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DIGITAL SCHEMAX AND THE FUTURE OF THE DIGITAL CALIBRATION CERTIFICATE

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Abstract – The Digital Calibration Certificate (DCC) is an endeavour spearheaded by the *Physikalisch-Technische Bundesanstalt* (PTB) to digitalise the creation of calibration certificates, which is currently analogue (paper based). This paper outlines some new developments of the DCC and describes future planned developments. We present the new Digital SchemaX (DX), which has been developed for DCC version 4. Second, an Envelope Digital Certificate (EDC) has been prepared to collect different calibration items that belong together. Third, a planned new schema for Digital Reference Materials (DRM) is briefly introduced. Fourth, a planned schema for Digital Test Certificates (DTC), which are based on test reports is described.

Keywords: Digital Calibration Certificate (DCC), Digital SchemaX (DX), Digital Reference Materials (DRM), Digital Test Certificate (DTC), Envelope Digital Certificate (EDC), Digital SI (D-SI)

1. INTRODUCTION

Calibration certificates have a special place in metrology and industry. They contain important data, including but not limited to calibration data (depending on the field: temperature, mass, humidity, etc.). Unfortunately, as of today calibration certificates are still on paper. This makes the reusability of this data hard and prone to mistakes. The Digital Calibration Certificate (DCC) [1] is an endeavour headed by the PTB to digitalise calibration certificates, i.e. issue them in digital form. XML is the chosen format for the DCC. An XML-Schema has been published by the PTB [2].

This paper describes selected ongoing developments of and new tools devised for the DCC. At the moment, there are four versions of the DCC XML-Schema that are publicly available (version 3.0.0 [3], version 3.1.0 [4], version 3.1.1 [5] and version 3.1.2 [2]). More information about the differences between these version can be found in this paper [6]. The version 3x (all versions from version 3.0.0 until version 4.0.0.) will be available for the long term. There will be only minor changes and fixes in the future updates of version 3x. All the versions that come after the version 3.0.0 are and will be upwards compatible with the version 3.0.0.

Calibration certificates are crucial for the world of metrology. However, they are not the only relevant certificates that are still paper based. Among the paper-based certificates are the certificate of analysis for reference materials and test certificates (test reports). These certificates share some aspects with calibration certificates, but also contain unique information. Making use of the know-how generated in the development of the DCC, we see new opportunities and synergies for the digitalization of such analogue certificates. In addition to presenting these suggested approaches, the paper also explains the development of a new schema, which we call Digital SchemaX (DX), and which will be described in-depth below. DX will be the basis of DCC version 4 and of other digital certificates that are currently under development.

2. DIGITAL SCHEMAX (DX)

Until now (versions 2.x and 3.x), the DCC depended on a standalone schema (dcc.xsd). This means that almost every complex or simple type is defined in this schema. That leads to a very big schema for the DCC [7]. The DCC schema has a root element and a tree-like structure. Only a couple of elements, which are used for representing measured values, come from the Digital SI (D-SI) [8]. D-SI also defines an XML schema. However, unlike the DCC schema, D-SI has no tree structure and consequently no root element. Therefore, the D-SI schema cannot be used for generating and validating XML files. It consists of simple and complex types, which can be imported, and elements, which can be referenced. Thus, one doesn't have to define these types and elements themselves. This helps with simplification, modularization, and reusability of schemas. Fig. 1 depicts the usage of D-SI.

