DIN DKE

WHITEPAPER

SCENARIOS FOR DIGITIZING STANDARDIZATION AND STANDARDS

AUTHORS/CONTACTS

Introduction
Damian A. Czarny, DKE of DIN and VDE
Johannes Diemer, Diemer Consulting 4.0 UG
Dr.-Ing. Mario Schacht, DIN e.V.

Scenario Level 2
Dr.-Ing. Gilles Bülow,DKE of DIN and VDE
Michael Noll, Open Grid Europe GmbH

Scenario Level 3
Dietmar Lochner, Schaeffler Technologies AG & Co. KG
Dr.-Ing. Mario Schacht, DIN e.V.

Scenario Level 4
Damian A. Czarny, DKE of DIN and VDE
Dr.-Ing. Jens Gayko, SCI 4.0
Jui Nahid Pervin, SCI 4.0
Peter Rauh, DIN e.V.

Scenario Level 5
Prof. Dr.-Ing. Christian Diedrich, Otto von Guericke University of Magdeburg
Johannes Diemer, Diemer Consulting 4.0 UG

Outlook and conclusions
Johannes Diemer, Diemer Consulting 4.0 UG

This Document is a translation of the German original version.
The German version is nationally aligned within the IDiS community.

PUBLISHED BY

DIN

DKE

DIN e. V.

Burggrafenstraße 6
10787 Berlin
Germany
Phone: +49 30 2601-0
Email: presse@din.de

DKE Deutsche Kommission Elektrotechnik
Elektronik Informationstechnik in DIN und VDE
Stresemannallee 15
60596 Frankfurt am Main
Germany
Phone: +49 69 6308-0
Fax: +49 69 08-9863
Email: standardisierung@vde.com

Photo credit cover picture: Rymden / stock.adobe.com
June 2021

CONTENTS

FIGURES

PREFACE

Left:
Michael Teigeler
DKE Managing Director

Right:
Christoph Winterhalter
Chairman of the
Executive Board, DIN

Dear Readers,

The standards of tomorrow will be digital, and there are good reasons for this: they must continue to provide all relevant information in a way that is appropriate for the application. As applications are being increasingly digitized, standards must follow suit. Welcome to digital Standards! Welcome to IDiS: the digital Standards Initiative.

Current standardization and standard application will have to go through comprehensive further development and digital transformation in order to become digital standards. This new approach offers the potential of further significant increases in the sum of 17 billion Euro currently saved every year by standards in Germany.

With this Whitepaper, Germany is the first country to present a description of the possible changes for standardization and standard application in the next ten years. The conceivable scenarios were elaborated in IDiS, giving explicit consideration to the different perspectives of the value creation process involved in standardization. IDiS thus makes an important contribution to German, European and international development of standardization in a digital world.

At this point we would like to express our gratitude to all authors and other contributors from industry, research and the associations for their great commitment in supporting the digital standards Initiative (IDiS) with great motivation and well-substantiated contributions.

We hope all readers enjoy reading the Whitepaper and ask for your active support in the further elaboration of the digital standards of tomorrow.

Michael Teigeler
DKE Managing Director

Christoph Winterhalter
Chairman of the
Executive Board, DIN

INTRODUCTION

„Digital Standard[1] comprises all relevant information for a standardization task and provides this in a method and scope that is suitable for specific applications. Digital Standards can be initiated, created, processed, implemented and adapted by both humans and machines.“

That is the vision of IDiS (Digital Standards Initiative /IDiS-21/) for the future of standards and specifications. But exactly what does it mean? What will Digital Standards look like and how can they be used? How will they differ from traditional document-based standards, and how will this influence the standardization processes? What will be done automatically, what influence does artificial intelligence have, what influence do people have? This Whitepaper takes four scenario descriptions for a closer look at the possible answers to these questions. The scenarios also include the two extreme positions: „Nothing ‘s really changed“ and „General artificial intelligence has replaced the human expert knowledge“. The scenarios depict the varying status in terms of the maturity and readability of standards and the degree to which they can be implemented and interpreted, looking at possible automatic compilation by machines. They thus describe the related different autonomy attributes in the compilation and use of standards and specifications (utility levels 2 to 5, see 1.1). Theoretically, all described scenarios or corresponding manifestations are possible in 10 years. The scenarios that actually occur will depend essentially on the possible step-by-step developments to the next maturity level in each case.

The description of possible scenarios for Digital Standards is a first step towards establishing a common understanding. The White Paper thus provides a basis for discussing the digital future and transformation of standardization and standards begun on a national level by the IDiS in 2019 and which will continue in future. Section 6 gives an overview of the planned further activities.

1 In the German version of this document the term “Digitale Norm” has been introduced. The direct translation of this expression would be “digital norm”. Since the term “norm” is not very common in English language we use the term “Digital Standard” instead. Currently no approved definition for the term “digital standard” exists so that the provided definition describes the common understanding within the IDiS community. It is not intended to replace the internationally known term “SMART Standard” which is also already used in the literature and the standardization community. “SMART” stands for: “Standard whose contents are applicable and readable for machines, software or other automated systems, and furthermore can be provided digitally in an application/user-specific manner (transferable)” /SCM-20/. Nevertheless, the Digital Standard and the“SMART Standard” can be regarded as synonymous. There are still discussions within the international standardization community about the appropriate term.

1 BASIS FOR THE SCENARIOS

Content Creation	Content Management	Content Delivery	Content Usage
standardization	hosting repository	Content-as-a-Service	Use of standards content

Fig. 1: Phases in the value creation process

The scenarios describe various levels for Digital Standards. The descriptions are based on the workflow currently used by known standardization organizations such as DIN and DKE, which can be broken down into the four essential value creation process phases **Content Creation, Management, Delivery** and **Usage** /SCM-20/ (see Fig. 1). However, Digital Standards as defined by the IDiS present new challenges for both standardization organizations and standards users. There will have to be fundamental changes within the individual process phases, to the stakeholders in each specific process, the respective objectives and the workflow itself for the vision of Digital Standards to become reality.

1.1 Utility model SMART Standards

The actual manifestation of Digital Standards has a direct impact on how fundamental and comprehensive the changes will be. The step model or classification and utility model used by the IEC[2] to describe the analyzability of digital standards can be taken as an initial starting point /CZS-19/. The model describes characteristics of Digital Standards, assigning them to different levels that define the digitization degree[3] of a standard. The model distinguishes between the following five levels:

Level 0:	Paper format. Not suitable for direct automatic processing or usage.
Level 1:	Digital document. Automatic management and display of the document is possible (WORD, PDF).
Level 2:	Machine-readable document. The structure of the document can be digitized and certain granular content[4] can be exported (chapters, graphics, definitions etc.). Content and presentation are separated.
Level 3:	Machine-readable content. All essential granular information units can be clearly identified, their reciprocal relationships recorded and made available for further processing or partial implementation.
Level 4:	Machine-interpretable content. The information in a standard is linked with implementation and usage information in such a way that it is implemented by machines directly or interpreted and combined with other information sources so that complex actions and decision-making processes take place automatically.

2 This model was drawn up in the IEC SG12 and is currently going through further development in the various ISO and IEC working groups.

3 The digitization degree of Digital Standards is called maturity, or also automation degree or autonomy level, in accordance with /PLT-20-2/.

4 Granularity as per /ISO-05/ means “the boundary where an object functions as a self-contained, stand-alone unit to support a common vision or goal”. Accordingly, granular information refers to the smallest information units of a standard that fulfill a purpose. Fragment is meanwhile also being used for granularity.

