Security aspects of XML and Web services

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Outline

- Introduction: architectures
- XML security: transmission
- XML security: documents
- Web services security
- Industry implementations
- Conclusions

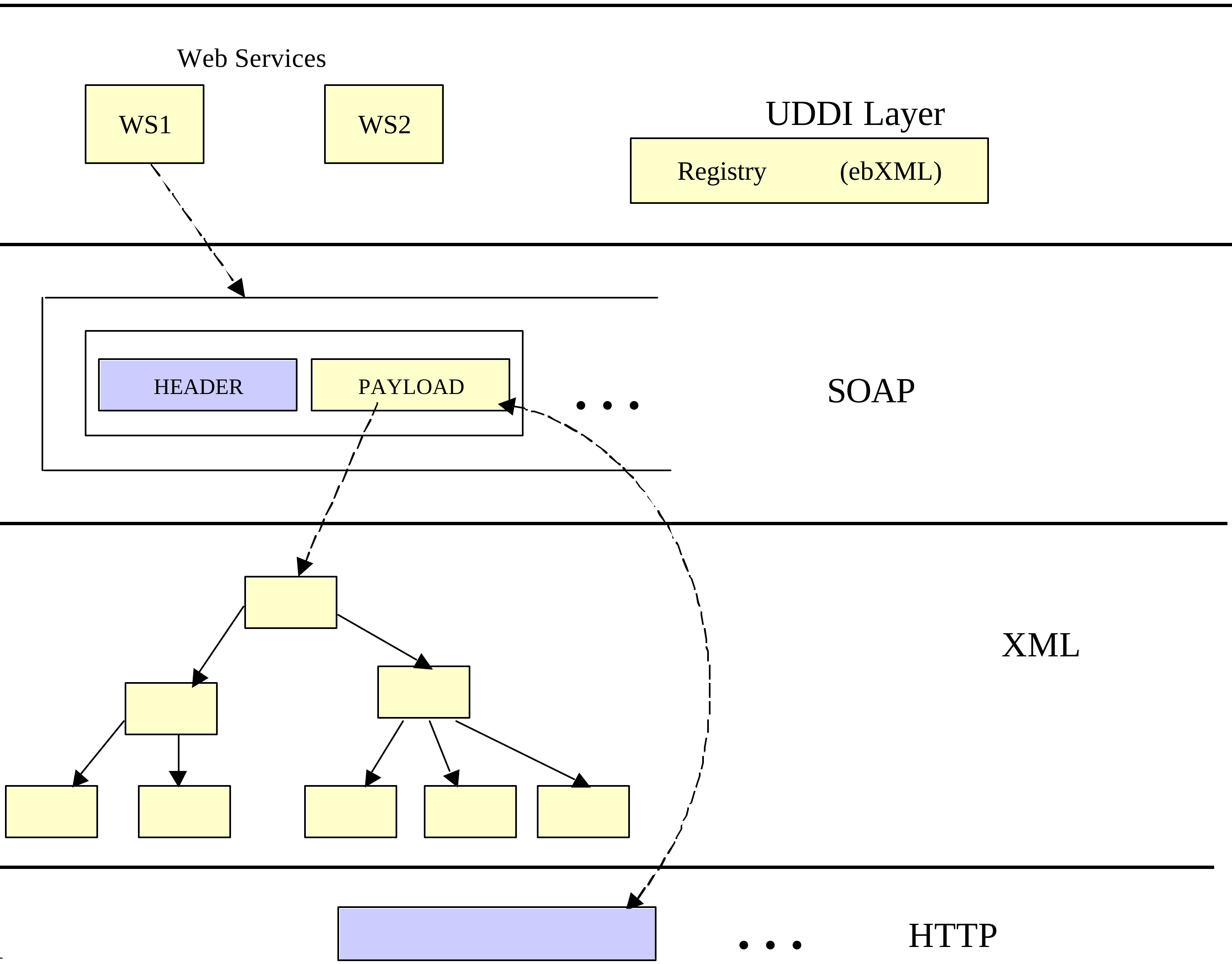
Introduction

- XML is a metalanguage used for defining markup vocabularies
- SOAP is a text-based wire protocol used to transmit XML messages
- A Web Service is a type of component that is available in the web and can be incorporated in applications or used as a standalone service