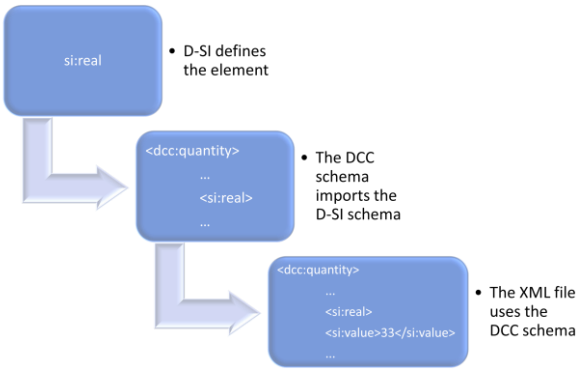

Fig. 1. D-SI usage in DCC

The DCC aims to digitalise calibration certificates. But why not digitalise the whole calibration process? The calibration process consists of three parts. First, the company, which has an item to be calibrated, sends a calibration request to a calibration laboratory. Second, the calibration laboratory calibrates the item and produces a calibration certificate. Finally, the calibration laboratory sends a calibration answer, which includes among other information the calibration certificate. If we have standards for the calibration request and answer documents, we can digitise the whole calibration process. In the course of the development of the DCC, we saw that many elements and types can be useful for these certificates, for instance, contact information or location. Hence, we decided to build another schema using the elements of the DCC schema. This schema does not have a root element and a tree like structure, just as the D-SI schema. It only contains the building blocks for other schemas. It enables importing the schema and then to use its elements in a modular way. This schema is called Digital SchemaX (DX). DX can be best understood as a toolbox. One can take any tool (i.e., schema element) that one needs and build a new schema for a specific purpose. Therefore, it is well-suited to be used for other documents issued in the calibration process.

Although the DCC-schema version 3.x will be available for a long time, there will be a version 4.0.0 of the schema with major changes within the next year.

This schema will be based on the DX-schema. With the changes, the DCC-schema version 4.0 will become very lightweight and easy to read. The elements, which are defined in the DCC-schema, have ‘dcc’ as namespace. The elements, that are imported from the DX-schema, have ‘dx’ as namespace. Fig 2. shows a possible ‘administrativeData’ element as an example.

3. HOW TO USE DX-SCHEMA

The DX-schema consists of simple and complex types in addition to some elements of the DCC-schema. Whenever the DCC-schema gets an update, the DX-schema is also updated. Moreover, it is already in use in some of our solutions. The PTB prepares a Proof of Concept (PoC) with the industry partners of the GEMIMEG-II project [9]. For the PoC, two digital certificates are currently developed: Digital Calibration Request (DCR) and Digital Calibration Answer (DCA) which both use the DX-schema. Together with the DCC, DCR and DCA will be used to digitalise the entire calibration process.

Other solutions exist that have either been developed or are currently in development. One of them is the ‘Envelope Digital Certificate’ (EDC) that is used for bundling more than one digital certificate in one document. A beta version of the envelope has already been developed. Another solution that is still in development is for Reference Materials: Digital Reference Material (DRM). The last one, which is also in development, is for Test Reports: Digital Test Certificate (DTC). In the following we will describe the three solutions in detail.

