VDA	Long term archiving (LTA) of digital product data which are not based on technical drawings Part 3: Data model	4958 T 3

This recommendation serves to establish basic, common requirements regarding the processes, data and organization of the long-term archiving of digital product data generated during product development that is not based on technical drawings. It is the result of the project carried out by the VDA “Long-Term Archiving” project group, which is part of the VDA “CAD/CAM” working group. The VDA recommends its application.

1st edition from September 2006

VDA Working Group "CAD/CAM"

Published by: Verband der Automobilindustrie
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The document is a translation of the German version. Therefore the German document represents the original and should be referenced in the case of discrepancies. Due to the fact that this document is a translation, it may be the case that the English text leaves room for interpretation because certain terms are often deeply rooted in the original language, and therefore it is not possible to translate them into another language without a certain degree of ambiguity arising.

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1 General

1.1 Preface

The introduction of digital technology throughout the lifecycle of an automobile has brought about fundamental changes in the handling of product data. These changes also affect the long-term archiving of digital product data in particular.

Up until now, the long-term archiving (LTA) of product data involved the creation and storage of 2D drawings. Administrative and organizational product data (PDM/PLM data) was archived as part of the 2D drawing (e.g. in the title block) and/or in other documents. Without 2D drawings, the 3D CAD model shall fulfill the same requirements for long-term archiving.

The recommendation VDA 4958 was drawn up because there were previously no rules according to which 3D CAD data could be archived securely and later be accessed and interpreted.

This part of the recommendation, Part 3, builds on Parts 1 and 2 (see 1.5) and addresses the following aspects:

- Description of a procedure for identifying and specifying LTA-relevant content and administrative information and for mapping this information to standardized, LTA-conform implementation methods.
- Identification and description of the requirements regarding LTA-relevant content and administrative information for the archiving of 3D CAD data and associated non-geometric product data.
- Identification of criteria for selecting one or more suitable implementation options.

1.2 Objectives and scope of application

The existing recommendations are relevant to development and documentation processes if 3D representations (3D master models) are the only basis for development and documentation and if the established 2D archiving processes are not longer applicable due to economic or technical aspects.

The description of the data and models relevant to long-term archiving refers to 3D CAD data and requisite non-geometric data. With regard to this data, every company must give due consideration to generally accepted rules and recommendations regarding the archiving of digital documents such as, for example, security and backup solutions in the archive system.

VDA 4958-3 provides methodical recommendations for the definition and mapping of LTA-relevant information to standards, as well as their company-specific application. Part 3 also provides an overview of the relevant information that must be archived and additional information that should also be archived. Recommendations regarding the data required to manage the relevant product data are also provided. Part 3 is valid in conjunction with the other parts of VDA 4958.

The recommendations in this part are intended to ensure that the data to be archived is stored correctly and can be reconstructed at any time to allow it to be viewed and interpreted by humans. This is intended to ensure that manufacture of the product described by the data can be reproduced and repeated.

1.3 Changes compared with previous version

Version	Change	Chapter	Page
1.0	No changes; first edition		

1.4 Compatibility with previous version

Not applicable; first edition.

1.5 Structure of the recommendation

Part 1 identifies requirements relating to the long-term archiving of product data that exists in digital form only and summarizes certain legal and technical aspects. Part 1 provides the basis for the other parts of the recommendation.

Part 2 describes typical use cases and provides recommendations for designing the processes used to prepare the data for long-term archiving, the archiving of the data itself, and the process steps required to access and reprocess the archived data. The primary goal is safeguarding the quality of the data and the documents.

Part 3 defines the minimum requirements to be satisfied by the archived information regarding the information in the 3D CAD representations and product structure descriptions from the user's point of view and concerning the process definition.

Chapter 2 provides basic recommendations for handling LTA-relevant Content Information giving due consideration to possible use cases for data usage that need to be supported.

Chapter 3 describes a general procedure for defining the data to be viewed in concrete use cases, the mapping of this data to descriptive standards and to implementation standards. The application of this procedure with regard to development and documentation data for 3D representations and non-geometric product information is described.

Chapter 4 identifies the LTA-relevant information by means of a data dictionary.

Chapter 5 presents possible archiving scenarios.

Chapters 6 and 7 provide examples illustrating the mapping of the requirements to standards for describing and implementing the information objects.

Work on Part 4 is currently in progress. Part 4 provides recommendations for the verification of reliable LTA workflows as the basis for certification.

1.6 Abbreviations, definitions and normative references

1.6.1 Abbreviations

3D	three **D**imensional
AIP	**A**rchival **I**nformation **P**ackage
AP214	**A**pplication **P**rotocol **214** – ISO 10303-214

CAD	**C**omputer **A**ided **D**esign
CI	**C**ontent **I**nformation
DI	**D**escriptive **I**nformation
DIN	**D**eutsches **I**nstitut für **N**ormung e. V.
DIP	**D**issemination **I**nformation **P**ackage
GD&T	**G**eometric **D**imension **& T**olerances
ID	**Id**entification
ISO	**I**nternational **O**rganization for **S**tandardization
JT	**J**upiter **T**essilation
LTA	**L**ong**T**erm **A**rchiving
OAIS	Reference Model for an **O**pen **A**rchiving **I**nformation **S**ystem
PDF	**P**ortable **D**ocument **F**ormat
PDI	**P**reservation **D**escription **I**nformation
PDM	**P**roduct **D**ata **M**anagement
PI	**P**ackage **I**nformation
PLM	**P**roduct **L**ife Cycle **M**anagement
SIP	**S**ubmission **I**nformation **P**ackage
SASIG	**S**trategic **A**utomotive product data **S**tandards **I**ndustry **G**roup
STEP	**ST**andard for the **E**xchange of **P**roduct Model Data
TDM	**T**eam **D**ata **M**anagement
UML	**U**nified **M**odelling **L**anguage
VDA	**V**erband **d**er **A**utomobilindustrie
VP	**V**alidation **P**roperties

1.6.2 Definition of terms

3D model: is a three-dimensional representation of product data in digital form, which primarily defines the shape of the product.

Annotations: are part attributes and technical specifications such as, for example, GD&T information (dimensions, tolerances and symbols), production-specific information, as well as all non-geometric information, text and non-geometric data associated with the 3D model.

Archiving: Certified processes for writing, saving/storing and reusing information in an archive.

Associativity: relation from an entity to its associated information that can be represented. Example: Information about length, position and tolerance of a line (geometrical element) can be retrieved and represented. VDA 4958 focuses on bidirectional associativity, i.e. the relationship between geometric elements themselves and associated annotations and not the associativities typically found for changes to the model in parameter-oriented CAD systems where, for example, a change in the dimensions automatically results in a change in the geometry and vice versa.

Core model: Identifies the necessary minimum of the data, rules and dependencies, which ensures the interpretability of a 3D model (concerning functionality and features) during the archiving period.

Data schema: describes a basic specification for defining information objects, their attributes, structure and interdependencies. The LTA data is stored according to a data schema that guarantees that the data can be reconstructed and interpreted even after a significant period of time has elapsed.

Digital engineering signature: is a digital signature which is normally used to confirm the correctness of the contents of a document. Vital to the signature is the reference to the person affixing the signature.

Digital time signature: is normally an automatically generated, digital signature that seals a document. Vital to the signature is the time stamp documenting when the signature was affixed.

Document: A document is a container for (in this context) any type of product data. A document can be assigned to a component or other object (e.g. project, change request) and exists in either physical (paper, microfiche) or digital form.

EXPRESS: is a formal data modeling specification according ISO 10303-11

Information block: represents a group of topically-related information objects.

Intelligent document: is an electronic document with a conventional appearance that combines the attributes of static documents and the contents (the Content Information in the document) with embedded logical functions. In applications, these functions allow, for example, interactive associativities to be identified or the view to be adapted as required by, for example, hiding geometric elements or callin up predefined clipping planes in the 3D model. They also support associativities between text and geometry.

Master model (also 3D master)**:** is the primary 3D model representation of a product and for the most part contains a detailed description of the geometric shape, but can also include dimensions, tolerances and other product data. A master model is normally used as the basis for deriving other documents that describe a product.

Presentation: Depiction of an element or piece of information in a certain way, e.g. the visualization of the contents of a file on the screen.

Representation: is the (interpretable) form of information regarding a circumstance or an element. Example: The 3D CAD data stored on a data carrier (as bits and bytes) are interpreted by a program and presented on the screen in a different form (as a geometric image) for interpretation by humans.

Semantics: define the meaning of terms and information objects in a defined context. Example: In the context of 3D geometry, a solid is the extension of a surface model that allows the description of a volume by means of additional design rules.

Validation properties: Predefined parameters which are used to check the validity of, for example, a geometric model or the hierarchy of a product structure after the conversion of Content Information. Validation properties examples include centre of gravity and number of assembly knots within a product structure.

Version: A version represents a specific stage of design or maturity of a part, document, or geometric model.

Administrative data: Information directly relating to utilization of the archive environment, the storing and later use of the content data.

1.6.3 Terms from ISO 14721

The recommendations contained in this document reference the" Open Archival Information System (OAIS)" function model described in ISO 14721, referred to in the following by the acronym OAIS.

Certain important terms from ISO 14721 (OAIS) are described briefly below. These descriptions do not, however, replace the definitions provided in ISO 14721.

Archival Information Package (AIP, corresponding to IPA): The AIP consists of the following elements:

- Content Information (CI) (archiving formatted and optionally native formatted)
- Packaging Information (PI)
- Preservation Description Information (PDI) (Validation Properties, context information for the Content Information)
- Digital Signature Information

Content Information (CI, corresponding to NI): is the set of digital (content) information that is the original target of preservation and the corresponding presentation information

Descriptive Information (DI, corresponding to BI): represents the meta data of the archiving system and describes among others which Information Package contains which Content Information, i. e., the Descriptive Information contains a brief description of the package content as well as reference information like the storage information within the archive (e.g. according to ISO9660).

Information package: are data packages used for the communication with and within the archival architecture respectively the archiving systems

Package Information (PI, corresponding to PI): is used to identify and bind the components of an Information Package.

Provenance Information: Provenance describes the source of the Content Information, which has had custody of it since its origination, and its history (including processing history).

Preservation Description Information (PDI, corresponding to ABI): is the information which is necessary for adequate preservation of the Content Information and which can be categorized as Provenance, Reference, Fixity, and Context information.

Presentation Information: is an information, which is necessary to make the information presentable for the consumer, (e.g. display presentation of a 3D CAD model)

Submission Information Package (SIP, corresponding to IPE): consists of the following main information objects:

- Content (native formatted data)
- Preservation Descriptive Information (Validation Properties)
- Context information (regarding the content information)
- Packaging Information:

1.7 Further applicable documents

ISO 10303-21: Industrial automation systems and integration - Product data representation and exchange: Part 21 Implementation methods: Clear text encoding of the exchange structure

ISO 10303-214: Industrial automation systems and integration - Product data representation and exchange: Part 214 Application Protocol: Core data for automotive mechanical design processes

ISO 14721: Space data and information transfer systems -- Open archival information system -- Reference model

ISO 16792: Technical product documentation — Digital product definition data practices

SASIG PDQ Guidelines: Product Data Quality Guidelines for the Global Automotive Industry

VDA 4955: VDA recommendation – Scope and Quality of CAD/CAM Data

VDA 4956: VDA recommendation – Product Data Exchange, Part 1: Exchange of Assemblies

VDA 5006: Unique identification of partner companies, UPIK (Unique Partner Identification Key)

1.8 Further references

EN 9300(standard): Aerospace industry; long-term archiving and retrieval of digital technical product documentation, e.g. 3D CAD and PDM data, within the aerospace industry

ISO 10303-1: Industrial automation systems and integration - Product data representation and exchange: Part 1: Overview and basic principles

ISO 10303-11: Industrial automation systems and integration - Product data representation and exchange: Part 11: Description methods: The EXPRESS language reference manual

ISO 19005-1:2005: Document management – Electronic document file format for long-term preservation – Part 1: Use of PDF 1.4 (PDF/A-1)

ISO/IEC 19501: Information technology – open distributed processing – Unified Modeling Language (UML) Version 1.4.2

2 Data management principles for long-term archiving

This chapter provides basic recommendations for handling LTA-relevant Content information and administrative information based on ISO 14721 (OAIS) and defines possible use cases to be supported for data usage. This chapter also provides recommendations for ensuring a sufficient level of data quality, and general rules that can be applied to various information objects are formulated.

2.1 OAIS reference model

2.1.1 OAIS data management model

The aim of the reference process in VDA 4958-2 is to deliver the Content Information from the Data Creator (Producer = Data Creator + Preparer (Archive)) to the Consumer correctly and intact. To do this, the Content Information is combined with the Preservation Description Information in an information package (Figure 1). During an LTA process from Data Creator to Consumer, the package may be subject to administration-related changes such as, for example, transfer to a different storage medium. Change information, as well as other system-related information (e.g. the size of the package) is stored in the Packaging Information.

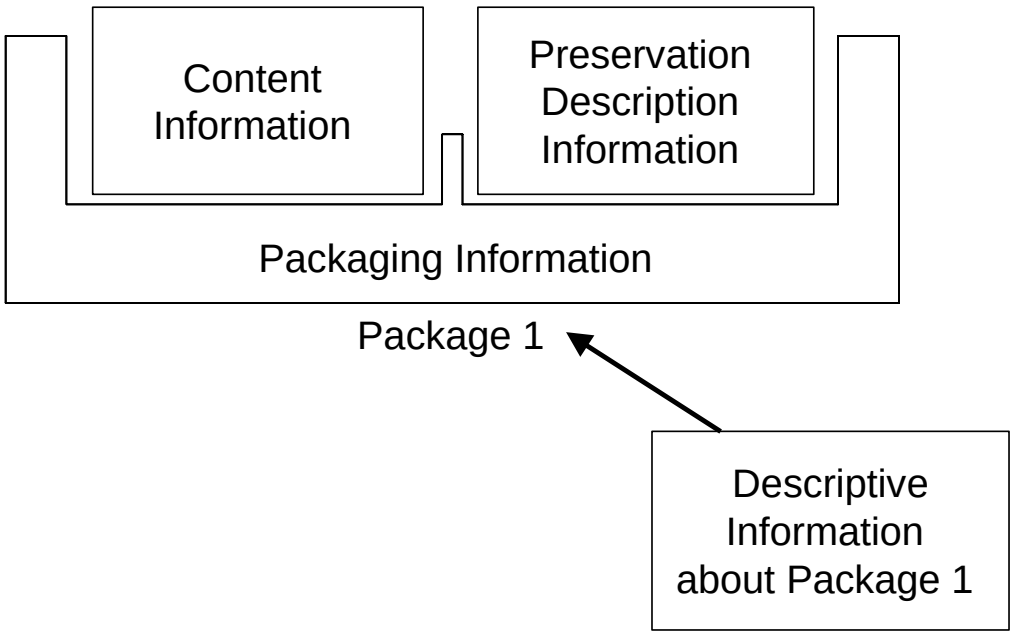

Figure 1: Structure of an OAIS information package (source: OAIS)

The Descriptive Information is the administrative data of the archiving system which contains a brief description of the package contents as well as reference information, e.g. to the storage space within the archive. The following in particular are required for the reference process role Archive (Management and Archive):

- the administrative data relevant to storage within the archive
- the information data relevant to quality assurance
- the information relevant to retrieving data

Information packages can contain different information depending on the process step and application involved. The basic structure of the information packages is, however, independent of the process step.

It is recommended that the relevant information packages in the process be structured in the same way regardless of the respective process phase and its application.

The following information packages exist, depending on the process phase involved:

- the Submission Information Package (SIP)
- the Archival Information Package (AIP)
- the Dissemination Information Package (DIP)

Each of these information packages comprises the information object itself and the Descriptive Information relating to the information object at the relevant point in time.

The form of representation of the actual Data Object changes during interaction according to the reference process for archiving and data usage. This may happen several times for a Data Object in the process. The description of the current form of representation and the information itself that describes these changes are referred to collectively as Representation Information. This Representation Information is, for example, required to convert the Data Objects in the archive into a form that can be understood by the user (Consumer) (e.g. display of a 3D CAD model on the screen). A Data Object as such can, on the other hand, only be interpreted by an IT system with the help of the Representation Information. Figure 2 shows the basic structure of an information object.

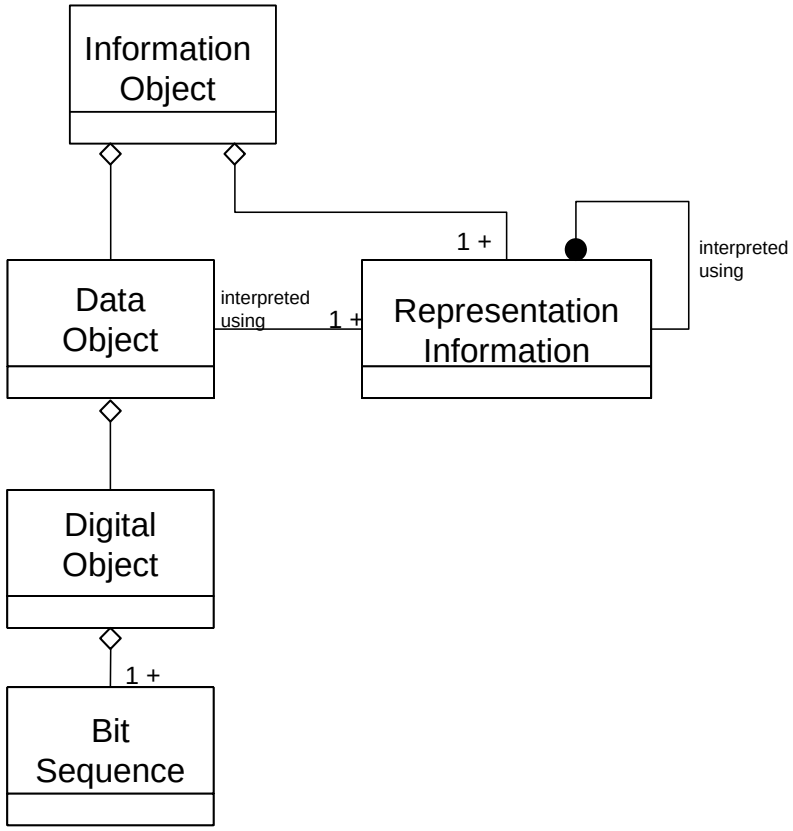

Figure 2: Structure of an information object (source: OAIS)

The Representation Information essentially defines the semantics and the (structural) dependencies according to which the Data Objects are to be interpreted. Reference data models such as the one defined in ISO 10303, for example, are typical representatives of Representation Information (Figure 3).

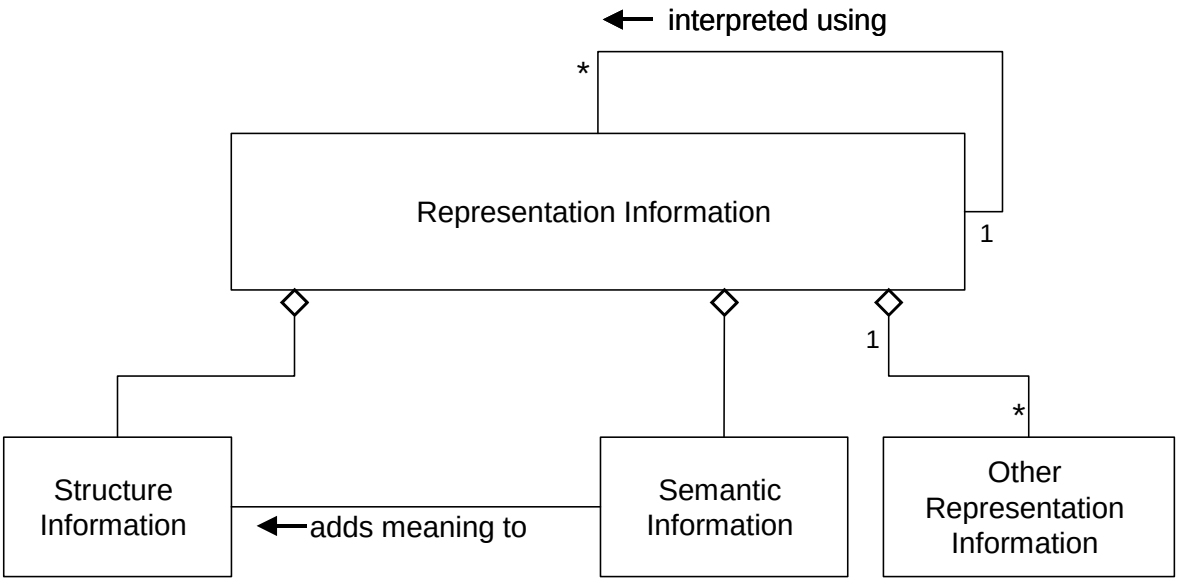

Figure 3: Structure of Representation Information (source: OAIS)

Not only the Content Information itself but also all the other information objects should adhere to the structure shown below (Figure 4).

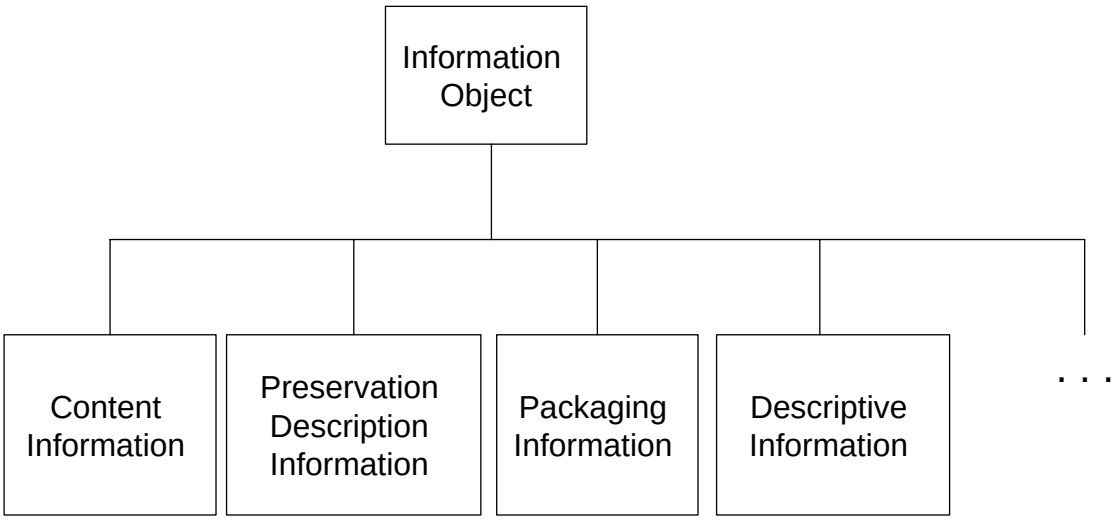

Figure 4: Types of information objects (source: OAIS)

Figure 5 provides an overview of the main data structures in an archive architecture in compliance with ISO 14721 (OAIS).

