**Title:** How Metrology Institutes can start working with DCCs without any prior knowledge

**What we need**

Two Examples for temperature

* XML example PTB
* PDFA3 including XML example PTB (or including DAVID‘s JSON)

Expertise

* Peter, how to create PDF DCC
  + Overview and explanation from Jonas/Jakob
* Using expertise from PTB Web Page
* For information on signature we can refer to guideline from Task 2.2

**Structure of Guideline**

how to create a DCC,

the necessary data that should be included,

what IT infrastructure is needed

How to deal with the IT tools for handling the DCC - How to ensure data traceability.

step by step instructions for a complete workflow (i.e. from start to end) for DCC implementation.

**Next Steps**

* Project meeting 6th Feb to discuss issues, etc.
* Have first „full“ version by 10th February
* Until 20th February comments by others.
* Final update until end February and upload to DCC2GO web page

Peter back 6 Feb

David away 13-17 Feb

1. Introduction (0.5 pages, David [Look at Annex 1)

2. Two handson examples

2.1 XML DCC (1- max of 2 pages, PTB)

* Structure and format of the DCC type
* advantages and disadvantageous
* Tools for getting familiar and start working with the DCC type
* Where to find further information about the DCC type & temperature examples

2.2 PDF A3 DCC (1- max of 2 pages, Peter)

### 2.2.1 Introduction and advantages

One of the steps towards machine readable DCCs which are used by many calibration laboratories, is the use of PDF/A for transferring the data from the calibration laboratory to the costumer.

There are numerous advantages in using PDFs rather than paper certificates and other digital formats.

The PDF/A is an ISO standard, developed with the purpose of being archiveable. This gives a certainty, that the documents will still be valid within any foreseeable future, regardless of developments in digital infrastructure and formats.

The PDF/A can be digitally signed. This can be used to ensure, that the document received by the costumer is identical to the one created by the calibration laboratory.

The PDF/A3 (third version of PDF/A) can contain attached files. This has the potential of facilitating further developments for the calibration laboratories within the field of DCCs, as extra data can be attached to the PDF-document. As such, an XML-DCC can be created as described in section 2.1. This XML-DCC can be used for machine readability and full automation of implementation of calibration results at the consumer site. At the same time, the same calibration data can be used for creating the PDF certificate, which are human-readable.

As can be seen from the above, the PDF/A can not in itself work as a machine readable DCC, but it can facilitate as a digitally signed container for the DCC, while also having the function of presenting the data in a human readable format.

The structure of distributing calibration data in two parallel methods, both the PDF and the attached DCC must be verified, as it must be verified, that data from the two sources is identical. This, however, can be considered to be regulated within ISO 17025, and should not pose a problem to the calibration laboratory.

### 2.2.2 Tools for creating PDF/A

As PDF/A is an ISO-standard, many tools exist for creating the format from various sources. It is possible to create PDF/A from excel-sheets and word-files, scanned from paper, or build using LaTeX.

Assuming that an XML-DCC has already been produced, a PDF/A containing the identical information as the XML will be straight forward to create, populating a TeX-template with the relevant data from the XML followed by running the LaTeX interpreter. The original XML-document can be attached to the PDF/A-certificate in the process, as described by METAS [METAS].

If instead, the calibration data is already saved in a database, both the XML and the TeX source file can be populated directly from here, ensuring the data source is identical for the two documents.

Once the PDF/A containing the XML (or other DCC-format) is produced, the document can be signed and shipped, and any tampering with either the PDF-file or the attached XML-file can be identified.

Populating the XML and TeX-file can be performed using any scripting language, capable of reading XML-data or by other means extracting data from such files.

3. Steps taken by DFM, DTI, PTB (workflow, 2-3 pages)

* **Nearer term implementation of DCCs (1 year, the frist year) - [max 1 page, start with list of „headline“ followed by short paragraphs explaining each headline, PTB]**
  + Start writing down measurement data created at calibration in digital formats
  + Identify calibration services that would most benefit from introducing DCCs, for example there is a need from customers, or a harmonized DCC format is already available (and hence would be a good starting point for implementations) in your organization, e.g. need from external customers, digital data already available, high numbers of certificates, large datasets and benefit for automization.
  + Trying out various formats - trying to find out which formats suitable for start (Starter Kit, and examples in 2.1 / 2.2)
  + Create initial (internal) pilot group with management, calibration, and IT experts as well as pilot laboratory to implement first DCCs.
  + Pilot group working to establish the first DCC example (exploring ways how to create a DCC file for an exisitng calibration service, what tools to use, discussion how to store the data, how to sign the certificate, how to send it to the customer,
  + Having first events / workshops with externals (customers, accreditation, etc.) to inform about DCCs and to identify need for DCCs and timescales considered by stakeholders for DCC usage.
* **Medium term implementation of DCCs (1-2 years)** **- [max 1 page, David]**
  + Develop and implement concept how to archive DCCs for the time your organization needs to keep a record (e.g., with proper backup systems), this could also include considerations to track a history of instruments for internal purpose, this may for example comprise your organization introducing e-file systems or other long therm data bases.
  + Develop and implement processes and tools for cryptographically protecting the DCCs (electronic signatures, verification of correctness of data, protection from manipulation of data, etc.)
  + Update policies of company to allow DCCs to be issued to customers (where relevant), e.g., considering EA guideline, national accreditation guidelines, etc.
  + Update Quality Management (QM) guidelines/documentation of your organization to taking account of the DCCs.
  + Pilot laboratory developping DCC creation to a stable part of its calibration service
    - Pilot project where a customer is receiving a DCC from your company and using it
  + Other laboratories start piloting DCCs
  + Management developping roadmap for wider introduction of DCCs in organization (as part of its calibration services)
  + Starting first internal trainings and knowledge transfere as well as traings / workshops with stakeholders (customers, national accreditation, etc.)
  + Get involved in communities dealing with harmonization of DCCs relevant for your laboratory
* **Longer term implementation of DCCs and automation in the laboratory - [max 1 page, Peter Ø.]**

Once the initial phases of implementing the DCC have been carried out, maintaining and developing the existing DCCs to other areas of calibration becomes a next step.

