prostep ivip / VDA Short Report

9th JT Application Benchmark

Version 1.0

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1 Introduction

JT has become a widely used standard format for product visualization in the industry. The prostep ivip Association and German Association of the Automotive Industry (VDA) are driving this adoption with three connected projects focusing on both users and vendors communities:

- The prostep ivip / VDA JT Workflow Forum,
- The prostep ivip / VDA JT Implementor Forum and
- The prostep ivip / VDA Application Benchmark.

From the start, these projects have continuously developed JT recommendations and implementation guidelines; performed benchmarks, documented requirements and discussed issues.

In August 2010, the prostep ivip Association submitted a JT specification to ISO for standardization. ISO published it as ISO 14306:2012 international standard in December 2012.

In June 2021 prostep ivip Association released the "JT Industrial Application Package" version 3 (PSI 14/part 1 v3): An enhanced specification of JT, combining guidelines and latest use case requirements. This prostep ivip recommendation is compatible with the JT ISO standard released in 2012 and provides latest capabilities of the file format. It was also released as DIN Spec 91383 in 2021.

As the latest in a row of nine benchmarks, this JT Application Benchmark was carried out in 2022 and 2023 to achieve an independent evaluation of the progress being made concerning the development of JT translators and viewing applications. The object of testing was the DIN Spec 91383 JT specification. Additionally, the interoperability between JT and the STEP AP242 Edition 3 Domain Model XML schema (published as ISO Standard ISO 10303-242:2022) was also part of the benchmark. In particular, the aim of the benchmark was to carry out a neutral comparison of current JT applications with a focus on proving the maturity of JT and AP242 XML applications concerning JT geometry and semantic PMI, Validation Properties, Assembly Structure, and Kinematic Mechanism.

The benchmark was managed by the JT Workflow Forum and JT Implementor Forum. It is an independent activity, financed directly by the prostep ivip association and VDA, and by the participating companies, whose products were tested. It is a neutral test of trendsetting JT applications against selected criteria, carried out by a neutral service provider. Therefore, the results of the benchmark cannot only be used to evaluate the application of JT in PLM environments, but also for improvement of the interoperability of the applications.

As such applications are undergoing a permanent development; the benchmark can only give a snapshot of the functions and qualities of the applications.

2 Approach

The JT Application Benchmark is a joint activity of the prostep ivip Association and the VDA aiming at a neutral evaluation of actual JT applications. Focal points of the 9th JT Application Benchmark were the following:

- The test of CAD to JT and JT to CAD translators;
- The state of the art of JT and STEP AP242 XML interaction;
- The test of JT consuming applications.

2.1 Four Steps

Based on lessons learned from previous benchmarks, the JT Workflow and JT Implementor Forum agreed on the following four-step approach:

1. The JT Workflow Forum clarified the target intent for the benchmark and provided details on the expected outcome.
2. The vendors made proposals for the JT file scope, configuration settings and evaluation approach which in their eyes would best fit the requirements.
3. A proof of concept / test run for the benchmark was conducted, using agreed-on settings and test models, with close involvement of the vendors.
4. After the successful test run, the actual benchmark was conducted.

Figure 1 shows which tasks were performed by the involved actors during the benchmark.
The involved actors are the following:

- The prostep ivip / VDA JT Workflow Forum (JT-WF)
- The participating vendors from the prostep ivip / VDA JT Implementor Forum
- PROSTEP AG (PS, as service provider)

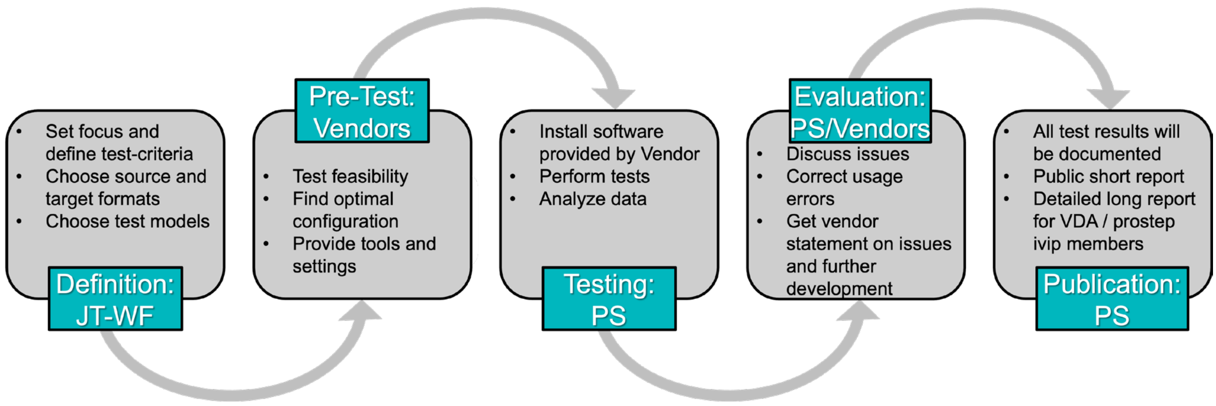

Figure 1: Process and involved actors

In the first step, the definition phase, JT Workflow Forum members set the focus of the benchmark and defined the test criteria. They specified source and target formats (native CAD or neutral) in addition and chose appropriate test models.

The second step was the Pre-Test, which was conducted by the participating JT application vendors within the frame of the JT Implementor Forum. In this phase, they tested the feasibility of given test models and test criteria. They hereby had to find and optimize their tool configuration to achieve best results. These resulting configuration settings were finally provided for the benchmark testing.

In the third step, the benchmark testing was conducted by PROSTEP. Software made available by the vendors was installed, tests were performed, and results were analyzed.

In the fourth step, the preliminary results were discussed with vendors to correct usage errors, to get statements regarding further development of the affected software and to resolve identified issues.
The last step is the publication of all results in a public available short report and in a detailed long report that is available for all VDA and prostep ivip members.

2.2 Building Blocks

This benchmark was composed of two building blocks: test case A (JT geometry, PMI, validation properties) and test case B (JT + STEP AP242 XML, assembly structure, kinematics, validation properties).
In both test cases, the results of CAD to JT and STEP AP242 XML translations and the results of JT and STEP AP242 XML to CAD translations were evaluated in two steps.

- CAD to JT translations: Translation of CATIA V5-6R2022, Creo7, NX2206 and 3DEXPERIENCE CAD models to JT and STEP AP242 XML with quality checks regarding geometry, PMI annotations, validation properties, assembly structure & kinematics.
- JT to CAD translations: Translation of the JT and STEP AP242 XML models that were created during the first translation step back to CATIA V5-6R2022, Creo7, NX2206 and 3DEXPERIENCE CAD models with quality checks regarding geometry, PMI annotations, validation properties, assembly structure & kinematics. As well as the import of the JT and STEP AP242 XML models into JT consuming applications.

2.3 Documentation

This short report is made publicly available; a long report with more detailed information is provided to the members of prostep ivip and VDA.

3 Testing

The benchmark tests were executed at PROSTEP to ensure neutral testing and documentation. The vendors provided the software to be benchmarked and licenses for the runtime of the benchmark testing and evaluation.

3.1 Test Environment

The test system was set up as follows:

- Operating System:
  - Windows 10 Pro
- Hardware:
  - CPU: Intel® Xeon ® W-2225 CPU @ 4.10GHz
  - RAM: 32GB
  - Graphics: NVIDIA TX A2000

3.2 Configuration and Settings

The vendors of the translators were asked to provide the configuration and settings that would fit best to the benchmark criteria.

4 Test Case A

Test Case A includes the check of JT geometry. The vendors could decide if they wanted to test semantic PMI or validation properties in addition.

4.1 Scope

- **3D Geometry** defines the manufactured part shape. Within a JT file, it is provided in a precise boundary representation (XT-BRep), as well as a lightweight tessellated representation for efficient visualization.
- **Product Manufacturing Information (PMI)** describes the capability to embed information about dimensions, tolerances and other parameters which are necessary input for the manufacturing and measuring of the part from the 3D model.
- **Validation Properties** are a type of meta data, as they provide information about the model they are derived from, inside the model. Validation properties are key characteristics of a model, which are deemed important for the respective use case and thus shall not be modified during translation and exchange.

4.2 Criteria

The following criteria were defined by the JT Workflow Forum. Details, especially the validation methods, were elaborated in collaboration with the JT Implementor Forum.

The used CAD source formats for the CAD to JT translations and the target CAD formats for the JT to CAD translations were CATIA V5-6R2022, Creo7, NX2206 and 3DEXPERIENCE. The used JT format for all translations was JT according to DIN Spec 91383:2021 (JT IAP v3).

4.2.1 Geometry Criteria

Regarding the correctness of geometry, the models were checked with two tools: xCompare and LiteComply from TECHNIA. These are neutral checkers, because TECHNIA is not a participant of the benchmark. The tolerance for geometry deviations was set to 0.01 mm.

4.2.2 Semantic PMI Criteria

Regarding the correctness of the Product Manufacturing Information (PMI), the models were checked in the context of JT data exchange. Among others, it is prerequisite for long-term data archiving. In addition, PMI can be used to drive downstream applications such as coordinate measuring and manufacturing.