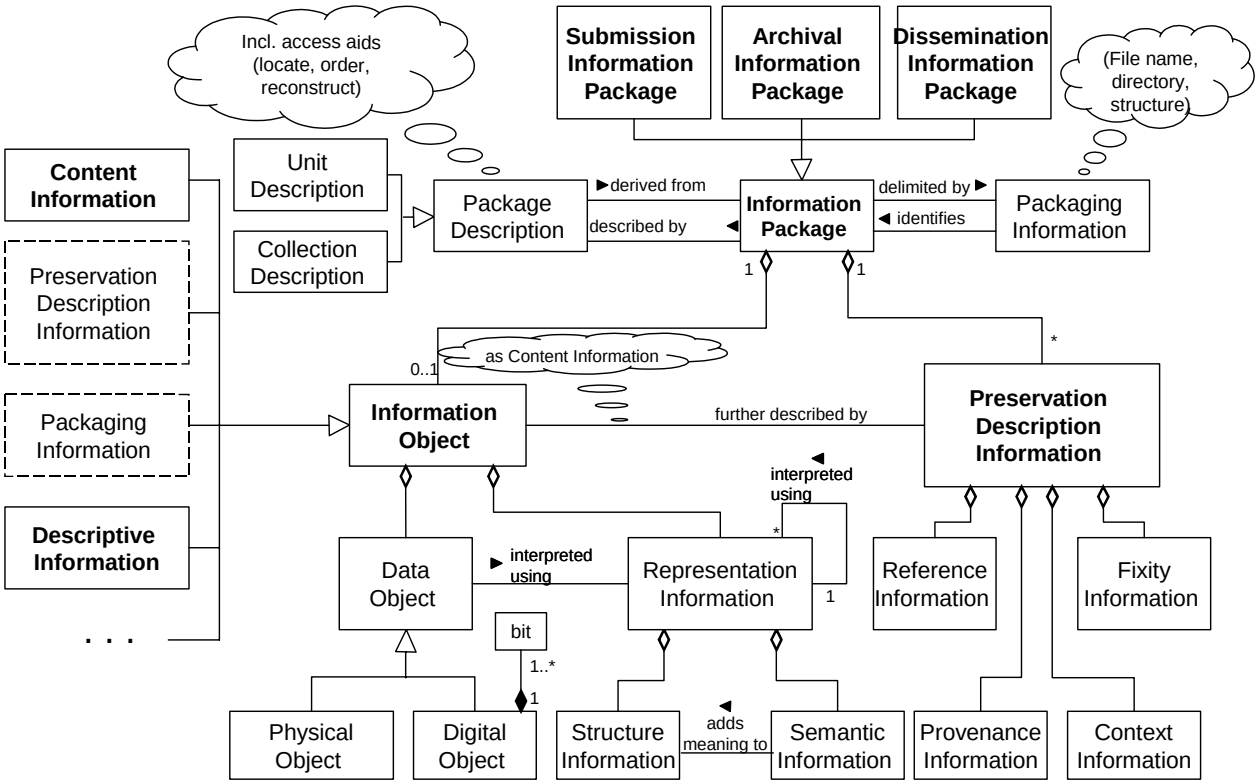

Figure 5: Overview of the data model in compliance with ISO 14721

2.1.2 Differentiation OAIS – VDA 4958-3

OAIS provides a detailed description of the dependencies and interactions of the main functionalities within the archiving architecture and the information objects involved. Although the most important information objects for managing the relevant Content Information during the retention period are identified, the Content Information itself is not described. VDA 4958-3 extends the data and model descriptions on the basis of OAIS and describes in more detail for the content and administrative information the use of the Data Objects defined in OAIS with regard to 3D CAD models and associated non-geometric information.

In addition, recommendations regarding the definition of the archiving formats and a description for ensuring a sufficient level of data quality are provided. This concerns the definition of the minimum information and possible forms of representation of the information required to ensure that the data can still be interpreted by the target system and the Consumer even after an extended retention period.

This recommendation does not, however, go into detail with regard to administrative information such as Package Description, Packaging Information, Representation Information, etc. It thus makes no claim to completeness regarding this type of information.

2.2 Use cases for data usage

The requirements that must be satisfied by the Content Information to be archived with regard to its representation in LTA and the options for presentation are for the most part determined by the required use cases for future data usage. **Fehler! Verweisquelle konnte nicht gefunden werden.** shows typical use cases for data usage and the document representations required.

A simple UML use case diagram (Annex A) is used for representation. This is used to identify the relevant use cases (business cases, activities) that can affect the

organizations, areas and/or systems that participate in LTA. The most important structural dependencies between the individual cases are revealed and the scope under consideration is positioned and demarcated.

The possible use cases for data usage can range from simple documentation, e.g. as proof of state-of-the-art design or specification-compliant manufacturing, to supplying data to down-stream processes, to the further constructional application of Content Information for change or connection designs, for example.

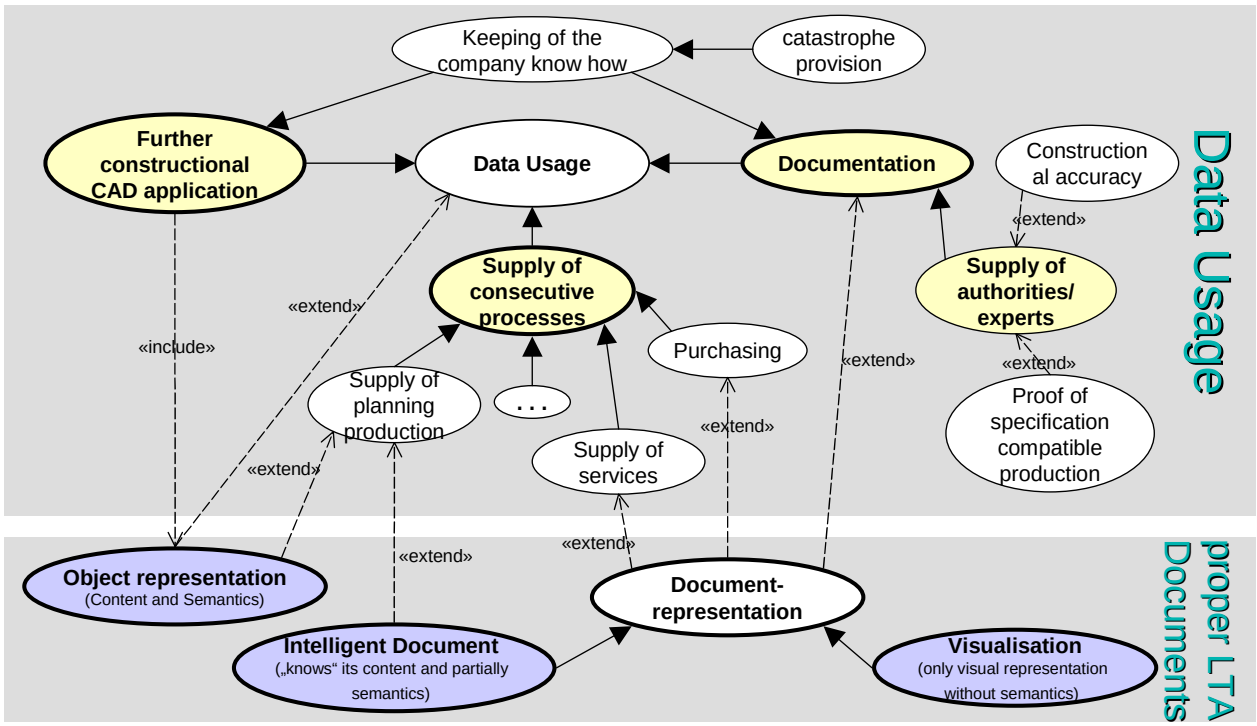

Figure 6: Use cases of the Data Usage and necessary LTA document representations

Forms of representation that provide at least a graphical representation (visualization) of the relevant Content Information in such a way that the data user can interpret this information completely are sufficient for simple documentation purposes. So-called “intelligent documents” provide additional functions such as geometric associativities, selected clipping planes and references as well as dependencies from and to non-geometric information. If almost all the functionality and accuracy of the source information is required for data usage, the data must be archived as an object representation. Storing data as an object representation has the advantage that the need for simple documentation can also be satisfied without problem.

Both the recommendations for the LTA-relevant data and the requirements regarding data quality depend on the use cases that need to be supported for data usage (retrieval).

2.3 Ensuring data quality

The documents “Product Data Quality Guidelines for the Global Automotive Industry“ (SASIG_PDQ_Guidelines) and the VDA guideline “Scope and Quality of CAD/CAM Data“ (VDA 4955) define product data quality (PDQ) and describe criteria for the quality of product data with regard to CAD data.

The geometric data quality provides information about how and to what degree of accuracy geometric elements are generated.

The non-geometric data quality refers to the non-geometric information in the CAD model and includes organizational criteria such as those for the model structure, for example.

A defined and documented target level of data quality against which the data can be verified must be specified by the Data Preparation process step (VDA 4958-2) at the latest. The rules for the verification of geometric and non-geometric data, which are normally an in-house prerequisite for data release, can be derived from generally accepted standards and recommendations such as SASIG PDQ Guidelines, VDA 4955 and from company-specific guidelines.

The result of the verification must also be archived in accordance with the reference process so that the existing quality of the content data can be assessed if necessary. In all the use cases, documentation relating to the data quality requirements – the quality rules that define the target level of quality – should be available during the entire retention period so that a reference to the quality rules applied can be established when the data is used.

The required product data quality is derived from the use cases for data usage to be supported (2.2). Company-specific guidelines for data release are to be taken into consideration for all the use cases. The quality requirements in the use case “document representation” are normally a subset of the criteria for the application scenario “further constructional CAD application “.

It could be that the data quality requirements change over the course of the retention period. More stringent data quality requirements can be expected as a result of new findings. According to the reference process, the data that is taken from the archive is converted into a target data format. A new verification must then subsequently be performed. In the use case “document representation”, it must be ensured that no “old” quality rules are violated. On the other hand, in the use case “further constructional CAD application “ (see Figure 6), it is recommended that verification is performed using the “new” quality rules. The result of validation (validation report) is crucial for an evaluation of whether the archived data can continue to be used or whether, in the case of violation of “new” quality rules (validation error report), the data must be edited. Appropriate measures can be “raising” the data quality to a new level (preferred measure) or “lowering” the error tolerance limits.

Data verification is normally supported by software tools. It is recommended that, at the time the data is used, the software tools are able to support all the data quality requirements relevant during the retention period.

2.4 General specification rules

In addition to the mapping recommendations for the requirements on the various definition levels, this section provides additional, general specification rules. These rules are intended to more precisely define or enhance specifications that are not unequivocally defined within the descriptive standards or implementation standards.

2.4.1 Contents of text-related attributes – mapping multilingualism

Multilingualism is an organizational necessity in today’s global automotive industry. It is therefore necessary that data objects also be available in multiple languages. This multilingualism should be integrated within the third definition level (mapping to implementation standards). The name of a part is an example of a multilingual attribute.

If multilingualism is to be established, one language must be specified as the “default” language. This can be defined specific to a company and should be valid for all (text-related) attributes.

A language can be identified by a language identifier in compliance with DIN 2335 (corresponds to ISO 639). This indicates the language in which the attribute values were stored or are to be interpreted.

2.4.2 Multiple identifiers and owners

In order to insure that information objects are unique, identifying attributes such as, for example, part number or document number in a data set are also to be marked with the identifier of the ‘owner” (‘ID OWNER’). The owner ensures that the identifiers are unique within his realm of responsibility.

A distinction between data that describes information for different companies under the same identifier is made by means of the ‘owner’. This ensures that associated data for each company can be identified, e.g. in order to specify references to parts from suppliers that (happen) to have the same identifiers.

If several languages are being used, contents that belong together have the same identifier and the same ‘owner’ in all the languages. This makes it possible to store master data for different companies in several languages in parallel in the same data set.

2.4.3 Definition of company-specific attributes

Chapter 4 describes the minimum requirements relating to the LTA-relevant content and administrative information. Depending on product- and/or company-specific requirements, it may also be necessary to define specific attributes and incorporate them in the LTA processes. In this case, these are to be dealt with as described in 3.2 ff.

Company-specific attributes must be sufficiently documented so that a semantically correct interpretation is possible even if the data is not used for years.

2.4.4 Handling company-specific standards

The documentation of all referenced information is required for long-term archiving. Therefore the adequate storage of documents such as standards, company standards, previous data inventories and other similar items must be ensured if these are referenced or used in a 3D CAD model or in the non-geometric data.

In the case of references, not only must the link be declared but it must also be ensured that the information itself is archived. If existing company standards are directly connected to the current use case, a reference to the standard or to the physical document must be established. If referenced, company standards must be taken into consideration in the requirements model (3.2 ff.) and must be described together with their attributes.

2.4.5 Handling part libraries

The documentation of all referenced information is required for long-term archiving. If components from 3D part libraries are referenced or used in a 3D CAD model or the non-geometric data, the adequate storage of these components must also be ensured.

In the case of references, not only must the link be declared, but it must also be ensured that the information itself is archived. Any library parts used must either be included in the design documentation or must defined as references to (valid) components in adequately archived libraries.

3 Procedure for defining LTA-relevant information and mapping it to standards

This chapter describes a procedure for defining the data required for specific use cases that is relevant to long-term archiving, and the mapping of this data to descriptive standards and data schemas as part of an implementation. This procedure should be used for all data that is to be archived, regardless of specific scenarios and use cases.

The application of this procedure is described for the area of application relevant to VDA 4958-3 in Chapter 4 using examples for the most important steps.

3.1 Definition levels for Content Information

A three-stage approach is recommended for identifying and defining the LTA-relevant Content Information and its LTA-conform storage in suitable forms of representation. The three levels in this approach are:

E1. Definition of a requirements model (referred to in the following as a core model), which reflects, in a neutral and implementation-independent manner, the company-specific user requirements regarding the relevant information objects.

E2. Mapping to a standardized description models, which describes the form of representation (description, semantics) of the information objects in the requirements model.

E3. Mapping to standardized implementation models and formats (referred to in the following as a data schema) for the physical or digital storage of the information objects over very long periods of time.

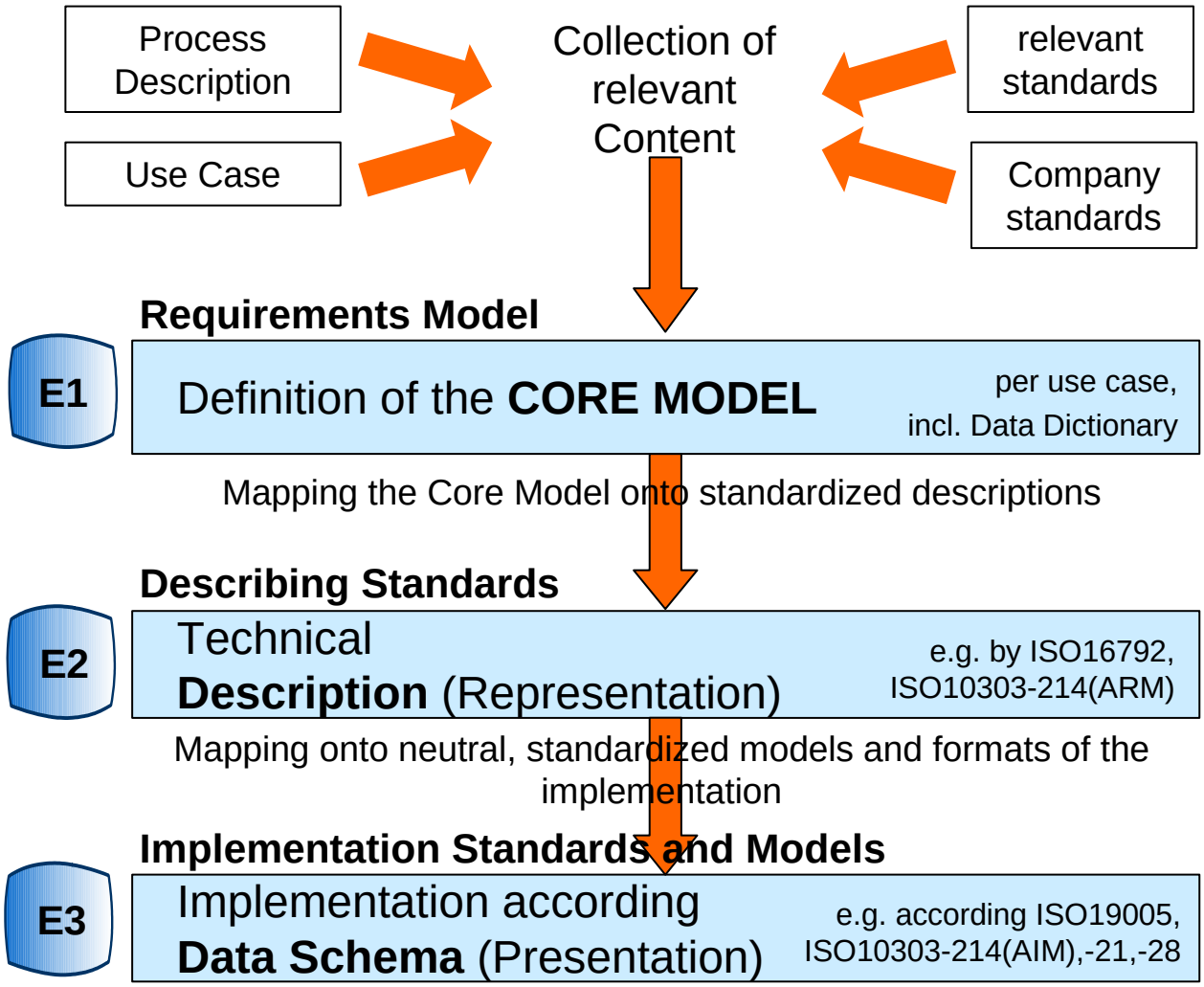

Figure 7: Definition levels for Content Information

In level E1, it is important that all the information, rules and value ranges which are – or which might be needed – for the specification of a product are identified and described. This is required to later reproduce the product according to this documentation, if necessary, or to prove that the product was created in compliance with the specification. The identification of the relevant information should give due consideration to currently applicable standards for product development and product documentation.

In level E2, descriptive standards that can represent the objects in the requirements model in a standardized form are identified. The mapping of the requirements to these standardized description models and methods and their application ensure that the appropriate personnel, such as authorized experts and design engineers, are able to interpret the data objects with regard to the content and meaning without error even after years have passed. An example of a standardized description method is ISO 16792, which defines, among other things, the presentation of GD&T information in 3D.

In level E3, the mapping to standardized implementation models and methods, which allows the information objects to be stored for years independent of hardware and software, is described. The definitions in level E3 are not a data format description. The LTA-relevant data and models are merely described by data objects and attributes that are then converted into a corresponding target format of the archiving file.

This approach offers the advantage of three independent levels which are modular and can be exchanged individually and can therefore easily be adapted in part to future

requirements. For example, adaptations can be carried out on the implementation level (level E3) by adapting the format representation to reflect technological progress while the requirements model (level E2) remains unchanged. On the other hand, it is possible that adaptations or extensions in the requirements model are covered by the descriptive standards (level E2) and/or implementation models (level E3) already being used.

3.2 Procedure for defining and using a core model

The following are essential to the utility of archived documents:

- the intactness of the technical content
- the completeness of the data contained in the documents
- the integrity of the information contained in the documents

The core model is used to identify and describe the LTA-relevant content data from the user's point of view. The role played by such a core model in the archiving process is described in Part 2 of VDA 4958.

The shape and content of a core model can be very different. This depend, for example, on

- the type of product to be described
- the LTA data identified as being relevant
- company-specific requirements
- the use cases and archiving scenarios to be supported

A reference model for 3D CAD data and associated non-geometric data that serves as the basis for defining a core model is recommended in 4.5.

The following sections contain a description of a procedure for creating company-specific core models, which are to be created on the basis of the minimum requirements defined in 4.5.

3.2.1 Definition of a core model

The starting point for an archiving solution is the definition of a core model. A prerequisite for identifying and defining the necessary data objects is a decision about the use cases concerning data usage that are to be supported. An appropriate assessment of future requirements relating to the data, its quality and its usage must be carried out and documented accordingly.

Specification of the use cases concerning data usage that are to be supported and the core models derived from these use cases determine which Content Information is relevant to long-term archiving and which information from the source system no longer needs to be made available to the Consumer. This means that the only information archived is the information that is required for data usage, and that all other information is excluded from in the process if possible.

If different use cases concerning data usage are to be supported, it may be necessary to develop, document and store (in an LTA-conform manner) a separate core model for each of these cases if the volume of LTA-relevant data and/or quality requirements of the use cases are different.

The definition of a core model can be carried out using different description methods such as, for example,

- entity-relationship models
- UML class diagrams
- EXPRESS in compliance with ISO 10303-11

It is recommended that a core model be specified as a formal data model that includes, if possible, a clear definition of the following:

- all relevant data objects
- their attributes
- permissible value ranges
- rules for data consistency and integrity

A data dictionary provides a detailed description of the semantics of the information objects and additional information about their application.

Company- and product-specific minimum requirements, as well as optional extensions, are defined in the core model. It is recommended that appropriate organization instructions, or something similar, be drawn up for optional functionality and data definitions that specify exactly when and how information that has been declared optional is to be archived.

The quality criteria and permitted value ranges to be defined include, for example, specifications regarding valid standard tolerances for geometric and production-related annotations (dimensions) for which no explicit tolerances are specified. They also include definitions of test criteria for non-geometric data such as part numbers, nomenclature and material properties.

When applying the recommendations in this document, the specifications in the data directory (4.5) for a company-specific core model must be defined in more detail. Appropriate decisions must be made regarding the attributes marked as “optional” (“o”) or as “relevant, if available” (“x”) (see 4.2).

3.2.2 Using the core model

The core model provides the basis for all further steps regarding the specification and implementation of data management in a LTA solution and provides the reference for the system components and converters involved. The converters (see also VDA 4958 Part 2) convert the information in a Submission Information Package (SIP) into an Archival Information Package (AIP) and later into the target representation for data usage via a Dissemination Information Package (DIP).

The core model must be mapped to the existing applications (source systems such as CAD, PDM/TDM, etc.) and interfaces that are to be incorporated in order to check the availability and processability of the required information. If deviations are detected, appropriate measures must be determined to ensure that the documentation and archiving requirements are satisfied.

Any differences compared to the company-specific core model must also be determined and appropriate adaptations must be carried out for the converters and quality assurance tools (e.g. VDA-Checker, Q-Checker) involved in the archiving and data usage process.

In the case of functional extensions to the set of data to be archived, the systems involved in the LTA process, including the documentation, must be extended based on the core model.

3.2.3 Checking a core model

When creating core models and when periodically checking core models to ensure that they are complete and correct, currently valid standards for product development and product documentation must be taken into consideration.

Depending on the use cases to be supported, a check must be performed as to whether the respective core model provides support for the required information and functionality. This is best accomplished using test scenarios that incorporate all the relevant information blocks and information objects in the core model.

When introducing a core model, test runs covering every step from data preparation through to data usage must be used to prove that the LTA-relevant information is available in the current target representation. In the use case “object representation” of 3D CAD data (Figure 6), this means, for example, that the associativities remain intact and the individual objects can be modified for reuse.

In the use case involving simple visualization for documentation purposes, it must be ensured that all the relevant information can be viewed and interpreted by the Consumer.

It is recommended that random checks be performed during productive operation. A new check must be performed if either the scope of information to be archived changes or one of the components involved change (e.g. change in the release/version of the CAD source system).

3.3 Mapping to standardized description models

In addition to the use cases, the information objects that have been identified for the respective use case as being relevant to long-term archiving must be mapped to descriptive standards in accordance with the three levels of the method description in 3.1.

The requirements specified in the core model are included in the data dictionary (4.5) and provide the basis for mapping to suitable descriptive standards.

Standards can be considered suitable if, for example, they

- are national, international or company standards
- are valid when the data is generated
- define the form of representation of the data objects from a technical point of view
- define the information and its representation needed to describe technical circumstances with a sufficient degree of accuracy, such as for example:
    - definition of fits
    - description of a join (e.g. welded, glued, riveted)
    - specification of measurement points for quality control in manufacturing
    - identification of the materials used

Once the definition of the core model has been completed, mapping to the descriptive standards can be carried out. Consideration must be given to the fact that descriptive standards may have different description levels.

