DAIMLERCHRYSLER

Contributions to Information Integration from XML Technology

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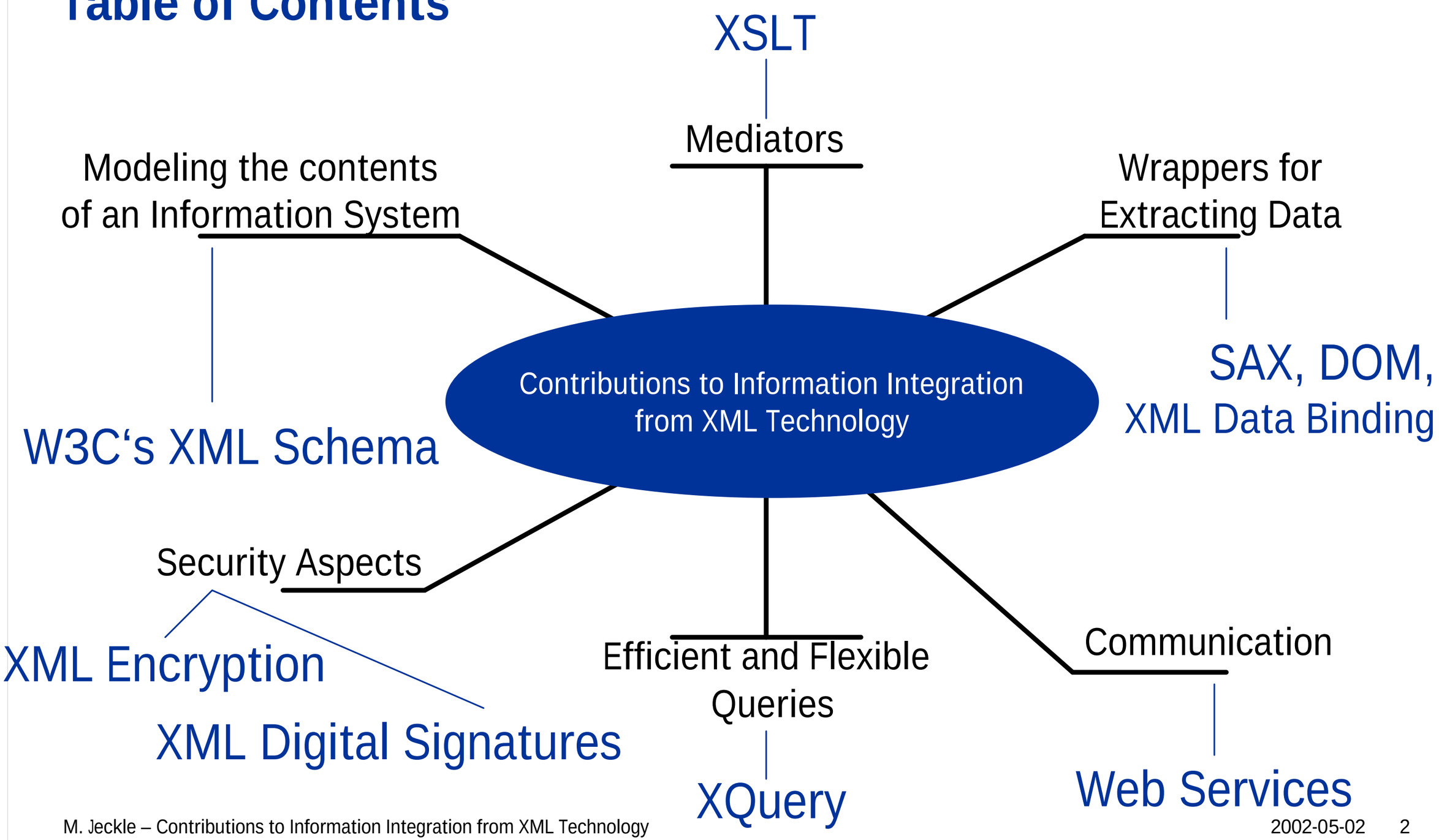
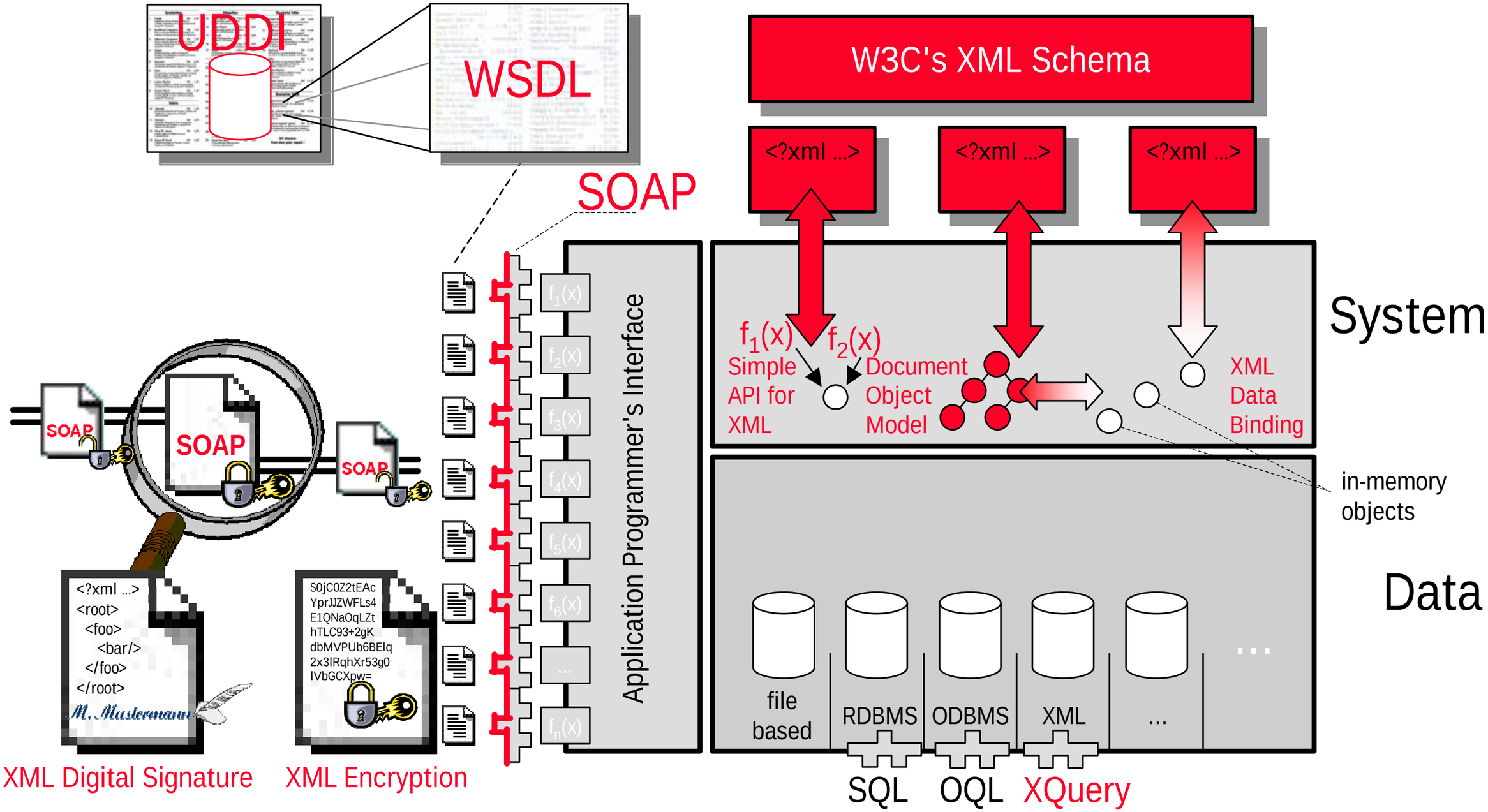


