

The F-35 FACO project Final Assembly and Check Out (FACO) PLM Interoperability

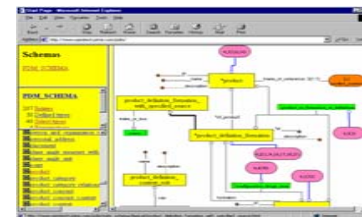
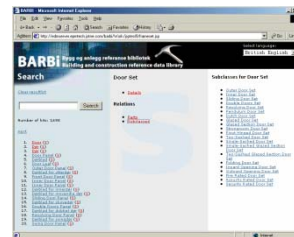
**NATO LCM
29 January, 2013**

**Kjell A. Bengtsson
Jotne**



World leaders in Industrial Data Management using ISO standards

- Data modeling**
Create your own data models, or use for viewing and documentation (ISO)
- Database management**
The ideal tool for data integration and application development projects
- Rule engine**
Validate your data sets, using your own business, knowledge rules or any other sets of rules
- Web services**
For use in web server applications (thin clients)



Universal Solutions for Interoperability and Sharing of Product Data

**The F-35 FACO project
Final Assembly and Check Out
PLM Interoperability**

Agenda

- 1. Highlights from the 2012 AIA Product Support Conference**
2. Standards Overview
3. Implementation Projects related to F-35
4. Some observations related to project requirements of CM/ILS

ISO TC 184 SC4 – ISO 10303 STEP

The big picture



ISO 10303-203

ISO 10303-214

ISO 10303-239

ISO 10303-209e2

1994



1999



2005



2012

CAD



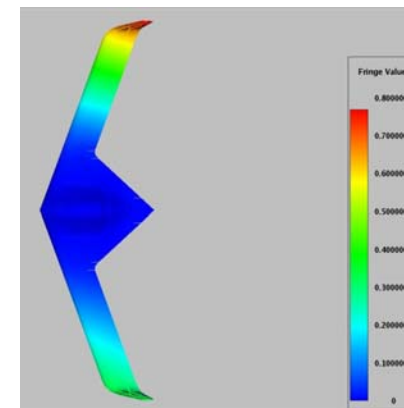
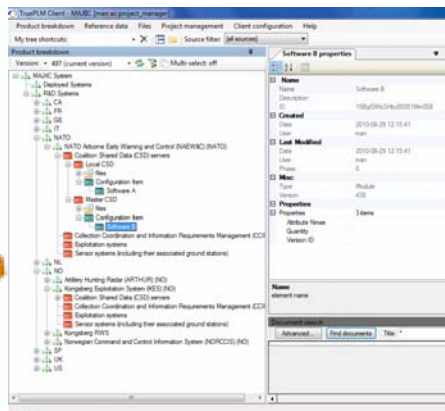
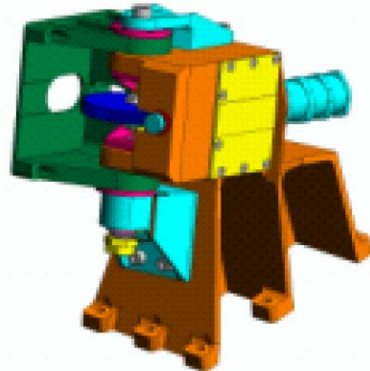
PLM



ILS



CAE-SDM





Data that Government may “need”

1. Highlights from the 2012 AIA Product Support Conference

**Government
entitled to
Unlimited Rights**

- Operation, maintenance, installation, or training (other than detailed manufacturing or process data)
- Form, fit, or function
- ...

**Government may
also want data**

- for emergency repair and overhaul
- to support design reviews
- to support downstream systems
- to compete spares, support, upgrades, mods, and/or production

SOURCE:
AIA Product Support Conference
November, 2012

Benefits

- Reduce cost and risks of translation and formatting of acquired data
- Facilitate transition from contractor-managed to Government-managed data
- Reduce costs of managing data by using common processes, tools, and formats

Challenges

- Specify standards on new acquisitions
- Pursue standards on existing programs
- Work with solution providers and industry to accelerate adoption of standards

Benefits

- Save money on content creation and maintenance through re-use
- Provide a better solution to customers (e.g., data, integrated data environments)
- Standardized internal tools and processes for configuration management of data

Challenges

- Incorporate standards as part of internal operations
- Work with solution providers and Government to accelerate adoption of standards



Supportability Analysis Effort Introduction

- **Services requested re-issue of MIL-STD 1388**
- **Nov 2011 Defense Standardization Council outbrief concluded:**
 - There is no standard approach to identify (contractually require the contractor to provide) the supportability analysis tasks that must be accomplished across the system life cycle to provide affordable and effective product support
 - Policy
 - DODI 5000.02 Volume 2 Encl 8 (DRAFT) requires the Product Support Manager “Determine the most effective product support strategy using appropriate analytical tools (e.g., **Supportability Analysis**, Product Support Business Case Analysis (BCA), Core Logistics Analysis/Source of Repair Analysis). The tools shall incorporate risk analysis, sensitivity analyses, and the cost-benefit analysis concepts contained in Office of Management and Budget Circular A-94”
 - Guidance
 - MIL- HDBK – 502, *Acquisition Logistics* (requires major revision)
 - Standards
 - ANSI/GEIA 0007, *Logistics Product Data Model*
 - ISO 10303 *Standard for the Exchange of Product Data*
 - ASD Sx000x Series, *International Specifications*

SOURCE:
AIA Product Support Conference
November, 2012

- Aerospace OEMs are seeking a different approach to ILS
 - No re keying of data - Nobody wants an army of typists!
 - BoM/Product Centric
 - Provides ability for physical/functional structures and hybrid structures
 - Closes the gap for engineering source data and change management
 - Enables selective standards compliance (pick list)
 - Enables direct re use rather than “Re Type”
 - Eng/Manuf BoM to Service Parts (IPD)
 - Service plan to service task (xml data module)
 - Associative to source CAD data – automatic illustration update
 - Enables non proprietary data transfer
 - PLCS Dex 1, Dex 3
 - S3000L>S1000D – S1003X

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The big picture



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1994

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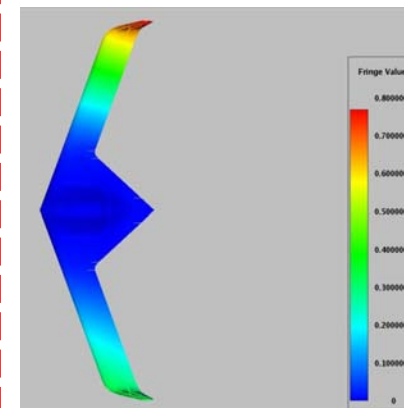
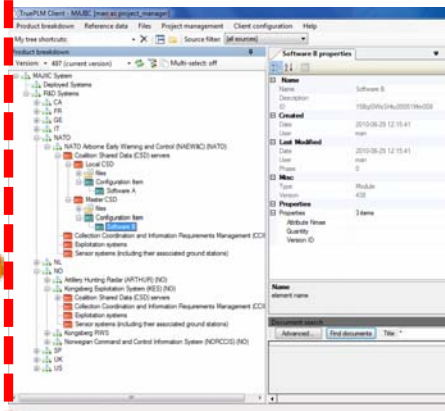
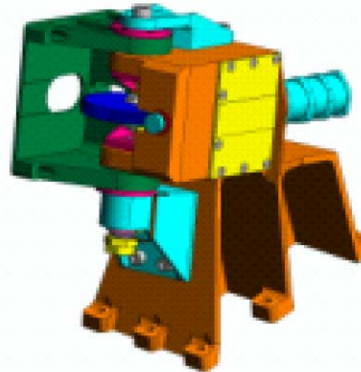
2012