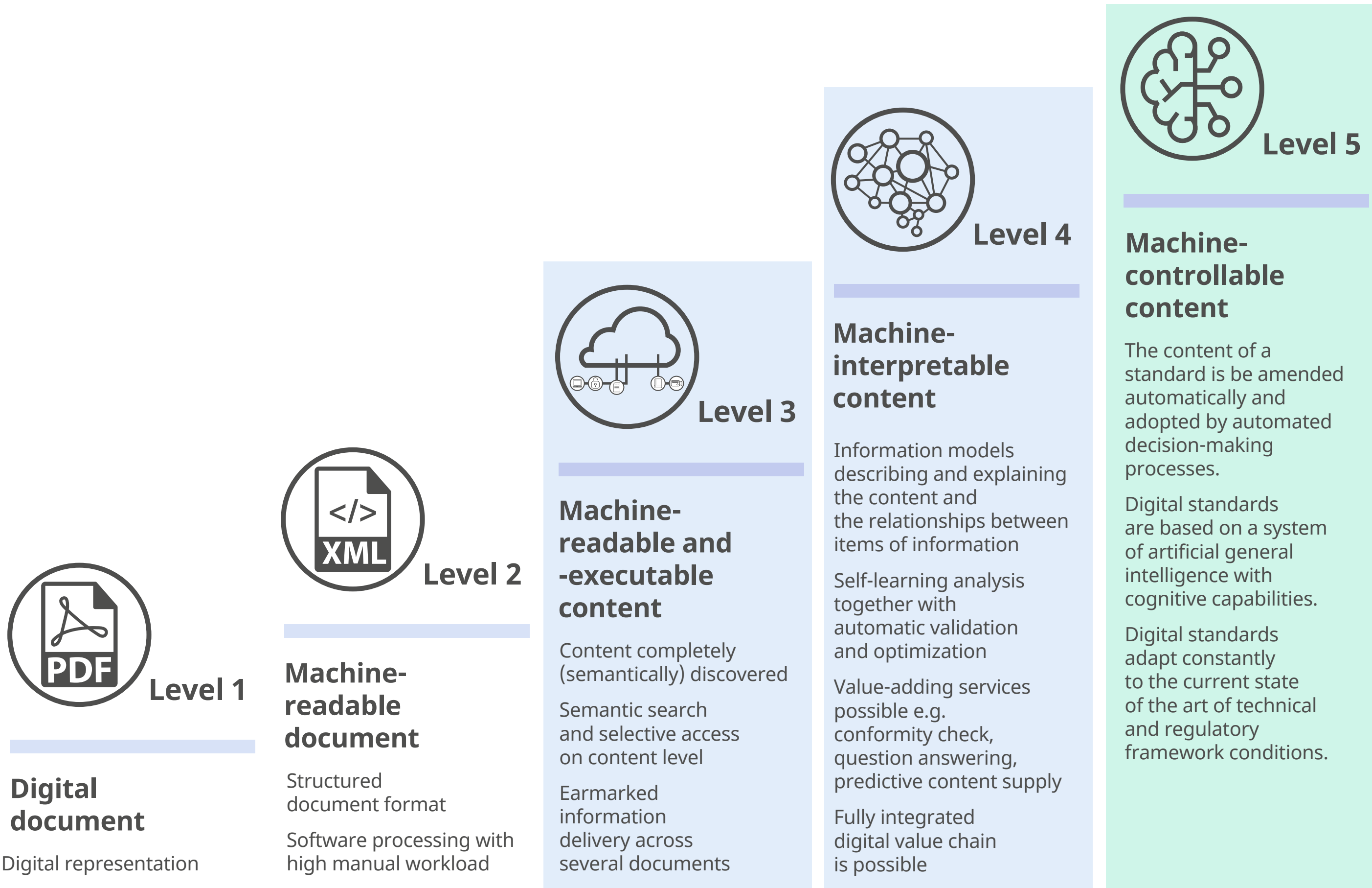


Fig. 2: The extended utility model

As shown in Fig. 2. the levels are connected with certain developments so that the corresponding level target can be achieved. Furthermore, the individual levels can be seen as development steps that build on each other. Each level builds on what was achieved in the previous level, thus forging ahead with digitization. The model makes it possible to take stock of the current status with regard to machine interpretability respectively digitization of standardization and standards

1.2 Extending the utility model

In order to describe a visionary target scenario, an additional level is defined that comes above level 4 in the IEC utility model (see Fig. 2):

Level 5:	Machine-controllable content. The content of a standard can be amended by machines working unassisted, and adopted by automated (distributed) decision-making processes. The content adopted in this way is automatically reviewed and published via the publication channels of the standardization organizations.

Level 5 is a consistent continuation of the growing influence of AI in the previous levels that extends selectively across the individual process phases and develops in level 5 into cohesive artificial general intelligence (AGI)[5] /GOE-07/. Artificial general intelligence has cognitive capabilities and is capable of making cross-process and cross-phase optimizations and decisions. The content of Digital Standards can thus be com-

5 Artificial general intelligence describes a software program capable of solving many complex problems in many different areas that controls itself automatically, with its own thoughts, concerns, emotions, strengths, weaknesses and inclinations /GOE-07/.

piled and amended automatically or triggered by machines, achieving a further level of maturity: in addition to machine interpretability, this also allows machine control of the standardization process based on machine knowledge, possibly even without human intervention.

The standardization process in level 4 is characterized by the fact that information and knowledge from the delivery and usage phases flow into the content creation phase in the sense of an overarching life cycle. Furthermore, the content is amended and renewed all the time. The process therefore takes place in continuously repeating cycles and not in a successive time sequence. Every digital standard is thus capable of adapting constantly (and intrinsically) to the new knowledge. This process is also automated in level 5.

1.3 Scenarios as substantiation of the utility model

The utility model describes the main distinctive features between the levels for assessing the degree to which Digital Standards can be evaluated and automated. Examples are provided of what seems possible on which level and which aspects may be involved. However, the main changes within a level are not given a cohesive description and put in sequence (in the sense of a road map). This makes it harder to estimate the consequences or necessary realization activities for each level.

The following descriptions of the scenarios for levels 2 to 5 aim to close this gap. There is no need to consider a scenario for level 1, as the corresponding value creation process already corresponds to present-day practice (see Fig. 9 in section 6). Each scenario describes a possible future picture of standardization and standards by presuming that the corresponding target level is fulfilled within a period of 10 years. Each scenario describes the level of achievement in the context of the current value adding process phases of the standardization organizations (creation, management, delivery and usage). The table in Annex A summarizes the essential distinctive features of the individual scenarios, comparing them in condensed form.

2 SCENARIO LEVEL 2 – MACHINE-READABLE STANDARDS

In 10 years, there has been no essential change in standardization.

Comprehensive electronic delivery of national/European/international standards is still mainly carried out using PDF-based standards management processes organized by means of meta data /SCM-12/.

In technological terms and seen from the user' s point of view, the situation is in a mature, reliable status, given that this refers to very broad-based information provision in terms of the number of verified regulations and indexing depth.

The workflow that has been in place for decades (see Fig. 3) works successfully and is well-balanced due to conventions agreed between the various process partners involved. The basic principles have been carefully coordinated in compliance with standardization and legislation, and guarantee reliable management of the standardization results in customer-oriented systems. Amendments to the standardization system are made conscientiously and with the consensus of all stakeholders, taking due account of the rules valid in each case /DIN-20, ISO-04, ISO-18/.

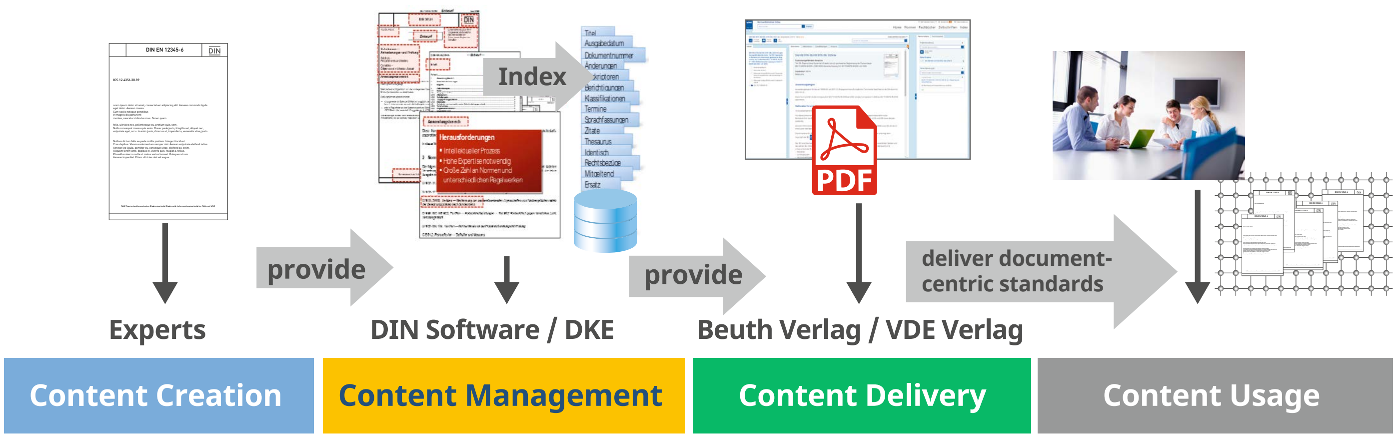
2.1 Content creation

The consultation process (in virtual or physical sessions) can still take several years in some cases. Measures have been implemented to shorten the process with the aim of reducing the processing times to less than 12 months for most consensus-based standards. Content reviews usually take place after 5 years, initiated by system-assisted deadline tracking on the part of the standards body. as in the past, every standardization request (new/change) needs an individual initiative ("new work item proposal").

