Designing the Future Landscape:
Digital Architecture, Design and Engineering Assets

Library of Congress
Architect of the Capitol
National Gallery of Art

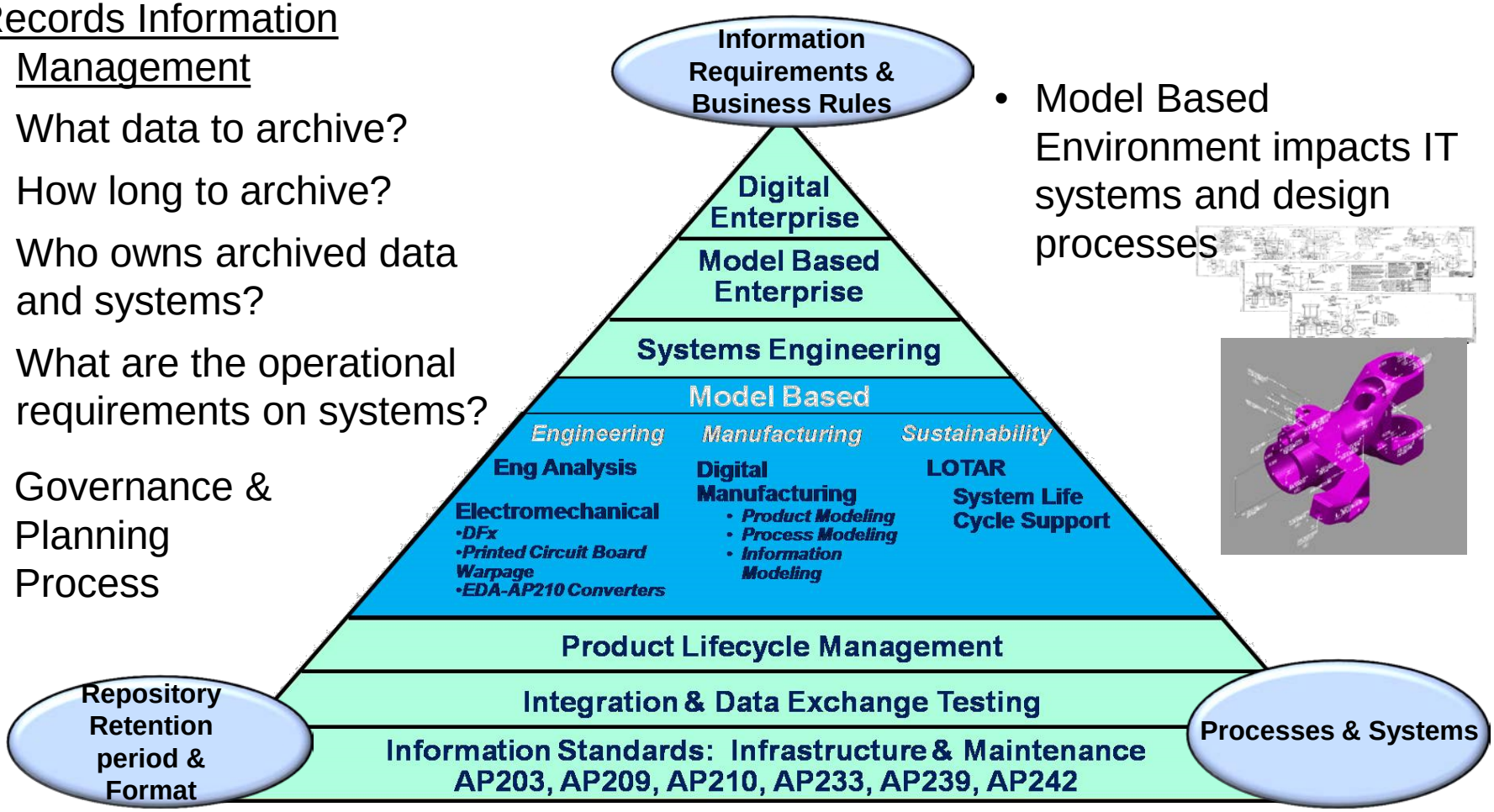
Phil Rosche – ACCR for Rick Zuray – The Boeing Company

16 November 2017

Model-Based Definition/Enterprise

Records Information Management

- What data to archive?
- How long to archive?
- Who owns archived data and systems?
- What are the operational requirements on systems?
- Governance & Planning Process



- Model Based Environment impacts IT systems and design processes

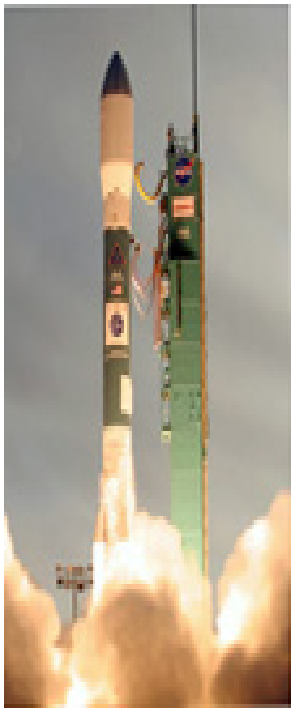
Transition to a Model Centric Approach for structured digital data.