CAD

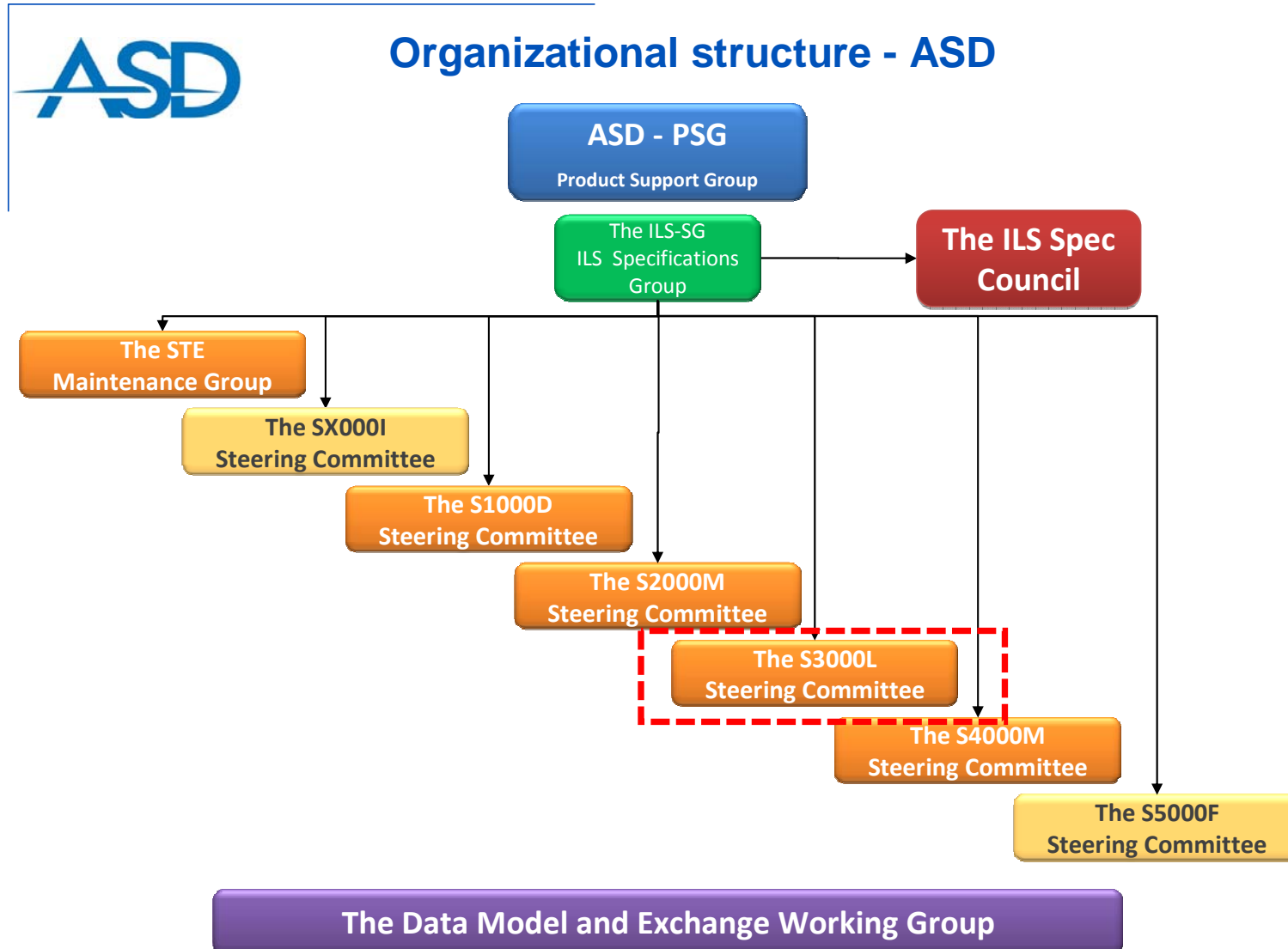
PLM

ILS

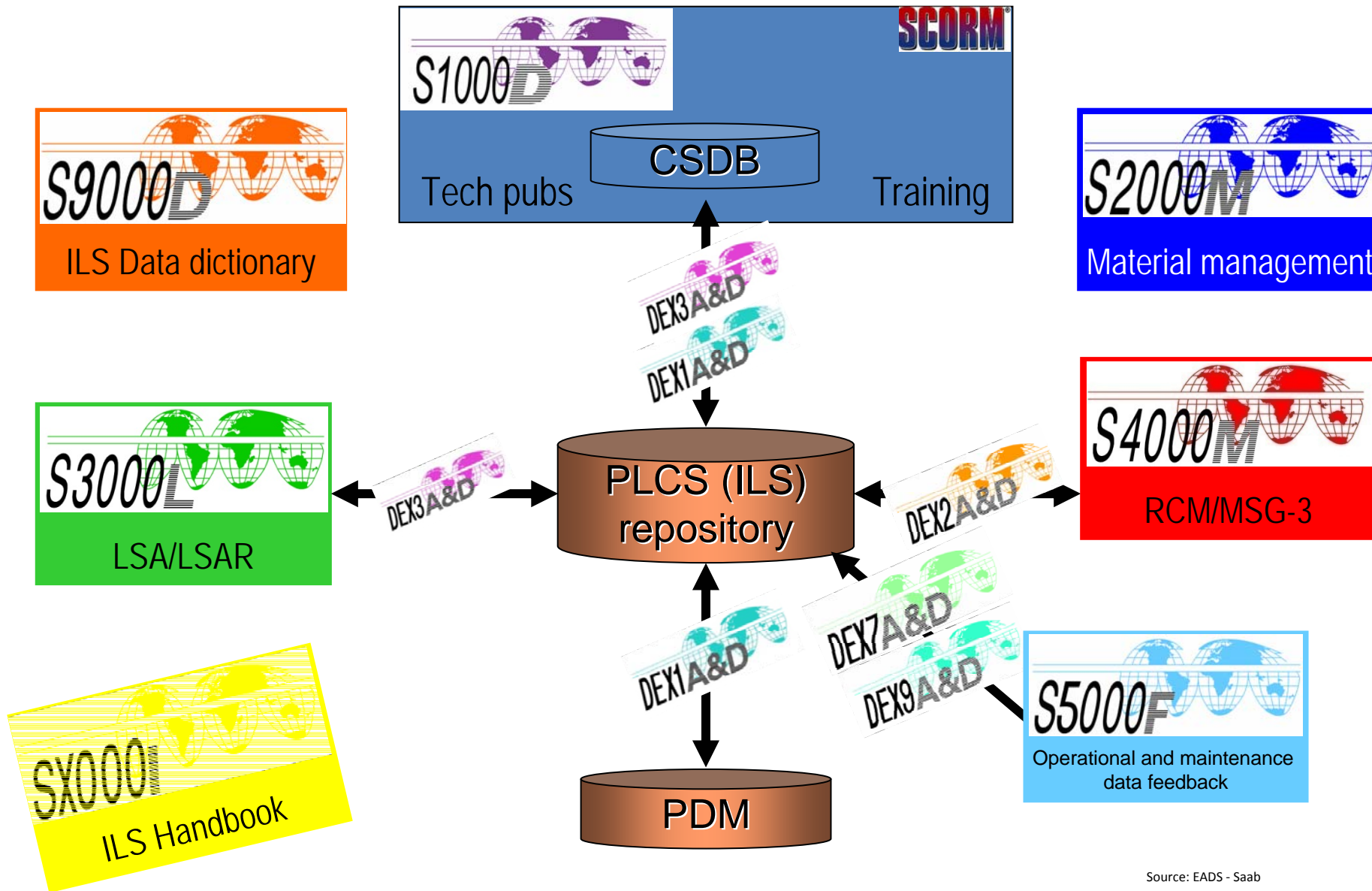
CAE-SDM



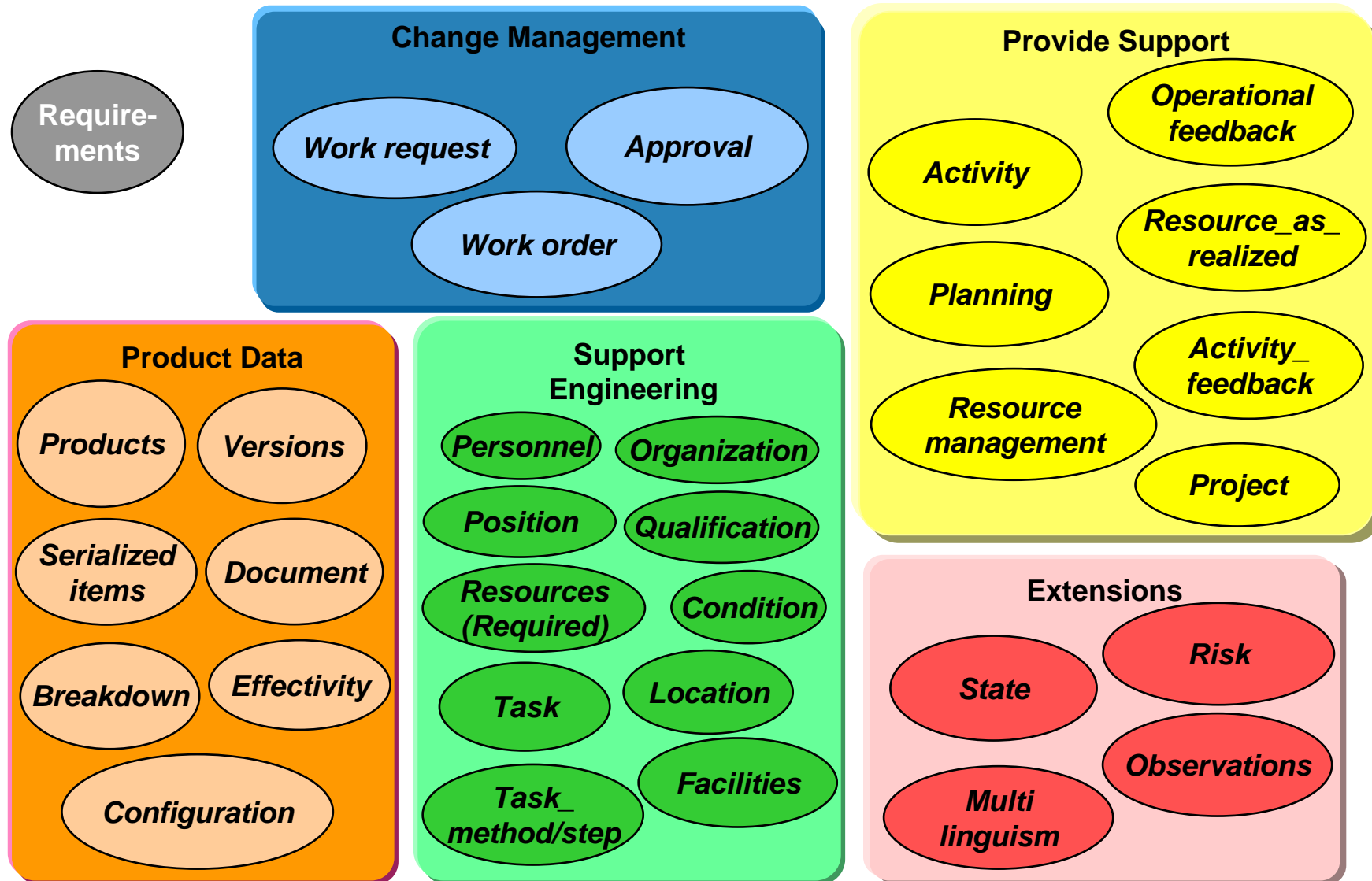
ASD Organization



ASD Suite of standards supported by PLCS



PLCS capabilities





PLCS – Data Exchange Specifications

- DEXs are: (S3000L= AD DEX 1 and AD DEX 3 from ASD/AIA)
 - Subsets of the AP239 Information model
 - Selected to meet a specific data exchange need
 - Built from relevant modules
 - Supported by usage guidance, capabilities, templates and reference data
 - Can be refined from other DEXs
- DEXs may be standardized at any level (work group, company, project, organization, national, international)
- DEXs enable
 - Consistent implementation of AP239
 - Data consolidation through time

DEX3: Task Specification Overview

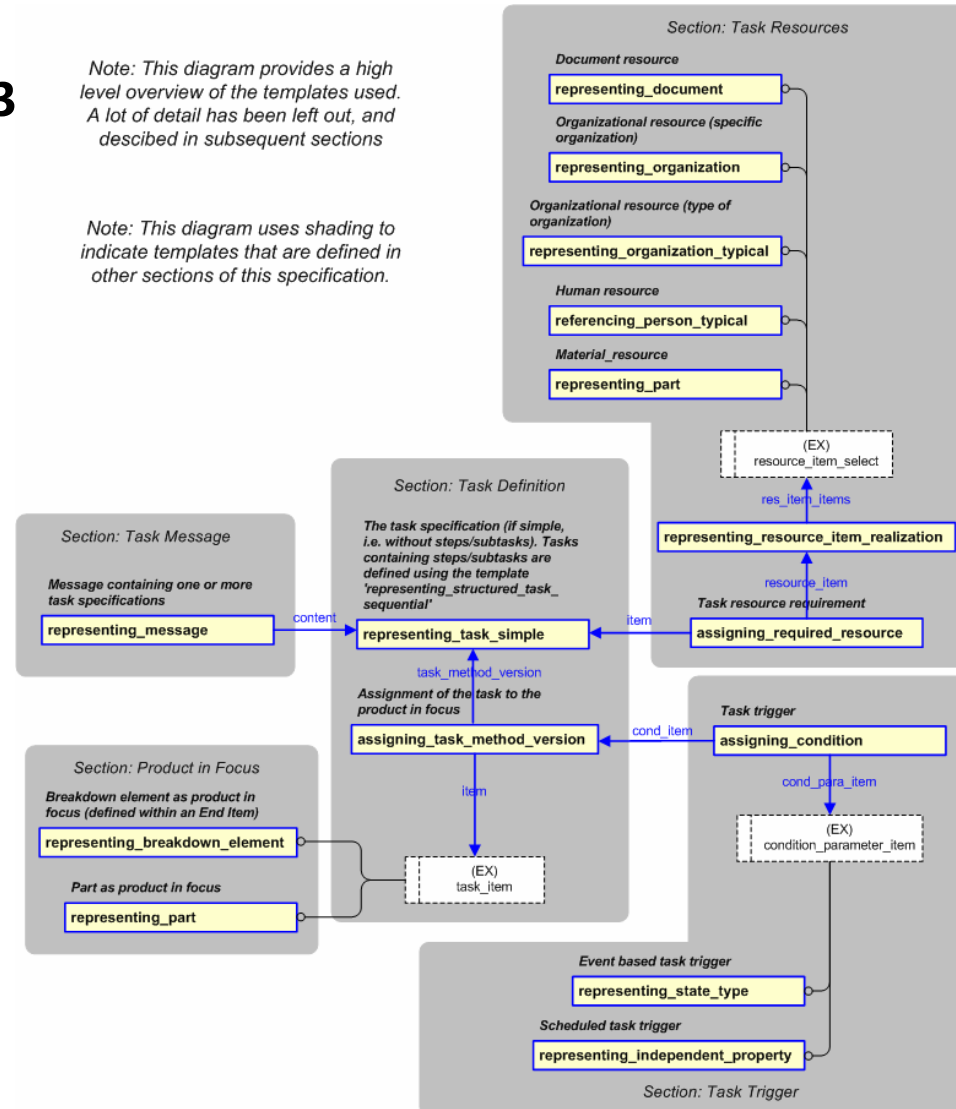


- **Templates used to configure DEX3**

- [Product in Focus;](#)
- [Task definition;](#)
- [Task resources;](#)
- [Task trigger;](#)
- [Task end item context;](#)
- [Structured task;](#)
- [Task effectivity;](#)
- [Task compound conditions representation;](#)
- [Task administrative information;](#)
- [Task message;](#)
- [Optional characterizations of templates;](#)

Note: This diagram provides a high level overview of the templates used. A lot of detail has been left out, and described in subsequent sections

Note: This diagram uses shading to indicate templates that are defined in other sections of this specification.



ISO 10303 PDM Modular breakdown

PDM Schema

- Product identification
 - part identification
 - document identification (logical documents, not files)
 - product version
 - part version
 - document version
 - product definition
 - part definition
 - document definition
- File identification (external ref.)