Adopting the finished standard as a consensus document still produces top quality results (human benchmarks of the experts involved) while also avoiding high complexity (for example by not considering manufacturer-specific aspects). Diversity and substantiation can be described in the form of supplementary standards or accompanying documents, for example as a consortium standard, a SPEC or a guideline.

The standard document itself has an XML document structure that makes it machine-readable. The structure is based on separating content and presentation, making it possible to identify and research typical document elements such as chapters, graphics, definitions and bibliography entries, but not meaningful elements. Standard creation is thus still primarily geared to developing standards that can be read by machines and interpreted by people. New (collaborative) tools for creating standards have been successfully established.

Fig. 3: Phases in the value creation process: from content creation to content usage



The following prerequisites are fulfilled for using the new tools:

→ The standard structure as (XML) document is extensively harmonized.
→ Complete templates for standards exist and are used by the major standardization organizations.
→ Standardization organizations can share and combine standards when the need arises, as facilitated for example by the NISO-STS shell model /NISO-17/.
→ Creation tools are offered as a service.

2.2 Content management

The standard publisher is responsible for content management. The content management systems used by the standardization institutions are mainly proprietary solutions. Data and meta information are shared in the form of XML-based document formats, although there is no warranty that all relevant information will be shared throughout the entire process.

Standards are created and managed in editor systems. Editor systems are supported by interfaces to other tools used in standard production, e.g. translation management systems or tools for creating factory standards. There is no integrating system that can be used by all processes and stakeholders involved in standard production. Depending on the process step, there is a possibility of media disruption which demands manual data input in other tools to warrant data consistency.

The meta data describing the standard or standardization projects are kept in databases or ideally in the content management system for standards management and made available for various usage purposes (most of which are not integrated).

2.3 Content delivery

Standards are available as one-off sales or subscriptions in printed or digital form (PDF, XML or as HTML fragments in standards websites). All output formats are produced directly or indirectly from the content management systems (single source publishing).

By using meta data and additional information, standards websites and standards management systems can be upgraded with Digital Standards to allow for detailed searches for standards (e.g. according to various facets) or language/version comparisons.

Beside the “traditional” standards websites, possibilities are being created for alternative access to standards with CaaS (Content-as-a-Service) interfaces /GZL-20/.

2.4 Content usage

Standards are still read, understood, reviewed, selected and implemented by people on the basis of the standards made available by content delivery and the supporting help functions (search, favourites lists, document comparisons etc.).

Digital access makes it significantly easier to handle and process standards. Standards management systems help with (internal) licensing, administration and distribution of the documents. Standards websites offer various research and convenience functions that make it easier to understand and work with standards.

3 SCENARIO LEVEL 3 – MACHINE-READABLE AND -EXECUTABLE CONTENT

In 10 years, some of the processes involved in standardization have changed

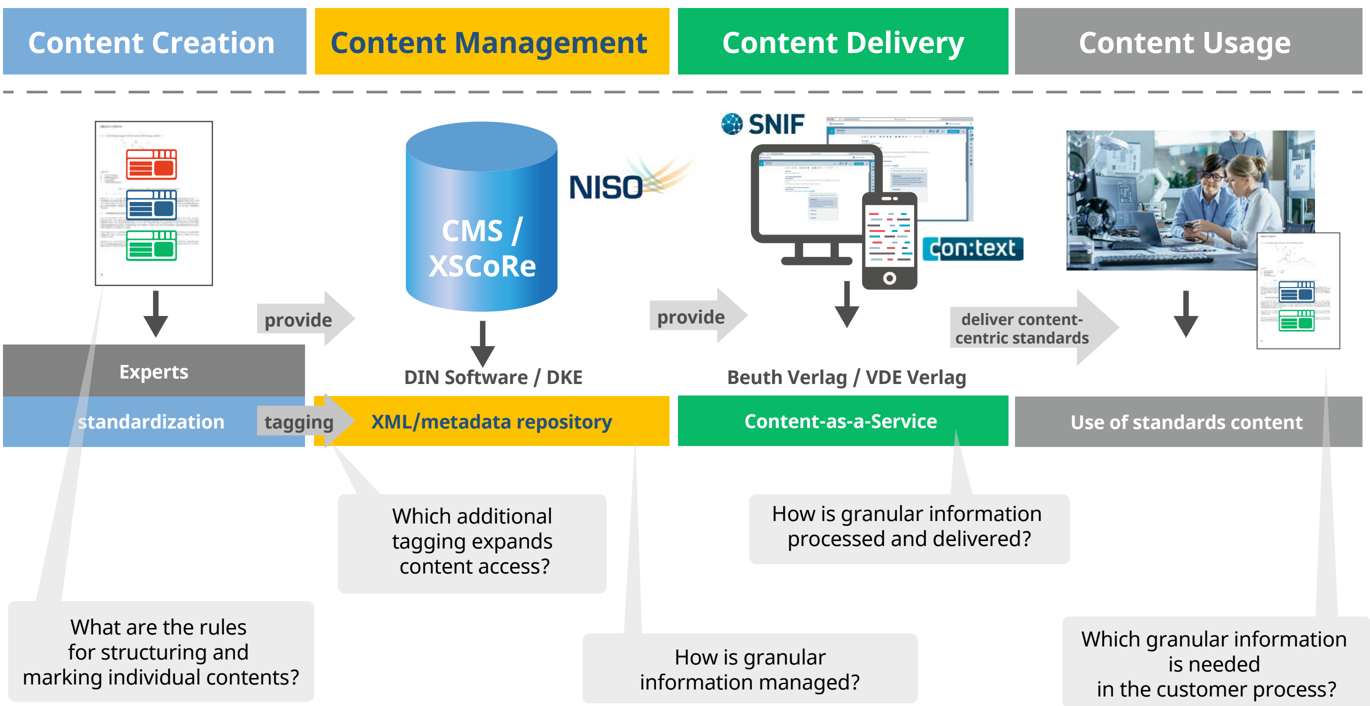
The process for level 3, like level 1 and 2, is characterized by distinct areas of responsibility. Although this simplifies the implementation of solutions in terms of organization, it prevents the integrated overarching approach that will be vitally necessary for the Digital Standard in level 4. Focusing on IT-assisted processes and their further development in content management and content delivery makes it possible to swiftly achieve specific machine-readable solutions. Fig. 4 shows the main questions to be answered, with explanations provided below.

3.1 Content creation

A document is created with a data structure according to the current creation framework conditions for standardization, but with the whole content delivered in XML, e.g. for further use in editor systems or other usage environments. Furthermore, digital objects defined in the standard (e.g. tables, formulae, graphics) are stipulated for direct usage in customer systems. The requirement for semantic granularity of standards down to the smallest meaningful information elements and their marking is one of the core tasks characteristic of level 3. In level 3, this refers initially to standardized facts that are required and necessary in the content usage phase of the value adding process.

Rules for describing granular information in standards together with systematic stipulation of the usage context (e.g. standardization function, sites of action, see /LMN-19, SCM-20/) are available for technology-based usage with considerable improvements in the usage quality of IT-assisted application processes. Stipulations of a corresponding information model are established and standardized on an

Fig. 4: Level 3 processes and main questions



international scale /WHR-19, CZO-20, RUH-20/, together with corresponding ontology for standards documents and highly granular information elements.[6]

Examples of highly granular information elements and their usage are as follows:

→ Stipulations (requirements, recommendations, etc.) can be clearly identified in the XML structure and exported to the standard user' s requirement management systems. Definitions in the standards content are marked with TBX (TermBase eXchange)-compatible tags for cross-platform terminology management with rough cross-linking of the content.
→ Formulae are described by data formats such as MathLab, MathML, etc. and made available to the user in a machine-executable form.
→ Images are embedded unchanged as raster graphics and exported with connected information (caption, legend, etc.)

