Standards for Enabling the Long Term Preservation of Engineering Data

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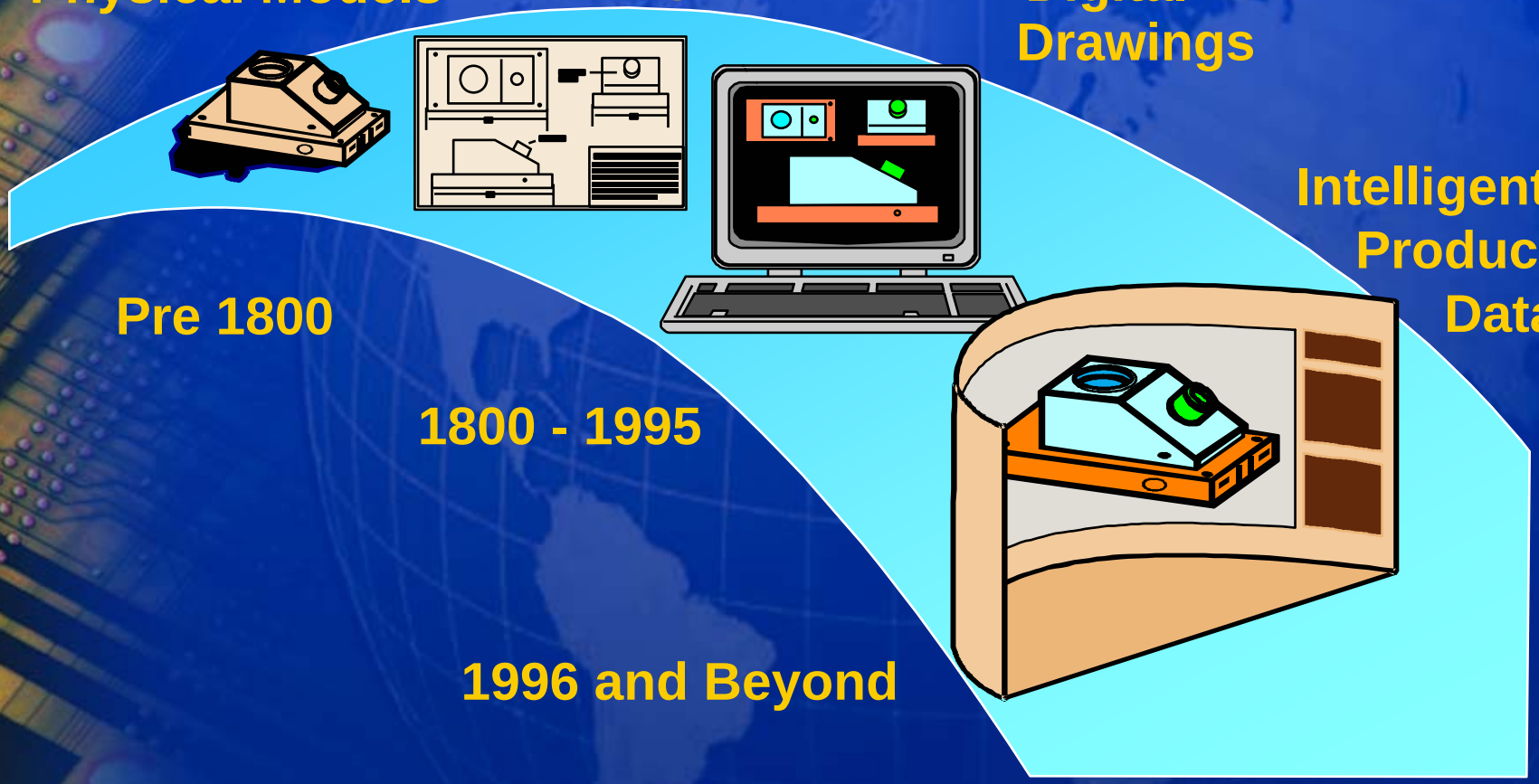
PDES, Inc.

Partnerships in Innovation
College Park, Maryland
November 15, 2004

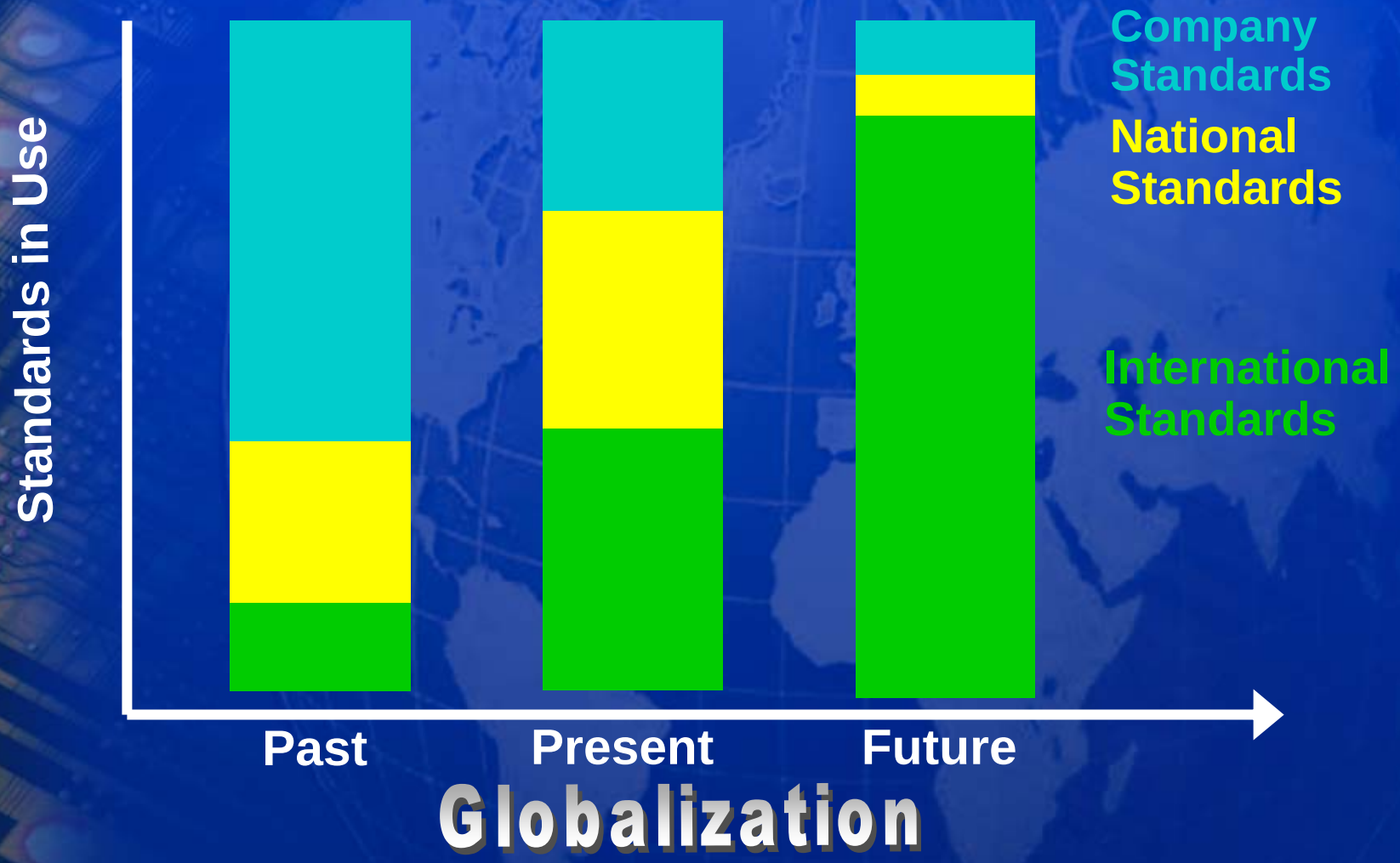
Outline

- Introduction
  - Evolution of Product Data Standards; Overview of ISO 10303 STandard for the Exchange of Product model data (STEP)
- Activities of the PDES, Inc. consortium
  - Participants, Standards development, interoperability testing
- Industrial Use of STEP
  - success stories from aerospace and defense, ongoing pilot projects
- Activities in Archiving Engineering Data
  - The PDES, Inc. Long Term Data Retention pilot
- Summary, Q&A

Evolution of Product Definition Capabilities



Movement Toward International Standards



What is STEP?