Architectures

- Web services (eServices) are a part of the application layer
- Web services are built out of XML, a lower-level data layer
- A SOAP layer is used for XML message transmission
- Internet layers and web server layers provide support for these layers

Web Services Architectural Layers



Web Services

WS1

WS2

UDDI Layer

Registry (ebXML)

HEADER

PAYLOAD

. . .

SOAP

XML

. . .

HTTP

Security

- Protection against :
    - Illegal (unauthorized) data disclosure (confidentiality)
    - Illegal data modification (integrity)
    - Illegal data destruction
    - Denial of service (availability)
    - Repudiation of messages

Policies

- Policies are high-level institution guidelines
- There are business policies, security policies, and system policies
- From security policies we define security models for the security systems
- Protection of messages in networks and of stored data

Message security

- Message confidentiality
- Digital signatures
- Message integrity
- Key management
- Certificates
- Authentication

Security of stored data

- Access matrix: defines who can do what to a data object . Based on authorization rules with subjects, objects, and access types

- Role-Based Access Control (RBAC): users are assigned roles according to their functions and given needed rights

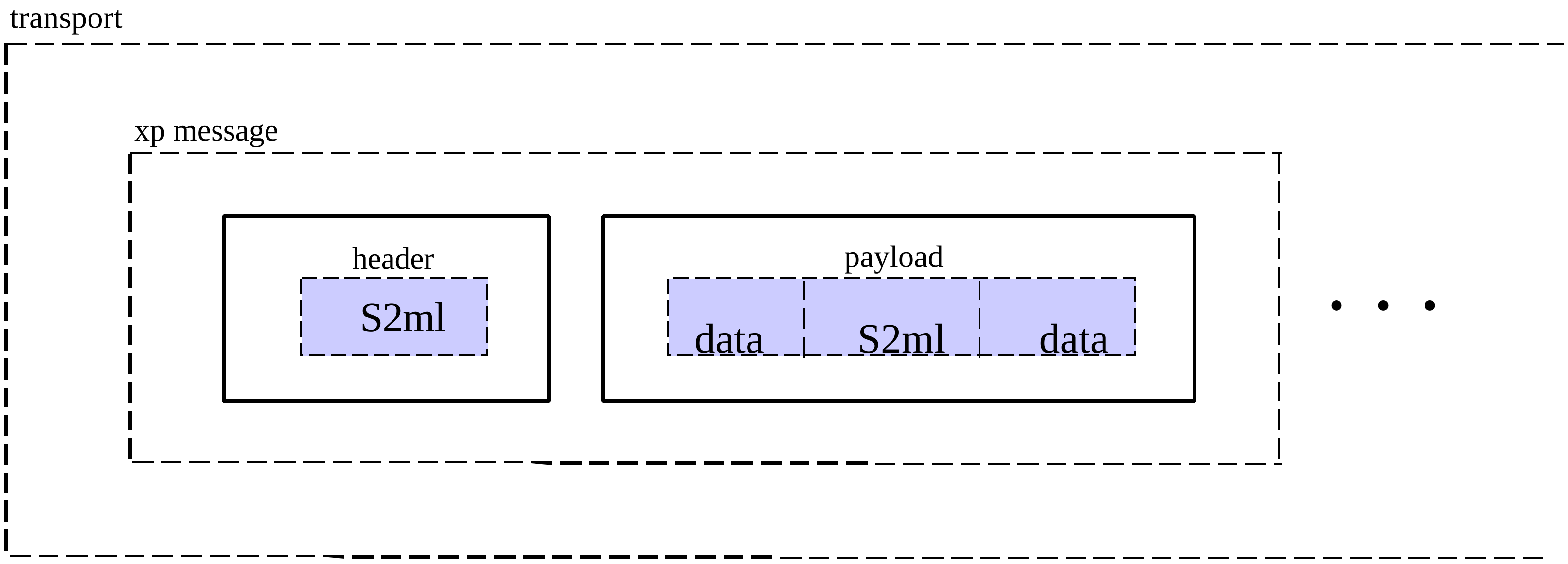
XML security: transmission

- Based on transport security and document encryption
- SOAP and its lower layers provide authentication, signatures, key management, and confidentiality
- XML encryption provides confidentiality

SOAP security

- No security specification
- Security delegated to lower layers: vendor-dependent
- Authentication: Kerberos, Windows NTLM,…
- Message confidentiality: SSL, XML encryption
- Authorization: web servers

XML Message



SOAP message security

- Headers can be used for signatures
