
# Protection and security of information systems

## Security in electronic business systems

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# Electronic business

## Examples of electronic business

- electronic communication with other companies to order products and services and their electronic payment
  - business between companies - B2B (Business-to-Business)

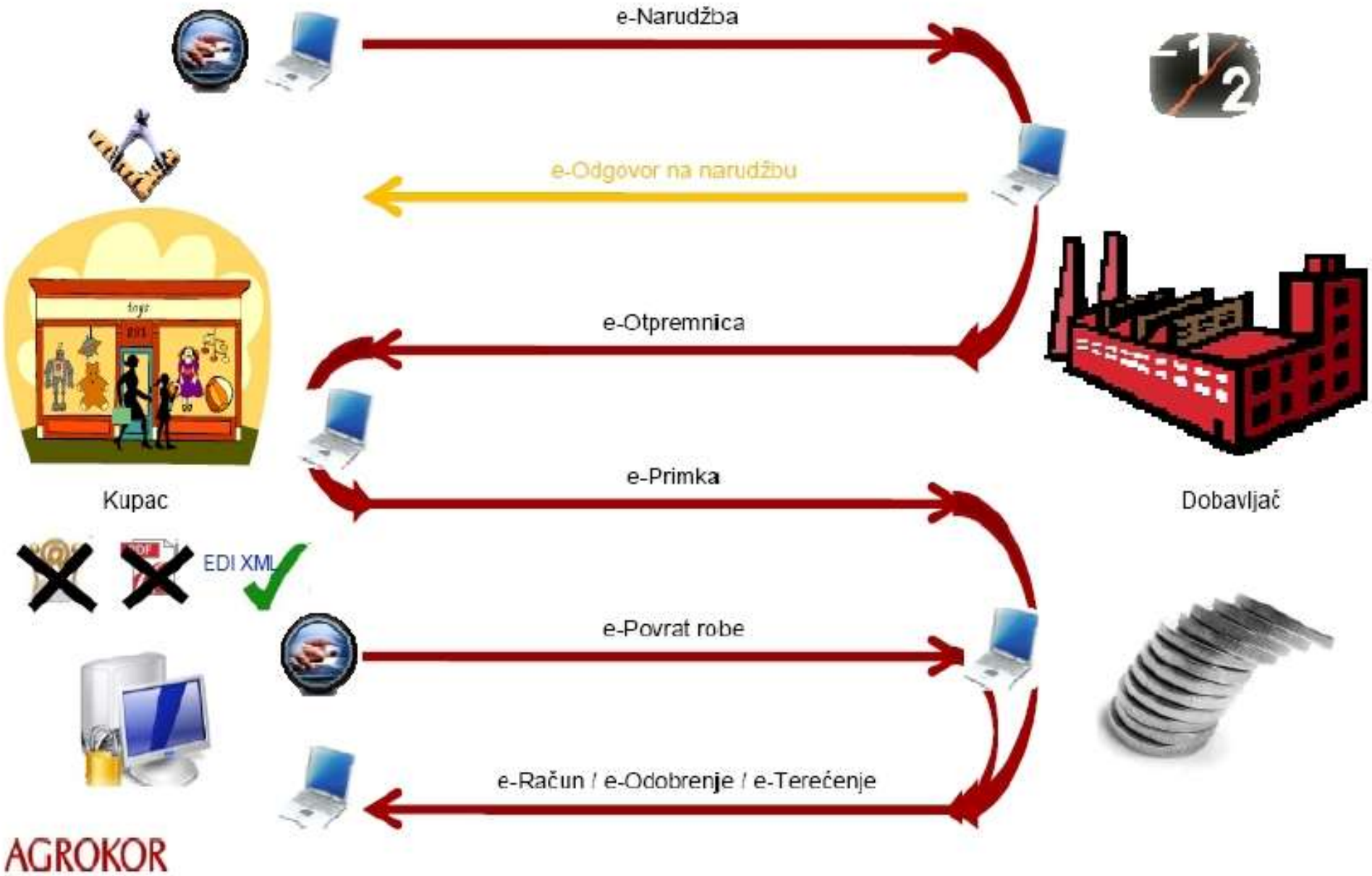
- selling products and services through the Web site
  - e-commerce, business of the company with the final consumer - B2C (Business-to-Consumer)

# B2B electronic business - exchange of business documents

Basic business processes in the supply chain and electronic documents that are exchanged:

| | |
|---|---|
| - Catalog | e-catalog |
| - Ordering | e-order form |
| - Shipping | e-shipping |
| - Receiving | e-receipt |
| - Invoicing | e-invoice |
| - Payment | e-order for payment |

# Primjer razmjene e-dokumenata



# Supply chain - basic business processes and documents

- Contemporary electronic documents which are exchanged in electronic business are mostly in XML format.

- There are also older norms EDDIE (Electronic Data Interchange), the most important of which is the norm EDIFACT (Electronic Data Interchange For Administration, Commerce and Transport).

- exchange of modern business electronic documents - technology: XML and Web services
- SECURITY?

# Security of electronic business

- B2B - exchange of XML documents and use of Web services

  - Ensuring authenticity (the declared sender is the real sender) and integrity (impossibility of changing the message)
    - E-signature
  - When the digital certificate expires, how do you prove that the certificate was valid at the time the document was signed?
    - Time verification, time stamp (timestamp)
  - Signing and encryption in XML format
    - XML Signature and XML Encryption
  - Security of Web services
    - Web Services Security (WSS) and other standards (WS-Extensions)
    - WS-I Basic Security Profile
    - Security of RESTful Web Services

# Security when exchanging electronic documents

- e-invoiceis the most widespread electronic business document

- all EU member states should enable receivinge-Invoicefor tax purposes (VAT) if two conditions are met:

  1)recipient must agreewith receipt of invoices in electronic format;

  2)integrity (cannot be changed)and authenticity (the declared sender is the actual sender) must be secured during transmission and archiving.

This second requirement can be fulfilled eitheradvanced electronic signatureor through electronic data interchange (EDI) with agreed security measures.

# Electronic (digital) signature

- In the business and ICT world, we often encounter the term digital signature, electronic signature, e-signature or the English namee-signature.

- The Croatian encyclopedic dictionary says that a digital signature is "encryption that proves the authorship, i.e. the originality of the electronic document".

- The electronic signature is defined by the eIDAS regulation (adopted by the EU) as follows:data in electronic form which are associated or logically connected with other data in electronic form and which the signatory uses to sign".

- As part of this subject:
  - we will use the terms electronic signature and digital signature as synonyms,
  - the term electronic signature will not include the image of a handwritten signature (although it can also be considered a type of electronic signature in a broader sense).

# Asymmetric cryptography

It is used for digital signingasymmetric cryptography.

- one algorithm andpair of keys:one key for encryption, the other for decryption

- Encryption: transformsplaintext (plaintext)using a pre-arranged key

- The encryption result is calledcipher (ciphertext)orcryptogram

- the mathematical algorithm determines how to encrypt the plaintext complexity
- depends on the length of the key (number of bits)

- the strength of an encryption system rests on the key
  - an attacker can have ciphertexts and know the algorithms, the vulnerability of the system depends on the strength of the key
  - longer keys are harder to break (time, money)
  - key length: 128, 192 or 256 bits

# Asymmetric cryptography

- in asymmetric cryptography, the keys are tied to each other
- knowing the algorithm and one key, it is impossible to discover another
- often: it doesn't matter which key is used to encrypt and decrypt
    - they work exclusively in pairs
- one of twothe key must remain secret

Each user has a pair of keys:

- private (secret) key
    - Available exclusively to the user, may not be distributed
- publickey
    - Available to all, must be distributed

# Asymmetric cryptography

- what is encrypted with a public key can only be decrypted with a private key
- what is encrypted with a private key can only be decrypted with a public key

- knowing the public key, one cannot calculate the secret key in any reasonable time
- the time required to calculate the secret key from the known public key, i.e. breaking the code, is measured in millions of years on the most powerful computers available today

- Asymmetric cryptography is also calledpublic key cryptography.