Semantic PMI representation relates to the capability to store PMI data in the JT file in a computer-interpretable way, so that it can be used for model redesign or downstream applications. Semantic PMI representation data by itself may not be visible in 3D.

4.2.3 Validation Properties

Regarding the correct translation of validation properties from CAD to JT, two categories of attributes were checked:

Geometric Validation Properties (GVP) are intended to validate the shape of a part regarding completeness and position. A GVP mismatch indicates that there is an issue with the geometry in general; further investigations are most likely needed to pinpoint the problem exactly. A GVP match on the other hand provides a level of trust for the import results.

GVP cover parameters such as the center of gravity, volume, or surface area of a model.

PMI validation properties (PMI VP), on the other hand, aim at validating the completeness and correctness of the product and manufacturing information. These definitions are an integral part of model-based design and provide vital information about the design intent to downstream processes, thus creating detailed PMI VP is justified.

PMI VP cover parameters based on counting certain types of elements, e.g., the total number of PMI elements, or the number of datum targets. Other properties aim at validating the model views defined in the JT file, as well as checking the completeness of individual annotations and their correct association to the model geometry by calculating certain lengths and areas.

4.3 Participants Test Case A

Table 1 gives an overview of the participating vendors in test case A. It also shows who participated in the CAD to JT tests or in the JT to CAD tests.

Vendor	CAD to JT	JT to CAD
CT CoreTechnologie	Yes	Yes
Elysium	Yes	Yes
Siemens	Yes	Yes
Theorem	Yes	Yes
Threedy	No	Yes
T-Systems	Yes	No

Table 1: Vendor participation in test case A

4.3.1 Tested Translators

Table 2 gives an overview of the translators tested in the CAD to JT test of test case A. It also shows which CAD systems were supported by each translator.

Vendor	Translator	Version	CATIA V5	Creo 7	NX 2206	3DExperience
CT CoreTechnologie	3D_Evolution		x	x	x	–
Elysium	3DxSUITE	EX 9.1	x	x	x	x
Siemens PLM	NX, JT bidirectional to Creo and CATIA V5	12.0	x	x	x	–
Theorem	CADverter		x	–	–	x
Threedy	Instant3Dhub		–	–	–	–
T-Systems	COM/FOX	6.4.5	x	–	–	x

Table 2: Benchmarked JT translators and supported CAD formats in the CAD to JT tests

Table 3 gives an overview of the translators tested in the JT to CAD tests of test case A. It also shows which of the tested CAD systems were supported by each translator. A short summary for each translator is listed in the following subchapters.

Vendor	Translator	Version	CATIA V5	Creo 7	NX 2206	3DExperience	Viewer
CT CoreTechnologie	3D_Evolution		x	x	x	–	x
Elysium	3DxSUITE	EX 9.1	x	x	–	–	–
Siemens PLM	NX, JT bidirectional to Creo and CATIA V5	12.0	–	–	x	–	x
Theorem	CADverter	25.1	x	–	–	x	–
Threedy	Instant3Dhub		–	–	–	–	x
T-Systems	COM/FOX	6.4.5	x	–	–	–	–

Table 3: Benchmarked JT translators and supported CAD formats in the JT to CAD tests

4.3.1.1 CT CoreTechnologie: 3D_Evolution

Tested Version: 4.6

Description: 3D_Evolution is a standalone tool for data conversion, analysis and repair. The Conversion Engine supports all primary systems and data formats such as CATIA, NX, Creo, Ideas, SolidWorks, Robcad, JT, STEP, and many more.

4.3.1.2 Elysium: 3DxSUITE EX9.1

Tested Version: EX 9.1

Description: The solution 3DxSUITE is a holistic platform to support all phases of the MBE lifecycle. Therefore, the individual options are freely configurable. All common CAD systems are supported by this solution and the conversion to many native formats can be done, including JT.

4.3.1.3 Siemens PLM: NX2206

Tested Version: 2206

Description: NX is a CAD system which is capable of reading and writing many neutral and native data formats. These include JT.

4.3.1.4 Siemens PLM: JT Bidirectional Translator for CATIA V5

Tested Version: 17.0

Description: The JT Bi-directional Translator for CATIA V5 can be used to translate CATIA V5 files to JT files and JT files to CATIA V5 files. CATProduct, CATPart, CGR, and CATShape files created in CATIA V5 worksessions can be converted to JT files. The translator can be operated by using the interface, which is installed in CATIA V5, by using an interface through the operating system, or by using command prompt options. JT can be translated to CATIA V5 CATProduct and CATPart files by using command prompt options.

4.3.1.5 Siemens PLM: JT translator for Creo parametric

Tested Version: 18.0

Description: The JT translator for Creo parametric can be used for the data exchange between the CAD system Creo and JT files. The translator uses the interface of Creo parametric.

4.3.1.6 Theorem: CADverter

Tested Version: 25.1
Description: The CATIA V5 to JT CADverter is a Bi-directional direct database converter for CATIA V5 and the JT file format. It enables the user to convert all forms of 3-dimensional mechanical design geometry and assembly data, together with system defined attribute information and color information, between these two systems.

4.3.1.7 Threedy: instand3dHub

Tested Version: 3.5.3

Description: instant3Dhub is a solution for web-scale visual computing-as-a-service to enable 3D data as a key for the digital transformation. To support the complex CAD operations the solution provides access to the underlaying topological structures of the corresponding 3D data.

4.3.1.8 T-Systems: COM/FOX

Tested Version: 6.6.8

Description: COM/FOX is a translator for CATIA V5. It is able to translate CATIA V5 files to and from multiple neutral data formats, including JT and STEP AP242 XML.

4.4 Testing Procedure

In this Test Case A, the basic (mandatory) scope is the translation of geometry (XT-Brep). Furthermore, there are two extensions of this test case: 1. Semantic PMI, and 2. Validation Properties. The vendors could choose their scope before the testing started. The options were: Basic, Basic + Extension 1, Basic + Extension 2, or Basic + Extension 1 + Extension 2. In all cases, the vendors could choose to export & import, only export, or only import.

Figure 2 gives an overview of the CAD-JT-CAD benchmark testing procedure. The quality of each individual step was checked and the errors that had occurred in the first step did not affect the results of the second step.

JT Geometry and validation properties were checked with Technia LiteBox/xCompare. PMI were checked with the PMI Print tool from Siemens (part of JT Toolkit), which writes out all PMI that are contained in a JT file and with the help of an Excel-based evaluation it was possible to check whether all PMI were included. During the import, the geometry was checked using the model properties (center of gravity), PMI were checked using a visual comparison and the validation properties were also checked using the model properties.

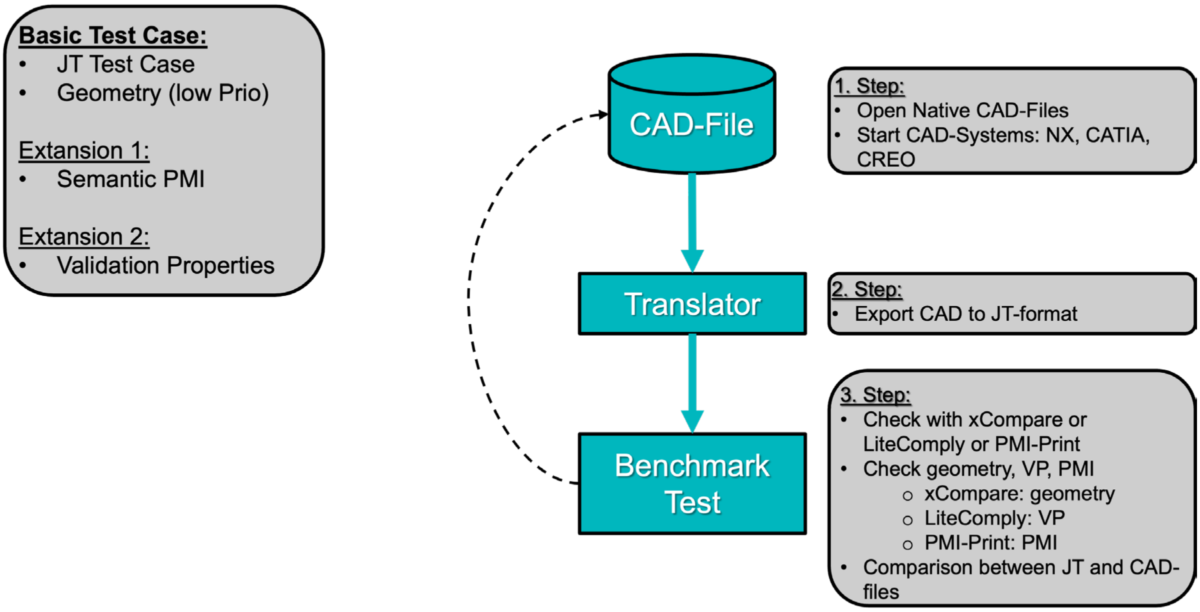

Figure 2: Testing procedure for CAD-JT-CAD benchmark

4.5 Test Models

The models for test case A are a vise assembly, with the parts Base, Cheek, Spindle, and Pole. Additional to this, the NIST CTC models 3 and 4 are used in benchmark.