3.2 Content management

Database processing and export of content takes place in a suitable system. All existing German, European and international standards are available as XML and managed in XML databases /WHK-16, EKW-17/ with the following attributes:

→ Central provision and management of meta data and standards content for digital information and knowledge products, also in usage-relevant, partially granular form, as corresponding content and purposes are identifiable and classified (→ content creation requirement).
→ The management process for granular content considers life-cycle information that can be coupled to the total document.
→ Further development of digital search and delivery platforms based on semantic (additional) information which e.g. can describe the relationships between granular content, which in turn can be included in a relevance appraisal.
→ Provision and further development of interfaces to assist the content management processes in the XML workflows.

The "Semantic Standards Information Framework (SNIF)" is used for semantic indexing of standards /SCW-14/. In level 3, this semantic indexing closes the gap that emerges when there is no 100% semantic indexing of the content of a standard. SNIF links the intellectually elaborated meta data with the semantic indexed standards texts to provide better quality information to systems involved in further processing.

3.3 Content delivery

New digital solutions for standards usage based on XML technology have emerged or been developed /GZL-20/. The solutions made possible by structured, highly granular information are mainly developed by solution providers and made available for the content usage phase in the value adding process.

The XML versions of the standards documents permit specific access to all possible information units within the documents, as well as linking these to other information sources, such as document meta data or further additional information. Suitable digital search and delivery platforms have uniform access to this information and safeguard shared exporting. The semantic enrichment of information allows access to highly granular information and the reciprocal relationships.

6 In 2020, the NISO Working Group began corresponding work on a Standards Specific Ontology Standard (SSOS) /NISO-19/. On the national level, the NAGLN (DIN Standards Committee Principles of Standardization) has expanded the rules for standardization work.t.

3.4 Content usage

Standards users are provided with highly granular information and semantic enrichment of standards and specifications. These can be integrated, although still by hand, in the company processes and taken into account in the development and production process (PEP). Possible applications include e.g.:

→ Construction: support in product development by linking product requirements with requirements from standards. This is possible because the requirements are identified or marked in the content of a standard. Cross-linking allows for traceability, providing specific information when there are changes to the granular standards information. This allows swift assessment of the impacts on the product.
→ Automation: existing highly granular standards information is used in production processes in the form of a management shell (Industry 4.0). Standards information is brought together with the user information (the asset) in a shared place, which is the management shell, and processed together.
→ After sales: standards information is available in the usage context of after sales (e.g. commissioning, maintenance, servicing).

Besides “traditional” ICT-assisted usage methods (e.g. database applications, standards management) from solution providers, a future usage scenario reveals far greater usage benefit for Digital Standards with the possibility of deriving rules for formalizing and modelling the content of standards and specifications for AI-based applications. The resulting quality improvements in the basic data are indispensable for optimum functionality of AI systems /WTH-19/. The intended development by DIN/DKE and other standards bodies of a repository for structured standards data acts already in level 3 as the basis for company-specific AI applications, developed initially for the main part in innovative companies with high investment potential, possibly in cooperation with the standards bodies.

4 SCENARIO LEVEL 4 – MACHINE-INTERPRETABLE CONTENT

In 10 years, standardization has changed.

Significant improvements in the information basis will be necessary, in terms of both quantity and quality, for the content of standards to be machine-interpretable. The identified information units resulting from level 3 are broken down into their semantic components and supplemented with information about the application context and execution behaviour (execution semantics). Interpreting, embedding and executing the granular content is still up to the standards user respectively the systems he uses. However, these are able to transfer for information units relevant for a specific usage to the user domains and interpret them according to the execution semantics in its own decision-making and automation processes.

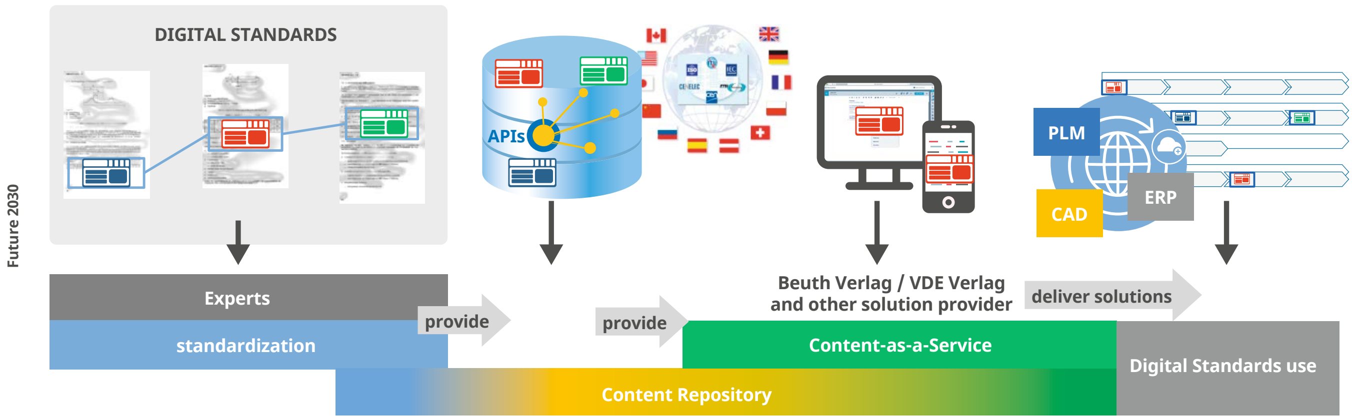
Fig. 5 /DKI-20/ shows the direction in which a future workflow should develop in 10 years. Crucial importance will be attributed above all to greater integration of the previously mainly autonomous, sequential process phases. The concept of semantic interoperability, as implemented for example in Industry 4.0, eliminates media disruption and the need for data conversion at the transition points in the value adding process.

The increased demand for information results in the introduction of specialized tools and management systems together with further merging of classical areas of responsibility. On the IT and process level, this leads to the establishment of a distributed overall system for standardization.

4.1 Content creation

The standardization process must be able to provide the required granularity of information in each case, which is necessary for interpretation in the respective application context. The creation tool used in the process plays a central role, because not only the content of a standard but also its semantic structure has to be created and then maintained. For standards creation conforming with level 4, the document creation tools introduced in levels 2 and 3 (XML Online Authoring Tools /ISO-20/) are supplemented by a large number of (plug-in) creation modules. These modules are used for native creation of domain-specific content which is then integrated in the context of the standard. For the creation tool and underlying content management system to create

Fig. 5: Integrated value adding process



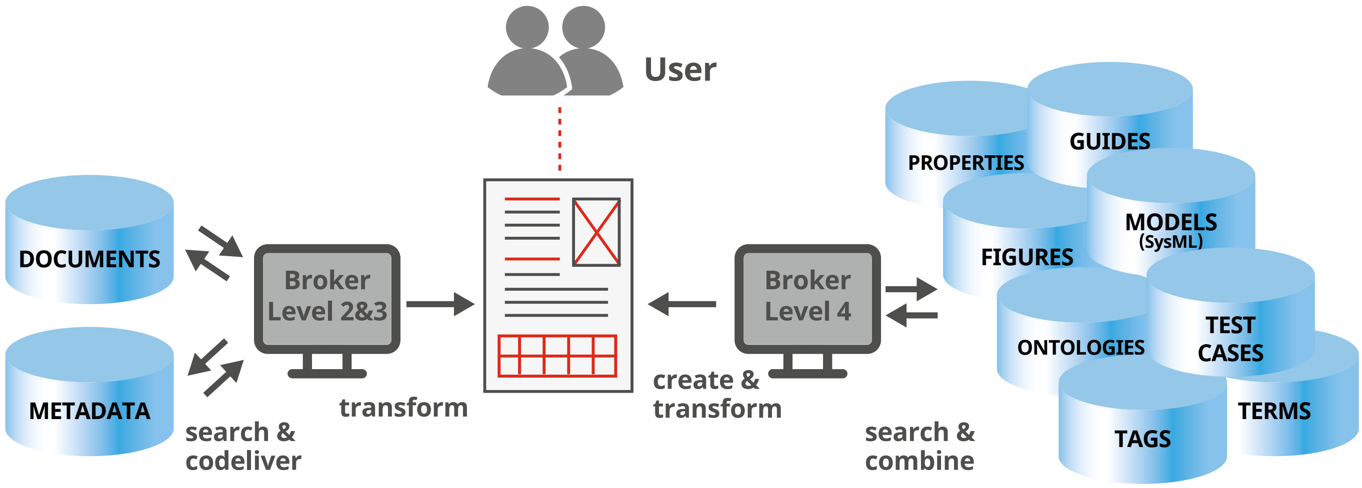


Fig. 6: Moving towards information-centered content management (level 4)

and process the domain-specific elements (often present in varying formats), there is urgent need for a uniform semantic description of all elements according to an information model (see 3.1) and new standardized rules.