Complex Products







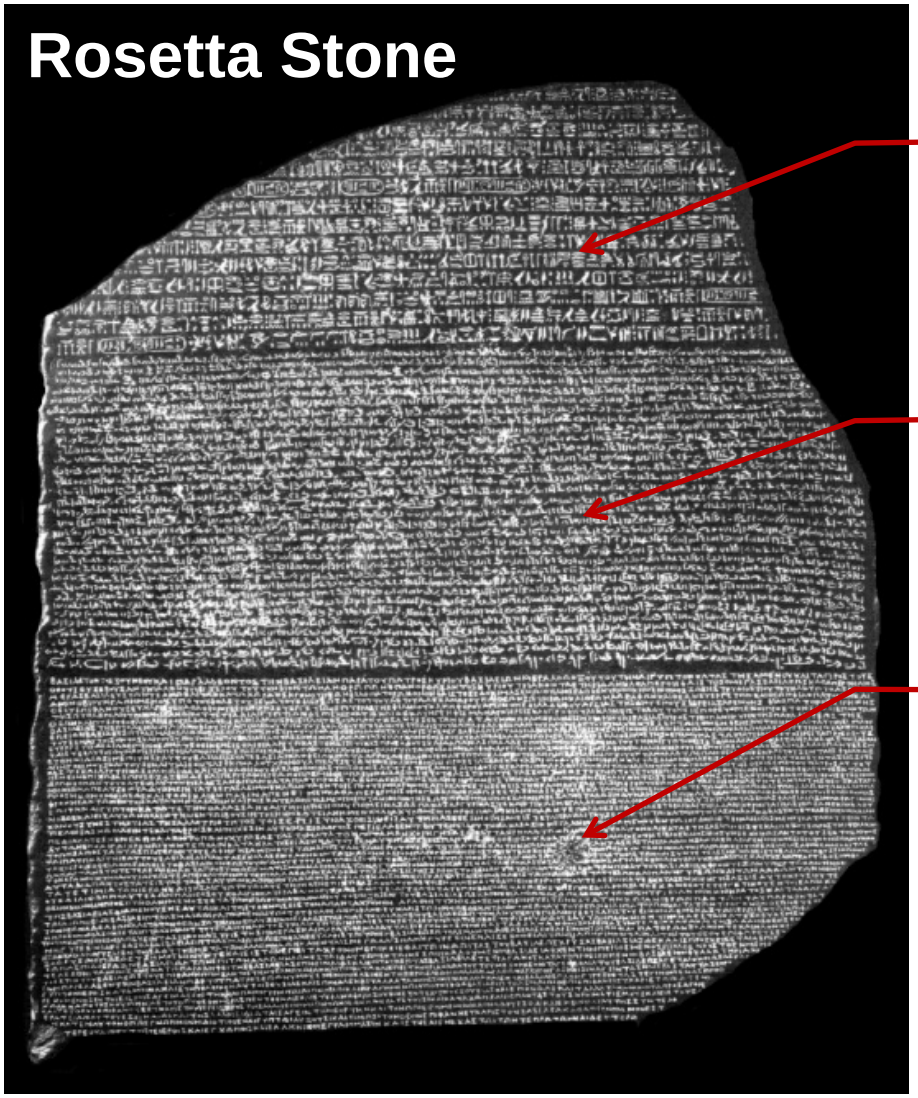


Evolution of the Design Process

Product	767	747-400	777	787
Media	Paper Drawings	2D CAD	3D CAD w/ 2D Dwgs	3D MBD
Parts per airplane	3,100,000	10,000,000	3,000,000	2,300,000
Data volume (GB)	354.6	1143.8	343.1	4401.5
Built/Delivered (as of Sept, 2017)				
Airplane Fleet	1,034	1,536	1,518	600
Data volume (GB)	366,656.4	1,675,366.3	353,393.0	154,052.6

25.5 petabytes of data – Boeing widebody airplanes

Evolving Technologies: Early Data Exchange Example



Hieroglyphics

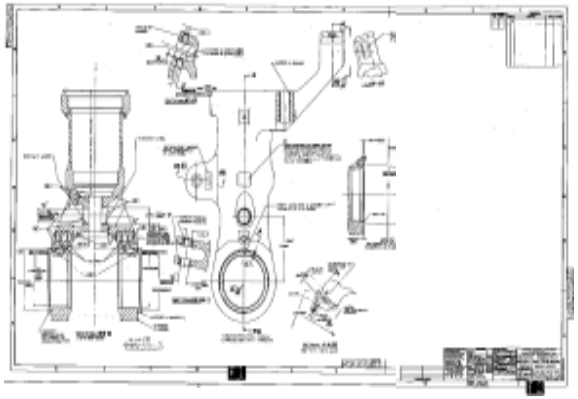
Demotic Script

Greek

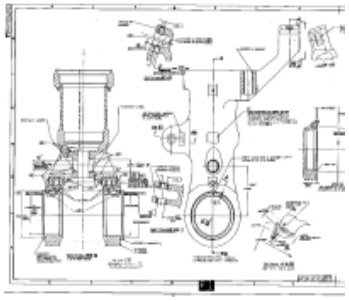
Evolving Technologies: The Product Definition Example

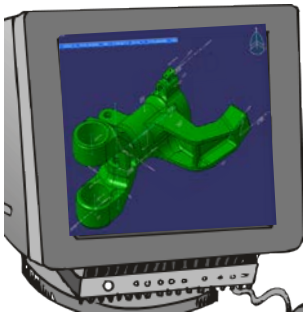
Product Definition Data (PDD) creation, storage and distribution has significantly changed in the past 50 years. PDD is the source for “Type Design” as defined by the FAA.