NIST has created a Test System to measure conformance of Computer-Aided Design (CAD) software to American Society of Mechanical Engineers (ASME) standards for Product and Manufacturing Information (PMI), specifically geometric dimensioning and tolerancing (GD&T) information. A Combined (or Complex) Test Case (CTC) is a combination of Atomic Test Cases (ATC). An Atomic Test Case highlights an individual PMI annotation to be tested, called the measurand. The ATC is not a complete specification of the part's PMI, but rather contains only the PMI needed to specify enough context information to understand the measurand. Typically, this means one or more examples of the measurand, along with any datum features referenced. ATCs, although useful for conformance testing, are not "realistic" in that they include only measurand-related PMI. A CTC is not intended to be a fully-toleranced test case, it is only a combination of PMI from a set of ATC.

All the models were created in all tested CAD formats. The NIST models are constantly updated to the latest CAD software by the respective system vendors, to improve the definition of the models using the latest CAD system capabilities. Figures 3, 4 and 5 show the tested models.

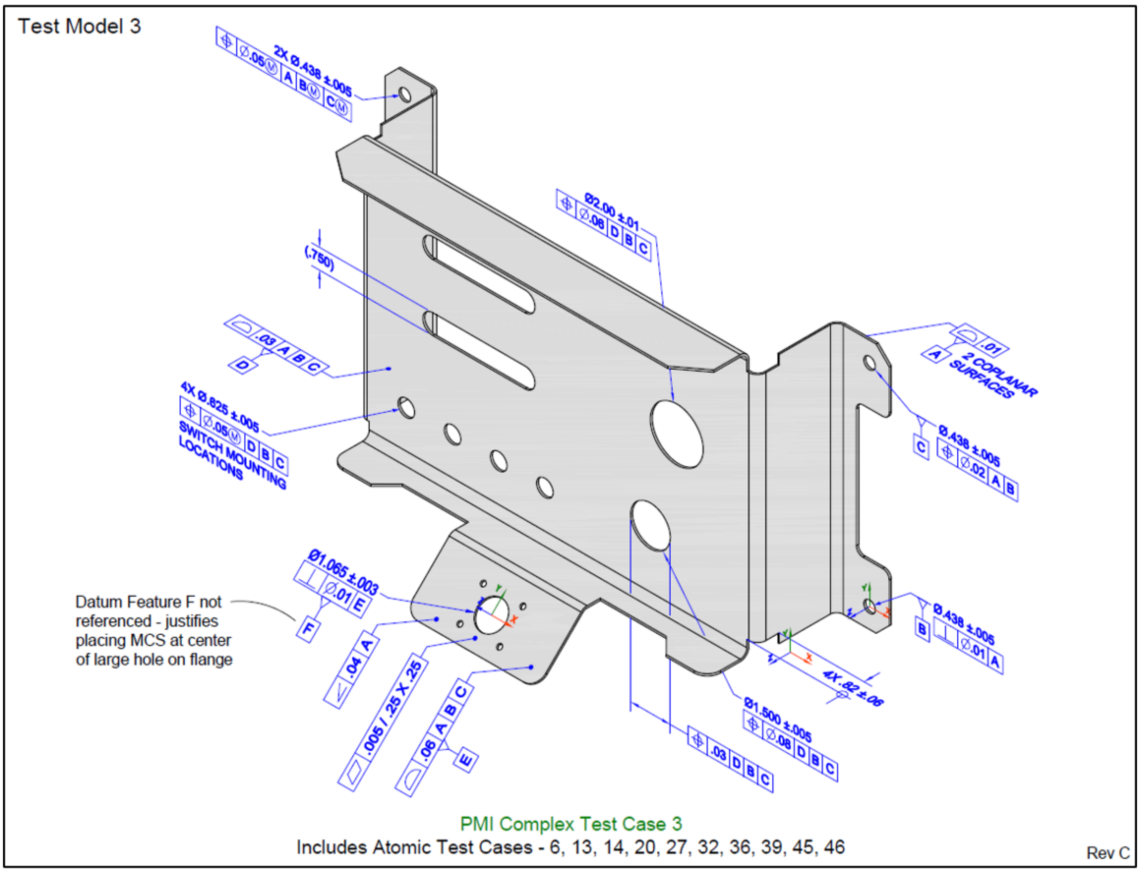

Figure 3: Figure of NIST CTC PMI Test Model 3

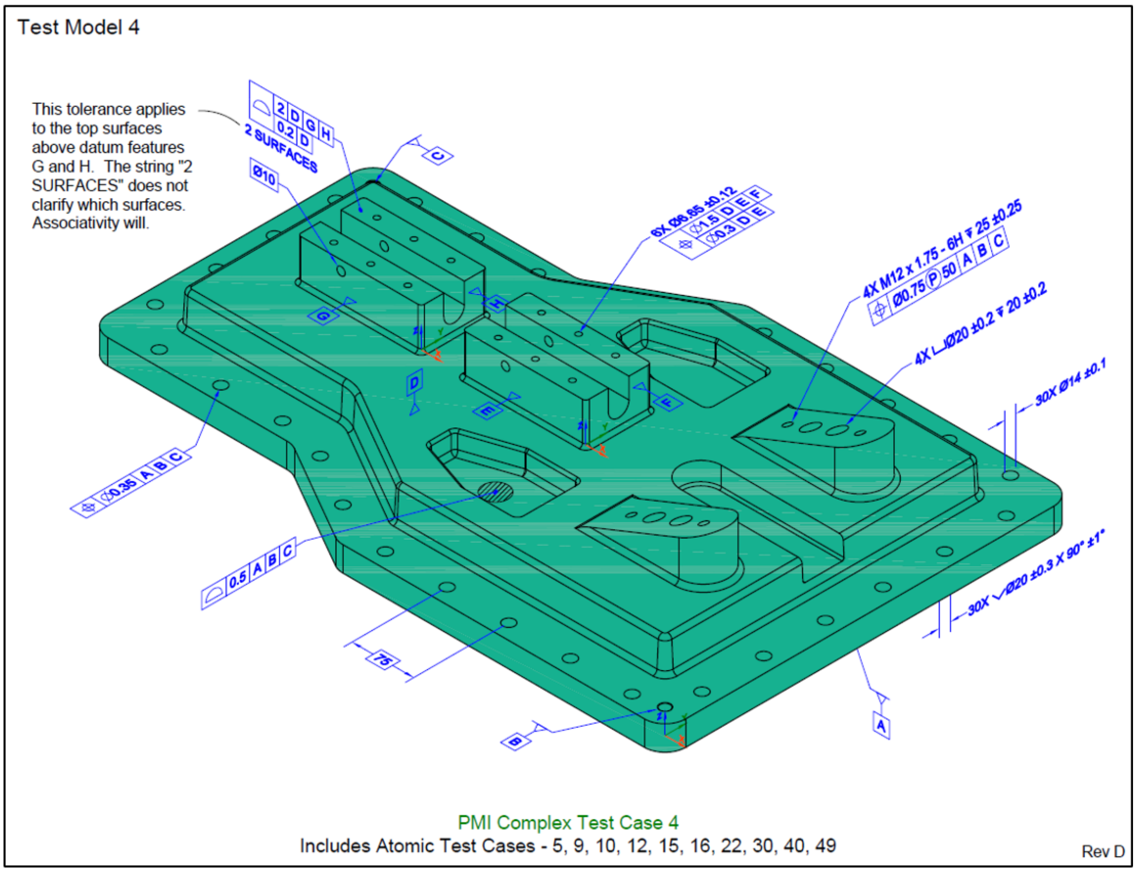

Figure 4: Figure of NIST CTC PMI Test Model 4

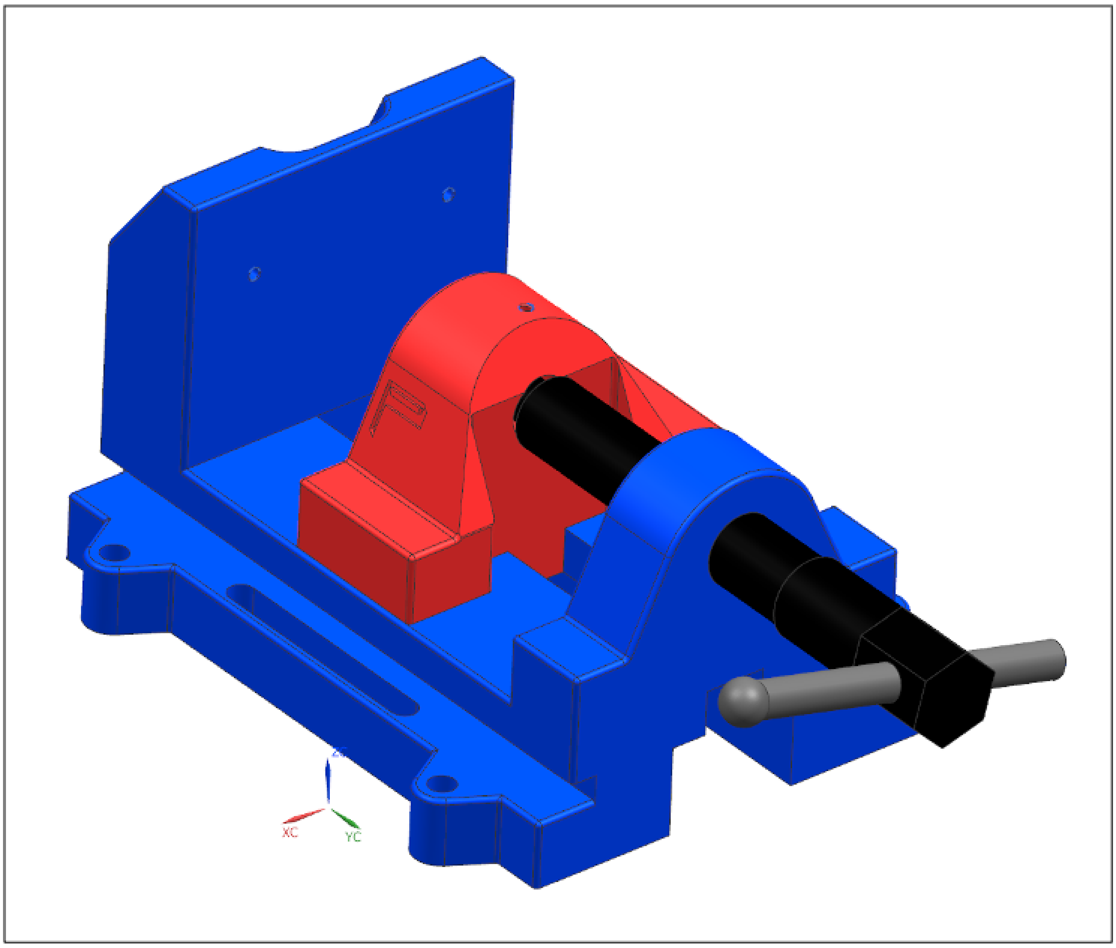

Figure 5: Vise test model

Table 4 shows the PMS annotations, which are contained in the models:

Category	Symbol	Description	Model
Form	⌒	Profile any line	
	⌓	Profile any surface	
Orientation	//	Parallelism	
	⊥	Perpendicularity	
Location	⌖	Position	
Additional Symbols	Ⓟ	Projected tolerance zone	
	Ⓜ	Maximum material requirement	
Tolerance Frame	// | 0,1 | A	tolerance frame: datum	
	◎ | ⌀0,1 | A-B	tolerance frame: circular tolerance zone	
	6 x ▱ | 0,2 ; 6 x ⌀12 ± 0,02 ⌖ | ⌀0,1	multiple feature	
