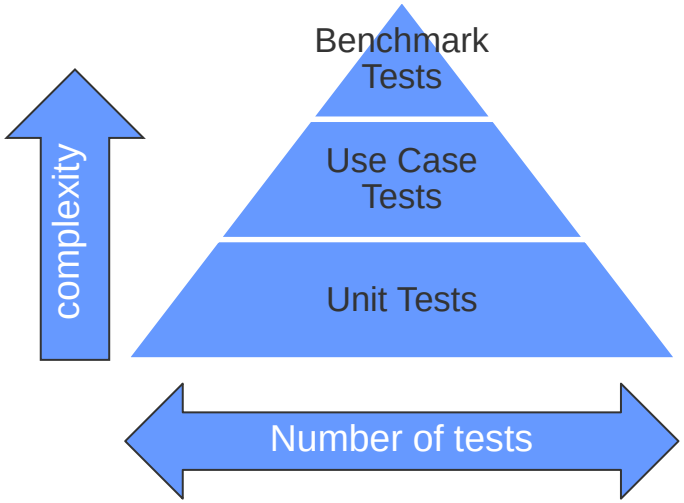
Active:

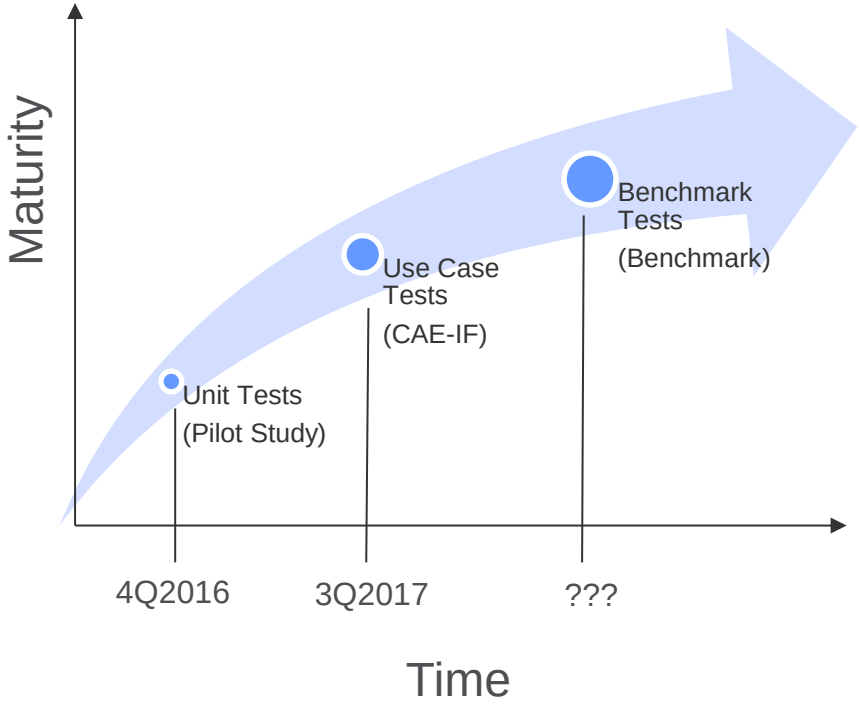
- Attend CAx-IF meetings
  - Four per year; alternating between Europe (Jun/Dec) and the US (Mar/Sep)
  - Discuss results, identify issues, develop solutions
- Participate in conference calls
  - Track test round progress and action items
- Actively collaborate in STEP interoperability testing
  - Provide STEP files
  - Upload results to online database

Development and Testing of Software supporting LOTAR EAS Standards

Introduction to testing/development

- Testing follows a building block approach synchronized with STEP and LOTAR standards