2D Only Creation
2D Authority

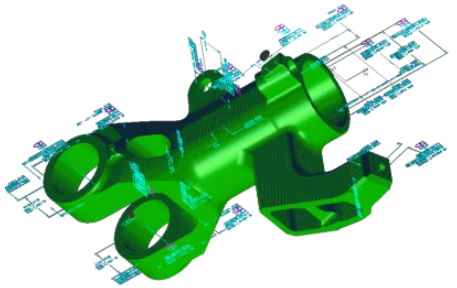


Hybrid 2D / 3D Creation
2D Authority





3D Only Creation
3D Authority



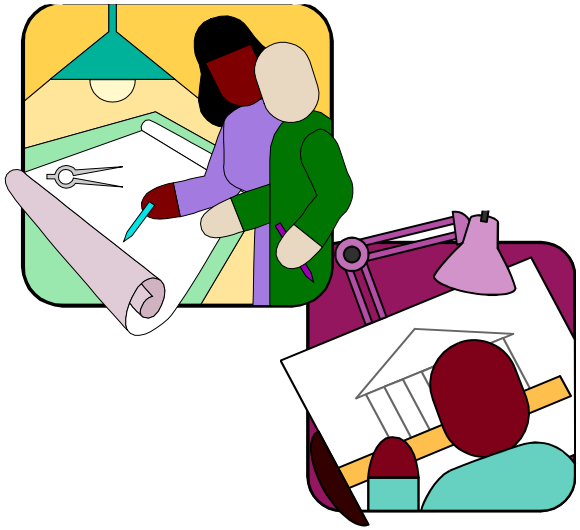
Model Based Definition (MBD)

1st Generation **2nd Generation** **3rd Generation**

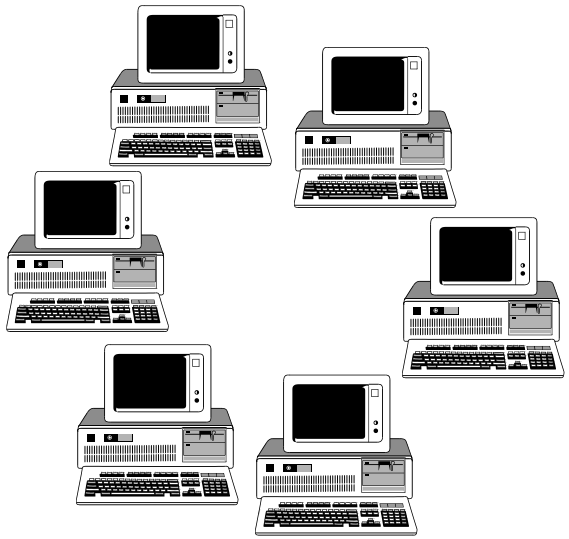
Technology Evolution: Processes Can Be Tool Independent

How parts are controlled

Configuration Management
- Paper-based
- Master controlled by the originator (desk drawer)
- Engineering intent defined in multiple locations



Product Data Management
- File-based
- Controlled by 1st generation product data manager (file vault)
- Engineering intent defined in multiple locations



Product Lifecycle Management
- Relationship-based
- Controlled by product lifecycle manager
- Engineering intent defined in a single location (single source of product definition)

1st Generation **2nd Generation** **3rd Generation**

Product Lifecycles

3 Months

Software
Length of time between software version upgrades

10 Years

Storage Media
Data shelf-life of software media

59+ Years

Minuteman
The program began in **1956** and is expected to continue until 2040

1 5 10 15 20 25 30 35 40 45 50 55 60 65

Computer Processors
Processor speed doubling "Moore's Law"

18 Months

Careers
The average turnover rate at Boeing

5 Years

707
The program began in **1952** and is still in use today

65+ Years

B-52
The B-52 program began in **1946** and still in use today

71+ Years

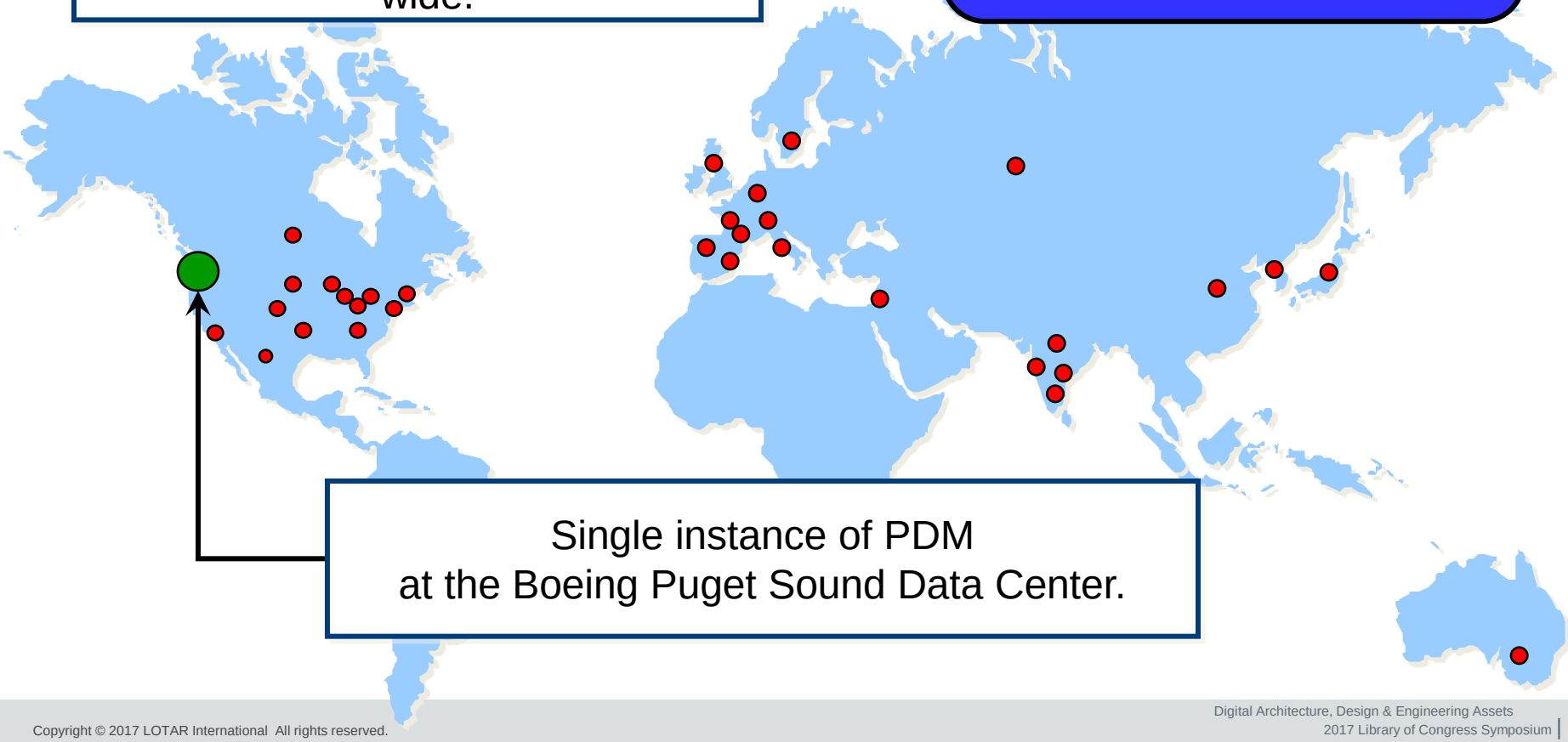
Program lifecycles are lengthening and technology lifecycles are compressing
There will be 260+ software upgrades over the B-52's lifetime

