Test report for the STEP AP242 Benchmark #2

PDM test case - Short Report

March 2017
Preamble

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The mission of AFNeT & ProSTEP iViP associations is to promote the use of digital technologies in the extended enterprise and in cross-company, cross-domain collaboration scenarios. To reach this goal, these two associations are strongly involved in the development and the support of deployment of PLM interoperability standards.

3D Model Based interoperability in global engineering and manufacturing of complex products relies on international open standards. The industries request the pre-qualification of PLM editor interoperability solutions; this function is ensured by the Implementor Forums.

Thus, AFNeT & ProSTEP iViP associations have contributed to the launch and development of the STEP AP242 (ISO 10303-242) initiative since 2010. The availability of the first COTS STEP AP242 solutions for PDM interoperability is a key achievement of this challenge.

Today, we are pleased to provide you the results the STEP AP242 Benchmark #2 report, focused on PDM test case. The report on CAD test cases will be provided as a separate document in April 2017.

New editions of this Benchmark report will be published, addressing additional software & functionalities.

This work has been realized with the support of Airbus, Dassault Aviation, Daimler, Daher, MBDA, Liebherr, Zodiac Aerospace, ASD-SSG, GALIA, GIFAS, PFA, VDA, AFNeT & ProSTEP iViP Members and the AFNeT & ProSTEP iViP Benchmark Team.

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Related websites

AP242 project:  http://www.ap242.org/
AP242 Benchmark:  http://benchmark.ap242.org/
PDM-IF:  http://www.pdm-if.org/
CAx-IF:  http://www.cax-if.org/
1 Introduction

ISO 10303 STEP AP242 is available for the Automotive and Aerospace industries, as well as many other branches of the manufacturing industry, as a unique product standard for Managed model based 3D engineering data interoperability. STEP AP242 has been released as “International Standard” (IS) in August 2014. Multiple COTS applications have been tested by the CAx Implementor Forum and the PDM Implementor Forum.

STEP AP242 applications become increasingly important for CAD and PDM interoperability in the manufacturing industries. This project will allow our communities to reach a status of maturity for these applications. The benchmarking activities are needed to apply quality control to AP242 based implementations.

Therefore, AFNeT and ProSTEP iViP decided to conduct the STEP AP242 Benchmarks and to support the user community that will drive the project, with the support of several industry associations (ASD SSG, GALIA, GIFAS, PFA, VDA) and manufacturers, for getting an independent assessment of COTS STEP AP242 interfaces.

The objective of this Benchmark is to provide a public status of STEP AP242 functionalities available for operational use, tested by the industry and to identify limitations of the tested PLM COTS AP242 applications.

This project is composed of two work packages:
- CAD work package managed by AFNeT;
- PDM work package managed commonly by AFNeT and ProSTEP iViP.

The organization of this Benchmark is based on the following principles:
- business priorities defined by the industry stakeholders supporting the STEP AP242 Benchmark;
- AP242 interoperability functionalities already tested by the CAx-IF and PDM-IF;
- tests based on STEP AP242 COTS solutions available on the market or on their way to be shipped to the industry.

This document presents the test results of the PDM work package which cover the tests of the following AP242 PDM functionalities:
- exchange of PDM Information using AP242 BO Model XML including Assembly Validation Properties;
- references to CAD and non-CAD documents;
- management of changes.
Since PLM vendors and CAD integrators constantly enhance the functionalities and robustness of their STEP AP242 interfaces, the results of this Benchmark provide a snapshot of the functionalities tested at a certain moment in time for a specific version of the vendors’ solutions. New editions of this Benchmark report will be published, addressing additional software & functionalities.

# 2 References and terms

## 2.1 Reference documents

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<tr>
<th>ID</th>
<th>Name</th>
<th>Status version</th>
<th>Date</th>
<th>Link</th>
</tr>
</thead>
</table>

*Table 1 – Reference documents*

## 2.2 Terms

AVP  Assembly Validation properties  
CAD  Computer-aided design  
CAx-IF  CAx Implementor Forum  
COTS  Commercial off-the-shelf  
PDM  Product Data Management  
PDM-IF  PDM Implementor Forum  
IS  International Standard  
ISO  International Organization for Standardization  
LTA  Long-term archiving  
PDF  Portable Document Format (ISO 32000)  
3D PDF  3D viewer format defined by PDF/E (ISO 24517)  
PLM  Product Lifecycle Management  
Part 21  ISO 10303-21  
STEP  Standard for the Exchange of Product model data  
XML  Extensible Markup Language
3 Test methodology

This document describes the suite of test cases to be used by the PDM work package of the STEP AP242 Benchmark #2. The Benchmark concentrates primarily on testing the interoperability and compliance of STEP processors based on AP242.