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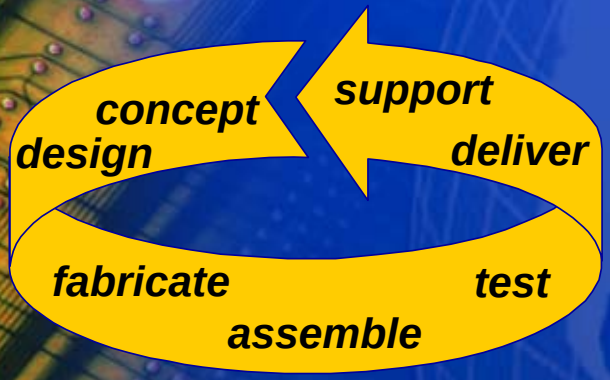

...an international standard (ISO 10303) for exchanging data between different systems (CAD, CAM, CAE, and PDM)

...a computer interpretable definition of the physical and functional characteristics of a product throughout its life cycle

...a proven way to ensure fast, reliable data exchange between partners and suppliers using different systems

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STEP Usage Scenarios: Between Organizations

Customers

Primes

Concept

Design

Fabricate

Assemble

Test/Deliver

Support

Suppliers

Subcontractors

Enables Consistent and Timely Data Sharing by Participants

STEP Usage Scenarios: Between Functions

Enables Complete and Accurate Data Exchange and Use

STEP Usage Scenarios: Between Designs

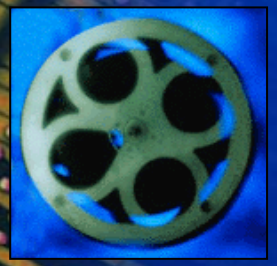
Enables Reuse of Design, Planning and Manufacturing Data