- Product structure
 - part structure
 - document structure
- Product properties
 - part properties
 - document properties
- File properties
(document properties applied to file references)

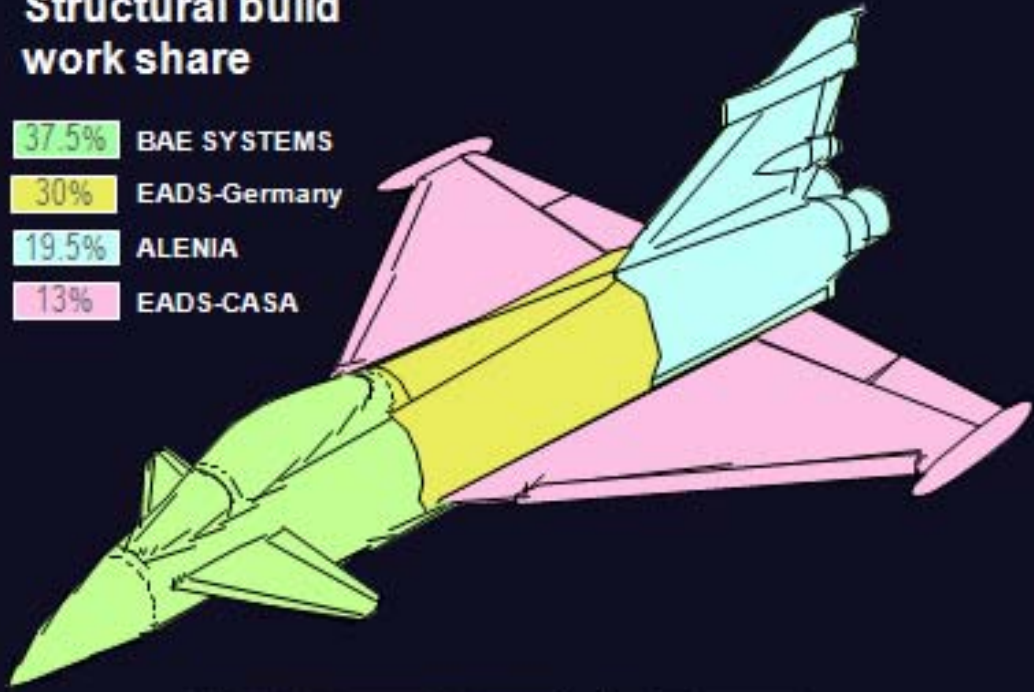
- general organisational/management data
- end item identification
 - product concept, configuration item
- effectivity
 - planned configuration
 - general validity period

Eurofighter Typhoon

Suppliers

Structural build work share

- 37.5% BAE SYSTEMS
- 30% EADS-Germany
- 19.5% ALENIA
- 13% EADS-CASA



National and export customers

Common supplier base

Concurrent product development

Four assembly lines

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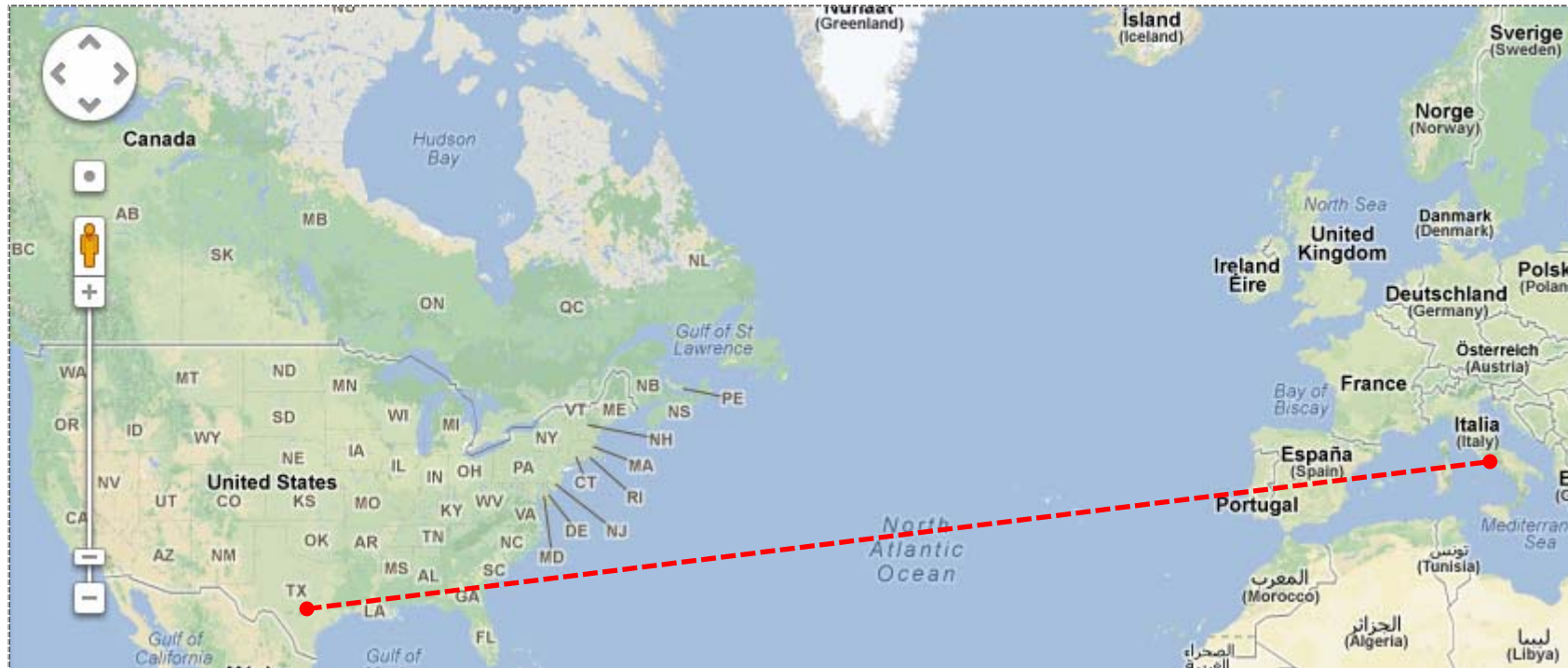
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Lockheed Martin F-35 Final Assembly and Check out



F-35 FACO
Video

Connecting 2 PLM systems



F-35 team in Fort Worth, Texas, USA

F-35 final assembly and checkout facility (FACO) is being constructed at Cameri Air Base (Novara, Piedmont).