- Authorization and authentication information in payload
- XML data can be encrypted
- Transport data can be encrypted

```
<SOAP-ENV:Envelope
                                        xmlns:SOAP-ENV="
                     http://schemas.xmlsoap.org/soap/envelope/"
                                        xmlns:xsi="
                     http://www.w3.org/1999/XMLSchema-instance"

xmlns:xsd="http://www.w3.org/1999/XMLSchema">
                         <SOAP-ENV:Header>
                         </SOAP-ENV:Header>
                        <SOAP-ENV:Body>
                            <ns1:sayHelloTo
                                       xmlns:ns1="Hello"
                                      SOAP-ENV:encodingStyle="
                     http://schemas.xmlsoap.org/soap/encoding/">
                               <name xsi:type="xsd:string">John</name>
                            </ns1:sayHelloTo>
                        </SOAP-ENV:Body>
                     </SOAP-ENV:Envelope>
```

XML encryption requirements

- XML Encryption Working Group
- Granularity of encryption to the element (including start/end tags) or element content (between the start/end tags)
- Super-encryption possible

Public Key Infrastructure

- XML Key Management Specification (XKMS)
- Registration of key pairs (X-KRSS)
- Location of keys for later use
- Validation information associated with a key (X-KISS)
- X-KRSS and X-KISS use SOAP and XML

Adding cryptographic providers

```
public void addProvider(String providerClassName) {
    outln("Adding Provider: " + providerClassName);
    try {
      Class providerClass =
              Class.forName(providerClassName);
      Provider provider =
              (Provider) providerClass.newInstance();
      Security.addProvider(provider);
    } catch (ClassNotFoundException cnf) {
      throw new RuntimeException
      ("Provider class not found: "+providerClassName);
```