STEP Usage Scenarios: In Data Archival

Past → Future

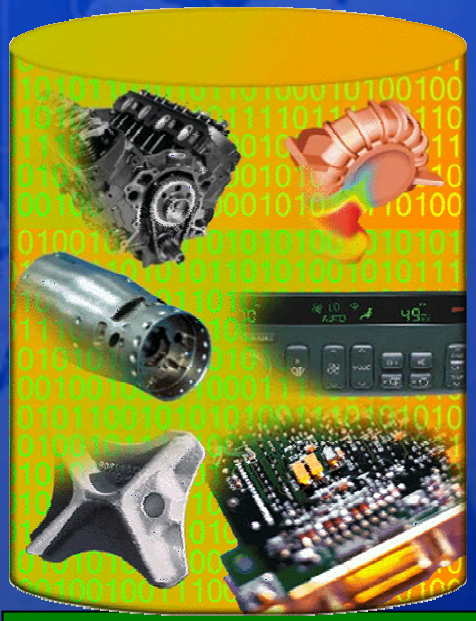
Drawings

Warehouses



Tapes

Underground Mines

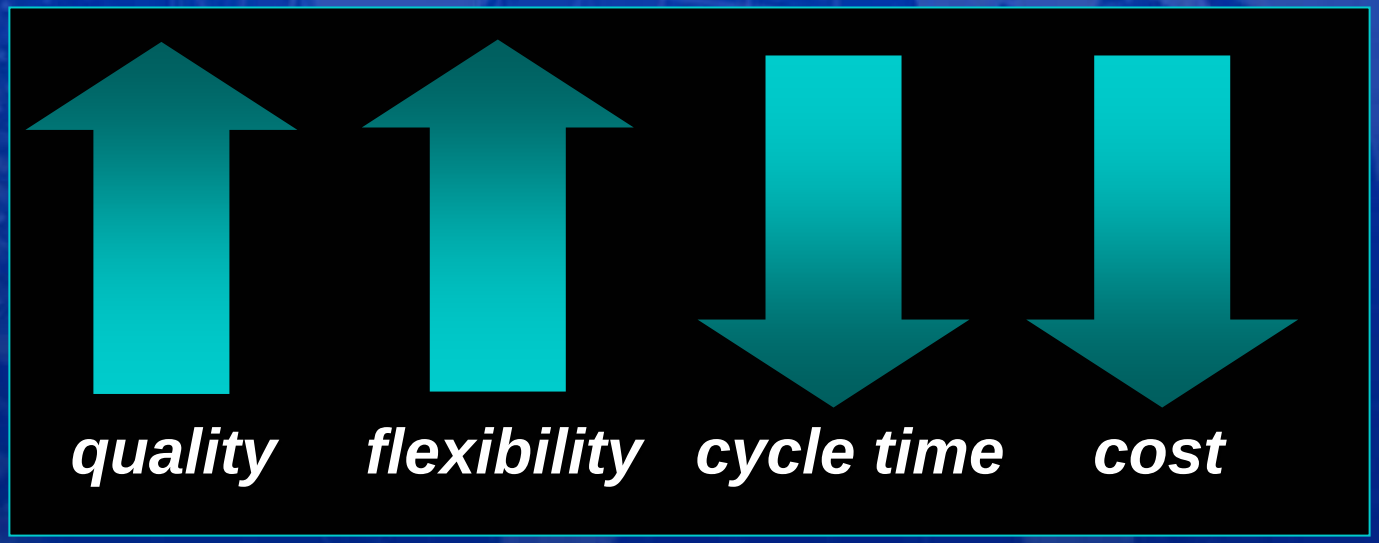


Neutral STEP Archival Database

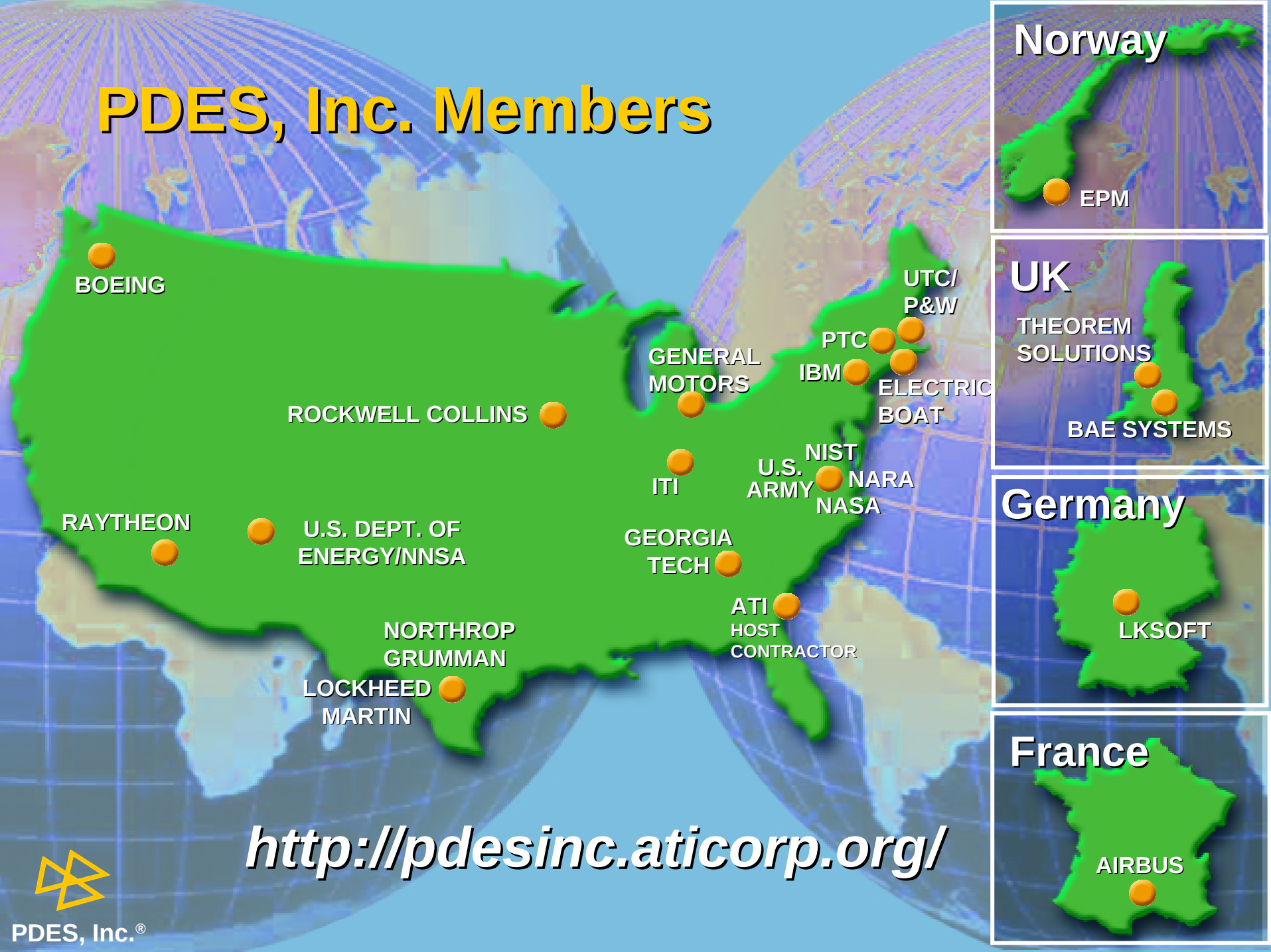
PDES, Inc. Consortium

PDES, Inc.'s Mission

Accelerate the development and implementation of product data exchange using STEP to improve product quality, increase flexibility, reduce product cycle time and reduce costs



PDES, Inc. Members



http://pdesinc.aticorp.org/

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PDES, INC. Roadmap

ACCCOMPLISHMENTS through 2004	PLANS for 2004-2006	VISION for 2008
OUTREACH **STEP Education and Training**—Fundamentals, Languages (EXPRESS, XML), Modules, APs, PDM Schema **STEP Promotion**—Website Resources, ISO/SC4, Int'l Industry STEP Centers, Value Propositions, Press Releases, STEP Videos, Newsletters, Website, Business Users Forums, Conferences	• Recruit and nurture PDES, Inc. members from the larger community • Provide public demonstrations of STEP technology • Publicize interoperability testing results • Disseminate STEP technologies through demonstrations, freely available tools • Heighten PDES, Inc. participation by speaking at Business Users Forums and conferences; target such groups as AFEI, AIAG/AutoTech • Utilize a dynamic, robust PDES, Inc. website	• STEP widely accepted and PDES, Inc. membership robust
SUPPORT **Pilot Projects**—Recommended Practices, Demonstrations, Software Evaluations **Vendor Product Development**—Usage Guides, Implementor Roundtable, Test Cases **Testing**—Plug Fest, Prove-Outs, STEPnet/PDMnet, CAx and PDM Implementor Forums, Certification	• Support STEP pilot projects and prototype implementations • Continue CAx-IF interoperability testing • Validate modules (AP203 E2-GD&T, AP209, AP233, and others) • Maintain deployed APs and modules	• STEP-driven design and manufacturing widespread • Entire supply chains integrated with STEP • Significant reductions in cost, development time • STEP a proven mechanism for LTDR
DEPLOYMENT **Pilot Projects**—Digital Mockup, Collaborative Design, Supply Chain, Configuration Management, Finite Element Analysis, Electromechanical Design, Mechanical Assembly, Engineering Process Improvement, Design Intent, Long-term Data Retention, Net Change, Sheet Metal Die Design, Concurrent Engineering **Production Use by Members**—Commercial Aircraft and Engines; Defense Aircraft, Ships, Missiles; Automotive and Aerospace Electronics; Computer Hardware	• Demo exchange of CAD models using GD&T, construction history, parametric features, constraints • Validate STEP use for Long Term Data Retention, develop best practice guidelines • Share STEP data between electrical and mechanical designers using AP210 • Demo PDM/CAD interoperability using AP214, AP203 E2 • Demo Technical Data Package exchange using AP232 • Accelerate production deployment of analysis of metal parts and composites using AP209 • Deploy Systems Engineering modules for industry use	
DEVELOPMENT **STEP Foundations—**Architecture, Tools, Methods, Processes, Languages, Resource Parts **STEP Applications**—AP202, AP203, AP207, AP209, AP210, AP213, AP232, AP233, PDM Schema **Technical Solutions**—Interoperability, Geometric Accuracy, Upward Compatibility, STEP on the Web **Modularization**—Concepts, Methods, Modules, Web-based Repository	• Develop standardized data models and modular architecture • Deploy modular architecture via the Web • Continue integrating STEP with mainstream modeling technologies • Promote AP203 E2 to International Standard	• Modular STEP used easily • Web-based STEP implementations common • STEP Systems Engineering demo' d in complex systems

***LEGEND**: AP202-Draughting, AP203-Geometrical Design, AP207-Sheet Metal Processes, AP209-Engineering Analysis, AP210-Printed Circuit Assemblies, AP213-Process Plans, AP214-Automotive Mechanical Design Processes, AP232-Technical Data Packages, AP233-Systems Engineering*

STEP
Success Stories

ELECTRIC BOAT CORPORATION
A GENERAL DYNAMICS COMPANY

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Electric Boat expands its use of STEP Standards to support production needs

- STEP standards have become the tools of choice for many production data transfers
  - AP203 (Geometry) is used for the exchange of data for thousands of solid models each year
  - AP209 (Analysis) and AP227 (Piping) are routinely used for CAD-CAE integration efforts
  - AP227 (Piping) is used in production for PIPESTRESS transfers
  - Production and Development efforts are using XML and STEP for the Web to demonstrate data transfer using AP203, AP216, AP218 and AP227
- STEP is viewed as an enabling technology for data exchange and improved product lifecycle management capabilities
- The use of STEP standards promotes collaboration and interoperability among platforms and among vendors

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STEP is being used in production at Boeing today

- Boeing routinely uses STEP in every division of the company
  - Commercial Airplanes
  - Integrated Defense Systems
  - Phantom Works
- Use of STEP for production activities is so commonplace that we don't track it anymore

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Rockwell Collins

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STEP for Electronics in use at Rockwell Collins

- STEP is playing a significant role in the design and manufacture of electronic circuit assemblies, interconnects, and packaging at Rockwell Collins
- APs 203 and 210 being used for
  - Simulation for flexible manufacturing
  - Computer integrated manufacturing
  - Integration of electrical/mechanical design
  - Capturing the product definition
- STEP supports the implementation of Rockwell Collins' enterprise integration strategy

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Raytheon

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STEP Production Deployment Reduces Costs for Raytheon Missile Systems

- STEP Technical Data Package (TDP) delivery is currently deployed in production on Exoatmospheric Kill Vehicle (EKV) program, a component of the National Missile Defense system
- Raytheon pilot (STAMP Program) demonstrated significant labor and cycle reduction for preparation and delivery of TDPs to its suppliers using STEP
  - 50% - 88% labor, 59% cycle time savings at Raytheon
  - 42% labor, 95% cycle time savings at suppliers
- Raytheon Missile Systems plans to deploy STEP TDP delivery on all programs and is actively participating in a pilot to enable STEP PDM data import from suppliers

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Pratt & Whitney
A United Technologies Company

AIRBUS

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STEP is in Production at AIRBUS and Pratt & Whitney

- Technology developed as part of the PDES, Inc. Aerospace Engine Alliance (AEA) pilot project is now being used in production at AIRBUS and Pratt & Whitney for the A380 commercial aircraft
- Using a process called “Validation Properties” allows fully validated assembly exchange
- Defined a method of using external references to break up very large CAD models