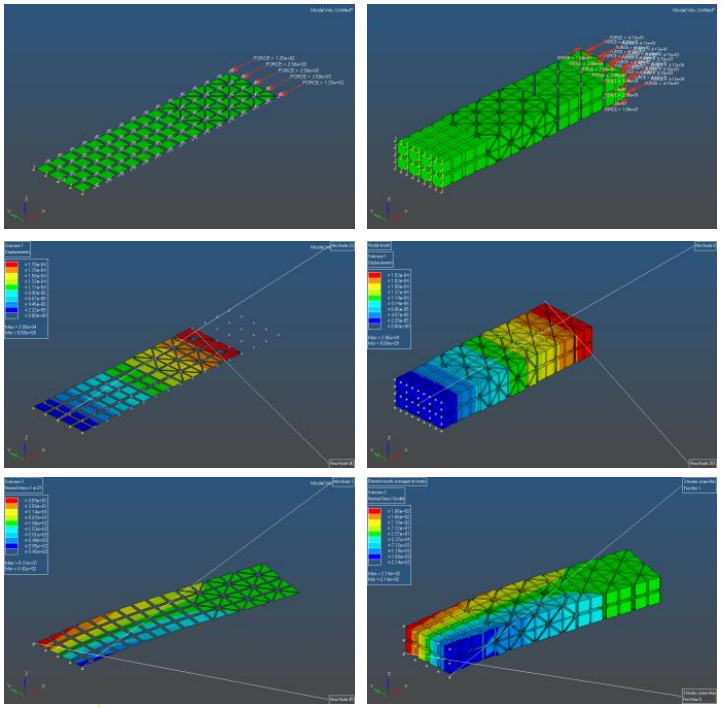


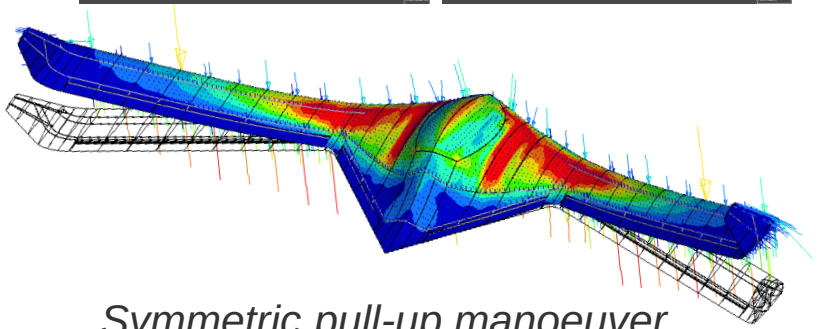


LOTAR EAS test models

- Unit test models
  - To test single functionalities

- Ultra-light glider model (ULG)
  - Representative of model, load cases and results for a total vehicle quasi-static linear internal loads finite element model
  - Additional load cases available
  - Coarse mesh FEM representative of semi-monocoque construction
  - Simulation Data Management (SDM) elements such as metadata to establish pedigree
  - Publically available