ISO 16792 can, for example, be used for dimensions, tolerances and annotations in 3D models. ISO 16792 describes, among other things, how a design model with annotations

is to be documented in 3D. A distinction is made between the actual model and the representation. For example,

- it must be possible to obtain all the model values and rounded units in the model (object representation) by retrieving the model
- associativities for digital element must remain intact and must be accessible electronically
- product definition data such as notes, parts lists, identifiers, dimensions and tolerances must be included or must be referenced
- product definition data in the 3D model must be consistent with the data in the representation (e.g. on the screen, derived drawings)
- the representation of annotations must be complete, and it must be possible to activate or deactivate them according to type or by means of selection

For the use case “object representation, the minimum requirements for geometric models that provide an adequate description of the model are specified in the data directory. They include the nominal dimensions of the model and the GD&T information for the permitted deviations from the specified nominal dimensions, as well as the defined geometric and dimensional tolerances.

In the use case “visualization”, it must be possible to display all the required information and allow it to be interpreted by the Consumer. However, due to the reduced functionality compared to an object representation, it can be assumed that the model will be more difficult to navigate, e.g. due to the missing associativities.

3.4 Mapping to a data schema

Mapping the requirements from a core model to the implementation level “E3” specifies how the information objects are stored physically or digitally, as appropriate. The data schema for the implementation level describes the data objects used for this level with regard to their semantics and syntax (data representation). Physically, the data objects are represented by digital files that conform to a standardized format specification (data representation or data format, as appropriate). The mapping to the implementation level must be defined in line with the selected use case.

Standards can be considered suitable for the implementation level if, for example, they

- are national or international implementation standards
- are valid when the data is generated
- define the form of representation of the data objects from an IT-related point of view
- define the form of presentation, i.e. structure and syntax of the non-binary data format
- facilitate mapping of the information objects from the core models[1]
- support downward compatibility to previous standards

[1] It is recommended that standards be used that, if possible, support all the required information objects in a core model to avoid distribution of the information over numerous different data representation forms and formats.

- are independent of hardware, operating systems and application software (e.g. CAD, PDM systems

The mapping to a data schema (E3) must be defined based on the definition of the core model (E1) and giving due consideration to the selected description model (E2). This mapping regulation provides the basis for converting the data objects in the SIP into AIP and DIP (see VDA 4958-2).

4 LTA requirements/core model (user point of view)

Based on the general use cases concerning data usage (2.2), this chapter provides recommendations for possible use cases involving the usage of 3D CAD data and associated, non-geometric product information The basis for defining a core model in the form of a data directory is established using the procedure described (chapter 3) and based on a selected description methodology.

4.1 Use cases and representations for 3D CAD and associated product data

In order to be able to support the described use cases concerning data usage, a distinction is made between document representation and object representation for LTA documents.

In the case of 3D data, procedures for visualization are deemed adequate as long as all the information that the Consumer needs can again be made visible. The possible document representations differ with regard to ease of use and available functionality. The most simple form is purely graphic representation involving graphical elements that exhibit no associativities. This type of documentation is well known from technical drawings in paper-based, microfilm card and digital raster formats

It can be expected that there will be a need for associativity and functionality for data usage. Intelligent documents can provide these associativities and functionalities. For example, the associativities between geometric elements, their dimensioning and tolerance information and to the non-geometric part information are required to allow an unambiguous interpretation of the data. Or functions for hiding and displaying certain elements and groups of elements and for creating clipping planes in the model are required to simplify navigation in the 3D model (see also ISO 16792)

Documentation in the form of an object representation is recommended for further application of the Content Information. In this case, both the geometric elements describing the part and the annotations such as, for example, dimensions, tolerances and material specifications are available explicitly in the Content Information. LTA data in object representation form can be processed further by computers without restriction and can be used by the Consumer.

Documentation representations, on the other hand, are heavily dependent on the level of integrated associativities and functionalities and can therefore only be further processed on a computer to a limited extent or not at all. They therefore rely more or less on the interpretation by the Consumer.

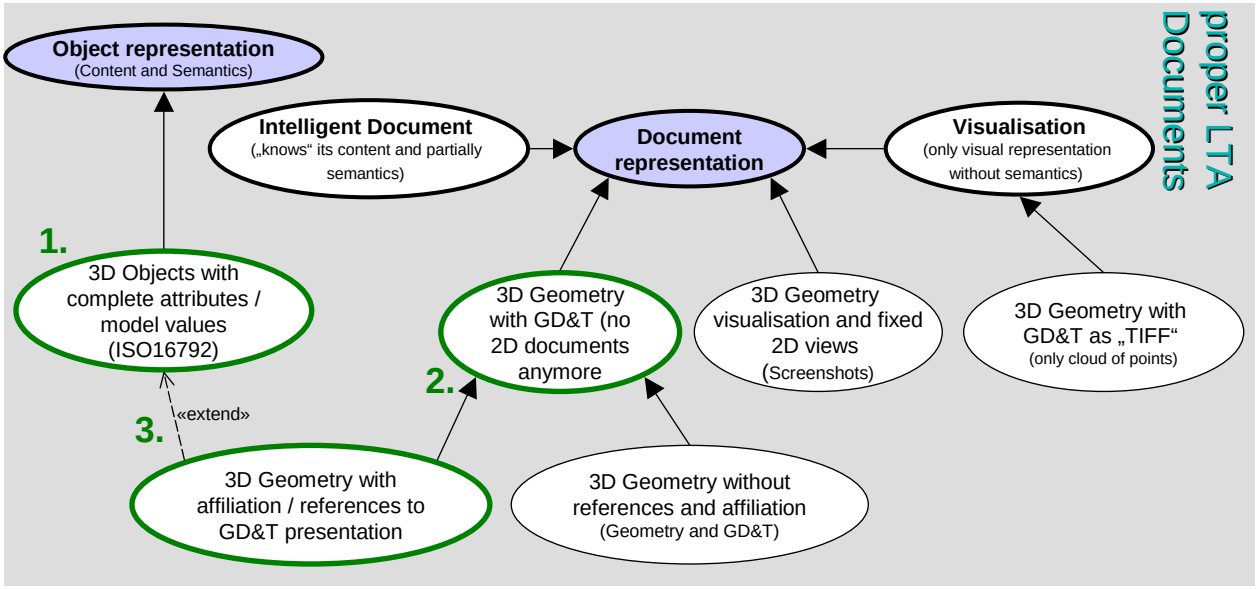

Figure 8: Possible representations of LTA documents concerning content and semantic

The recommended use cases (Figure 8) for archiving 3D CAD data without technical drawings are:

1. Complete 3D object representation with specification of attributes, model values and the option of generating the presentation of annotations on the model according to ISO 16792 (or future presentation methods) so that they can be visualized.
2. 3D geometry visualization and presentation of the annotations with associativities between the presentation objects as a document representation.
3. 3D object representation with specification of attributes and model values as for 1., but extended to include explicitly stored presentation information for the visualization.

4.2 Requirements relating to standards

The information relevant to long-term archiving is described in the core model as attributes. The core model is based on the requirements relating to the 3D CAD data and PDM data that result from application of the appropriate valid standards and recommendations (e.g. VDA 4953). Only binding data relevant to series release are subject to long-term archiving (e.g. VDA 4950, VDA 4955).

In the case of parts whose attributes rely heavily on the selected manufacturing process or procedure, it is recommended that this information also be archived.

4.3 Differentiation between master model and core model

A master model (also called 3D master) is taken to mean a fully modeled 3D model that does not require technical drawings. A master model represents the entirety of the Content Information in the native format of a source system. At a minimum, the core model identifies the information from a master model that is relevant to storage.

The minimum set of data from the master model that is to be archived is described in the following by the core model for the scope of VDA 4958. The information designated as validation properties will be classified accordingly by their necessity (m, x, o see 4.5).

4.4 Description methodology

The development and description of a core model can be carried out using different formal specification methods, e.g. with EXPRESS or UML (see also 3.2.1).

A prerequisite and integral part of core model development is the identification and description of the LTA-relevant content data from the point of view of the user. The following provides a description of the method involving a data directory (table structure) selected here, which serves as the basis for developing a core model. In addition to the identification and definition of the relevant information objects, information regarding their usage as administrative information in a LTA environment is also included. The data dictionary is extended to include a mapping to implementation standards.

The information objects are described individually in 4.5. The data directory can be found in Annex B. The following descriptions refer to the individual sections of this table.

4.4.1 Information objects and attributes

The LTA-relevant information objects are listed in a table as indicated in Figure 9. On the first data definition level (see 3.1), the information objects are identified by name in the “Entity” column. The “Description” column contains a brief description within the context of VDA 4958. The information objects are specified in more detail by means of their attributes. These attributes are identified by name in the “Attribute” column. A brief description of their meaning within the context of VDA 4958 is also included in the “Description” column.

Relevant LTA/LZA Data (Requirements of 3D CAD and PDM data)		
Requirements Data Model (Level E1)		
Entity	*Attribut*	*Description*

Figure 9: Identifikation and description of the information objects relevant for LTA

The identifying names indicate which general information object or attribute is involved. The standard EN 9300 and recommendations such as VDA 4953 and VDA 4956 were consulted when selecting the names.

If necessary, company-specific information objects and attributes should be added to this data dictionary in accordance with 2.4.3. These must be identified as such.

4.4.2 Classification of LTA-relevant information objects

To improve readability, the information objects and attributes are grouped together as information blocks. These are identified by name in the “Entity” column and are described in the “Description” column. Information blocks are indicated by a colored background and bold type.

The tables are divided into the following information blocks:

- Geometrical definition
- Geometrical structure

- Document representation
- Part master
- Product structure
- Manufacturing information

It may be necessary to use different implementation or quality assurance methods for the various information blocks.

4.4.3 Classification of Content Information and validation properties

In the “Content in” columns in the following tables (Figure 10), the relevant information is classified as geometric or non-geometric data, and recommendations regarding its suitability as validation properties (VP) are given.

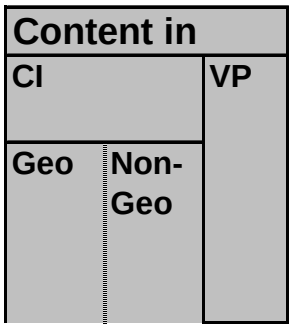

Figure 10: Matrix of information objects and attributs with respect to information packages

The primary source of geometric information is CAD systems. In the case of non-geometric information, the primary source is normally data management systems such as PDM/PLM systems or TDM systems according to VDA 4956. The CAD systems themselves may, however, also be the source of non-geometric information.

In the matrix, recommendations for using the LTA-relevant information are given by means of the following classifying designators (Figure 11).

Information package	Classification	Recommendation
CI	m - mandatory	The archiving (LTA) shall be safeguarded in any case, if necessary a considering adaption of the source system respectively the entire LTA process shall be made.
	x - extension	The information ahsll be archived, if available, i.e., functionality shall be apppropriated for the Data Preparation, the Ingest and Data Usage. Information with „x“ mark may be re-declarated to „m“ for company specific reasons.
	o - optional	Information which are marked as optional may be branch, product or company specifcally relevant for LTA. Information with „o“ mark may be re-declarated to „x“ or „m“for company specific reasons.
Validation Property	m - mandatory	These information are necessary for validation. Adaquate functionality shall be appropriated.
	x - extension	If the information is available, it is of relevance for the validation,

		i. e., adaquate functionality has to be appropriated. Information with „x“ mark may be re-declarated to „m“ for company specific reasons.
	o - optional	Information which are marked as optional may be used branch, product or company specifcally for the validation. Information with „o“ mark may be re-declarated to „x“ or „m“for company specific reasons.

Figure 11: Classification and recommendations of the matrix of Content Informationen (CI) and Validation Properties

The usage rules in the data directory are applied from top to bottom, i.e. from the information blocks, to the objects, to the attributes. If, for example, an information object is designated as “m” (mandatory), at least one representation of this object type is required. The attributes behave according to their designation (Figure 11), i.e. at least all of the attributes for this object that are marked with an “m” are involved. If, on the other hand, and information object is marked with an “x” (extension), it is only relevant if at least one representation of this information object is available regardless of how its attributes are classified. If, however, a representation of this object is available, the rules for its attributes apply as specified in the data directory.

In the case of the information object “Organisation” in the example in Figure 12, this means that a least one representation of this object with its identifying attribute “ID” is relevant (e.g. via DUNS numbers from Dun & Bradstreet, see also VDA5006).

Relevant LTA/LZA Data (Requirements of 3D CAD and PDM data)			**Content in**		
Requirements Data Model (Level E1)			**CI**		**VP**
Entity	*Attribut*	*Description*	**Geo**	**Non-Geo**	
Organization Organisation, Firma		Identification of the organization owning the part information or of the supplier as well as the organisation approving the part.		m	
	Name	Name of the organization.		m	o
	ID	Unique identifier of the organization.		m	m
	Address	identifies a place where the organizational unit may be located		o	
	Organization Type	Identification of the organisation type e.g. Supplier, OEM, Location, Plant		m	

Figure 12: Example of a classification

If the name of the organization and/or the type is to be available as information, it must also be archived. The address, on the other hand, is optional and is therefore not necessarily required. The archiving of the address can, however, be advantageous and should therefore be defined specific to the company involved. In the case of company-specific specification, only one tightening of the rules should ever be carried out.

4.5 Data directory for the core model and validation properties

The data dictionary identifies the minimum of LTA-relevant content data in the area of application covered by the recommendation. It provides the basis for defining a core model in accordance with 3.2. In addition to classification as geometric and non-geometric information, recommendations regarding suitability as validation properties for quality

assurance are also given. Any dependencies on use cases (4.1) will be mentioned as appropriate.

4.5.1 Geometrische Definitionen

Requirements Data Model (Level E1)			**CI**		**VP**
Entity	*Attribut*	*Description*	**Geo**	**Non-Geo**	
Geometrical Definition Geometrische Definitionen		are representations of information defining geometry (e.g., the 3-dimensional shape of a part) as well as information related to geometry or with a geometrical aspect (e.g. torque of screws)	x		m

Objects are modeled either in the form of solid models or surface models. The minimum requirement is that models should be available as B-rep (boundary representation) models. Wireframe models are generally unsuitable for comprehensive product documentation. Faceted surface models are sufficient for the purposes of document representation (4.1, use case 2).

The component must be represented completely and dimensioned accurately (nominal dimensions). This means that all shaping elements such as drafts, rounded corners, holes and ribs must be represented. Simplified models are permitted provided that they do not become ambiguous. Required connection geometries and installation geometries can be reduced to the effective areas. This means, for example, that threads and interlocked parts do not need to be fully modeled and that only one side needs to be modeled in the case of thin-walled parts that have a constant thickness (e.g. sheet metal parts). If, however, this is done, an explicit indication must be provided of which side of the material is being modeled and a directional arrow must be used. Alternatively, the thickness of the material can also be represented by a line perpendicular to the surface (Figure13) or by an offset curve at a distance away from the surface that corresponds to the material thickness (Figure14). The representation of the component (modeling method) must comply with the applicable design guidelines of the company involved.

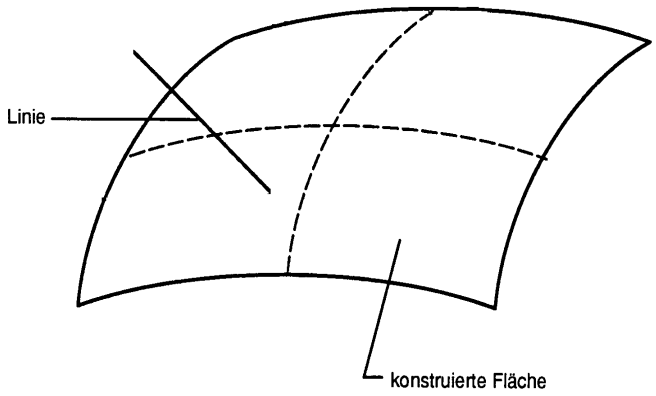

Figure13: Line with length=100 x material thickness

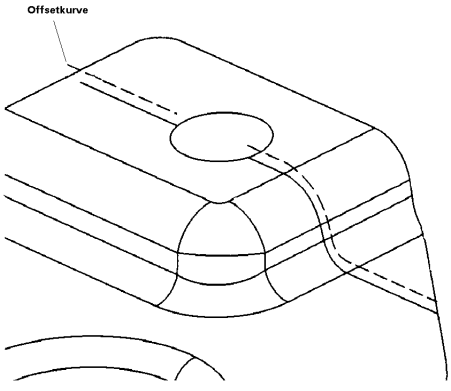

Figure14: Offset curve

4.5.1.1 Coordinate System

Requirements Data Model (Level E1)			CI		VP
Entity	*Attribut*	*Description*	**Geo**	**Non-Geo**	
Coordinate System *Koordinastensystem*		is a system for assigning a tuple of scalars to each point in an n-dimensional space	m		
	Point (x,y,z)	a Point is a location in a Cartesian coordinate space (an entity that has a location in space but no extent)	m		
	Direction x	is an imaginary line which connects origin of e.g. a coordinate system with all other points along the x-axes	m		
	Direction y	is an imaginary line which connects origin of e.g. a coordinate system with all other points along the y-axes	m		
	Direction z	is an imaginary line which connects origin of e.g. a coordinate system with all other points along the z-axes	o		

4.5.1.2 Geometrical Representations

Requirements Data Model (Level E1)			CI		VP
Entity	*Attribut*	*Description*	**Geo**	**Non-Geo**	
Geometrical Representations *Geometrische Darstellungs-Elemente*		are the geometrical definitions, e.g. using geometrical basic elements for defining the shape of a part (like a CATPART)	m		
	Point	is a location in a Cartesian coordinate space	m		
	Curve	is a path of a point moving in a coordinate space	m		
	Surface	is a set of mathematical points which is the image of a continuous function defined over a connected subset of the plane R2. It can be envisioned as a set of connected points in 3-dimensional space which is always locally 2-dimensional, but need not be manifold.	m		
	Solid	A magnitude which has length, breadth, and thickness; a part of space bounded on all sides	o		
	Reference Point Single Part	is a point which is used as reference, e.g., welding points, or feature definitions	x		
	Measurement Point Single Part	is a point which is used as reference, e.g., for measurements and quality control of a resulting part	x		
	Reference Points Assembly	are points which are used as references, e.g., welding lines, or feature definitions	x		
	Measurement Points Assembly	are points which are used as references, e.g., for measurements and quality control of a resulting assembly	x		

The use case involving further constructional CAD application (4.1) – if necessary also for the (new) production of a component – requires the use of solids as geometric elements.

4.5.1.3 Geometrical Features

Requirements Data Model (Level E1)			**CI**		**VP**
Entity	*Attribut*	*Description*	**Geo**	**Non-Geo**	
Geometrical Features Funktionselement		are sets of geometrical elements representing features, that are either defined as components of geometrical representations or are used to assign further information to a single feature as a whole	x		
	Reference to geometric element [1:?]	Reference to geometrical elements that represent this feature	m		
	Description	Description of the feature's nature (e.g. sflanges, thread feature, rib feature, planar feature)	m		
	Classification	Classification of the feature (e.g. design feature, machining feature)	o		

An explicit identification of geometrical features is not mandatory for document representations provided that the visualization does not allow for any design ambiguity and allows the semantics to be recognized.

4.5.1.4 Dimensions

Requirements Data Model (Level E1)			**CI**		**VP**
Entity	*Attribut*	*Description*	**Geo**	**Non-Geo**	
Dimensions Abmessungen		are geometrical properties of the dimension value and of associated information necessary to accurately depict its area of application.	m		
	Length	the linear extent in space from one end to the other	m		
	Angle	the inclination of one line to another; measured in degrees or radians	x		
	Diameter	the length of a straight line passing through the center of a circle and connecting two points on the circumference	x		
	Radius	the length of a line segment between the center and circumference of a circle or sphere	x		
	Classification	identifies the typ of a dimension, e.g., gap, functional, check, manufacturing measures	x		
	Unit	Any determinate amount or quantity (as of length, time,heat, value) adopted as a standard of measurement for other amounts or quantities of the same kind	m		

In the case of an object representation, the dimensions are, at the very least, available as model values and can be determined by taken measurements within the model. Dimensions in a document representation must be visible as presentation elements since existing model values cannot be considered reliable.

4.5.1.5 Tolerances

Requirements Data Model (Level E1)			CI		VP
Entity	*Attribut*	*Description*	Geo	Non-Geo	
Tolerances *Toleranzen*		are sets of values or properties for dimensions to represent limits within which manufactured shapes are permitted to vary	x		
	Reference to geometric element [1:?]	Reference to geometrical elements affected by this tolerance	x		
	Type	Type of tolerance, e.g. parallel, orthogonal, angular, positioning, surface/line tolerance as well as special tolerances like bending radius or stamp degree	x		
	Measures	Tolerancing measure(s) are described by value and unit	x		

4.5.1.6 Annotation

Requirements Data Model (Level E1)			CI		VP
Entity	*Attribut*	*Description*	Geo	Non-Geo	
Annotation *Bemerkung*		are additional information assigned to one or more geometric representations	x		
	Text	check and functional requirements / specifications, change notes	m		
	Classification	identifies the type of notification, e.g., check property	o		
	Reference to geometric element [1:?]	Reference to geometrical elements the annotation is relevant for	m		

4.5.1.7 Geometrical Material Information

Requirements Data Model (Level E1)			CI		VP
Entity	*Attribut*	*Description*	Geo	Non-Geo	
Geometric Material Information *Werkstoffinformationen mit Geometrieanteilen*		are material properties which have a geometrical aspect (dependent on coordinats) with respect to the substance out of which the product is made of	x		
	Material Direction	the material direction is represented by an arrow, indicating the material at the constructed area.	x		
	Thickness	sheet thickness, material thickness (the material vectors length indicates the material thickness at this point)	x		
	Material Structure Direction		x		
	Mould separation	plane, where a mold is cut	o		
	Remould direction	recast-/ drawing directing	o		
	Reference to geometric element [1:?]	Reference to geometrical elements the material information is relevant for	m		

The specification of the material thickness must be supplemented with the material direction.

4.5.1.8 Geometric Surface Information

Requirements Data Model (Level E1)			CI		VP
Entity	*Attribut*	*Description*	**Geo**	**Non-Geo**	
Geometric Surface Information *Geometrische Flächeninformationen*		are surface properties with respect to all or only specific surfaces to describe the required surface quality and/or the treatment to reach a certain quality, e.g., finish, painting or hardness	x		
	Surface property type	defines the characteristic or property of the referenced surface (e.g. Protecded treatement)	m		
	Treatment parameter [0:?]	set of parameters specifying the value and unit of the treatment	o		
	Reference to geometric element [1:?]	Reference to geometrical elements the surface information is relevant for	m		

4.5.1.9 Geometric Part Properties

Requirements Data Model (Level E1)			CI		VP
Entity	*Attribut*	*Description*	**Geo**	**Non-Geo**	
Geometric Part Properties *Geometrische Informationen zum Teil*		to be used as Validation Properties; for parts, not expected for single geometric model, which do not represent a part	m		m
	Centre of gravity	that point of a body about which all its parts can be balanced, or which being supported, the whole body will remain at rest, though acted upon by gravity.	m		m
	Moments of inertia	the sum of the mass of each particle of matter of the body into the square of its distance from the axis of rotation related to the local coordinate system	x		x

In the LTA process, center of gravity information and moments of inertia also serve as primary validation properties for components.

4.5.1.10 Presentation Information

Requirements Data Model (Level E1)			CI		VP
Entity	*Attribut*	*Description*	**Geo**	**Non-Geo**	
Presentation Information *Darstellungsinformationen*			x		
	Color settings	is the assignment of color as presentation property to a geometric element for the appearance of the element regarding the optical impression	o		
	Layer settings	is a general structuring mechanism to group / collect geometric and annotation elements used for different presentation functions	o		
	Captures	are planes (like major / camera views or clipping planes) within a 3D model to support the navigation throughout the model and for a better visibility of specific details. Planes may also be important for domains following the design phase.	o		
	Geometric Dimensions Tolerances Presentions	are the geometrical elements, signs and text strings representing the presentation of geometrical dimension and/or tolerancing information	x		
	Annotation Presentions	are the geometrical elements and text strings representing the presentation of annotations	x		

This information is required for use cases involving an object representation with explicit presentation information (4.1, use case 3).