# Algorithms for asymmetric cryptography

- RSA (Rivest-Shamir-Adleman) - MIT
  - the most popular algorithm, developed in 1977.
- Diffie-Hellman
  - developed in 1976.
- Elliptic Curves Cryptosystem (ECC)
- others:

  ElGamal, Rabin, Knapsack, McEliece, NTRU, Braid Groups, Lucas

# Hash function and digital signature

- agodigital signatureshouldgenerate summary (hash, digest) messages hash
- functions
  - input: a string of characters of arbitrary length
  - output: string of characters of fixed length (eg 256 bits) basic
- properties of the hash function:
  - hashis a one-way function
    - it is not possible to regenerate the input message based on the output
    - it is not possible to specify an input message that would have a default hash
  - "application" and "change" will give a completely different summary (hash)
  - changing one bit of the input produces a completely different output

# Hash-algorithms

- Secure Hash Algorithm (SHA-1) – not recommended to use
  - US Government Algorithm (NSA)
  - giveshasha value of length 160 bits from a character string of any length
  - collisiondiscovered in $2^{69}$hasheva, 2005

- SHA-2 (variants SHA2-224, SHA2-256, SHA2-384, SHA2-512)

- SHA-3 (variants SHA3-224, SHA3-256, SHA3-384, SHA3-512)

- Message Digest Algorithm 5 (MD5) – not recommended to use
  - giveshashlength 128 bits
  - MD5 cracked in 2008

# Digital signature procedure

is calculated

summary (hash)messages

sign the summary of the message

areown

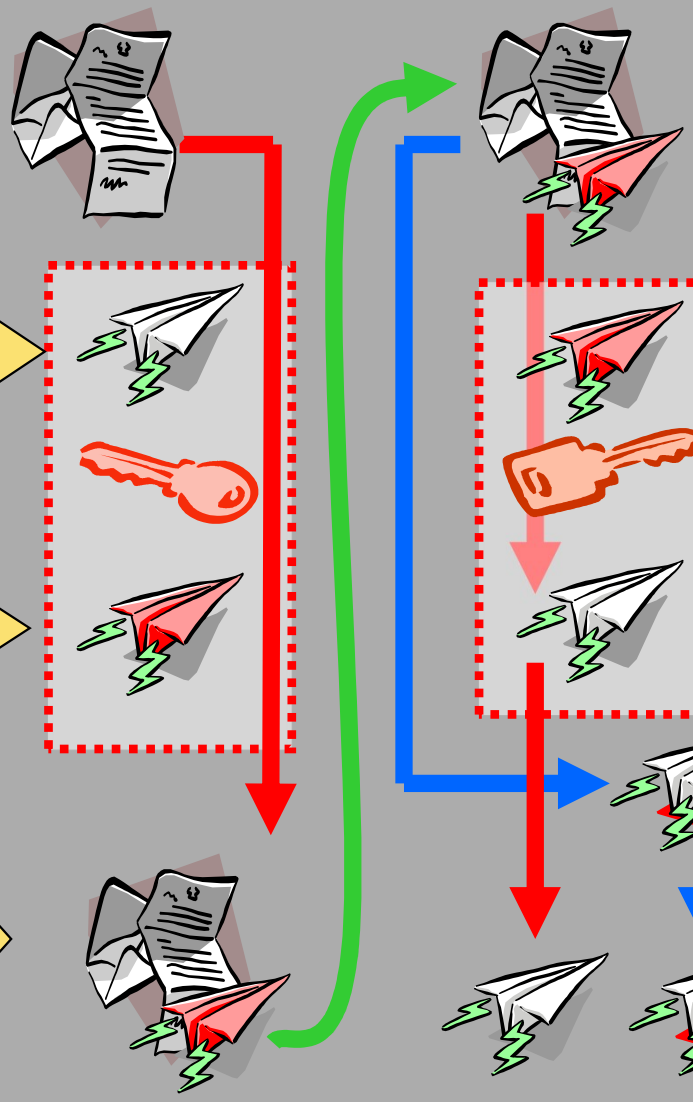
private key

to the original message

a signed summary is added and

everything is sent to the recipient as

text



an encrypted digest is

extracted from the message

the digest is decrypted

public key

sender

from the original message

a new summary is calculated

if the summaries are equal,

the identity of the sender is proven

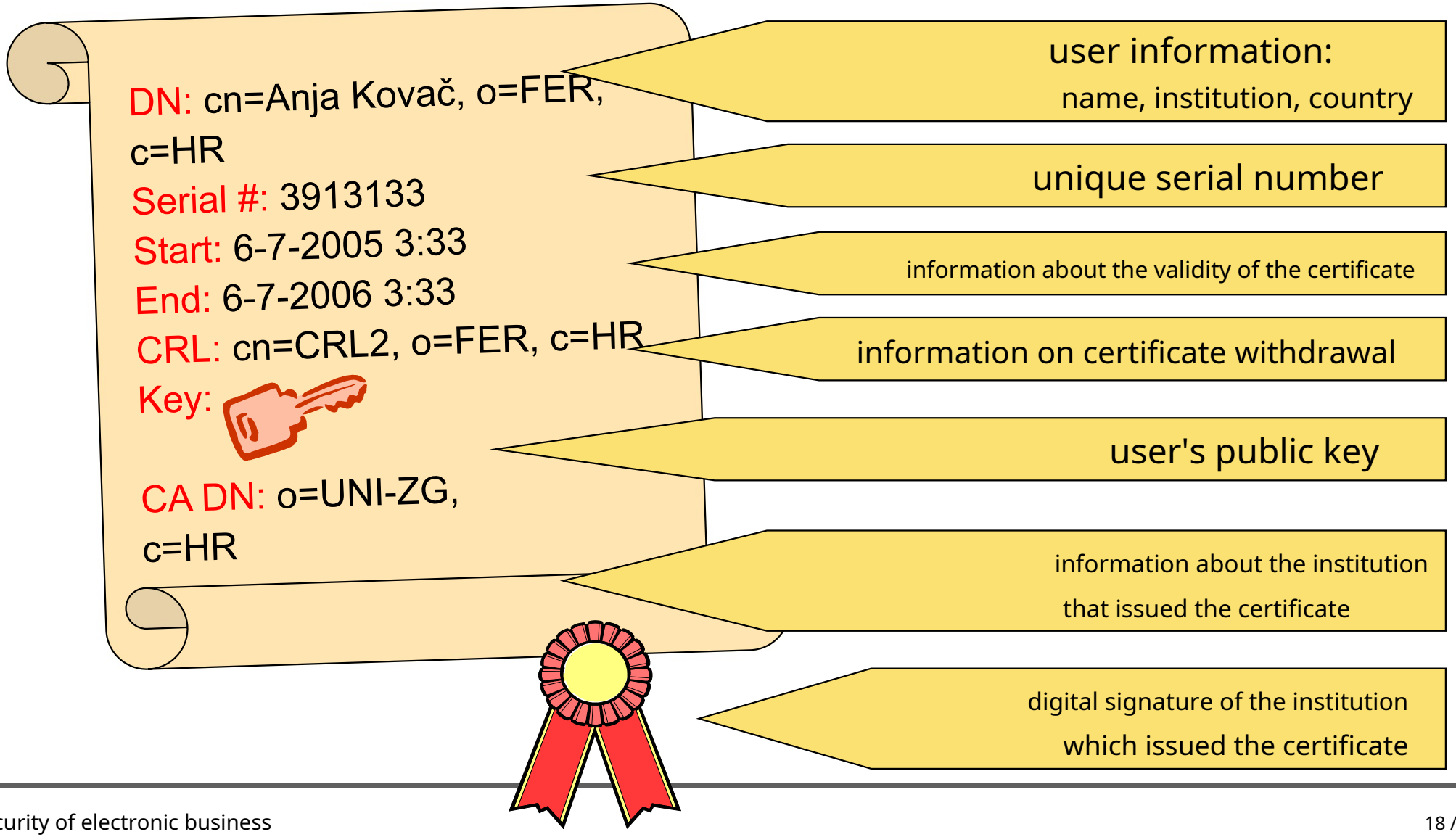
and content integrity

# Digital certificate

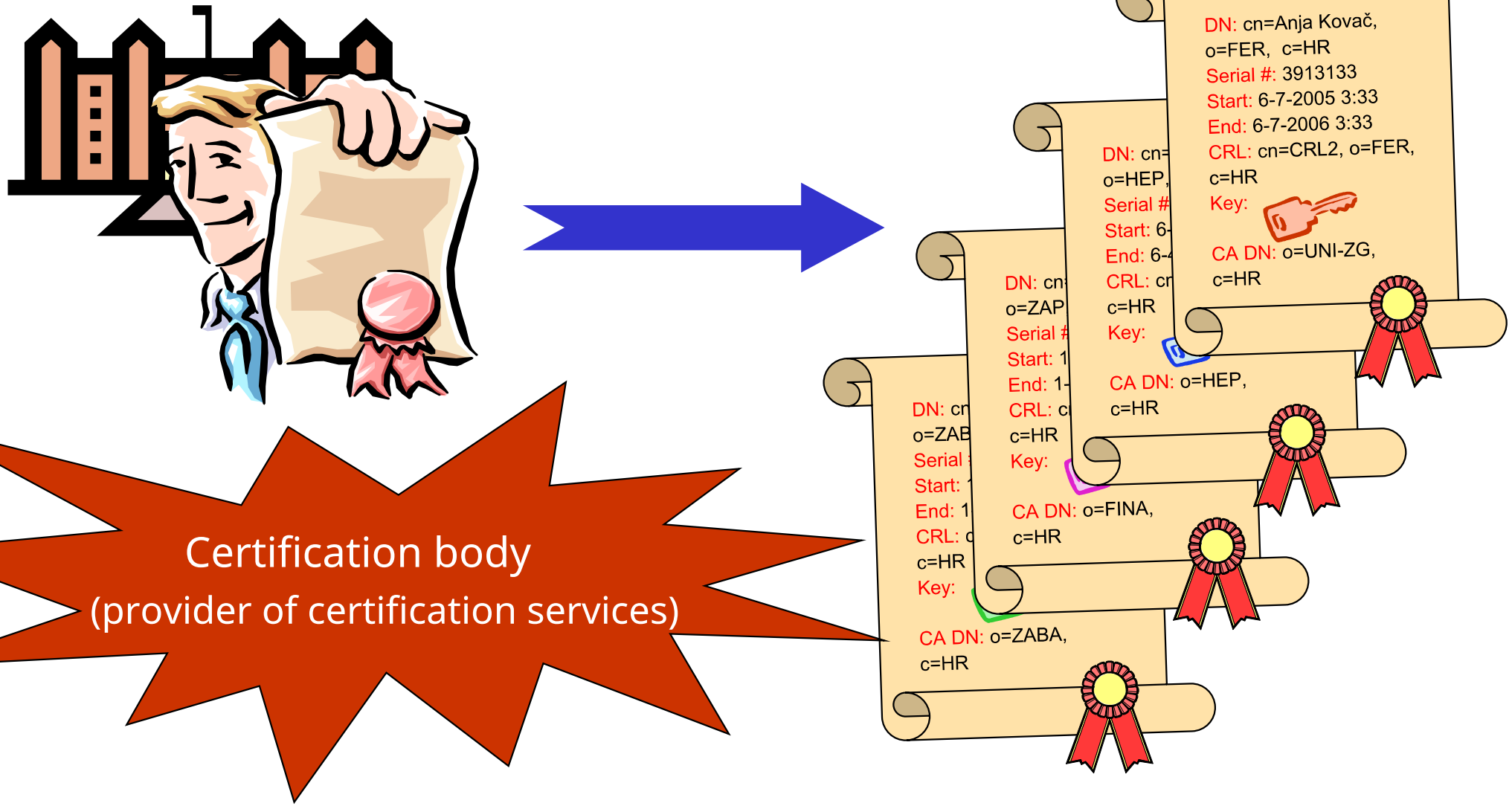
- It solves the problem of proving identity
- Connects user identity with his public key - confirms that a specific user is the owner of a specific public key
- A set of data that identifies the user and the certification service provider