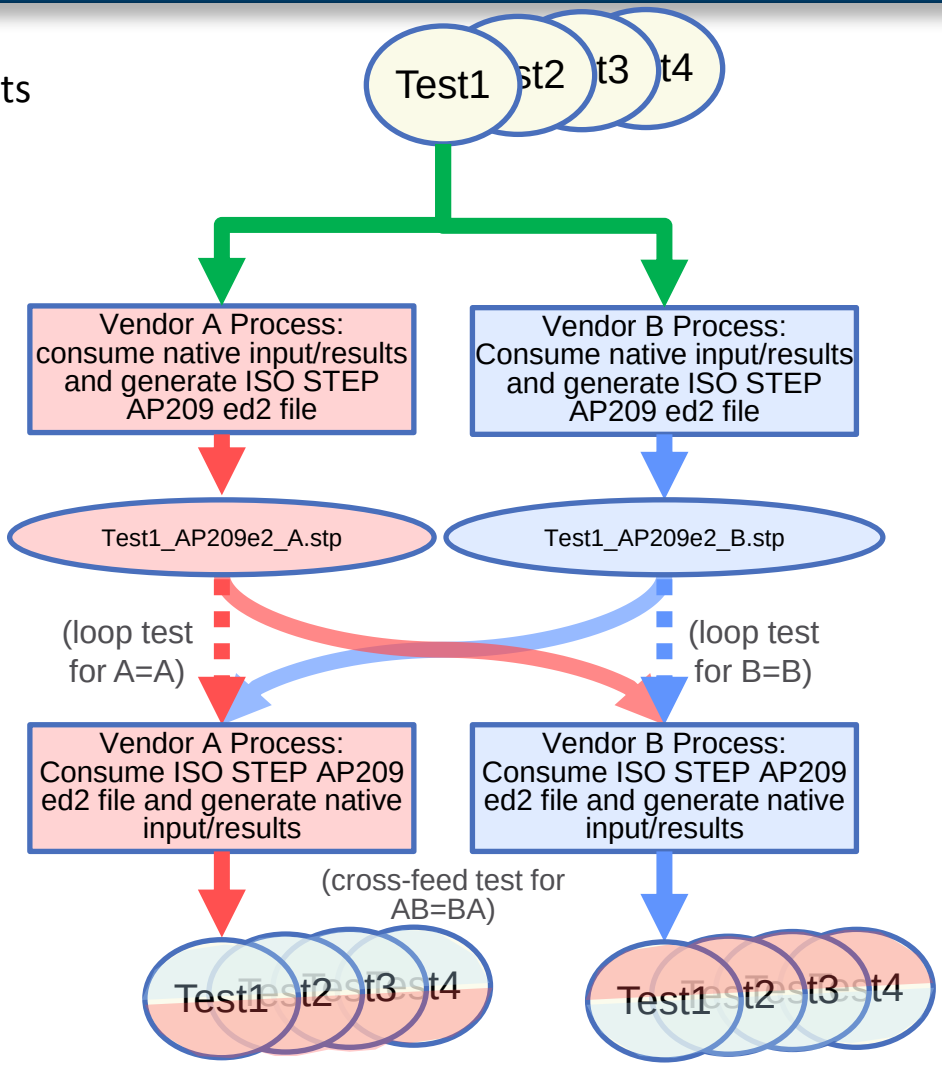


Symmetric pull-up manoeuver

Pilot study – using unit tests – bi-directionally generate and consume ISO STEP AP 209 ed2 files and native FEA

LOTAR
LONG TERM ARCHIVING AND RETRIEVAL

1. Test Models in native FEM format for input/results
2. Processes (including standalone translators) to consume native FEM input/results and generate ISO STEP AP209 ed2 file
3. ISO STEP AP 209 ed2 files
4. Cross-feed the ISO STEP AP 209 ed2 files (and perform loop tests)
5. Processes to consume ISO STEP AP 209 ed2 file and generate native FEM input/results
6. Test Models in native FEM format for input/results should result in “equivalent outcome” relative to the original input/results



