DIN DKE

2022 PILOTS OF THE INITIATIVE DIGITAL STANDARDS (IDIS) – PRACTICAL USAGE OF SMART STANDARDS

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1 MANAGEMENT SUMMARY
Spotlight on the four IDiS pilots.

Following project periods between 12 and 18 months, four pilots of the Initiative Digital Standards (IDiS) were brought to a successful conclusion, with submission of the project results and interim statuses. Working on the basis of identical questions, the project participants were asked to give a retrospective indicating the findings and challenges in the pilots. The aim on the one hand is to introduce the chances and possibilities of digital standards to further stakeholders who are not directly involved in IDiS. On the other hand, experience gained with IDiS should also be shared with other partners and standardization organizations, such as those on the European level, where they have been made part of the backlog hosted by CEN/CENELEC that collects European application scenarios for digital standards and their assets.

The seven questions for the retrospective are as follows.

1. What was the starting point for the project/plot, who was involved, what was the motivation, which "pain points" arising from the application of standardization were to be addressed by the pilot project?
2. Which stakeholders were involved and when, which (different) stakeholder interests were put into words?
3. Which problems/challenges were to be overcome?
4. What were the learnings/findings/results of the pilot project?
5. Which requests are made of standardization, of collaboration with internal and external stakeholders, of technological prerequisites?
6. Which requests are made of the international standardization community, if any?
7. What happens now – is there a follow-up project??

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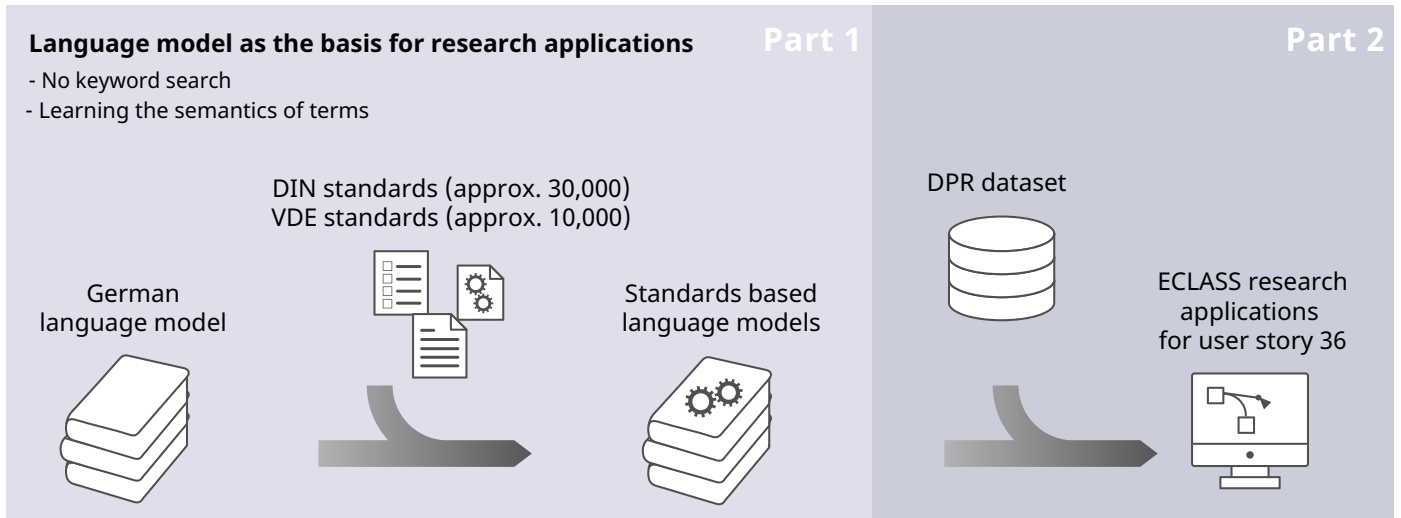# 2   PILOT: "STANDARDS BASED LANGUAGE MODEL"

Fig. 2.1: Pilot project: Standard based language model

1.   "People using standards spend a lot of time doing research before they can extract and use relevant information from standards.

 Research is made even more time consuming by the large number of potentially relevant standards.

 Significant improvements in language comprehension are generally based on modern methods used in artificial intelligence and concrete language models used in natural language processing.

 A language model trained on German standards should make the process of researching in standards much easier and faster."

2.   DIN and VDE/DKE were the stakeholders at the start of the project. Given that the model is based on German standards with the aim of accelerating the research process, DIN and VDE/DKE were particularly interested in the model.

 ECLASS was also involved as a further stakeholder."

3.   "Intensive discussions about legal framework conditions were necessary at the beginning. The technology behind language models is so new that there is still not adequate clarification as to what these can be used for. As a result, discussions were necessary about access rights to the trained model and standards.

 Computing the model requires high computational effort in the form of modern GPUs. Providing the necessary computational capacity was a problem during the project."