There are multiple aspects of the DCC, which needs to be maintained by a team in order to constantly provide the newest version of the available DCC schema, and to ensure, that old DCCs are still accessible and readable according the the FAIR-principle.

One of the most vital elements of long term implementation of DCCs is the proper archiving of DCCs. The archiving must follow the rules laid out in ISO 17025, meaning it must be archived for at least XX years. During this period, it will also be a good idea to keep track on which DCCs follow which schema and keep software capable of interpreting the DCCs, in case costumers request this. Although costumer interpretation of the DCC is not the responsibility of the DCC, it is still good practice to ensure this possibility.

An option for doing this is to archive the DCCs and the required software in a nonSQL, where there is a link between the DCCs and the relevant software.

Using a proper archiving system/structure will furthermore make it easy to remove DCCs which are obsolete, when they have exceeded the archiving requirements stated in ISO 17025.

Ensuring the correct link between the DCC and the software can either be ensured by adding the software details in the DCC or as an attribute in the database.

Keeping up with new versions of DCC schema is also a requirement in the long run implementation of DCCs. Most probably, the majority of the schema-updates are minor and will not affect the implementation at the specific laboratories, but not being able to deliver the DCC which supports the newest schema can be a deal-breaker for some costumers. Hence ensuring that the local implementation of the DCC schema is in place is practically a necessity.

Similarly, it can easily become a requirement for certain costumers to request a DCC following a specific schema version. This backwards compatibility must be considered when updating the tool for creating ones DCCs.

The above requirements are mainly of a maintenance character. In parallel to these, expansion of DCCs to other laboratories should be performed with the goal of implementing DCCs at a global level in the organization.

When implementing the DCCs in to new areas, it must be identified, where the new areas overlap with the existing areas, where DCCs have already been implemented. This way the work carried out can be transferred to the new areas, thereby reducing the ressources required to get it up and running here.

An example of this can be expanding DCCs from a temperature lab to a flow lab. In the flow lab, it is also necessary to measure the temperature of the medium, and this can be transferred directly from the temperature lab’s implementation of the DCC. New aspects, specific to the flow lab, can then be implemented on top of this.

Furthermore, this requires efforts in how to handle different units. Even in a single lab, such as temperature, the units from a DUT can come either as °C, Kelvin, mV (thermocouples), or Ω

(Pt-100, NTC etc.)

Along with implementing DCCs in the different laboratories also comes an increased advantage in automation of the calibration procedure and reading of instruments, including reading of the device under test.

Automation of the laboratories and automatic reading of the instruments will assist in improving the collection of the valuable meta-data from the calibration, such as specific environmental data, timestamps etc. Eg. automatic capturing images of the displays of the devices under test and archiving these along with the DCC helps in documenting calibration methods/procedures during accreditations.

Automation of the calibration setup and data handling will also assist in the next step after DCC, namely Digital Calibration Requests, where the calibration can be set up to run as requested by the costumer.

* + Develop customer portal, that automates delivery of DCCs and requests for calibration (DCR).
  + API/mail and secure data transfer to correct persons only
  + Check between DCR and DCC (are all requiested calibration points included in the DCC).
  + Check the XLS schema
  + Revisions of certificates.
  + Establishing routine maintenace of tools and proceeses for creating, storing, and using DCCs
    - Keeping up with advancements of formats and concepts in national, Regional, International DCC communities relevant for your laboratories.
  + Ensure correct version control of both DCC and software used for creating/reading/interpreting
  + XML-DCC has field for identifying which software was used for creating the DCC
  + Possibility of rolling back to previous version of DCC
  + Costumer should be able to request DCC in a specific version
  + New version: Feed to send out update, when new version of DCC is specified
  + Crew for updating/maintaining the XML/DCC based on the newest specifications
  + Adopting DCCs in all laboratories, where it is appropriate, especially where harmonized DCCs are available would streamline a relyable data exchange to users and from DCC creators.
  + uniquenes on units used in different labs, i.e. differentiation between namespaces
  + Find where laboratories are identical and where they are unique/different. Reuse where possible, invent/create where necessary
  + Identify different types of calibration in each laboratory. What is identical between the different calibrations, and where do they differentiate. How to handle different units (dew point, %rh, ..., Kelvin, Ohm, Celcius). Potentially based on an DCR
  + Make cost analysis on the different laboratories/calibration setups to see, if DCCs make sense
  + Advance DCC storage to longer term archiving and readability (ensuring, software to read DCC data is still avialable & working) where needed.
  + DCC storage and Software storage, where DCC is linked to the software, including backup
  + 17025 controls how long the DCC should be archived. Automatic processes for deleting DCCs which are older than this.
  + Development of higher (fully) automated calibration processes in your lab, where measurement devices and data are linked to DCCs
  + Control of meta-data. DUT with display reading requires images of the display, specific software for data from DUTs
  + Automatic data handling including automatic uncertainty management of reference equipment.

References

[METAS]: https://github.com/metas-ch/metas-ecertificate