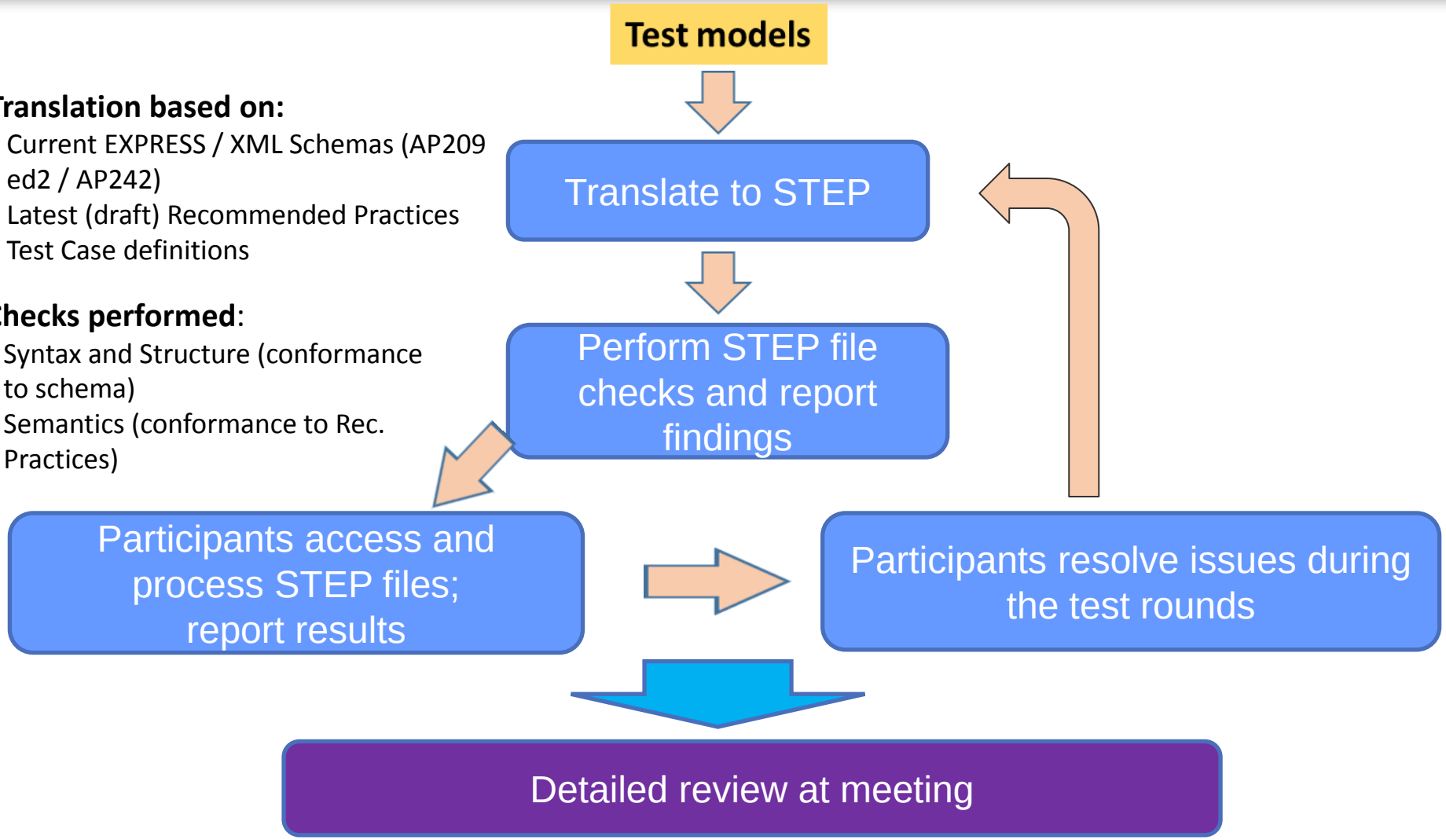
CAx-IF testing methodology

Translation based on:

- Current EXPRESS / XML Schemas (AP209 ed2 / AP242)
- Latest (draft) Recommended Practices
- Test Case definitions

Checks performed:

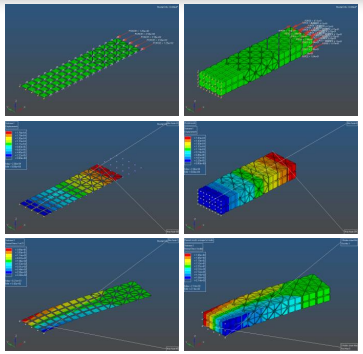
- Syntax and Structure (conformance to schema)
- Semantics (conformance to Rec. Practices)

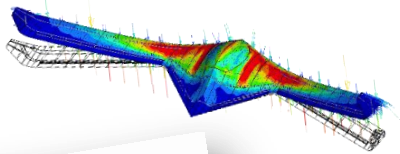


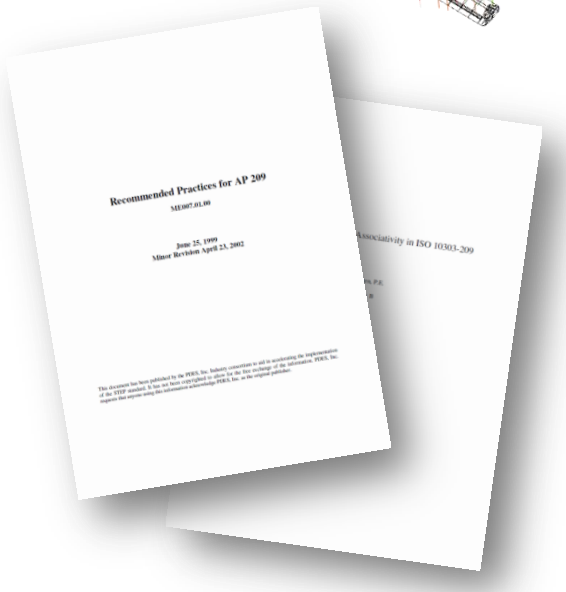
Resources provided

Resources Provided
(see backup slides for additional information)

- Test models
  - Unit test models
  - Ultra-light glider realistic model
- Training
  - Information model
  - Recommended practices overview
- Recommended Practices updates
  - In response to inputs from vendor testing
- Support
  - Regular meetings, workshops, test rounds
  - Conference calls
  - Access to STEP and domain experts







Summary
&
Next actions

Summary: LOTAR EAS "On a Page"

LOTAR
LONG TERM ARCHIVING AND RETRIEVAL

Why: Business Need

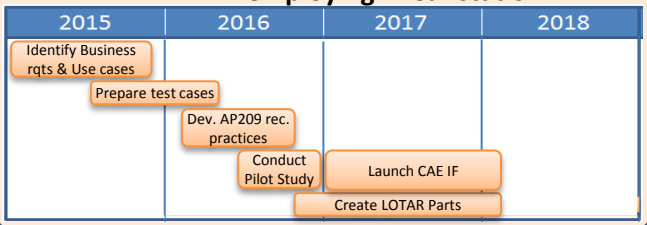
In an environment of rapidly changing software and hardware, a general requirement exists for access to and viability of digitally formatted engineering assets over the life of the product