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LOCKHEED MARTIN

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STEP is being used in production for streamlined data exchange with suppliers

- STEP adopted for all F-16 Military Fighter Aircraft production re-bid activities
- Recent major re-bid of F-16 machined parts:
  - Involved about 2300 part numbers and 50 potential suppliers
  - STEP provided 95% reduction in printing and reproduction costs and 52% reduction in labor by the prime contractor, not including similar savings by the suppliers
- Lockheed Martin plans to implement STEP across all new aircraft programs which use CAD (F-22, F-2, T-50, JSF, etc.) and at all sites in the consolidated Lockheed Martin Aeronautics Company

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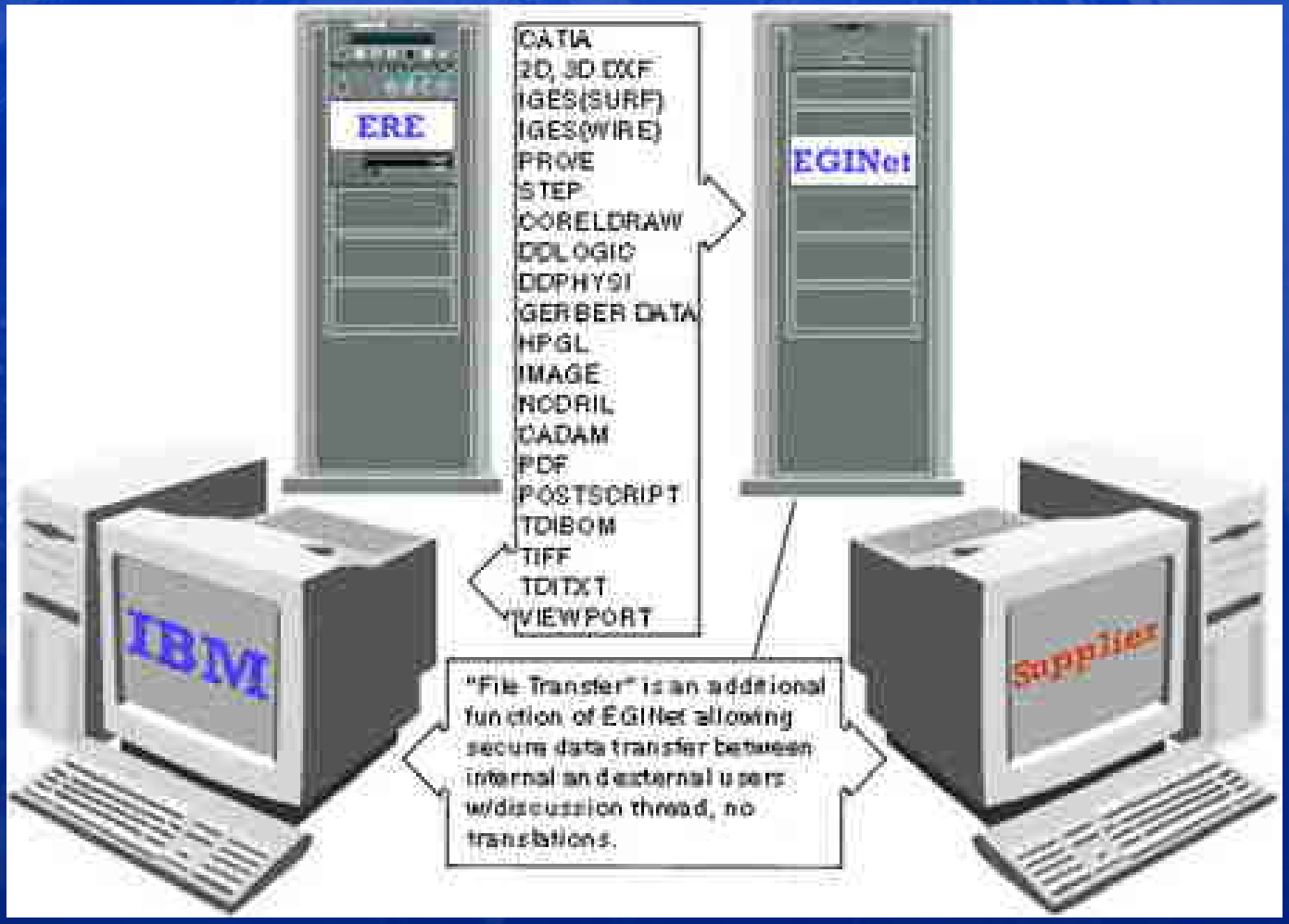
STEP comprises over 25% of IBM's global e-procurement design data exchange



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The U.S. National Aeronautics and Space Administration (NASA) has adopted STEP for data exchange

- Currently NASA is exchanging CAD models using STEP between SDRC Ideas, PTC ProEngineer, PTC ComputerVision, Solidworks, and AutoCAD
- Planned uses of STEP include PDM, electronics design, thermal analysis, systems engineering, structural analysis, and machining
- NASA's long term vision is to develop a STEP infrastructure of services supporting end-to-end, interdisciplinary data integration and data reuse

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Pilot Projects

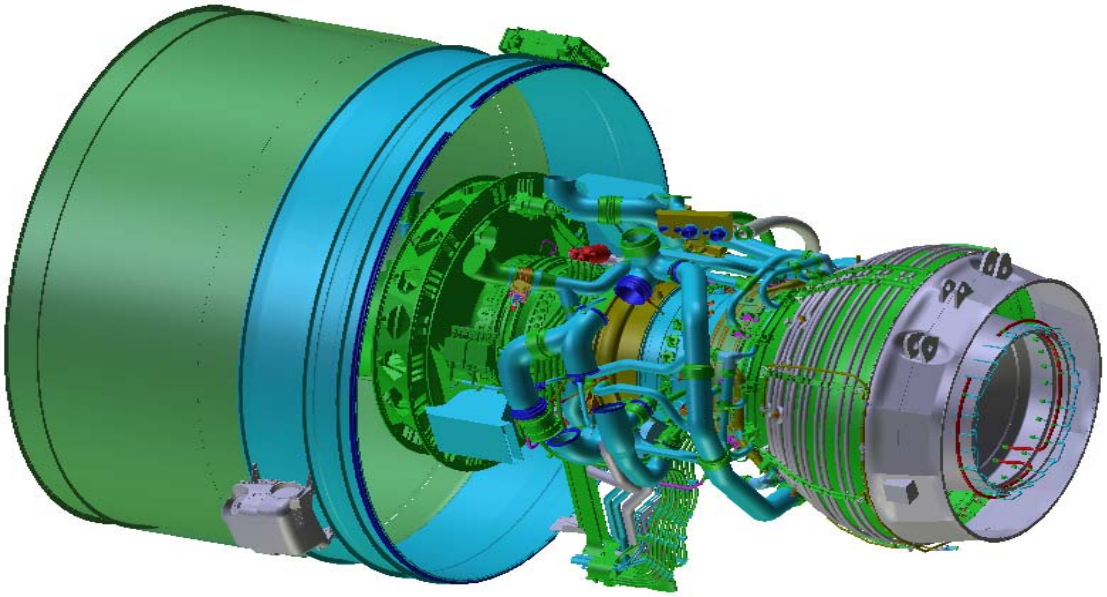
CAx Implementor Forum

- Joint interoperability testing activity between PDES, Inc. and ProSTEP
- Accelerating CAx translator development and ensuring that user's requirements are satisfied

Participants:

Alias
Alibre
AutoDesk
Bentley Systems
CATIA
CoCreate
debis
EDS PLM Solutions
OpenCascade
PTC
STEP Tools, Inc.
Theorem Solutions

