Contemporary approaches to archiving of digital originals: a review of concepts and technologies

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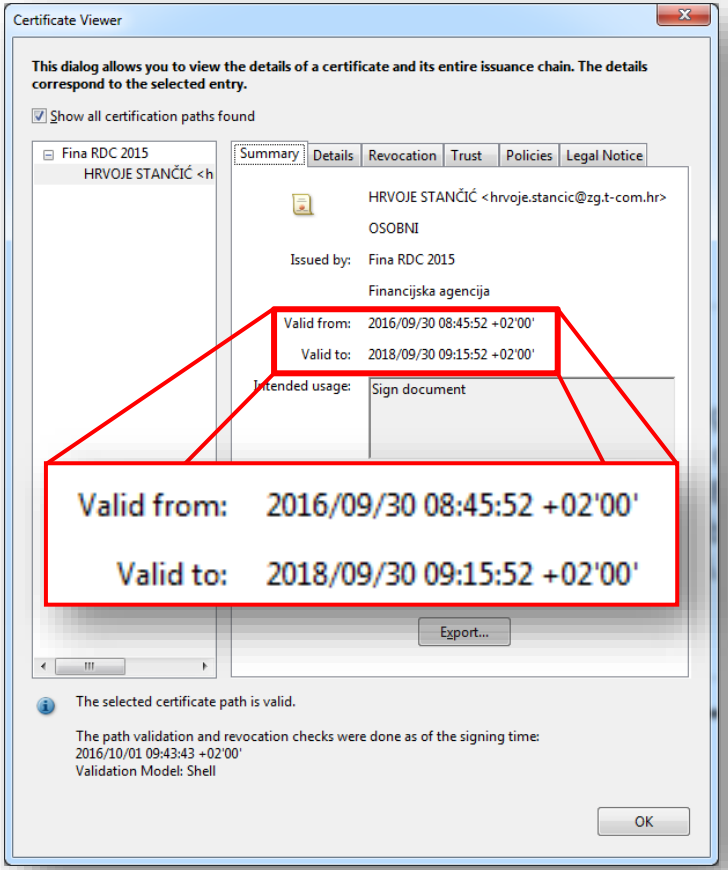
Contents

1. Introduction

- Digital transformation of society – digital originals
- Digital signatures and seals
  - authenticity
  - trustworthiness
  - issue with validity period



2. Project I.Trust.Original

- Long-term preservation of the authenticity of digital originals using blockchain technology and artificial intelligence (2025-2029) - **I.Trust.Original**
  - funded by the European Union – NextGenerationEU fund
- Explores ways to extend the validity period of digital originals
- Harmonises technological concepts and archival principles
- Aims to explore the possibilities offered by emerging digital technologies such as **blockchain** and **artificial intelligence** in the context of the long-term preservation of the trustworthiness of digital originals

2. Project I.Trust.Original ...

- Project aim leads to the following fundamental **research questions**:

1. How can blockchain technology be applied to the long-term preservation of the trustworthiness of digital originals without the need for their periodic (re)signing?

2. How can machine learning and artificial intelligence methods be used to classify and (semi-)automatically establish an archival bond between related documents?

2. Project I.Trust.Original ...

3. What is the optimal model for the creation, description, and long-term preservation of unique digital originals?

4. What are the security, legal, ethical and technical advantages and limitations of the proposed innovative solutions compared to traditional digital archiving methods?

➢ Project positions itself at the intersection of **archival theory and technological innovation**

3. Research activities

- Research on the impact of technological development on the trustworthiness of digital sources
  - first activity of the project I.Trust.Original
  - collection and analysis of relevant sources
  - key topics include laws, bylaws, and regulations governing archival materials, as well as specifications and literature
  - based on initial findings, a digitisation and maintenance process for digitally born documents will be developed, integrating new principles and technologies to produce trustworthy digital originals eligible for acceptance as evidence