Global Collaboration Environment - 787

Common processes, computing applications, and training materials accessible by over 100 partners and thousands of suppliers world-wide.

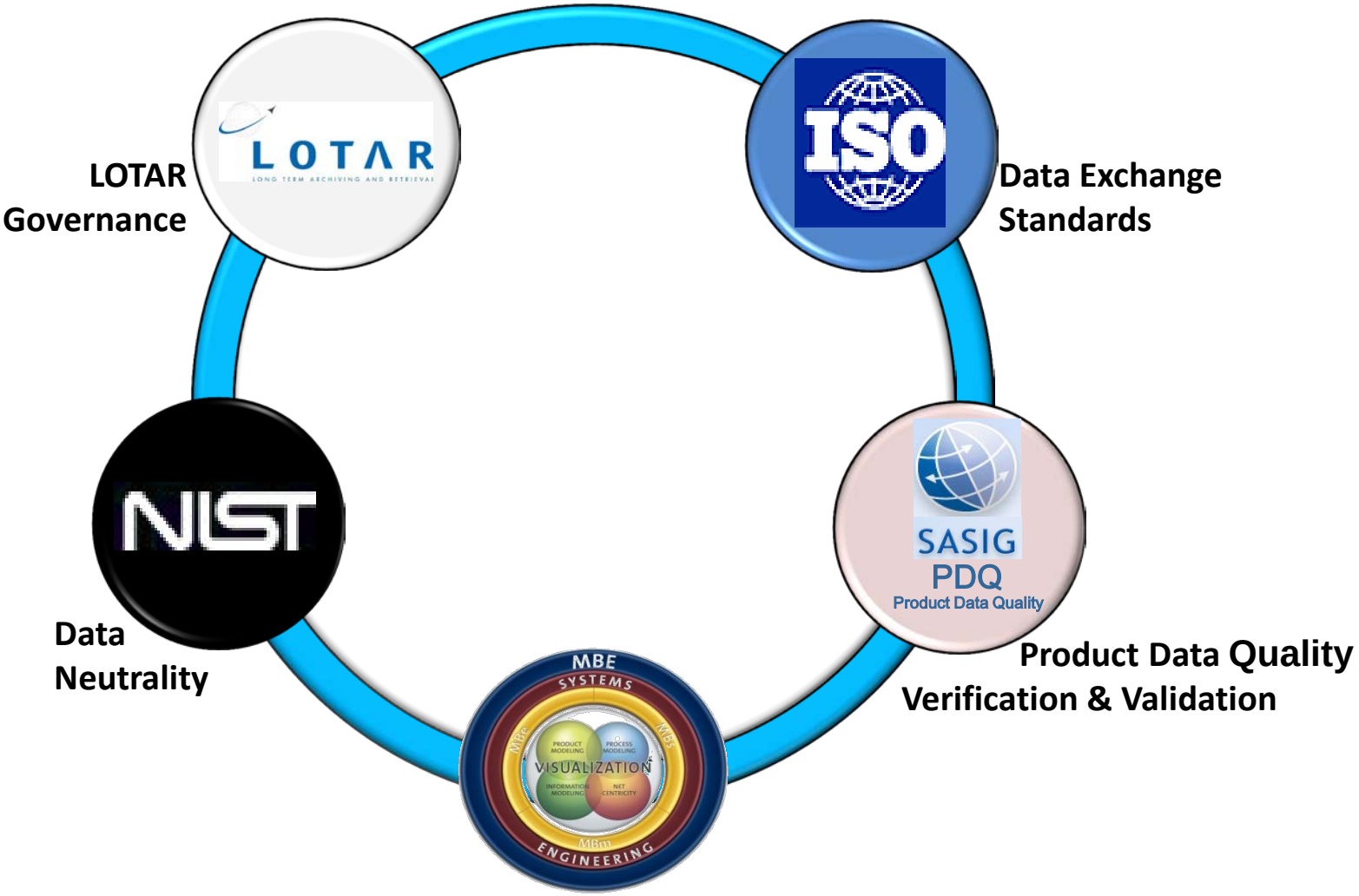
=

Data compatibility
Standard design language
Global Design resource
24 hour workday



Single instance of PDM
at the Boeing Puget Sound Data Center.

