XML–Signatures and the Presentation Problem

Fraunhofer Institut Sichere Telekooperation
XML–Signatures and the Presentation Problem

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Fraunhofer Institute Secure Telecooperation (SIT)

- Development of security technologies
- Incorporation of security technologies in pre-existing applications
- Realisation of innovative forms of telecooperation
- Activities based on XML, e.g.
  - TMF – Telematikplattform for medical research networks: Medical data in XML
  - Media@com (e-government): X.509 authentication protocol
  - Diploma- and PhD theses about XML-Encryption, secure auctioning systems using XML-Dsig, presentation problem, etc.
Our collaboration:

Thomas Kunz
- Studies in informatics Uni Frankfurt/Main
- Since 2001 research assistant at SIT.MINT
- Themes: security in e-business processes, security-solides

Ulrich Pordesch
- Studies in informatics TU-Darmstadt
- Since 1997 PhD student/researcher at SIT
- Schwerpunkt: judicial requirement analysis
- PhD Dissertation (TU-Ilmenau): Die elektronische Form und das Präsentationsproblem (the electronic form and the presentation problem)

Dr. Andreas U. Schmidt
- Studies in mathematics and physics, University Frankfurt/Main, 1999 PhD in Mathematics
- 1999/2000 researcher at the GMD Institute SIT, AG MINT.
  Subject: digital signatures in XML
- 2000/01/02 research stays in ZA (UDW) and Italy (Univ. Pisa)
- since october 2002 researcher at SIT.MINT.
  subject: security-policies
Overview

1. Common Content- and Signature Formats

2. The Presentation Problem

3. Pros and Cons of XML as Content- and Signature Format

4. Remaining Problems and Possible Solutions
**Usual Content Formats**

Word processors: Word

Spreadsheets: Excel

E-Mail: Mime-ASCII

Internet: HTML

Financial data exchange: EDIFACT

Archiving: PDF

Fax/Scan: TIFF

Pictures: JPEG, GIF

"Security properties"

- No secured authenticity/integrity
- Content and authorship repudiable
- No judicial proofs

Therefore even today in many use cases

- Print
- Sign
- Scan, and/or archive as paper ...
Common Signature Formats (I): CMS

ASN.1-Syntax, binary coding

Signature generation

- Hash content (e.g. file)
- Hash the hash value and further attributes (time, used algorithms, content format)
- Generate signature value
- Add certificates and further attributes (endorsement signature, time stamp,..)....

Form CMS-Container: Content integrated or external

Numerous ASN.1-based standards for attributes, certificates, CRLs, ...
Common Signature Formats (II): Usage

a) Signed message within a file in CMS format

b) Document remains unchanged, signature placed in additional file in CMS format

c) Integration in usual document formats
   - Selection, transformation coding of document data by application yields signable content
   - Signature is placed into document file, document format (syntax) is extended by a CMS-block for that
   - Example: PDF
The Presentation Problem (I)

Two presentations of the very same signed document contents differ significantly and lead to (legally) incommensurable interpretations.
The Presentation Problem (II)

A variety of possible presentations results from (intended and non-intended) ambiguities, and misrepresentation due to error and/or abuse.

Unique prescriptions are lacking for

- Data format and syntax
- Presentation of content
- User interface
- User-system-interaction

In conclusion: Judicial value of signed data might be limited, although it contains a technically correct digital signature.
Presentation Problem with Common Formats

Content format

- Content itself is mostly non-unique concerning representation; but worse:
  - **What** is signed is often not recognizable:
    - Origin, selection, transformation, coding is opaque
    - Content is not human-readable, syntax and pertinent semantics are not disclosed
- With CMS-signatures: Only one file can be signed, but not, for instance, stylesheets, textual descriptions, presentational variants, etc.

Signature format

- Content format can be defined (as a MIME-type), but is often not used properly ("data")
- Differing content formats can be used in parallel signatures
- Signature data itself is implementation dependent
XML as Signature- and Content-Format

The common standard of IETF and W3C for XML-Signatures (XMLDSig, W3C Recommendation 12.4.2002) provides a format for signatures of:

- Structured (XML) and unstructured data in single or multiple files
- from different application contexts (interoperability),
- in a multitude of variants (enveloped, enveloping, detached, selected content, ...)
- Web-wide distributed or local,
- mobile or with fixed location,
- with low demands on implementations,
- using established as well as advanced cryptographic standards,
- with open-source implementations
Basic Structure of XML-Signatures (XML DSig)
XML Components Associated to the Presentation Problem

