

Electronic Archive Information System

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Abstract. Development of Electronic Archive Information System was the final step in completing Lithuania's preparation for signed electronic documents. The system is unique not only in Lithuania, but also in Europe. It allows to submit to the state archives the official electronic documents signed by qualified e-signature, assuring their integrity, authenticity, non-repudiation and possibility to use and store them for a long or unlimited time. To resolve the interoperability problems the universal model, sufficient for complex electronic documents during whole of their life cycle has been created and described in two specifications: ADOC - for human readable electronic documents and MDOC - for machine readable electronic documents. The public free software tools for preparation, signing, preview and verification of official electronic documents have played an important role in promoting the usage of electronic documents. The paper presents practical fundamental solutions applied in Lithuania.

Keywords. State archives, official electronic documents, qualified e-signature

Introduction

Life in the digital age raises the need for electronic documents. E-Government, e-business, e-commerce, and other e-services are impossible without electronic documents and security features that must be based on PKI (Public Key Infrastructure) technology [1].

Paper documents are no longer sufficient. If the original document is paper based, usually it is scanned to save time and costs of ordinary post services. However, detailed calculation shows that in the case of Lithuania the scanning costs per year exceed 10 M€. In European Union such procedure costs few billion yearly. Use of official electronic documents also provides a lot of other advantages: full reliability of document content, possibility to use fragments of documents for preparation of other documents, possibility to search in a document text. Quality of electronic documents is certainly better than that of scanned paper copies. So, it is completely clear that with time, electronic documents will replace conventional documents everywhere.

First Lithuania wide system with e-signature was the e-Servicing System of the Insurers (EDAS) launched by State Social Insurance Fund Board of the Republic of Lithuania (SoDra) in the end of 2007. It allows the insurers (employers) to provide digitally signed Abbyy eFormFiller forms instead of hand-signed paper documents. As

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these forms are XML based, XAdES enveloped signature format has been selected as the simplest but suitable for this application approach.

The main issue with the electronic document usage is the interoperability. At the moment, most of the EU member states are still in the process of defining clear strategy in the area of the official electronic documents and their usage in every day communication between businesses, citizens and public sector. The main standardization efforts in EU are still targeted to electronic signature formats. Decision 2011/130/EU [2] obliges member states to be able to technically process some of the most common formats of advanced e-signatures XAdES, CAdES, and PAdES. But the true artefact of interoperability is an electronic document. Lithuanian solution for the interoperability problems was the universal model, sufficient for complex electronic documents during whole of their life cycle that was defined in specifications ADOC and MDOC which were approved by Office of the Chief Archivist of Lithuania (Lithuanian Archives Department until year 2011).

The public free software tools for preparation, signing, preview and verification of official electronic documents according to the approved specifications have played an important role in promoting the usage of electronic documents. These tools are available as Web-based and desktop applications.

Currently more than half million machine-readable electronic declarations signed by qualified electronic signature are created each month using systems of State Social Insurance Fund Board and State Tax Inspectorate. The ministries and state main institutions have upgraded their document management systems with functionality for creating and verifying official electronic documents.

Another important date on the road to electronic documents is September 7, 2011, when Lithuania's Prime Minister and the cabinet have put their first electronic signatures to the legal acts passed by the Government. Since then, the originals of Government decrees are electronic documents of ADOC format. The electronic signature system ELPAS allows the Government to manage documents more efficiently by allowing to electronically sign the submitted legal acts at any convenient time and in any place. The Government also uses ELPAS for the submission of draft Presidential decrees as well as draft laws to the Seimas.