	— | 00,1 ; // | 00,6 | B	multiple geometric characteristics for a feature	
	— | 0,1 ; 00,5/200	two or more tolerances of the same characteristic	
ISO 5459	A A	Datum feature indication	
Basic Spec for linear size	2; ⌀38 +0,2 −0,1; 55 ± 0,2	Nominal size	

Table 4: PMI Annotations in test models

4.6 Result Summary Test Case A

In the following, the results for the two steps of test case A are presented.

4.6.1 CAD to JT test results

In the first step of test case A, the quality of CAD to JT with PMI and validation properties was evaluated. An overview of the results is given in Figure 6, Figure 7 & Figure 8. The tests showed very good results for the translation of geometry as well as for PMI and validation properties.

If a vendor has stated in advance that they do not support a criterion or will not participate in a specific test case extension in this benchmark, the criterion is “not supported”. If a vendor has specified a criterion to be supported during import, but the file to be imported does not contain a PMI or validation property, the criterion is “not tested”.

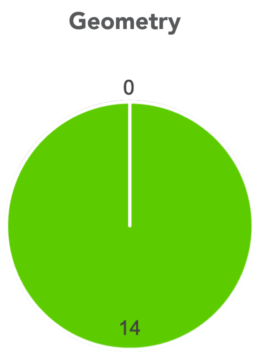

Figure 6: CAD to JT results, Geometry

All 14 translators translated the geometry and PMI according to all criteria correctly.

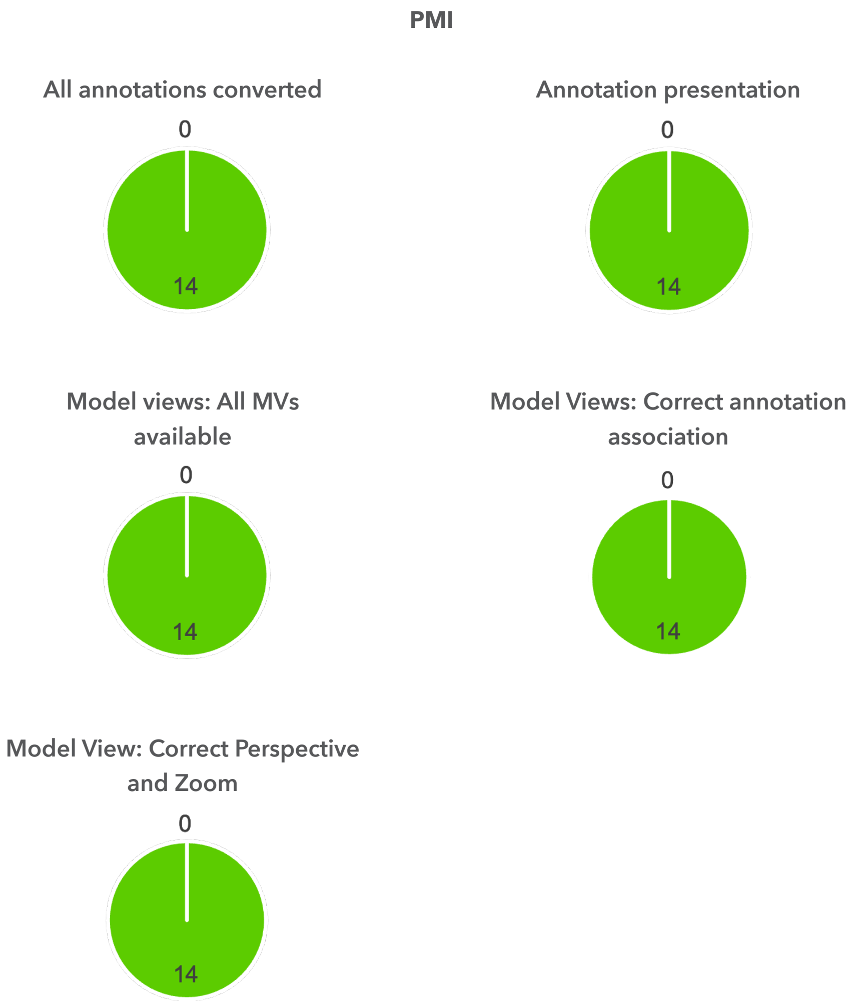

Figure 7: CAD to JT results, PMI

All tools support the export of PMI and met all criteria for correct translation.

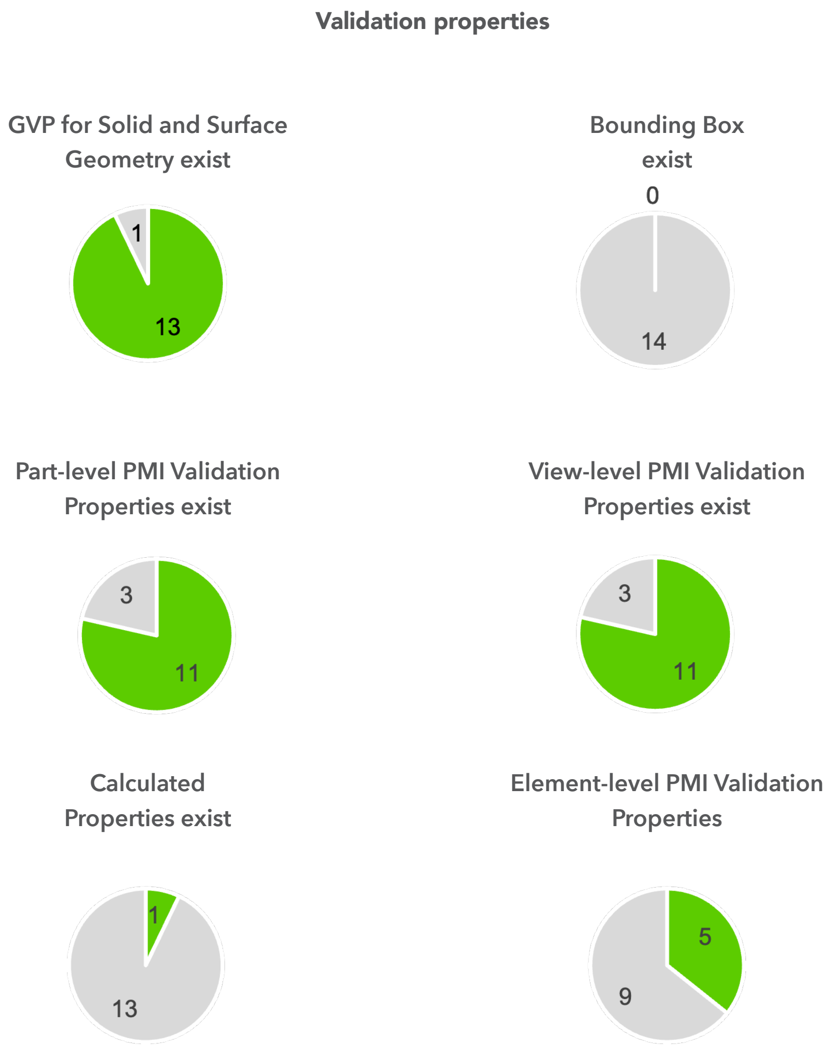

Figure 8: CAD to JT results, Validation properties

Before the benchmark, all vendors were asked which validation properties were already supported by their tools. Of the translators who took part in this test case, all but one tool supports the export of GVP for solid and surface geometry, none support the creation of the validation property "Bounding Box", eleven of the 14 tools support the export of part-level and view-level validation properties and one of the tools supports the creation of "Calculated properties".

