A Guideline to Secure Web Services

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Outline

- Web Services and their Relation to Security
- Dimensions for Secure Web Services
- Web Services Security Standards
- Secure Implementation Tools and Techniques
- Challenges and Conclusions

What are Web Services?

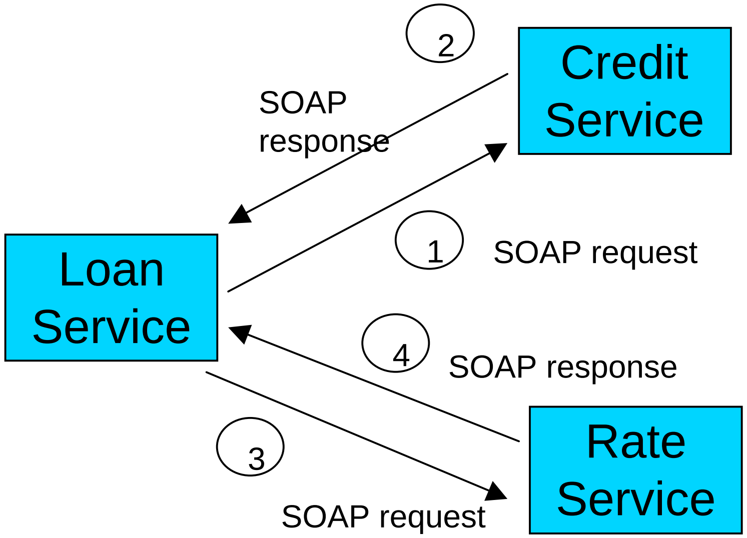
- Today, we normally use Web browsers to talk to Web sites
  - Browser names document via URL (lots of fun and games can happen here)
  - Request and reply encoded in HTML, using HTTP to issue request to the site
- Web Services generalize this model so that Applications can talk to Applications

Web service definition

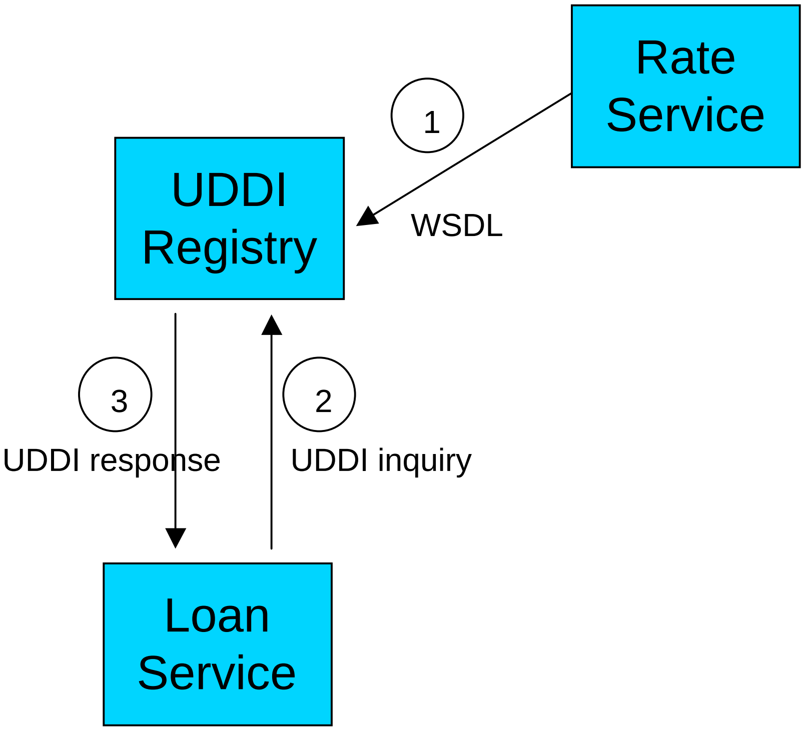
"A Web Service is a software system designed to support interoperable machine-to-machine interaction over a network. It has an interface described in WSDL. Other systems interact with the Web service in a manner prescribed by its description using SOAP messages and XML."