How are we going to manage this complex data over its 70+ year lifecycle?

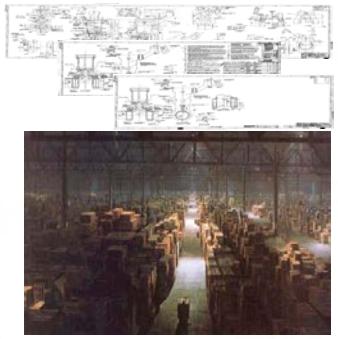


Addressing the Challenge

LOTAR

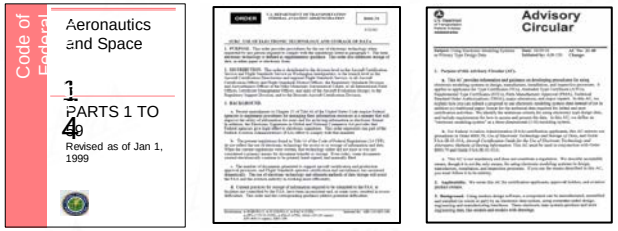
LONG TERM ARCHIVING AND RETRIEVAL

LOTAR Project



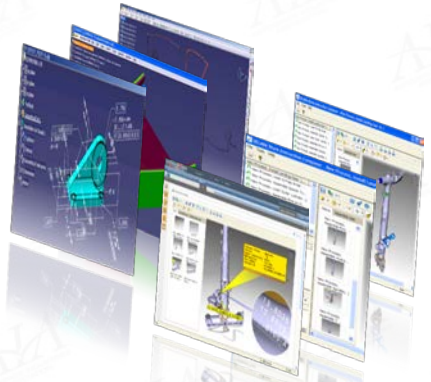
Paper-based process

Past



Code of Federal Regulations | FAA Order 8000.79 | AC21-48

Requirements



Digital-based process

Future

Mission Statement

The project objective 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.

The standards are published as NAS 9300 US, (EN9300 Europe), series and cover both the information content as well as the processes required to ingest, store, administer, manage and access the information.

Key Team Members:

Team Leaders and Represented Companies:

- Rick Zuray: US Chair
- Jeff Holmlund: US Coordinator
- Jean-Yves Delaunay: EU Chair
- Jochen Boy: EU Coordinator
- Phil Rosche: CAx-IF Chair
- Mike Jahadi: PDES President