Compared to level 3, this not only increases the depth of detail (granularity level) and the number of supported formats: above all, new semantic concepts are developed and standardized for format-independent execution and behaviour description of standards content (execution semantics). Similar developments can already be seen today in the context of Industry 4.0 /PLT-18, PLT-20-1/.

For certain content types, the content life cycle introduced in level 3 is now decoupled from the actual document with regard to process (content creation) and IT (content management). Information quantity and complexity together with the overarching network of relationships require specialized standardization and management of the information units detached from the actual standards document.

Level 4 sees a dramatic change in the requirements profile for standardization experts. A level 4 standardization expert must write in a way that people can understand, that is formalized and modelled appropriately for the machine/domain, while producing a semantic description of the elements according to the standardization domain. As a rule, this wide range of skills cannot be covered by one expert alone, so that the committees increasingly consist of technical, methodical and system experts.

4.2 Content management

The level 4 scenario adds the challenge of interpretation to the identification and export of information units in level 2 and 3. These are supplemented by additional definition aspects and execution descriptions /execution semantics) for continuous interpretation of all information units in the specific application context (see 4.1). This extended information cannot be (repeatedly) present completely in every standards document. To a certain extent, this is still possible in level 3 as here it refers primarily to simple annotations with relatively fixed vocabulary, managed in the form of lists or simple structures. The scope and complexity of the annotations increases in level, thus making it increasingly necessary to use specialized database systems or repositories for certain types with corresponding references made in the standards documents. One example of this consists of property repositories such as the Common Data Dictionary (CDD) /IEC-17/, which assume the role played previously by definitions of terms, and also offer the possibility of adding further information. These property definitions are so complex that the standards have to refer directly to the property definitions (or certain aspects) in the property repositories. Fig. 6 shows the transition from a central document repository (levels 2 and 3, on the left of the picture) to a number of specialized information repositories (level 4, on the right of the picture).

This large number of individual repositories, which may possibly be managed by different organizations and in different ways, are merged to a uniform overall system. The overall system, which Tannenbaum also calls "Distributed System" /TAN-07/, appears to the user to be one single system, despite its distributed sub-systems, thanks to harmonized user management (usability, rights, personal data) and information management (data security, licensing, etc.). In addition to system fusion, the main property of the distributed system consists in data fusion and quality control. Data fusion consists of merging information from individual repositories that use different data structures, on one and the same meta level (see 5.1). This allows for semantic searching, exporting and data optimization across repository borders (consistency, dead references, duplications etc. Optimization increasingly uses AI-based methods with on-going analysis of the standards stock, also generating recommendations for content creation for example, or ascertaining the need for harmonization in the data stocks and suggesting solutions at the same time.

In the level 3 scenario, the content management systems form the link between content creation and content delivery, but the systems tend to be rather in the background of the individual organizations. In the level 4 scenario, the distributed system is more in the foreground and partially accessible for both authors (content creation, for definitions, searches and editing) and for standard users (content delivery for definitions, explanations, comments, etc.). However, for most users, access is primarily indirect from intermediary applications from other areas, e.g. the tools used for content creation. Even so, there is an increasing number of direct users alongside the IT process owners who are responsible for instance for normative and overarching data and methods maintenance.

4.3 Content delivery

Content delivery in level 3 is still basically document-centered provision of information supplemented by access and search methods to consider any information units within and across several standards. Initial export possibilities handle the data in general formats or directly in common industrial formats, e.g. ReqIF (Requirements Interchange Format) for requirements or RDF (Resource Description Framework) for semantic meta data. Level 3 thus permits a kind of raw information provision in various formats with initial minor convenience functions. It is still up to the individual user to know which formats or information components are relevant for the specific use case or how these have to be combined or processed. Level 3 only makes it possible for the user to obtain this information.

In the level 4 scenario, execution and interpretation information is added to the provision of raw data. However, the biggest change in this area consists of the growing content-related integration of standardization and user information. On the one hand, initial user information (experience, user descriptions, etc.) is fed back into the content management systems and linked with normative content. On the other hand, the content delivery systems develop an improved understanding for user-related information, e.g. when searching for relevant normative information or when it comes to providing information. Asset or requirement descriptions of products can be used directly for searches by analyzing such data and comparing it with the meta models of the standards information.

As far as actual delivery is concerned, the raw data services have developed into use case-related service packages. For common use cases such as simulations, evaluations or conformity statements, the content delivery systems take the user information to ascertain which combined information needs to be provided, which formats used, which notification functions should be adjusted and which user information is still missing.

It is still up to the user to proceed with execution or information, but the content delivery system is increasingly responsible in the case of common use cases for which information packages or service settings help the user to obtain and interpret the data.

4.4 Content usage

The introduction of level 3 systems already gave users access to individual highly granular information from standards for corresponding integration in their own development and production processes (PEP). In turn, this acted as the driving force behind their own internal digitization, for instance by automating decision-making processes based on normative information or making normative information an integral part of their own engineering.

Experience gained in this way was fed back in turn to the use case oriented provision that was developing in level 4 content delivery (see 4.3). In this process, the individual and in some cases special experience of level 3 users was generalized and mapped for the broadest possible range of appropriate use cases. This is beneficial not just for new users who profit from the experience of former users, but also for the level 3 pioneers who thus successively simplify or refine their information procurement with the sheer general growth in size of the systems. Content usage users can generally be broken down into two groups:

→ Use case oriented users who are satisfied with tried-and-tested procedures and delivery forms.
→ Users needing a highly customized approach who require specialized, highly granular standards access including extended control and configurability.

The second group includes, above all, the content solution providers (see 3.3), who take this data and service basis to develop further solutions and offer them to specialized groups of standards users.

In level 4, internal digitization and automation within a company is joined increasingly by the need for cross-company digitization. This mainly happens by making the normative information part of the larger digitization platforms, rather than giving all standards users access to the same content delivery systems with corresponding synchronization. Systems such as the management shell of the Industry 4.0 platform act as a central point for digitizing whole chains of companies by defining and providing the data and mechanisms for interoperability between different instances. Standards and specifications are an integral part of these platforms to offer standards users the corresponding normative information and services at the point where sharing and interaction with other companies takes place.

5 SCENARIO LEVEL 5 – SELF-EXECUTING AND OPTIMIZING CONTENT

In 10 years, standardization has changed fundamentally.

Development processes in the industrial setting have become highly agile, closely integrating the specification, prototype implementation and validation of compliance with standards, specifications and directives or, if necessary, their amendment or formulation. Consensus-based standardization processes are replaced by automated AI-assisted decision-making processes. Standards and specifications are no longer static documents. Instead, as Digital Standards they describe the optimum current state of the art of technical and regulatory framework conditions that are necessary for sustainable functionality in a global ecosystem.

5.1 Content creation

Digital Standards adapt constantly to the new knowledge acquired from the installed products, production systems and environmental influences as these change in the course of time. The system of artificial general intelligence[7] behind the Digital Standards is capable not only of reactive learning: it also takes a proactive approach in a smart, flexible manner comparable with human cognitive skills. Its characteristics include among others knowledge-based presentation, communication in natural languages, an understanding of syntax and semantics, use of strategies as well as handling and assessing irregularities.

Furthermore, it has methods for identifying important past events and saving these with their context. These events can then be downloaded as associative knowledge (in the sense of a remembered memory). These capabilities allow the system to automatically and constantly expand its expert knowledge as the basis for creating a RAMI[8] 4.0-compliant model description for a new technology, and to decide whether the current Digital Standards can be used or have to be extended, proceeding in the latter case automatically with the process of adaptation.

This automatic knowledge-based decision-making process replaces historical consensus-based standardization.

Besides automatic review and adaptation of the Digital Standards, it is also possible to proceed with planning and implementation of the whole systems engineering process. The human contribution in this scenario then consists of describing the new product as a SCRUM story line with the required functionalities and characteristics (appearance, shape, size, material), with allowance being made for incomplete descriptions. Similarly, when drawing up a new digital standard it is also possible to proceed with an ecological assessment, formulating the requirements and required conditions for the new standard. Here again, all other Digital Standards are then reviewed in terms of compatibility and adjusted accordingly where necessary.