Engine Digital Mock-Up: Approximately 115 Assemblies



GD&T Model

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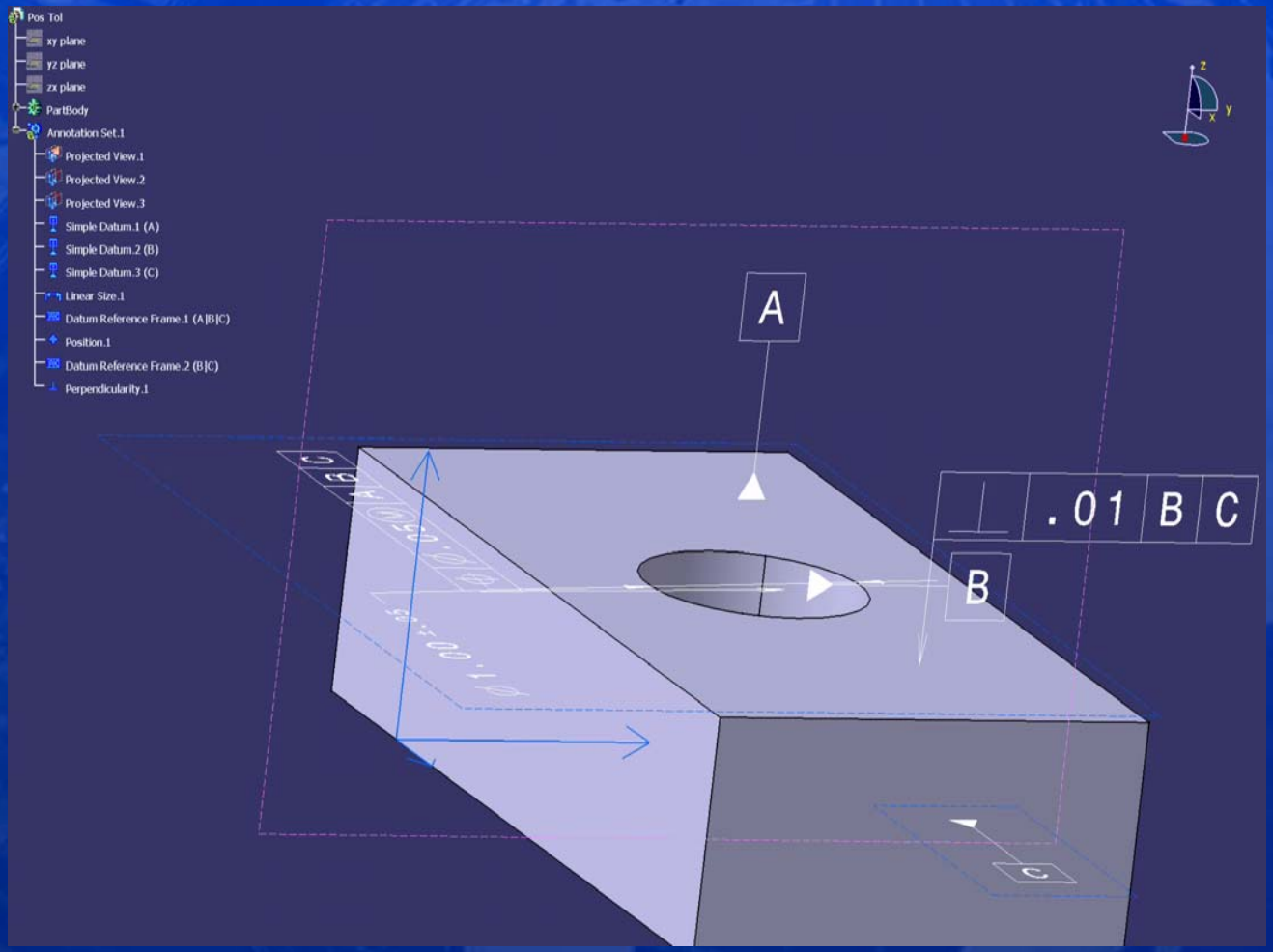

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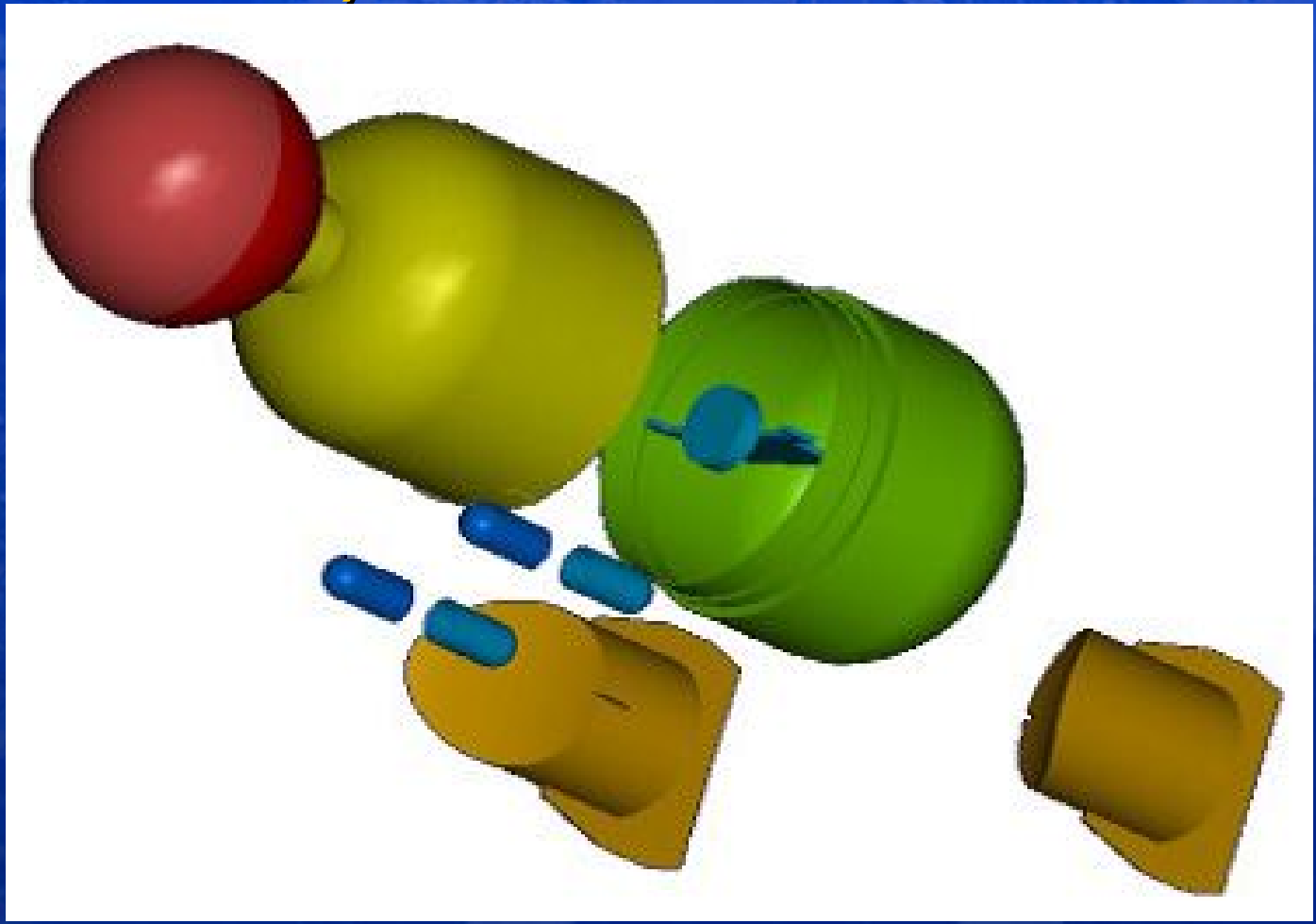
Model for AP203 E2 Migration, External References, and Nested Assemblies



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Alias Production Surface Model