Source: http://www.w3.org/TR/ws-arch/

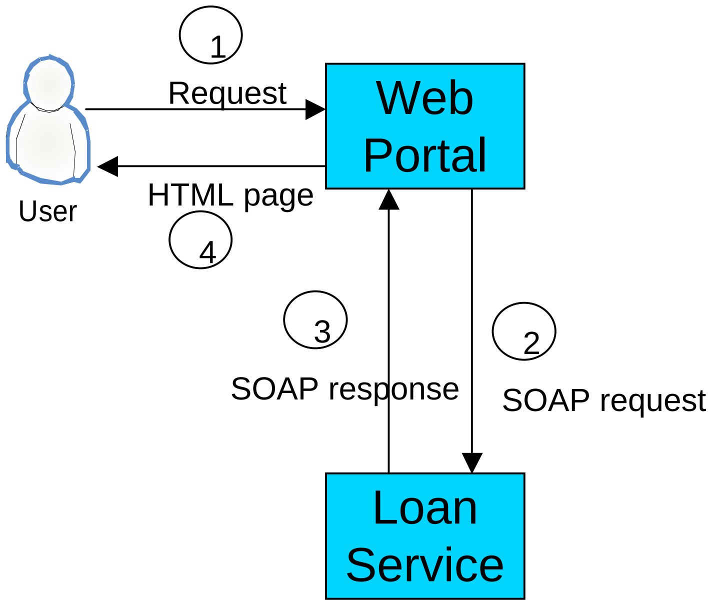
Web Services Example



Web Services Example



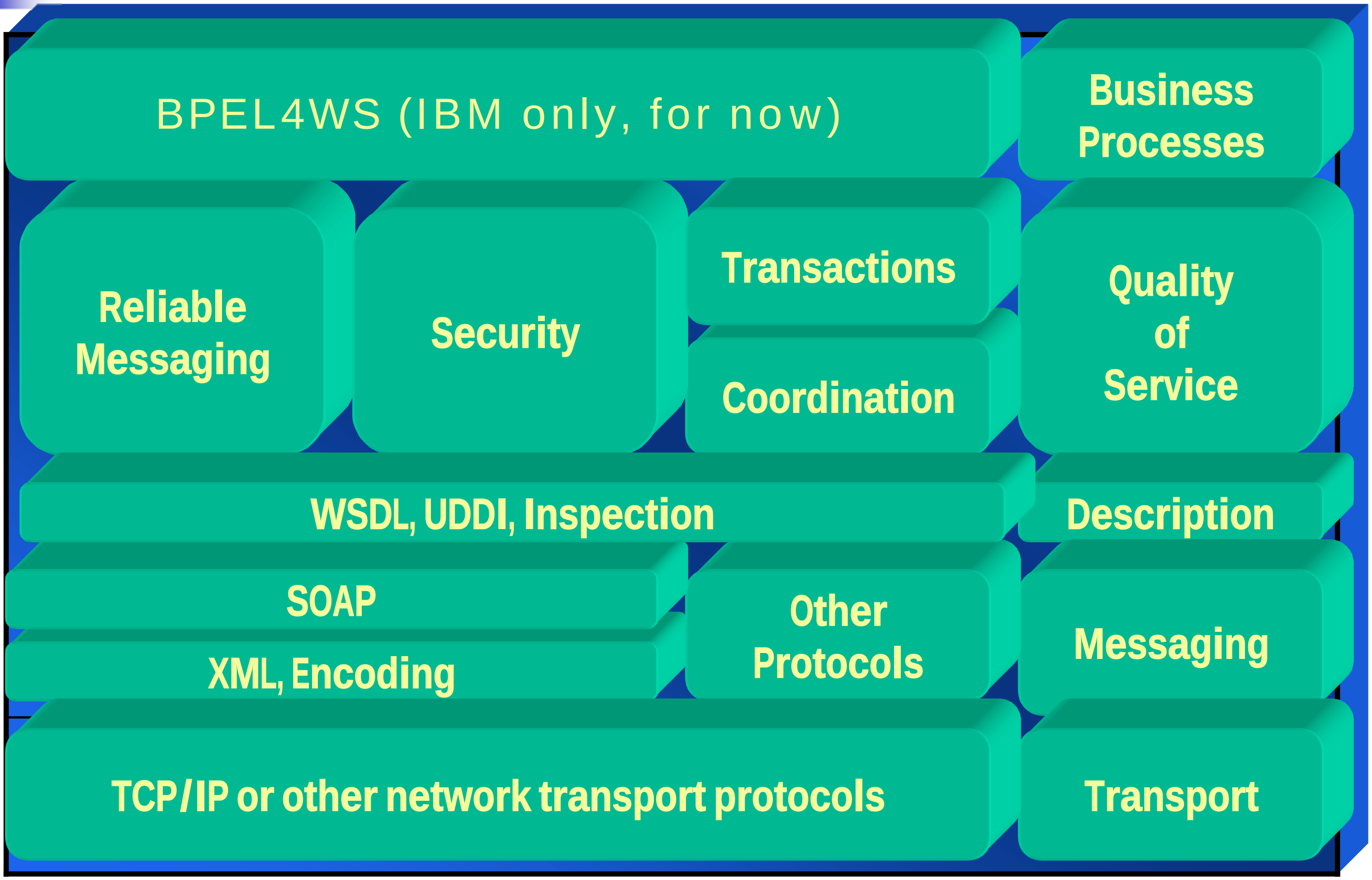
Web Service Example



Advantages of web services?*

- Web services provide interoperability between various software applications running on various platforms.
  - “vendor, platform, and language agnostic”
- Web services leverage open standards and protocols. Protocols and data formats are text based where possible
  - Easy for developers to understand what is going on.
- By piggybacking on HTTP, web services can work through many common firewall security measures without requiring changes to their filtering rules.