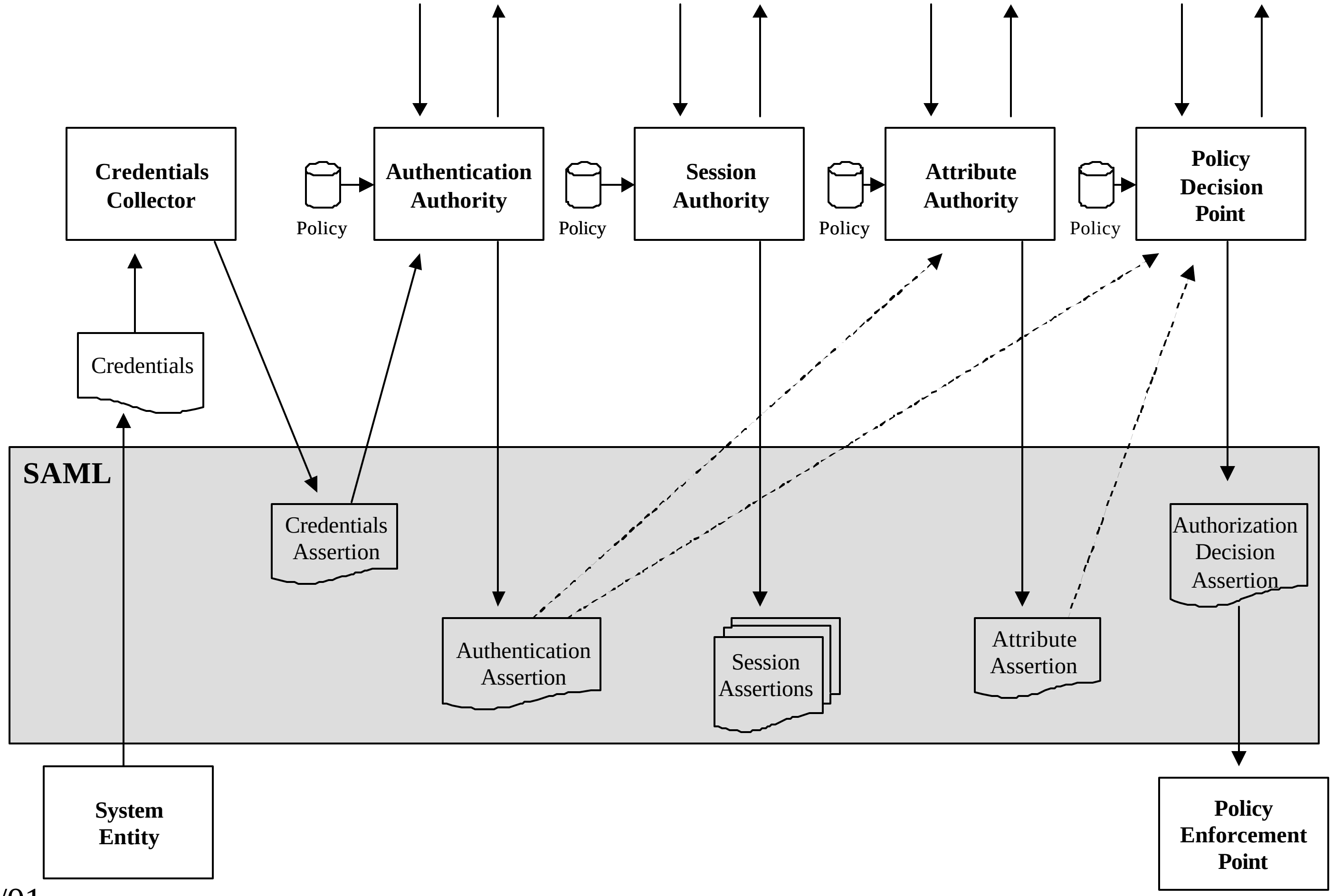
XML security: Document

- One can (and should) use domain-based security according to document contents
- Languages to define authorizations on elements (access matrix)
- SAML (Security Assertion Markup Language)
- XACL (XML Access Control Language)
- Encryption of elements
- DTDs, DOMs, and links can also be used for security

Security Assertion Markup Language (SAML)

- Part of XML-based Security Services
- XML framework for exchanging authentication and authorization information
- SAML information can be added to XML messages

SAML


Credentials Collector
Policy
Authentication Authority
Policy
Session Authority
Policy
Attribute Authority
Policy
Policy Decision Point
Credentials
SAML
Credentials Assertion
Authentication Assertion
Session Assertions
Attribute Assertion
Authorization Decision Assertion
System Entity
Policy Enforcement Point

XACML

- Special technical committee of OASIS
- Specification of policies for information access over the Internet
- Combines work of IBM Tokyo and University of Milano, Italy.