- **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*

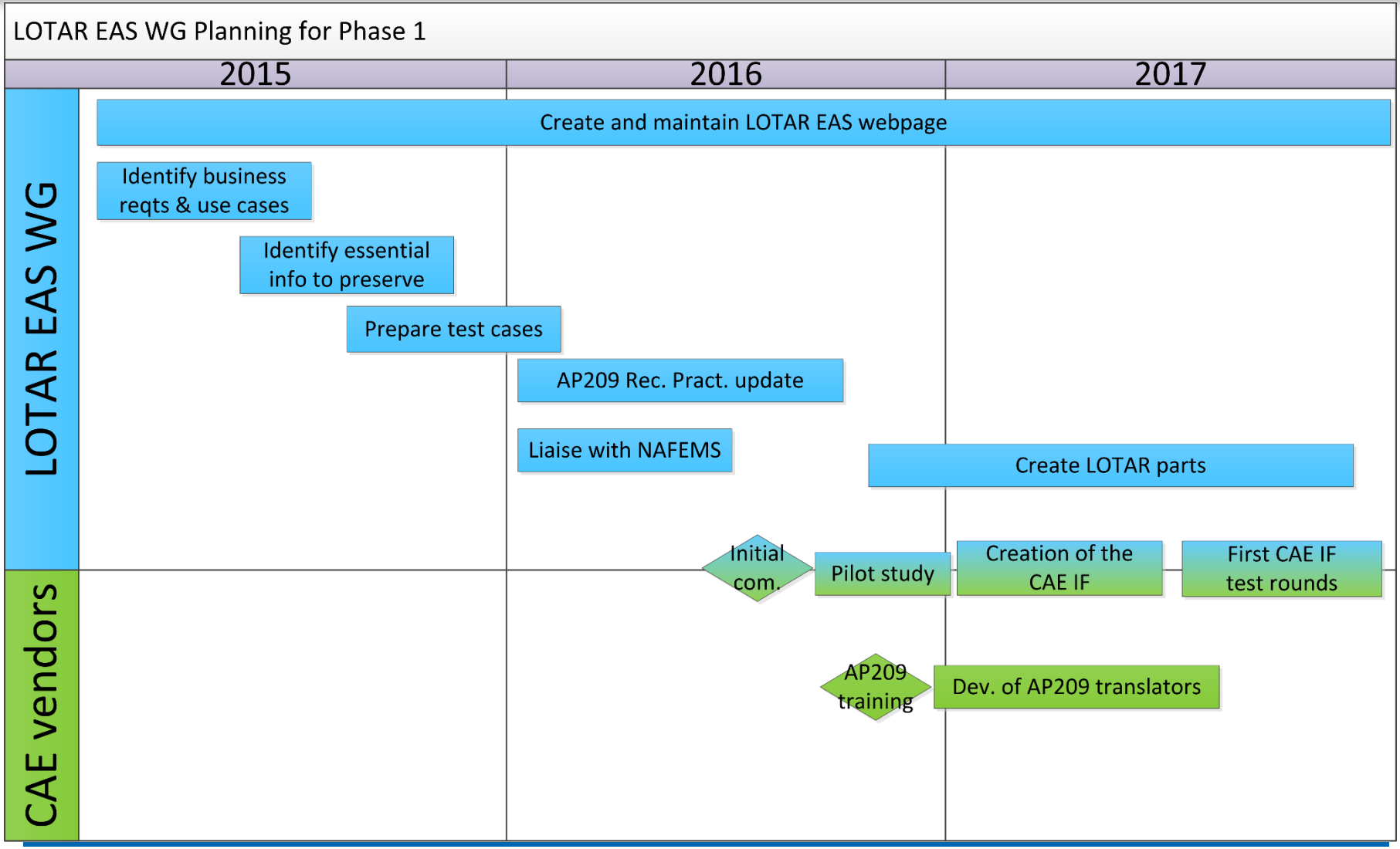
LOTAR International EAS Working Group

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

ProSTEP iViP PDES, Inc.