Over recent years there has been an increase in awareness on the part of state archives of the EU Member States of the need to preserve electronic records. The legal situation across Europe with regard to the archiving of public records generated by government agencies, and public access to such records, remains diverse. Differences exist not only in terms of the legal requirements, but also in the extent to which these are interpreted and enacted [3]. Development of Electronic Archive Information System (EAIS) was the final step in completing Lithuania's preparation for signed electronic documents. EAIS is intended for efficiently administering the whole National Document Fund (NDF), including paper documents, and providing electronic services. The system is unique not only in Lithuania, but also in Europe because the electronic documents it deals with are original documents, having the same legal value as handwritten documents. EAIS assures the integrity, authenticity, non-repudiation and possibility to use the electronic documents for a long or unlimited time.

1. Model of Electronic Document

The electronic documents' interoperability issue influences even the understanding of an electronic document as such. Interoperability is ensured if the electronic document is created and accepted using the same document processor. Therefore, the document processor's format often is treated as format of electronic document. Lithuanian approach is based on the principle that an electronic document as independent entity should be adequate to the conventional documents.

A real document is very complex entity. The document provides some content that may consist of texts, spreadsheets, tables, calculations, drawings, pictures, etc. as well as appendices or attached independent earlier created documents. In turn the appendices may contain their own appendices. An attached document may contain other attached documents and so on. The documents having legal value must be signed by one or more signatures. A signature expresses the conscious and voluntary will of the signatory to approve the content signed "lu et approuvé". Official documents achieve legal value only after signed documents are registered and possess corresponding attributes. Therefore, in general the documents consist of three parts: content, signatures and metadata.

An adequate electronic document having legal value equal to handwritten documents should be very complex entity too. It also must consist of content, signatures and metadata. However, usually these three areas are addressed by three different fields of interests – document processors, electronic signatures initiatives and record management systems, i.e. file formats, electronic signatures formats and metadata are standardized separately but signed electronic document format is not standardized.

An electronic document has a complex life cycle starting with document creation, including sophisticated document creation procedure, usage, storage, until destruction if a document has limited life cycle.

First of all, in October 2008 Lithuanian Archives Department has adopted the minimal requirements for the specifications of electronic document signed by the electronic signature that addresses all three components of the document: content, signatures and metadata without limitation of complexity of document's structure. The task was to create universal electronic document model to be sufficiently powerful to address the needs for complex electronic documents operated by public sector institutions including documents' whole life cycle. In this context, the natural choice without alternatives was a zip-based electronic documents format approach. The document format (container) is conformant with the requirements for signature containers defined by ETSI TS 102 918 [4].

The requirements for content are defined separately at logical and physical levels. The logical level operates by such notions as main document, one or more appendices, and one or more attached independent documents. The physical level is defined in terms of files and directories including file formats allowed.

XAdES electronic signature format of detached topology shall be applied according to ETSI TS 101 903 [5]. Multiple signed data objects and multiple signatures are allowed. Metadata as a sub-tree of xml-based metadata file can be signed.

The basic principle of Lithuanian approach is that metadata is an integral part of the electronic document. International standard ISO 15489-1 [6] indicates that "the metadata embedded in, attached to, or associated with, a specific record". This means that according to standard, metadata can be embedded into a document or attached to a

document, or associated with a document. Electronic documents interoperability issues and the needs for electronic documents automated processing force to use embedded metadata as an integral part of electronic document.

Currently there are two main official electronic documents' specifications adopted by Lithuanian Archives Department: ADOC [7] – for signed human readable electronic document and MDOC – for machine-readable electronic documents. These specifications were awarded as the main strategic innovation 2010 in Lithuania.

It could be noted that e-Servicing Systems of SoDra are based on different specifications:

- the Citizens system (launched in 2009) on EGAS specification that is subset of MDOC specification;
- the Insurers system (launched in 2007) on EDAS specification that is not conformant with minimal requirements for the specifications.

Universal electronic documents model implemented by specifications ADOC and MDOC has sufficient power to express such extremely complex documents as State Budget 2012.

2. Implementation of Electronic Documents Specification

The electronic documents specification defines the format of valid electronic document but not the procedure how such format should be produced. The software requirements for creation and verification of electronic documents are defined in the international technical standards [8, 9, 10, 11].