XML Access Control Language

- XACL is being developed at IBM’s Tokyo Research Lab
- Defines access matrix authorization rules to control access to documents or portions of a document
- Rule has subject, right, object, and condition

Access matrix authorization rules

- Basic rule (s, a, o) , where s is a subject (active entity), a is an access type , and o is an object
- Extended rule (s, a , o , p) , where p is a predicate (access condition or guard)

Example

- Documents have ‘contents’ and ‘policy’
- Alice has read and write privileges on the contents element
- Bob has only read privilege on the contents element
- No other users can access this document (closed system policy)

```
<document>

        <contents id="contents">
          <userInfo id="section1">
            <date>Oct. 8, 1999</date>
            <name>Kudo</date>
          </userInfo>
          <bidInfo id="section2">
            <price currency="USD">150</price>
            <brand name="VISA"/>
          </bidInfo>
        </contents>
```

```
<policy>
    <xacl>
     <object href="id(contents)"/>
     <rule id="rule1">
      <acl>
       <subject><uid>Alice</uid></subject>
       <privilege type="read" sign="+"/>
       <privilege type="write" sign="+"/>
      </acl>
     </rule>
     <rule id="rule2">
      <acl>
       <subject><uid>Bob</uid></subject>
       <privilege type="read" sign="+"/>
      </acl>
     </rule>
```

```
<rule id="rule3">
         <acl>
          <subject></subject>
          <privilege type="read" sign="-"/>
          <privilege type="write" sign="-"/>
         </acl>
        </rule>
       </xacl>
       </policy>

       </document>
```

Other security issues

- Different representations for the same document and the same representation for different documents
- Security of links
- Trust in intermediate steps
- Security across institutions– need for abstract models

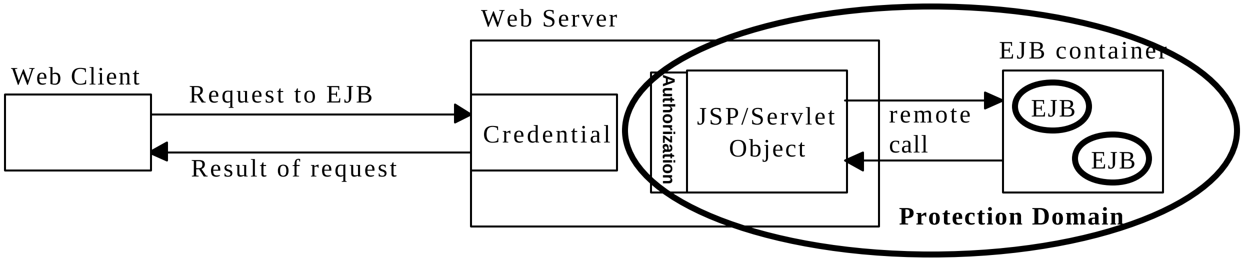
Privacy preferences

- User control over personal information
- P3P (Platform for Privacy Preferences), developed by the W3C
- A standardized set of multiple-choice questions about privacy policies

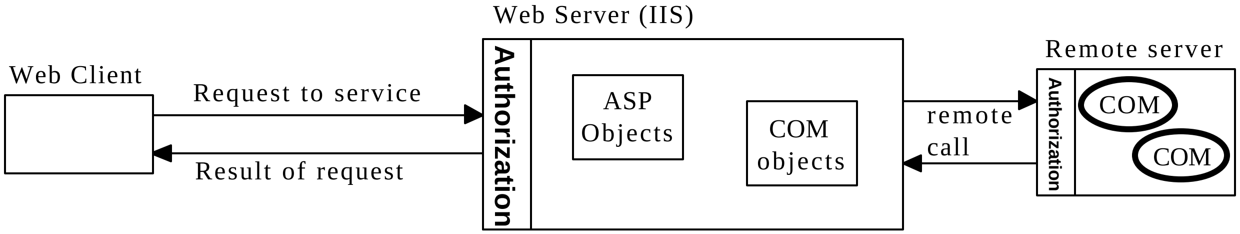
Security enforcement

- XML and Web services security is platform-independent but must be enforced by specific platforms
- Web Server and Web Application Integrator define execution environment
- Effect of JSP, ASP, J2EE, .NET components, DBMS,…
- Effect of OS and hardware

Java-based architecture security *



Microsoft architecture *



Web services security

- Transmission security is the same as SOAP security
- UDDI registries must be secure
- WSDL should have security statements
- Registries can also be protected according to ebXML security

