XXI IMEKO World Congress "Measurement in Research and Industry"
August 30 – September 4, 2015, Prague, Czech Republic

ELECTRONIC CALIBRATION CERTIFICATE

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Abstract – The use of electronic calibration certificates provides a number of advantages. In NSC "Institute of Metrology" (Ukraine) development of electronic system for creation and storage of electronic calibration certificates was started. Also java applet program was developed for the purpose of creation of electronic calibration certificate in PDF with following electronic digital signature. The structure and contents of the certificate are fully compliant with COOMET Recommendation R/GM/15:2007.

Keywords: CIPM MRA, COOMET, electronic calibration certificate.

1. THE ELECTRONIC DOCUMENT MANAGEMENT

In recent years, due to the rapid development of computer technology, the use of various electronic documents management (EDM) systems is a crucial task. According to Delphi Consulting Group, the scope of corporate electronic (text) information doubles every 3 years [1].

Many countries have adopted laws on the gradual transition to the use of electronic documents instead of paper ones. Thus, for example:

- in August 2012 in the United States by the Office of Management and Budget of Presidential Administration in cooperation with National Archives and Records Administration the order [2] was published on the state records management, according to which all federal agencies will manage all permanent electronic records in electronic format by December 31, 2019;

- in the European Union the exchange of electronic invoices (e-invoicing) has been working for over than 7 years. Since the introduction of EDM each EC country annually saves billions of euros.

Today the development of EDM is a global challenge. Many states are involved into development of a common policy of transition from paper documentation to an electronic one. One of the results of this activity is the program eUnion, which has integrated EU countries, candidate countries to the EU and members of the European Free Trade Area. The program started in 2009, after the adoption of the European Declaration on Electronic Government and an action plan for e-Government creation in Europe.

Since 2013 Ukraine has the Law "On Electronic Documents and Electronic Documents Management" [5], wherein EDM is defined as the accumulation of the processes related to making, processing, sending, transfer, receipt, storage, use and elimination of electronic documents, which are performed applying integrity verification and, if required, contain with confirmation of the fact of receipt of such documents.

2. BENEFITS OF EDM

The use of electronic documents circulation provides a number of advantages. Among them are following:

- *reduction in material costs*: significantly less resources are spent on the storage of an electronic document than on its paper version;

- *speed-up of access to documentation*: any employee of the company who has the right of access, can quickly find documentation necessary for him/her using various attributes without leaving his/her workplace;

- *prevention of loss or spoiling of documents*, including force-majeure circumstances;

- *increase in employee productivity*: number of routine operations reduces, time is saved and working environment is improved, the human-factor errors are excluded;

- *simultaneous work with documents*: automation of documents circulation allows several users to work with the same file, which is not possible for paper documentation;

- *access restriction to documents*: each user of the system sees only the documents to which he/she has access.

3. ELECTRONIC DIGITAL SIGNATURE

To validate an electronic document the Electronic Digital Signature (EDS) is used, which enables:

- to control the integrity of the transmitted document and to ensure secure data transmission;

- to protect the document from unauthorized changes;

- to make repudiation impossible.

The document is signed with EDS by personal ("private") EDS key, which exists in a single copy only for his owner. This private key corresponds to the public key with which you can check whether the document was changed after signing.

The legislative basis of the electronic documents circulation in Ukraine is the Law "On Electronic Digital Signature" [6], which states that "Electronic signature is a mandatory requisite of the electronic document, which is used for identification of

the author and/or signatory of electronic document. The validity of the electronic document shall not be denied exclusively due to its electronic form".

4. ELECTRONIC CALIBRATION CERTIFICATES

One of the forms of metrological activity is calibration of measuring instruments, an operation that, under specified conditions, in the first step, establishes a relation between the quantity values with the measurement uncertainties provided by measurement standards and corresponding indications with associated measurement uncertainties and, in the second step, uses this information to establish a relation for obtaining of a measurement result from an indication [7].

4.1. Evolution from paper format to paperless one

Together with the implementation of electronic documents circulation, in organizations performing calibration the implementation of electronic calibration certificates takes place.

The issues of their creation and evolution from paper format to paperless one, and then also to its machine readable true electronic form are actively discussed at international metrological conferences. At the annual conference on development of measuring instruments, which is held in the USA (Measurement Science Conference, Long Beach, California), a number of reports and meetings were addressed to the standardization and automation of calibration systems [8].

ISO/IEC 17025 "General requirements to the competence of testing and calibration laboratories" [9] includes the minimum requirements to testing and calibration documentation. However, despite the existence of this document, in practice a large space for creativity appears at creation of the certificate template. The certificates designed to meet the requirements of these standards may vary significantly. It causes a range of problems with certificate maintenance, creates confusion and may cause errors. Some companies create their own intra-company standard forms of certificates, which are used for all types of calibration works.

4.2. Documenting of the results of calibration of measuring instruments

According to The Law of Ukraine "On Metrology and Metrological Activity" [10], calibration is applied to measuring instruments. The certificate is issued according to the results of the calibration. This is the document certifying the fact and results of calibration of measuring instruments, which is issued by the organization performing the calibration.

To render methodological help in development of the calibration certificate corresponding to ISO/IEC 17025 [9] in Euro-Asian cooperation of State Metrology Institutions there was developed and approved the COOMET Recommendation R/GM/15:2007 "The rules of completion of the form of calibration certificates issued by National Metrology Institutes within the scope of the CIPM MRA" [11].