Most solutions in Lithuania with qualified e-signature according to ADOC specification are based on product line Signa. It consists of four products:

- Signa Desktop – public free Windows OS application (available to download from <http://www.mitsoft.lt/>);
- Signa Web – public free web application (available at <https://signa.mitsoft.lt/>);
- Signa SDK – a set of application libraries for Java and .NET platforms; it supports MDOC and EGAS specifications also;
- Signa Docs – web application for enterprises featuring multiple users, electronic document workflows and the ability to sign with qualified signatures multiple electronic documents in bulk (ELPAS is based on it).

Signa is known to provide the most complete implementation of ADOC specification, from documents creation to documents validation, e-signatures verification, signature formats upgrade. Both signing possibilities – using local secure signature creation device as well as mobile electronic signature services – are ensured. Product line Signa was awarded as a winner of national contest “Innovative Product 2011”.

3. Archive of Electronic Documents

The goal of the Electronic Archive Information System (EAIS) project was to create an integral open information system for accepting and storing electronic documents of

National Document Fund (NDF), providing a legal access to the stored documents using IT and communication means, administering NDF efficiently and providing electronic services. Experience of other countries [12, 13] as well as research ideas [14, 15] has been taken into account.

EAIS consists of the 3 main parts:

- Public portal (<https://eais-pub.archyvai.lt>) that serves all external users;
- Internal portal (<https://eais-int.archyvai.lt>) that serves the users of state archives and Office of the Chief Archivist of Lithuania;
- Storage of electronic documents.

Physically e-documents are stored in two geographically remote electronic archive data centers: one in Vilnius, another in Šiauliai. The system implements the replication of archive data between the main and the reserve data centers with the possibility to switch operations between the centers in case of a failure. Because of security reasons, the storage of electronic documents is accessible through internal portal only.

Authentication of external users is implemented through e-government gateway. The authentication service is provided for the users of Internet banking systems of all commercial banks operating in Lithuania and owners of class 2 or 3 personal digital certificates. It should be noted that some EAIS functions (e.g. creation of electronic documents, search in NDF) are available for not authenticated users also.

EAIS consists of the following modules:

- Acceptance of electronic documents (both portals);
- Retention of electronic documents (internal portal only);
- Publication and presentation of documents (both portals);
- Organization of documents management (both portals);
- Administration (both portals);
- Software tools of free accessibility for preparation, signing, preview, and verification of official e-documents (public portal only);
- Accumulation and analysis of statistical data about the stored documents and their usage (both portals).

It is important to emphasize that all functions of the public portal could be invoked interactively and through corresponding Web services. It is intended that organizations will extend functionality of their document management systems and operate with EAIS through Web services.

Acceptance of electronic documents module provides functionality to agree the suitable time for electronic documents transfer to state archive, to transfer the documents package through computer network or load it from physical media, to perform checks of e-documents integrity, authenticity and conformance to specification, to prepare them for storage a long or unlimited time, and to store.

The very important feature of EAIS is flexible configuration of authenticity checks. It is essential because some institutions may require final one signature over whole document to ensure document's integrity. Other institutions may require the use of qualified electronic signatures for any purpose of electronic signatures. Third institutions may require electronic document content signed by the purpose of signature, confirmation or approbation. All these partial cases are examples of valid electronic documents according to some specification.

The possibility to use electronic documents for unlimited time is assured by converting their contents into long-term storage files (PDF/A format) and formats for previewing the documents in Internet (PNG and JPEG). In the future these formats will be regularly reviewed and updated. The e-signatures that legal value (integrity, authenticity, non-repudiation) should be preserved are extended to the XAdES-A format.