UID Information data exchange



Type
Marking

DOOR ASSY, REFUEL PROBE - FWD

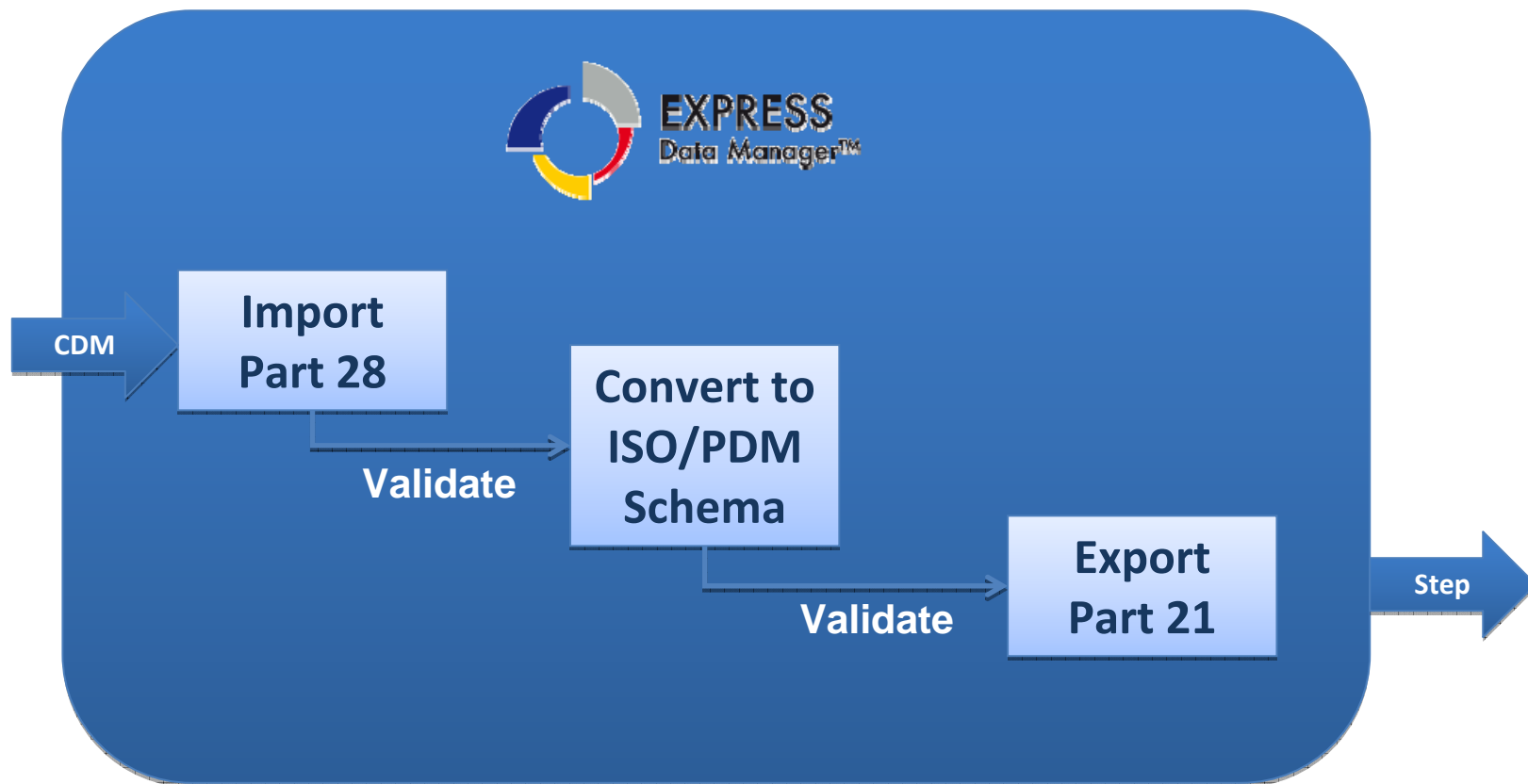
CAG 6B023

PNO 2FSH61011-0002

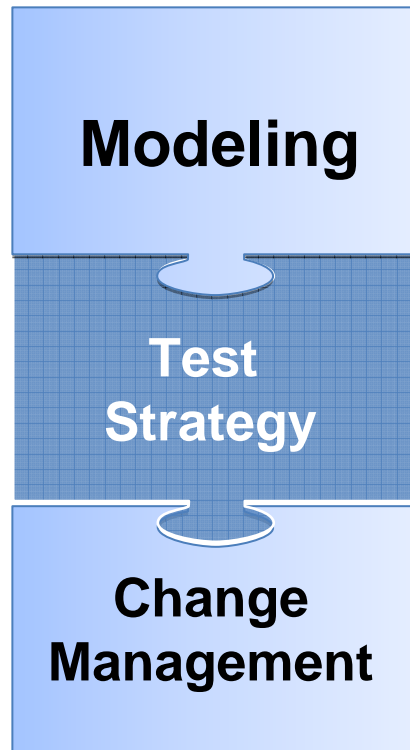
SEQ 00034



STEP Conversion



Lessons Learned



- Avoid Complexity
- Start Simple
- Defer Non-Essentials
- Good reading



“Aerospace Industry Guidelines for Implementing Interoperability Standards for Engineering Data”

AIA Data exchange Handbook

3 Concepts of operation

Companies wishing to adopt standards based data exchanges should follow an overall process similar to figure 3-1.

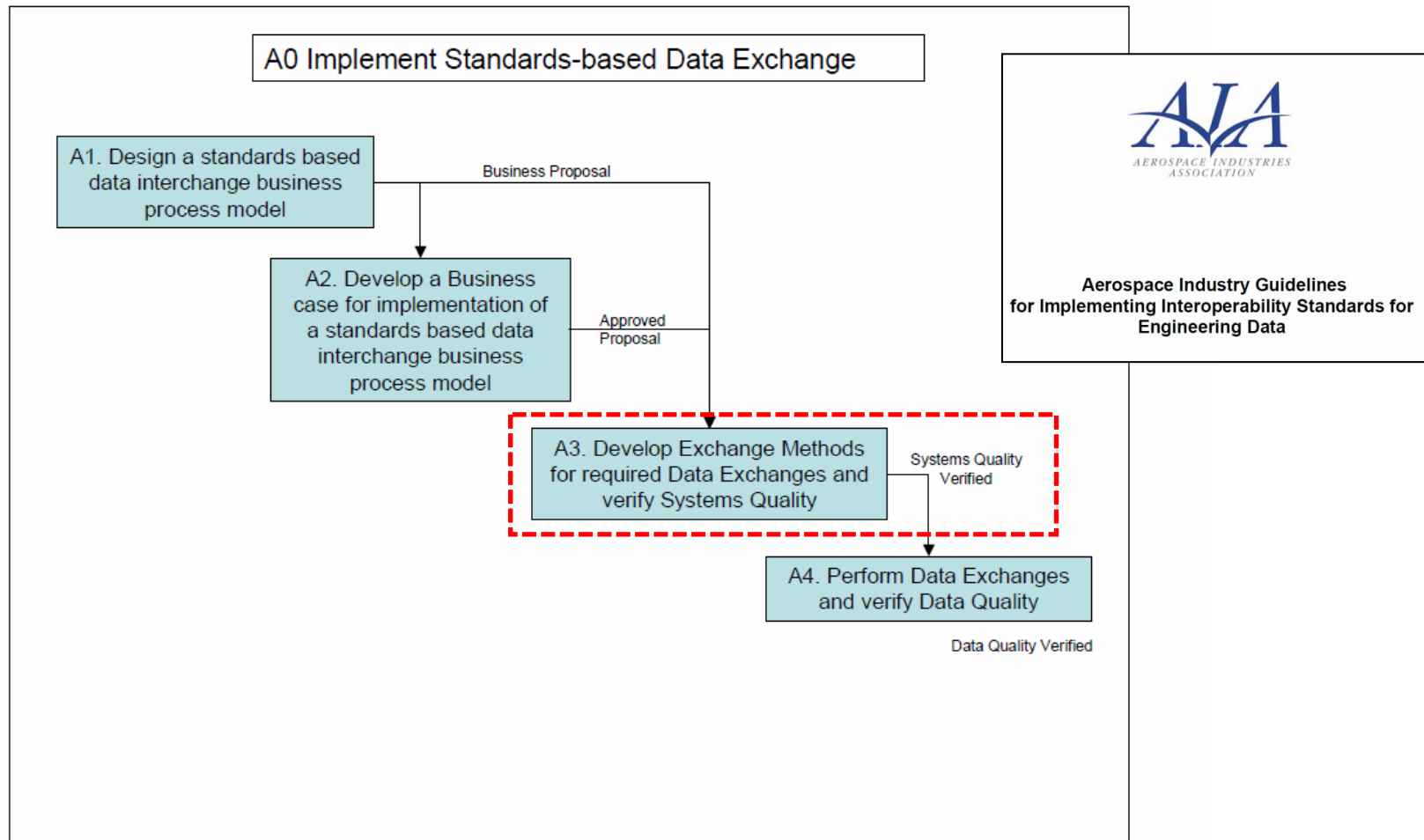
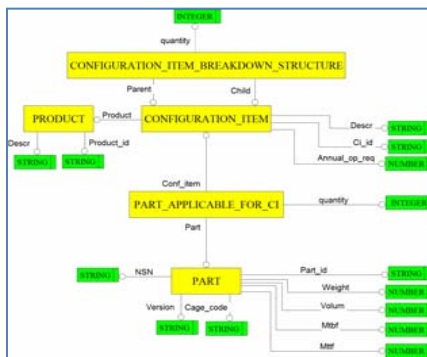
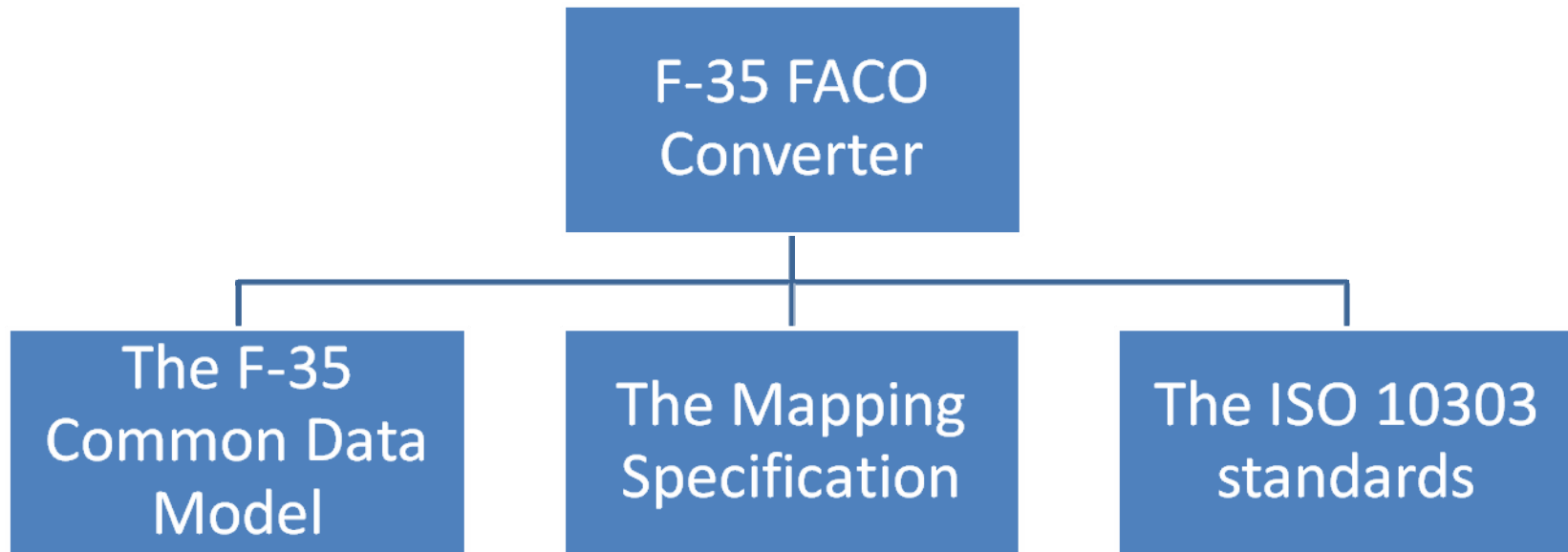
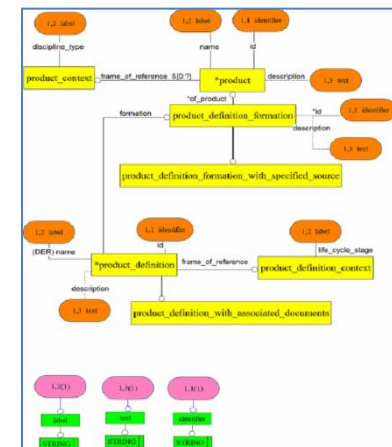