The Web Services “stack”



BPEL4WS (IBM only, for now) — Business Processes

Reliable Messaging | Security | Transactions / Coordination — Quality of Service

WSDL, UDDI, Inspection — Description

SOAP / XML, Encoding | Other Protocols — Messaging

TCP/IP or other network transport protocols — Transport

Elements of Security

- Authentication
- Authorization
- Integrity
- Non-repudiation
- Confidentiality
- Privacy

Dimensions for Secure Web Services

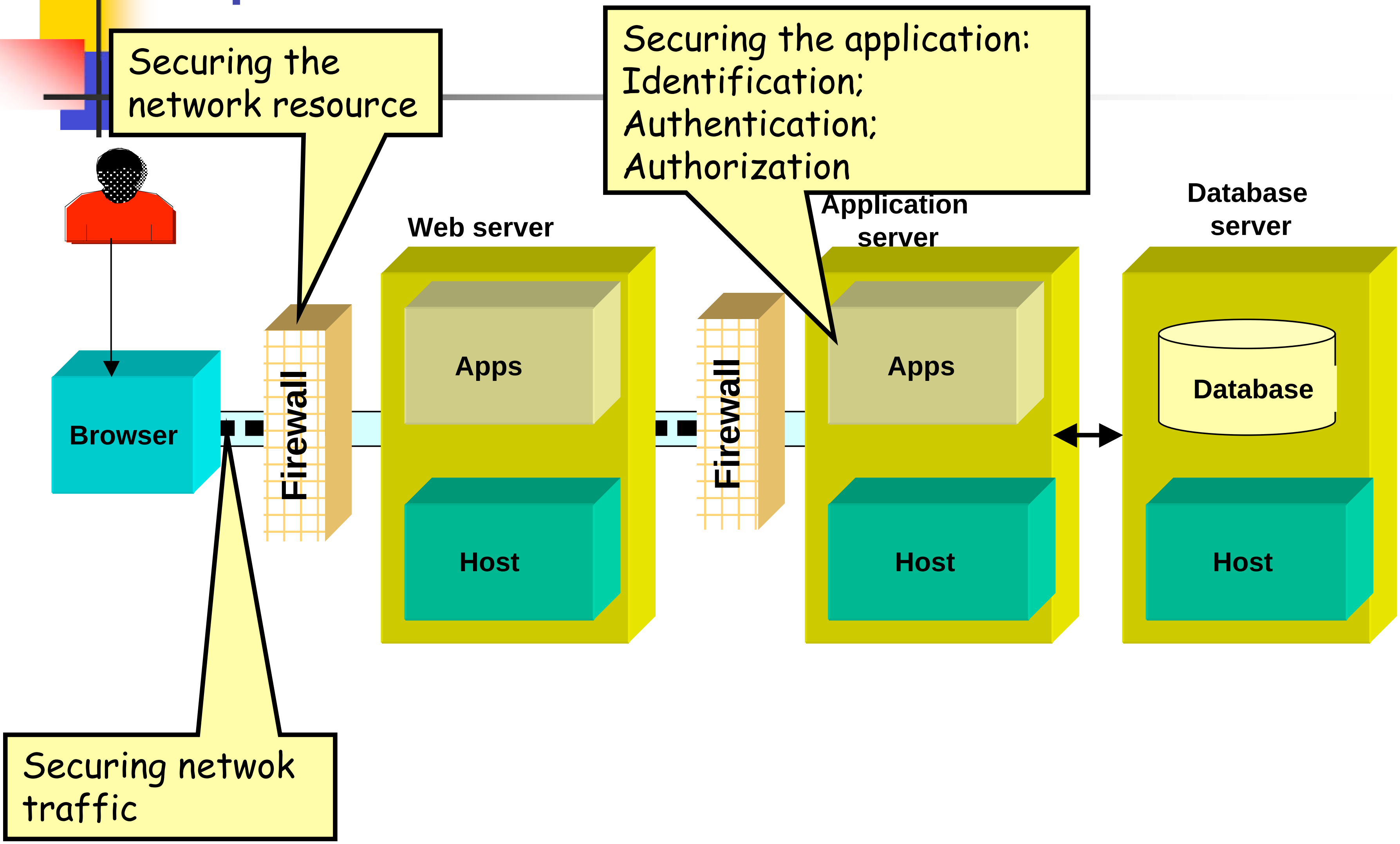
- Secure Messaging
  - HTTPS
  - XML Encrypt. XML Digital Sig.
  - WS-Security