4.5.2 Geometrical Structure

Requirements Data Model (Level E1)			**CI**		**VP**
Entity	*Attribut*	*Description*	**Geo**	**Non-Geo**	
Geometrical Structure Geometrische Strukturen		are representations of the relationship between two geometrical representations that are geometrically related as well as information which are assiged to respectively are dependend on these relationships	x		

As a rule, components are documented in their final form as finished parts.

Explicit identification of geometrical structures is not mandatory for document representations provided that the visualization does not allow for any design ambiguity and allows the semantics to be recognized.

4.5.2.1 Geometrical Assemblies

Requirements Data Model (Level E1)			**CI**		**VP**
Entity	*Attribut*	*Description*	**Geo**	**Non-Geo**	
Geometrical Assemblies Geometrische Zusammenbauten		is a relationship between two geometrical representations where the shape of the subordinated component is part of the definition of the assembly shape	m		
	Reference to Component	Identification of the geometrical element as a constituent of an assembly ("child" of the assembly relationship). Each occurence of a component shall be identifed unique within the related assembly	m		
	Reference to Assembly	Identification of the geometrical element which is defined by its subordinated components ("parent" of the assembly relationship)	m		
	Geometrical Transformation	defines the location and orientation of the related geometric component relative to the relating geometric assembly (parent)	m		

4.5.2.2 Geometric Assembly Features

Requirements Data Model (Level E1)			**CI**		**VP**
Entity	*Attribut*	*Description*	**Geo**	**Non-Geo**	
Geometric Assembly Features Geometrische Funktionselemente eines Zusammenbaus		Represents features, that are used to group assembly components, e.g., for assigning further information to the assembly feature as a whole	x		
	Reference to geometric element [2:?]	Reference to the geometrical elements that are related to eachother; the related surfaces are identified, e.g., to describe which parts are connected by subjected fasteners at which particular surfaces	m		
	Description	Description of the feature's nature (such as component parts, mounting holes)	m		
	Classification	Classification of the feature (possibly according ISOxxxx), e.g., as called at DaimlerChrysler "Assembly Joint" and " Joint Body"	o		

4.5.2.3 Assembly Tolerances

Requirements Data Model (Level E1)			CI		VP
Entity	*Attribut*	*Description*	**Geo**	**Non-Geo**	
Assembly Tolerances *Zusammenbau-Toleranzen*		Sets of values or properties to represent limits within which manufactured assemblies are permitted to vary	x		
	Reference to geometric element [2:?]	Reference to geometrical elements affected by this tolerance	m		
	Type	Type of tolerance, e.g. parallel, orthogonal, angular, positioning, surface/line tolerence	m		
	Measures	Tolerancing measure(s) with name, value, and unit	m		
	Geometric Dimensions Tolerances Presentions	are the geometrical elements, signs and text strings representing the presentation of geometrical dimension and/or tolerancing information	x		

Assembly tolerances are required for document representations (see use cases in 2.2 and 4.1) if they are included in the source representation.

4.5.3 Document Representations

Requirements Data Model (Level E1)			CI		VP
Entity	*Attribut*	*Description*	**Geo**	**Non-Geo**	
Document Representations **Dokument-Repräsentationen**		A "Document" is the representation of information about an object (to be) created by a physical activity and made of a material by means of, e.g., a CAD system, drawing system, or a word processing system.		m	x

4.5.3.1 Document Identification

Requirements Data Model (Level E1)			CI		VP
Entity	*Attribut*	*Description*	**Geo**	**Non-Geo**	
Document Identification *Identifikation eines Dokumentes*		Identifies a document (possibly a version of a document) uniquely.		m	
	Document ID	Unique identification of the document in the context of an organization (ID Owner). Specific conventions may apply.		m	
	Document Version	Current version of the document		m	
	ID Owner	Unique identification of the organization responsible for the designation of the identifier for uniqueness of document (see Document Representations - Organisation)		m	
	Document Name	Name of the document. Uniqueness is recommended.		m	
	Description	Additional information about the document.; further description of the document; subtitle		x	
	Reference: part number [1:?]	Identification of the part (via Part Identification), the document is assigned to (is description for); multiple references for mirrored parts or parametrical part definitions		m	

4.5.3.2 3D Model Information

Requirements Data Model (Level E1)			**CI**		**VP**
Entity	*Attribut*	*Description*	**Geo**	**Non-Geo**	
3D model information Information zum 3D Modell		Information about the digital 3D model of the part.		x	x
	model name	Describes an additional/different model name from the document ID or document name (for a 3D CAD model)		x	
	Accuracy information	Specification of the accuracy of the 3D model		m	x

In the case of an object representation, specification of accuracy information is required for the qualitative interpretation and evaluation of the numeric values.

4.5.3.3 Classifications

Requirements Data Model (Level E1)			**CI**		**VP**
Entity	*Attribut*	*Description*	**Geo**	**Non-Geo**	
Classifications Klassifizierungen		Association of the document to a familiy of documents in a classification system.		o	
	Classification Name	Classification name related to the document according a general or company specific classification system, e.g., geometry, FE data, specification, manual		m	
	Classification System	Contains the information about the definition of the classification and how to interpret the name of the classification within the referenced general or company specific classification system		m	

4.5.3.4 System Information

Requirements Data Model (Level E1)			CI		VP
Entity	*Attribut*	*Description*	Geo	Non-Geo	
System information Systeminformationen		Information about the IT environment used to create this (version of the) document. It depends on the process phases data preperation with its SIP, ingest with its AIP and retrieval with its DIP		x	
	Document format	Specification of the file format the document is provided in, e.g., in case of SIP: Catia V4 native, in case of AIP: ISO 10303-214.		x	
	Character code	Identification of the character code used in the document, e.g., binary, IEC 61286, ISO 646 (zurückgezogen)		x	
	Creation date	Date on which the (version of the) document was created		x	
	Creation time	Time on which the (version of the) document was created.		x	
	Creating system	System (application or machine) used to create this (version of the) document, e.g. incase of SIP: CATIA 4, in case of AIP: STEP processor XYZ		x	
	Location	Name of the place where the document is stored, e.g. URL, file system path in case of SIP; storage/media location in case of AIP		o	
	File	Name of the file representing the document		o	

The location and file are information that is not normally part of the Content Information, but rather information that is specified for management purposes in the archive environment by Archive Management (see Annex B). If the location and file are available as Content Information, they act as a reference to the source information as it was at the time that the data was prepared. The reference in the archive environment, on the other hand, indicates the currently valid location of the document in the archive.

4.5.3.5 Document Properties

Requirements Data Model (Level E1)			CI		VP
Entity	*Attribut*	*Description*	Geo	Non-Geo	
Document Properties Dokument-Eigenschaften		Properties to further define the document.		x	o
	Geometry type	Identification of the type of geometry, e.g. surface model, closed volume, solid model etc. (in case the document is a geometrical model)		x	
	Type	Specification of the kind of data held by the document, e.g. geometry, NC data, FE data, etc.		x	
	Language [1:?]	Language used within the document		o	o

4.5.3.6 Status Information of the Document

Requirements Data Model (Level E1)			**CI**		**VP**
Entity	*Attribut*	*Description*	**Geo**	**Non-Geo**	
Status Information *Status-Informationen zum Dokument*		Information related to (this version of) the document for describing the obligation/maturity of it. Also used to identify the responsible person/organisation from engineering point of view		x	
	Approval status	Identification of the current status of release/approval.		m	
	Checked by person	Identification of the person who performed the ckeck prior to the release/approval (see Document Representations - Person).		x	
	Creator	Identification of the person who creates the (see Document Representations - Person).		x	
	Release date	Date of the release/approval.		m	
	Relesed time	Time of the release/approval.		o	
	Released by person	Identification of the person who is responsible for the release of the document (see Document Representations - Person).		m	
	Released by department	Identification of the department responsible for the release of the document (see Document Representations - Organisation).		m	

4.5.3.7 Organisation, Company

Requirements Data Model (Level E1)			**CI**		**VP**
Entity	*Attribut*	*Description*	**Geo**	**Non-Geo**	
Organisation *Organisation, Firma*		Identification of the organization owning the document information or beeing responsible for the approval		m	
	Name	Name of the organization.		x	
	Organisation ID	Unique identifier of the organization.		m	
	Address	Mail address of the organization.		o	
	Organization type	Identification of the organisation type, e.g., company, department, supplier, OEM		x	

Organization information can be used by various other information blocks such as, for example, as “Released by department” in the information block “Status information”.

4.5.3.8 Person

Requirements Data Model (Level E1)			**CI**		**VP**
Entity	*Attribut*	*Description*	**Geo**	**Non-Geo**	
Person *Person*		Identification of the creator of the document or of the person which has approved the document.		x	
	Person ID	Unique identifier of the person, e.g., the designer		x	
	Person name	Name of the person, e.g., the designer		m	
	Role	Identification of the person's role within the organisation, e.g., designer		o	
	Department	Identification of the department the person belongs to (see Document Representations - Organisation).		m	

Information about a person can be used by various other information blocks such as, for example, as “Released by person” or the creator of the document in the information block “Status information”.

4.5.4 Part Master

Requirements Data Model (Level E1)			CI		VP
Entity	*Attribut*	*Description*	Geo	Non-Geo	
Part Master Teil		A "Part" is the representation of information about a single object or a unit in a group of objects (to be) created by a physical activity and made of a material, by means it may be either a single piece part, an assembly of arbitrary complexity. In the context of cars, an Item may be the car as a whole, the assembly of the engine, the car body, a fender, the side window glass, grease, or a stamping die.		m	m

4.5.4.1 Part Identification

Requirements Data Model (Level E1)			CI		VP
Entity	*Attribut*	*Description*	Geo	Non-Geo	
Part identification Teil-Identifikation		Identifies a part (possibly a version of a part) uniquely in a PDM environment		m	m
	Part Number	Unique identifier of the part in the context of an organization (ID Owner). Specific conventions may apply.		m	m
	Version	Unique identification of the version of the part. It serves as the collector of the data characterizing a physically realizable object in various application contexts. Specific conventions may apply.		x	m
	ID Owner	unique identification of the organization responsible for the designation of the identifier for uniqueness of Part (see Part Master Organisation)		m	m
	Supplier [0:?]	(List of) reference information to supplier's ID / part number (supplier: someone whose business is to supply a particular service or commodity)		x	x
	Part Name	Name of the part. Uniqueness is recommended.		m	
	Description	Additional information about the part.		o	
	Copyright	Intellectual Property Rights information about the exclusive rights of the owner of the copyright on a work to make and distribute copies, prepare derivative works, and perform and display the work in public (these last two mainly apply to plays, films, dances etc., but could also apply to software)		m	
	Trade mark	Information about a peculiar distinguishing mark or device affixed by a manufacturer or a merchant to his goods, the exclusive right of using which is recognized by law.		x	

The correct identification of a part (or assembly) is an important part of validation.

4.5.4.2 Classification

Requirements Data Model (Level E1)			**CI**		**VP**
Entity	*Attribut*	*Description*	**Geo**	**Non-Geo**	
Classifications Klassifikation		Association of the part to a familiy of parts in a classification system. Parts in there are differentiated in features or characteristics		x	
	Classification Name	Classification name of parts according to general or company specific classification systems, e.g. M5x20x4.8, security class, confidential class		m	
	Classification Description	Additional information about the classifiation.		o	
	Classification System	contains the information about the definition of the classification and how to interpret the name of the classification, e.g., ATA -Chapter, ICAO-Code, ISO1207, MBN10317 (company specific standard)		m	

4.5.4.3 Context

Requirements Data Model (Level E1)			**CI**		**VP**
Entity	*Attribut*	*Description*	**Geo**	**Non-Geo**	
Context Kontext		Context of a part e.g. life cycle stage, validity		x	
	Application [1:?]	Specifies the application for which the part is relevant within the identified context, e.g. assembly study, digital mock-up, preliminary design, or process planning		x	

4.5.4.4 Part Properties

Requirements Data Model (Level E1)			CI		VP
Entity	*Attribut*	*Description*	Geo	Non-Geo	
Part Properties *Eigenschaften des Teiles*		Non-geometric properties to further define the part.		m	m
	Volume	the amount of 3-dimensional space occupied by an object		m	m
	Surface	the extended two-dimensional outer boundary of a three-dimensional object ("wetted surface")		m	m
	Material ID	Unique identification of a material according to a technical specification (e. G. VDA 260)		m	
	Material name	Description of the material the part is/shall be made of.		m	
	Material density	specifies the density value and unit of the material the part is made from inclusive		m	
	Material strength	specifies the strength value and unit of the material the part is made from inclusive		o	
	Reference: Material specification	reference to the material specification containing the definition and properties of the used material in detail		x	
	Weight calculated	Calculated part weight during development process.		o	o
	Weight measured	Measured part weight after production.		x	x
	Weight prototype	Measured weight of prototype parts.		o	o
	General tolerance frame	defines the default values where the correct tolerance type and values are provided per range of dimension or according to the number of significant digits of the dimension. These default values are overwritten by tolerances that are assigned explicitly to particular aspects of the shape. The concept of General_tolerances is defined in ISO2768.		m	m

In the LTA process, the part properties such as, for example, volume and surface also serve as primary validation properties.

4.5.4.5 Specification References

Requirements Data Model (Level E1)			CI		VP
Entity	*Attribut*	*Description*	Geo	Non-Geo	
Specification references *Verweis auf technische Vorschriften*		References to documents that are relevant for the development, manufacturing or application of the part.		x	
	Reference: Technical specifications [0:?]	Specification of technical aspects to make, assembly, use, etc. the part.		x	
	Reference: Standards [0:?]	reference(s) to general or company specific technical standards or standards of laws, which are relevant for the part		x	

4.5.4.6 Information of source system

Requirements Data Model (Level E1)			CI		VP
Entity	*Attribut*	*Description*	Geo	Non-Geo	
Information of source system *Informationen des Quellsystems*		Information about the the source IT environment used to create this (version of the) part.		x	
	Creation date	Date on which the (version of the) part system was created		x	
	Creation time	Time on which the (version of the) part system was created.		o	
	Creating system	System used to create this (version of the) part, e.g. Matrix, VPM		o	

4.5.4.7 Organisation, Company

Requirements Data Model (Level E1)			CI		VP
Entity	*Attribut*	*Description*	Geo	Non-Geo	
Organization *Organisation, Firma*		Identification of the organization owning the part information or of the supplier as well as the organisation approving the part.		m	
	Name	Name of the organization.		m	o
	ID	Unique identifier of the organization.		m	m
	Address	identifies a place where the organizational unit may be located		o	
	Organization Type	Identification of the organisation type e.g. Supplier, OEM, Location, Plant		m	

Organization information can be used by various other information blocks such as, for example, by “Part identification” as the part owner and/or supplier or for “Status information”.

4.5.4.8 Person

Requirements Data Model (Level E1)			CI		VP
Entity	*Attribut*	*Description*	Geo	Non-Geo	
Person *Person*		Identification, e.g., of the creator of the part information, the approver or person, which is responsible for the check of the part		m	
	Person ID	Unique identifier of the creator.		o	
	Person Name	Name of the creator.		m	
	Role	Identification of the persons role, e.g. designer		o	
	Department	Identification of the department / company the person belongs to.		m	
	Language	Language used for the definition of the part information.		o	

Information about a person such as, for example, the person who checked, approved or created the part information, can be used by various other information blocks.

4.5.4.9 Authority Reference

Requirements Data Model (Level E1)			CI		VP
Entity	*Attribut*	*Description*	Geo	Non-Geo	
Authority Reference *Referenz für die Änderungserlaubnis*		Reference information pertinent to the creation or change of the part data.		m	
	Project	Identification of the project that is the administrative context for the creation of (this version of) the part.		x	
	Work order number	Identification of the internal workorder.		m	
	Work order version	version		x	
	Work order type	Description of the nature of the work order, e.g. change order		x	
	Change description	Description of the nature of the change. This can be a reference to a change document.		m	

4.5.4.10 Status Information

Requirements Data Model (Level E1)			CI		VP
Entity	*Attribut*	*Description*	Geo	Non-Geo	
Status Information *Statusinformationen*		binding information of who checked and approved the quality of part data (and ist version)		m	m
	Approval status	Indicates the level of acceptance of the part/assembly		m	
	Checked by person	Indicates the person who performed the ckeck prior to the release/approval. This check could be, e.g., a design consistency check.		o	
	Checked for	Indicates the maturity stage of the part/assembly information that shall be reached by this realease/approval (e.g. design, manufacturing, service)		o	
	Release date	Specifies the date when the approval/release actually became valid.		m	m
	Released time	Specifies the time when the approval/release actually became valid.		o	x
	Released by person	Indicates the person who is responsible for the approval/release of the part/assembly information.		o	
	Released by department	Indicates the department/organisational unit responsible for the approval/release of the part/assembly information (the person has to belonging to, if specified).		m	
	Released for	Indicates the maturity stage of the part/assembly information that is reached by this realease/approval (e.g. design, manufacturing, service)		m	
	Effectivity date	Indicates the point in time, the production of the part / assembly / product is stopped		m	
	End of Production	Indicates the point in time, the production of the part / assembly / product is stopped			

In the LTA process, status information can also be used to validate non-geometric information.

4.5.5 Product Structure

Requirements Data Model (Level E1)			CI		VP
Entity	*Attribut*	*Description*	Geo	Non-Geo	
Product Structure Produktstruktur		Description of relationships between parts, such as links between an assembly and a component or other dependencies on part level.		x	m

4.5.5.1 Part Structure

Requirements Data Model (Level E1)			CI		VP
Entity	*Attribut*	*Description*	Geo	Non-Geo	
Part Structure Teilestruktur		Description of the relationships between assemblies and its constituents.		x	m
	Reference to Component	Identification of the part / sub-assembly as a constituent of an assembly ("child" of the part structure)		m	m
	Instance number	Identification of the occurrence of the constituent component within the part structure		m	
	Reference to Assembly	Identification of the assembly part, which is defined by its subordinated components / constituent elements ("parent" of the part structure)		m	m
	Quantity	indicates the amount and unit of the referenced components within the assembly with respect to the related instance number		m	m

In the LTA process, references to the components involved also serve to validate product structures.

4.5.5.2 Part Relationships

Requirements Data Model (Level E1)			CI		VP
Entity	*Attribut*	*Description*	Geo	Non-Geo	
Part Relationships Teilebeziehungen		Description of relationships between parts and assemblies which are not of type Part Structure (constitutuents of another component)		x	
	Mirrorpart Relationship	Description of a relationship of a assembly / part to its mirror part		o	
	Replacement for	specifies a reference to an other assembly / part the part is a replacement for.		x	

4.5.5.3 Context

Requirements Data Model (Level E1)			CI		VP
Entity	*Attribut*	*Description*	Geo	Non-Geo	
Context Kontext		Association of the part structure to a context (such as life cycle stage) it is relevant in.		m	
	Context name	indicates the context of the part structure relationship with a unique string, e.g., as functional assembly (such as a system) or as relevant for design, planning or manufacturing		m	
	Context description	Additional information about the context		o	

4.5.6 Manufacturing Information

Requirements Data Model (Level E1)			CI		VP
Entity	*Attribut*	*Description*	Geo	Non-Geo	
Manufacturing Information Herstellungsinformationen		are information which are relevant for manufacturing or assembling a part or group of parts	x	o	

4.5.6.1 Manufacturing Features

Requirements Data Model (Level E1)			CI		VP
Entity	*Attribut*	*Description*	Geo	Non-Geo	
Manufacturing Features Funktionselemente für die Herstellung		are sets of (geometrical) elements representing features, that are either relevant for manufacturing or assembling a part respectively group of parts	x		
	Reference to geometric element [1:?]	Reference to geometrical element(s) which is/are constituent of the definition of the manufacturing feature	m		
	Description	Description of the manufacturing feature's nature (such as welding points)	m		
	Classification	Classification of the manufacturing feature (e.g., welding point)	x		
	Parameter [0:?]	set of parameters specifying value(s) and unit(s) of the manufacturing feature	m		

4.5.6.2 Process Information

Requirements Data Model (Level E1)			CI		VP
Entity	*Attribut*	*Description*	Geo	Non-Geo	
Process information Prozess-Informationen		Relevant information important for the target product or part		o	
	Assembly Method	describes certain properties and/or constrains for assembling the target product, e.g., torque of screws, possibly according a referenced standard / specification		o	
	Production Method	describes certain properties and/or constrains for producing the target part, possibly according a referenced standard / specification		o	
	Related Row Material Part	describes the link to the related row material or semi-final product, which is the basic for manufacturing the part, but only if it is essentual for the quality and properties of that part		o	
	Related Semi-finished product	Information about the semi-finished product used to make the part, such as raw material.		o	
	Part Tool Relationship	Description of a relationship of an assembly / part to a tool or a set of tools required to manufacture /assemble the part / assembly		o	

4.6 Binding nature of LTA data

The anchoring of a distinct status and, if necessary, the joint archiving of the 3D CAD data and the non-geometric data must be ensured. This also applies to the careful handling of the attributes used to identify documents that belong together.

The binding nature of the LTA data must be ensured in compliance with the description in Part 1 and 2 of VDA 4958 before the LTA process.

The LTA data is sealed during the archiving process. The seal can be used to safeguard data retrieval when data from the archive is made available to the Consumer. Validation of the consistency and integrity of the Content Information by the Consumer can be performed using appropriate validation and verification measures in compliance with VDA4958-2.

4.6.1 Handling existing standards and archiving

The standards and directives relevant to a company must be applied to the documentation of product data. At the same time, consideration must also be given to national and international statutory provisions.

If company-specific standards are used, these must also be archived.

4.6.2 Geometric definition

In general, the editing of the content of binding information and its representation is sufficient for the geometric definition within the context of LTA.

Reproduction of the graphical representation that is true to the source is only required if a modified representation means that the information content can no longer be interpreted or is no longer unambiguous.

Depending on the use case involved (Figure 8), the geometric definition of a part in the context of LTA comprises the following information:

1. the representation (explicit geometry using nominal dimensions)
2. additional tolerance specifications
3. additional optical presentation information (depiction derived from a geometry representation, tolerance specifications and dimensions)

This makes reproducibility for manufacturing and a new derivation of the depiction as an optical presentation possible using a representation and the associated tolerance specifications.

Archiving the optical presentation information provides additional documentation of the original representation.

5 Archiving scenarios

As a result of the requirements stemming from the various use cases, the connected systems and the types of information to be supported, a number of different archiving scenarios are possible. This chapter presents possible archiving scenarios and provides recommendations for their implementation.