4.   The results of the pilot consisted in two separate language models trained on DIN standards or VDE standards.

 Moreover, the models were refined using a compiled dataset to demonstrate the use case for simplified research in standards (see Fig. 2.1).

 The results show that using the language model approach is a highly promising way of simplifying the research process in standards.

 At the same time, the compiled dataset requires considerable extension to make the use case more comprehensive."

5.   Over the next few years, standardization will deal increasingly with projects that have AI character.

 The hardware infrastructure will have to be improved to cope with such projects. At the moment, this is not yet available."

6.   "A model trained on international standards as well as German standards would move the use case from the German to the international sphere.

At the same time, it would be a good idea to have one multilingual model trained on a wide range of standards from different international standardization bodies, rather than different models covering individual areas.

The request made to the international community would therefore be to reach a joint decision about such a project."

7.   "For one thing, the results of the pilot should be integrated in another IDiS pilot (asset administration shell for standards).

This would entail creating a new use case to demonstrate the use of standards based language models.

Up to now, the model has been trained on German standards. A comprehensive model would need to be trained on international standards (ISO/IEC), thus considerably extending the capabilities of the model."
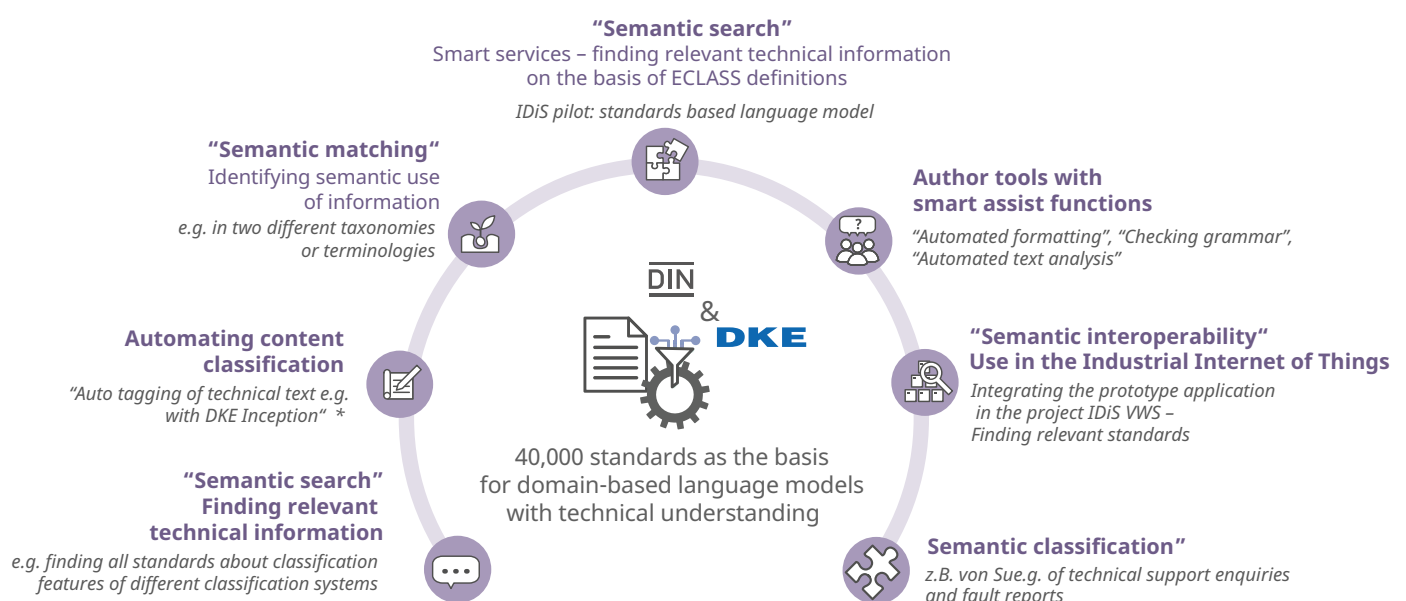
Technology
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Conclusion

There are altogether about 40,000 documents in the German standards collection consisting of DIN/DKE classified standards with a plethora of information that is simply beyond the scope of new/individual players. Testing a model based on natural language processing looked at whether information is easier to retrieve with a targeted structure of training data, particularly when the standards collection is being used to deal with specific questions (see Fig. 2.2).

The pilot produced positive results. It was recommended to extend and continuously improve the models based on the standards contents of both organizations in addition to multilingual language extension, with the aim of obtaining results that are identical and, as far as possible, consistent and non-conflicting across all languages.