BOEING

LOCKHEED MARTIN

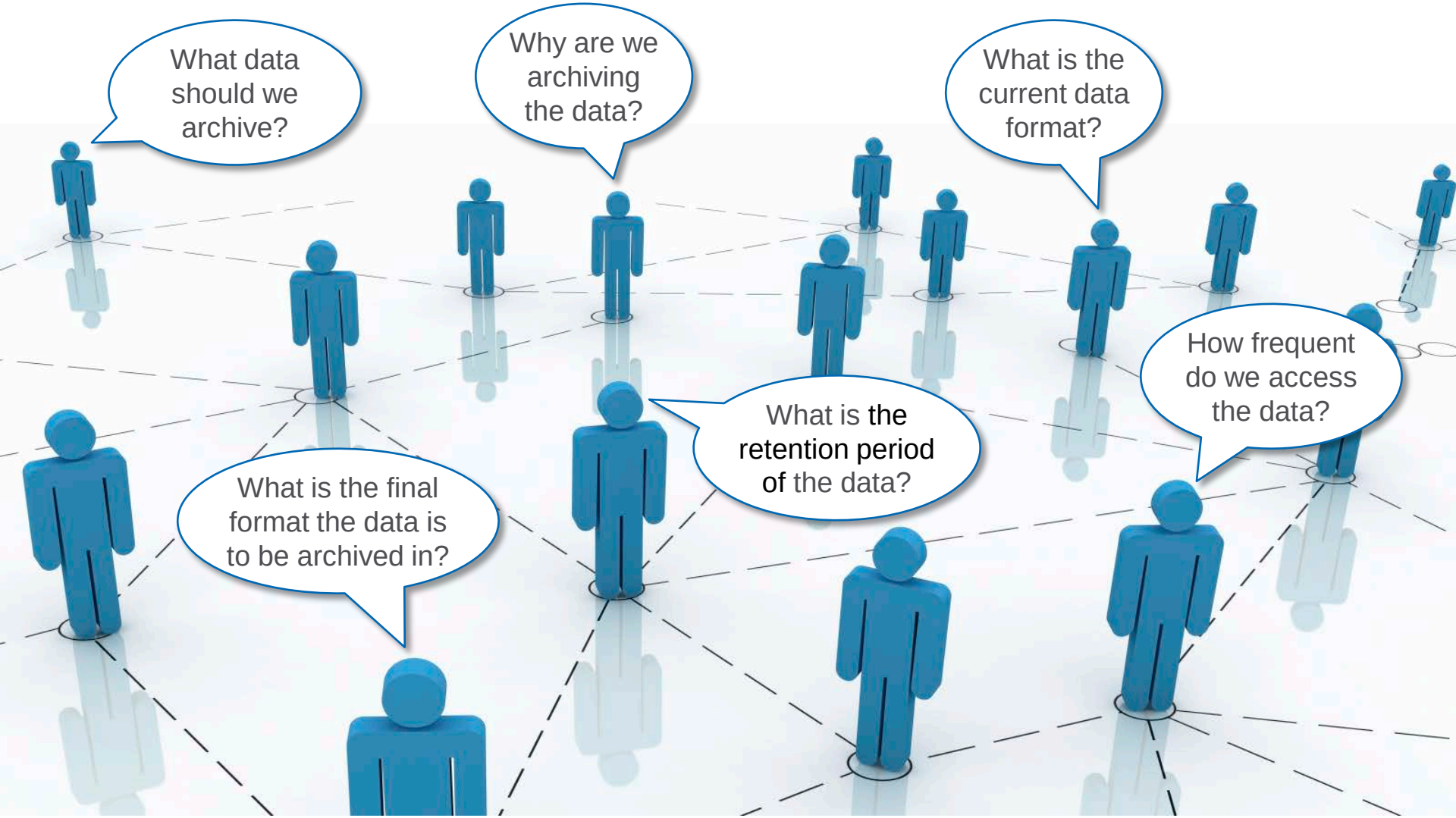
AIRBUS

prostep ivip

ACCR

PDES, Inc.®
Connecting the Digital Enterprise

Information Lifecycle Planning Driving Questions



LOTAR Timeline

Late 1990s:
- AIA in the US and ASD-Stan in Europe launched separate initiatives for the Long-term Preservation of Aerospace & Defense Digital ProductDefinition Data.

2000
- Start of the PDES, Inc. LTDR Project (US) coord w/AIA LTDR

2002
- Start of the ASD Stan – ProSTEP iViP LOTAR Project (Europe)
- IAQG* approved charter for AIA/ASD Stan Joint Project
- AIA LTDR Published ARP9034

2003
- First joint team meeting of the international AIA - ASD-Stan LOTAR effort under the mgt of the IAQG* (MoU: AIA/ASD-Stan)

2004
- Launch of the 3D CAD and PDM Workgroups

2005
- First Publication of LOTAR Basic Parts

2006
- First Publication of LOTAR Common Process Parts

2009
- Creation of the joint LOTAR International consortium (AIA / ASD-Stan / PDES, Inc. / ProSTEP iViP)
- Launch of the Composites WG

2012
- First Publication of LOTAR Domain Specific Parts (3D CAD)
- Launch of the Workgroups for Electric Harness, Meta Data for Archive Packages, and 3D Visualization

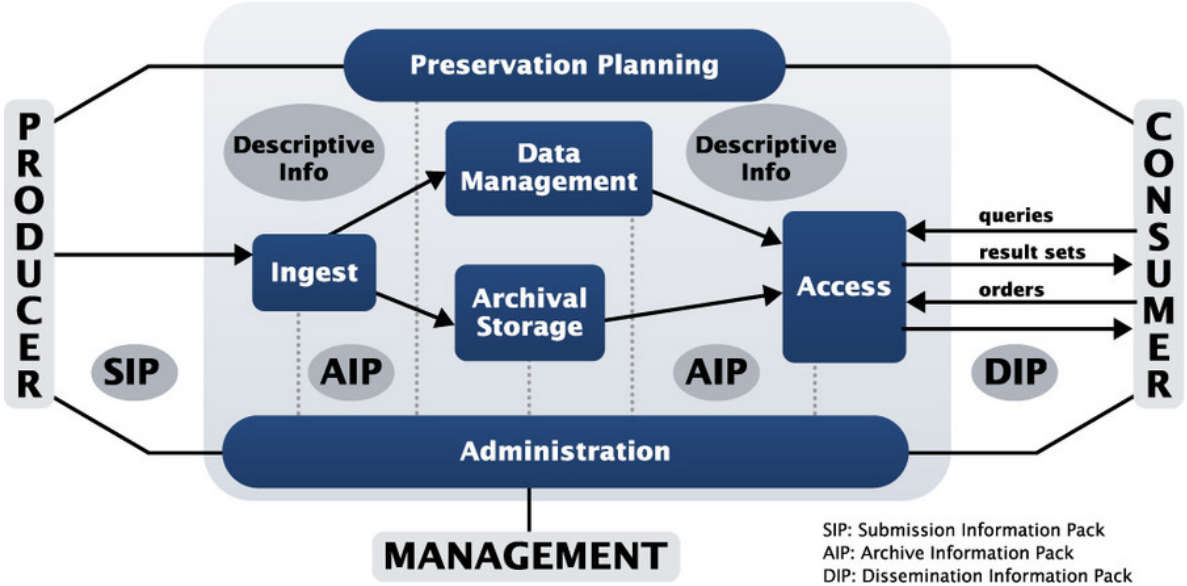
2014
Kicked off LOTAR Eng Analysis & Sim Workgroup Sept 2014

2015:
- Launch of the LOTAR Additive Manufacturing WG

2017:
- Evaluation of Model Based System Engineering Requirements

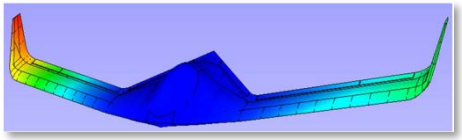
LOTAR Standard Foundation
ISO 14721:2012 (OAIS)

- „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.