Retention of electronic documents module includes the means for physical preservation of electronic documents, e.g. backup copies, saving original packages of electronic documents into WORM (write once, read many) devices, and the risk management. There are two types of risk identified:

- Related to content formats: over the time they could become old and not supported by current version of software;
- Related to electronic signatures: the cryptographic algorithms that are used for creating secure signatures today might become breakable in the future due to sudden advances in cryptanalysis or in computational capabilities; the keys used for signing could become too short; the validity period of certificate used last time stamp could end or even certificate could be compromised.

Risk of the first type is resolved by creation/renewing the long-term storage and previewing copies: all content files are transformed into the PDF/A format which provides a mechanism for representing electronic documents in a manner that preserves their visual appearance over time, independent of the tools and systems used for creating, storing or rendering the files [16]. Additional time stamp to XAdES-A format resolves risk of the second type. Of course, suitable up-to-date algorithms and the length of key should be used for this time stamp.

Archives of Lithuania are open to public. Any person, upon the presentation of an ID card, may have an access to archival records. Records of state institutions without restraints (except a few, access to which is restricted by law) are available for reference. Publication and presentation of documents module ensures the access to documents of the National Document Fund stored in EAIS. A person who wishes to get acquainted himself with the documents the access to which is not limited restricted, must authenticate through e-government gateway.

For the transparency and accountability purposes of the public administration state archives service play an important role in the processes of records management in public sector. State archives controls approximately 2000 institutions and agencies. State and municipal institutions, agencies and enterprises which transfer documents to state archives shall co-ordinate with the state archives the documentation plans, registers, and other registration documents of activity documents. Organization of documents management module allows to perform these functions by IT and communication means.

EAIS includes the functionality for providing applications for attested copies of documents, extracts intended for the approval of juridical facts, and certificates, management of these applications, preparation the copies of electronic documents and signing them.

The software tools of free accessibility for preparation of official e-documents, signing them by e-signature, preview, and verification include:

- Web application (available at <https://adoc.archyvai.lt>); if compared to Signa Web this application is more beginners oriented, as all the time user is guided by wizards;
- Signa Desktop.

EAIS has been launched in October 2011. It is the first national archive storing electronic documents signed with qualified e-signatures. Currently EAIS deals with electronic documents of ADOC and EGAS specifications.

4. Future Plans

There are two main trends in electronic documents formats evolution that can be called zip-based and pdf-based electronic documents formats. All specifications currently adopted in Lithuania define zip-based electronic documents format. Traditionally a portable document format (PDF) [17] is applied for documents of the flat structure. However, the evolution of documents structure has forced to consider it as a container format. Furthermore, in order to address the needs for extended functionality of signatures ETSI introduced PAdES signature format as new semantics based on PDF syntax.

It is possible to implement universal document model using pdf-based container but zip-based approach is more suitable for this purpose. However, in the case of simple documents PDF has some advantages. The document could be previewed with freely available PDF readers.

Therefore, PDF-LT specification is on the final stage of preparation. Correspondingly the minimal requirements for the specifications will be adjusted. PDF-LT specification will be recommended for short term documents only. But such documents could become long term or even unlimited term. Therefore, EAIS should be extended to accept and store electronic documents of PDF-LT specification.

Current version of the Law on Documents and Archives [18] defines that only permanent retention documents are accepted to state archives. Amendments of the legal base that long storage electronic documents could be submitted to the state archives also are prepared. They should be adopted by the Seimas of the Republic of Lithuania.

5. Conclusions

Lithuania's experience has shown that the "tool-first" approach does not lead to interoperability of electronic documents. Instead an opposite approach "standard-first" should be chosen. Implementing it, the minimal requirements for electronic documents specification and the specifications themselves – ADOC for unstructured human readable and MDOC for structured machine readable signed electronic documents – were developed based on universal document model to support all life cycle of the document. These specifications were nominated as main strategic innovation 2010 in Lithuania.