"Semantic search"
Smart services – finding relevant technical information on the basis of ECLASS definitions

IDiS pilot: standards based language model

"Semantic matching"
Identifying semantic use of information
e.g. in two different taxonomies or terminologies

Author tools with smart assist functions

"Automated formatting", "Checking grammar", "Automated text analysis"

Automating content classification

*"Auto tagging of technical text e.g. with DKE Inception" ***

DIN & DKE

"Semantic interoperability"
Use in the Industrial Internet of Things

Integrating the prototype application in the project IDiS VWS – Finding relevant standards

"Semantic search"
Finding relevant technical information

e.g. finding all standards about classification features of different classification systems

40,000 standards as the basis for domain-based language models with technical understanding

Semantic classification"

z.B. von Sue.g. of technical support enquiries and fault reports

Fig. 2.2: Evaluating the domain models
* DKE annotation tool for identifying and classifying standards content with AI support.

3   PILOT: "SMART STANDARDS BASED ON FACTORY STANDARDIZATION & REQUIREMENTS ENGINEERING"

Content Creation	Content Management	Content Delivery	Content Usage
Factory standardization — Standardization process for smart standards		Factory standardization — Standardization process for smart standards	
standardization	**hosting repository**	**Content-as-a-Service**	**Use of standards content**

Content creation (& management)

Demonstrator:
· Emulating first factory standards in NISO-ST
· Developing a tool chain for subsequent productive operation

In the longer term:
· Compiling the factory standards in NISO-STS, embedded in the tool landscape and processes at Schaeffler

Content Usage

Demonstrator:
· Further developing the import process for public standards and factory standards for requirements engineering and enhancing efficiency.

In the longer term:
· Automated import of the requirements from factory standards and public standards where available as ReqIF.
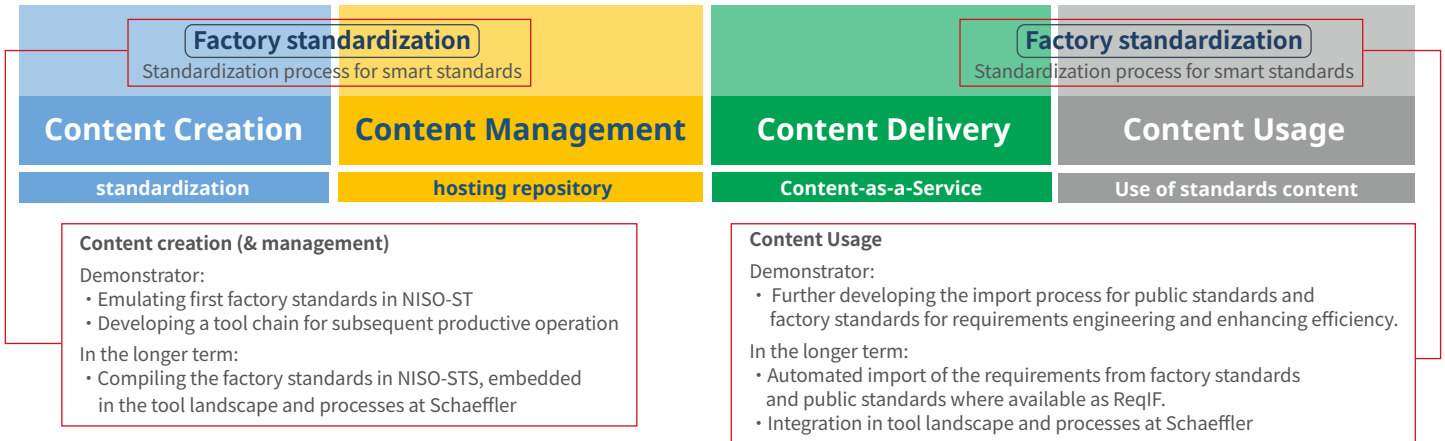· Integration in tool landscape and processes at Schaeffler

Fig. 3.1: Aims in the context of the smart standards process models

1. "Up to now, public standards are only available in the PDF format. The requirements are not semantically identified in the content. For use in a Requirements Management Tool (RMT) on content level, a separate tool has to be used for laborious analysis or breakdown of the content.

    Aims of the demonstrator (see Fig. 3.1):
    ■ Greater automation of the import process for public standards and factory standards in RMT, with greater efficiency for requirements engineering.
    ■ Improving the quality of imported content through semantic enrichment, additional attributes and finer granularity
      - Emulating first factory standards in NISO-STS
      - Developing a tool chain for subsequent productive operation.
      Beteiligte: Schaeffler Technologies AG & Co. KG, DIN"

2. "The most important stakeholders are the requirements engineers, whose task is to evaluate all requirements relevant for product development. Other stakeholders are the units responsible for the corresponding IT tools.
       In addition to extensively concurring interests such as improving speed and efficiency, it became clear that the content quality of requirements ascertainment and provision plays a central role for requirements management.

    "Errors cannot be tolerated in requirements management, given that every single requirement can be crucial to the success of a product, while disregarding just one requirement can have serious consequences."