LOTAR EAS WG planning for Phase 1



Next actions

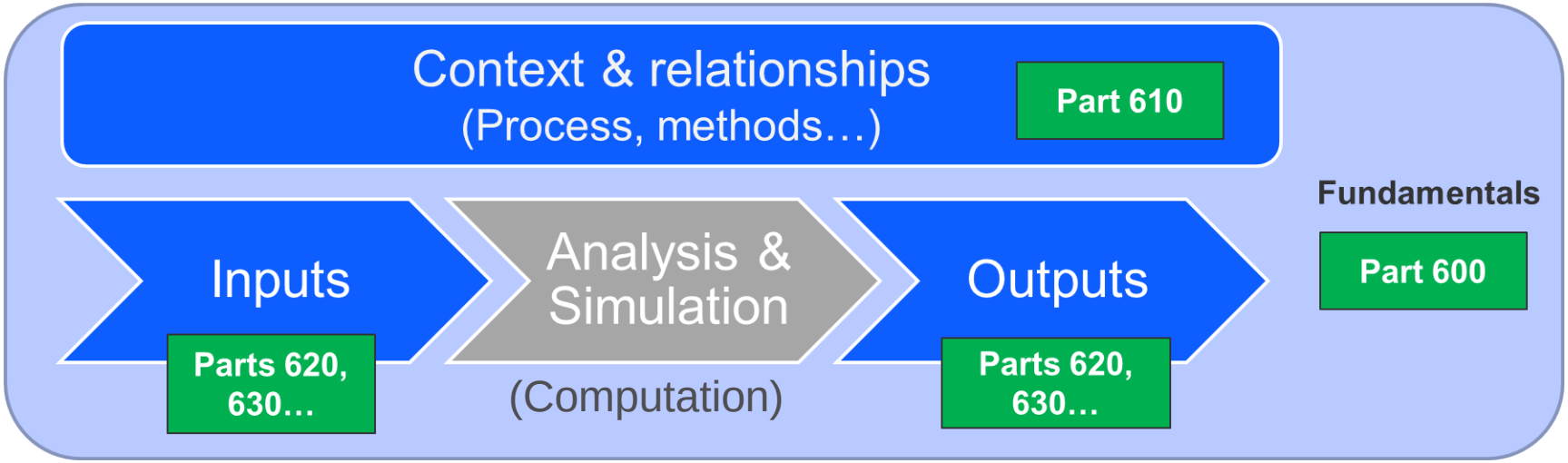
- Vendors
  - Review the current presentation and the back-up slides for more information
  - Ask questions if needed
  - Respond to a questionnaire
  - Brief the LOTAR EAS WG & CAx-IF about the capabilities you currently have and lessons learned
  - Inform LOTAR EAS WG of your desire to engage in the development and deployment of software solutions that enable use of ISO STEP AP209 ed2 files
- LOTAR EAS WG
  - Respond to questions from vendors
  - Collect feedback from questionnaires
  - Select pilot study participants following a process using feedback from questionnaires and analysis of readiness
  - Provide support for implementation development: AP209 ed2 up to date recommended practices, training, STEP expertise, etc.

LOTAR EAS is available for follow-up meetings if you have questions:
LOTAR-EAS-Contact@lists.purdue.edu

Backup slides

LOTAR parts
EN/NAS 9300 standards to be developed

- Scope



- Structure

Part no.	Title
Part 600	Fundamentals and Concepts for LOTAR of Engineering Analysis & Simulation information
Part 610	LOTAR of Simulation Process and Data Management
Part 620	LOTAR of Structural Analysis information
Part 630	*LOTAR of additional analysis domain*

Business needs for LOTAR of EAS data

The need for LOTAR revolves around **retrieval** and **reuse** of **previous analysis and simulation input data and results** for a variety of purposes, such as:

- Evaluate changes to products (new materials, processes, etc.)
- Evaluate damage (design repairs, improve design, accident investigation, etc.)
- Address customer questions (fleet support, inspection, etc.)
- Evaluate new conditions and mission requirements (extend the range, increased payload, etc.)
- Engineer modifications (convert from passenger to freighter, add winglets, respond to changes in regulations, etc.)
- Engineer derivatives (“stretch” the fuselage, re-engine, freighter, military, etc.)
- Capture/recover knowledge (analysis assumptions, analytical basis, etc.)

CAx-IF Testing Methodology
Criteria for successful roundtrip – What is an “equivalent outcome”?
Comparison of Pilot Study, CAE-IF and Benchmark Testing
Pilot Study – algorithm for loop and cross-feed testing
Test Models used for Phase 1