UDDI

- The Universal Description, Discovery, and Integration specs define a way to publish and discover information about Web services.
- The UDDI business registration is an XML file that describes a business entity and its Web services
- Entities are discovered via marketplaces and portals

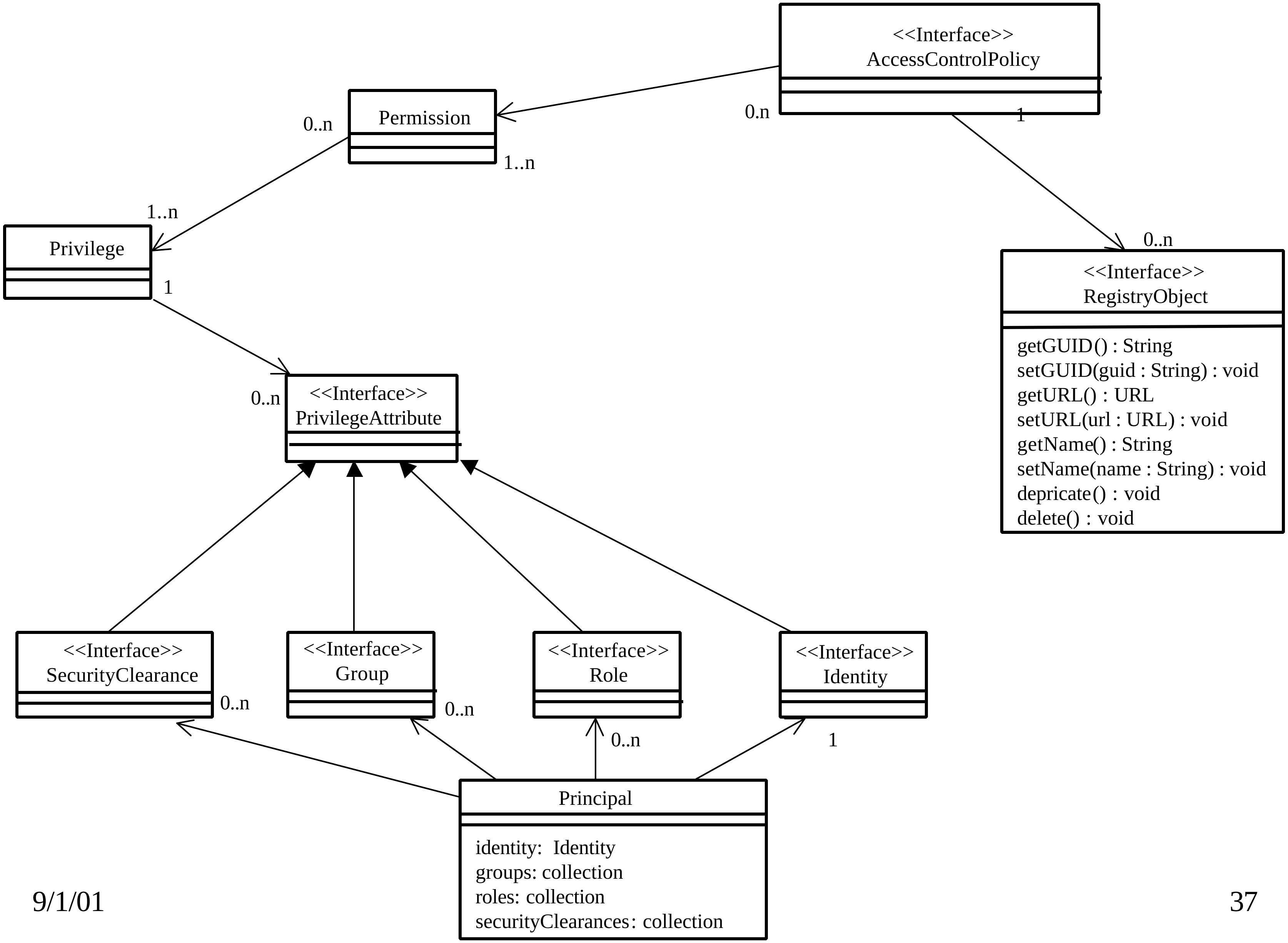
UDDI security

- Not specified in detail, only general policies
- Only authorized individuals can publish or change information in the registry
- Changes or deletions can only be made by the originator of the information
- Each instance of a registry can define its own user authentication mechanism