3. "The challenges were of a technical kind, for example:
    ■ Adapting the ReqIF file in terms of quality and formal aspects at the start of the project to facilitate import in the first place
    ■ Reconciling the attributes provided in the ReqIF file with the attributes in the RMT
    ■ Correct visualization of the imported content in the RMT (e.g. figures, tables, formulas)"

4. "It was possible to demonstrate tool chain functionality (see Fig. 3.2) for both public standards and also Schaeffler factory standards. The NISO-STS documents were converted using a tool developed by DIN that also integrated Schaeffler's requirements.
       The tools and processes need further optimization, e.g. the RMT at Schaeffler or the DIN converter. This can only be done in joint consultation."

5. "Public standards should always be made available as ReqIF as well as PDF. In the course of ongoing digitalization of all development processes, this should become

the rule rather than the exception in every case. Otherwise there is a risk that standardization will get left behind by progressive development.

Similarly, legislation should also be made available in the ReqIF format. In future, harmonized rules should be available for digital standards and integrated in the editor tools."

6. "All standards everywhere in the world should be compiled in the NISO-STS format, using the Standard Information Model (SIM) currently being developed by IEC as the basis for the future.

Requirements should already be granular, precise and clear in their wording when standards are being compiled. Proven sentence templates already exist that can be integrated in modern XML editor tools as part of the author assist features."

7. "The pilot is being continued as a project at Schaeffler dealing with requirements, in collaboration with DIN. The aim is for the process and tool to be developed so that productive operation can begin. Furthermore, a new IDiS pilot is currently being prepared for further harmonization of the ReqIF format."
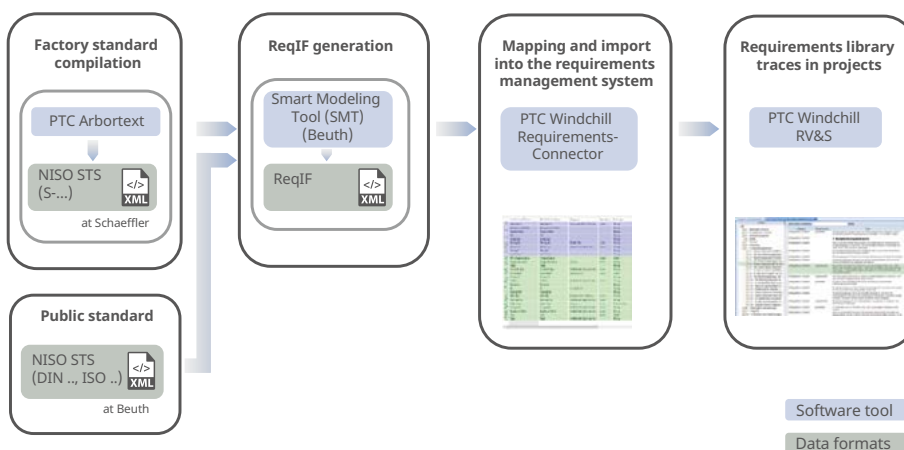
SCHAEFFLER

Conclusion

Holistic digital mapping of a company' s value chain is a necessary component on the way to efficient, faultless processes. This pilot project examined requirements engineering as an essential part of the value chain with the aim of dismantling current barriers. The findings are quite clear in terms of

1. National and international standardized data models
2. Uniform formats and interfaces for supplying or receiving systems, and
3. Seamless tracing of exchanged information.

A homogeneous service landscape in the background is conducive for the named aspects, but is not crucial.
Further successful work on these three aspects can make the digital transformation much easier and faster.
By contrast, if these aspects diverge and become increasingly heterogeneous, this will lead to higher friction losses and necessitate greater adjustments.

Fig. 3.2: Process and tool chain

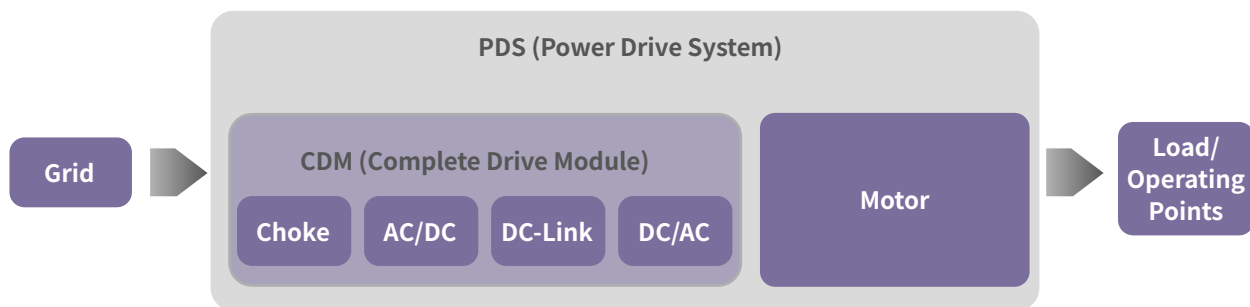# 4   PILOT: "CONFORMITY ASSESSMENT"

Fig. 4.1: Simulation based conformity assessment

1. "The pilot aimed to indicate current challenges and possibilities when using digital standards. Furthermore, the project idea (see Fig. 4.1) also intended to illustrate how this approach could be applied to other standards and also to other environments thanks to the machine-readable data."