SOFTWARE TESTING FOR PHASE 1

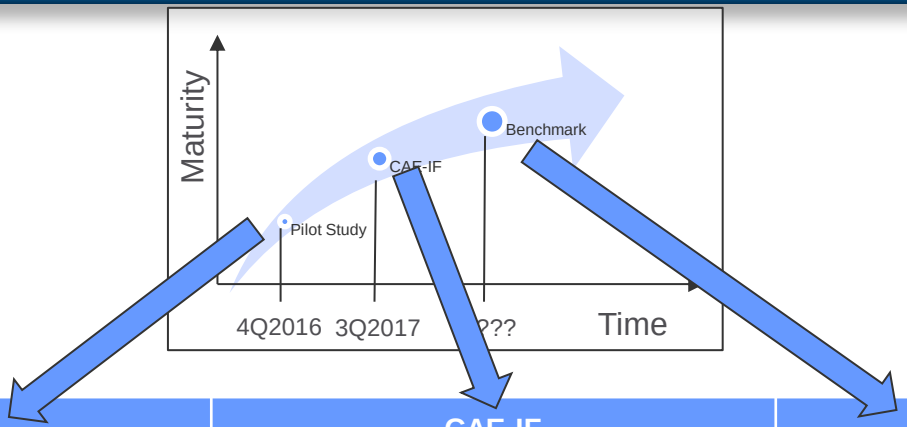
CAx-IF Testing Methodology

1. First inputs are test models to be translated into STEP, based on:
   - Current EXPRESS / XML Schemas (AP209 ed2 / AP242)
   - Latest (draft) Recommended Practices
   - Test Case definitions
2. STEP files are checked for:
   - Syntax and Structure (conformance to schema)
   - Semantics (conformance to Rec. Practices)
3. STEP files and corresponding statistics are provided in the member area of the CAx-IF homepage
4. Participants download all provided files, process them, and report on their results.
5. If issues are found, they are resolved during the test round as far as possible.
6. Detailed review at meeting.

Criteria for successful roundtrip – what is an "equivalent outcome"

- SDM/SPDM information (Metadata, pedigree, etc.) matches the validation properties of the original
- Input data conforms to the original FEA (units, node locations, etc.) and matches the validation properties of the original
- Results match original FEA within a specified tolerance and match the validation properties of the original and meets the test criteria

Comparison of Pilot Study, CAE-IF and Benchmark testing



	Pilot	CAE-IF	Benchmark
Who?	2~3 vendors with a prototype ISO STEP AP 209 ed2 product	Any member of PDES, Inc or ProSTEP iViP with a functional ISO STEP AP 209 ed2 product	Independent third party testing COTS ISO STEP AP 209 ed2 products
What?	Unit tests with limited scope, but enough to exercise the ISO STEP data model	Use cases based on requirements used to define LOTAR standards	A collection of tests that conform to best practices in the industry
Why?	Proof of concept, allowing for further refinement of recommended practices and requirements.	Develop and mature product in a controlled forum for collaboration	To independently verify and validate the COTS products with analysis representative of intended usage in the industry
When?	After pilot study test plan is ready and pilot study candidates have been selected	After use case tests are defined and initial recommended practices are complete	After planning, funding, resources and COTS products become available.
Where?	At vendor sites with regular coordination	At vendor sites, with regular coordination and test files shared through sandbox, quarterly face-to-face meetings	At an independent test facility with up-to-date production versions of COTS software
How?	PDES, Inc. and ProSTEP iViP coordinate testing, EAS WG provides test models and criteria	PDES, Inc. and ProSTEP iViP coordinate testing, EAS WG provides test models and criteria	Third party defines a plan, funds and monitors the work

Pilot Study – Loop and Cross-feed tests are repeated for each test model with the goal being an equivalent outcome

LOTAR
LONG TERM ARCHIVING AND RETRIEVAL

Loop test (for=1 to N):

$$Test_i^{native} \xrightarrow[Vendor\ A]{} Test_{i_A}^{AP\ 209\ ed2} \xrightarrow[Vendor\ A]{} Test_{i_{AA}}^{native}$$

$$\boldsymbol{Test_{i_{AA}}^{native} \overset{\text{def}}{=} Test_i^{native}}$$

$$Test_i^{native} \xrightarrow[Vendor\ B]{} Test_{i_B}^{AP\ 209\ ed2} \xrightarrow[Vendor\ B]{} Test_{i_{BB}}^{native}$$

$$\boldsymbol{Test_{i_{BB}}^{native} \overset{\text{def}}{=} Test_i^{native}}$$

Cross-feed tests (for=1 to N):

$$Test_i^{native} \xrightarrow[Vendor\ A]{} Test_{i_A}^{AP\ 209\ ed2} \xrightarrow[Vendor\ B]{} Test_{i_{AB}}^{native}$$

$$\boldsymbol{Test_{i_{AB}}^{native} \overset{\text{def}}{=} Test_i^{native}}$$

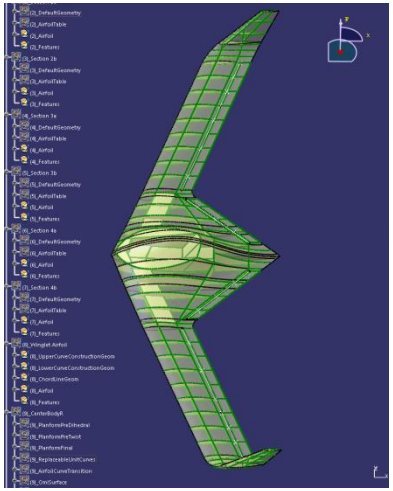
$$Test_i^{native} \xrightarrow[Vendor\ B]{} Test_{i_B}^{AP\ 209\ ed2} \xrightarrow[Vendor\ A]{} Test_{i_{BA}}^{native}$$