Figure 3-1, Implementing data exchange based on standards

Input to converter development

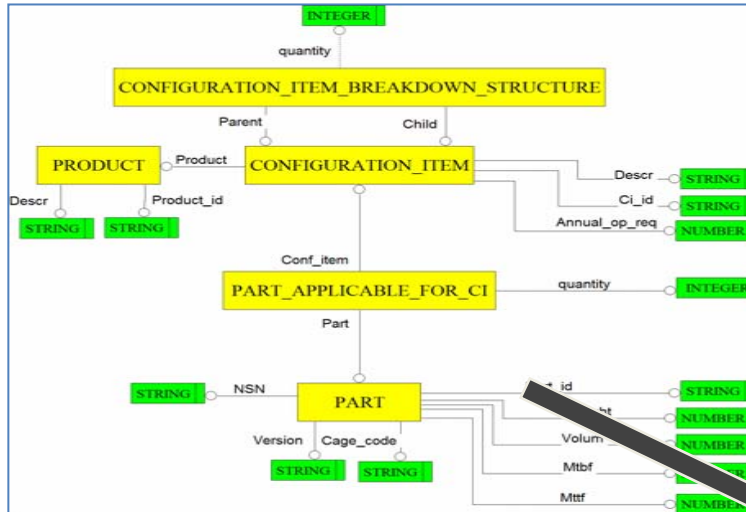


Teml_inst_id	Templ type and parameters	Cardinality	Static binding	CDMentity (source)
#32.1	representing product as realized id id_class_name in_id in_id_class_name life_cycle_stage domain product_design_version = #32.1a (*version)	one-to-one	Serial_identification_code NULL Version_identification_code Utilization_stage Product_life.cycle_support	aircraft
#32.17	assigning_identification id id_class_name items = #32.1 = #18.1 (*pai)		Tail_number	ac_tail_no

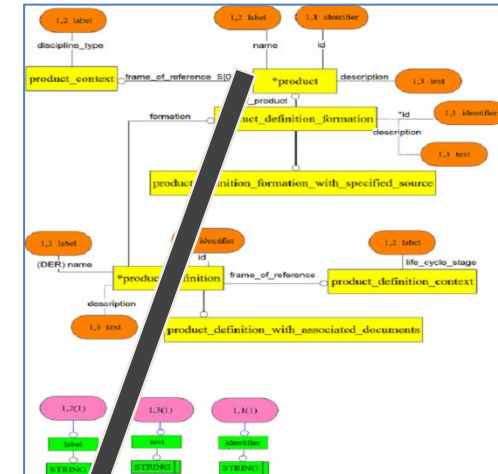


What the IT developer produces : Mapping Code

Source Model



Target model



Templ_inst_id	Templ type and parameters	Cardinality	Static binding	Source entity
#1	representing part id id_class_name vn_id vn_id_class_name life_cycle_stage domain	one-to-one	Product_variant_identification_code /NULL Version_identification_code Support_stage Product_life_cycle_support	PRODUCT product_id
#7	assigning_descriptor descr id_class_name items: 1..2..4..4		Product_description	descr
#3	representing breakdown element id id_class_name vn_id vn_id_class_name life_cycle_stage domain bkdn_vn = #2 (*bkdn_vn)		Breakdown_element_identification_code /NULL Version_identification_code Support_stage Product_life_cycle_support	CONFIGURATION_ITEM ci_id

Mapping specification

```

MAP Map_Part FOR;
FROM(mypart:src::PART)
WHEN(TRUE);
BEGIN_MAP
LOCAL
  rep_part : plcs::REPRESENTING_PART;
  ass_id : plcs::ASSIGNING_IDENTIFICATION;
  ass_prod_prop : plcs::ASSIGNING_PRODUCT_PROPERTY;
END_LOCAL;

ON_ERROR_DO
  handleException;
END_ON_ERROR_DO;

my_default_org_id := DEFAULT_ORG_ID;
DEFAULT_ORG_ID := mypart.cage_code;

-----
-- #6 Part
-----

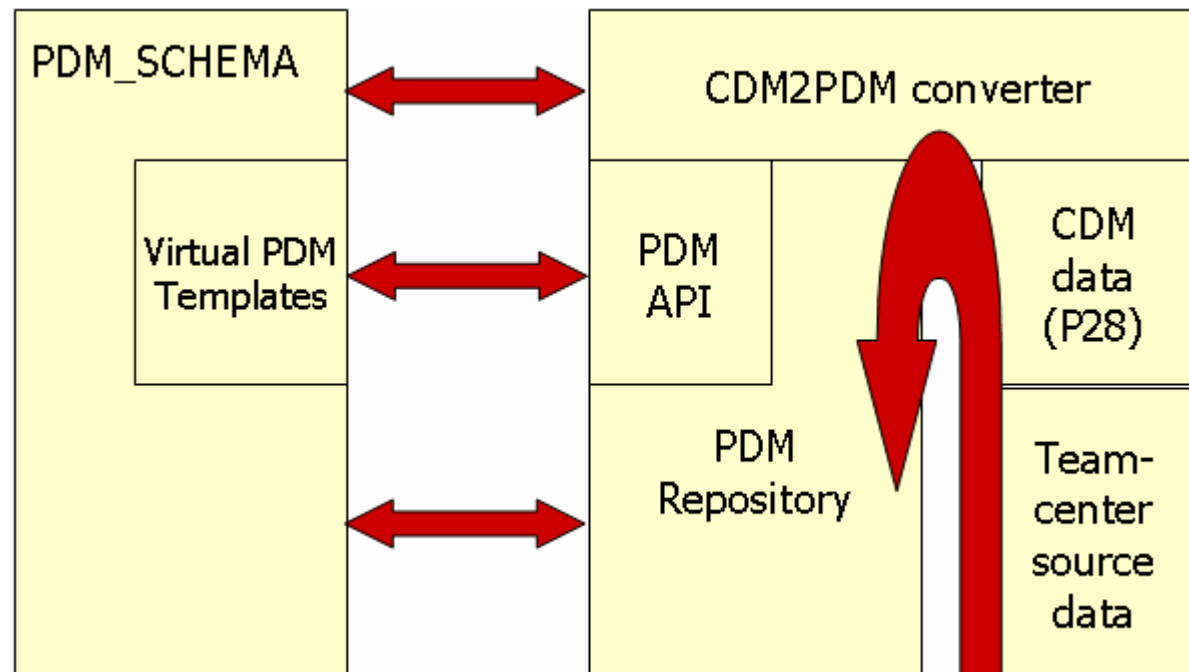
rep_part := create_representing_part(mypart.part_id,
  PART_IDENTIFICATION_CODE,
  mypart.version,
  PART_VERSION_IDENTIFICATION_CODE,
  PRODUCT_LIFE_CYCLE_SUPPORT,
  SUPPORT_STAGE
);
    
```