2. "There were several project partners: SMEs such as Block Transformatoren, KSB, ZES-Zimmer and Bosch (as "sponsor"), DIN/DKE and PE-Systems as initiator. The digital standard is still "far, far away" for many project participants. Normal work procedures use standards in hard copy/PDF. Feedback from the participants was very positive. The second phase of the pilot (measurement-based conformity assessment) showed how a combination of smart standards (knowledge source), software (tool) and hardware (development object) facilitates targeted, automated completion of all work steps. "

3. "Implementing the pilot revealed a gap between wanting to work with a digital standard on the one hand, and what is actually possible at the moment on the other. However, the pilot demonstrated many of the advantages of smart standards, even if complete technical provision was not possible yet".

4. "The demonstrators in this pilot showed that it is possible to export tables, formulas and texts from the standard,

but this still entails a considerable manual workload in post-processing the digital standard. Human interpretation of the contents is necessary in particular where texts are concerned. Demonstrators such as those used in this pilot illustrate the advantages of digital standards, and could play an intermediate role in the transition to digital standards. However, fundamental adaptation is necessary to the structure of standards to allow tools automatic access the necessary information. The next steps to increase the degree of automation would consist in automatic population of the symbols used in the formulas, as well as development of a corresponding code generator. Interpreting standards remains complex and will probably have to be solved by addressing the compilation process and the basic notation used in a standard. Additional use cases are already resulting from semi-automated solutions, including for example when digital standards that are used in all applications are updated from a central point. Data collected from using the standard can also be fed back to the standardization bodies where standards are then reviewed for gaps or obsolete content."

5. "The results obtained from pilots such as these should be submitted to the standardization bodies for further discussions. The results should already start being implemented in standards where possible at this point in time.

Conclusion

·Pe·Systems

Using standards is a crucial step in developing new products. The work involved usually consists of tedious individual manual steps. The necessary information has to be found in the corresponding standard (in PDF format), then extracted and transferred to other systems before it can be used. Simulations, calculations or measurements are then compared with the requirements of the underlying standard.
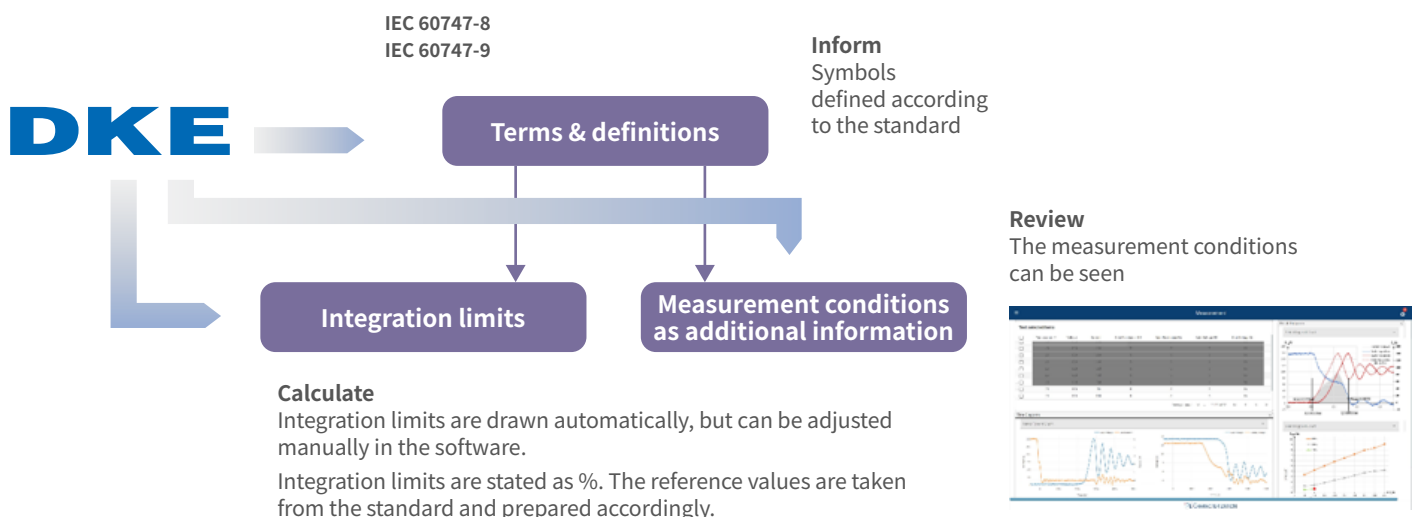
The concepts and results developed in the project should form the basis for possible automation in this field: minimizing the manual workload and reducing possible error transmissions should clearly enhance quality and efficiency while creating documentable verification at the same time.