Given that basic artificial general intelligence merges various types of knowledge with different learning methods (cognitive synergy), this means that the types and granularity of content creation also differ and can come from various sources. The creation of new content for Digital Standards is triggered by

- → people formulating an idea (e.g. for a product or specification), or
- → AI systems automatically detecting the need for adaptation or formulation.

7 One basic characteristic of this AI system consists in the ability to merge the different kinds of limited knowledge (including declarative, procedural, sensitive knowledge) obtained with different learning methods, like human brains do. This capability is also called cognitive synergy and was described in software terms for the first time with the project /GOE-14/. Working on the basis of this merged knowledge, the system then reacts rationally.

8 RAMI – Reference Architecture Model Industry 4.0 /DIN-16/.

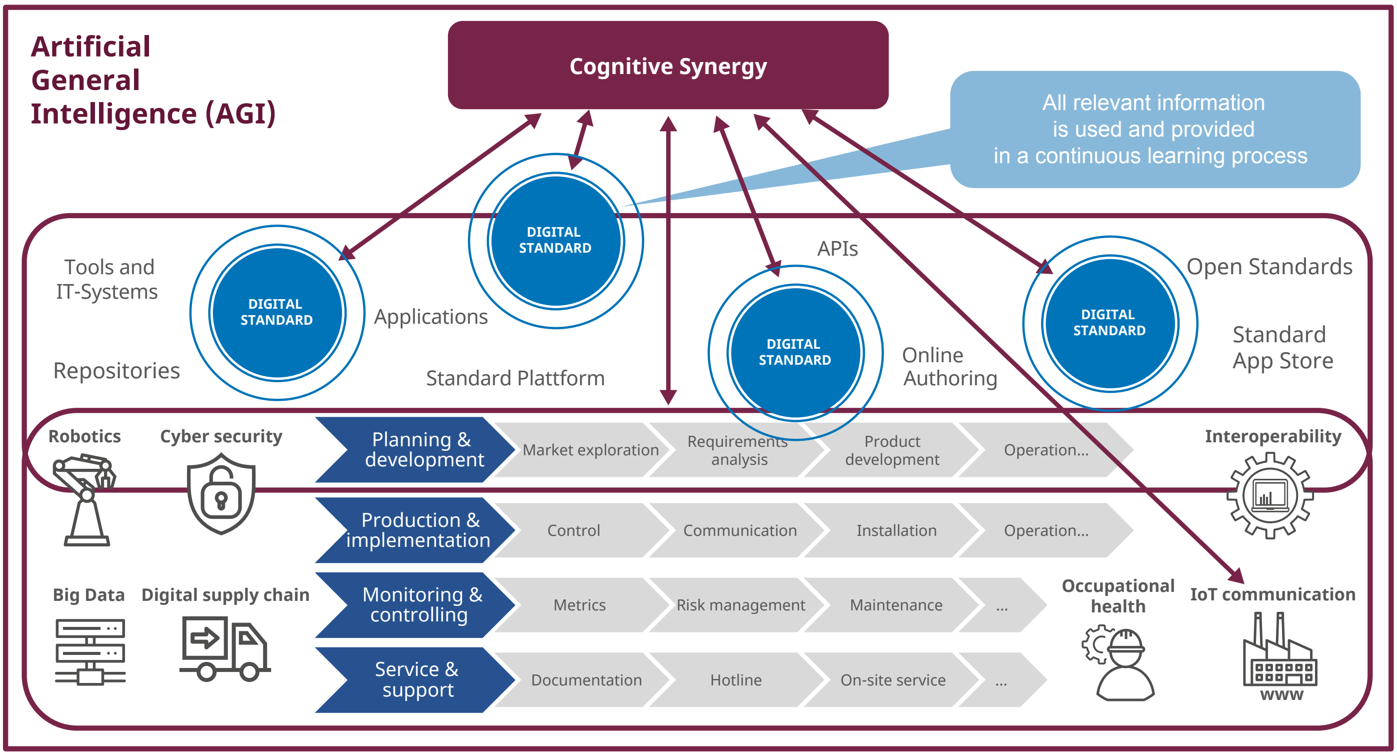


Fig. 7: Consolidated knowledge of AGI

The AI systems use both current and historical data and information and are learning all the time. Among others, the following sources can be used to generate knowledge:

- → Data from installed machines and production lines
- → Ambient data (room climate, weather, ...)
- → Databases
- → Social networks
- → Any unstructured data (including documents with texts and figures (laws, regulations, ...))
- → Dialogue with experts, with the system using natural language processing to communicate and debate directly with the experts (e.g. on the basis of a future version of the Watson Project Debater /IBM-21/)

5.2 Content management

The cognitive synergy mentioned above has access to a distributed network of differing knowledge. This requires content management to link the knowledge in a meta representation, for example as a semantic (neural) network that builds up a semantic memory in the course of time. It contains links to external knowledge or how to obtain knowledge with external methods.

At the moment, the actual content is described using a meta data architecture that distinguishes several abstraction levels. According to the Meta Object Facility Specification /OMG-16/, the meta data architecture of UML 2.0 for instance consists of the four levels:

→ M0 level (user object): the lowest level records and manages data about specific objects and their characteristics.
→ M1 level (user model): on the second level, the data are described as models, for example physical or logical data or process models, or specific forms of UML or object models that define the data of the lowest level.
→ M2 level (UML): the third level contains the meta models and defines the (general) structure of the models being used.
→ M3 level (MOF): the last level defines the M2 level with the means of the M3 level and thus concludes the meta levels.

5.3 Content delivery und usage

Both the content of Digital Standards and also related topics are provided using the instance of cognitive synergy. The content usage and delivery phases coincide. The main aspect of the artificial general intelligence scenario is that creating or changing a digital standard should, as far as possible, include all links to the relevant information, so that the digital standard represents the current state of knowledge, see Fig. 7.

In the case of systems engineering for example, this ensures that when a new technology is introduced, the corresponding standards include not only the technical aspects but also regulations regarding sustainability, social standards and profitability aspects.

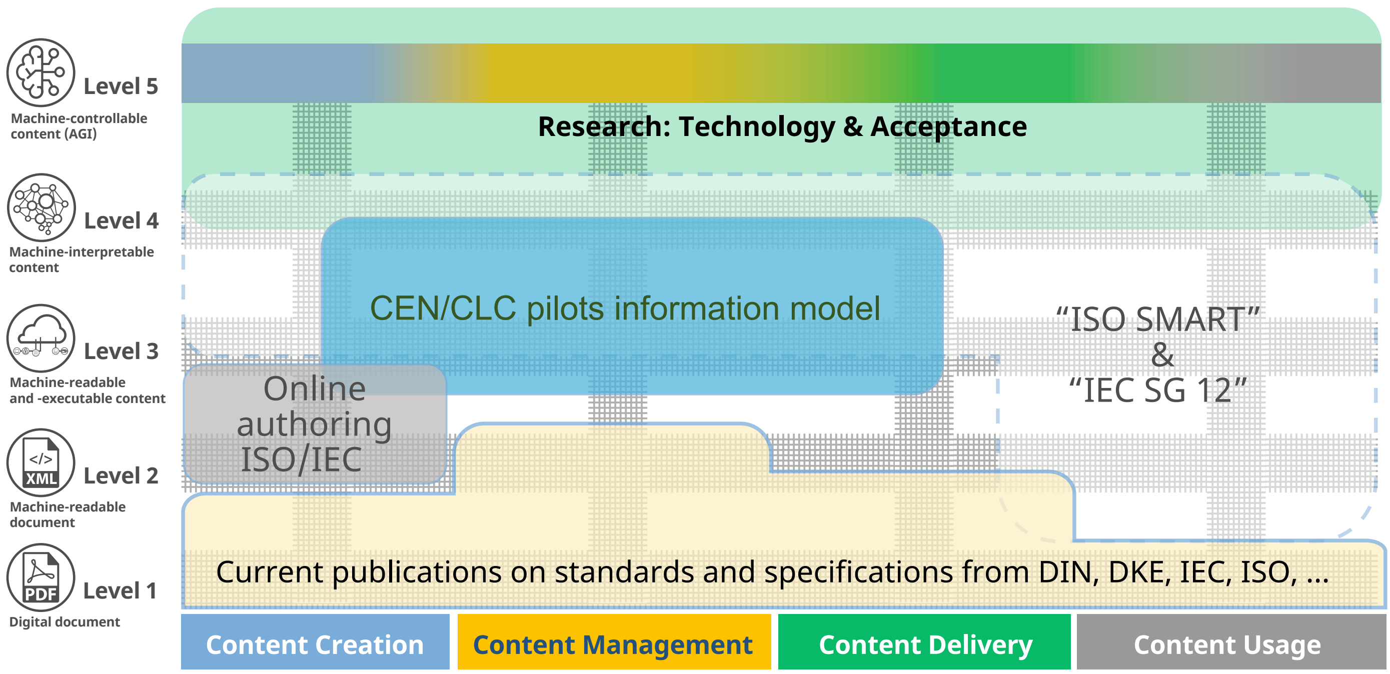
6 CONCLUSIONS AND OUTLOOK

The scenarios describe possible manifestations of Digital Standards and their autonomy. The current developments with digital documents mentioned in the scenarios, the corresponding meta data architectures and the continued strong growth in the capabilities of ICT provide the prerequisites for incremental further development of Digital Standards through to level 4. By contrast, level 5 brings a major departure from current standardization procedures and will depend to a great extent on future development and acceptance of artificial general intelligence.