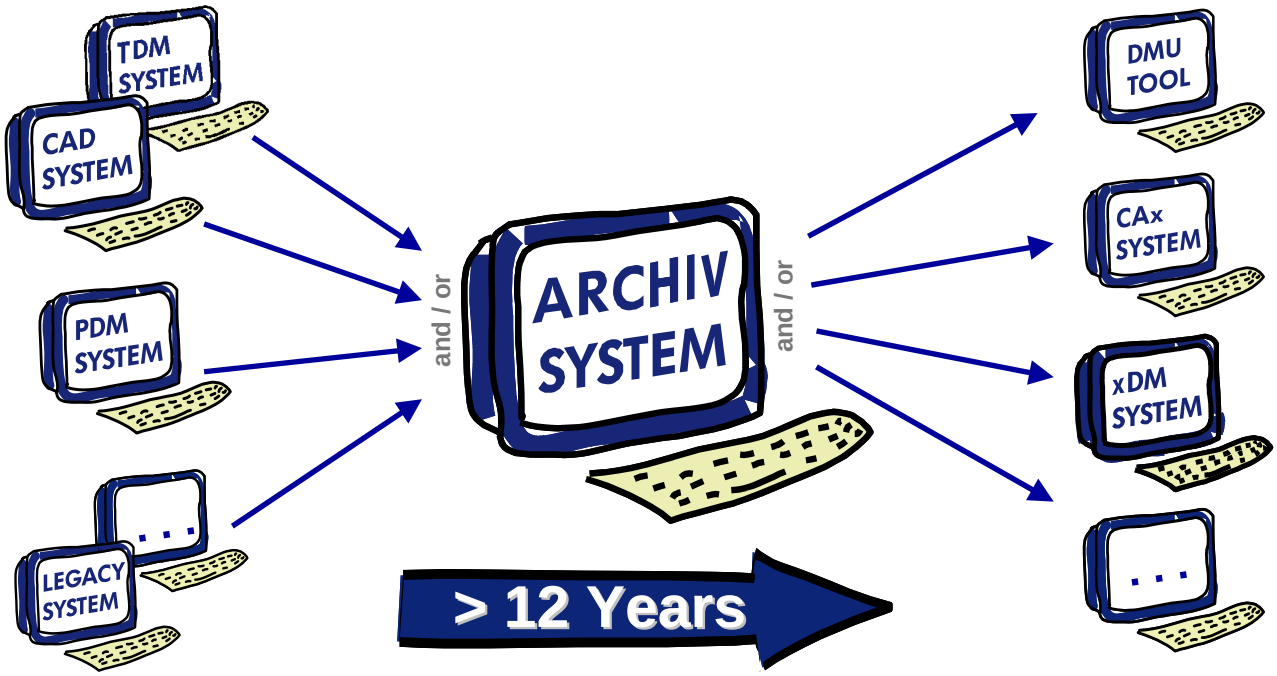

Figure 15: Support of different Source and Target Systems

5.1 System-dependent archiving scenarios

The archiving scenarios can be shaped by various system dependencies. It can be assumed that a long-term archiving environment will be operated in a heterogeneous system landscape. A variety of source systems (CAD, PDM, TDM systems, etc) supply the data and documents to be archived. A variety of target systems (viewers, CAD, PDM systems, etc.) need to be catered for over the years during which the data is stored.

5.1.1 Long-term archiving of similar information objects from heterogeneous system landscapes

This archiving scenario involves connecting various source systems to the archive environment. Within the archiving processes, data packets, such as, for example, 3D CAD models from various CAD systems, are transferred to the archive system. In this archiving scenario, it must be ensured that the data packets received by the archive environment observe the agreements between the archive and sending system in equal measure.

The agreements must describe

- which type of data
- with which level of quality
- in which form of representation and

- using which data format

will be accepted by the archive system. The agreements should at least include specifications regarding the:

- format of the data packets
- size of the data packets
- formats of the Content Information
- Descriptive Information
- quality criteria for the content and administrative data.

Similar agreements are to be made for data usage (target system).

The archiving requirements regarding the data are to be satisfied in equal measure regardless of the source system involved. Special characteristics intrinsic to a system are to be avoided in the AIP.

If it is to be possible to make information with the same content available for archiving from different source systems, a senior system must be identified whose information is considered binding (see also 4.6), and only this information is to be archived.

Software tools adapted for data preparation and archiving must be provided for the various source systems (CAD, PDM, etc.). These software tools must satisfy the various requirements of the source systems.

5.1.2 Long-term archiving of different information objects in heterogeneous system environments

This archiving scenario is characterized by the generation of the data to be archived from different source systems. The focus of this scenario lies on the consolidation of different data and documents from different systems, such as, for example, PDM, TDM and CAD information.

Within the archiving processes, attention must be paid to making sure that reference information that safeguards the link between the various information blocks is available, e.g. the reference to the associated geometry model from a product structure. Corresponding agreements must be defined between the archive system and the systems supplying the data. It is possible that a single SIP contains a combination of different information blocks or that the different data is handled in separate SIPs.

The archiving requirements relating to the different types of data must be satisfied in equal measure regardless of the respective source system. The requirements are to be oriented to the various concerns of the information (e.g. geometric accuracy, requirements regarding the integrity of non-geometric information).

Special characteristics intrinsic to a system must be avoided in the SIP.

5.2 Data-dependent archiving scenarios

These archiving scenarios are characterized by the LTA-conform, system-independent archiving of content and administrative data with various data representations and data formats.

5.2.1 Archiving a “purely” 3D CAD model

Depending on the intended use case (4.1), 3D CAD models must be available within an AIP in a suitable form of representation that meets the criteria in 3.3 and 3.4. Appropriate

software tools transfer the 3D data from the source representation to the neutral form of representation or the desired data format. These tools are known as converters or processors for CAD systems.

For example, when using ISO 10303-214 as the form of representation, different Conformance Classes (CC) are defined, which provide modular functionalities for various information objects (see also Chapter 6).

If purely geometric information is being archived, it must be ensured that the reference information, e.g. to relevant non-geometric content data within the information package and the Descriptive Information of the AIP is included.

5.2.2 Archiving non-geometric information

When archiving only non-geometric information such as part master data, product structure information or manufacturing information (PDM data), the data must be available within an AIP in a suitable form of representation. The forms of representation must satisfy the criteria in 3.3 and 3.4.

Appropriate tools transfer the non-geometric data from the source representation to the neutral form of representation or the desired data format. These tools are known as converters or processors for PDM and TDM systems. Information can also be obtained from planning systems or manufacturing control systems.

If using ISO 10303-214 as the form of representation, for example, the Conformance Classes CC6 and higher are to be used depending on the required functionality and content data to be mapped (see also Chapter 6).

When archiving non-geometric information, it must be ensured that reference information relating to geometric information is included in the information package and the Descriptive Information. Otherwise, it will be impossible to retrieve the relevant geometric information.

5.2.3 Combining geometric and non-geometric information

When archiving a combination of 3D, PDM and structure information, the data within an AIP must be available in a suitable form of representation that satisfies the criteria in 3.3 and 3.4. Appropriate tools transfer the data from the source forms of representation to a neutral form of representation or the desired data format.

Software tools for data preparation and archiving must be available for the various source systems and must satisfy the different requirements of these systems. The data can be combined in a single information package or distributed over a number of different information packages. It must, however, be ensured that reference information between the relevant content data (within a single information package or across a number of packages) and in the Descriptive Information is consistent.

If using ISO 10303-214 as the form of representation, for example, the Conformance Class CC7 or CC9 and higher are to be used depending on the required functionality and content data to be mapped (see also Chapter 6).

When archiving a combination of CAD and PDM information, it must be ensured that reference information between the information blocks is included in the information package and the Descriptive Information.

5.3 Incremental archiving

In addition to the system- and data-dependent archiving scenarios described, a distinction can be made between generally applicable use cases within an archiving process. Thus the information blocks can be stored in

- several individual information packages (files) or
- in one single “large” information package.

If a combination of information (geometric and non-geometric information including positioning information) and large product structures are being archived, it is recommended that the information be subdivided into individual information packages to minimize redundancies and to simplify process handling.

A subdivision in the context of a classic building block structure in analogy to the previous archiving of 2D drawings is recommended. Individual parts are archived in separate information packages, and assemblies (product structures) are broken down into individual, so-called “single-level” building blocks and archived. The incremental archiving results from the fact that individual parts that are ready for serial production are archived in individual information packages together with their release and are referenced when used in assemblies. When archiving an assembly, a reference mechanism (see also VDA 4956) to the components on the next lower structure level is used to indicate which components taken together define the assembly. A referenced component can, in turn, itself be an assembly or an individual part.

Figure 16 show a simplified representation of a product structure comprising two assembly nodes (ASM) and three individual parts (Part). The individual parts are described in more detail by corresponding CAD models (M). The structure relationships define the positioning of the components within this structure.

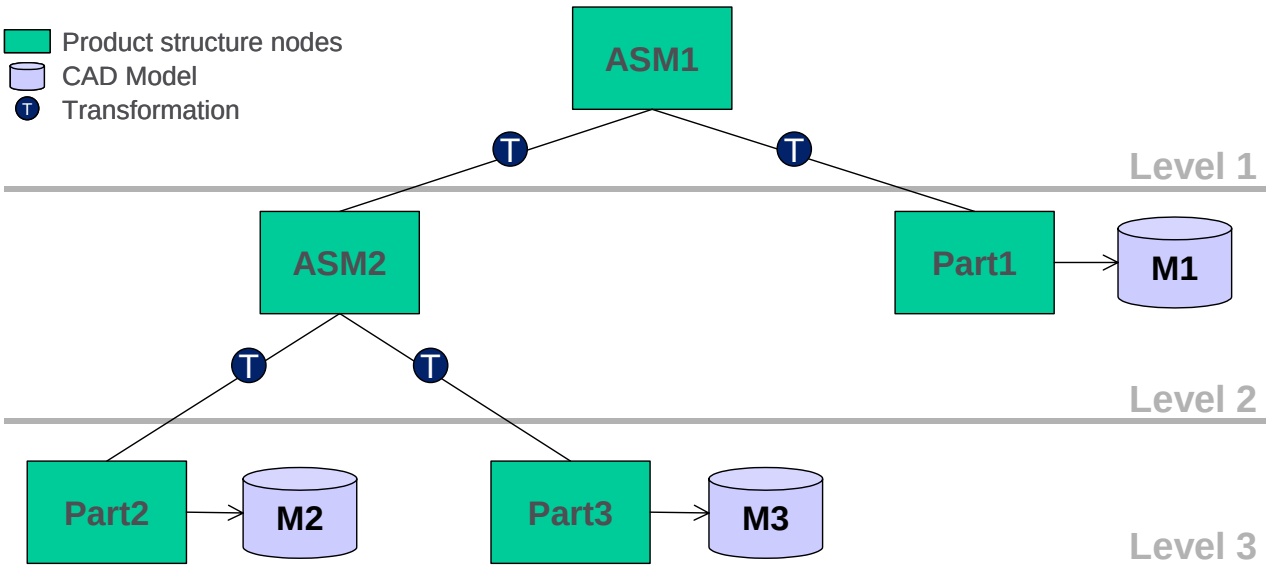

Figure 16: Example of Product Structure respectively Assembly Structure

In accordance with a release process, this structure is broken down into individual building blocks (information packages) and archived in the case of incremental archiving (Figure 17). The order is only important inasmuch as only components that have already been archived can be referenced in the archive environment (in the example Part1 to Part3 and ASM2). Otherwise, a reference that could not be resolved would exist in the archive.

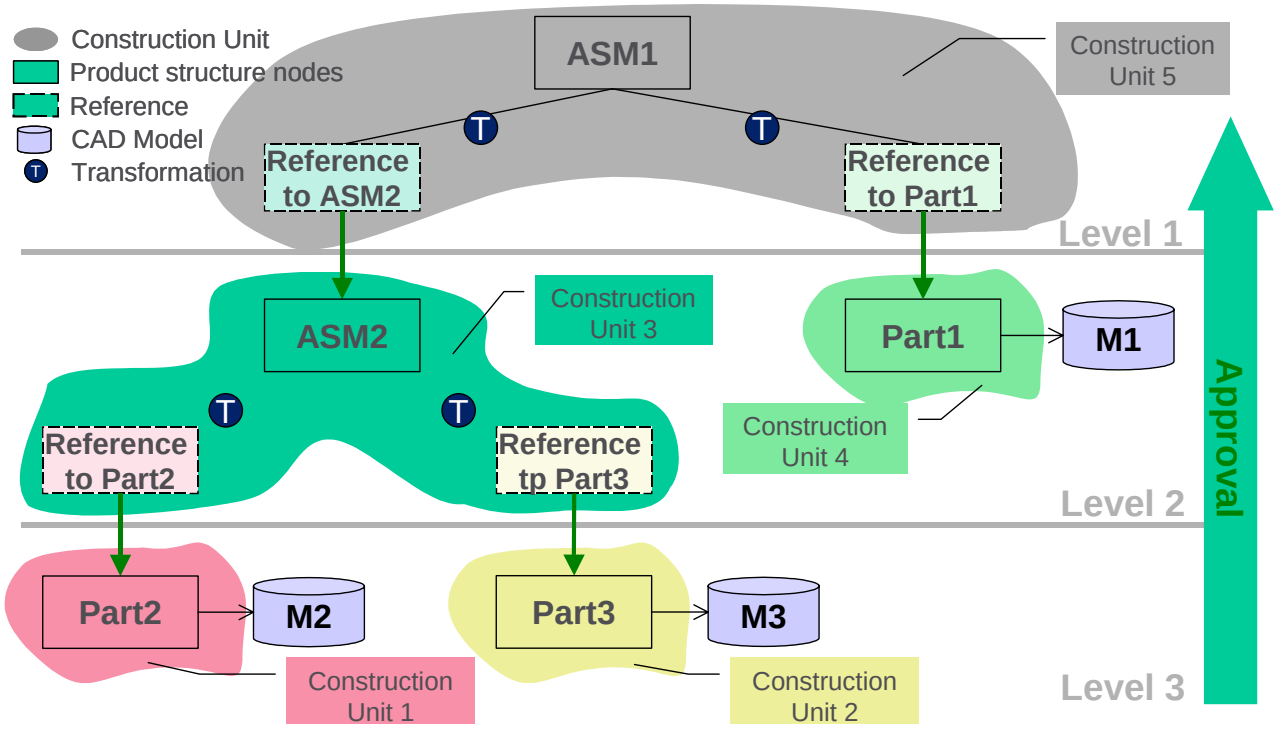

Figure 17: Schematic presentation of a product structure în an increment archiving

The advantages offered by the incremental archiving approach include the ability to perform archiving with a low level of redundancy as well as incorporating the archiving activities in the progressive release process.

The additional possible subdivision into different information packages can be oriented towards the following grouping:

- geometric definitions and structures (if available)
- document representations
- part master information, product structure (if available) and manufacturing information
- document representations combined with part master information, product structure (if available) and manufacturing information

An information block-oriented subdivision offers the advantage of optimization with regard to the creation and handling of the information packages since different data contents require different processing and quality assurance measures.

Subdividing the Content Information into geometric and non-geometric data in 4.5 is done using the columns “Geo“ and “Non-Geo“.

As previously mentioned in the archiving scenarios, the reference information is a fundamental component of incremental archiving. More information about the structure and use of reference mechanisms can also be found in VDA 4956.

6 Mapping the LTA-relevant data and models to descriptive standards

This chapter provides recommendations for mapping the requirements from the core model (chapter 4) to descriptive standards. A distinction is made between

- content data
- administrative data
- process data

Content data is data that represents the actual information to be stored. If digital product development data that is not based on drawings is to be subject to long-term archiving, the content data is identified in the data dictionary (4.5).

Administrative data is data that supports the searching and finding of archive packages. The Descriptive Information (see 6.3.4) is an example of administrative data.

Process data describes information that must be brought into play when archiving and retrieving content data and which supports the LTA processes. This category of data comprises a wealth of information whose use depends on the use case involved and on the implementation of the process recommendations according to VDA 4958-2.

6.1 Mapping of information packages and data structures according to ISO 14721

The following sections describe the mapping of the various types of data according to the data structure in ISO 14721 (2.1.1). The basic structure of the Submission, Archival and Dissemination Information Packages is the same (see also 2.1). The content and form of representation of the information in the packages is, however, different and depends on the LTA process (see VDA 4958-2).

6.1.1 SIP – Submission Information Package

The SIP belongs to the category content data. It comprises the following package parts (Figure 1):

- Content Information (CI)
- Packaging Information (PI)
- Preservation Description Information (PDI)

The archiving process focuses on the Content Information, which should satisfy the requirements relating to the requisite quality or quality agreed upon for long-term storage. The CI in the SIP comprises the information in its original form of representation. The actual data is represented in the form of data objects in compliance with OAIS. Only in conjunction with the representation information can the content data (information objects) be interpreted semantically and structurally. (Figure 2, Figure 3)

The PI in the SIP is information that is used to bind and identify the components of an information package (Figure 5) and is created as the result of data preparation. It is required for further processing in the data transfer phase. This information includes information about size and file structure, e.g. according to ISO 9660, on the respective data carrier, as well as file names and information about the storage location.

The PDI in the SIP is information that is required for data preparation and data transfer of the Content Information within the framework of the LTA process. The PDI can be categorized as provenance, context, reference or fixity information (Figure 5). This administrative information is updated according to the LTA process. The validation properties for quality assurance are also part of the PDI. Annex B provides recommendations regarding the contents of the administrative data in the PDI according to 6.3.1.

6.1.2 AIP - Archival Information Package

The AIP belongs to the category content data. It comprises the following package parts:

- Content Information (CI)
- Packaging Information (PI)
- Preservation Description Information (PDI)
- Digital Signature Information

The CI in the AIP is available as a LTA-conform form of representation and must satisfy quality requirements for the duration of the retention period.

The PI in the AIP is the information that is required to bind and identify the components of an Information Package during the retention period.

The PDI in the AIP is the information that is required for the period of retention after data transfer of the Content Information within the framework of the LTA process. The PDI comprises provenance, context, reference and fixity information and is updated as required.

The digital signature information is information which, in addition to the validation properties and check results, ensure and document the authenticity and integrity of the data.

6.1.3 DIP – Dissemination Information Package

The DIP belongs to the category content data. It comprises the following package parts:

- Content Information (CI)
- Packaging Information (PI)
- Preservation Description Information (PDI)
- Digital Signature Information

The DIP is generated from a copy of the stored AIP since the original AIP remains in the archive. Generation of a DIP occurs in response to request made by a Consumer. The DIP can comprise several AIPs.

The CI in the DIP is the CI from one or more AIPs in the target form of representation needed by the Consumer. This data representation must satisfy the requirements relating to the requisite quality or quality agreed upon and is the result of retrieving the archived data.

The PI in the DIP is information that is required to bind and identify the components of an information package for its retrieval.

The PDI in the DIP is information that required in order to use the data in the course of retrieving the Content Information.

The digital signature information is information which, in addition to the validation properties and check results, ensure and document the authenticity and integrity of the data on the way to the Consumer.

6.2 Mapping the Content Information (CI)

The Content Information is the information (data objects) to be stored – as identified in the data dictionary (4.5) – for the purpose of the LTA of digital product data that is not based on drawings. The CI can, for example, be represented by a 3D CAD model and/or non-geometric data from a PDM system.

The form of representation of the CI changes during the course of the LTA process. After data generation, the CI in the native format is converted into the archive representation of the CI via data preparation and data transfer (ingest). The CI from the archive is converted into the target representation of the CI when it is retrieved for data usage.

Archive representation and target representation are the result of mapping to the descriptive standard being used, and they are documented by means of the representation information in compliance with Figure 2 and Figure 3. The descriptive standards facilitate a semantically and structurally uniform interpretability of the Content Information and ensure the required or agreed upon level of quality.

The following sections provide examples of the mapping to descriptive standards for the data elements in the LTA reference process.

6.2.1 Data in native format

The CI in the SIP comprises the information in its original form of representation (native format) just as it made available to the archiving environment as the result of data preparation. The actual data is represented as data objects in compliance with OAIS.

Content Information that is transferred to the archive in its original data representation should, regardless of the use case, at least be conform to ISO 16792. The following criteria, for example, must be satisfied:

- It must be possible to obtain the geometry of the design model, the annotations (including GD&T), associated documentation, the model values and the rounded units from the 3D model.
- It must be possible to retrieve the model using this information.
- Associativities between the digital elements must be retained and they must be electronically accessible.
- Non-geometric information such as, for example, notes, parts lists, inspection marks and other markings must be included in the CI or must be referenced.
- CI in the model (and in any derived drawings) must not be contradictory.

In addition, any representation of the CI must allow the display of the information to be activated or deactivated

- entirely
- grouped according to information type or
- according to individual selection

It should be possible to identify geometric elements that are grouped together in an associated group of elements by selecting any one of the geometric elements in the group. It must, however, also be possible to identify all the elements in a group by selecting one of the elements.

Associativity, e. g. for tolerances and references must be supported. Retrieval of a reference element must provide access to all the information relevant to that reference element. This includes the reference code, the nominal dimensions (if applicable), every specified geometric tolerance and the corresponding coordinate system.

Figure 18 shows an example of the mapping of Content Information as defined in 4.5 to the descriptive standard ISO 16792. The mapped CI includes, for example, the coordinate system (4.5.1.1), the geometrical representations (4.5.1.2) with the feature (4.5.1.3) “HOLE_PATTERN“, dimensions (4.5.1.4) and tolerances (4.5.1.5).

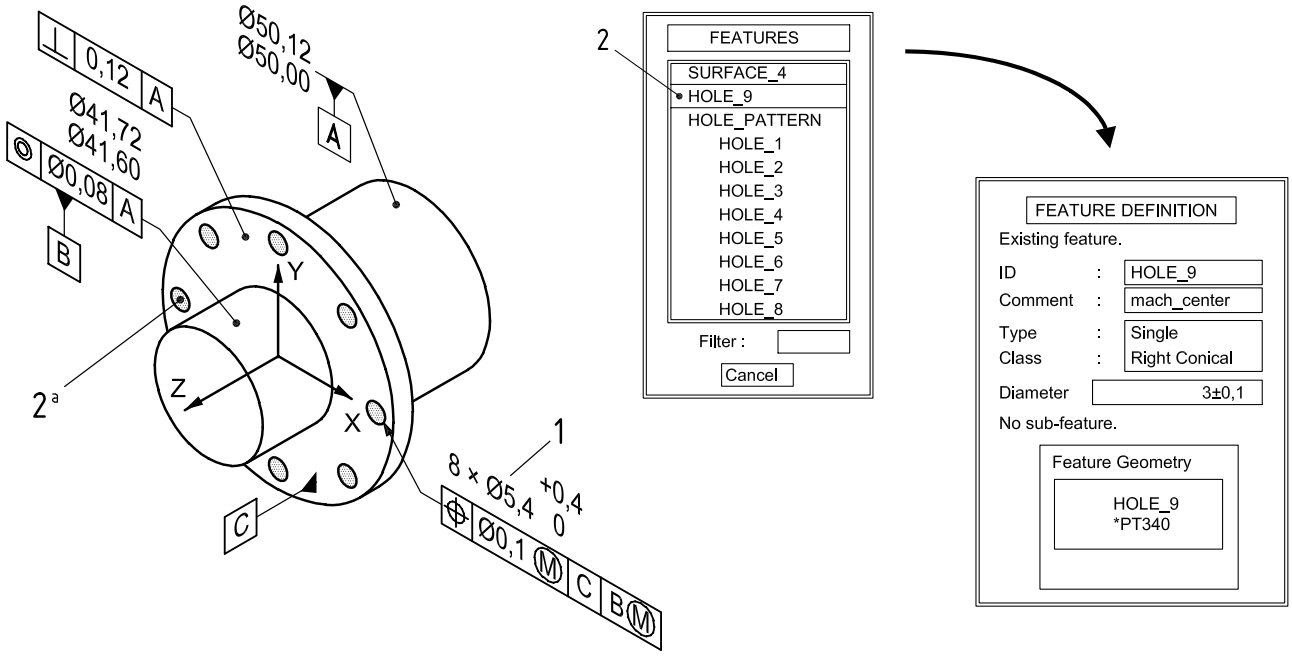

Figure 18: Example of a mapping of CI onto descriptive standard (Source: ISO 16792)

Other standards must be taken into consideration as necessary and depending on technological progress and the requirements of the information identified in the core model.

The CI in the SIP may already be available in the archive format (“SIP in the archive format”), or it is converted to this format in the process step “Generate AIP” at the latest (see VDA 4958-2).