This Recommendation establishes the form and the rules of filling-in the calibration certificates issued by the National Metrology Institutes (NMI), which have signed "Mutual recognition of national measurement standards and of calibration and measurement certificates issued by national metrology institutes" (CIPM MRA), at calibration of measurement standards and measuring instruments (hereinafter calibration objects) for vendors including those from other countries. The form of the calibration certificate template is given in the Recommendation, as even at similar text contents, the elements assembly in the draft certificate can significantly vary.

The Recommendation [11] was developed by one of the authors of this paper. Since Ukraine is a member of COOMET [12], in NSC "Institute of Metrology" there was implemented the Recommendation [11] and the issued certificates are in compliance with this Recommendation.

As NSC "Institute of Metrology" has the experience in development of the paper document template, we set the task to ourselves to develop the electronic form of this certificate in order to realise the paperless document circulation.

The developed electronic form has the option to keep all data of the certificate in XML format, that allows using both finite data of the calibration and any intermediate data or data of the chain of previous calibrations and, thus, to make obvious the traceability from the national standard to the end measuring instrument.

4.3. Electronic Calibration Certificates of the NSC "Institute of Metrology"

In NSC "Institute of Metrology", the work on development of the electronic system for creation and storage of electronic calibration certificates was carried out, including the program that was developed as a java-applet running in a browser, the purpose of which is creation of the electronic calibration certificate with the future possibility of signing the obtained PDF-file with EDS. The certificate created by the program fully complies with the requirements of COOMET Recommendation R/GM/15: 2007.

The private key used to sign the certificate complies with PKCS #12 [13]. The public key is stored in the signed document and is available using the standard features of Adobe Reader.

The main program window is shown in Fig. 1 and contains three tabs:

1. The first tab contains fields for entering text data of the certificate. All the information necessary to create the certificate is entered here, except tabular data with the results of the uncertainty.

2. The second tab is designed to fill the table with the results of calibration. The table can be filled-in manually or imported from a Microsoft Excel file.

3. The third tab is used to sign the certificate file created with the help of this program. To sign the certificate it is necessary to have a private key in PKCS #12 format, to know the key name ("alias"), its password and have a PDF-file of the certificate, which is to be signed.

The electronic calibration certificate is signed twice: by the person who has carried out the calibration and by the

person who approves this certificate, and after that it becomes valid. The recommended calibration interval and, correspondingly, the certificate retention period shall be established so that the definite or controlled metrological characteristics are maintained during this time period. At the expiry of the validity period, the appropriate message will be displayed at the top of the document when opening the certificate in Adobe Reader.

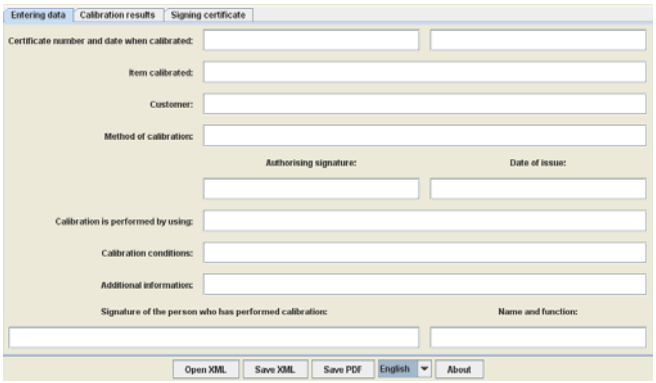

Fig. 1. Look and fill-in of the main program window.

When running the program there is an option to save the certificate text data entered into the program in XML format at any stage of filling-in the certificate data and to close the program, and then to open the saved document and to continue working on filling-in the certificate.

This program is available to authorized employees and is the part of the internal network of NSC "Institute of Metrology". All the valid and archival electronic certificates will be stored within the time allotted by the law similarly to paper certificates after making of the decision about implementation of electronic certificates into document circulation.

5. EVOLUTION OF CALIBRATION CERTIFICATE

The electronic documents are not something unusual and are used widely. Currently, the electronic certificate is gradually replacing the paper one, but in most cases it is a complete analogue of the paper certificate only in electronic form. People are still forced to handle certificate data manually up to the present time. In the article [14] it is suggested to "improve" the electronic calibration certificate so that the information contained in the document would be logically structured and available for processing by special software. After such certificates implementation the software will be able itself (automatically):

– to read and to store the certificates transmitted directly from the vendor;

– to check the vendor's accreditation, administration content, dates and identification numbers;

– to check the results of measurements, uncertainties, specifications related to requirements of the laboratory and vendor's scope of accreditation;

– to inform the customer about any nonconformities;

– to detect the uncertainty value and to provide notifications of any access violations.

Such electronic "smart" calibration certificate can help to solve another problem: the certificate presently contains the calibration result of the current calibration object, but the "way" from the national measurement standard remains unknown, i.e. the traceability chain is unavailable. But if we embed into the PDF certificate the file that will "accumulate" and unambiguously identify all relevant sources of the uncertainty arising during the calibration of measuring instruments at all "levels" of the traceability chain, starting from the national standard, then, in addition to tables with current calibration results of this object, the certificate will contain the file with the calibration results of all the traceability chain elements.

It is necessary to work out the electronic calibration certificate developed by NSC "Institute of Metrology" in future; in order the software to handle calibration certificates automatically. For this purpose a uniform template format of the certificate and a single storage format for these specifications data are required. Strictly speaking, the certificate template and the storage format of additional calibration data need not be single, but they all have to be standardized, that leads to an increase in the amount of work that shall be done and to the emergence of other difficulties.

In order to approve the uniform calibration certificate format it is necessary to create a working group to investigate these issues, which shall include representatives of all the regional metrological organizations. This will allow to use the existing experience and to take into account the interests of many countries and organizations.

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