In 10 years, it can be expected that all described scenarios occur with differing probabilities and for different use cases. To what extent the scenarios are then implemented depends on developments and value adding chains in the years to come.

The scenarios need to be described in the form of "change stories" for targeted management of these developments and the corresponding activities. A change story describes how a specific application area can reach the next utility level within the four individual value adding process phases. Besides technical aspects, this should also include economic, ecological and social factors, while also considering the question of establishing the necessary expertise in the respective players throughout the value adding process (cf. Fig. 1). A preferably complete evaluation then allows for an assessment of which solutions can be implemented and how probable it is that they will prevail. IDiS will be taking an intensive look at these questions in future in the context of drawing up a road map for Digital Standards.

Fig. 8: Positioning activities of existing and future solutions



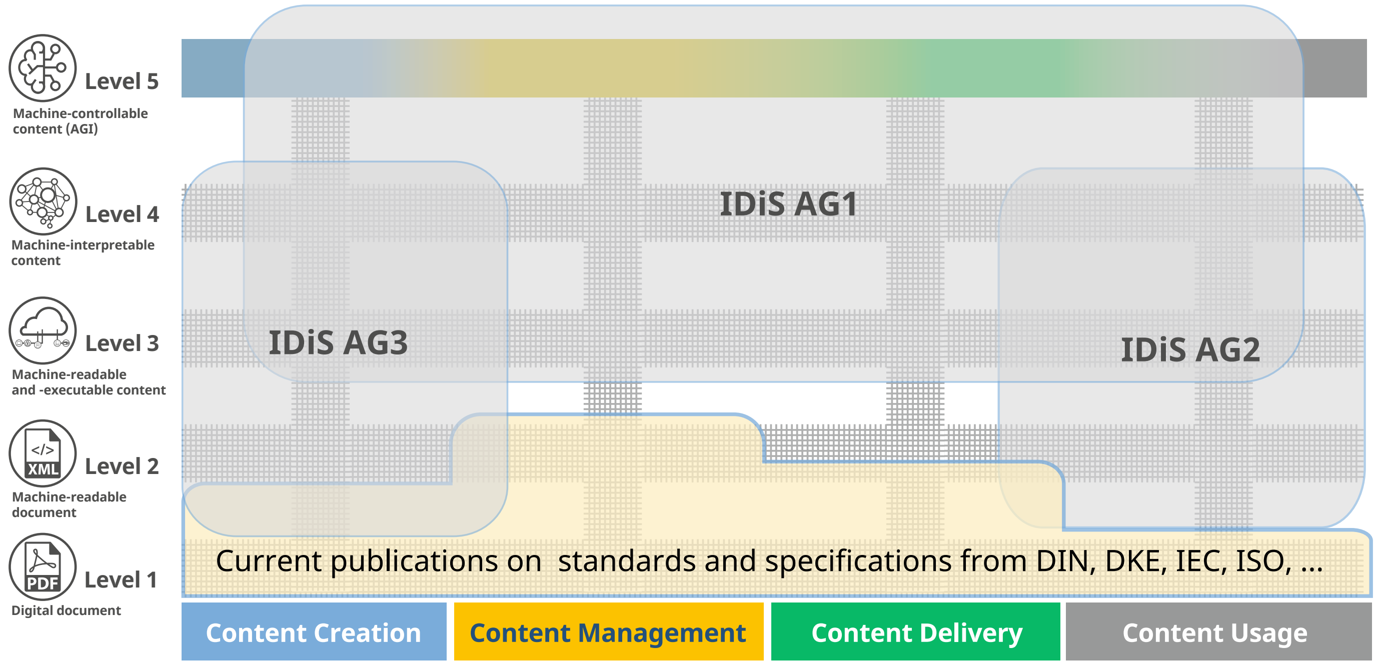


Fig. 9: Positioning of the IDiS working groups

The basic structure consisting of the x axis with the value adding process phases of standardization and the y axis with the utility levels is used to position the relevant activities together with existing and future solutions. Fig. 8 shows an example of such positioning for the creation, management and usage of currently published standards (as PDFs), the activities for developing an information model in ISO/IEC, and for CEN/CENELEC pilots in the context of an information model, as well as the necessary research in terms of technology and also corporate and social acceptance.

In addition to the actual standards and specifications, aspects such as functionality, communication, business and regulations in the context of standards and specifications are sure to be taken into consideration as well when positioning the activities. The reference architecture model Industry 4.0 (RAMI4.0 /DIN-16/) with its levels offers a good template.

There remains an urgent need for coordinated cooperation on a European and international level in view of the broad range of topics, the many possible ICT-assisted solutions and the fact that numerous different organizations, particularly standardization organizations and publishers as content providers, are working separately on Digital Standards all over the world.

On a national level, IDiS has taken up this task and is coordinating activities and collaboration on Digital Standards. There are currently three working groups. Working group 1 (AG1) takes a top-down approach and is looking at the vision for Digital Standards together with the journey involved in the sense of a road map, using the change stories mentioned above. Working group 2 (AG2) specifies mock-ups to illustrate the benefit of Digital Standards /CZW-20/. AG2 is thus pursuing a bottom-up approach, using practical tests and pilots to collect comprehensive experience of content usage, experience which is vitally necessary for further substantiation of use areas that have not been covered yet. Working group 3

(AG3) reflects the (international) activities on the topic and decides how relevant this work is for IDiS. AG3 is focusing on the positioning and coordination of external and internal activities. AG3 also acts as the first point of contact for national experts involved in the international activities. The activities of the IDiS working groups can also be positioned in the diagram, as shown in Fig. 9.

If in future Digital Standards are to be generated and managed by artificial general intelligence as described in scenario 5, acceptance of this by users and by society at large will rely on the degree to which they feel able to put their trust in the fact that this solution has proven to be beneficial to mankind. The impacts of AGI depend on the intentions behind the development. That makes it important to begin now already to shape this future with our European values of man-centered AI. Within the scope of its possibilities, IDiS will therefore also be looking at the role of AGI and its significance for standardization and try to describe the intentions and desired purpose and ensure that these are integrated in the development of AGI.

ANNEX A
DISTINCTIVE FEATURES OF THE SCENARIOS

Scenario	Level 2	Level 3	Level 4	Level 5
Level reached according to the utility model	Documents are machine-readable.	Documents are machine-readable and certain content can be used for implementation.	Content is machine-interpretable.	Machine-interpretable content supplemented with self-creating and optimizing aspects.
Preamble: In 10 years …	... there has been no essential change in standardization.	... some of the prop cesses involved in standardization have changed.	... there have been essential changes in standardization.	... standardization has changed fundamentally.
Standardization process	Consensus-based standardization still usual in industry.	As level 2.	User information is fed into the standard-ization process.	Human consensus-based and consortium standard processes are replaced by automat-ed decision-making processes. Collaborative standardization pro-cess established.
Significance of AI	AI is not involved.	AI is developed and used in the processes in companies. This also includes internal solutions that consider standards and spec-ifications in system engineering.	AI is not involved in the creation of standards. Expert knowledge comes from people and is further devel-oped by AI in the form of recommendations. Digital Standards act as input for AI for greater automation of system engineering processes.	KI plays the crucial role in the semantic description and creation of the (partial) models. Expert knowledge is presented by strong AI and goes through constant further devel-opment.