According to specification various interoperable tools for electronic documents creation and verification were developed and rolled-out for use of inhabitants, civil servants, providing public services. Documents management systems were integrated with functionality of signed electronic documents. Thanks to well established and now

generally accepted document format the true interoperability between document management systems is about to be achieved: documents created and signed in one system may be opened in another system. Product line Signa was awarded as a winner of national contest “Innovative Product 2011”.

The Lithuanian Government started to prepare and issue Decrees originals in electronic form.

Electronic Archive Information System is ready to accept electronic documents into the Lithuanian National Documentary Fund, to preserve their integrity, authenticity, non-repudiation for unlimited time, and to make them accessible to the citizens and governmental and public institutions, providing public services. The system is unique not only in Lithuania, but also in Europe.

The authors have played key role in development of all specifications, information systems and tools mentioned in the paper.

References

- [1] P. Risztics and I. Jankovits, Electronic government and public administration in Hungary. In: *Proceedings of the 38th Annual Hawaii International Conference on System Sciences HICSS05 Track 5*, 2005, 122a (1-8).
- [2] Commission Decision 2011/130/EU of 25 February 2011 establishing minimum requirements for the cross-border processing of documents signed electronically by competent authorities under Directive 2006/123/EC of the European Parliament and of the Council on services in the internal market, *Official Journal of the European Union L 53* (26.2.2011), 66-72.
- [3] I. Petravičiūtė, Long term preservation policy of electronic records in the European Union Countries, *Knygotyra 47* (2006), 243-261 (in Lithuanian).
- [4] *ETSI TS 102 918 V1.1.1: 2011-04 Electronic Signatures and Infrastructures (ESI); Associated Signature Containers (ASiC)*, European Telecommunications Standards Institute, 2011.
- [5] *ETSI TS 101 903 V1.4.1:2009 XML Advanced Electronic Signatures*, European Telecommunications Standards Institute, 2009.
- [6] *ISO 15489-1:2001 Information and Documentation - Records Management - Part 1: General*, International Organization for Standardization, 2001.
- [7] Specification ADOC-V1.0 of the electronic document signed by the electronic signature, *Valstybės žinios 108-4574* (09.10.2009) (in Lithuanian). Available from: https://signa.mitssoft.lt/static/signa-web/webResources/docs/ADOC_specification_approved20090907_EN.pdf (in English).
- [8] *CWA 14170:2004 Security Requirements for Signature Creation Applications*, European Committee for Standardization, 2004.
- [9] *CWA 14171:2004 General Guidelines for Electronic Signature Verification*, European Committee for Standardization, 2004.
- [10] *ETSI TS 101 861 V1.2.1:2002 Time Stamping Profile*, European Telecommunications Standards Institute, 2002.
- [11] *ETSI TS 101 862 V1.3.3:2007 Qualified Certificate Profile*, European Telecommunications Standards Institute, 2007.
- [12] *EDRMS Functional Specification, Standard*, Government of South Australia, Adelaide, 2009.
- [13] *Functional Specification for Integrated Document and Records Management Solutions*, National Archives and Records Service of South Africa, Pretoria, 2004.
- [14] A. J. Blazic, Long term trusted archive services. In: *ICDS '07 Proceedings of the First International Conference on the Digital Society*, IEEE Computer Society, 2007, 29-35.
- [15] T. Kunz, S. Okunick, and U. Viebeg, Long-term security for signed documents: services, protocols, and data structures. In: *Long-Term and Dynamical Aspects of Information Security: Emerging Trends in Information and Communication Security*, Nova publishers, 2007, 125-139.
- [16] *PDF/A – the Standard for Long-Term Archiving*, PDF Tools AG, 2009.
- [17] *ISO 32000-1:2008 Document Management. Portable Document Format. Part 1: PDF 1.7*, International Organization for Standardization, 2008.
- [18] *Law on Documents and Archives 18 June 2010 XI-917*, Seimas of the Republic of Lithuania, 2010. Available from: http://www3.lrs.lt/pls/inter3/dokpaieska.showdoc_l?p_id=404607.