3.1 Functionalities tested in this Benchmark
- exchange of PDM Information using AP242 BO Model XML (Part number, Version, Life cycle status, document management information, etc.);
- transfer of Assembly Validation Properties;
- references to geometry (STEP Part 21 files / CAD models);
- references to non-CAD documents (PDF, JPG);
- management of changes (new versions, updated life cycle status).

3.2 Testing strategy

Figure 2 below illustrates the testing strategy for Benchmark PDM work package:

![Figure 2 – Illustration of the PDM testing strategy](image)

The general steps for testing are:

1. import sample STEP AP242 dataset into PDM system;
   - check for completeness of data.
2. re-import the same STEP dataset into the PDM system;
   - evaluate system behaviour (ignore / overwrite / duplicate / versions incremented / etc.).
3. PDM system export data to STEP dataset.
4. check exported STEP data;
   - check STEP XML files using XML and XSD [2] conformity validator tool and apply rules defined from Recommended Practices,
   - compare to original AP242 XML Sample File using comparison tool.

Select the best STEP dataset file to be used for import into all target systems. Details concerning best STEP file are provided in 3.5.

5. import selected STEP dataset into PDM System B. System B’s database shall not contain the test model;
   - check for completeness of data.
6. apply modifications (modification overview is provided in Figure 4 and details in associated Test Suite [3]) to data in PDM system and export new STEP dataset;
   - check exported STEP dataset;
   - check STEP XML files using XML and XSD conformity validator tool and apply schema rules defined from recommended practices,
   - selection of the best STEP dataset file to be used for import into all target systems. Details concerning best STEP file are provided in 3.5.
7. import select STEP dataset into PDM System B. System B’s database shall contain the test model imported in step 5;
   - check STEP XML files using XML and XSD conformity validator tool and apply rules defined from recommended practices,
   - manage Changes.

For some tools, only a subset of the procedure is applied and the details are provided in 3.4.

Three phases are defined:
- sample STEP import;
- STEP export and check;
- import from selected STEP files.
3.3 Synthetic test case specifications: PDM assembly with 3D geometry

3.3.1 Motivation
Product structures and additional PLM attributes can be exchanged from one PDM System to another PDM System via STEP AP242 BO Model XML. This is a use case in collaboration or data migrations scenarios.

The PDM work package of the STEP AP242 Benchmark #2 is based on the experiences gathered in the first two rounds of testing of the joint AFNeT / ProSTEP iViP PDM Implementor Forum. It reuses the test case specification of PDM-IF Round 2.

3.3.2 Test model overview
The test model used in this test is the well-known “AS1” model, which is defined in STEP ISO10303 Part 44 standard. It is simple at first glance, yet contains a certain level of complexity with sub-assemblies and re-use of components.

Though geometrically simple, the assembly structure contains sub-assemblies including multiple usages of components and parts:

- the sub-assembly ‘bracket_asm’ is used 2 times in the top assembly node;
- the sub-assembly ‘nut and bolt’ is used 3 times in the sub-assembly ‘bracket_asm’;
- the single part ‘nut’ is used 2 times in the sub-assembly ‘nut and rod’, and once in the sub-assembly ‘nut and bolt’.

The full structure is shown in Figure 4 below.

![Figure 3 – Illustration of the PDM assembly with 3D geometry test case](image)

![Figure 4 – Overview of the AS1 assembly structure, including indication of changes](image)
3.4 List of tested applications

This section describes the list of tested applications during this Benchmark. The selection of applications has been done according to:

- the needs of industry representatives supporting the Benchmark;
- the availability of resources and funding;
- the availability of COTS tools according to the tests planning;
- the commitment of the support of PLM vendors to the Benchmark.

<table>
<thead>
<tr>
<th>Company</th>
<th>Solution</th>
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<td>COMPDM 2.0</td>
<td>Aras Innovator 11</td>
<td>STEP AP242 interface for Aras Innovator by T-Systems International GmbH</td>
</tr>
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<td>3D_Evolution 4.1</td>
<td>*</td>
<td>CAD &amp; Converter system with STEP AP242 interface</td>
</tr>
<tr>
<td>Datakit</td>
<td>CrossManager 17.1</td>
<td>*</td>
<td>Converter system supporting STEP AP242 conversions</td>
</tr>
</tbody>
</table>

*Testing for solutions without target PDM system:

- 3D_Evolution was tested as a PDM data exchange system without change management. The following procedure steps defined in 3.2 were used: 1, 2, 3, 4a and 4b;
- CrossManager was tested as a PDM to CAD-viewing format converter. The selected target format is 3D PDF (PDF/E ISO Standard) as it meets the industry needs and the tests criteria scope. The procedure steps used are 5 and 8, but with the target system as a 3D PDF viewer (named 5bis and 8bis). The results from this tool is not considered in the test results by functionalities (4.2.1) and by STEP conformity criteria (4.2.2).

3.5 STEP file selected as reference for phase 3

The general approach was to select a STEP file of good quality for each functionality tested in phase 3. Two datasets must be selected: the first to perform step 5 containing not modified model data and the second to perform step 7 containing modified model data.