Various prerequisites are necessary to warrant such a degree of automated standard application in product development:

- Soft- and hardware tools for measurement and documentation must be coupled to a smart standards interface
- Smart standards must be tailored to the needs of user systems; as far as possible, this should be taken into account already during standard compilation in the form of annotations and uniform formats
- The digital process chain for the standard must begin already with standard compilation (XML first) so that content modeling is standardized.

6. "The results and subsequent developments (e.g. from a follow-up project) can be incorporated at IEC (e.g. in the standardization bodies that compile the standard for power semiconductors used in the project)".

7. "There are no plans for a direct follow-up project, but the results from the project flow into the development of systems for the provision of digital standards at DIN and DKE, and into necessary change processes for standard compilation at ISO and IEC. "

Fig. 4.2: Measurement-based conformity assessment

IEC 60747-8
IEC 60747-9

DKE

Terms & definitions

Inform
Symbols defined according to the standard

Integration limits

Measurement conditions as additional information

Review
The measurement conditions can be seen

Calculate
Integration limits are drawn automatically, but can be adjusted manually in the software.

Integration limits are stated as %. The reference values are taken from the standard and prepared accordingly.

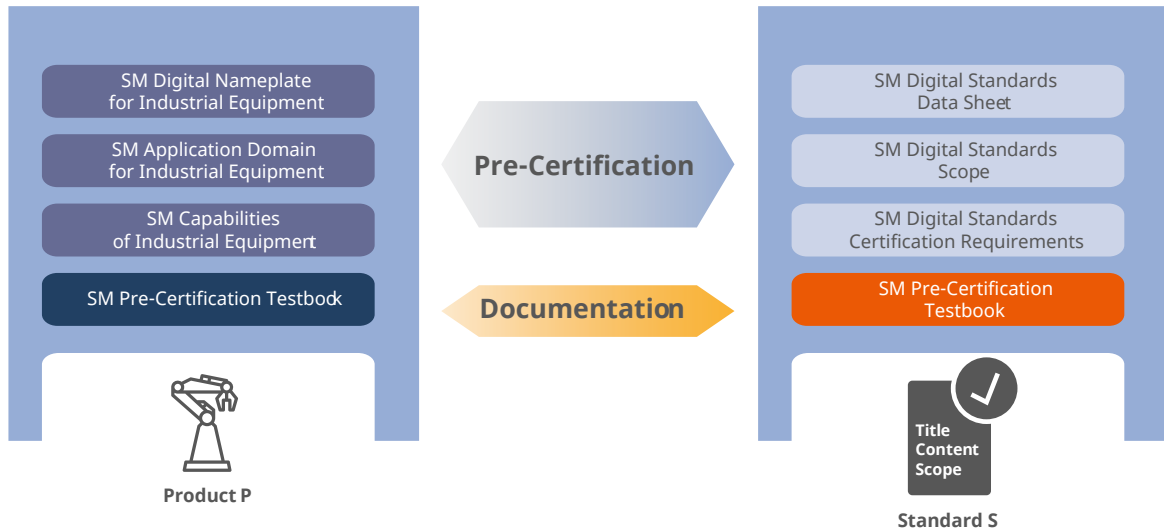# 5 PILOT: "STANDARD INTEGRATION IN THE ASSET ADMINISTRATION SHELL"

Fig. 5.1: I4.0 Pre-certification: "At time Z and development status E, product P fulfils the requirements of standard S to X percent."

1. "In the IDiS pilot "Standard integration in the asset administration shell" (standard AAS), smart standards are equipped with asset administration shells (Industry 4.0 (I4.0) compliant digital twins). Smart standards can then be integrated as Industry 4.0 components – i.e. smart standard + asset administration shell (AAS) – in Industry 4.0 eco systems.

   Expected benefits:
   - Integration and semantic enrichment of standard content on the document and content level in the asset administration shell
   - Direct retrievability of relevant standard content and fragments from the asset administration shell
   - Automatic matching of product capabilities and standard requirements
   - Feedback of application knowledge to a standard management portal to be assessed and possibly adopted by the standard compiler"

2. "The Industry 4.0 and digital twin experts of Fraunhofer IOSB-INA and the iiRDS experts of Parson AG achieved the main results in consultation with a pilot consortium consisting of Phoenix Contact GmbH & Co. KG, wordbsign, WAGO Kontakttechnik GmbH & Co. KG and DIN German Institute for Standardization and VDE German Association for Electrical, Electronic & Information Technologies / DKE German Commission for Electrical, Electronic & Information Technologies"

3. "The pilot Standard AAS tests how standard content and particularly relevant standard fragments can be integrated in the asset administration shell of a standard to simplify testing and certification processes, for example. Pre-certification services are thus capable of matching the product capabilities and requirements of the standard to the corresponding asset administration shells, ascertaining to what extent a developed product can already be certified according to a standard, and which requirements still have to be fulfilled by further product development."