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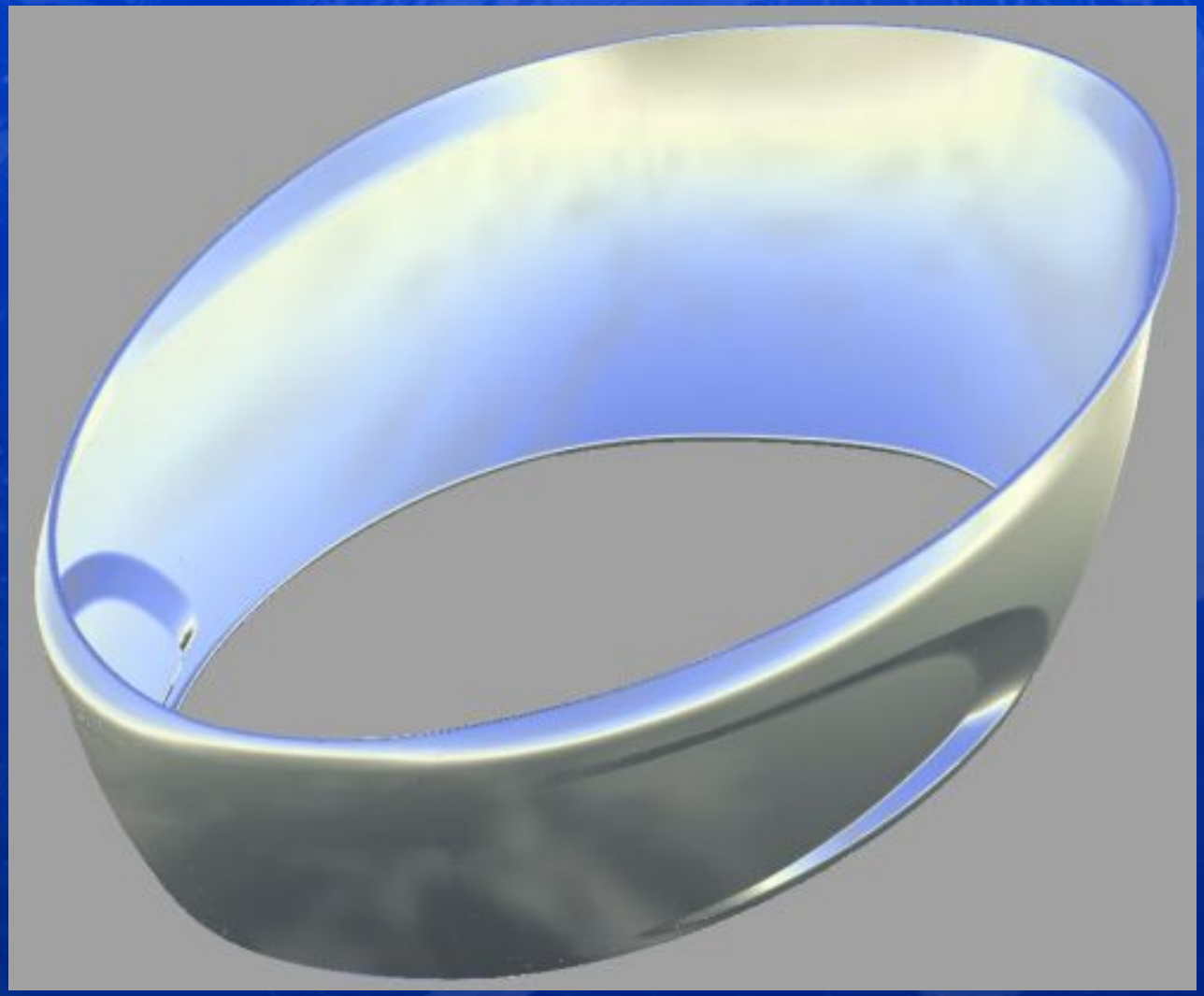

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Inventor Production Model

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CATIA Production Model from Electric Boat

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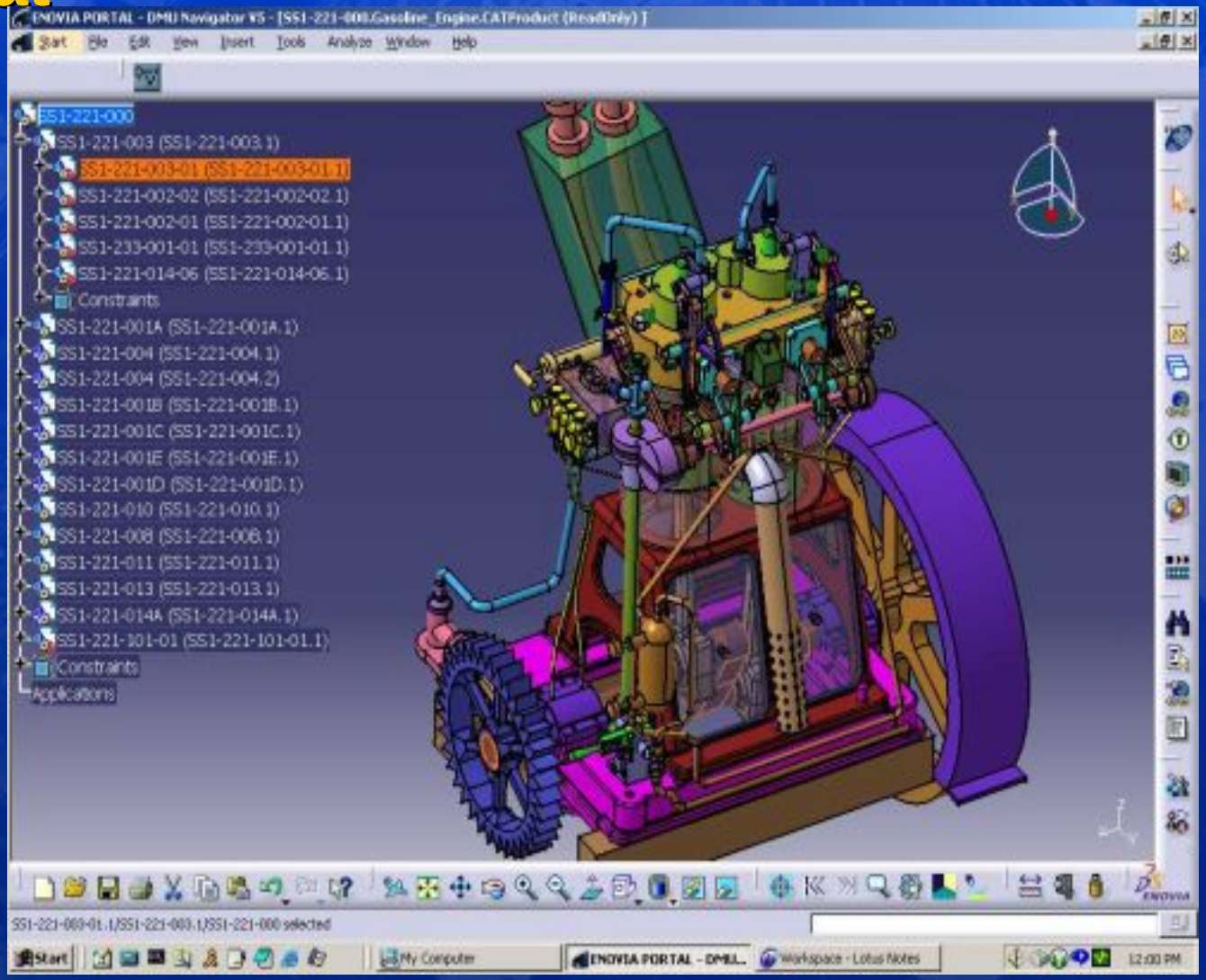

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UG Production Model from Pratt & Whitney