- Norm:
  - the norm is used for digital certificates X.509
  - names are displayed in certificates as pairs: name - value

# Content of the certificate



## Certification Authority (CA –Certificate Authority)



# Digital certificate

- If the sender signs the message with his private key, the receiver canto know that it is precisely this sender:
  - if possibledecipherdigital signatureby the sender's public key and
  - ifdigital certificate confirmsthat the public key used is exactlypublic key of that sender.
  - if a digital certificatenot expired or revoked

- The assumption for this procedure is that users havetrust in the certification body (i.e. the certification service provider) that issued the certificate and signed it with its private key or to the certification body that was certified by the certification body that issued the certificate.

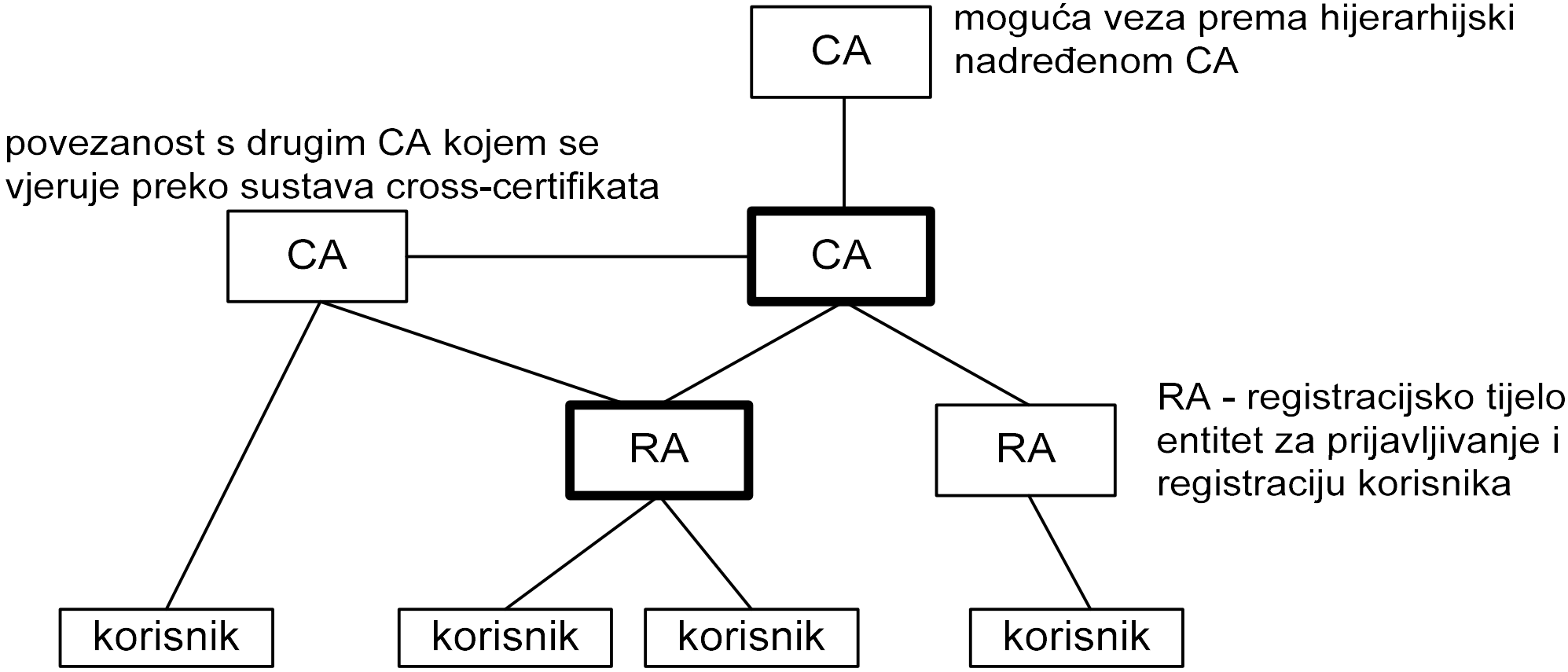
# Public Key Infrastructure

- PKI - Public Key Infrastructure
  - a set of hardware, software support, people, policies and procedures necessary to create, manage, issue, use, store and revoke digital certificates
  - basis for creating safe and confidential data exchange between participants in the system
  - provides:
    - the integrity of electronic communication, making it impossible to change data during their transmission over the network
    - confirming the identity of the parties participating in the communication
    - non-denial of any party's participation in the communication

# Parts of PKI

- certification authority (CA –Certificate Authority)
  - issues and withdraws certificates, maintains information on the status of certificates, publishes valid certificates...
- registration authority (RA –Registration Authority)
  - performs user registration (checks the content of certificates for CA, performs identification and authentication of parties applying for certificates)
- repository
  - contains a database of issued certificates and a database of revoked certificates (CRL - Engl. Certification Revocation List)
- clients (applications)
  - they verify digital signatures and certificates with a CA
- users of the PKI system
  - certificate holders
- Center for Trusted Time Stamping (TSA –EnglishTimestamp Authority)
  - creates timestamps

- one CA can have multiple RAs for different groups of users, one RA
- can be associated with multiple CAs



# Hierarchy of certification bodies

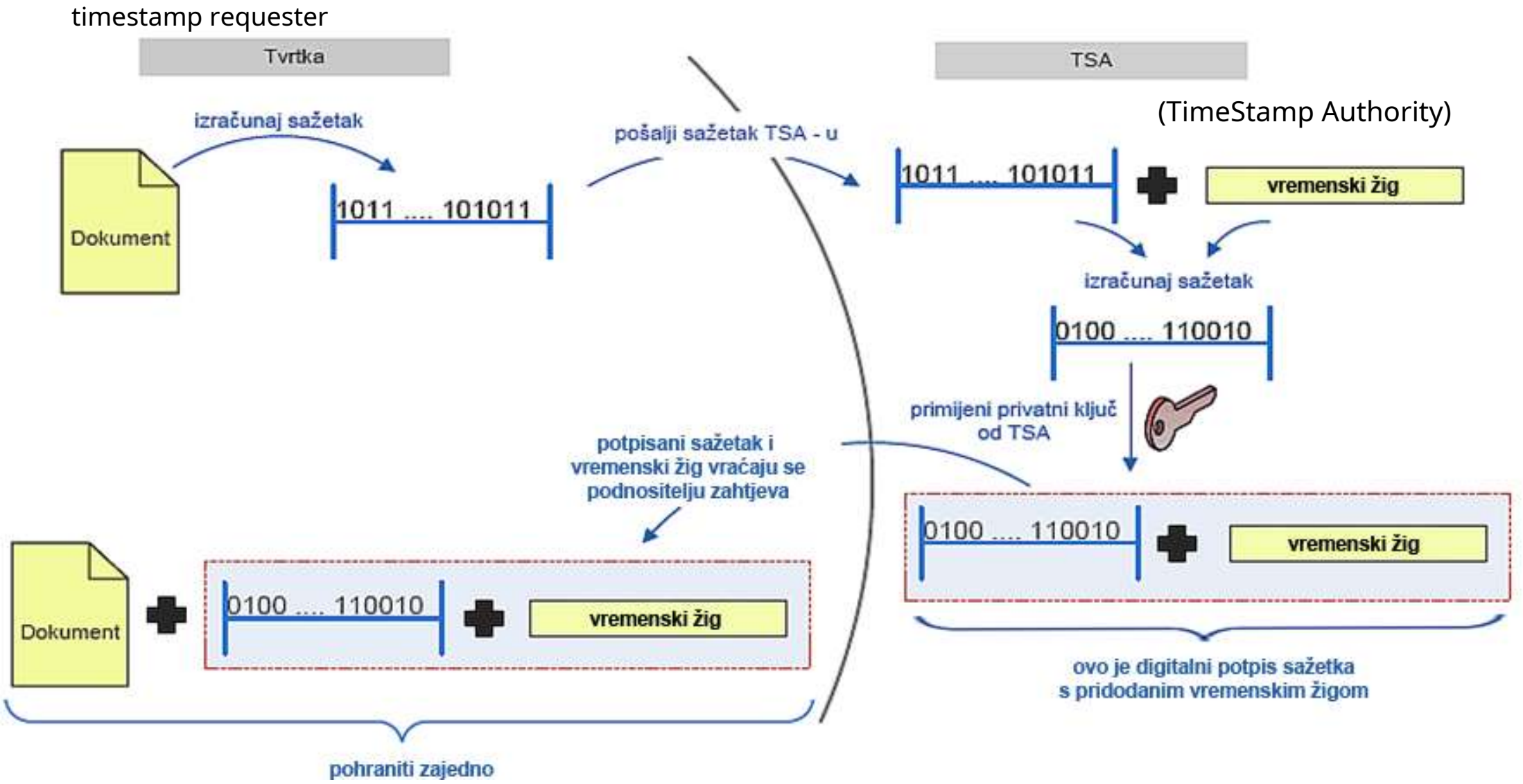
- One CA can sign another CA's certificate
- It can be donehierarchy of certification authorities (CA)
- If we don't trust a CA, we might trust a CA that is in the hierarchy above it. In this way, we also gain trust in the CA at a lower level of the hierarchy
- The CA at the highest level signs its own certificate – it is then a self-signed certificate. A CA with a self-signed certificate is a root CA