- Resources Protection
  - Access Control
  - Authorization
  - Protection from DOS Attacks

- Contracts and Obligations

- Trust Management

Components to be secured



Securing the network resource

Securing the application:
Identification;
Authentication;
Authorization

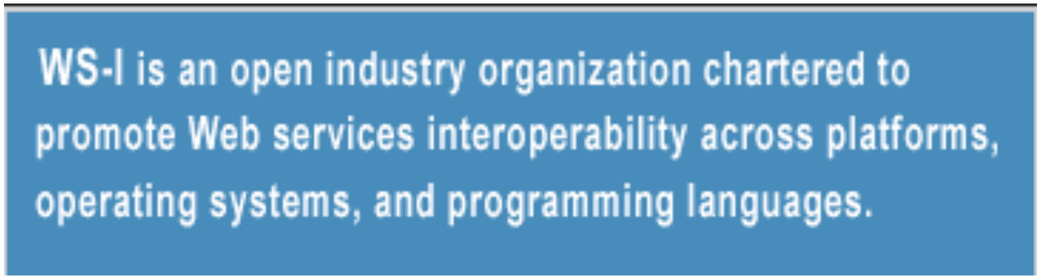
Securing netwok traffic

Standardization bodies

W3C® World Wide Web consortium

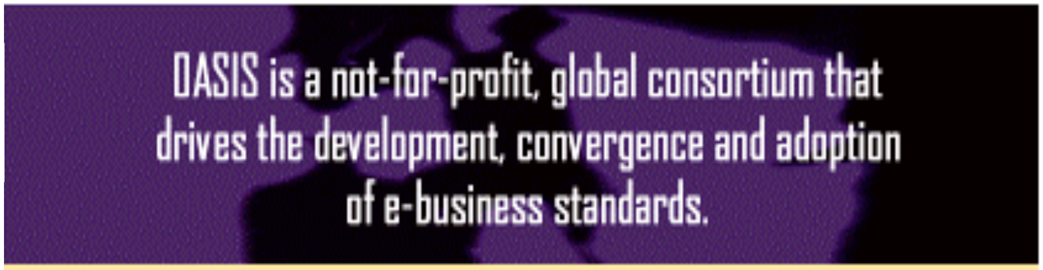
WS-I

WEB SERVICES INTEROPERABILITY ORGANIZATION



WS-I is an open industry organization chartered to promote Web services interoperability across platforms, operating systems, and programming languages.