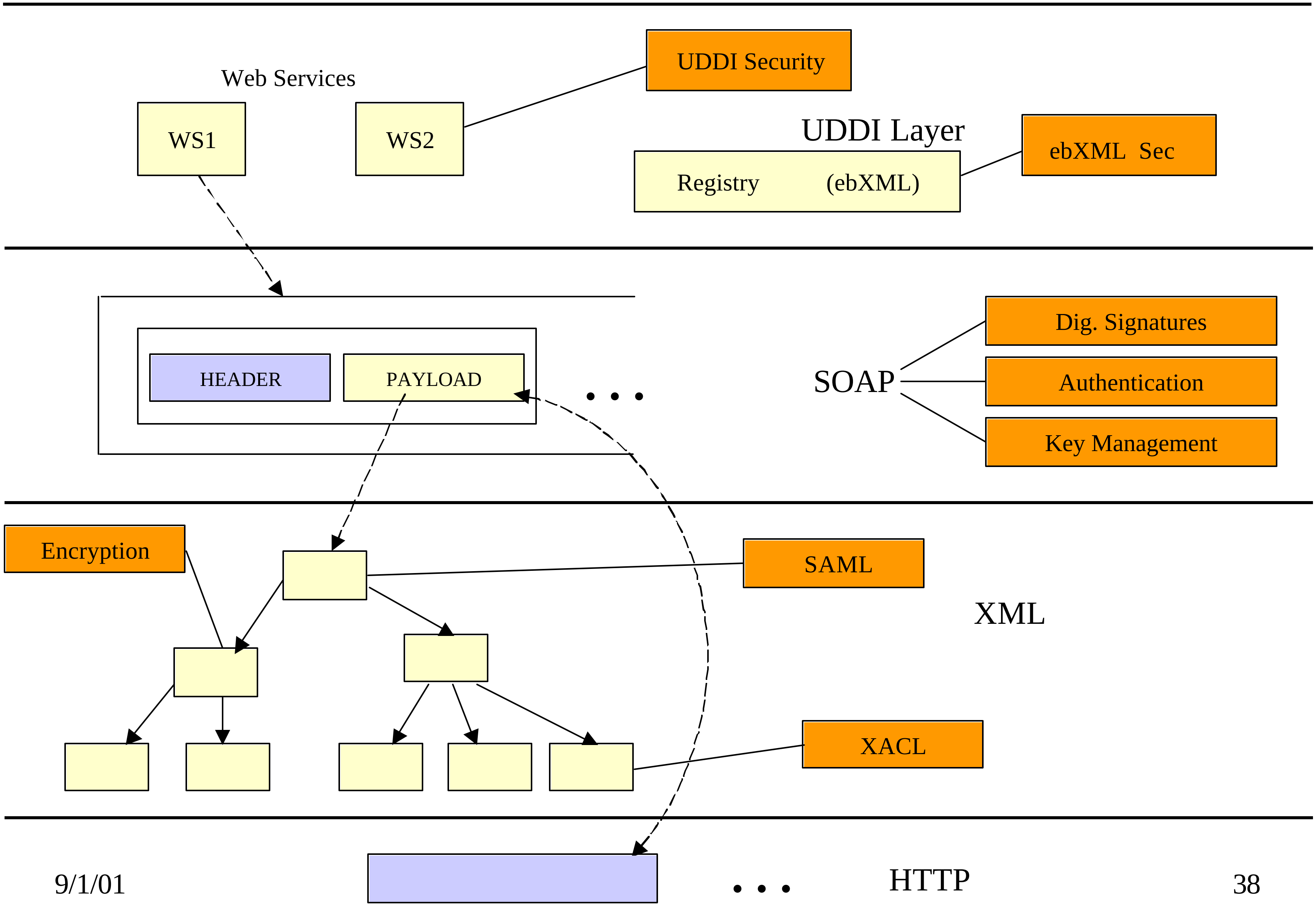
Security in ebXML

- Proposal for registry security (May 2001)
- Requirements for authentication, integrity, and confidentiality
- Each request must be authenticated
- Policy: any known entity can publish and anyone can view
- UML model for registry security

ebXML Registry Security model



Security at each layer



Some industry products *

- Microsoft’s HailStorm
- IBM Web services
- Sun ONE
- Oblix
- Netegrity
- Securant
- Distributed systems
- Glue

HailStorm

- A set of web services from Microsoft that provide a centralized way to store and access user data
- Services include calendar, wallet, notification, and others.
- Users must log in through MS Passport authentication service
- Services and data in MS servers

HailStorm security

- Passport uses Kerberos for authentication
- Doesn’t use SOAP’s security
- Users are owners of their data and can see who has had access to their data
- Microsoft web servers (IIS) have rather poor security
- .NET has RBAC security

IBM Web services

- New version of WebSphere Application Server
- WS Business Integrator will allow MQSeries to deliver SOAP messages
- DB2 Version 7.2 has a new XML Extender, where Web Services can access DBMS and can store SOAP and UDDI data
- SOAP security extensions

WebSphere Security

- WebSphere has several levels of security and provides a good environment for security
- Uses RBAC authorization
- Developed by Tivoli

SUN ONE   *

- A web service can use a policy engine to dynamically adapt processing and/or results according to rules based on user identity, authorization levels, and other contextual information
- User and policy information from LDAP
- PKI and Kerberos for authentication and message protection
- SAML for exchanging security information

Sun’s iPlanet *

- Role-based authorization
- Role hierarchies
- Administrative privileges
- Domains for segmentation of roles
- One administrator per domain
- Superuser administrator over all domains
- Authentication options