6.2.2 SIP in the archive format and AIP representation

Once the CI has been converted successfully, the SIP is available in the archive format. The AIP can be generated together with the PI and the PDI. The information within an AIP must be available in a suitable form of representation that satisfies the criteria in 3.3.

Depending on the use cases to be supported (documentation and/or further constructional CAD application), the Content Information in the AIP must be mapped to suitable, descriptive standards. Because of the different level of requirements made of a document and object representation (2.2 and 4.1), a number of different standards may be suitable

with regard to the criteria in 3.3. A decision as to suitability must be made on a case-by-case basis since other standards may be suitable with regard to

- the state of the art
- the required functionality
- the variety of information to be archived

6.2.2.1 Content Information in the AIP as an object representation

The full functional scope of the LTA-relevant information is only available for later data usage in the use case involving a complete 3D object representation. The object representation comprises specification of attributes, model values and the option of generating the presentation of these annotations on the model, e.g. in compliance with ISO 16792, for the purpose of their visualization.

The advantage offered by an object representation is not only the possibility of constructional reuse and/or further use but also the fact that more simple document representations can be derived from the object representation at any time (also retroactively). Doing this usually results in a loss of functionality, information and/or accuracy.

If using, for example, ISO 10303-214 as the form of representation, the Conformance Classes at least CC10 and higher must be used depending on the required functionality and the content data for geometric information (5.2.1) that needs to be mapped. One of the Conformance Classes CC12 to CC15 or CC19 and higher must be used, for example, for archiving features and manufacturing information. If mapping to ISO 10303-214 as the form of representation, the various Conformance Classes offer modular functionality for the various information objects. The Conformance Class at lease CC6 or higher must be used for mapping only non-geometric content data (5.2.2) depending on the required functionality and the content data to be mapped. Since the archiving of geometry, e.g. within a CC6 representation, is not provided for, Conformance Classes CC7, CC9 or higher should be used for combinations of geometric and non-geometric information (5.2.3).

When archiving PDM information, it must be ensured that reference information relating to geometric information is included in the information package and the Descriptive Information because otherwise it will be impossible to retrieve the relevant geometric information without the reference information.

The object representation with specification of attributes and model values can be extended to include explicitly stored presentation information for visualizing GD&T information and annotations. The presentation information is described, for example, by ISO 16792 or the standard used when the information was generated. This means that an accurate presentation that is true to the source is also stored, i.e. information including colors, clipping planes, etc. that correspond to the source presentation can also be reproduced. Mapping to ISO 10303-214 already provides support for this in, for example, in the Conformance Classes CC12 and CC13.

Annex C contains an example of a rough mapping of the required Content Information (Chapter 4) to the Application Reference Model (ARM) with ISO 10303-214 as the descriptive standard. The most important objects from ISO 10303-214 are identified to which the requirements according to 3.3 can be mapped. This mapping thus defines the form of data representation with regard to the description, semantics and the interdependencies of the data. Figure 19 shows the structure of this table.

Mapping approach onto standard based description and implementation model		
Data Level E2 / E3 , e.g., for ISO10303-214 Application Reference Model (ARM)		
Entity	*Attribut*	*Remarks, Rules, Constrains*

Figure 19: Mapping of a Core Model onto a descriptive and implementation level

The STEP objects (entities) and their names are identified in the column “Entity”. The main object attributes (data types) from the reference model are listed in the column “Attribute”. The third column contains remarks, rules and constraints, if applicable. This figure is intended only as an orientation guide and makes no claim as to being complete since only the feasibility is established here, i.e. proof that the requirements can be mapped with the same object representation. A detailed mapping rule should be described in the existing specifications and should be implemented in the processors of the components involved.

6.2.2.2 Content Information in the AIP as a document representation

In order to supply data

- for the development of downstream processes
- to agencies or technical experts as proof of specification-compliant manufacturing

or in similar cases, it can be assumed that documentation representation, which is more simple compared with object representation, can be used. The mapping to what are referred to as intelligent document representations is recommended for this purpose. It is characterized by a 3D geometry visualization including the presentation of the Content Information and provides functionality for handling associativities between the presentation objects such as GD&T, annotations, geometric elements and non-geometric Content Information, for example.

Suitable forms of document representation must also satisfy the criteria in 3.3. Candidates for this use case with regard to the current state of the art could be, for example, PDF/E (ISO/CD 24517-1)[2] or JT. However, at the time that this recommendation is being released, they do not (yet) meet all the criteria regarding a LTA-conform form of document representation. A corresponding check is therefore required at the appropriate point in time.

6.2.3 Content Information in the target data format

The Content Information in the target data format represents the converted Content Information when the archived data (DIP) is retrieved. The target data format depends on the current or future system and the requirements of the Consumer. (See also 6.1.3)

With regard to the current state of the art, Content Information that is transferred to the Consumer in the target data representation must at least be compliant with ISO 16792.

The form of representation (document or object representations) depends on the form available in the AIP.

[2] ISO 19005-1 for PDF/A can only currently be used for non-geometric information and does not support 3D geometric data

6.2.4 Reference information

Reference information is a special kind of Content Information. A reference represents identifying information at data object level. The identification of a part as a component (to be used) in an assembly is, for example, such a reference.

Reference information does not belong to the category Content Information but rather plays a crucial role as administrative data since it provides information about which information packages belong together. Without the reference information, only part of the required data and documents would be made available to the Consumer, for example, when an assembly is retrieved. Without reference information, it would be impossible within the dissemination processes to retrieve all the required archive packages automatically in many cases.

6.3 Mapping the administrative data

The following sections describe the mapping of the various types of data according to the data model structure in ISO 14721. The basic structure of the Submission, Archival and Dissemination Information Packages is the same (see also 2.1), but there is a difference between the content and forms of representation of the information in the packages, which depend on the LTA process (see VDA 4958-2).

6.3.1 Matrix for assigning information objects to administrative data

Recommendations regarding which information objects and attributes should be used for which administrative data are provided in the columns “PDI”, “PI”, and “DI” in the data dictionary (Annex B) as shown in Figure20. Mapping is performed according to the data model structures in ISO 14721.

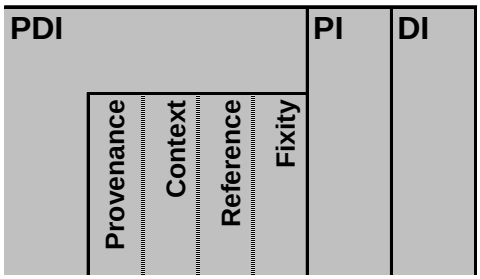

Figure20: Assigning information objects and attributes to administrative data

A distinction is made between assignment to the Preservation Description Information (PDI), the Packaging Information (PI) and the Descriptive Information (DI).

In compliance with ISO 14721 and VDA 4958-2, the PDI is categorized as:

- information for identifying the provenance
- information for identifying the context
- reference information
- information for safeguarding fixity (immutability of the archive information)

In the matrix, recommendations are made regarding the usage of the LTA-relevant information by means of the following classification indicators (Figure21).

Information package	Classification	Recommendation
PDI, PI, DI	m - mandatory	The information is necessary for the selected domain for administration and safeguarding of the archiving and data reuse.
	x - extension	If the information is available, it is of relevance for the selected domain, i. e., adaquate functionality has to be appropriated. Information with „x“ mark may be re-declarated to „m“ for company specific reasons.
	o - optional	Information which are marked as optional may be used branch, product or company specifcally for the administration. Information with „o“ mark may be re-declarated to „x“ or „m“for company specific reasons.

Figure21: Classification and recommendations of the matrix for administrative data

The usage rules are applied in the data directory from top to bottom, i.e. from the information blocks, to the objects, to the attributes. If, for example, an information object is designated as “m” (mandatory), at least one representation of this object type is required for archive administration. The attributes behave according to their designation (Figure21), i.e. at least all of the attributes for this object that are marked with an “m” are to be used. If, on the other hand, and information object is marked with an “x” (extension), it can only be used for administration purposes if at least one representation of this information object is available regardless of how its attributes are classified. If, however, a representation of this object is available, the rules for its attributes apply as specified in the data directory.

In the case of the information object “Part identification” in the example in Figure 22, this means that at least the identifying attribute “Part Number” and “ID Owner” are to be used for the Descriptive Information.

Relevant LTA/LZA Data (Requirements of 3D CAD and PDM data)			**Content in**									
Requirements Data Model (Level E1)			**CI**		**PDI**					**PI**	**DI**	**VP**
Entity	*Attribut*	*Description*	**Geo**	**Non-Geo**		**Provenance**	**Context**	**Reference**	**Fixity**			
Part Master Teil		A "Part" is the representation of information about a single object or a unit in a group of objects (to be) created by a physical activity and made of a material, by means it may be either a single piece part, an assembly of arbitrary complexity. In the c		m	m	x	x	m			m	m
Part identification Teil-Identifikation		Identifies a part (possibly a version of a part) uniquely in a PDM environment		m	m	x	x	m			m	m
	Part Number	Unique identifier of the part in the context of an organization (ID Owner). Specific conventions may apply.		m	m			m			m	m
	Version	Unique identification of the version of the part. It serves as the collector of the data characterizing a physically realizable object in various application contexts. Specific conventions may apply.		x	x	x		x			x	m
	ID Owner	unique identification of the organization responsible for the designation of the identifier for uniqueness of Part (see Part Master - Organisation)		m	m			m			m	m

Figure 22: Example of a calssification of administrative data

If a “Version” is to be available for part identification, it must also be maintained as administrative information.

6.3.2 PDI – Preservation Description Information

The PDI groups information that is needed for the correct storage of the Content Information. According to ISO 14721, it is categorized as

- provenance information
- context Information
- reference information
- fixity information

The PDI categories can be described as follows:

Provenance: describes the source of the Content Information. This includes information from the system that has managed the CI since it originated as well as the history of the CI.

Context: describes the relationships of the CI to objects outside of the information package. This can, for example, include information about the system in which the CI was generated.

Reference: provides one or more attributes or a system of attributes that can be used to identify the CI without ambiguity.

Fixity: provides information that ensures the fixity (immutability) of the archive data. This means that an object that is not immutable could be altered without this being known.

The validation properties are also part of the PDI within the framework of VDA 4958-2.

The PDI can contain a substantial set of information and should be stored in an ASCII format to ensure reusability after the retention period.

6.3.3 PI – Packing Information

The PI is administrative data that is needed for archive management. The PI is the part of the information that describes the CI and PDI and other components in an information package in more detail.

The packaging information is not discussed in more detail within the framework of VDA 4958.

6.3.4 DI – Descriptive Information

The DI provides information about the contents of an archive package and is required by the role “operator of the archive system”. This information is needed when a Consumer requests archive information, and it supports finding and retrieving archive information. The Descriptive Information is extended to include storage information and reference information relating to, for example, a CAD model.

Descriptive Information can, for example, be the name of the Content Information or reference information relating to relevant archive packages. In addition, the name of the assembly used, the reference project or the relevant designed space can be listed in the Descriptive Information.

6.4 Mapping the process data

The process data is defined in Part 2 of VDA 4958 and serves to control the LTA process steps, the process documentation and error handling. The process data is not discussed in more detail here since it is not part of an information package and does not serve the direct administration of the LTA data.

Mapping of the process data is performed within the framework of the implementation for which the use of recognized standards is also recommended. The implementation of an archive environment is not the focus of this recommendation.

7 Mapping to implementation standards

The mapping of the requirements from a core model to the implementation level determines how the information objects are stored physically or digitally. Appropriate data schemas and data formats must be selected depending on the required data scope (Chapter 4), the use cases to be supported (2.2 and 4.1), as well as the archiving scenarios to be supported (chapter 5). The must satisfy the criteria specified in 3.4.

7.1 Data schema

The data schema for the implementation level describes the data objects with regard to their semantics and syntax (data representation). Physically, the data objects are represented by digital files that conform to a standardized format specification (data presentation or data format, as appropriate). The data format thus defines how data is to be interpreted by the program during loading and saving.

Mapping to the implementation level is to be defined in line with the selected use case.

The use of ISO 10303-214 as the descriptive standard (level E2) for mapping the core model (see 6.2.2.1) automatically results in mapping to the implementation level (level E3). Mapping to the data schema is already part of ISO 10303-214 in the form of a mapping specification to what are referred to as the integrated resources (IR), the Application Interpreted Model (AIM). A large number of corresponding mapping specifications and recommendations have already been described in other documents and recommendations, e.g. for STEP-based data exchange. Therefore, this will not be dealt with in more detail here.

7.2 Data format

Various data formats such as ASCII, XML, etc. lend themselves to implementation of the mapping to the implementation level E3. These formats must satisfy the criteria specified in 3.4. Important is that the format is a plain text format that can be read and interpreted by humans so that it is

- reproducible and
- independent of hardware, operating systems and application software.

When using ISO 10303, the following LTA-compliant forms of representation are currently available:

- Part 21 as a format typical of STEP data exchange files (ISO 10303-21)
- Part 28 as the format for XML representations (ISO 10303-28)

When using ISO 10303-214 (for the representation and presentation of the Content Information), it fulfills levels E2 and E3 in equal measure. Mapping of the core model should be performed on level E2 according to the method description (2.2). In the case of ISO 10303-214, level E2 corresponds with the Application Reference Model (ARM). Mapping to the implementation model AIM and the possible implementation methods at presentation level have already been defined in the standard by ISO 10303-21 (STEP physical file) and ISO 10303-28 (XML representation). They are therefore not discussed in more detail here.

If company-specific mappings exist within the LTA process roles involved in the archiving process, the matter of whether these can be transferred to a standardized mapping must be clarified. If not, consideration should be given to the option of an individual mapping. This type of mapping must be documented comprehensively and must itself be archived.

Annex A UML modeling elements

Contents

List of figures

1 Preface

This annex describes the elements of the Unified Modeling Language (UML) for software and other systems as used in VDA4958-3.

UML is a language for modeling software and other systems developed and standardized (ISO/IEC 19501) by the Object Management Group (OMG). As its language sources, UML defines labels for most of the terms that are important in modeling and specifies possible relations between these terms. UML furthermore defines graphical notation for these terms and for models of static structures and dynamic workflows which can be formulated using these terms.

In VDA4958-3

- Figure 2: Structure of an information object

was represented as an object diagram

- Figure 3: Structure of representation information
- Figure 4: Types of information objects
- Figure 5: Overview of the data model in compliance with ISO 14721

were represented as class diagrams and

- Figure 6: Use cases when utilizing data and the necessary LTA document representations
- Figure 8: Possible variants of LTA documents with respect to contents and semantics

were represented as use case diagrams. The three diagram types used are UML structure diagrams and the notation they use is described below.

2 Object diagram

The object diagram is a structure diagram, as it shows a particular view of the structure of the system being modeled. An object diagram typically represents instantiations of classes and associations.

2.1 Notation used

In VDA4953-3, the instantiation of an object and the instantiation of an object relation are used in a simplified manner.

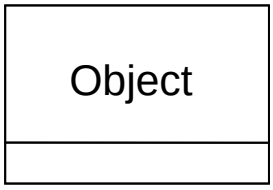

Figure 1: Simplified instantiation of an object

An instance of an association is referred to as an object relation or link. The graphical notation for a link broadly corresponds to the graphical notation for an association and these are therefore described together in sections 3.1.2 through 3.1.5.

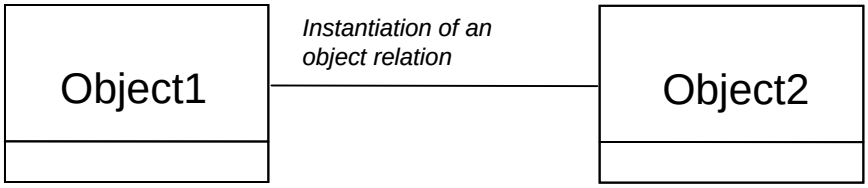

Figure 2: Instance specification for an object relation

3 Class diagram

In information technology, a class diagram is a graphical representation of classes and the relations between these classes. In the context of object-orientation, a class is an abstract generic term for describing the common structure and common behavior of objects (classification). Its purpose is to abstract objects.

3.1 Notation used

3.1.1 Class

A class describes a set of instances with the same features, the same restrictions and the same semantics.

The class is a type. It possesses a list of features, in particular attributes and operations.

A class can be a specialization of one or more other classes and can be related to other classes and model elements via associations and dependency relations.

Classes are represented in class diagrams. The simplest form for representing a class was selected in VDA4958.

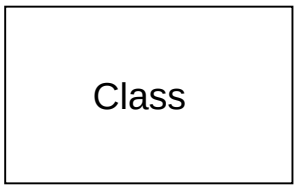

Figure 3: The simplest form for representing a class

3.1.2 Association

An association describes a relation between two or more types. Most commonly, this is a link between two classes. In this case, it is termed a binary association and specifies that the two classes involved are related to each other.

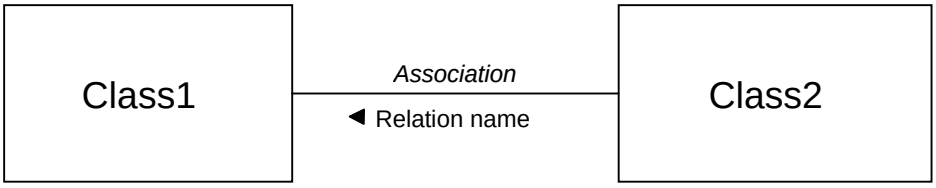

Figure 4: Binary, bidirectional association

An association forms a type of bridge between two types: Starting from an instance of one of the types involved, it is possible to navigate to an instance of the second type via an object relation. UML permits restrictions to be applied to the extent that it is possible to navigate to the ends of associations.

The class diagrams of VDA4958-3 contain only bidirectional associations, which means that navigation can take place from both ends.

The small triangles assist the reader. They indicate the direction in which the name of the association (relation name) is to be read.

An association is referred to as reflexive or recursive if it joins a type to itself. In this case, the two ends of the association point to the same type. A reflexive association is also known as a "parent/child relation".

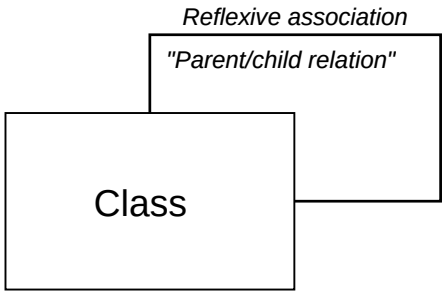

Figure 5: Reflexive association

3.1.3 Inheritance

Inheritance, also known as generalization, in UML is a directional relation between a more general and a more specific class. Instances of the more specific class are thus also instances of the more general class. In concrete terms, this means that the more specific class implicitly possesses all the features (structural and behavioral features) of the more general class. This is implicit because these features are not explicitly declared in the more specific class. The features are said to be "inherited" from the more general class.

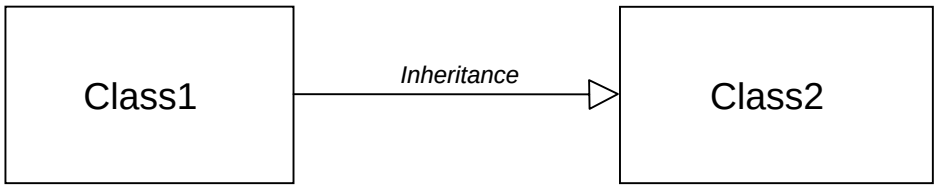

Figure 6: Inheritance

A generalization is represented by an unbroken line between the two classifiers involved. A closed arrowhead which has not been filled in is placed at the end at which the more general classifier is located.

3.1.4 Composition and aggregation

One relation between classes which is modeled relatively frequently is the relation between a whole and its parts. UML provides two special associations for this purpose: Composition and aggregation.

Like aggregation, composition is an association with the meaning "is made up of". It establishes an existence dependency:

- If the aggregate "dies", its components also "die".
- It is not possible to assign a component to a different aggregate.

Aggregation is an association with the meaning "is made up of" (parts list logic). It does not establish an existence dependency:

- If the aggregate "dies", the components are retained.
- If a component "dies", the aggregate is retained.

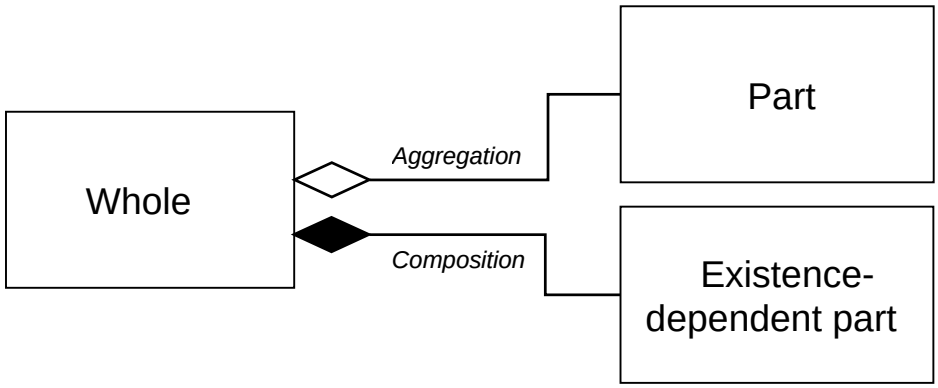

Figure 7: Composition and aggregation

In the graphical representation of a composition, a filled diamond indicates the end connected to the whole. In the case of an aggregation, an empty diamond is used.

3.1.5 Multiplicity

A multiplicity refers to a range of non-negative integers at the ends of the association in UML. The range is defined by an upper and lower limit. If a model element in UML has a multiplicity, this generally means that it can contain a number of values or objects and that the concrete number must be greater than or equal to the lower limit and less than or equal to the upper limit of the multiplicity. The value "unlimited" is also permitted for the upper limit.

The multiplicity is often specified in the form "UpperLimit..LowerLimit", where "*" specifies "unlimited" as the upper limit. The lower limit must be less than or equal to the upper limit. It is not permitted for "0" or "*" to be specified for both limits.

An element with a multiplicity of 0..1 is termed optional. A multi-value element is an element with an upper limit greater than 1.

4 Use case diagram

A simple UML use case diagram is used for representation. This is used to identify the relevant use cases (business cases, activities) that can affect the organizations, areas and/or systems that participate in LTA. The most important structural dependencies between the individual cases are revealed and the scope under consideration is positioned and demarcated.

4.1 Notation used

The purpose of the use case diagram is to impose a rough structure on the possible, required scenarios and to represent the target definition. The use case diagram is intended to provide an overview of the key elements of a scenario and of the required capabilities of the software under development. Thus, important functions are identified and relations between them are drawn. Technical implementation is of no significance in this overview; the important issue is "what" and not "how".

4.1.1 Use case - function

The various key requirements are placed in the use case diagram. To do this, brief descriptions of the functions are written in ellipses, with each ellipse representing exactly one function.

The interrelationships between use cases are indicated by connecting lines.