OASIS

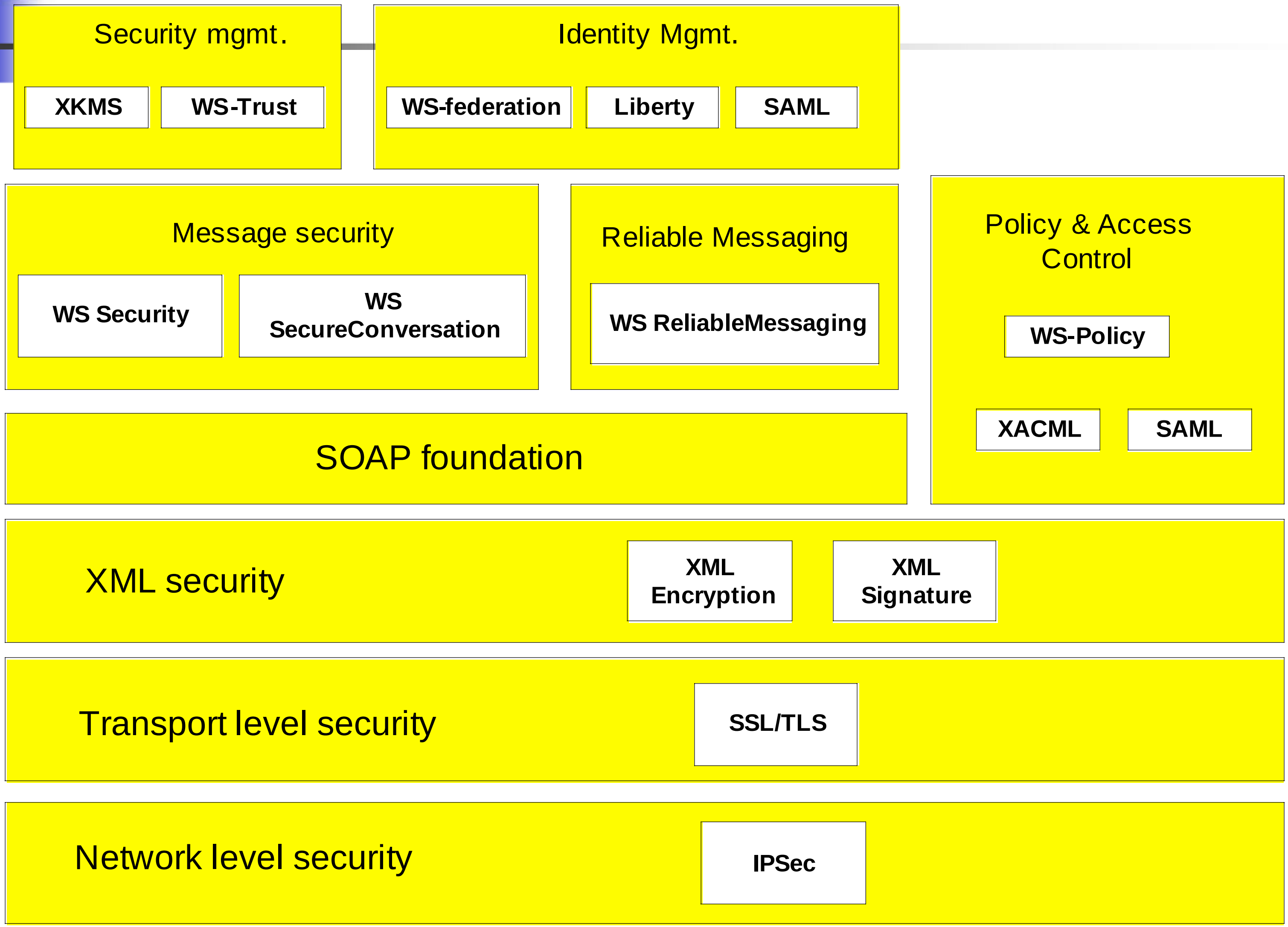


OASIS is a not-for-profit, global consortium that drives the development, convergence and adoption of e-business standards.

Standards

Dimension	Requirement	Specifications
Messaging	Confidentiality and Integrity	WS-Security (XML DSig/Enc)
		SSL/TLS (HTTPS)
	Authentication	WS-Security (SAML, X.509)
		SSL/TLS (X.509)
Resource	Authorization	XACML
		XrML
		RBAC
	Privacy	EPAL
		XACML
	Accountability	Auditing
Discovery	Registries	UDDI
		ebXML

WS-* security Standards framework



Security mgmt.