4. The key results were as follows:
   - Specification of a pipeline to transfer standards/specifications from the DIN or DKE databases into asset administration shells via the interim format iiRDS
   - Establishment of a standards domain in iiRDS
     - A standards domain in iiRDS has been applied for and an initial modeling proposal submitted
   - Specification of a demonstration "I4.0 Standards Determination Service" (see Fig. 5.1) to illustrate the significance of I4.0 specifications/standards:
     - Suitable standards/specifications for certification are ascertained for products undergoing development
     - Suitability matching is based on the asset administration shells executed in an I4.0 eco system of the standards/specifications and the products being certified
   - Spezifikation Specification of a first version of the sub-model "Digital Standards Data Sheet" (see Fig. 5.2) with interoperable integration of information on the document level of a standard/specification: final standardization then takes place in the eponymous InterOpera project."

5. "Basically, the first part of the pilot showed that smart standards in the current stage of development do not yet provide sufficient information and meta information for automatic generation of asset administration shells that satisfy the minimum requirements of an automated pre-certification service, for example.

   Such a service would match product capabilities and standard requirements on the basis of the asset administration shells of a product and a standard, producing for example the following result: "At time Z and development status E, product P fulfils the requirements of standard S to X percent. The following requirements are not yet fulfilled ".

Part 2 of the pilot ascertains the existing gaps to be closed, with feedback into the smart standard development process."

„Die in Teil 2 des Piloten ermittelten und zu schließenden Gaps werden in die nationale und internationale Normungscommunity eingebracht."

6. "The gaps ascertained in part 2 of the pilot that need to be closed are reported to the national and international standardization community."

7. "Working on the basis of the results from part 1, the aims of part 2 of the pilot consist in
   - Implementing a demonstration for "I4.0 pre-certification":
     - Matching product capabilities and standard requirements on the basis of the respective asset administration shells

     Result of pre-certification: "At time Z and development status E, product P fulfils the requirements of standard S to X percent. The following requirements are not yet fulfilled …"
   - Documentation of existing gaps to be closed in the smart standards
     - Feedback into the smart standard development process for automatic generation of standards asset administration shells in the meantime, together with real implementation of "I4.0 pre-certification"

Conclusion

Industry 4.0 (I4.0) aims to achieve smart, autonomous networking of assets in industry using information and communications technology. The asset administration shell (AAS) is a concept for I4.0 compliant implementation of digital twins. The digital twin of an asset improves, among others, cross-lifecycle documentation and interoperability. Assets include e.g. components, machines or systems for which standards (also assets) or parts thereof are used for documentation or certification.

Up to now, a wide range of administration systems (also proprietary and incompatible systems) are available for different types of assets, depending on the specific organization or even department. By specifying an AAS version of the digital standard or digital standard contents, smart standards pave their way into I4.0 eco systems, thus ensuring interoperability with partners in the value network and simplifying standard-based processes such as product certification.

The compilation of sub-models that describe a digital standard could be automatically integrated in processes exporting standards to warrant interoperability in the I4.0 application.
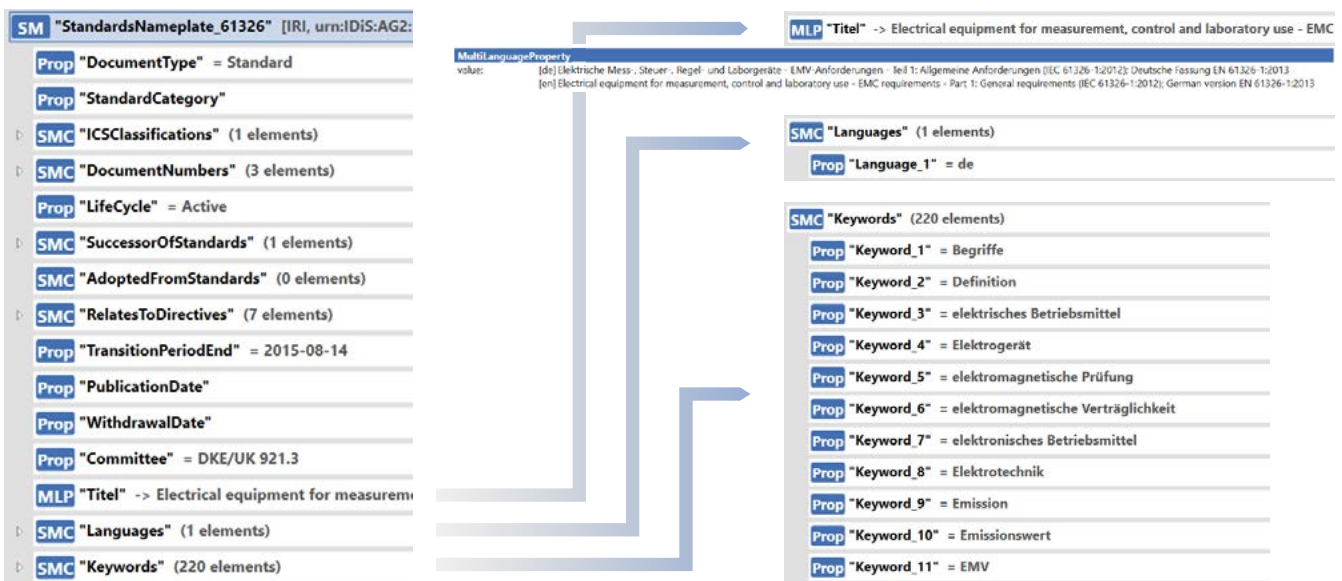