# Trusted Time Stamp Center (TSA)

- It creates timestamps to prove that certain data existed before a certain time

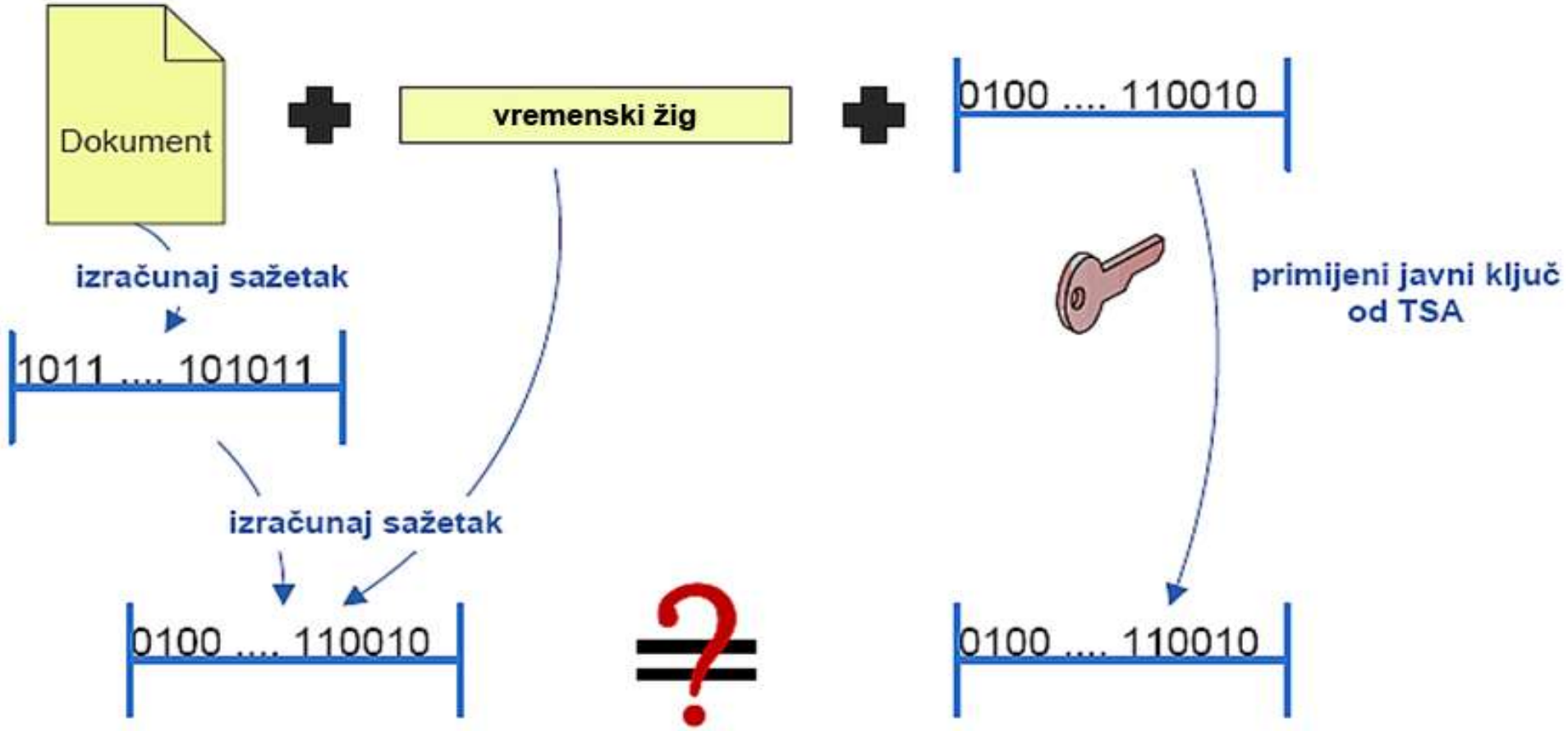
- TIME STAMP
  - Time stamp, time stamp, time stamp, time certification, Engl. timestamp
  - It ensures the reliability of the digital signature even after the expiration or revocation of the signer's certificate
    - Using a timestampit can be proven that the signature was made before the certificate expired

# Timestamp assignment procedure




- TSA does not receive original data from applicants but always handles summaries

# Timestamp verification procedure



# Timestamp verification procedure

- If the summaries are the same, it is proven that both the timestamp and the document are intact and that TSA issued the timestamp
  - It cannot be denied that the time stamp applicant was in possession of the original document at the time indicated by the time stamp.

- If the summaries are not equal, it means
  - that the timestamp or document has been changed
  - or that the time stamp was not issued by said TSA

1. Financial Agency (FINA)
   - Date of registration: 16 July 2008.
   - Services:qualified e-signature certificate, qualified e-seal certificate, qualified website authentication certificate, qualified time stamp, electronic signature certificate (nationally recognized
   - It issues certificates to individuals and legal entities for general purposes
2. Agency for Commercial Activity (AKD)
   - Date of registration: 29 May 2015.
   - Services:qualified e-signature certificate, qualified e-seal certificate, qualified time stamp
   - Certificates for eOI –smartID card
3. Zagrebačka banka (ZABA)
   - Date of registration: June 7, 2016.
   - Services:qualified e-signature certificate, qualified time stamp
   - Certificates primarily for banking services

The records of certification service providers in the Republic of Croatia are maintained by the Ministry of Economy and Sustainable Development

## FINA TSA –public time verification service provider

-FINA (asTSA)is a service providercertification of electronic signature

- FINA TSA verifies the signatory's signature with a time stamp
- it is confirmed that they aredata and electronic signature existed before the time stamp was applied

- Electronic signature
  - data in electronic form that are associated or logically connected with other data in electronic form and which the signer uses to sign
- Advanced electronic signaturemust meet the following requirements:
  - is undoubtedly related to the signatory
  - enables identification of the signatory
  - it is created using data for creating an electronic signature that the signer can, with a high level of confidence, use under his sole control
  - it is linked to the data signed by it in such a way that any subsequent modification of the data can be detected
- Qualified electronic signature
  - an advanced electronic signature that is created using qualified electronic signature creation tools and is based onqualified certificatefor electronic signatures

- member states have accepted qualified electronic signatures as legally equivalent to manual signatures and accept them as evidence in legal proceedings
  – the legal basis for the use of digital signatures exists
- some countries still have formal obstacles to the wider introduction of digital signatures (e.g. requirements for a written signature on two copies on a special form)
- the use of digital signatures in EU countries has not yet reached its peak, but there has been an increase in use over timelockdowncaused by the COVID pandemic
- legal uncertainty -the lack of a large number of previous court cases is a significant problem

# Regulation eIDAS

- eIDAS – Electronic Identification and Signature (Croatian electronic identification and signature)
- Regulation of the European Parliament and the Council on electronic identification and trust services for electronic transactions in the internal market - adopted on 23 July 2014.
  - A binding legislative act for all member states
- Enacted due to inconsistency of national legislation
  - Differences in the implementation of norms and rules in practice
  - How to reliably validate the e-signature of a signatory from another country?
  - Lack of reliable information necessary for complete validation of the e-signature
- Goal: establishment of trust and mutual recognition of e-signatures and e-seals within the EU

- To 7/7/2017 in the Republic of Croatia, the Law on Electronic Signature (from 2002)

- 23/07/2014 The European Parliament and the Council adopt the eIDAS regulation

- From 1 July 2016 The Law on Electronic Signature ceases to be valid in the part that contradicts the eIDAS regulation

- 19 June 2017 The Croatian Parliament passes the Law on the Implementation of the Regulation (...)