LOTAR Working Groups



Engineering Analysis and Simulation

EN/NAS 9300-6xx series

ISO STEP AP209 ed2

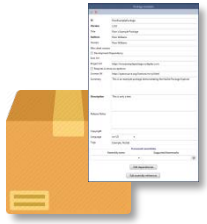
2014 launch

Wiring Harness

EN/NAS 9300-4xx series

STEP AP242 ed2

2012 launch

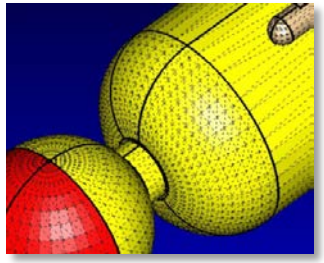


Meta Data for Archive Packages

EN/NAS 9300-21

STEP AP239 ed3
STEP AP 242 ed2

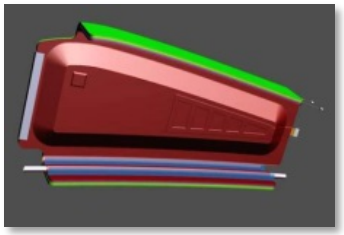
2012 launch



3D Visualization

Requirements and Compliance Documents

2012 launch

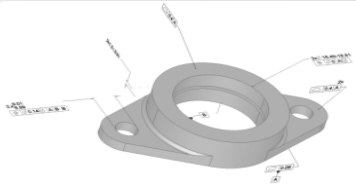


Composites and Advanced Manufacturing

EN/NAS 9300-3xx series

STEP AP203 ed2
STEP AP242 ed1

2009 launch

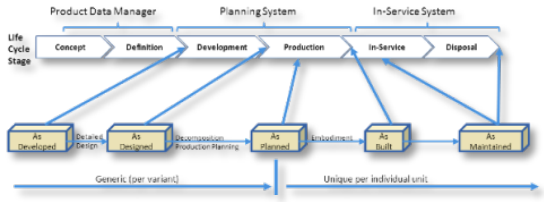


Mechanical 3D CAD with Product and Manufacturing Information (PMI)

EN/NAS 9300-1xx series

STEP AP203 ed2
STEP AP214 ed3
STEP AP242 ed1

2004 launch



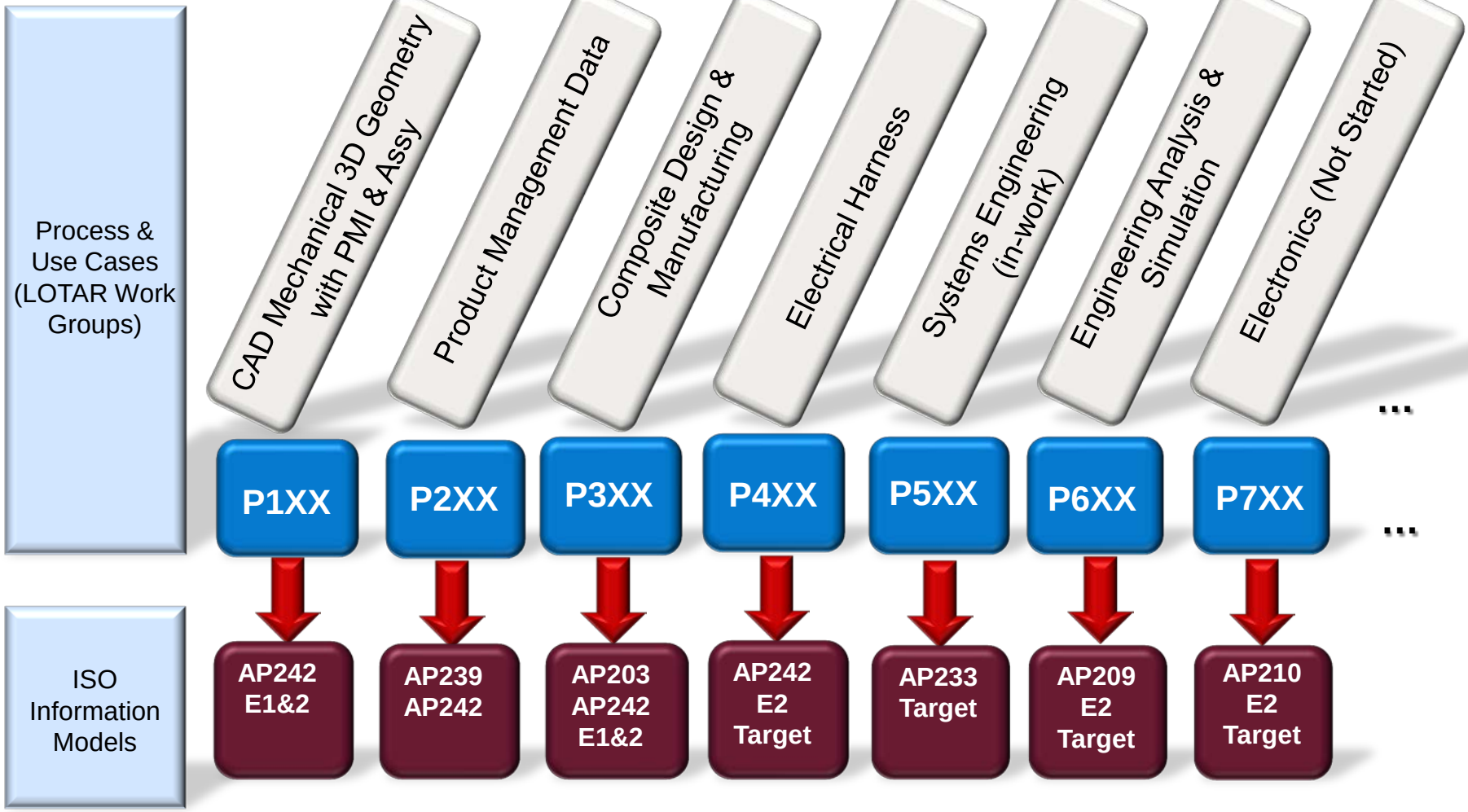
Product Data Management (PDM)

EN/NAS 9300-2xx series

STEP AP239
STEP AP242 ed1

2004 launch

Process Domain Technical Working Groups



LOTAR Homepage:
www.lotar-international.org

Why LOTAR?
- Mission, Objectives & Scope
- Legal & Business Motivation
- Technical & IT Background
- Goals & Benefits