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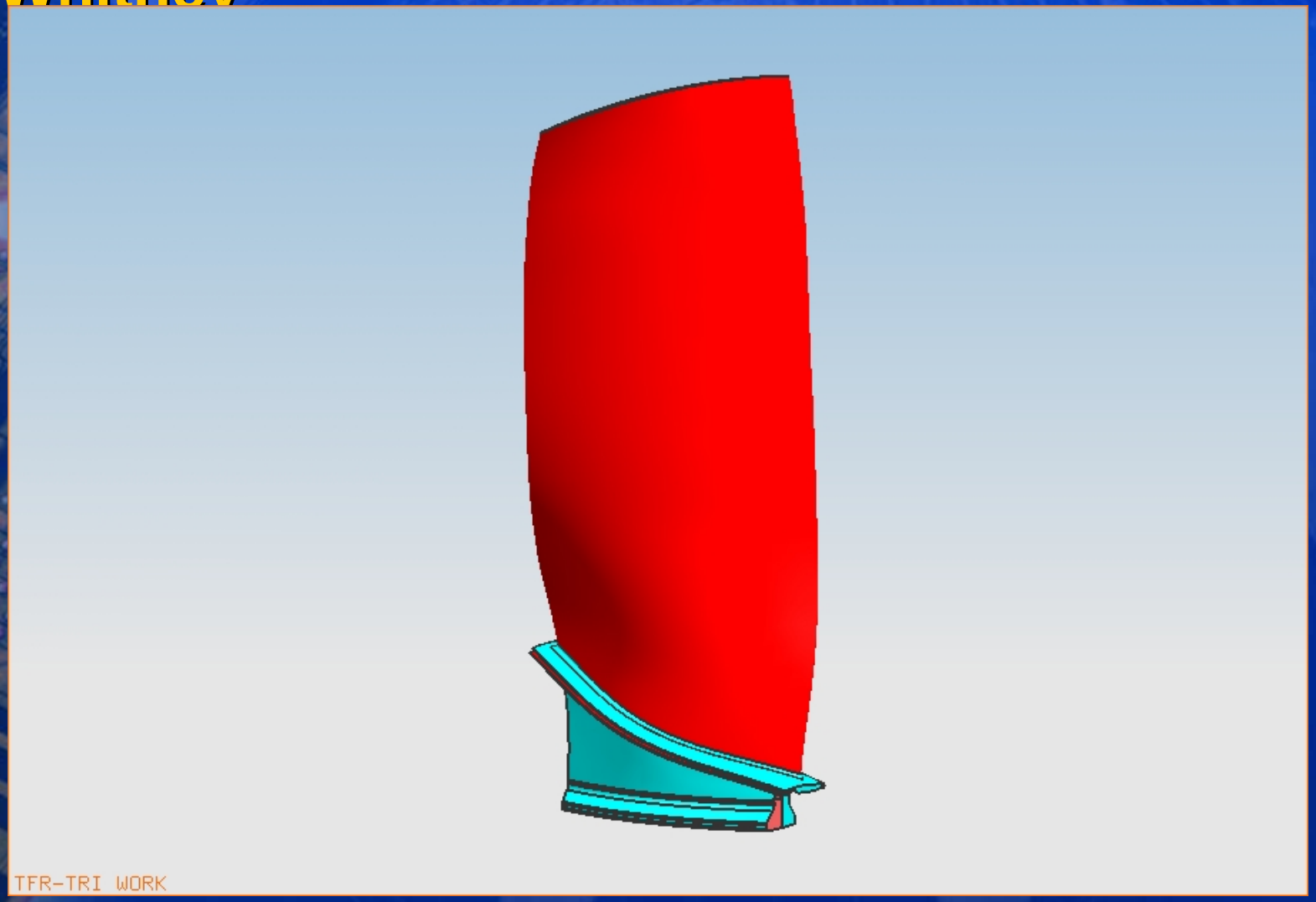

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Overview of Pilot Projects

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Pilot Project Name/ Member Participants	Pilot Objective(s)	Pilot Scope
Engineering Analysis (EA) ▪ AIRBUS ▪ Electric Boat ▪ Lockheed Martin Aeronautics ▪ Theorem Solutions ▪ NIST	Accelerate the development and production deployment of AP209 in member companies	AP209 as mechanism to: ▪ Manage analysis for metal parts and composites ▪ Represent CAD, analysis, and PDM information in a single repository
Long Term Data Retention (LTDR) ▪ AIRBUS ▪ DoE/NNSA ▪ Boeing ▪ UTC/Pratt & Whitney ▪ Electric Boat ▪ NARA ▪ Lockheed Martin Aero ▪ ITI ▪ EPM Technology ▪ NIST ▪ PTC	Validate use of STEP for retaining digital product data over long periods of time, define essential characteristics of product data to be retained, implement and test data retention processes, and develop best practice guidelines	Scope (4 Tracks): 1. Continued testing of AP203E2, AP214: 3D geometry, GD&T, product structure, PDM, and assemblies 2. Expanded scope: AP209, XML, AP232, and machining features 3. Investigation and analysis of LTDR infrastructure tools and frameworks 4. Detailed definition of essential characteristics and validation criteria

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Overview of Pilot Projects (cont.)

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Pilot Project Name/ Member Participants	Pilot Objective(s)	Pilot Scope
Aerospace Engine Alliance (AEA) ▪ UTC/Pratt & Whitney ▪ AIRBUS ▪ Theorem Solutions ▪ EPM Technology	Develop and test methods for the exchange of configuration-controlled interface information and associated 3D geometry between airframe structure and propulsion systems	PDM/CAD interoperability using AP214 and AP203 E2, including net change
Electromechanical (EM) ▪ Rockwell Collins ▪ NASA ▪ Boeing ▪ General Motors ▪ Georgia Tech ▪ LKSoft ▪ NIST ▪ U.S. Army ▪ Theorem Solutions	Share STEP data between electrical and mechanical designers during the design process for printed circuit assemblies	Using AP210, develop/refine existing and newly defined member implementations and resolve implementor/ translator developer issues
Supply Chain ▪ Lockheed Martin Aeronautics ▪ U.S. Army ▪ EPM Technology	Develop, validate and demonstrate STEP solutions to increase data management capabilities	Mechanisms to support supply chain data exchange, including AP232

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Long Term Data Retention (LTDR)

1995 Survey Results

- All survey respondents archive product data in some form
- Many different reasons and/or requirements exist for retaining product data; These include internal, customer, legal, FAA and historical requirements
- Some respondents archive product data anywhere from 7 to 40 years and many do so indefinitely
- Many types of product data are archived, including CAD, CAE, CAM, CAPP, and PDM
- The amount of product data archived ranges from thousands of drawings and files to hundreds of gigabytes of data

1995 Survey Results (cont.)

- The most common archival media are tape, microfilm, and paper
- Archived product data is generally in native CAD, proprietary, or paper formats
- A conversion is sometimes necessary to make the archived data usable
- About half of the respondents keep old versions of application systems to make use of the archived product data
- Most of those that responded use a tiered mechanism for archiving product data, e.g., keeping data on-line for a certain period of time, then off-line, then off-site

1995 Survey Results (cont.)

- Almost all the surveys indicated that archiving product data in an international standard format would be practical and beneficial to their business
- Many specific benefits to archiving product data in an international standard format were cited. Some of these benefits were:
  - Sharing of data that is not platform independent;
  - Greater availability of COTS software to access and use the data;
  - Reduction in loss of data
  - Ability to restore files to any application
  - Reduction in time in accessing data
  - Reliance on the value of the data
- All but one of the survey respondents knew about STEP

Four Top Issues from 1995 Workshop

- Completeness of the archived data - For data archival STEP should support the ability to maintain both STEP and non-STEP data, as well as handle company-specific data
- The Business Case - The question here is where does support for data retention lie internally, as well as in the vendor community
- Usability issues - What processes will be using the retained data, and what will be changing in STEP, and will it be upwardly compatible?
- Framework issues - There is a need for a reference model that include all of the mechanisms to support it

LTDR Objectives

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- Validate the use of STEP to support archival and retrieval of digital technical data for 50 or more years
- Initial scope is retention of 3D design information to satisfy requirements for Aircraft Type Certification