# Electronic seal

- Three types of seals:
  - Electronic seal
    - data in electronic form that are associated with other data in electronic form or are logically connected to them in order to ensure the originality and integrity of that data
  - Advanced electronic sealmust meet the following requirements:
    - it is undoubtedly related to the author of the seal
    - enables identification of the author of the seal
    - it was created using data for creating an electronic seal that the author of the seal can, with a high level of confidence and under his control, use to create an electronic seal
    - is linked to the data to which it refers in such a way that any subsequent modification of the data can be detected
  - Qualified electronic seal
    - an advanced electronic seal that is created using a qualified electronic seal maker and is based on a qualified electronic seal certificate

Uvodi se uredbom eIDAS

# Electronic signature and seal

| Elektronički potpis | Elektronički pečat |
|---|---|
| Potpisnik: **fizička osoba** koja izrađuje elektronički potpis | Autor pečata: **pravna osoba** koja izrađuje elektronički pečat |
| Elektronički potpis: podaci u elektroničkom obliku koji su pridruženi ili su logički povezani s drugim podacima u elektroničkom obliku i koje potpisnik koristi **za potpisivanje** | Elektronički pečat: podaci u elektroničkom obliku koji su pridruženi drugim podacima u elektroničkom obliku ili su logički povezani s njima radi **osiguravanja izvornosti i cjelovitosti** tih podataka |
| Sredstvo za izradu elektroničkog potpisa | Sredstvo za izradu elektroničkog pečata |
| Certifikat za elektronički potpis | Certifikat za elektronički pečat |

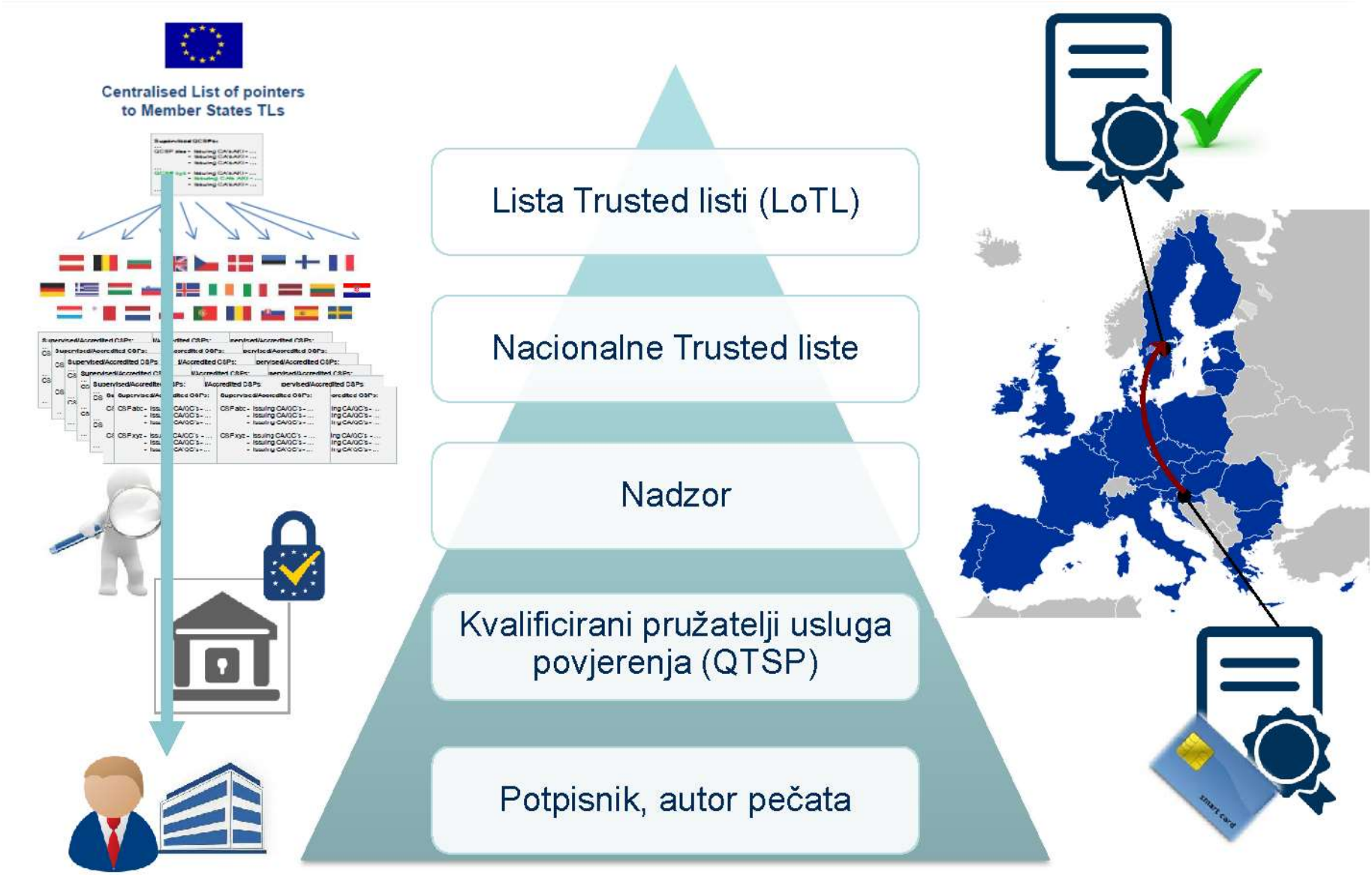
taken from: Perinčić, M., eIDAS regulation – Trust and mutual recognition of e-signatures and e-seals in the EU, expert meeting e-biz 2015, Zagreb, April 2015.

# Electronic signature and seal (2)

| Elektronički potpis | Elektronički pečat |
|---|---|
| **Napredan elektronički potpis**<br>• Na nedvojben način je povezan s potpisnikom<br>• Omogućava **identificiranje potpisnika**<br>• Izrađen je korištenjem podacima za izradu elektroničkog potpisa koje potpisnik može, uz visoku razinu pouzdanja, koristiti **pod svojom isključivom kontrolom**<br>• Povezan je s njime potpisanim podacima na način da se može se otkriti bilo koja naknadna izmjena podataka | **Napredan elektronički pečat**<br>• Na nedvojben način je povezan s autorom pečata<br>• Omogućava **identificiranje autora pečata**<br>• Izrađen je korištenjem podacima za izradu elektroničkog pečata koje autor pečata može, uz visoku razinu pouzdanja i **pod svojom kontrolom**, koristiti za izradu elektroničkog pečata<br>• Povezan je s podacima na koje se odnosi na takav način da se može otkriti bilo koja naknadna izmjena podataka |
| **Kvalificirani certifikat za elektronički potpis**<br>Izdaje ga kvalificirani pružatelj usluga povjerenja i ispunjava posebne uvjete | **Kvalificirani certifikat za elektronički pečat**<br>Izdaje ga kvalificirani pružatelj usluga povjerenja i ispunjava posebne uvjete |
| **Kvalificirano sredstvo za izradu elektroničkog potpisa**<br>Dodatno ispunjava zahtjeve za povjerljivost i sigurnost podataka za izradu e-potpisa, zaštićuju e-potpis od krivotvorenja i sl. | **Kvalificirano sredstvo za izradu elektroničkog pečata**<br>Dodatno ispunjava zahtjeve za povjerljivost i sigurnost podataka za izradu e-pečata, zaštićuju e-pečat od krivotvorenja i sl. |

taken from: Perinčić, M., eIDAS regulation – Trust and mutual recognition of e-signatures and e-seals in the EU, expert meeting e-biz 2015, Zagreb, April 2015.

# Trust system according to the eIDAS regulation




taken from: Perinčić, M., eIDAS regulation – Trust and mutual recognition of e-signatures and e-seals in the EU, expert meeting e-biz 2015, Zagreb, 2015.

# Security of XML documents

- Electronic business is mainly based on exchangeXML documents.

- Security standards embedded in XML:
  - XML-EncryptionandXML-Signature
  - are added to the document without violating XML rules
  - such documents can be viewed using standard XML tools

- security of XML documents can be implemented using standard security protocols
  - these algorithms use binary files that can then only be interpreted using special tools

# Security of XML documents

- TLS protocol can be used for secure transfer of documents through the network
  - that's itit only protects the transmissiondata through the network, anot storage
  - a document sent using only TLS ceases to be secure the moment it reaches its destination

- by applying security measures over the document itself using the XML security standard, the document is secured both in transmission and in later storage, because it is not the link that is secured, but the document itself

- normXML Digital Signatureis used to store a digital signature in an XML document
- normXML Encryptionis used to store encrypted content in XML format

# Canonicalization

- two logically identical XML documents can be written differently,
- for example, one containsextra space or extra empty line

- two documents logically equal, but a summary of those two documents obtained hash-algorithm is not equal!

  → with digital signing it forresults in unsuccessful signature verification, although the document is logically not changed, i.e. it would be expected that the verification should succeed

- to avoid such problems,XML documents should be canonicalized i.e.reduce to the same (canonical) form (standardization of spacing, etc.)