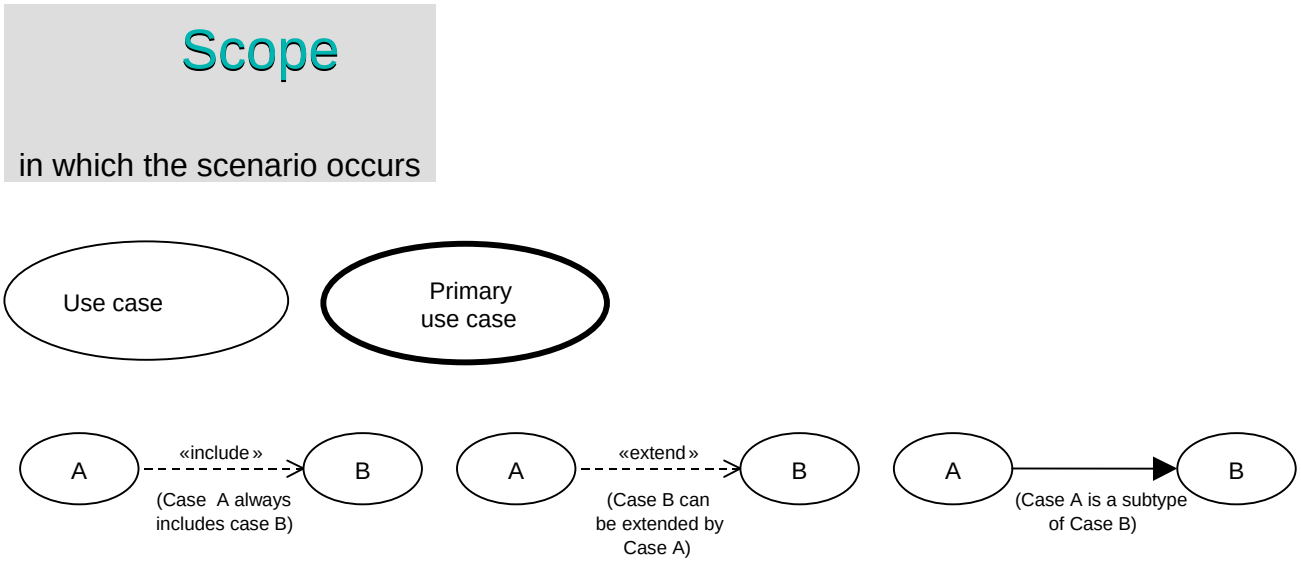

Figure 8: Symbols used for describing use cases

4.1.2 Association

Connecting lines in UML diagrams are referred to as associations. They represent the relations between elements of the ends of the associations. The type of association being expressed depends on the way in which the connecting lines are represented and on the keywords which may appear next to the connecting line.

The dashed connecting line represents an association between two use cases. A keyword is placed next to the dashed connecting line to distinguish between two different types of associations between use cases. In UML, keywords used to specify connecting lines or other geometrical forms are always enclosed in double angle brackets. These keywords are referred to as stereotypes in UML.

An "include" association means that the use case from which the connecting line emanates includes the use case to which the connecting line points. In the example above, this means that whenever Case A is executed, Case B is started from within this use case. This means that sometime during execution of Case A, Case B starts running. When Case B is complete, execution of Case A continues.

An "extend" association means that the use case from which the connecting line emanates may extend the use case to which the connecting line points. The critical difference between an include and extend association is that the second use case is always executed with an include relation, whereas the second use case is executed depending on conditions in the first use case with an extend association. In the example above, this means that Case A is executed when certain conditions in Case B are true.

Annex B
Data Dictionary of the relevant LTA Data (Requirements Model)

Relevant LTA/LZA Data (Requirements of 3D CAD and PDM data)			**Content in**									
Requirements Data Model (Level E1)			**CI**		**PDI**					**PI**	**DI**	**VP**
Entity	*Attribut*	*Description*	**Geo**	**Non-Geo**		**Provenance**	**Context**	**Reference**	**Fixity**			
Geometrical Definition **Geometrische Definitionen**		are representations of information defining geometry (e.g., the 3-dimensional shape of a part) as well as information related to geometry or with a geometrical aspect (e.g. torque of screws)	x		m				m			m
Coordinate System *Koordinastensystem*		is a system for assigning a tuple of scalars to each point in an n-dimensional space	m									
	Point (x,y,z)	a Point is a location in a Cartesian coordinate space (an entity that has a location in space but no extent)	m									
	Direction x	is an imaginary line which connects origin of e.g. a coordinate system with all other points along the x-axes	m									
	Direction y	is an imaginary line which connects origin of e.g. a coordinate system with all other points along the y-axes	m									
	Direction z	is an imaginary line which connects origin of e.g. a coordinate system with all other points along the z-axes	o									
Geometrical Representations *Geometrische Darstellungs-Elemente*		are the geometrical definitions, e.g. using geometrical basic elements for defining the shape of a part (like a CATPART)	m									
	Point	is a location in a Cartesian coordinate space	m									
	Curve	is a path of a point moving in a coordinate space	m									

Relevant LTA/LZA Data (Requirements of 3D CAD and PDM data)			**Content in**									
Requirements Data Model (Level E1)			**CI**		**PDI**					**PI**	**DI**	**VP**
Entity	*Attribut*	*Description*	**Geo**	**Non-Geo**		**Provenance**	**Context**	**Reference**	**Fixity**			
	Surface	is a set of mathematical points which is the image of a continuous function defined over a connected subset of the plane R2. It can be envisioned as a set of connected points in 3-dimensional space which is always locally 2-dimensional, but need not be manifold.	m									
	Solid	A magnitude which has length, breadth, and thickness; a part of space bounded on all sides	o									
	Reference Point Single Part	is a point which is used as reference, e.g., welding points, or feature definitions	x									
	Measurement Point Single Part	is a point which is used as reference, e.g., for measurements and quality control of a resulting part	x									
	Reference Points Assembly	are points which are used as references, e.g., welding lines, or feature definitions	x									
	Measurement Points Assembly	are points which are used as references, e.g., for measurements and quality control of a resulting assembly	x									
Geometrical Features Funktionselement		are sets of geometrical elements representing features, that are either defined as components of geometrical representations or are used to assign further information to a single feature as a whole	x									
	Reference to geometric element [1:?]	Reference to geometrical elements that represent this feature	m									
	Description	Description of the feature's nature (e.g. sflanges, thread feature, rib feature, planar feature)	m									
	Classification	Classification of the feature (e.g. design feature, machining feature)	o									

Relevant LTA/LZA Data (Requirements of 3D CAD and PDM data)			Content in									
Requirements Data Model (Level E1)			CI		PDI					PI	DI	VP
Entity	*Attribut*	*Description*	Geo	Non-Geo		Provenance	Context	Reference	Fixity			
Dimensions Abmessungen		are geometrical properties of the dimension value and of associated information necessary to accurately depict its area of application.	m									
	Length	the linear extent in space from one end to the other	m									
	Angle	the inclination of one line to another; measured in degrees or radians	x									
	Diameter	the length of a straight line passing through the center of a circle and connecting two points on the circumference	x									
	Radius	the length of a line segment between the center and circumference of a circle or sphere	x									
	Classification	identifies the typ of a dimension, e.g., gap, functional, check, manufacturing measures	x									
	Unit	Any determinate amount or quantity (as of length, time,heat, value) adopted as a standard of measurement for other amounts or quantities of the same kind	m									
Tolerances Toleranzen		are sets of values or properties for dimensions to represent limits within which manufactured shapes are permitted to vary	x									
	Reference to geometric element [1:?]	Reference to geometrical elements affected by this tolerance	x									
	Type	Type of tolerance, e.g. parallel, orthogonal, angular, positioning, surface/line tolerance as well as special tolerances like bending radius or stamp degree	x									
	Measures	Tolerancing measure(s) are described by value and unit	x									
Annotation Bemerkung		are additional information assigned to one or more geometric representations	x									
	Text	check and functional requirements / specifications, change notes	m									
	Classification	identifies the type of notification, e.g., check property	o									

Relevant LTA/LZA Data (Requirements of 3D CAD and PDM data)			Content in									
Requirements Data Model (Level E1)			CI		PDI					PI	DI	VP
Entity	*Attribut*	*Description*	Geo	Non-Geo		Provenance	Context	Reference	Fixity			
	Reference to geometric element [1:?]	Reference to geometrical elements the annotation is relevant for	m									
Geometric Material Information Werkstoffinformationen mit Geometrieanteilen		are material properties which have a geometrical aspect (dependent on coordinats) with respect to the substance out of which the product is made of	x									
	Material Direction	the material direction is represented by an arrow, indicating the material at the constructed area.	x									
	Thickness	sheet thickness, material thickness (the material vectors length indicates the material thickness at this point)	x									
	Material Structure Direction		x									
	Mould separation	plane, where a mold is cut	o									
	Remould direction	recast-/ drawing directing	o									
	Reference to geometric element [1:?]	Reference to geometrical elements the material information is relevant for	m									
Geometric Surface Information Geometrische Flächeninformationen		are surface properties with respect to all or only specific surfaces to describe the required surface quality and/or the treatment to reach a certain quality, e.g., finish, painting or hardness	x									
	Surface property type	defines the characteristic or property of the referenced surface (e.g. Protecded treatement)	m									
	Treatment parameter [0:?]	set of parameters specifying the value and unit of the treatment	o									
	Reference to geometric element [1:?]	Reference to geometrical elements the surface information is relevant for	m									

Relevant LTA/LZA Data (Requirements of 3D CAD and PDM data)			**Content in**									
Requirements Data Model (Level E1)			**CI**		**PDI**					**PI**	**DI**	**VP**
Entity	*Attribut*	*Description*	**Geo**	**Non-Geo**		**Provenance**	**Context**	**Reference**	**Fixity**			
Geometric Part Properties *Geometrische Informationen zum Teil*		to be used as Validation Properties; for parts, not expected for single geometric model, which do not represent a part	m		m				m			m
	Centre of gravity	that point of a body about which all its parts can be balanced, or which being supported, the whole body will remain at rest, though acted upon by gravity.	m		m				m			m
	Moments of inertia	the sum of the mass of each particle of matter of the body into the square of its distance from the axis of rotation related to the local coordinate system	x		x				x			x
Presentation Information *Darstellungsinformationen*			x									
	Color settings	is the assignment of color as presentation property to a geometric element for the appearance of the element regarding the optical impression	o									
	Layer settings	is a general structuring mechanism to group / collect geometric and annotation elements used for different presentation functions	o									
	Captures	are planes (like major / camera views or clipping planes) within a 3D model to support the navigation throughout the model and for a better visibility of specific details. Planes may also be important for domains following the design phase.	o									
	Geometric Dimensions Tolerances Presentions	are the geometrical elements, signs and text strings representing the presentation of geometrical dimension and/or tolerancing information	x									
	Annotation Presentions	are the geometrical elements and text strings representing the presentation of annotations	x									
Geometrical Assemblies *Geometrische Zusammenbauten*		is a relationship between two geometrical representations where the shape of the subordinated component is part of the definition of the assembly shape	m		m			m				
	Reference to Component	Identification of the geometrical element as a constituent of an assembly ("child" of the assembly relationship). Each occurence of a component shall be identifed unique within the related assembly	m		m			m				

Relevant LTA/LZA Data (Requirements of 3D CAD and PDM data)			**Content in**									
Requirements Data Model (Level E1)			**CI**		**PDI**					**PI**	**DI**	**VP**
Entity	*Attribut*	*Description*	**Geo**	**Non-Geo**		**Provenance**	**Context**	**Reference**	**Fixity**			
	Reference to Assembly	Identification of the geometrical element which is defined by its subordinated components ("parent" of the assembly relationship)	m		m			m				
	Geometrical Transformation	defines the location and orientation of the related geometric component relative to the relating geometric assembly (parent)	m									
Geometric Assembly Features Geometrische Funktionselemente eines Zusammenbaus		Represents features, that are used to group assembly components, e.g., for assigning further information to the assembly feature as a whole	x									
	Reference to geometric element [2:?]	Reference to the geometrical elements that are related to eachother; the related surfaces are identified, e.g., to describe which parts are connected by subjected fasteners at which particular surfaces	m									
	Description	Description of the feature's nature (such as component parts, mounting holes)	m									
	Classification	Classification of the feature (possibly according ISOxxxx), e.g., as called at DaimlerChrysler "Assembly Joint" and " Joint Body"	o									
Assembly Tolerances Zusammenbau-Toleranzen		Sets of values or properties to represent limits within which manufactured assemblies are permitted to vary	x									
	Reference to geometric element [2:?]	Reference to geometrical elements affected by this tolerance	m									
	Type	Type of tolerance, e.g. parallel, orthogonal, angular, positioning, surface/line tolerence	m									
	Measures	Tolerancing measure(s) with name, value, and unit	m									
	Geometric Dimensions Tolerances Presentions	are the geometrical elements, signs and text strings representing the presentation of geometrical dimension and/or tolerancing information	x									
Document Identification Identifikation eines Dokumentes		Identifies a document (possibly a version of a document) uniquely.		m	m	m	x	m			m	

Relevant LTA/LZA Data (Requirements of 3D CAD and PDM data)			**Content in**									
Requirements Data Model (Level E1)			**CI**		**PDI**					**PI**	**DI**	**VP**
Entity	*Attribut*	*Description*	**Geo**	**Non-Geo**		**Provenance**	**Context**	**Reference**	**Fixity**			
	Document ID	Unique identification of the document in the context of an organization (ID Owner). Specific conventions may apply.		m	m			m			m	
	Document Version	Current version of the document		m	m	m		m			m	
	ID Owner	Unique identification of the organization responsible for the designation of the identifier for uniqueness of document (see Document Representations - Organisation)		m	m			m			m	
	Document Name	Name of the document. Uniqueness is recommended.		m	o			o			x	
	Description	Additional information about the document.; further description of the document; subtitle		x							x	
	Reference: part number [1:?]	Identification of the part (via Part Identification), the document is assigned to (is description for); multiple references for mirrored parts or parametrical part definitions		m	m		x	m			m	
3D model information Information zum 3D Modell		Information about the digital 3D model of the part.		x	x			x	m			x
	model name	Describes an additional/different model name from the document ID or document name (for a 3D CAD model)		x	x			x				
	Accuracy information	Specification of the accuracy of the 3D model		m	x				m			x
Classifications Klassifizierungen		Association of the document to a familiy of documents in a classification system.		o	x		x				x	
	Classification Name	Classification name related to the document according a general or company specific classification system, e.g., geometry, FE data, specification, manual		m			m				m	
	Classification System	Contains the information about the definition of the classification and how to interpret the name of the classification within the referenced general or company specific classification system		m			m				m	

Relevant LTA/LZA Data (Requirements of 3D CAD and PDM data)			Content in									
Requirements Data Model (Level E1)			CI		PDI					PI	DI	VP
Entity	*Attribut*	*Description*	Geo	Non-Geo		Provenance	Context	Reference	Fixity			
System information Systeminformationen		Information about the IT environment used to create this (version of the) document. It depends on the process phases data preperation with its SIP, ingest with its AIP and retrieval with its DIP		x	m	m				m	m	
	Document format	Specification of the file format the document is provided in, e.g., in case of SIP: Catia V4 native, in case of AIP: ISO 10303-214.		x	m	m					x	
	Character code	Identification of the character code used in the document, e.g., binary, IEC 61286, ISO 646 (zurückgezogen)		x	m	m						
	Creation date	Date on which the (version of the) document was created		x	m	m					x	
	Creation time	Time on which the (version of the) document was created.		x	x	x					o	
	Creating system	System (application or machine) used to create this (version of the) document, e.g. incase of SIP: CATIA 4, in case of AIP: STEP processor XYZ		x	x	x						
	Location	Name of the place where the document is stored, e.g. URL, file system path in case of SIP; storage/media location in case of AIP		o	x	x				m	m	
	File	Name of the file representing the document		o	x	x				m	m	
Document Properties Dokument-Eigenschaften		Properties to further define the document.		x	x	x	o				m	o
	Geometry type	Identification of the type of geometry, e.g. surface model, closed volume, solid model etc. (in case the document is a geometrical model)		x	x	x					m	

Relevant LTA/LZA Data (Requirements of 3D CAD and PDM data)			Content in									
Requirements Data Model (Level E1)			CI		PDI					PI	DI	VP
Entity	*Attribut*	*Description*	Geo	Non-Geo		Provenance	Context	Reference	Fixity			
	Type	Specification of the kind of data held by the document, e.g. geometry, NC data, FE data, etc.		x	x	x					m	
	Language [1:?]	Language used within the document		o	x	x	o				m	o
Status Information *Status-Informationen zum Dokument*		Information related to (this version of) the document for describing the obligation/maturity of it. Also used to identify the responsible person/organisation from engineering point of view		x	m	m	m					
	Approval status	Identification of the current status of release/approval.		m		m	x					
	Checked by person	Identification of the person who performed the ckeck prior to the release/approval (see Document Representations - Person).		x		x						
	Creator	Identification of the person who creates the (see Document Representations - Person).		x		o						
	Release date	Date of the release/approval.		m		m						
	Relesed time	Time of the release/approval.		o		o						
	Released by person	Identification of the person who is responsible for the release of the document (see Document Representations - Person).		m		m						
	Released by department	Identification of the department responsible for the release of the document (see Document Representations - Organisation).		m		m	m					
Organisation *Organisation, Firma*		Identification of the organization owning the document information or beeing responsible for the approval		m	m		m				x	
	Name	Name of the organization.		x	m		m				x	
	Organisation ID	Unique identifier of the organization.		m	m		m				x	
	Address	Mail address of the organization.		o	o		o				x	
	Organization type	Identification of the organisation type, e.g., company, department, supplier, OEM		x	m		m				x	
Person *Person*		Identification of the creator of the document or of the person which has approved the document.		x	o		o					

Relevant LTA/LZA Data (Requirements of 3D CAD and PDM data)			Content in									
Requirements Data Model (Level E1)			CI		PDI					PI	DI	VP
Entity	*Attribut*	*Description*	Geo	Non-Geo		Provenance	Context	Reference	Fixity			
	Person ID	Unique identifier of the person, e.g., the designer		x	x		x					
	Person name	Name of the person, e.g., the designer		m	m		m					
	Role	Identification of the person's role within the organisation, e.g., designer		o	x		x					
	Department	Identification of the department the person belongs to (see Document Representations - Organisation).		m	m		m					
Part identification Teil-Identifikation		Identifies a part (possibly a version of a part) uniquely in a PDM environment		m	m	x	x	m			m	m
	Part Number	Unique identifier of the part in the context of an organization (ID Owner). Specific conventions may apply.		m	m			m			m	m
	Version	Unique identification of the version of the part. It serves as the collector of the data characterizing a physically realizable object in various application contexts. Specific conventions may apply.		x	x	x		x			x	m
	ID Owner	unique identification of the organization responsible for the designation of the identifier for uniqueness of Part (see Part Master Organisation)		m	m			m			m	m
	Supplier [0:?]	(List of) reference information to supplier's ID / part number (supplier: someone whose business is to supply a particular service or commodity)		x	o			o				x
	Part Name	Name of the part. Uniqueness is recommended.		m	o			o			x	
	Description	Additional information about the part.		o							x	
	Copyright	Intellectual Property Rights information about the exclusive rights of the owner of the copyright on a work to make and distribute copies, prepare derivative works, and perform and display the work in public (these last two mainly apply to plays, films, dances etc., but could also apply to software)		m	x		x				x	

Relevant LTA/LZA Data (Requirements of 3D CAD and PDM data)			**Content in**									
Requirements Data Model (Level E1)			**CI**		**PDI**					**PI**	**DI**	**VP**
Entity	*Attribut*	*Description*	**Geo**	**Non-Geo**		**Provenance**	**Context**	**Reference**	**Fixity**			
	Trade mark	Information about a peculiar distinguishing mark or device affixed by a manufacturer or a merchant to his goods, the exclusive right of using which is recognized by law.		x	x		x					
Classifications Klassifikation		Association of the part to a familiy of parts in a classification system. Parts in there are differentiated in features or characteristics		x	x		x				m	
	Classification Name	Classification name of parts according to general or company specific classification systems, e.g. M5x20x4.8, security class, confidential class		m	m		m				m	
	Classification Description	Additional information about the classifiation.		o	o		o				o	
	Classification System	contains the information about the definition of the classification and how to interpret the name of the classification, e.g., ATA -Chapter, ICAO-Code, ISO1207, MBN10317 (company specific standard)		m	m		m				m	
Context Kontext		Context of a part e.g. life cycle stage, validity		x	x	x	m				m	
	Application [1:?]	Specifies the application for which the part is relevant within the identified context, e.g. assembly study, digital mock-up, preliminary design, or process planning		x	x		m				m	
Part Properties Eigenschaften des Teiles		Non-geometric properties to further define the part.		m	m				m		o	m
	Volume	the amount of 3-dimensional space occupied by an object		m	m				m			m
	Surface	the extended two-dimensional outer boundary of a three-dimensional object ("wetted surface")		m	m				m			m
	Material ID	Unique identification of a material according to a technical specification (e. G. VDA 260)		m							o	
	Material name	Description of the material the part is/shall be made of.		m							o	
	Material density	specifies the density value and unit of the material the part is made from inclusive		m								

Relevant LTA/LZA Data (Requirements of 3D CAD and PDM data)			Content in									
Requirements Data Model (Level E1)			CI		PDI					PI	DI	VP
Entity	*Attribut*	*Description*	Geo	Non-Geo		Provenance	Context	Reference	Fixity			
	Material strength	specifies the strength value and unit of the material the part is made from inclusive		o								
	Reference: Material specification	reference to the material specification containing the definition and properties of the used material in detail		x								
	Weight calculated	Calculated part weight during development process.		o								o
	Weight measured	Measured part weight after production.		x								x
	Weight prototype	Measured weight of prototype parts.		o								o
	General tolerance frame	defines the default values where the correct tolerance type and values are provided per range of dimension or according to the number of significant digits of the dimension. These default values are overwritten by tolerances that are assigned explicitly to particular aspects of the shape. The concept of General_tolerances is defined in ISO2768.		m	m				m			m
Specification references *Verweis auf technische Vorschriften*		References to documents that are relevant for the development, manufacturing or application of the part.		x	o			o				
	Reference: Technical specifications [0:?]	Specification of technical aspects to make, assembly, use, etc. the part.		x	o			o				

Relevant LTA/LZA Data (Requirements of 3D CAD and PDM data)			Content in									
Requirements Data Model (Level E1)			CI		PDI					PI	DI	VP
Entity	*Attribut*	*Description*	Geo	Non-Geo		Provenance	Context	Reference	Fixity			
	Reference: Standards [0:?]	reference(s) to general or company specific technical standards or standards of laws, which are relevant for the part		x								
Information of source system *Informationen des Quellsystems*		Information about the the source IT environment used to create this (version of the) part.		x	x	x		x			x	
	Creation date	Date on which the (version of the) part system was created		x	x	x		x			x	
	Creation time	Time on which the (version of the) part system was created.		o		x		x			x	
	Creating system	System used to create this (version of the) part, e.g. Matrix, VPM		o							x	
Organization *Organisation, Firma*		Identification of the organization owning the part information or of the supplier as well as the organisation approving the part.		m	m		m				m	
	Name	Name of the organization.		m	m		m				m	o
	ID	Unique identifier of the organization.		m	m		m				m	m
	Address	identifies a place where the organizational unit may be located		o	o		o				o	
	Organization Type	Identification of the organisation type e.g. Supplier, OEM, Location, Plant		m	m		m				m	
Person *Person*		Identification, e.g., of the creator of the part information, the approver or person, which is responsible for the check of the part		m	x	x	x				x	
	Person ID	Unique identifier of the creator.		o		x	x				x	
	Person Name	Name of the creator.		m		x	x				x	
	Role	Identification of the persons role, e.g. designer		o		x	x				x	
	Department	Identification of the department / company the person belongs to.		m		x	x				x	
	Language	Language used for the definition of the part information.		o		x	x				x	