4.6.2 JT to CAD/JT to Consuming Application results

In the second step of test case A, the quality of JT to CAD or consuming applications with PMI and validation properties was evaluated. An overview of the results is given in Figure 9, Figure 10, Figure 11. The tests showed very good results for the translation of geometry as well as for PMI and validation properties.

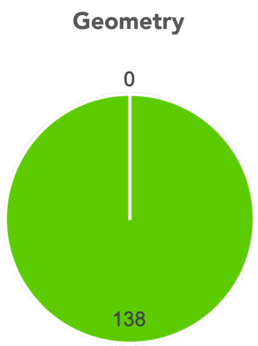

Figure 9: JT to CAD results, Geometry

All 138 imports were successful on the geometry side.

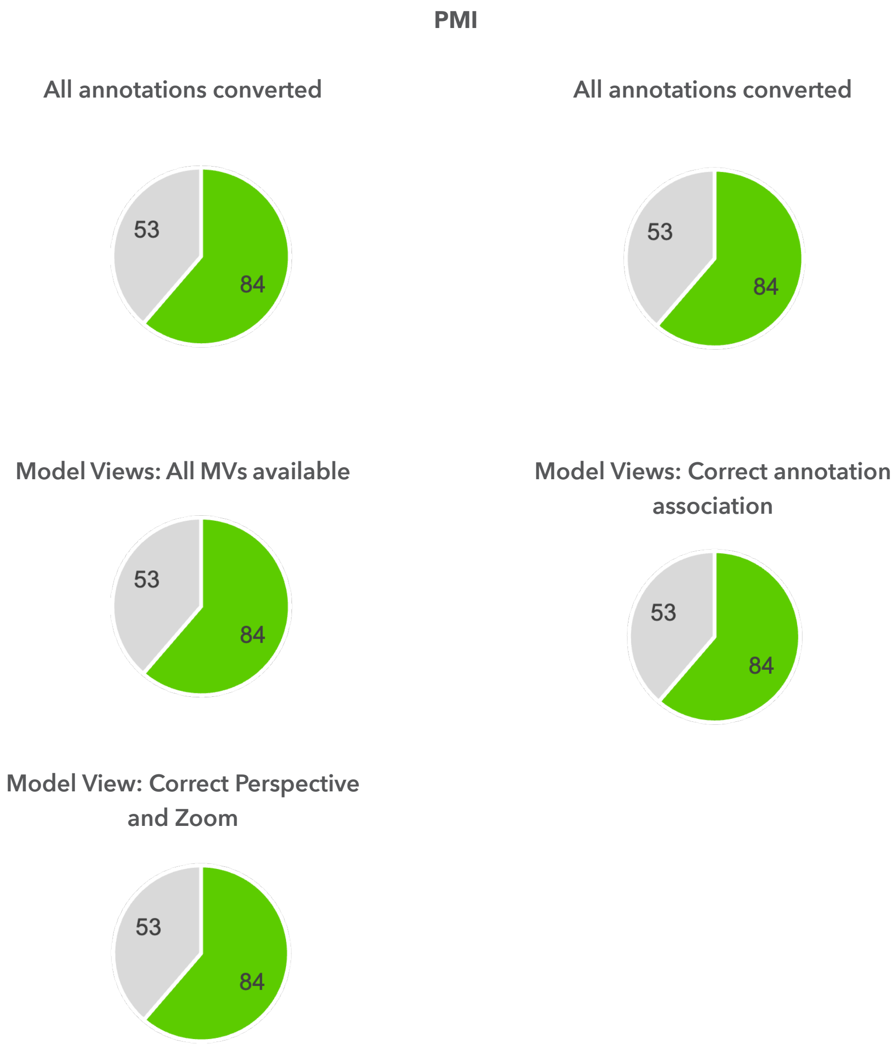

Figure 10: JT to CAD results, PMI

Of the 138 imports, 85 support the import of PMI and met all criteria.

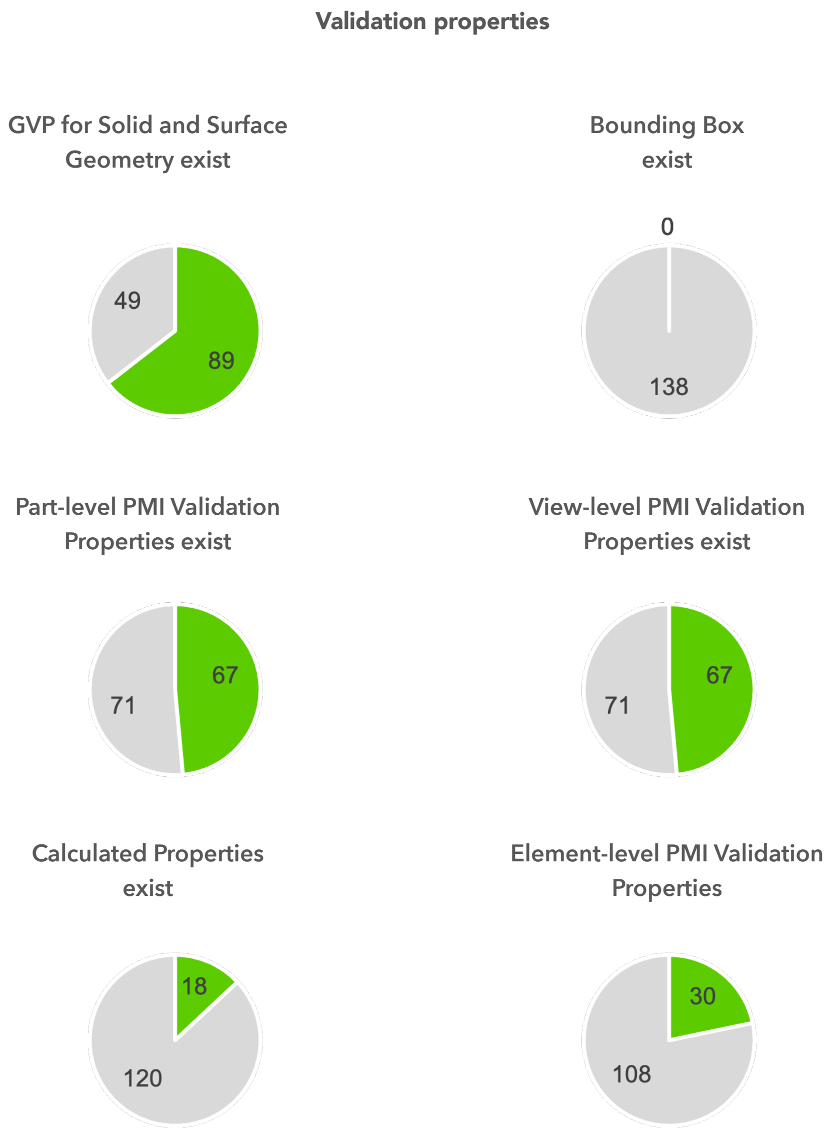

Figure 11: JT to CAD, Validation Properties

As with export, the vendors were able to specify whether they support a specific validation property when importing or not, which results in the corresponding values. If a validation property was not supported during export but would be supported during import, the criterion for import is "not tested". All supported validation properties were present.

5 Test Case B

Test case B includes the check of AP242 XML Assembly Structure + JT Geometry. The vendors could also decide if they want to test the basic AP242 XML assembly structure or the basic with the extensions: kinematic mechanism or validation properties.

5.1 Scope

- **AP242 Ed.3 Domain Model XML Assembly Structure** is an implementation format introduced with AP242, and the designated process format for many applications in the aero-space and automotive industries. It will be used in combination with geometry formats matching the respective requirement. In the JT benchmark, the geometry files will be in JT format. The XML files contain the assembly structure and part master information.
- **Kinematic Mechanism** is a capability in AP242 that allows describing the motion of parts over time and in relation to each other. This includes the definition of mechanisms with joints and constraints, defining the kinematic relationships between the parts, as well as motions, which are defined by capturing the positions of the moving parts at discrete points in time. Implementations of this capability are rather new, and all vendors are so far supporting only a basic scope, based on initial industry test cases.
- **Validation Properties** are a type of meta data, as they provide information about the model they are derived from, inside the model. Validation properties are key characteristics of a model, which are deemed important for the respective use case and thus shall not be modified during translation and exchange.

5.2 Criteria

The following criteria were defined by the JT Workflow Forum. Details, especially the validation methods, were elaborated in collaboration with the JT Implementor Forum.

The used CAD source formats for the CAD to JT + AP242 XML translations and the target CAD formats for the JT + AP242 XML to CAD translations were CATIA V5-6R2022, Creo7 and NX2206. The used JT format for all translations was JT according to DIN Spec 91383:2021 (JT IAP v3).