# XML-Signature (XML-DSig)

- XML-DSigis a W3C standard
  - W3C =World Wide Web Consortium
- defines how to embed a digital signature in an XML document (so that XML rules are met)
- not an algorithmfor digital signing
- with one signature, it is possible to sign several documents, it is
- also possible to sign documents that are not in XML format
- it is possible to sign only part of an XML document (in this way it is possible for different parts of an XML document to be signed by different people)

XML Signature Syntax and ProcessingVersion 1.1 (W3C recommendation, 11.4.2013)
http://www.w3.org/TR/xmldsig-core/

# XML-Signature (XML-DSig)

```
<SignatureID?>
    <SignedInfo>
        <CanonicalizationMethod/>
        <SignatureMethod/>
        (<Reference URI?>).
            (<Transforms>)?
        <DigestMethod>
          <DigestValue>
        </References>)+
    </SignedInfo>
    <SignatureValue>
      (<KeyInfo>)?
      (<Object ID?>)*
</Signature>
```

- An XML signature is implemented in an XML document via an elementsignatures

- ? -represents zero or one occurrence,

  \+ - one or more occurrences,

  * - zero or more occurrences

# XML-Signature (XML-DSig)

```
<Signature ID?>
      <SignedInfo>
            <CanonicalizationMethod/>
                  ...
       </SignedInfo>
                  ...
 </Signature>
```

- ElementSignedInfo–within its sub-elementsidentifies the data to be signed and different algorithmswhich will be used
- CanonicalizationMethod-contains a nameof the algorithm used to canonicalize the data

# XML-Signature (XML-DSig)

- SignatureMethod-definessignature generation algorithm

- SignatureValue-contains the signature value of the elementSignedInfo

```
<Signature ID?>
    <SignedInfo>
            <CanonicalizationMethod/>
            <SignatureMethod/>
            (<Reference URI?>).
              (<Transforms>)?
            <DigestMethod>
              <DigestValue>
            </References>)+
        </SignedInfo>
      <SignatureValue>
...
</Signature>
```

# XML-Signature (XML-DSig)

- References-identifies the resources to be signed and all algorithmswhich will be usedfor preprocessingdata. These algorithms are written in the element Transformsand include operations such as encryption/decryption, compression/inflation orXPath transformation (XPath allows signing part of the document).

```
<Signature ID?>
    <SignedInfo>
            <CanonicalizationMethod/>
            <SignatureMethod/>
            (<Reference URI?>).
              (<Transforms>)?
            <DigestMethod>
              <DigestValue>
            </References>)+
        </SignedInfo>
      <SignatureValue>
...
</Signature>
```

# XML-Signature (XML-DSig)

- ElementReferenceshas an attributeRUN which is optional butif the signature contains several elementsReferencesthen the URI is optional for only one element, and the others must have it.

- If the content of the URI"", i.e. an empty character string, it means that the document containing the element is being signed

```
<Signature ID?>
    <SignedInfo>
            <CanonicalizationMethod/>
            <SignatureMethod/>
            (<ReferencesURI?>
              (<Transforms>)?
            <DigestMethod>
              <DigestValue>
            </References>)+
        </SignedInfo>
      <SignatureValue>
...
</Signature>
```

# XML-Signature (XML-DSig)

EachReferencesincludes :

- DigestMethod-contains information about the algorithm used to calculate the summary of the document
- DigestValue-contains a summary of the document calculated by the algorithm specified in DigestMethod

KeyInfo-contains information about the io key certificate

```
<Signature ID?>
    <SignedInfo>
            <CanonicalizationMethod/>
            <SignatureMethod/>
            (<Reference URI?>).
              (<Transforms>)?
              <DigestMethod>
              <DigestValue>
            </References>)+
        </SignedInfo>
     <SignatureValue>
    (<KeyInfo>)?
...
</Signature>
```

# XML-Signature (XML-DSig)

```
<SignedInfo>
 <CanonicalizationMethod
  Algorithm="http://www.w3.org/TR/2001/REC-xml-c14n-20010315"/>
 <SignatureMethod
  Algorithm="http://www.w3.org/2000/09/xmldsig#rsa-sha1"/>
 <Reference URI="">
  <Transforms>
   <Transform
    Algorithm="http://www.w3.org/2000/09/xmldsig#enveloped-signature"/>
  </Transforms>
  <DigestMethod Algorithm="http://www.w3.org/2000/09/xmldsig#sha1"/>
  <DigestValue>tVicGh6V+8cHbVYFIU91o5+L3OQ=</DigestValue>
 </Reference>
</SignedInfo>
```

# XML-Signature (XML-DSig)

```
  <SignatureValue>
   dJDHiGQMaKN8iPuWApAL57eVnxz2BQtyujwfPSgE7HyKoxYtoRB97ocxZ
   8ZU440wHtE39ZwRGIjvwor3WfURxnIgnI1CChMXXwoGpHH//Zc0z4ejaz
   DuCNEq4Mm4OUVTiEVuwcWAOMkfDHaM82awYQiOGcwMbZe38UX0oPJ2DOE=
  </SignatureValue>
  <KeyInfo>
   <X509Data>
    <X509SubjectName>
     CN=My Name,O=Test Certificates Inc.,C=US
    </X509SubjectName>
    <X509Certificate>
     MIIB9zCCAWCgAwIBAgIERZwdkzANBgkqhkiG9w0BAQUFADBAMQswCQYD
     VQQGEwJVUzEfMB0GA1UEChMWVGVzdCBDZXJ0aWZpY2F0ZXMgSW5jLjEQ
     MA4GA1UEAxMHTXkgTmFtZTAeFw0wNzAxMDMyMTE4MTFaFw0zMTA4MjUy
     ...
    </X509Certificate>
   </X509Data>
  </KeyInfo>
 </Signature>
</PurchaseOrder>
```

# XML-Signature (XML-DSig)

- An XML signature can appear in three basic forms:
  - Wrapped signature (Enveloped) –the signature is inside the document.
  - Wrapping signature (Enveloping) –a signature delimits the document it signs.
  - Separate signature (Detached) –the signature is in a separate document, and the URI (Universal Resource Identifier)determines which document he signs.
  - it is possible to get new ones by combining these three forms
  - one of the possible combinations: insert the wrapping signature into the document so that it signs some precisely specified data

# XML-Signature (XML-DSig)

```
<Igrac xmlns="http://www.hou.hr/">
  <Ime>Antea</Ime>
  <Prezime>Tadic</Prezime>
  <Pozicija>Tehnicar</Pozicija>


  <Signature xmlns='http://www.w3.org/2000/09/xmldsig#'>

    <SignedInfo>
      <CanonicalizationMethod Algorithm="http://www.w3.org/TR/2001/REC-xml-c14n-20010315" />
      <SignatureMethod Algorithm="http://www.w3.org/2000/07/xmldsig#rsa-sha1" />
      <Reference URI="">
        <Transforms Algorithm="http://www.w3.org/TR/2000/WD-xml-c14n-20000710" />
        <DigestMethod Algorithm="http://www.w3.org/2000/07/xmldsig#sha1" />
        <DigestValue>jkhKJHHIhkklADKHj=dsfs34'FDE'?sdsa</DigestValue>
      </Reference>
    </SignedInfo>

    <SignatureValue>DFSLK89sdf?sdasHK</SignatureValue>

    <KeyInfo>
      <X509Data>
```

- Example of a wrapped signature - a document containing <Signature> is signed

# XML-Signature (XML-DSig)

- In the case of a wrapping signature, the content of the element is signedObject

```
<Signature ID?>
    <SignedInfo>
        ...
    </SignedInfo>
    <SignatureValue>
      (<KeyInfo>)?
      (<Object ID?>)* </
      Signature>
```

# XML-Signature (XML-DSig)

```
<?xml version="1.0" encoding="UTF-8"?>
<ds:Signature xmlns:ds="http://www.w3.org/2000/09/xmldsig#">
  <ds:SignedInfo>
    <ds:CanonicalizationMethod
         Algorithm="http://www.w3.org/TR/2001/REC-xml-c14n-20010315"/>
    <ds:SignatureMethod
         Algorithm="http://www.w3.org/2000/09/xmldsig#rsa-sha1"/>
    <ds:Reference URI="#obj">
      <ds:DigestMethod
          Algorithm="http://www.w3.org/2000/09/xmldsig#sha1"/>
      <ds:DigestValue/>
    </ds:Reference>
  </ds:SignedInfo>
  <ds:SignatureValue/>
  <ds:Object Id="obj">Hello, World!</ds:Object>
</ds:Signature>
```

- Example of a wrapping signature - the content of the <Object> element is signed

# XML-Signature (XML-DSig)

```
<?xml version="1.0" encoding="UTF-8"?>
<ds:Signature xmlns:ds="http://www.w3.org/2000/09/xmldsig#">
  <ds:SignedInfo>
    <ds:CanonicalizationMethod
         Algorithm="http://www.w3.org/TR/2001/REC-xml-c14n-20010315"/>
    <ds:SignatureMethod
         Algorithm="http://www.w3.org/2000/09/xmldsig#rsa-sha1"/>
    <ds:Reference URI="http://www.w3.org/TR/xml-stylesheet">
      <ds:DigestMethod
          Algorithm="http://www.w3.org/2000/09/xmldsig#sha1"/>
      <ds:DigestValue/>
    </ds:Reference>
  </ds:SignedInfo>
  <ds:SignatureValue/>
</ds:Signature>
```

- Example of a separate signature – the signature is in a separate XML file, and what is being signed is identified by a URI in the <Reference> elements