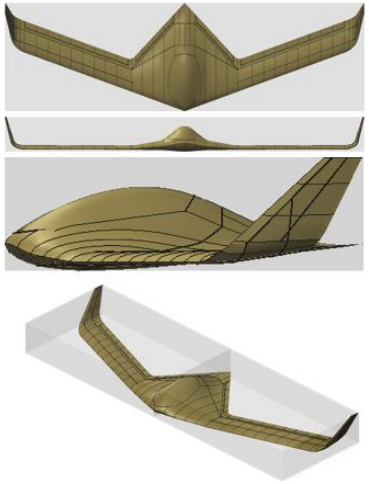
$$\boldsymbol{Test_{i_{BA}}^{native} \overset{\text{def}}{=} Test_i^{native}}$$

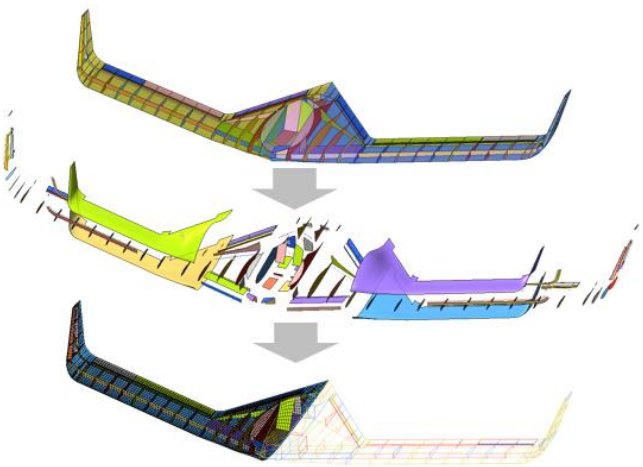
The LOTAR EAS WG (in collaboration with participating vendors) will define the criteria used to determine what substantiates an equivalent outcome. The concept of validation properties in ISO STEP will be used as much as possible to achieve this goal.

LOTAR EAS Test Models

- EAS Working Group is developing a suite of Finite Element Models (FEM) for use by LOTAR members and the CAx-IF
  - Unit test models for specific FEM constructs and element types
  - Models for testing ISO 10303 AP 209 ed2 geometric founding and transformation implementation
  - A publically available ultra-light glider FEM that contains analysis product structure and associativity to idealized surface geometries







AP209 ed2 Training

Recommended Practices for implementing STEP AP209 ed2

STEP AP209 ed2 Testing Support

ISO STEP AP209 BACKGROUND

AP209 ed2 Training

Objective: Explain AP209 ed2 to the implementers to a level needed so that they can successfully implement the protocol in their simulation analysis software and create solutions that satisfy the LOTAR EAS use cases and requirements. Training materials shall expand on information contained in the Recommended Practices document to provide instances typical of common solver data structures.

- Training sessions for implementers
  - 1 day high level review (ARM) to introduce scope of the information model
  - 3 day implementation model review (AIM) to provide details on using the Recommended Practices and Part 104 documents to implement compliant translators
- Training materials shall be accessible on-line

Recommended Practices for implementing STEP AP209 ed2

- Documents available so far are based on the first edition of STEP AP209:
  - Recommended Practices – April 23, 2002
  - Geometric Founding and Associativity – Feb. 15, 2001

- Available on the internet:
  - https://www.cax-if.org/joint_testing_info.html#recpracs

- Documentation updates are under way, in order to cover:
  - New and extended approaches of the second edition of AP209
  - Alignment with AP242
  - LOTAR EAS requirements

STEP AP209 ed2 Testing support

- Testing support will be given through the well-established CAx-IF Infrastructure:
  - Public and private web site at www.cax-if.org
  - Regular meetings, in conjunction with LOTAR workshops
  - Additional conference calls
  - Two test rounds per year
  - Intense technical discussions with STEP and domain experts
  - Syntax and structure, and semantic checking of STEP files