Fig. 5.2: Template standards nameplate instantiated for DIN EN IEC 61326-1 (VDE 0843-20-1)

6 CONCLUSION: JOINT, HOLISTIC VALUE CREATION FROM STANDARD COMPILATION THROUGH TO MANUFACTURING THE PRODUCT IN INDUSTRY

Radical change is necessary in the way standards are compiled. A standard that is created today now supports industry not just in technical terms but must also be available in a format that is compatible with the requirements made of further information processing in company workflows and procedures. Standard content must be granular and machine-readable, as well as fulfilling all requirements made by standard users in terms of information procurement, processing and exchange. Smart standards demand harmonization among standardization organizations by means of standardized formats (as intended in the planned IDiS pilot to harmonize ReqIF for standard content), processes and interfaces in transparent collaboration.
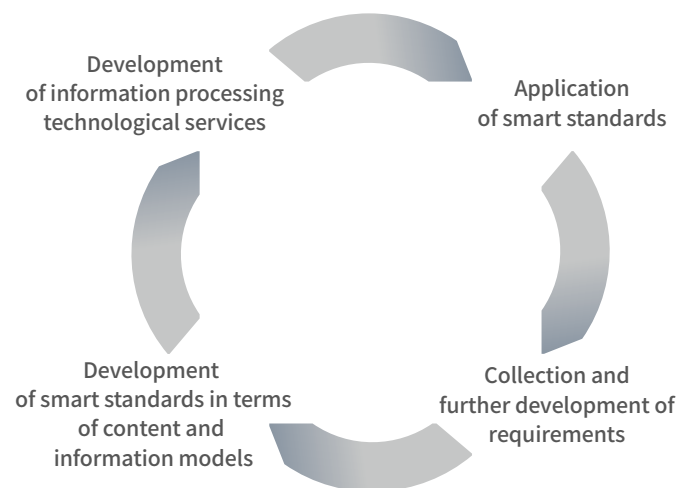
COMPANIES MUST PLAY A MORE ACTIVE ROLE:
Companies supply the technical expertise for the standard contents. At the same time, they are the users involved in processing the contents now and in future. Already while the standard is being compiled, equal attention must be given to how the standard is used, besides the technical content. The digital standard must be used in practice by the companies for verification of information models so that the requirements of all those involved in the value chain are depicted in the specification of a uniform format, as well as safeguarding continuous improvement of the smart standard.
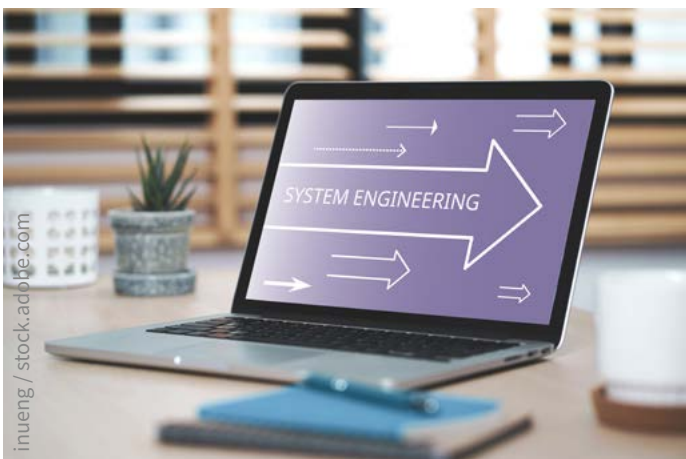
STANDARDIZATION ORGANIZATIONS AND COMPANIES MUST FORM A SYMBIOTIC RELATIONSHIP.
The development of efficient data management depends on performant systems being implemented by both standardization organizations AND companies. Future-oriented system landscapes create necessary development partnerships between standardization organizations and companies, resulting in constant sharing as equals about the development, funding and roll-out of smart standards.

Development of information processing technological services

Application of smart standards

Collection and further development of requirements

Development of smart standards in terms of content and information models

In the context of interdisciplinary cooperation, companies and standardization organizations implement a cycle that works on the basis of mutual learning and active involvement in the existing initiatives such as the IDiS, etc. Companies and standardization organizations create profitable added value in every single step, with smart standards as the key.

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