5.2.1 Structural Criteria

Independent from the used option for the file structure, the resulting models should fulfill the following criteria:

- The assembly structure in the target system is equivalent to source assembly structure
- The positions of all instances are correct in target application
- The instantiation of components in assembly are equivalent to source definition

5.2.2 Kinematic Mechanism Criteria

The AP242 Domain Model supports Kinematic Mechanism, providing all joint definitions, relationships and constraints between the elements so that their definition can be interpreted or changed in the receiving application, as well as Kinematic Motion, which works like a movie by providing discrete positions of the components over time. Kinematics are used to ensure the components of a model move correctly, and also illustrate the behavior of the finished product. Kinematic Mechanism is the primary use case and the corresponding definitions shall be included in all provided files. Regarding the correctness of the Kinematics the models were checked by different tools.

To describe the Kinematic geometric constraints, the following templates are involved:

- Curve/Surface
- KinematicLink
- KinematicPair
- Mechanism
- Import Mechanism

5.3 Participants Test Case B

Table 5 gives an overview of the participating vendors in the translation quality benchmark. It also shows who participated in the CAD to JT + STEP AP242 XML tests or in the JT + STEP AP242 XML to CAD tests.

Vendor	CAD to JT + STEP AP242 XML	JT + STEP AP242 XML to CAD
CT CoreTechnologie	Yes	Yes
Elysium	Yes	Yes
Siemens PLM	Yes	Yes
Theorem	Yes	Yes
Threedy	No	Yes
T-Systems	Yes	No

Table 5: Vendor participation in the translation quality benchmark

5.3.1 Tested Translators

Table 6 gives an overview of the translators tested in the CAD to JT + AP242 XML test of test case B. It also shows which CAD systems were supported by each translator.

Vendor	Translator	Version	CATIA V5	Creo 7	NX 2206
CT CoreTechnologie	3D_Evolution		x	x	x
Elysium	3DxSUITE	EX 9.1	x	x	x
Siemens PLM	NX, JT bidirectional to Creo and CATIA V5	12.0	x	–	–
Theorem	CADverter	25.1	x	–	–
Threedy	Instant3Dhub		–	–	–
T-Systems	COM/FOX	6.4.5	x	–	–

Table 6: Benchmarked JT translators and supported CAD formats in the CAD to JT tests

Table 7 gives an overview of the translators tested in the JT + AP242 XML to CAD tests. It also shows which of the tested CAD systems were supported by each translator. A short summary for each translator tool is listed in the following sub-chapters.

Vendor	Translator	Version	CATIA V5	Creo 7	NX 2206	Viewer
CT CoreTechnologie	3D_Evolution		x	x	x	x
Elysium	3DxSUITE	EX 9.1	–	–	x	–
Siemens PLM	NX, JT bidirectional to Creo and CATIA V5	12.0	x	–	x	x
Theorem	CADverter	25.1	x	–	–	–
Threedy	Instant3Dhub		–	–	–	x
T-Systems	COM/FOX	6.4.5	x	–	–	–

Table 7: Benchmarked JT translators and supported CAD formats in the JT to CAD tests

5.3.1.1 Tested Solutions

For the description of each solution, please see Tested Translators 4.3.1.

5.4 Testing Procedure

In Test Case B, the basic (mandatory) is the AP242 XML Assembly Structure + JT Geometry. Like in Test Case A, there are also 2 extensions: 1. Kinematic Mechanism and 2. Validation Properties. The vendors could choose their scope before the testing started. The options were: Basic, Basic + Extension 1, Basic + Extension 2, or Basic + Extension 1 + Extension 2. So also in this case, the vendors could choose to export & import, only export, or only import.

Figure 12 gives an overview of the CAD-JT-CAD benchmark testing procedure. The quality of each individual step was checked and the errors that had occurred in the first step did not affect the results of the second step.

Product structure, PMI and attributes were checked manually, while the geometry was checked by control of the properties.

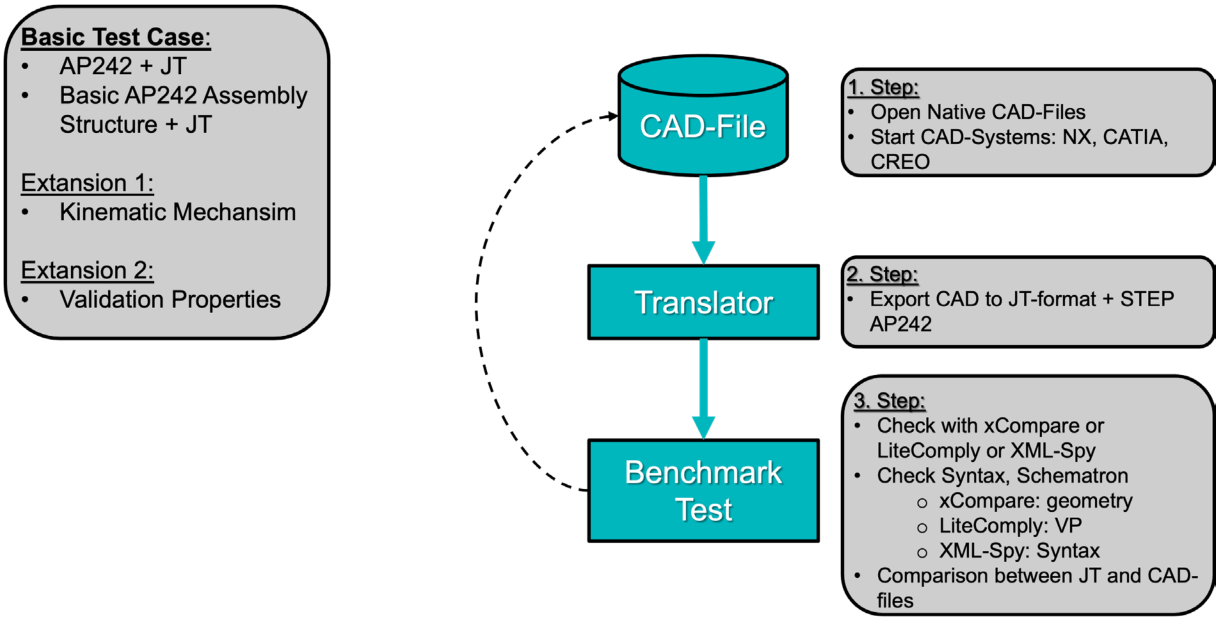

Figure 12: Testing procedure for CAD-JT-CAD benchmark

5.5 Test Model

In test case B, the "Gripper" test model is used. The model was originally developed by Stefani Maschinenbau and is provided by Audi and Volkswagen via prostep ivip / VDA JT Workflow Forum. It represents a gripper tool used in a production line assembly. This production-like model is used for internal pilot projects at Volkswagen and Audi and is being shared with the implementor forums for testing exclusively within these groups.

Figure 13 shows the CATIA test model and its assembly structure. The NX model has a similar structure. The Creo model only contains the designed parts, but no standard parts such as pneumatic cylinders etc.; the Creo model also does not contain any kinematics.

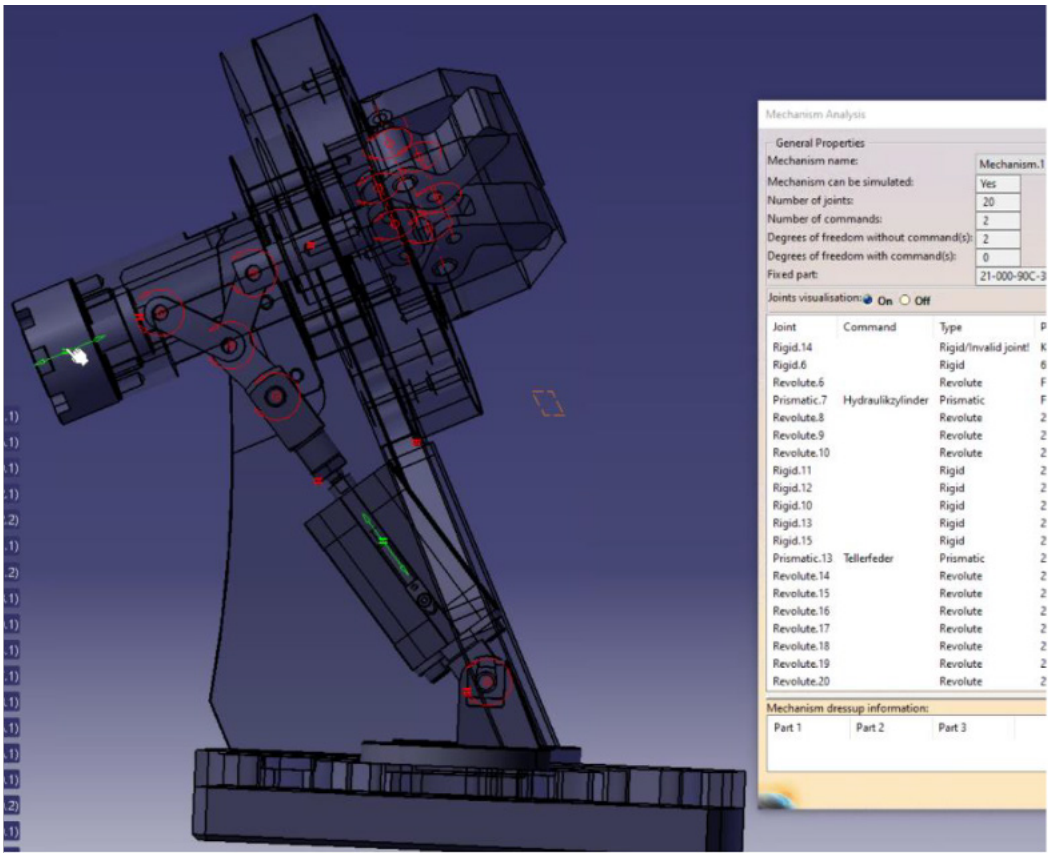

Figure 13: Illustration of the KM2 test model with indicated kinematic

Regarding the testing scope, the following has been agreed:

- Kinematic Mechanism is the primary use case and the corresponding definitions shall be included in all provided files.
- Assembly & Kinematic Data shall be provided in a single AP242 BO Model XML file, using the schema indicated above.
- Geometry shall be included as JT files (JT IAP v3 / v10.5 or JT IAP v2 / v10.0)

5.6 Result summary Test Case B

In the following, the results for the two steps of test case B are presented.