Relevant LTA/LZA Data (Requirements of 3D CAD and PDM data)			**Content in**									
Requirements Data Model (Level E1)			**CI**		**PDI**					**PI**	**DI**	**VP**
Entity	*Attribut*	*Description*	**Geo**	**Non-Geo**		**Provenance**	**Context**	**Reference**	**Fixity**			
Authority Reference *Referenz für die Änderungserlaubnis*		Reference information pertinent to the creation or change of the part data.		m	m		m				m	
	Project	Identification of the project that is the administrative context for the creation of (this version of) the part.		x	x		x				x	
	Work order number	Identification of the internal workorder.		m	m		m				m	
	Work order version	version		x	x		x					
	Work order type	Description of the nature of the work order, e.g. change order		x	o		o				x	
	Change description	Description of the nature of the change. This can be a reference to a change document.		m	x		x				x	
Status Information *Statusinformationen*		binding information of who checked and approved the quality of part data (and ist version)		m	m	x	m				m	m
	Approval status	Indicates the level of acceptance of the part/assembly		m	m	x	m				m	
	Checked by person	Indicates the person who performed the ckeck prior to the release/approval. This check could be, e.g., a design consistency check.		o							o	
	Checked for	Indicates the maturity stage of the part/assembly information that shall be reached by this realease/approval (e.g. design, manufacturing, service)		o							o	
	Release date	Specifies the date when the approval/release actually became valid.		m	m	x	m				m	m
	Released time	Specifies the time when the approval/release actually became valid.		o							o	x
	Released by person	Indicates the person who is responsible for the approval/release of the part/assembly information.		o							o	
	Released by department	Indicates the department/organisational unit responsible for the approval/release of the part/assembly information (the person has to belonging to, if specified).		m	m	x	m				m	

Relevant LTA/LZA Data (Requirements of 3D CAD and PDM data)			Content in									
Requirements Data Model (Level E1)			CI		PDI					PI	DI	VP
Entity	*Attribut*	*Description*	Geo	Non-Geo		Provenance	Context	Reference	Fixity			
	Released for	Indicates the maturity stage of the part/assembly information that is reached by this realease/approval (e.g. design, manufacturing, service)		m	m	x	m				m	
	Effectivity date	Indicates the point in time, the production of the part / assembly / product is stopped		m	m	m	x				m	
	End of Production	Indicates the point in time, the production of the part / assembly / product is stopped			m	m	x				m	
Part Structure Teilestruktur		Description of the relationships between assemblies and its constituents.		x	x			x			x	m
	Reference to Component	Identification of the part / sub-assembly as a constituent of an assembly ("child" of the part structure)		m	m			m			m	m
	Instance number	Identification of the occurrence of the constituent component within the part structure		m	x			x			x	
	Reference to Assembly	Identification of the assembly part, which is defined by its subordinated components / constituent elements ("parent" of the part structure)		m	m			m			m	m
	Quantity	indicates the amount and unit of the referenced components within the assembly with respect to the related instance number		m							m	m
Part Relationships Teilebeziehungen		Description of relationships between parts and assemblies which are not of type Part Structure (constitutuents of another component)		x	x			x				
	Mirrorpart Relationship	Description of a relationship of a assembly / part to its mirror part		o								
	Replacement for	specifies a reference to an other assembly / part the part is a replacement for.		x	x			x				
Context Kontext		Association of the part structure to a context (such as life cycle stage) it is relevant in.		m			m				m	
	Context name	indicates the context of the part structure relationship with a unique string, e.g., as functional assembly (such as a system) or as relevant for design, planning or manufacturing		m			m				m	
	Context description	Additional information about the context		o			o				o	

Relevant LTA/LZA Data (Requirements of 3D CAD and PDM data)			**Content in**									
Requirements Data Model (Level E1)			**CI**		**PDI**					**PI**	**DI**	**VP**
Entity	*Attribut*	*Description*	**Geo**	**Non-Geo**		**Provenance**	**Context**	**Reference**	**Fixity**			
Manufacturing Features *Funktionselemente für die Herstellung*		are sets of (geometrical) elements representing features, that are either relevant for manufacturing or assembling a part respectively group of parts	x									
	Reference to geometric element [1:?]	Reference to geometrical element(s) which is/are constituent of the definition of the manufacturing feature	m									
	Description	Description of the manufacturing feature's nature (such as welding points)	m									
	Classification	Classification of the manufacturing feature (e.g., welding point)	x									
	Parameter [0:?]	set of parameters specifying value(s) and unit(s) of the manufacturing feature	m									
Process information *Prozess-Informationen*		Relevant information important for the target product or part		o								
	Assembly Method	describes certain properties and/or constrains for assembling the target product, e.g., torque of screws, possibly according a referenced standard / specification		o								
	Production Method	describes certain properties and/or constrains for producing the target part, possibly according a referenced standard / specification		o								
	Related Row Material Part	describes the link to the related row material or semi-final product, which is the basic for manufacturing the part, but only if it is essentual for the quality and properties of that part		o								
	Related Semi-finished product	Information about the semi-finished product used to make the part, such as raw material.		o								

Relevant LTA/LZA Data (Requirements of 3D CAD and PDM data)			**Content in**									
Requirements Data Model (Level E1)			**CI**		**PDI**					**PI**	**DI**	**VP**
Entity	*Attribut*	*Description*	**Geo**	**Non-Geo**		**Provenance**	**Context**	**Reference**	**Fixity**			
	Part Tool Relationship	Description of a relationship of an assembly / part to a tool or a set of tools required to manufacture /assemble the part / assembly		o								

Annex C
Mapping of LTA Data onto ISO 10303-214 ARM

Relevant LTA/LZA Data			**Mapping approach onto standard based description and implementation model**		
Requirements Data Model (Level E1)			Data Level E2 / E3 , e.g., for ISO10303-214 Application Reference Model (ARM)		
Entity	*Attribut*		*Entity*	*Attribut*	*Remarks, Rules, Constrains*
Geometrical Definition Geometrische Definitionen			**(ABS)detailed_element resp./bzw. (ABS)detailed_geometric_model_element**		
Coordinate System Koordinastensystem			*cartesian_coordinate_space_3d*		single parts have to be stored in desgin position (not in final end product position !)
	Point (x,y,z)		AIM: axis2_placement_3d	.location	
	Direction x		AIM: axis2_placement_3d	.axis	
	Direction y		AIM: axis2_placement_3d	.axis	
	Direction z		AIM: axis2_placement_3d	.axis	
Geometrical Representations Geometrische Darstellungs-Elemente			*(ABS)detailed_geometric_model_element*		
	Point		point		
	Curve		curve		

Relevant LTA/LZA Data			**Mapping approach onto standard based description and implementation model**		
Requirements Data Model (Level E1)			Data Level E2 / E3 , e.g., for ISO10303-214 Application Reference Model (ARM)		
Entity	*Attribut*		*Entity*	*Attribut*	*Remarks, Rules, Constrains*
	Surface		surface		
	Solid		b_rep_model | csg_model | (ABS)swept_face_solid or others		for a reuse to manufacture, solids are recommended
	Reference Point Single Part		axis_placement		used, e.g., by (ABS)feature_definition
	Measurement Point Single Part		point_direction		used, e.g., by point_direction_model
	Reference Points Assembly		axis_placement		used, e.g., by (ABS)feature_definition
	Measurement Points Assembly		point_direction		used, e.g., by point_direction_model
Geometrical Features Funktionselement			*general_feature* | *included_feature* | *featured_shape*		including (ABS)feature_definition | thread_feature | (ABS)transition_feature dependent on use case
	Reference to geometric element [1:?]		featured_shape (ABS)feature_occurrence general_feature	via shape_description_association	
	Description		featured_shape | geometric_model | external_geometric_model	.description	
	Classification		. . .		implicitly via the use of one of the different feature type objects and/or with general_classification in addition attached, e.g., to feature_definition

Relevant LTA/LZA Data			**Mapping approach onto standard based description and implementation model**		
Requirements Data Model (Level E1)			Data Level E2 / E3 , e.g., for ISO10303-214 Application Reference Model (ARM)		
Entity	*Attribut*		*Entity*	*Attribut*	*Remarks, Rules, Constrains*
Dimensions Abmessungen			*(ABS)geometric_dimension with subtypes (ABS)size_dimension | (ABS)location_dimension*		
	Length		general_size_dimension		with .dimension_type='length'
	Angle		angular_size_dimension		
	Diameter		general_size_dimension		with .dimension_type='diameter'
	Radius		general_size_dimension		with .dimension_type='radius'
	Classification		. . .		implicitly via the use of one of the different dimension type objects (GD&T)
	Unit		(ABS)value_with_unit		
Tolerances Toleranzen			*(ABS)geometric_dimension, (ABS)geometric_tolerance*		
	Reference to geometric element [1:?]		(ABS)geometric_dimension | (ABS)geometric_tolerance	.is_applied_to	
	Type		. . .		implicitly via the use of one of the different dimension respectively tolerance (sub)type objects (GD&T)
	Measures		value_with_unit, value_limitation	dimension_value	
Annotation Bemerkung			*(ABS)annotation_element, opt. view_placed_annotation*		
	Text		text		or annotation_subfigure | fill_area | annotation_curve dependent on use case

Relevant LTA/LZA Data			**Mapping approach onto standard based description and implementation model**		
Requirements Data Model (Level E1)			Data Level E2 / E3 , e.g., for ISO10303-214 Application Reference Model (ARM)		
Entity	*Attribut*		*Entity*	*Attribut*	*Remarks, Rules, Constrains*
	Classification		. . .		implicitly via the different annotation objects
	Reference to geometric element [1:?]		draughting_callout		
Geometric Material Information *Werkstoffinformationen mit Geometrieanteilen*			*thickness_dimension* | *general_size_dimension*		
	Material Direction		measurement_path		as used by thickness_dimension.used_path
	Thickness		thickness_dimension		requires Material Direction
	Material Structure Direction		general_size_dimension		with .dimension_type='Material Structure Direction'
	Mould separation		general_size_dimension		with .dimension_type='Mould separation'
	Remould direction		general_size_dimension		with .dimension_type='Remould direction'
	Reference to geometric element [1:?]		thickness_dimension	.is_applied_to	
Geometric Surface Information *Geometrische Flächeninformationen*			*(ABS)surface_condition*		
	Surface property type		contact_ratio | treatment_result | hardness | visual_appearance | surface_texture | tactile_appearance		implicitly via the use of one of the different subtypes of (ABS)surface_condition

Relevant LTA/LZA Data			**Mapping approach onto standard based description and implementation model**		
Requirements Data Model (Level E1)			Data Level E2 / E3 , e.g., for ISO10303-214 Application Reference Model (ARM)		
Entity	*Attribut*		*Entity*	*Attribut*	*Remarks, Rules, Constrains*
	Treatment parameter [0:?]		(ABS)value_with_unit		dependent on the used subtype of (ABS)surface_condition
	Reference to geometric element [1:?]		surface_condition_association	.described_element	
Geometric Part Properties *Geometrische Informationen zum Teil*			*(ABS)shape_dependent_property*		optional for geometric model, which do not dirctly representing a part, e.g., constructive_geometry
	Centre of gravity		centre_of_mass		
	Moments of inertia		moments_of_inertia		
Presentation Information *Darstellungsinformationen*			*(ABS)styled_element* | *layer* | *view* | *draughting_callout*		
	Color settings		(ABS)styled_element (ABS)detailled_model_element	.element	as a collection of geometric and annotation elements describing the presentation information
	Layer settings		layer	.element	as a general structure for collecting geometric and annotation elements
	Captures		view, view_area, plan		recommended practices are still not public available
	Geometric Dimensions Tolerances Presentions		draughting_callout	.contents	
	Annotation Presentions		draughting_callout	.contents	

Relevant LTA/LZA Data			**Mapping approach onto standard based description and implementation model**		
Requirements Data Model (Level E1)			Data Level E2 / E3 , e.g., for ISO10303-214 Application Reference Model (ARM)		
Entity	*Attribut*		*Entity*	*Attribut*	*Remarks, Rules, Constrains*
Geometrical Assemblies Geometrische Zusammenbauten			*geometric_model_relationship*		
	Reference to Component		geometric_model_relationship	.related	
	Reference to Assembly		geometric_model_relationship	.relating	
	Geometrical Transformation		geometric_model_relationship_with_transformation	.model_placement	min. unit transformation matrix
Geometric Assembly Features Geometrische Funktionselemente eines Zusammenbaus			*general_compound_feature*		when .feature_category='assembly feature'
	Reference to geometric element [2:?]		general_compound_feature	.elements	
	Description		featured_shape | geometric_model | external_geometric_model	.description	
	Classification		. . .		implicitly via the use of one of the different feature type objects and/or with general_classification in addition attached, e.g., to feature_definition
Assembly Tolerances Zusammenbau-Toleranzen			*(ABS)location_dimension*		
	Reference to geometric element [2:?]		(ABS)location_dimension	.origin .target	

Relevant LTA/LZA Data			**Mapping approach onto standard based description and implementation model**		
Requirements Data Model (Level E1)			Data Level E2 / E3 , e.g., for ISO10303-214 Application Reference Model (ARM)		
Entity	*Attribut*		*Entity*	*Attribut*	*Remarks, Rules, Constrains*
	Type		Curved_distance_dimension | Linear_distance_dimension | Angular_location_dimension		implicitly via the use of one of the different subtype objects of (ABS)location_dimension
	Measures		(ABS)value_with_unit		
	Geometric Dimensions Tolerances Presentions		draughting_callout		
Document Identification Identifikation eines Dokumentes			*document, document_version, (ABS)document_representation*		
	Document ID		document	document_id	
	Document Version		document_version	id	shall be unique within the scope of the related Document ID.
	ID Owner		organization person_organization_asssignment	.id, .organization_name .is_applied_to -> document	person_organization_assignment.role='id owner'
	Document Name		document	name	
	Description		document	description	
	Reference: part number [1:?]		document_assignment	is_assigned_to	
3D model information Information zum 3D Modell			*geometric_model*		
	model name		geometric_model	model_id	
	Accuracy information		accuracy		necessary to interprete the quality of numeric values
Classifications Klassifizierungen			*specific_document_classification | general_classification*		

Relevant LTA/LZA Data			**Mapping approach onto standard based description and implementation model**		
Requirements Data Model (Level E1)			Data Level E2 / E3 , e.g., for ISO10303-214 Application Reference Model (ARM)		
Entity	*Attribut*		*Entity*	*Attribut*	*Remarks, Rules, Constrains*
	Classification Name		specific_document_classification | general_classification	classification_name	
	Classification System		classification_system	id	
System information Systeminformationen			*document_format_property, document_creation_property, external_file_id_and_location, document_location_property*		
	Document format		document_format_property	.data_format	
	Character code		document_format_property	.character_code	
	Creation date		date_time_assignment date_time	.is_applied_to .date	date_time_assignment.role='creation'
	Creation time		date_time	.time	
	Creating system		document_creation_property	.creating_system	

Relevant LTA/LZA Data			**Mapping approach onto standard based description and implementation model**		
Requirements Data Model (Level E1)			Data Level E2 / E3 , e.g., for ISO10303-214 Application Reference Model (ARM)		
Entity	*Attribut*		*Entity*	*Attribut*	*Remarks, Rules, Constrains*
	Location		external_file_id_and_location document_location_property	.location .location_name	
	File		external_file_id_and_location	.external_id	
Document Properties *Dokument-Eigenschaften*			*document_content_property, document_type_property*		
	Geometry type		document_content_property	.geometry_type	
	Type		document_type_property	.document_type_name	or with general_classification in addition attached to the document
	Language [1:?]		document_content_property	.languages	
Status Information *Status-Informationen zum Dokument*			*approval, approval_status*		
	Approval status		approval approval_status	.status .status_name	
	Checked by person		approval	.is_approved_by	different instances of approval for check and release
	Creator		person_in_organization organization person person_organization_assignment	.organization .organization_name .person_name .is_applied_to	person_organization_assignment.role='creator'
	Release date		approval date	.actual_date .date	
	Relesed time		approval time	.actual_date .time	

Relevant LTA/LZA Data			**Mapping approach onto standard based description and implementation model**		
Requirements Data Model (Level E1)			Data Level E2 / E3 , e.g., for ISO10303-214 Application Reference Model (ARM)		
Entity	*Attribut*		*Entity*	*Attribut*	*Remarks, Rules, Constrains*
	Released by person		approval date_and_person_organisation person_in_organization person	.is_approved_by .person_or_organisation .associated_person .person_name	
	Released by department		person_in_organization organization	.associated_organization .organization_name	
Organisation *Organisation, Firma*			*organization, organization_assignment*		
	Name		organization	.organization_name	
	Organisation ID		organization	.id	
	Address		organization	.postal_adress	
	Organization type		organization	.organization_type	
Person *Person*			*person, persin_in_organization*		
	Person ID		persin_in_organization	.id	
	Person name		person	.person_name	
	Role		persin_in_organization	.role	
	Department		organization	.organization_name	
Part identification *Teil-Identifikation*			*item, item_version, ddid*		
	Part Number		item	.id	
	Version		item_version	.id	

Relevant LTA/LZA Data			**Mapping approach onto standard based description and implementation model**		
Requirements Data Model (Level E1)			Data Level E2 / E3 , e.g., for ISO10303-214 Application Reference Model (ARM)		
Entity	*Attribut*		*Entity*	*Attribut*	*Remarks, Rules, Constrains*
	ID Owner		organization person_organization_asssignment	.id, .organization_name .is_applied_to -> item	person_organization_assignment.role='id owner'
	Supplier [0:?]		organization, person_organization_asssignment	.organization_name .is_applied_to	person_organization_assignment.role='supplier' shall be unique within the scope of the related Part Number.
	Part Name		item	.name	
	Description		item	.description	
	Copyright		specific_item_classification | general_classification		
	Trade mark		specific_item_classification | general_classification		
Classifications *Klassifikation*			*specific_item_classification | general_classification*		
	Classification Name		Specific_item_classification	.classification_name	
	Classification Description		Specific_item_classification	.description	
	Classification System		Classification_system	.id	
Context *Kontext*			application_context		

Relevant LTA/LZA Data			**Mapping approach onto standard based description and implementation model**		
Requirements Data Model (Level E1)			Data Level E2 / E3 , e.g., for ISO10303-214 Application Reference Model (ARM)		
Entity	*Attribut*		*Entity*	*Attribut*	*Remarks, Rules, Constrains*
	Application [1:?]		Application_context	.application_domain	
Part Properties Eigenschaften des Teiles			*item_property_association, property_value_association, (ABS)property_value*		
	Volume		numerical_value		
	Surface		numerical_value		
	Material ID		item	.id	
	Material name		item | material	.name | .material_name	
	Material density		material_property_value_representation material_property		
	Material strength		material_property_value_representation material_property		
	Reference: Material specification		document_file document_association		
	Weight calculated		item_property_association property_value_association (ABS)property_value		
	Weight measured		item_property_association property_value_association (ABS)property_value		
	Weight prototype		item_property_association property_value_association (ABS)property_value		

Relevant LTA/LZA Data			**Mapping approach onto standard based description and implementation model**		
Requirements Data Model (Level E1)			Data Level E2 / E3 , e.g., for ISO10303-214 Application Reference Model (ARM)		
Entity	*Attribut*		*Entity*	*Attribut*	*Remarks, Rules, Constrains*
	General tolerance frame		default_setting_association general_tolerances		
Specification references *Verweis auf technische Vorschriften*			*document_assignment, document/document_version | document_file*		
	Reference: Technical specifications [0:?]		document_assignment	.assigned_document	if it links to a managed document, e.g., a technical specification, the referenced objects shall be document_version, if not a simple reference to document_file may be enough
	Reference: Standards [0:?]		document_assignment	.assigned_document	if it links to a managed document, e.g., a technical specification, the referenced objects shall be document_version, if not a simple reference to document_file may be enough
Information of source system *Informationen des Quellsystems*			*date_time_assignment, date_time, item_property_association, general_property*		
	Creation date		date_time_assignment date_time	.is_applied_to .date	date_time_assignment.role='creation'
	Creation time		date_time	.time	
	Creating system		general_property	.id, .property_type	
Organization *Organisation, Firma*			*organization, organization_assignment*		
	Name		organization	.organization_name	

Relevant LTA/LZA Data			**Mapping approach onto standard based description and implementation model**		
Requirements Data Model (Level E1)			Data Level E2 / E3 , e.g., for ISO10303-214 Application Reference Model (ARM)		
Entity	*Attribut*		*Entity*	*Attribut*	*Remarks, Rules, Constrains*
	ID		organization	.id	
	Address		organization	.postal_adress	
	Organization Type		organization	.organization_type	
Person Person			*person, persin_in_organization*		
	Person ID		persin_in_organization	.id	
	Person Name		person	.person_name	
	Role		persin_in_organization	.role	
	Department		organization	.organization_name	
	Language		language string_with_language		identified for each string in the data population by String_with_language.language_specification
Authority Reference Referenz für die Änderungserlaubnis			*project, work_order*		
	Project		project	.name	
	Work order number		work_order	.id	
	Work order version		work_order	.version_id	
	Work order type		work_order	.work_order_type	
	Change description		work_order	.description	
Status Information Statusinformationen			*approval, approval_status*		

Relevant LTA/LZA Data			**Mapping approach onto standard based description and implementation model**		
Requirements Data Model (Level E1)			Data Level E2 / E3 , e.g., for ISO10303-214 Application Reference Model (ARM)		
Entity	*Attribut*		*Entity*	*Attribut*	*Remarks, Rules, Constrains*
	Approval status		approval approval_status	.status .status_name	The absence of approval information does not imply any approval status by default
	Checked by person		approval	.is_approved_by	different instances of approval for check and release
	Checked for		approval	.level .scope	
	Release date		approval date	.actual_date .date	
	Released time		approval time	.actual_date .time	
	Released by person		approval date_and_person_organisation person_in_organization (opt.) person (opt.)	.is_approved_by .person_or_organisation .associated_person (opt.) .person_name (opt.)	
	Released by department		person_in_organization (opt.) organization	.associated_organization (opt.) .organization_name	
	Released for		approval	.level .scope	
	Effectivity date		dated_configuration	.start_date	
	End of Production		dated_configuration	.end_date	
Part Structure *Teilestruktur*			*(ABS)item_definition_instance_relationship, (ABS)item_instance*		

Relevant LTA/LZA Data			**Mapping approach onto standard based description and implementation model**		
Requirements Data Model (Level E1)			Data Level E2 / E3 , e.g., for ISO10303-214 Application Reference Model (ARM)		
Entity	*Attribut*		*Entity*	*Attribut*	*Remarks, Rules, Constrains*
	Reference to Component		assembly_component_relationship	.related	
	Instance number		(ABS)item_instance	.id	
	Reference to Assembly		assembly_component_relationship	.relating	
	Quantity		quality_property | selected_instance | single_instance	.quality | .selected_quantity | NA	if single_instance quantity is not applicable
Part Relationships Teilebeziehungen			*(ABS)item_definition_relationship | item_instance_relationship ?*		
	Mirrorpart Relationship		geometrical_relationship		
	Replacement for		replaced_definition_relationship | replaced_usage_relationship		
Context Kontext			*application_context*		
	Context name		application_context	.application_domain	
	Context description		application_context	.description	
Manufacturing Features Funktionselemente für die Herstellung			*(ABS)feature_definition, (ABS)process_feature_in_solid | (ABS)process_feature_in_panel | (ABS)replicated_feature | general_feature*		
	Reference to geometric element [1:?]		shape_description_association		
	Description		featured_shape	.description	

Relevant LTA/LZA Data			**Mapping approach onto standard based description and implementation model**		
Requirements Data Model (Level E1)			Data Level E2 / E3 , e.g., for ISO10303-214 Application Reference Model (ARM)		
Entity	*Attribut*		*Entity*	*Attribut*	*Remarks, Rules, Constrains*
	Classification		. . .		implicitly via the use of one of the different feature type objects and/or with general_classification in addition attached, e.g., to feature_definition
	Parameter [0:?]		feature_parameter		
Process information Prozess-Informationen			*(ABS)item_definition_relationship | process_plan*		
	Assembly Method		process_operation_definition process_operation_input_or_output		
	Production Method		process_operation_definition process_operation_input_or_output		
	Related Row Material Part		make_from_relationship item		where specific_item_classification.classification_name='raw material'
	Related Semi-finished product		make_from_relationship item		where specific_item_classification.classification_name='in process'
	Part Tool Relationship		tool_part_relationship		