Scenario		Level 3	Level 4	Level 5
User usage and integration in corporate processes	Information about standards and specifications is read by the user and included in own development processes.	Information about standards and specifications is available in such a way that allows at least partially automated integration in own development and production processes (PEP).	Users and/or applications automatically integrate information about standards and specifications in own development and production processes (PEP), using the company 's own information for reconciliation.	Digital Standards are constantly changing (life cycle) and learning from the installed products and production systems that are adapting all the time, taking account of a developing decision-making body.
Granularity of standards information	Media disruptions still exist (no networked information), expert knowledge comes from humans alone, supported by intelligent information systems, also with granular standards information.	Granular information about standards and specifications emerges on the basis of an internationally coordinated information model. Standardization encompasses granular content whose life cycle has to be verified, but still coupled to the overall document.	Standardization encompasses granular content whose life cycle can be verified and managed separately from the overall document.	Digital Standards adapt constantly to the new knowledge acquired from the installed products, production systems and environmental influences as these change in the course of time. Individual functionalities or parameters can be standardized while at the same time integrating the total knowledge of the Digital Standards.

BIBLIOGRAPHY

/CZO-20/ Czarny, D.; Olsen, H. et al.: “Project 2 Standards of the Future - Pilot Petroleum sector”, Internal CCMC-Report February 2020

/CZS-19/ Czarny, D.; Salcedo, I. et al.: “Classification Scheme and Use Cases”, Internal IEC SG 12 Report July 2020

/CZW-20/ Czarny, D.; Wischhöfer, C.: „Aktuelles zum Thema SMART Standards – Die IDiS-Initiative“, in: DIN-Mitteilungen September 2020, Berlin, Beuth-Verlag 2020, p. 5-9

/DIN-16/ DIN SPEC 91345:2016-04: Referenzarchitekturmodell Industrie 4.0 (RAMI4.0), Berlin, Beuth-Verlag 2016

/DIN-20/ DIN 820-2:2020: Normungsarbeit - Teil 2: Gestaltung von Dokumenten, Berlin, Beuth-Verlag 2020

/DKI-20/ Wahlster, W.; Winterhalter Chr.: „Deutsche Normungsroadmap Künstliche Intelligenz“, DIN/DKE November 2020

/EKW-17/ Esser, M.; Koch, H.; Willuhn, H.: „Digitale Content-Dienstleistungen aus dem zentralen XML Content Repository - Zentrale Ablage von Inhalten und Trennung der Inhalte von ihrer Darstellungsform“, in: DIN-Mitteilungen Oktober 2017, Berlin, Beuth-Verlag 2017, p. 18-23

/GOE-01/ Goertzel, B.; Pennachin, C. (Eds.): “Artificial General Intelligence”, Berlin, Springer 2007

/GOE-14/ Ben Goertzel, C. P. (2014). Engineering General Inteligence, Part 1. Amsterdam — Paris — Beijing: Atlantis Press.

IBM Research. (18. 01 2021). Project Debater. At https://www.research.ibm.com/artificial-intelligence/project-debater/

OMG. (10 2016). ABOUT THE META OBJECT FACILITY SPECIFICATION VERSION 2.5.1. At https://www.omg.org/spec/MOF/2.5.1

/GZL-20/ Günzroth, N.; Zöllner, D.: „Neue Anforderungen an Norm-Content, Bedeutung für Content-as-a-Service (CaaS), praxisnahe Ansätze zur Entwicklung neuer Angebote, Unterstützung durch den Prozess SMART Standards“, in: DIN-Mitteilungen Dezember 2020, Berlin, Beuth-Verlag 2020, p. 9-13

/IBM-21/ IBM: „Project Debater“, at IBM Research, URL: https://www.research.ibm.com/artificial-intelligence/project-debater/ on 18.01.2021

/IDiS-21/ VDE e.V.: „IDiS - Initiative Digitale Standards“, at DKE, URL: https://www.dke.de/idis on 22.02.2021

/IEC-17/ IEC 61360-1:2017: Standards data element types with associated classification scheme – Part 1: Definitions – Principles

/ISO-04/ ISO/IEC Guide 2:2004: Standardization and related activities – General vocabulary

/ISO-05/ ISO/TR 17119:2005: Health informatics - Health informatics profiling framework, Clause 2.7

/ISO-18/ ISO/IEC Directives Part 2 - Principles and rules for the structure and drafting of ISO and IEC documents, Edition 8, 2018

/ISO-20/ ISO: “Online Standards Development for tomorrow”, at ISO, URL: https://www.iso.org/oca-0A1B2C-2 on 24.02.2021

/LMN-19/ Loibl, A.; Manoharan, T.; Nagarajah, A.: “Procedure for the transfer of standards into machine-actionability”, in: Bulletin of the JSME, 2019, Vol. 14, No. 2

/NAGLN-20/ DIN e.V.: „DIN-Normenausschuss Grundlagen der Normungsarbeit“, at DIN, URL: https://www.din.de/de/mitwirken/normenausschuesse/nagln on 14.01.2021

/NISO-17/ ANSI/NISO Z39 102-2017 - Standards Tag Suite (STS), Clause 8.1.8

/NISO-19/ National Information Standards Organization (NISO): “Standards-Specific Ontology Standard (SSOS)”, at NISO, URL: https://www.niso.org/press-releases/2019/02/niso-working-group-develop-standards-specific-ontology-standard-ssos on 05.02.2021

/OMG-16/ Object Management Group (OMG): “About the Meta Object Facility Specification Version 2.5.1.”, at OMG, URL:https://www.omg.org/spec/MOF/2.5.1, 2016, on 05.02.2021

/PLT-18/ Plattform Industrie 4.0.: „I4.0-Sprache: Vokabular, Nachrichtenstruktur und semantische Interaktionsprotokolle der I4.0-Sprache“, Berlin, Bundesministerium für Wirtschaft und Energie (BMWi) 2018

/PLT-20-1/ Plattform Industrie 4.0.: „Describing Capabilities of Industrie 4.0 Components“, Berlin, Bundesministerium für Wirtschaft und Energie (BMWi) 2020

/PLT-20-2/ Plattform Industrie 4.0.: „KI in der Industrie 4.0: Orientierung, Anwendungsbeispiele, Handlungsempfehlungen“, Berlin, Bundesministerium für Wirtschaft und Energie (BMWi) 2020

/RUH-20/ Rauh, P. et al.: “Project 2 Standards of the Future - Pilot Construction sector”, Internal CCMC-Report January 2020

/SCM-12/ Schacht, M.: „Erfolgsfaktor Normen-Management - Best Practice“, in: DIN-Mitteilungen April 2012, Berlin, Beuth-Verlag 2012, p. 27-33

/SCM-20/ Schacht, M.: „SMART Standards - Entwicklungsprozess und Contentstruktur“, in: DIN-Mitteilungen Juni 2020, Berlin, Beuth-Verlag 2020, p. 36-42

/SCW-14/ Schacht, M.; Wischhöfer, C.: „Nutzen semantischer Technologien in der Normung und Anwendung - Das Heben eines Wissensschatzes: Normen semantisch analysieren, Inhalte zielgerichtet extrahieren und in Folgeprozessen verwenden“, in: DIN-Mitteilungen Oktober 2014, Berlin, Beuth Verlag 2014, p. 6-11

/TAN-07/ Tannenbaum, A. S.; van Stehen, M.: „Verteilte Systeme“, 2. aktualisierte Auflage, München, Pearson Studium 2007

/WHR-19/ Wischhöfer, C.; Rauh, P.: „Standards of the Future - Stand der Arbeiten zum Thema maschinenausführbarer Normeninhalte“, in: DIN-Mitteilungen August 2019, Berlin, Beuth-Verlag, p. 4-8

/WTH-19/ Winterhalter, Chr.: „Die Rolle von Smart Standards bei der Anwendung von KI“, in: Auftaktveranstaltung „Normungsroadmap KI“, Bundesministerium für Wirtschaft und Energie (BMWi), October 2019

DIN

DKE

DIN e. V.

Burggrafenstraße 6
10787 Berlin
Germany
Phone: +49 30 2601-0
Email: presse@din.de
Website: www.din.de

DKE Deutsche Kommission Elektrotechnik
Elektronik Informationstechnik in DIN und VDE
Stresemannallee 15
60596 Frankfurt am Main
Germany
Phone: +49 69 6308-0
Fax: +49 69 08-9863
Email: standardisierung@vde.com
Website: www.dke.de

June 2021