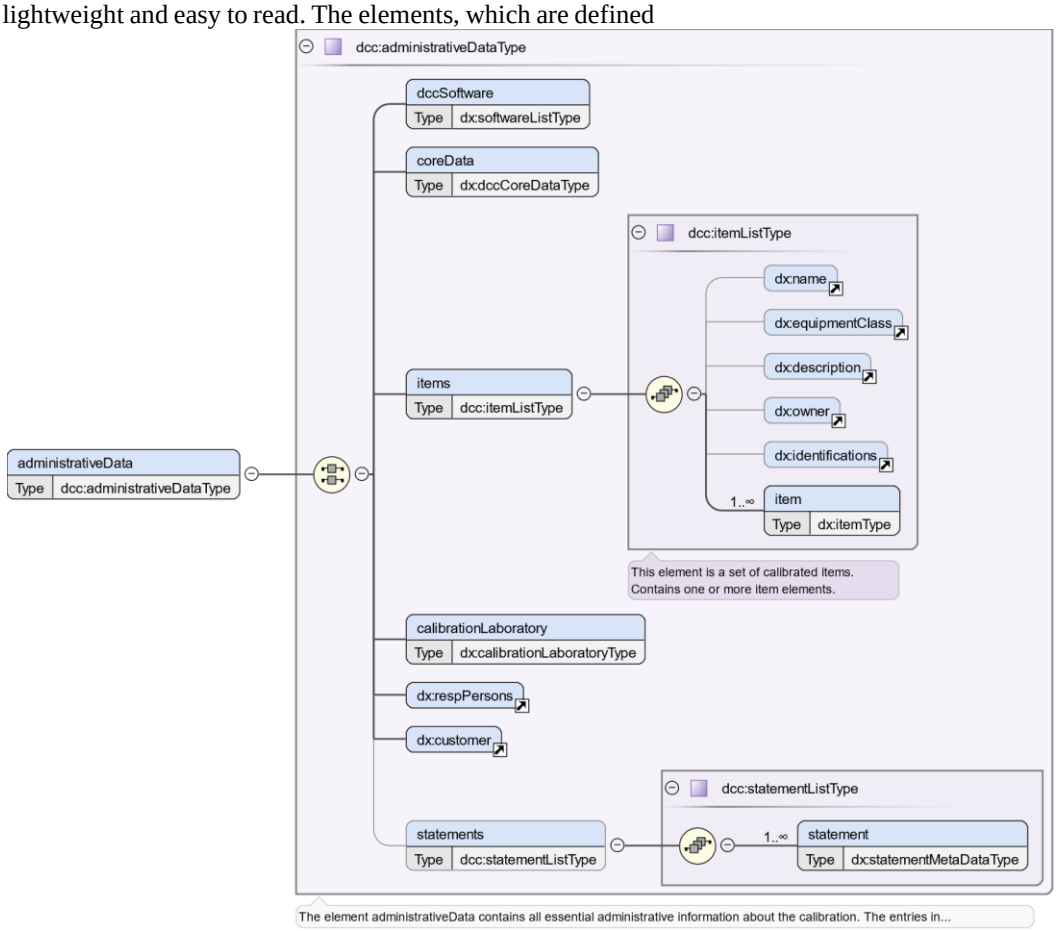

Fig. 2 The ‘administrativeData’ element of DCC version 4.0.0

3.1. Envelope Digital Certificate (EDC)

In some areas, it is possible that several items, which are to be calibrated separately, belong together. This is the case for instance for mass sets and gage blocks. In others, the item consists of several parts, which are calibrated separately, such as multimeter. These items or parts of them are calibrated individually. When all the data from these different calibrations is used to generate one calibration certificate, that leads to a rather complicated certificate and can cause misunderstandings and possible problems. For this reason, it is best to generate an individual DCC after every calibration. In that way, every single calibration item has its own calibration certificate. DCCs are modular and easy to understand. Creating a separate DCC for each item will optimize the calibration process. To provide an example, the different parts in a mass set can have different frequency of use during their lifetime. This means that they will have different recalibration intervals. In such a case, one has to calibrate only one item and generate a new DCC for just this item and generate a new envelope with the other DCCs of other items.

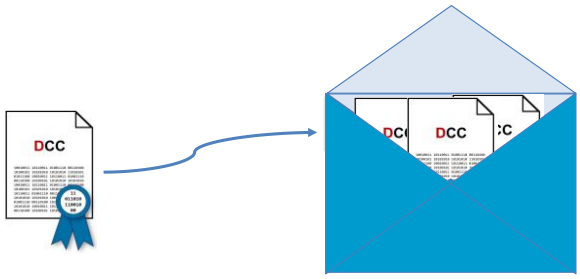

Fig. 3. The idea of the envelope

The PTB has developed a schema for such an envelope (Fig. 3) to bundle several certificates in one document. It has a similar structure as the DCC and uses many elements from the DX schema. Fig. 4 shows the main elements of the envelope.

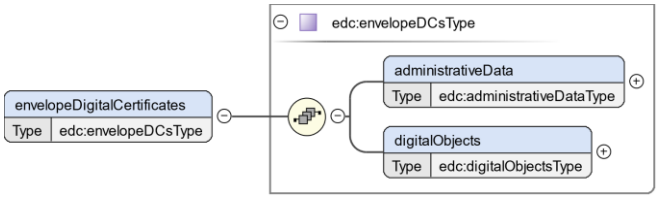

Fig. 4. The main elements of the envelope

The ‘administrativeData’ element contains similar data as in the DCC, such as used language code, country code, the contact information of the responsible person, the information about the institution that generates the envelope and about the customer.

The envelope concept is not just suitable for the DCC. It can be used for any digital certificate. The information about the certificate is found under the element ‘digitalObjects’. The ‘digitalObjects’ has many elements, such as description, owner, identification. It can have zero to endless ‘digitalElement’, which contains specific information about the certificate, that is in the envelope, and contains the certificate itself. Fig. 5 shows the child elements of the element ‘digitalElement’.

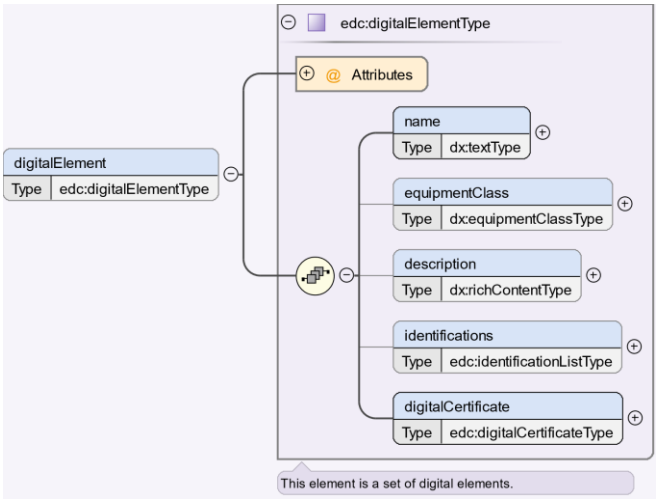

Fig. 5. The element ‘digitalElement’

The certificate itself is found under the element ‘digitalCertificate’. Fig. 6 shows the child elements of this element.