# XML-Signature (XML-DSig)

```
<Igrac xmlns="http://www.hou.hr/">
  <Ime>Antea</Ime>
  <Prezime>Tadic</Prezime>
  <Pozicija>Tehnicar</Pozicija>
  <Signature xmlns='http://www.w3.org/2000/09/xmldsig#'>
    <SignedInfo>
      <CanonicalizationMethod Algorithm="http://www.w3.org/TR/2001/REC-xml-c14n-20010315" />
      <SignatureMethod Algorithm="http://www.w3.org/2000/07/xmldsig#rsa-sha1" />
      <Reference URI="">
        <Transforms Algorithm="http://www.w3.org/TR/2000/WD-xml-c14n-20000710" />
        <DigestMethod Algorithm="http://www.w3.org/2000/07/xmldsig#sha1" />
        <DigestValue>jkhKJHHIhkklADKHj=dsfs34'FDE'?sdsa</DigestValue>
      </Reference>
      <Reference URI="http://www.abccompany.com/news/2000/03_27_00.htm">
        <DigestMethod Algorithm="http://www.w3.org/2000/09/xmldsig#sha1" />
        <DigestValue>j6lwx3rvEPO0vKtMup4NbeVu8nk=</DigestValue>
      </Reference>
    </SignedInfo>
    <SignatureValue>DFSLK89sdf?sdasHK</SignatureValue>
    <KeyInfo>...</KeyInfo>
    <Object>...</Object>
  </Signature>
</Igrac>
```

ovaj dokument

neki drugi dokument identificiran URI-jem

- An example of a hybrid signature – a combination of a wrapped and separate signature

# XAdES

XAdES (XML Advanced Electronic Signatures)

-XML-Dsig Recommendation Extension Set (only

reported for W3C recommendation)

ETSI (European Telecommunications Standards Institute)norm
TS 101 733

- It defines six profiles that differ in the level of protection they offer:
  - -XAdES - advanced electronic signature in accordance with Directive 1999/93/EC
  - -XAdES-T - includes a time stamp
  - -XAdES-C - adds to XAdES-T links to certificates and list of revoked certificates
  - -XAdES-X - adds to XAdES-C timestamps on introduced links
  - -XAdES-XL - adds certificates and a list of revoked certificates to the signed document
  - -XAdES-A - requires a sequence of timestamps for long-term archiving

# XMLEncryption (XML-Enc)

- XML-Encdescribes how encrypted contentembed in XML
- It's notencryption algorithm

- Non-XML documents can also be encrypted
- It is possible to encrypt only part of the XML document
- Different parts of the XML document can be encrypted with different keys - access control

- XML Encryption Syntax and ProcessingVersion 1.1. (11.4.2013)

  http://www.w3.org/TR/xmlenc-core/

# XMLEncryption

Encryption can be performed in three ways:

- usingsymmetric cryptography -the data is encrypted with a symmetric key that was previously exchanged by the communication participants in some (secure) way

- usingasymmetric cryptography -the data is encrypted with the recipient's public key
- usinghybrid approach -data is encrypted with a symmetric key, and that symmetric key is encrypted with the receiver's public key; the encrypted symmetric key and the content encrypted with that symmetric key are embedded in the XML document; this approach is the most common

# XMLEncryption –structure

```
<EncryptedData Id? Type? MimeType? Encoding?>
  <EncryptionMethod/>?
  <ds:KeyInfo>
    <EncryptedKey>?
    <AgreementMethod>?
    <ds:KeyName>?
    <ds:RetrievalMethod>?
    <ds:*>?
  </ds:KeyInfo>?
  <CipherData>
    <CipherValue>?
    <CipherReference URI?>?
  </CipherData>
  <EncryptionProperties>?
</EncryptedData>
```

Algoritam kojim se podatci šifriraju

Informacije o ključu kojim je sadržaj šifriran

Šifrirani podatci

Dodatne informacije

# XML-Encryption (XML-Enc)

- SpecificationXML Encryption Syntax and Processinghe betrayedW3CXML Encryption Working Groupwith the aim of establishing the encryption/decryption process of digital content (including XML documents as well as their parts) and syntax, in order to display:
  - encrypted contentand
  - enabling informationto a specific recipientdecoding received content.

- The result of encryption is a data element that contains (via one of its sub-elements) or identifies (via a URI reference)encrypted data.

- When we encrypt an XML element or element contentencrypted data (element EncryptedData)they replace the element or contentin an encrypted version of the XML document.

# XMLEncryption –example

```
<?xml version="1.0" standalone="no"?>
<igrac>
    <ime>Antea</ime>
    <prezime>Tadic</prezime>
    <EncryptedData Type="http://www.w3.org/2001/04/xmlenc#Element"
        xmlns="http://www.w3.org/2001/04/xmlenc#">
      <EncryptionMethod
          Algorithm="http://www.w3.org/2001/04/xmlenc#aes256-cbc" />
      <KeyInfo xmlns="http://www.w3.org/2000/09/xmldsig#">
        <EncryptedKey xmlns="http://www.w3.org/2001/04/xmlenc#">
          <EncryptionMethod
              Algorithm="http://www.w3.org/2001/04/xmlenc#rsa-1_5" />
          <KeyInfo xmlns="http://www.w3.org/2000/09/xmldsig#">
            <KeyName>session</KeyName>
          </KeyInfo>
          <CipherData>
            <CipherValue>r4f7SI1aZKSvibbfsd5345</CipherData>
        </EncryptedKey>
      </KeyInfo>
      <CipherData>
        <CipherValue>sGNhKqcSovipJdOFCFKYEEMRFsdaZIUh</CipherValue>
      </CipherData>
    </EncryptedData>
</igrac>
```

šifrirani sadržaj

algoritam za šifriranje saržaja

algoritam šifriranja simetričnog ključa

šifrirani simetrični ključ

podatci šifrirani simetričnim ključem

- the content of the element is encrypted<position>
- a hybrid approach is used

- symmetrical key

is encrypted with public ones

key

recipient

(RSA algorithm)

and together with

encrypted

sends the content

to the destination

# XMLEncryption –example

Example explanation:

- the content of the <position> element is encrypted
- hybrid approach - data is encrypted with a symmetric key, and then this symmetric key is encrypted with the receiver's public key, and it is sent to the destination together with the encrypted content
- in the picture, the algorithm that encrypts the symmetric key is marked in blue - the asymmetric RSA algorithm
- the encrypted key is shown in green
- the content of the XML document that needs to be hidden is encrypted with the symmetric AES algorithm, which is shown in orange in the picture. This is how the encrypted content is obtained, which is marked in gray in the picture.
- the <EncryptedData> element (red in the image) is located exactly where the element to be encrypted was previously located

# Security in electronic commerce

# Security requirements codeonlinepayments

- Authentication -in an online payment transaction, it is known who is participating in the transaction and it is known that the person is exactly who he claims to be.
- Integrity -the data from the transaction will not be changed
- Uniqueness of payment requests -enables the merchant to recognize repeated requests for the same transaction
- Non-repudiation of the transaction -after executing the transaction, the buyer cannot deny that he executed the transaction, that is, the merchant cannot deny that he received the transaction
- Confidentiality –transaction data cannot be accessed without authorization
- Customer privacy and anonymity -the merchant can only see the buyer's pseudonym or username, but not his private information
- System reliability -preventive actions in the event of a system crash and in case of errors during the execution of the transaction

# Card payment in the electronic store

- Example:PayPal –one of the most widespread and well-known online payment systems in the world

- to send money you only need to knowe-mail addressPayPalaccount of the person/company to whom the money is to be sent
- for paying money toPayPalthe account uses a credit or debit card
- onlinepayment: or sPayPalaccount or credit cards

- In October 2002eBayboughtPayPal (at the time of purchase more than 50% of users eBayhas already usedPayPal)

- He is in CroatiaPayPalcame in mid-2006.
  - initially only sending money, and since March 2011 users from Croatia have been able to receive money on their ownPayPalaccount

# Card payment in the electronic store

## SafetyPayPaltransaction

- the credit card number is not given to the merchant during the transaction
  - only the customer's e-mail address is forwarded to the merchant
  - the merchant receivesonlinepayment without being able to see the customer's financial data
  - after each transaction, the user receives an e-mail message to his e-mail address with information about the completed transaction

- all data (personal and financial) sent from the client computer toPayPalserver are encrypted.
  - when registering or logging in toPayPalwebsite uses TLS 1.2 (or higher)
  - the SHA-256 algorithm is used for SSL certificates
- servers with sensitive financial dataare not directly connected to the Internet

# Card payment in the electronic store

SafetyPayPaltransaction (continuation)

- Check:
- Address Verification Service (AVS)is the system used forverification of the person's address which claims to own a certain credit card. The system will compare the address provided by the credit card user when executing an online payment transaction (or when linking a credit card withPayPal account) with the address registered with the card issuer. AVS checks only the numerical part of the address (postal code, house number).
- Card Security Code (CSC)orCard Code Verification (CCV)- the three- or four-digit security code usually found on the back of the credit card written in reverse italics.
  - This code is used as a security check when it is not possible to use a PIN- And.
  - Merchants that require a CVV2 code on transactions of typecard-not-presentthey must notthat codeFeed.
  - This security measure is one of the security measures of the security standardPCI DSS (Payment Card Industry Data Security Standard).

# Card payment in the electronic store

- About security...