Mapping Code

Software architecture

Correspondence between specification and software layers:

- The CDM2PDM converter either instantiates pdm_schema entities directly or makes use of functions from an API which instantiates more complex structures (like properties, managed documents etc.) Each function in the API corresponds to a virtual template.
- The converted data is stored in a PDM repository which corresponds exactly to the data model of the PDM_SCHEMA.



Debugger tools for mapping code

The screenshot displays the EDMSDebugger interface, which is used for debugging code. The main window is titled "EDMSDebugger - Interrupted".

Source Code: The left pane shows the source code with the following content:

```
293 END_LOCAL;  
294  
295 ON_ERROR_DO  
296     handleException;  
297 END_ON_ERROR_DO;  
298  
299 my_default_org_id := DEFAULT_ORG_ID;  
300 DEFAULT_ORG_ID   := mypart.cage_code;  
301  
302 -----  
303 -- #6 Part  
304 -----  
X 305 rep_part := create_representing_part(mypart.part_id,  
306                                     PART_IDENTIFICATION_CODE,  
307                                     mypart.version,  
308                                     PART_VERSION_IDENTIFICATION_CODE,  
309                                     PRODUCT_LIFE_CYCLE_SUPPORT,  
310                                     SUPPORT_STAGE  
311                                     );  
312  
> 313 DEFAULT_ORG_ID := my_default_org_id;
```

Break Point Configuration: The right pane shows the "Break Point" configuration. The "Break at" section is set to "In exp/xpx" with the condition "map_ci_breakdown_structure". The "Break Points" list shows several active break points:

- X Line # 305: map_part
- X Line # 287: map_part.
- X Line #999997: #break_at_errors
- X Line #999996: #break_at_warnings
- X Line # 249: map_ci_breakdown_structure.

Call Stack: The "Call Stack" pane shows the current call stack:

- 2: map_part at line: 313
- 1: pdm2dex at line: 109

Instance View: The "Instance" window shows the details of the current instance (InstanceID: 1275072329) for the table "REPRESENTING_BREAKDOWN_STRUCTURE".

REL_TYPE	ASSIGNING_REFERENCE_DATA	Meta	References	Prev	Next	Delete	Cancel
PARENT	: ASSIGNING_REFERENCE_DATA	>	1275072063				S E
CHILD	: BREAKDOWN_ELEMENT_DEFINITION	>	1275072067				S E
USAGE	: BREAKDOWN_ELEMENT_USAGE	>	1275072122				S E
		>	1275072328				S E

Output: The "Output" pane shows the execution log:

```
At line: 109  
At line: 305  
At line: 313  
rep_part = #1275072449  
BREAKDOWN_ELEMENT_IDENTIFICATION_CODE = 'urn:epm:rc  
CI_ITEM_HASH_INDEX = 1  
DEFAULT_ORG_ID = 'N1R41'
```

Instance Details: The "Instance" window also shows the following details:

- InstanceID: 1275072329
- Table: REPRESENTING_BREAKDOWN_STRUCTURE
- Buttons: Meta, References, Prev, Next, Delete, Cancel

Quality assurance

7 Perform data exchanges and verify data quality

This section describes the production process of translating source information to the target system and validating the success of the translation process.

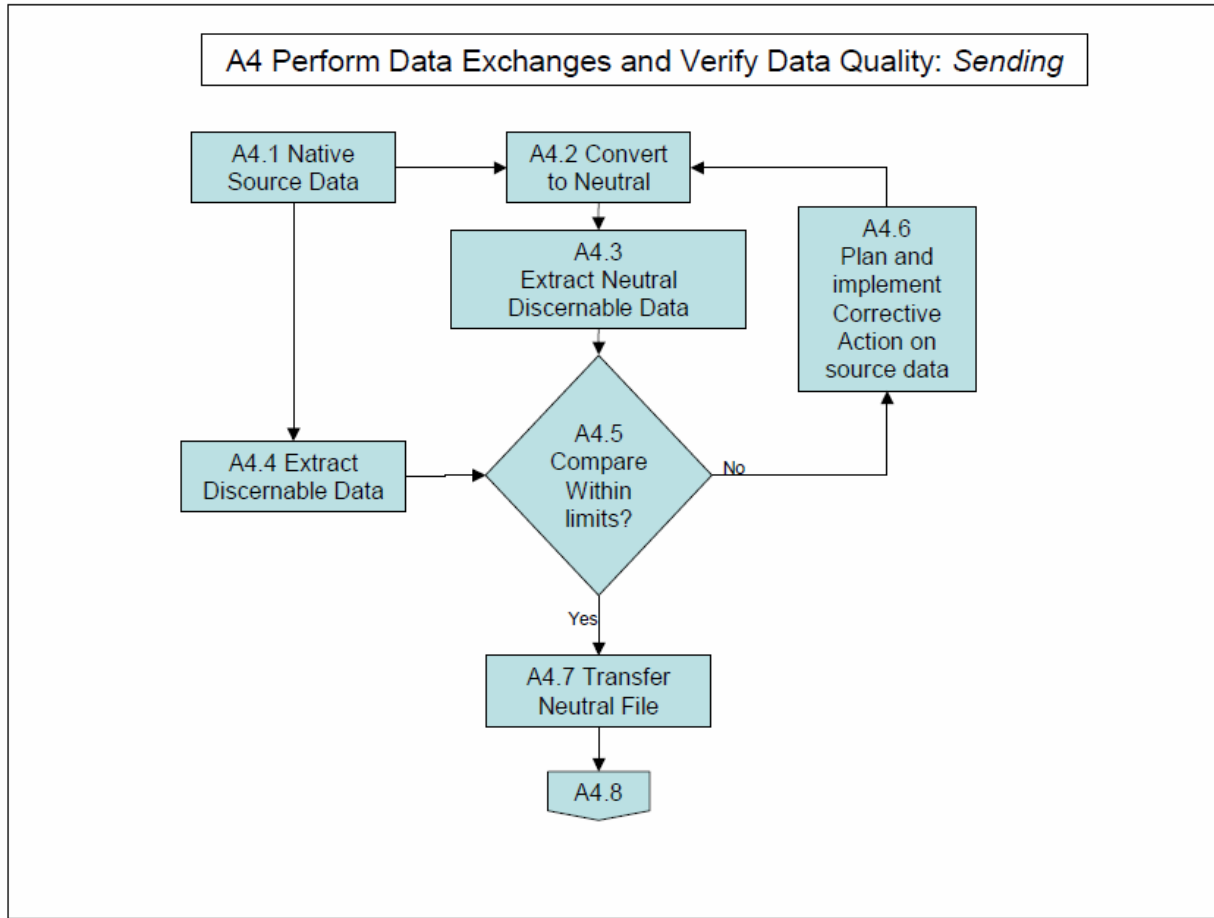


Figure 7-1, Outgoing exchange and quality process

Source: AIA Handbook

Quality assurance

Data Preparation

PDM model data submitted for release

Ingest

Exchange preparation

- **Generate STEP file from source, as required**
- **Read CAD/PDM data In STEP format Into EDM repository**