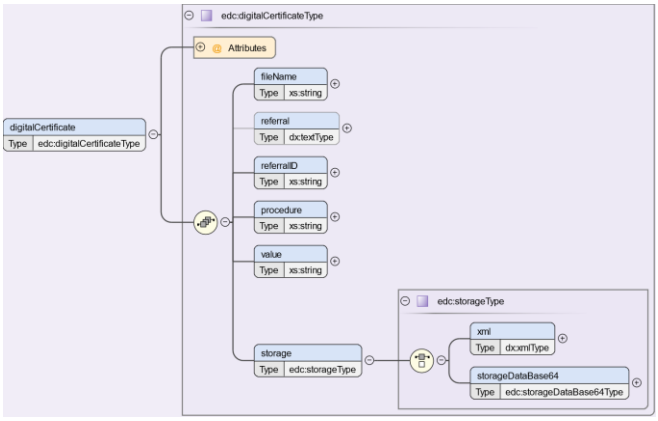

Fig. 6. The element ’digitalCertificate’

As can be seen in Fig. , the digital certificate can be stored in two ways. It can be added as an XML code block, or in base64 form. There is one thing to notice when the data is stored as XML code. If the XML file has the declaration line at the beginning of the file, that produces an error. The reason for this is that in XML files, the declaration line can be found only at the beginning (and not in other places). Hence, it must be commented, or deleted. However, one has to be careful not to disrupt the digital signature if the certificate is signed. As can be seen in the figures, some elements of the envelope have ‘edc’ as namespace, and others ‘dx’. The elements, which come from the DX schema, have the ‘dx’ namespace and the elements, that are defined in the envelope schema, have the ‘edc’ namespace, which is the namespace of the envelope schema.

3.2. Digital Reference Materials (DRM)

In some areas, such as medicine, the calibration process involves the use of reference materials. These are samples, the composition of which is known and is described by an

associated certificate. The production process of reference materials is defined in detail in ISO 17034 [10]. For these reference materials, there exist certificates of analysis. These certificates are in some ways similar to calibration certificates. However, they are not the same. In general, it is possible to define properties such as stability and homogeneity, which are important to reference materials [11], through the DCC. Still, given the specificity and importance of such concepts for reference materials, we see the need to develop a special schema for reference materials. This schema is very well suited to be based on the DX schema and therefore this approach will be followed in the development of DRM.

3.3. Digital Test Certificate (DTC)

Another important certificate, which is defined by ISO/IEC 17025, is the test report (test certificate) [12]. Test reports share some features with calibration certificates, such as title or unique identification. However, both have also some purpose-specific features. For instance, test reports contain information on test conditions and, if necessary, opinions and interpretations. Information on measurement uncertainty is not mandatory and is only required under certain circumstances, whereas it is mandatory for calibration certificates.

Just like calibration certificates, today these test reports are also analogue and based on paper. The PTB is currently developing a Digital Test Certificate (DTC), a specific schema for the test reports, which is also going to be based on the DX schema.

4. CONCLUSIONS

To summarise the main ideas presented above, it can be stated that the development process of the schema for Digital Calibration Certificates has clearly shown that a modularisation of schema elements will be beneficial for the next major version release. This led to the creation of the Digital SchemaX, the DX, that will form the basis of the DCC schema version 4.0. It is already actively used for creating the Envelope Digital Certificates, EDC.

Moreover, the DX enables the efficient development of related certificates such as Digital Reference Material, DRM and Digital Test Certificate, DTC.

Further work in this area will concentrate on optimising the DX in constant discussion with its users, project partners and stakeholders and shaping it towards the identified requirements. In particular, the development of the above mentioned PoC within the GEMIMEG-II project will serve as a valuable use case for this. As well, the DRM and DTC need to be discussed and defined in more detail so that the schemas meet the users' needs.

Have a look at https://www.ptb.de/dcc for more information and feel free to contribute to the project.

ACKNOWLEDGMENTS

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