XKMS

WS-Trust

Identity Mgmt.

WS-federation

Liberty

SAML

Message security

WS Security

WS SecureConversation

Reliable Messaging

WS ReliableMessaging

Policy & Access Control

WS-Policy

XACML

SAML

SOAP foundation

XML security

XML Encryption

XML Signature

Transport level security

SSL/TLS

Network level security

IPSec

What is WS-Security?

- WS-Security enhances SOAP messaging to provide *quality of protection* through:
  - message integrity,
  - message confidentiality, and
  - single message authentication.
- These mechanisms can be used to accommodate a wide variety of security models and encryption technologies.
- WS-Security also provides a general-purpose, extensible mechanism for associating security tokens with messages:

Security policies for Web Services

- The concept of Policy: Guiding principles and procedures
- Security policy might mean different things to different people:
  - Firewall filtering rules
  - Access control policy
  - Privacy policy

Standards for Web services policies

- WS-Policy
- XACML
- XACML profile for Web Services

WS-Policy

- **Web Services Policy 1.2 - Framework (WS-Policy) W3C Member Submission 25 April 2006**
- **Status**: public draft release for review and evaluation only
- **Main goal**: The WS-Policy and WS-PolicyAttachment aim to offer mechanisms to represent the capabilities and requirements of Web services as Policies

XACML

- **eXtensible Access Control Markup Language** 2 **(XACML) Version 2.0 OASIS Standard, 1 Feb 2005**

- **Status**: approved OASIS Standard within the OASIS Access 12 Control TC.

XACML Overview

- XACML is a general purpose access control policy language for managing access to resources
- It describes both a policy language and an access control decision request/response language
- Access control based on subject and object attributes
- Consistent with and building upon SAML

Security Assertion Markup Language (SAML)

- Developed by the OASIS XML-Based Security Services Technical Committee (SSTC)
- **Status**: SAML V2.0 OASIS Standard specification set was approved on 15 March 2005
- **Main goal**: *authentication* and *authorization*

SAML goal

- The goal:
  - promote interoperability between disparate authentication and authorization systems

- How:
  - defining an XML-based framework for communicating security and identity information (e.g., authentication, entitlements, and attribute) between computing entities

Secure Implementation Tools and Techniques

- **XML Parsers**
  - XML Parsers are the first component to process input to Web services
  - They must be robust
  - Large or specially formed XML documents can lead to DOS Attacks

Secure Implementation Tools and Techniques

- Procedural Languages:
- C and C++
  - Less overhead, which is useful for embedded systems: J2EE and .NET frameworks take up hundreds of megabytes of hard disk space
  - Can directly interface with legacy applications developed in C or C++
  - Susceptibility to programming errors may require addition protections like XML Gateways or OS level restrictions
- Java and .NET
  - Widely considered to be more secure languages
  - Two of the most popular languages for developing Web services
  - Provide robust sandboxes (JVM and .NET Code Access Security)
  - Large number of third-party libraries available for Java and .NET Web services

Secure Implementation Tools and Techniques

- **Security Testing**

- Functional testing of security mechanisms
  - Ensure that Web service security mechanisms work as required
- Security-focused unit testing
  - Perform security testing on individual components of the Web service
- Vulnerability assessments
  - Attempt to attack the Web service using known attack types
- Web service code reviews and testing
  - Check the source code for vulnerabilities or security errors
  - Perform testing with unexpected or random input to find susceptibility to unknown attacks

Common Attacks against Web Services

- Attacks on Integrity: Parameter Tampering, XML Schema Poisoning
- DOS Attacks: Flooding Attacks, Send Oversized Payloads to XML Parsers, Buffer Overflow Exploits
- Command Injection: SQL Injection, XML Injection
- Malicious Code Attacks: Virus, Worms, Trojan Horse

Challenges for Secure Web Services

- Contracts and Negotiation
- Protection from Common Attacks
- End to End QoS and QoP
- Interoperability among competing Standards
- Methodologies for Secure Web Services
- Life Cycle Management

Conclusions

- Web Services based computing has benefits
- W3C and OASIS have made good progress in laying the foundation
- Several research problems need to be solved
  - QOS & QOP
  - Automatic Service Discovery
  - Availability and protection from DOS Attacks