5.6.1 CAD to JT + STEP AP242 XML results

In the first step of test case B, the quality of CAD to JT + AP242 XML assembly structure with kinematics and validation properties was evaluated. An overview of the results is given in Figure 14, 15 & 16. The tests showed very good results for the translation of the assembly structure as well as for kinematic mechanism and validation properties.

Legend: ■ **OK** ■ **Failed** ■ **Not supported/Tested**

If a vendor has stated in advance that they do not support a criterion or will not participate in a specific test case extension in this benchmark, the criterion is "not supported". If a vendor has specified a criterion to be supported during import, but the file to be imported does not contain kinematics or a validation property, the criterion is "not tested".

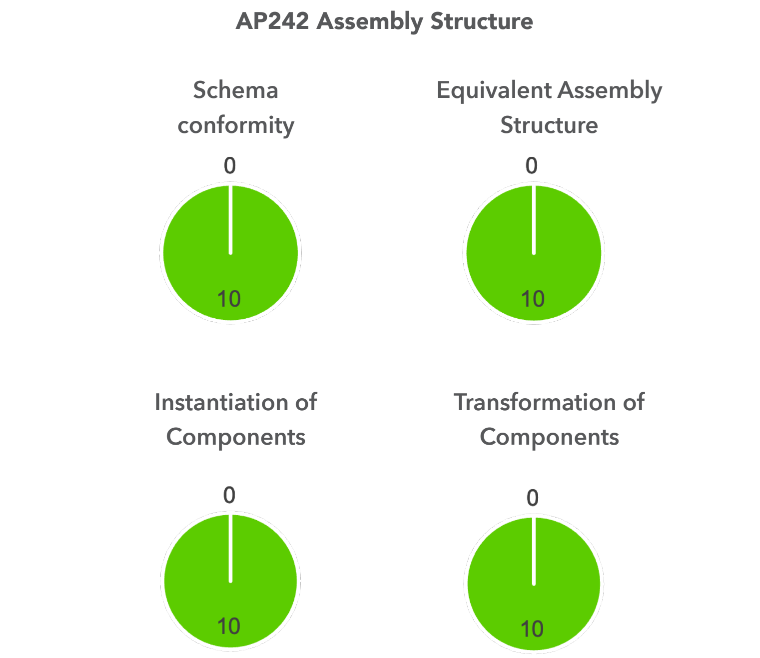

Figure 14: CAD to JT + AP242, Assembly Structure

All 10 translators translated the assembly structure to AP242 XML with JT geometry correctly.

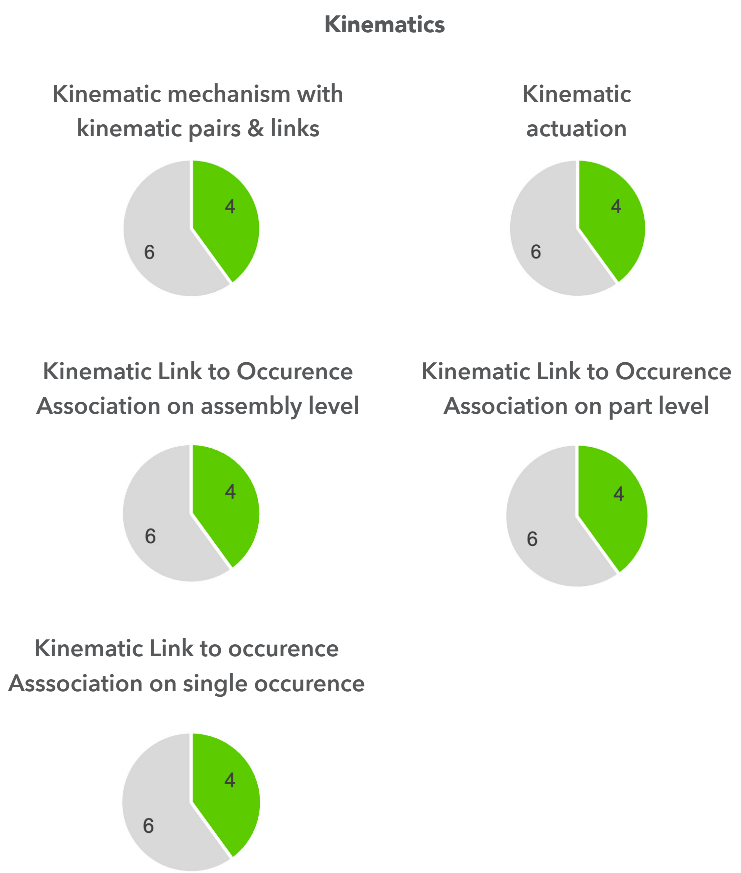

Figure 15: CAD to JT + AP242 XML, Kinematics

In the test case extension "Kinematics", 4 of the 10 translators took part and met all the criteria set in the benchmark when exporting kinematic mechanism.

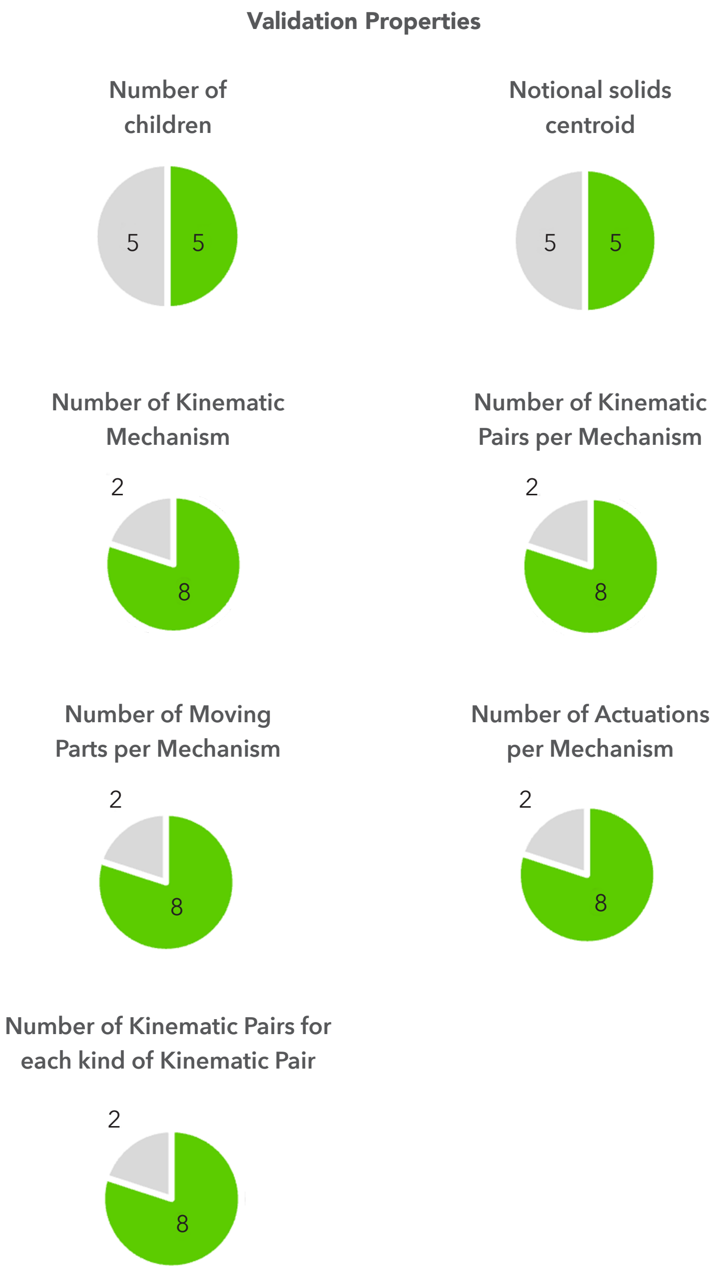

Figure 16: CAD to JT + AP242 XML, Validation Properties

In the test case extension "Validation Properties" for AP242, 8 of the 10 translators took part, "Number of children" and "Notional solids centroid" was supported/tested in five cases.

5.6.2 JT + STEP AP242 XML to CAD/JT + AP242 XML to Consuming Application results

In the second step of test case B, the quality of JT + AP242 XML to CAD or consuming applications with kinematics and validation properties was evaluated. An overview of the results is given in Figure 17, 18 & 19. The tests showed very good results for the translation of geometry as well as for PMI and validation properties.