Outline of a XML-based Information Infrastructure



Modeling the Contents of an Information System

Motivation:

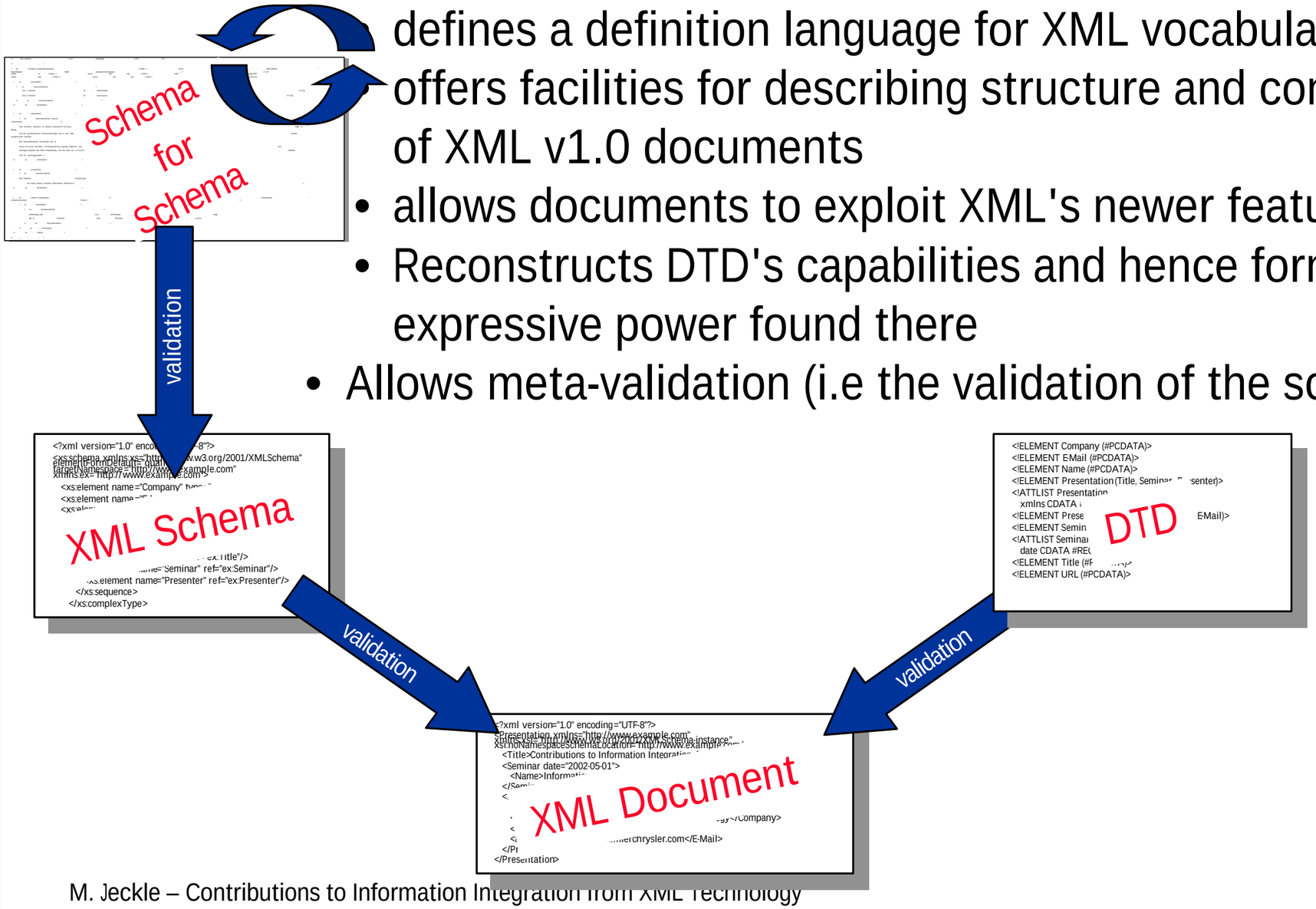
- XML inherited the Document Type Definition (DTD) from SGML
- The DTD mechanism ...
  - was designed to support document oriented structuring
  - defines a strictly hierarchical information structure (i.e. a tree containing elements as inner nodes and all the information placed within text and attribute nodes as leafs)
  - offers a rich set of string-based types :-(
  - does not support the new XML secondary standards like Namespaces or the Information Set
  - is not deployed (re-)using XML
  - does not come with a metamodel
- XML in contrast to SGML is used for expressing *data* not documents

=> DTDs cannot be considered as sufficient for XML

Modeling the Contents of an Information System

Purpose:

- XML schema ...
  - defines a definition language for XML vocabularies
  - offers facilities for describing structure and constraining content of XML v1.0 documents
  - allows documents to exploit XML's newer features like Namespaces
  - Reconstructs DTD's capabilities and hence forms a superset of the expressive power found there
- Allows meta-validation (i.e the validation of the schema itself)