- **Parse STEP file**

- **Validate/verify according to AP**

- **Compare retrieved and generated Validation Properties**

- **Validate/verify according to Rec. Practices**

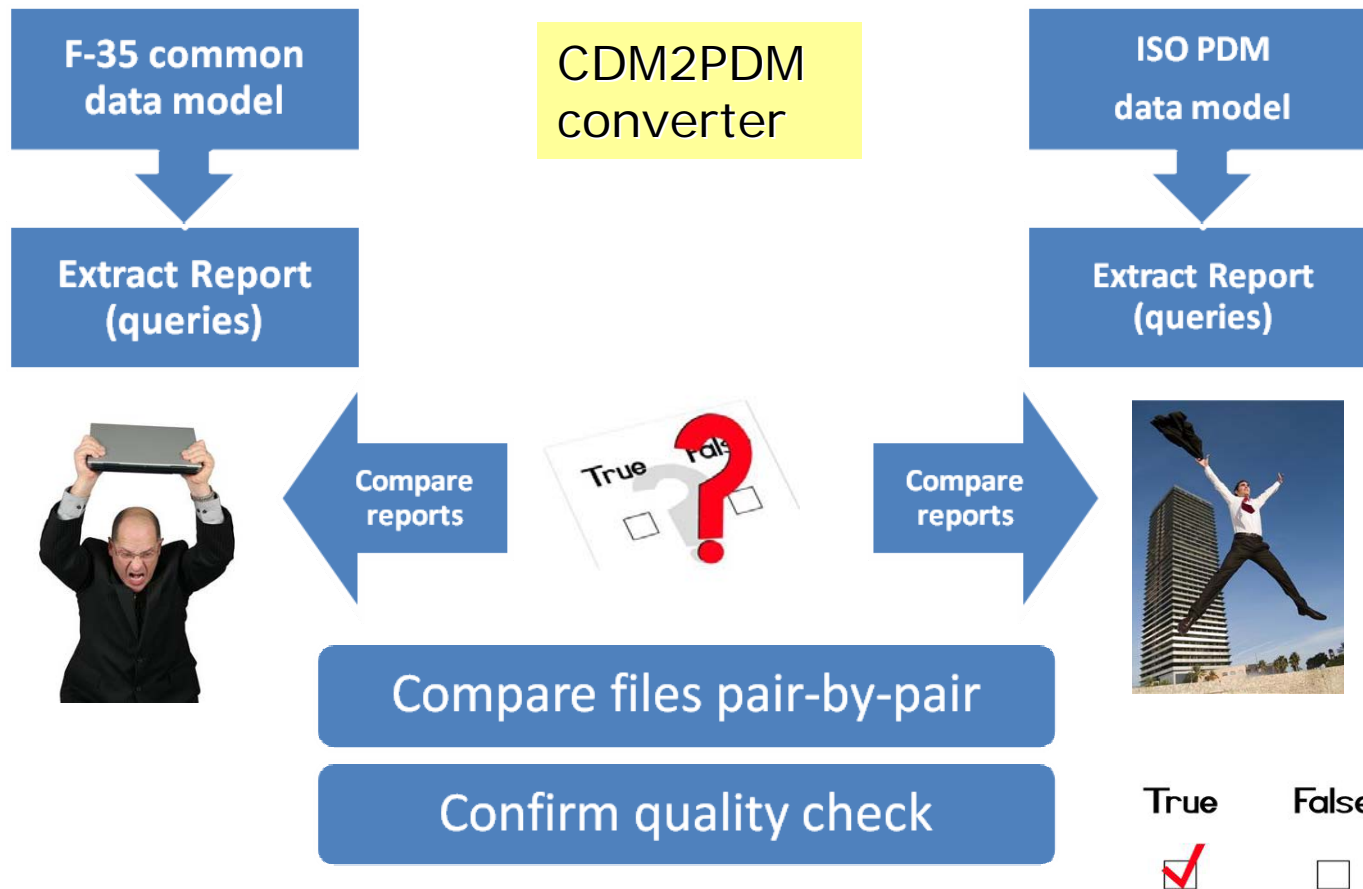
- **Validate/verify according to company rules**

- **Validate/verify according to EN 9300**

- **View data for end-user validation**

Quality assurance

Each test consist of a pair of test queries. The first query in such a pair is applicable for the CDM population. The second one is applicable for the PDM population. A test is passed if the two corresponding report files are identical. Sufficient test queries are written in order to verify that the complete population has been accurately converted.



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PLCS Requirements in US DoD projects

Department of Air Force, which relates to “*Acquisition and Sustainment Life Cycle Management*”, the following requirements are included;

- 3.91.1.1. The PM shall require the use of International Standards Organization (**ISO 10303, *Standard for Exchange of Product (STEP) Model Data, AP239, Product Life Cycle Support***, for engineering data.
- 3.91.1.2. Legacy system modifications shall implement **ISO 10303** for new engineering data to the maximum extent feasible. Conversion to **ISO 10303** for the entire legacy system is encouraged when supported by a positive business case analysis (BCA).
- 3.95.1. The PM shall address industrial base constraints in the LCMP. This should address mitigation to ensure that the system(s) can be supported during its life cycle. Open systems design, including Modular Open Systems Approach (MOSA), can help mitigate the risks associated with technology obsolescence and diminishing manufacturing capabilities by **avoiding being locked into proprietary technology or by relying on a single source over the life of a system**. Incremental development also should be considered to alleviate obsolescence concerns.
- The Complete Document is available at: <http://www.af.mil/shared/media/epubs/AFI63-101.pdf>

Program and Project Life-Cycle Logistics Support Policy

NPD 7500.1C -- main

Verify current version before use at:
<http://nodis3.gsfc.nasa.gov/>

Pa

| [NODIS Library](#) | [Program Formulation\(7000s\)](#) | [Search](#) |



**NASA
Policy
Directive**

COMPLIANCE IS MANDATORY

NPD 7500.1C

Effective Date: August 17, 2012
Expiration Date: August 17,
2017

[Printable Format \(PDF\)](#)

[Request Notification of Change](#) (NASA Only)

Subject: Program and Project Life-Cycle Logistics Support Policy

Responsible Office: Logistics Management Division

4. APPLICABLE DOCUMENTS AND FORMS

- a. NPR 7120.5, NASA Space Flight Program and Project Management Requirements.
- b. NPR 8735.1, Procedures For Exchanging Parts, Materials, and Safety Problem Data Utilizing the Government-Industry Data Exchange Program and NASA Advisories.
- c. **AeroSpace and Defense Industries Association of Europe (ASD) S3000L**, International Procedure Specification for Logistics Support Analysis (available at <http://www.asd-stan.org/s3000L.html>).
- d. Government Electronics Industry Association (**GEIA)GEIA-STD-0007**, Logistics Product Data (available at <https://standards.nasa.gov>).

From International RFP's

1. "The format of the communication of the agreed scope of product data shall be according to **ISO 10303-239 (named Product Life Cycle Support, PLCS)**. The product data shall describe a system structure. This system structure should serve as a basis for requirement, functional, product design, support system design and product in- service view of the entire system. For product shape related data ISO 10303-203 or relevant parts of ISO 10303-214 shall be used. The data should consist of both the metadata (the structure) and relevant documents describing the system. A description of the agreed scope, an appendix shall be developed jointly by the Purchaser and the Contractor. This appendix shall be updated continuously during project execution upon mutual agreement. The final specification with the product data information types, based on the refined appendix, and solution for delivery of product data shall be included."

2. FMV, Sweden, Protected Tracked All-Terrain Vehicles (360881-AI820276 RFQ BvNy System
 - Req. P66 "The Tenderer should use the principles of **ISO10303 AP239 PLCS** to information and data management"
 - Req. P79 "The Contractor shall deliver LSA data in the form of an LSAR compatible with **ISO10303 AP 239 PLCS.**"

Inspiring Interoperability of Information



Jotne PLCS Video

- Jotne and Lockheed Martin Aeronautics will conduct a seminar, on the subject of *"Global Integration and Management of 21st Century Fighters."* The seminar will help companies comply with the ISO standards for data exchange and sharing of engineering and logistics support data.