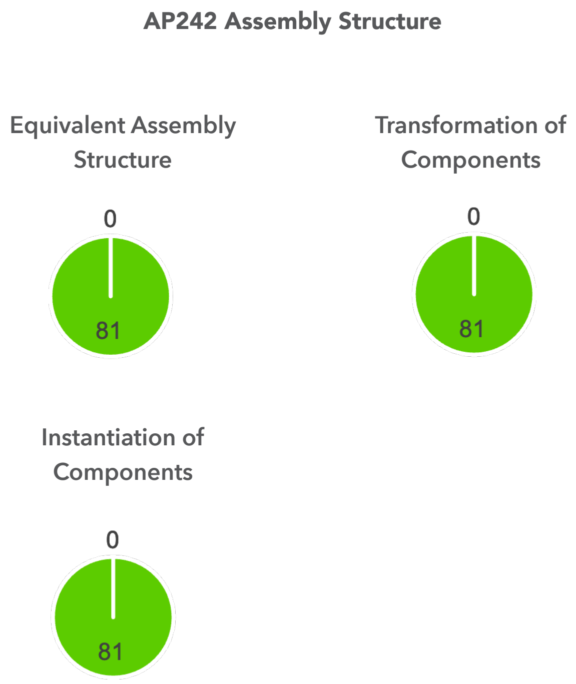

Figure 17: JT + AP242 XML to CAD/Consuming Application, Assembly Structure

All 81 imports were successful in terms of the assembly structure criteria.

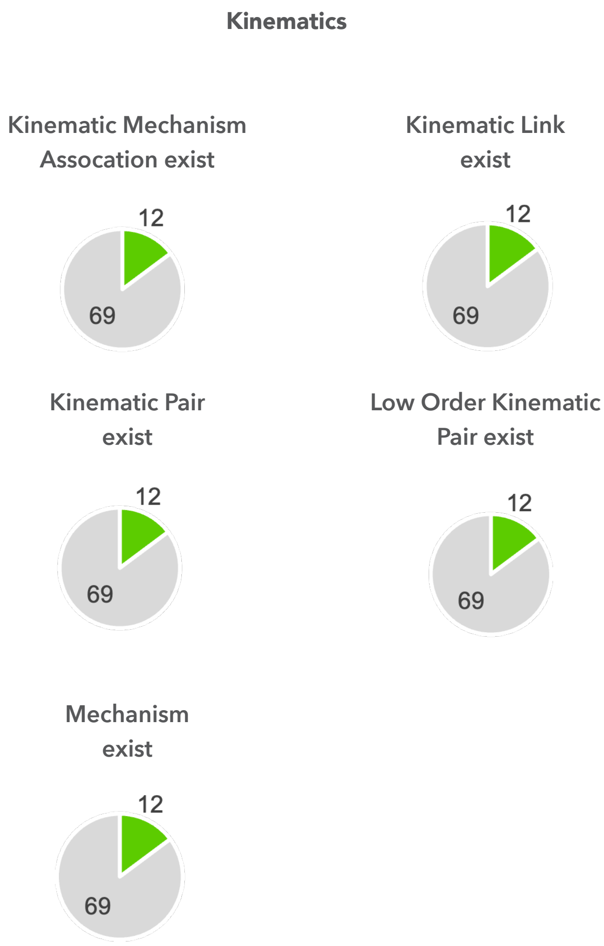

Figure 18: JT + AP242 XML to CAD/Consuming Application, Kinematics

In the 12 cases in which kinematics were supported during export and import, the import was carried out successfully.

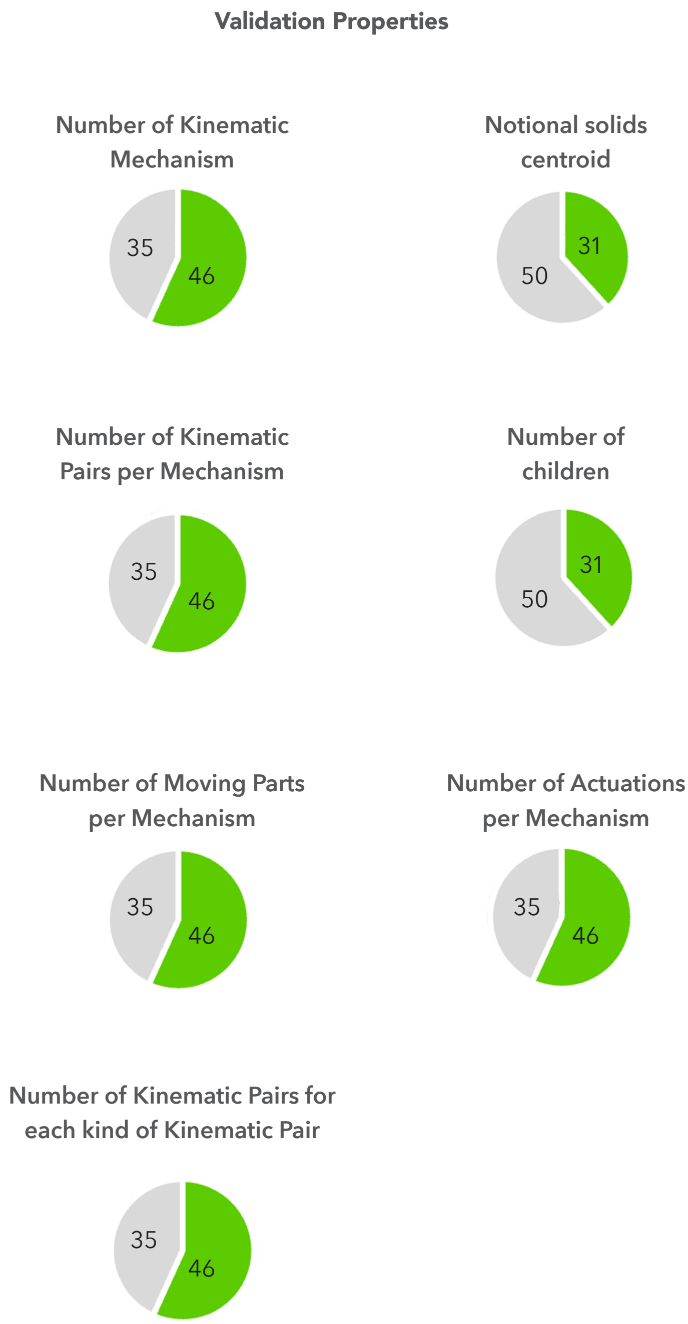

Figure 19: JT + AP242 XML to CAD/Consuming Application, Validation Properties

In cases where validation properties were supported during export and import, or the export was successful, the import was carried out successfully.

6 Summary and Outlook

The Benchmark has proven the capabilities of JT translators and consuming applications. The high level of JT data exchange quality achieved during the JT Implementor Forum test rounds has been confirmed independently, using production versions of the participating software tools. Hence, the JTIAP v3 (PSI 14/Part 1 Version 3) / DIN Spec 91383:2021 specification can be seen as a mature, reliable, and robust foundation for collaborative 3D engineering processes.

Taking advantage of the latest versions of the underlying standards, JT and STEP AP242 Domain Model XML, has also allowed to significantly increase the scope of this Benchmark compared to previous iterations. Product and Manufacturing Information (PMI) is now reliably transferred as semantic data in JT, which allows for automated consumption by target applications. This will allow to reduce manual interaction in cross-domain processes and to further move towards a model-based way of working. The corresponding Validation Properties will help to ensure that no information is lost along the way. This concept, which is well-proven in other exchange standards, has now been carried over to JT and, as shown during this Benchmark, is successfully supported by a growing number of software tools.

With Edition 3, published end of 2022, STEP AP242 adds support for an entirely new use case in its Domain Model XML representation: Kinematic Mechanism. Based on use cases where the static representation of a component is not sufficient to validate a system, user companies and software providers have worked together over the past years to implement support for this new capability, combining the advantages of AP242 XML and JT. Of course, in such a short time it is not possible to support the full scope of such a complex capability. But this Benchmark has proven that the concept itself works, by successfully transferring Kinematic Mechanisms with basic joint types such a revolute and prismatic pairs, from one system to another so the mechanism could be run in the target application. First JT translators will add support for Kinematic Mechanism in their production versions in 2024, further increasing the versatility of standards-based data exchange.

The Benchmark has been conducted in a trusted atmosphere, with constructive feedback supporting the direct communicated and solution of issues. This allows the vendors to consider the benchmark results in their development efforts and to further improve the interoperability between the various tools.

In closing, it can be said that the 9th prostep ivip / VDA JT Application Benchmark has proven the great level of reliability of standards-based data exchange. Furthermore, it has shown that the JT Industrial Application Package, also known as DIN Spec 91393, is a living environment where the standard itself as well as the applications built on it can accommodate the growing breadth and depth of user requirements. It clearly illustrates the value of the processes established by the JT Workflow Forum and JT Implementor Forum. Their joint efforts not only constantly increase the reliability of using JT and AP242 XML for collaborative model-based processes but are also capable of getting entirely new capabilities such as Kinematic Mechanism ready for market in a reasonable timeframe.

7 Acknowledgements

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