LOTAR Organization
- External View
- Internal View
- Working Together
- Fundamentals & Processes
- Member Companies

LOTAR Workgroups
- 3D CAD with PMI
- PDM
- Composites
- Electrical Harness
- 3D Visualization
- Meta-Data for Archival
- Simulation & Analysis

Communication
- Public Presentation
- Progress Reports

LOTAR Standard
- Overview on Parts
- Industry Use

News

Links

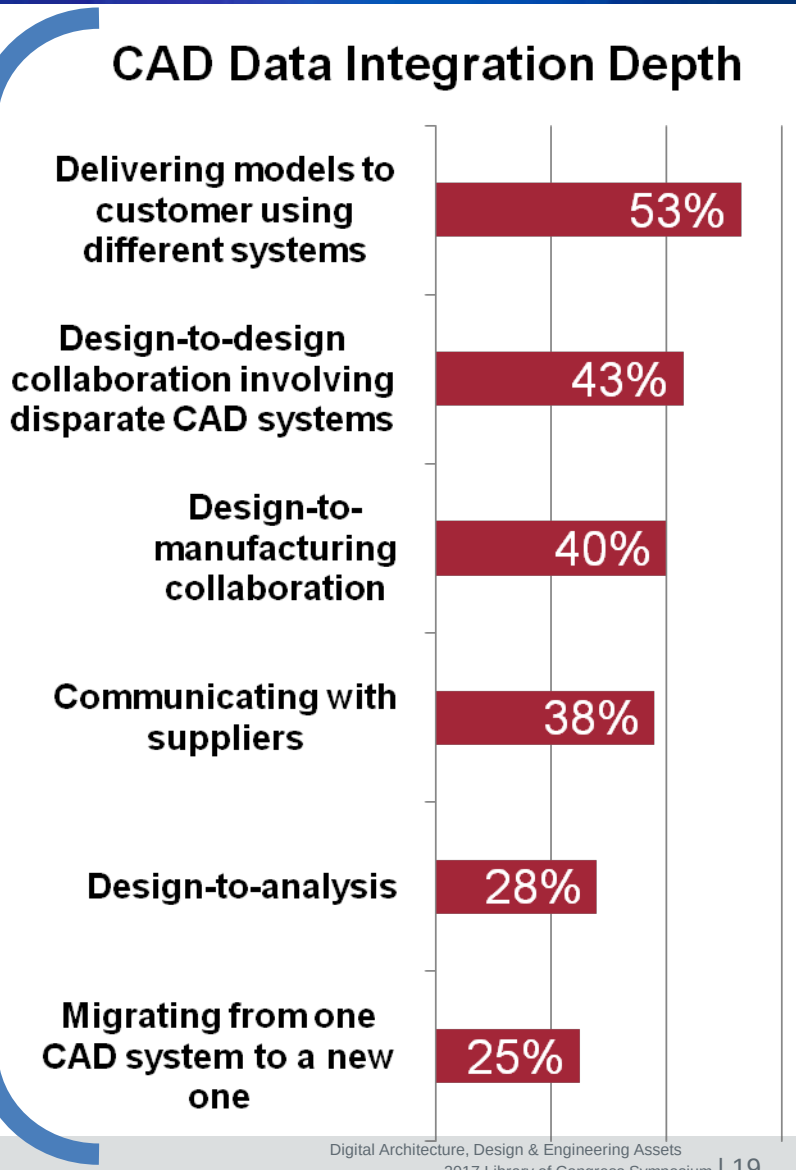
Contact

Interoperability Impact

- Digital data interoperability is costing A&D Industry $5B annually.
- Digital data interoperability is critical to exchanging and managing informational across the Supply Chain as well as across you company's infrastructure.
- There are huge saving opportunities by moving to open neutral data formats and enables a more efficient long term retention strategy over the lifecycle of your data.

NIST/RTI Survey

2008 design and manufacturing survey findings revealed:
"Unique CAD requirements added 20 % or more to the cost of doing business".



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

Development and use of LOTAR standards by the A&D industries allow for decreasing the costs and risks of LT archiving of aerospace product data

Any questions?

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Model Based Definition

3D Model Based Definition – Model Based Definition (MBD) is a set of concepts, processes, and tools that allow the creation of an annotated 3D product definition based on a 3D solid model. The MBD dataset includes all Engineering Intent requirements (including Process Specifications, Geometric Dimensioning and Tolerancing (GD&T), Product and Manufacturing Information (PMI), and other required information). Combined with product lifecycle management (PLM) attributes, a parts list, and general notes, this constitutes an authoritative, single source of master product definition data that does not include or depend upon traditional 2D drawings. The MBD dataset defines complete requirements for a product in its nominal condition as well as permissible limits of variation and other acceptance criteria, providing all the data needed to plan, fabricate, and validate an article of product hardware.

Model-Based Enterprise

- A Model-Base Enterprise is an environment that leverages the full benefits of Model-Based Definition/Design (MBD) dataset usage, translation, format management, archival, retrieval, and other uses relative to company processes and requirements. Discussion of issues related to using model-based product definition in the workflow. Following CAD data and its derivatives throughout company processes, addressing various tasks and how the data is used (i.e. CAD → NC, CAD → CMS etc.). Discussion of data use and translation requirements within design (CAD to CAD, CAD to CAE, CAD to neutral format, etc.), between design and downstream processes (manufacturing, inspection, assembly, service, clients, etc.). Discussion of addressing compliance issues with regulatory agencies, auditors, etc., long-term data archival issues, data management, data integrity, and data quality, data validation and verification strategies and tools is included.

Requirements

- 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.