Oblix *

- Security product: includes facilities for user profiles (Identity service), authorization (Access), and administration (Presentation)
- New product NetPoint 5.0 includes AccessXML, IdentityXML, and PresentationXML
- AccessXML uses SAML

Netegrity *

- TransactionMinder product for management and security of web services
- Uses SAML and XKMS
- Supports Sun ONE, MS .NET, Oracle 9i, BEA
- Had already a product for security of web sites: SiteMinder

Netegrity features *

- The facilities in Delegated Management Services (DMS) of Netegrity follow closely the proposals we made in 1979 [Woo79].
- Can assign users to roles; create, modify, and delete users; create, modify, and delete organizations and their administrators [net].

Securant *

- Access control
- Users, groups, and realms (domains)
- Can apply security constraints dynamically
- Transaction authorization
- Delegated administration
- Single Sign-on (SSO)
- Policy evaluation
- Auditing and reporting

Distributed systems

- CORBA services may be used as web services [Hou99]
- Simplifies their use in applications and browsers
- Can apply CORBA security
- Glue: Java/XML mapping for Web services, uses SOAP with HTTPS

Web services brokers

- Example: Wsbang
- A proxy server to manage Web services consumed by a given company
- Performs activities such as monitoring behavior, metering,caching,…
- Can be used forn authentication: storing passwords, certificates, authorization

Conclusions I

- Rather confusing state: not clear how everything fits together and much change
- A good security model is basic to produce a consistent and complete security specification
- Access matrix and Role-Based Access Control appear as obvious choices for authorization models

Conclusions II

- There is already a lot of work on cryptography, only hooks and protocols are needed
- UML models and patterns are very useful to get the complete picture and add precision
- Institution policies are important
- Security is an all-levels problem