4. Systematisation of concepts and technologies

- Legal and regulatory frameworks
  - Croatian archival laws, Croatian specifications from the Government and the Croatian State Archives, EU regulations, and international recommendations and standards for all research areas
- Archival concepts
  - Provenance, related principles, context, documents, metadata, paradata, and archival bond

4. Systematisation of concepts and technologies ...

- Archival processing
  - Archival description – Records in Contexts (RiC) standard
- Digital preservation concepts
  - OAIS reference modes, PAIS, PAIMAS, data and metadata packaging frameworks (e.g. XFDU), specification for distributed preservation environments, and European-based specifications of information packages derived from the eArk project

4. Systematisation of concepts and technologies ...

- Digital signatures
  - regulations and standards governing the creation of trust services, standards for the creation and certification of trusted digital repositories, standards and technologies relevant to the realisation of qualified e-signatures
- Digital originals
  - concepts of archival documents, including their elements of form(s), content, context, technological environment, action, agents involved, and archival bonds
  - digital equivalents and other information objects that require long-term preservation

4. Systematisation of concepts and technologies ...

- Archival bond
  - conceptual and practical challenge
- Metadata
  - use, portability, reusability, standards, and interoperability
  - partly addressed in archival description-related research by examining the Records in Contexts standard
  - standards such as METS (also addressed in the digital preservation concepts component), PREMIS, EAD, and the metadata specification produced by the Croatian State Archives in 2022

4. Systematisation of concepts and technologies ...

- Trust and authenticity concepts
  - blockchain and digital ledger technologies (DLT)
- Artificial intelligence
  - applicability to other parts of the project.
  - models, processes, and prototypes will be deployed wherever feasible to improve archival processes, particularly in relation to large language models (LLMs)
- Other emerging technologies
  - new and emerging technologies, including post-quantum cryptography, cybersecurity, smart contracts, and novel interoperability frameworks

5. Technological trust and its benefits for archival science

- Digital preservation systems
  - typically aligned with the OAIS reference model
  - ensure bit-level integrity through fixity checks and redundancy, thus supporting one dimension of authenticity
- Metadata frameworks
  - support the preservation of authenticity by documenting context, provenance, and relationships between records
  - linked data and knowledge graph approaches enable reconstruction of the archival bond across distributed environments

5. Technological trust and its benefits for archival science ...

- Artificial intelligence and machine learning
  - enhance archival processes through automation, particularly in description, classification, preservation, and access
  - improve efficiency and scalability
- Blockchain and distributed ledger technologies
  - provide robust mechanisms for ensuring data integrity and tamper-evidence through cryptographic hashing and distributed consensus

5. Technological trust and its benefits for archival science ...

- Digital signatures and trust services
  - establish legally recognized mechanisms for asserting authenticity at the time of record creation and validation
- Other technological domains
  - include cloud computing and digital forensics
  - contribute to the preservation of digital records by enhancing storage scalability and enabling the capture of technical metadata and original context

6. Open questions

- How digitally signed records behave in a digital preservation environment after the expiration of the digital certificates on which they rely to confirm the identity of the signatory and the time the document was signed
  - Laboratory for Research of Advanced Technologies and Innovation (**NEXTGEN-LAB**)
    - newly established
    - is being equipped with a **simulation environment to accelerate ageing** of digital signatures and digital timestamps

6. Open questions ...

- AI solution to (semi-)automate the establishment of archival bond
  - I.Trust.Original project aims to advance the TrustChain model developed during the InterPARES Trust project (2013-2019)
  - NEXTGEN-LAB
    - will provide an environment for research and development of blockchain and AI solutions
- Impact of trusted services relying on PKI during the long-term preservation of trustworthy digital records

7. Conclusion

- Blockchain and distributed ledger technologies
  - promising solution for registering the validity of signatures on-chain while they are still valid.
- Artificial intelligence
  - promising approach for (semi-)automating the establishment of an archival bond between documents already registered on the blockchain.
- Concept of digital original documents created simultaneously as human-readable and machine-readable documents
  - promising solution for both the digitisation of paper documents created as single originals and the creation of digital art, music, video, and other copyrighted works in digital form

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THANK YOU!

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