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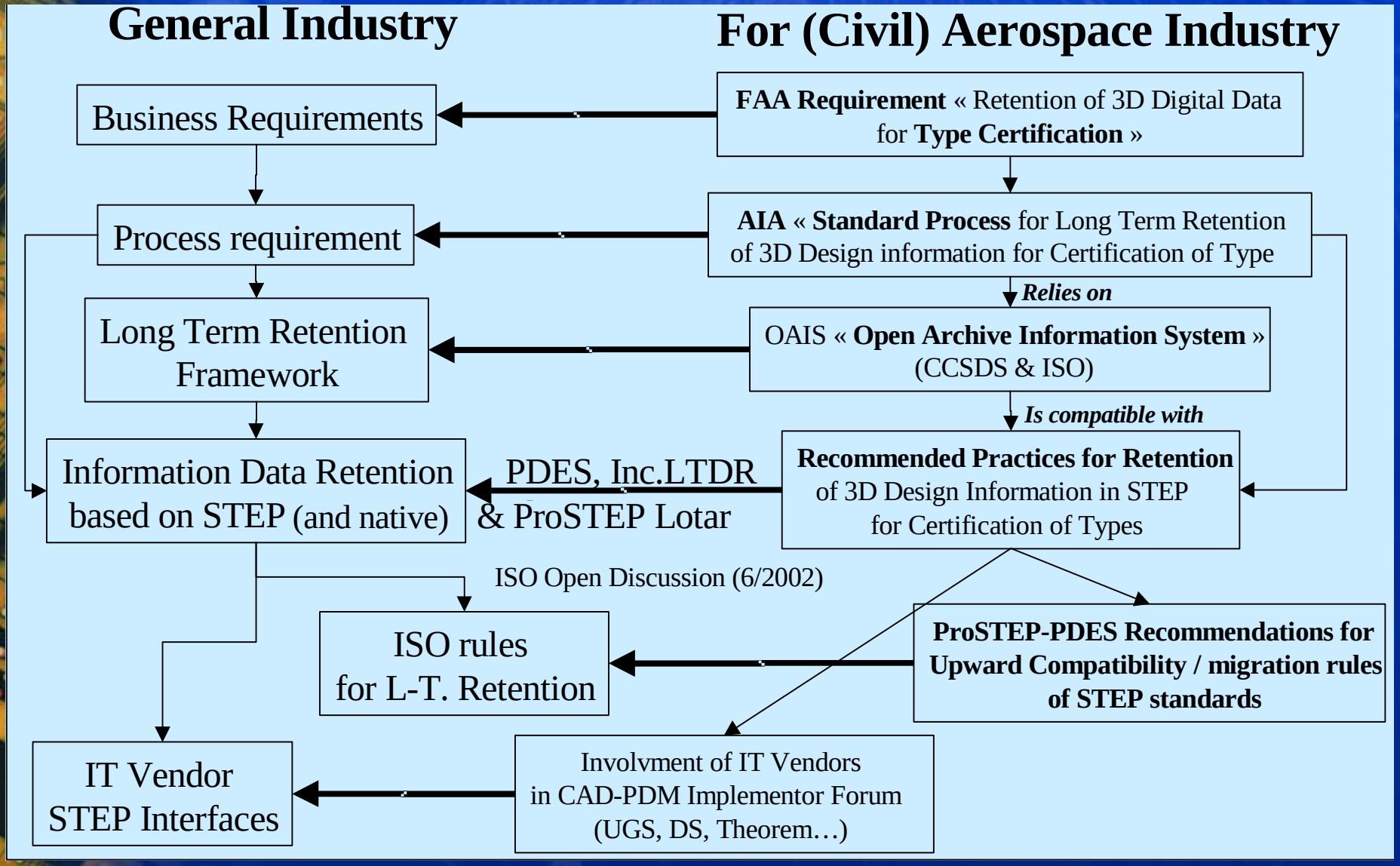
LTDR Pilot
Scope, Schedule, and Participants

- Scope (4 Tracks)
  - Continued testing of AP203E2, AP214: 3D geometry, GD&T, product structure, PDM, and assemblies
  - Expanded scope: AP209, XML, AP232, and machining features
  - Investigation and analysis of LTDR infrastructure tools and frameworks
  - Detailed definition of essential characteristics and validation criteria
- Schedule
  - Q4 2004:
    - Expanded requirements document for DoE, shipbuilding industry
    - Demo of archive ingest/retrieval using AP214
    - Begin AP203 E2 testing
  - Q2 2005: Demo shipbuilding scenario
  - Q3 2005:
    - Complete GD&T testing
    - Demo DoE/NNSA software environment
- Participants
  - Boeing
  - AIRBUS
  - Electric Boat
  - Lockheed Martin Aeronautics
  - UTC/Pratt & Whitney
  - International TechneGroup, Inc.
  - PTC
  - EPM
  - DoE/NNSA
  - NIST
  - NARA

Model of LTDR Relationships



Data Longevity on a Page

It is an FAA requirement that a Product Approver Holder ensures *type design data (*product design data approved by the FAA under the Type Certificate*)* is retained, retrievable, and usable for the life of the Type Certificate; in other words, available for 50+ years.

At least three technology life cycles need to be considered:

Product:

The products defined by the design data (50+ yrs)

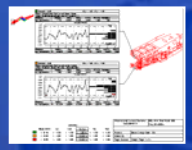
Storage:

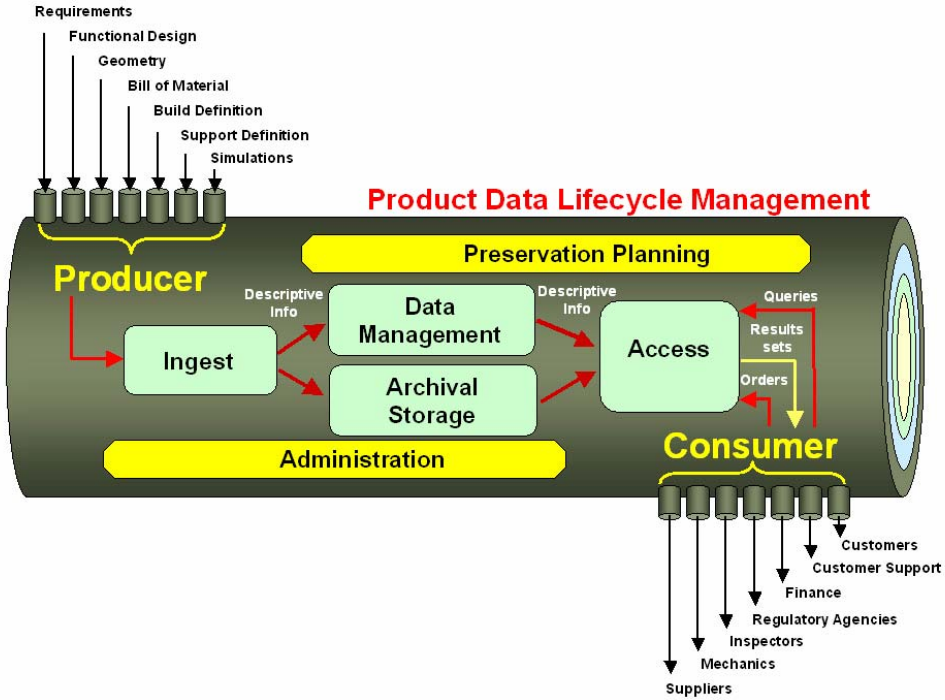
The technologies used to store & retrieve the digital data (~10 yrs)

Applications:

The technologies used to interpret the data (~3 yrs)

Engineering Release (Type Design Data)





Source: AIA

Summary

- STEP brings important capability for Long Term Data Retention
- Industry is ready to validate the use of STEP for Long Term Data Retention through pilot projects
- The stability of STEP and the support for upward compatibility are essential for successful long term retention of product data

Backup

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