  ... from websites

  provider of online billing services

- **3D Secure zaštita za sve trgovce i kupce**
  - WSpay™ sustav koristi najviše standarde zaštite i privatnosti podataka.
  - Svi trgovci koji koriste WSpay™ su uključeni u 3D secure zaštitu, čime se jamči korisnicima shopa da je kupnja sigurna.
  - Brojevi kreditnih kartica kupaca se ne čuvaju na sustavu a sami upis se štiti SSL enkripcijom podataka

Jamstvo sigurne online kupnje Klikni ovdje

MasterCard SecureCode learn more

Verified by VISA learn more

- **Certifikacija po PCI DSS standardima**
  - WSpay™ sustav radi kontinuirano na povećanju sigurnosti i potvrđivanju toga. Od ove godine će biti potvrđeno da posluje po najvišim standardima koji kartičar propisuje.
  - PCI Data Security Standard (PCI DSS) je norma koja definira sigurnosne mjere za obradu, spremanje i prenošenja (komunikaciju) kartičnih podataka.

## Sigurnost

Od 1.siječnja 2008. godine počeo se primjenjivati novi sigurnosni standard (PCI DSS) u CEMEA regiji. Sigurnosni standard vrijedi za sve trgovce, procesore i banke koji sudjeluju u kartičnom poslovanju. PCI DSS vrijedi i za proizvođače opreme, aplikacija kako i na tvrtke koje nude hosting usluge.

VISA, MasterCard, American Express, Diners, Discover Card i JCB su zajedno stvorili industrijski standard za sigurnost podataka kako bi zaštitili svoje korisnike. Ovaj standard za industriju kartičnog poslovanja osigurava svim trgovcima, bankama i pružateljima usluga zaštitu podataka vlasnika kartica.

Svi pružatelji usluga moraju se certificirati od strane kvalificiranih revizora sigurnosti za VISA-u i akreditiranog pružatelja usluga skeniranja za MasterCard kako bi zadržali pravo procesiranja kartičnog plaćanja.

# PCI DSS

PCI DSS -Payment Card Industry Data Security Standard

- -security standard for card business
- -defines minimum security measures and processes

- He defined itPayment Card Industry Security Standards Council
  - -Visa, MasterCard, American Express, Discover Card and JCBhave together created an industry standard for data security to protect their users.
  - -provides merchants, card houses, banks and other business entities that deal with card businesscardholder data protection
- The first version of the PCI DSS standard was issued in
- 2004. Version 3.2.1 was issued in May 2018.

https://www.pcisecuritystandards.org/documents/PCI_DSS_v3-2-1.pdf

# PCI DSS

- Banks and service providersthey have tocertify the codequalifiedauditor security, and merchants are obliged to comply with PCI DSS standards and conduct card transactions only with certified service providers.

- PCI DSS regulates requirements related to data security management, security procedures, network architecture, design of software support for data processing and other critical protective measures in card business.

- The core of PCI DSS consists of a group of principles and supporting requirements around which specific elements of data security in card business are organized.
  - 12 basic requirements and about 270 sub-requirements

Some of the requirements from PCI DSS:

Requirement 1:Install and maintain an appropriate firewall configuration (Eng.firewall)to protect cardholder information.

Request 2:Do not use passwords and other security parameters provided by the vendor of the software security solution

- Change initial passwordsset by the supplier

Request 3:All stored data about the cardholder must always and unconditionally be protected.

- card security codes (three- or four-digit number usually printed on the back of the card) used to confirm (verify) the transactionand PIN numbers must not be stored.

Some of the requirements from PCI DSS (continued):

Request 4:During transmission via open, public networks, all cardholder data must be protected by encryption.

- Use strong cryptographic methods and security protocols (eg SSL/TLS, IPSEC, SSH) to protection of sensitive card (user) data during transmissionthrough open, public networks (Internet, wireless transmission, GSM and GPRS).

Request 5:It is necessary to use and regularly update software to protect against malicious code, i.e. antivirus software

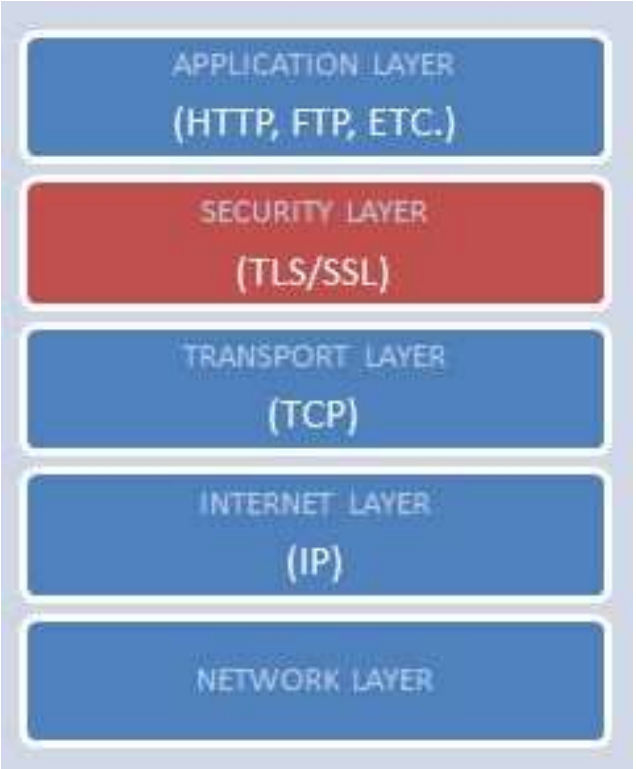
...

# TLS / SSL

- The credit card number is entered via a web browser and travels to the online store's web server

- with electronic paymentit is necessary between the transport protocol TCP and the application protocol HTTP to use isecurity protocol TLS / SSL

- TLS / SSLprovidescodingof all communications above the transport layer.



# TLS / SSL

- SSL protocol (Eng.Secure Socket Layer)developed by Netscape Communications - version SSL 3.0 was released in 1996
- protocol TLS (Eng.Transport Layer Security)was released in 1999 - an upgrade to SSL 3.0
  - In 2006, TLS 1.1
  - in 2008TLS 1.2-useshash-functionSHA-256(from SHA-2)
  - in 2018TLS 1.3

- TLS / SSL
  - is used for more secure exchange of confidential data, such as username and password, credit card number, etc.
  - is based on the use of cryptography and public key infrastructure. Public key infrastructure -PKI)
    - private and public keys

# TLS / SSL

- Forcard paymentover the network is recommended to useTLS 1.2 orTLS 1.3(published in August 2018)
- Do not use SSL.

- When using SSL/TLS
  - the address starts with a labelhttps://
  - all communication between the browser and the web server is encrypted

- HTTPS (Hypertext Transfer Protocol Secure) -a combination of HTTP and SSL/TLS protocols (Secure Sockets Layer / Transport Layer Security)

# TLS / SSL

- It serves to protect against attacks:
  - eavesdropping (eng.eavesdropping)
  - man-in-the-middle (eng.man-in-the-middle)

- interception and unauthorized eavesdropping of communications and possible theft of credit card numbers are prevented

- however, it does not solve the problemstoragecredit card numbers on the server itself

# TLS / SSL

- When a secure connection is established (certificate received and verified by CA), a padlock icon appears in the browser and the address begins with https://


- When entering confidential data on websites, check whether the website is currently protected (https://)
- The browser usually has built-in security mechanisms that alert if the web site is not secure

# TLS / SSL

- some CAs have introduced "domain check only" type SSL certificates (domain validation only)for which it worksminimal checkdetails in the certificate
  - for each successful SSL connection – a padlock icon appears
- many browsers did not clearly distinguish certificates with lenient validation from those that do rigorous validation
  - users are not aware whether the web site is sufficiently verified or not
  - possibilityphishing -web sites built to serve forphishing they can use TLS/SSL to get extra credibility
- Extended Validation Certificate (EV) prescribesstricter criteriafor identity verification
  - The name of the CA that issued the EV certificate is displayed
  - The color (usually green) indicates that the EV certificate is valid
- Today's web browsers display the EV status.

# Phishing

- Phishing -attackers try to find out confidential information (most often passwords, credit card information or PIN) by impersonating a credible subject in the communication.
- fake messagean attempt is made to lure the user by e-mail or by sending a message through the instant messaging systemto a fake website,in order to enter your username and password, PIN, credit card number, etc.
- For example "To verify that your account has not been used without authorization, please click on the link below and confirm your identity"
- fake websites of banks oronlinestores that visually look identical to real sites
- If the fake page mimics internet banking, when the user logs in to the system, a script in the background can automatically log him into the real bank page, while the generated OTP (one-time password) is still valid. After that, the script, hidden from the user, starts the money transfer...

# TLS / SSL

- The company that developed a particular web browser decides which certification authorities (CA -certification authority)will believe.

- The user should trust the HTTPS connection only if:
  - The user trusts that the browser correctly implements HTTPS with correctly pre-installed certificate checks from known and trusted CAs
  - The web site has a valid certificate (signed by a CA)
  - The user trusts that CA

# TLS / SSL

- TLS/SSL certificates
  - they confirm the identity of the website to website visitors,
  - guarantee safe and confidential data exchange As a
- result, the trust of visitors to the Web site grows.


- The most famous companies that issue SSL certificates:

  VeriSign, Thawte, GeoTrust, RapidSSL, GlobalSign, GoDaddy, Entrust, ...

- root CA – can authorize other CAs to sign and verify certificates on their behalf (CA hierarchy)

- Confidence in the certification system?
  - trust in CAs lower in the hierarchy who have received authority from root CAs?
  - adoption of standards for CA verification (like PCI standards in card business)?