Below is the list of selection criteria that need to be fulfilled:

- no errors listed in the export log files;
- no major unsuccessful STEP file conformity checks;
- loop test successful (import into the exporting system using the same translator);
- no errors in the validation properties;
- completeness of critical content;
- if possible, the two selected STEP file are produced by different STEP interfaces.

Based on the list of criteria above, the STEP files for the phase 3’s import tests have been selected amongst the exported files of the 6 STEP export interfaces:

- not modified model data: from 3D_Evolution;
- modified model data: from COMPDM.
4 Test results

4.1 Overview of the test results

![Table 3 – Overview of the test results]

4.2 Overall test results

The intention of this Benchmark however is not only to give an assessment of individual software tools, but also to derive a statement concerning the general maturity of STEP AP242 BO Model XML based implementations.

First, the test results shown in section 4.1 will be grouped by functionality. This will help the reader to answer general questions such as “how good does the transfer of relevant PDM information work overall?”.

Second, the test results will be combined to provide a rating of STEP and XML conformity. This renders a rating of the quality of the implementation and the conformity of the exchanged dataset, rather than the quality of the data exchange.
4.2.1 Test results by functionalities
The results shown in section 4.1 are grouped together so that it provides an overall assessment of the state of the art for AP242 BO Model XML PDM Interfaces. It also enables to reflect the main criteria introduced in section 3.1:

- exchange of PDM Information using AP242 BO Model XML (Part number, Version, Life cycle status, document management information, etc.);
- transfer of Assembly Validation Properties,
- references to geometry (STEP Part 21 files / CAD models);
- references to non-CAD documents (PDF, JPG);
- management of changes (new versions, updated life cycle status).

4.2.2 Test Results for STEP Conformity Criteria
This section provides the implementation quality’s overall statement of the tested AP242 BO Model XML interfaces. The following criteria were evaluated, and ordered check sequence:

- XML conformity (syntax);
- XSD conformity conformity (data model and associated rules, cardinalities, values, etc.);
- STEP AP242 Recommended practices conformity;
- comparison to original AP242 XML Sample File.

The first criterion is an important one, because a file must be valid XML so that it is accepted by the parsers. Next up, and more specifically, it must comply with the AP242 BO Model normative XML Schema to ensure the data structures are mapped correctly.

Conformance with the AP242 Recommended Practices is important for a correct interpretation of the data. It should be noted, however, that the Recommended Practices are an evolving document, developed by the PDM Implementor Forum’s Implementor Group in parallel to their test rounds, with input from other initiatives working with AP242 BO Model XML as well. As the interfaces tested in this Benchmark also take part in the PDM-IF test rounds, they are generally aware of these developments, but as their software development cycles are not synchronized with the test rounds, deviations naturally occur. As the Recommended Practices become more and more stable over time, so will the results in this area.

The comparison to the sample file covers the product structure (Parts, Part Versions, Part Views, and their respective relationships), which should not change by importing and re-exporting an assembly structure.

Figure 5 – Chart of the test results by functionalities

Figure 6 – Chart of the test results by STEP conformity criteria
5 Summary

STEP AP242 (ISO 10303-242 “Managed model based 3D engineering”) has been published as “International Standard” end of 2014.

The objectives of the industry are reached only when COTS STEP AP242 applications are available and used by a broad community, with the appropriate level of functionalities and quality.

The results show a good level of STEP AP242 BO XML implementation for PDM product structure exchange. Most of in-scope PDM functionalities are robustly supported, except for the transfer of the benchmarked assembly validation properties. Concerning the conformity tests of the produced STEP files, most of the results are positive. As the Recommended Practices become more and more stable over time, it is expected that the results will also be improved in this area.

The use of international open standards for 3D Model Based interoperability is seen as a key enabler to support global Engineering and Manufacturing of complex products within the Extended Enterprise. It also contributes to ensure a better independence regarding PLM vendor’s proprietary formats, and long-term preservation of 3D Model Based design. The availability of COTS STEP AP242 solutions for PDM data interoperability contributes to answer to this challenge.

6 Publication of the Long Reports

Detailed documentation of the STEP AP242 Benchmarks of the PDM and CAD test cases is only available for the members of the AFNeT and ProSTEP iViP associations, and can be downloaded from the following websites:


Short Reports are publicly available on http://benchmark.ap242.org

7 Acknowledgements

The AFNeT association and the ProSTEP iViP association thank the application Vendors who provided their COTS applications for the Benchmark testing, for their support in the installation, and for the analysis of the test results.

The AFNeT association and the ProSTEP iViP association thank the CAx Implementor Forum and the PDM Implementor Forum for the STEP Recommended Practices and the test case. We also thank the ASD SSG, GALIA, GIFAS, PFA, VDA for their funding and orientations.