**Syntax:** schema
- Old: DTD - SGML's `heritage`
- XML-Schema
  Syntax descriptions for XML in XML

**Presentation:** Stylesheets
- CSS - for presentation of (X)HTML in the Web browser
- XSL Extensible Stylesheet Language:
  - XSL Transformations
    (XML to XML, text, or (X)HTML)
  - XSL Formatting Language: detailed presentation prescriptions for XML-Documents
Advantages of XML Pertaining to the Presentation Problem

• Separation of signature- and application context:

  Syntax and presentation can be determined separately for Application data and signature data

  These components can be made attributable – by (XML)-signatures – to responsible parties

• Transparent codierung (human readable [?] XML)

• Adapted presentation variants possible by association to stylesheets

• Uniqueness of syntax through use of namespaces
  (fixing semantic context of the XML-elements)
Further Advantages of XML-DSig

- Signing of multiple data objects enables authentication of associated stylesheets and schema definitions
- Transformations (XSLT): data objects can be changed before signing them: inessential and potentially damaging parts can be eliminated (e.g. script code)
- Transparent selection of content parts before signing via XPath (powerful)
- Transparent normalisation
**XML-Signatures: Flexibility vs. Security**

**Flexibility**

- Explicit re-coding, execution of externally defined Operations before signing
- Content-selection with XPath/XPath Filters: useful for forms and workflow applications where parts of documents are to be signed by various parties
- Canonicalization: re-codings that keep the signature invariant - should also leave the semantics of the content invariant

**(In)security**

- Does the application of c14n, transformations, selection operations really leave the semantics of the signed content unaffected? The signed doc might have a meaning which differs from the original one.
- C14n and XPath even create problems on the syntactic level, i.e. for interoperability: Even for simple use-cases, XPath expressions become unintelligible and error-prone. (Standard was developed with emphasis on lightweight implementation and high functional power)
- On higher semantic levels: What is it, really that is signed - the XMLDSig standard knows not of content types. This meaning has to be provided within the application context.
Requirements w.r.t. Presentation Problem

- **Signed Stylesheets**: The authenticity of the stylesheet used for the presentation must be ensured by digitally signing it.
- **Binding of Context**: Syntax (Schema) and presentation must be bound to the signed XML data, i.e. their usage must be explicitly prescribed and signed. XMLDSig has no high-level semantics for that.
- **Otherwise**: Integrity of context components becomes a problem (is the signed stylesheet the same that has been used for presentation?)
- **Ambiguity**: To which level of detail shall context components be presented, if they are signed? E.g. Should also signed stylesheets be presented?
- **Presentation of Signature**: Should there be a unique, application independent (standardized, "officially regulated") presentation of signature, certificates, timestamps, etc.?
- **Interaction level is underspecified**: Even advanced XML form description languages do not specify user interaction; it is usually implemented by scripting languages.
XAdES (ETSI - Specification)

Extension of W3C-specification (success doubtful) by signature attributes
- ASN.1-time stamps, -certificates, - CRLs
- Counter signatures

Assignment of data formats (signed)
- Text descriptions of data
- Format specification via Object Identifier (OID) or MIME-Type with encoding

<ds:Object>
  <QualifyingProperties>
    <SignedProperties>
      <SignedSignatureProperties>
        (SigningTime)
        (SigningCertificate)
        (SignaturePolicyIdentifier)
        (SignatureProductionPlace)?
        (SignerRole)?
      </SignedSignatureProperties>
      <SignedDataObjectProperties>
        (DataObjectFormat)*
        (CommitmentTypeIndication)*
        (AllDataObjectsTimeStamp)*
        (IndividualDataObjectsTimeStamp)*
      </SignedDataObjectProperties>
    </SignedProperties>
  </QualifyingProperties>
</ds:Object>
Further Directions

Syntax and presentation of signed data

- Depends too much on applications for central prescriptions. Should there be guidelines?
- Evaluation, registration, and certification (by digital signatures) of stylesheets and schemas for applications
- Presentation of signature (nontrivial due to the large variety of signature types):
  
  "Officially prescribed" stylesheets for signature presentation could form a base infrastructure for XML signature applications.
- Binding of context elements: A meta standard based on XMLDSig could provide pertinent semantics and functionality.
- Expressive elements for user interaction...
An Example: BaKo - A Protocol for Mutual Non-Repudiation
Presentation of Signatures: Doubly Signed ACCEPT Document
Presentation of Signature: Detailed