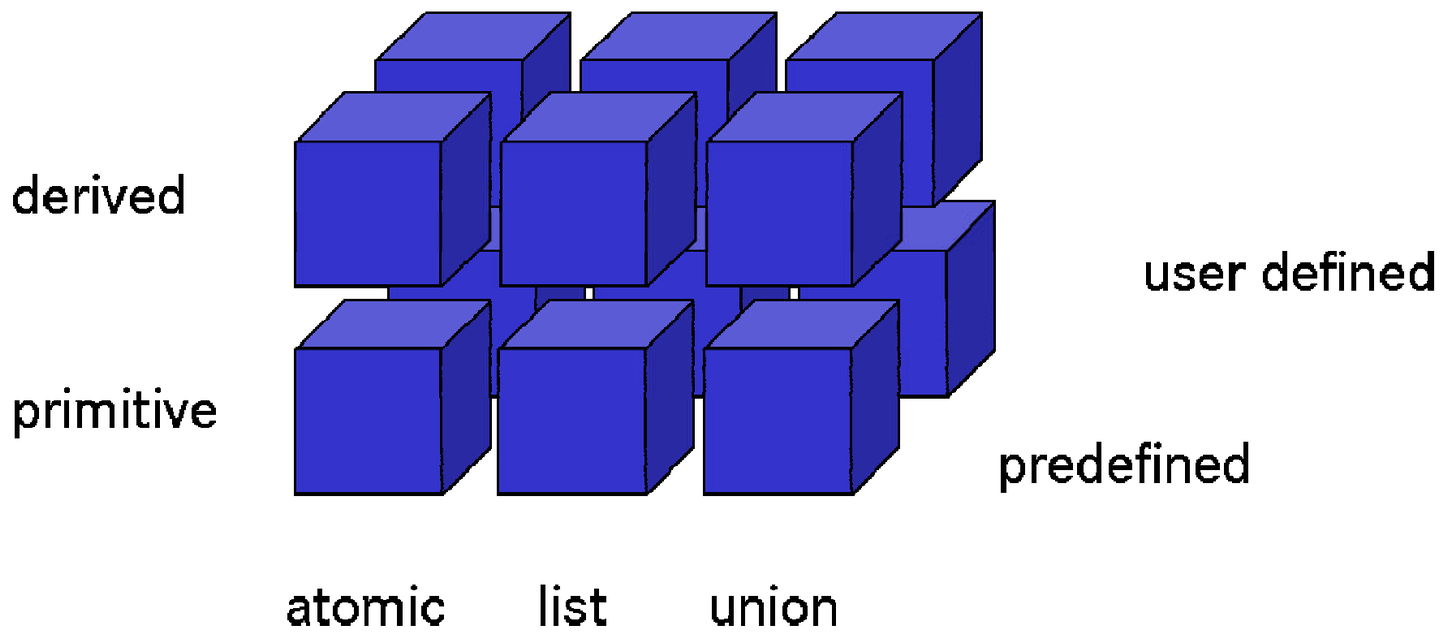
Modeling the Contents of an Information System

Basic Idea:

- W3C's XML schema is ...
  - a grammar for formulating arbitrary XML vocabularies
  - The specification consists of ...
    - Part 0 providing some introduction and basic examples
    - Part 1 describing structures and content of a XML vocabulary
    - Part 2 describing datatypes used within part 1 and elsewhere
  - a significant improvement over DTD's expressive power
    (in the long term it will practically supersede it)
  - a XML language itself
    (i.e. it consists of a vocabulary accompanied with a defined semantics)
  - a combination all of the major competing successors
  - a W3C recommendation since 2001-05-02
  - the basis of all W3C's second generation standards
    (e. g. XPath v2.0, XSLT v2.0, XHTML v2.0, XMLP / SOAP, ...)
  - well supported by tools

Modeling the Contents of an Information System

Technology:
- XML Schema ...
  - Enhances structural capabilities, e.g. by the introduction of re-useable structured types
  - adopts the idea of meta modeling
  - removes constructs with unclear semantics (e.g. Entities and Notations)
  - comes with an extended and extensible typesystem



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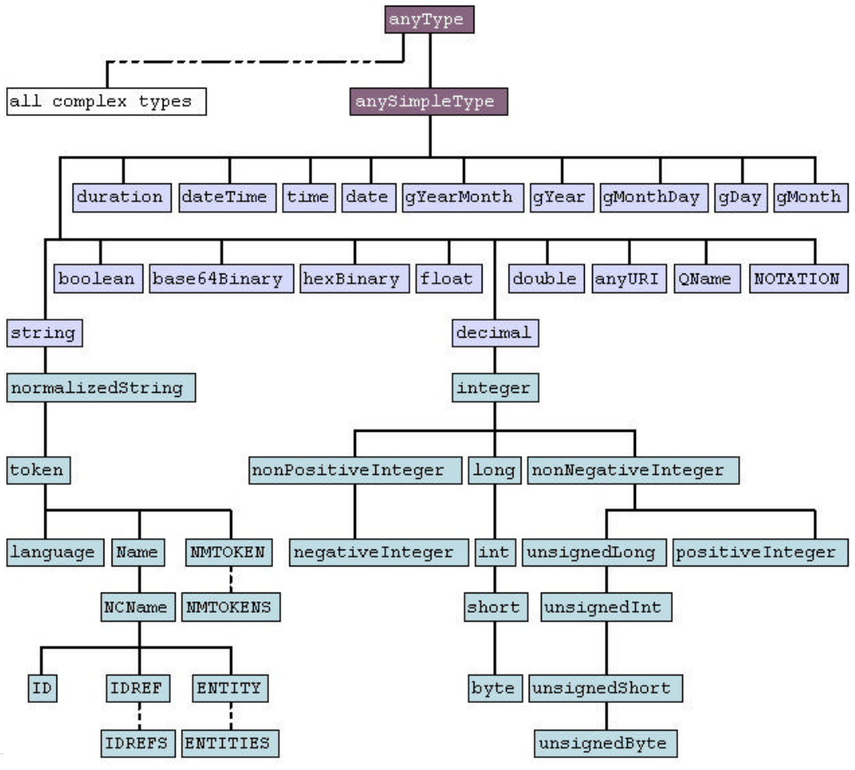
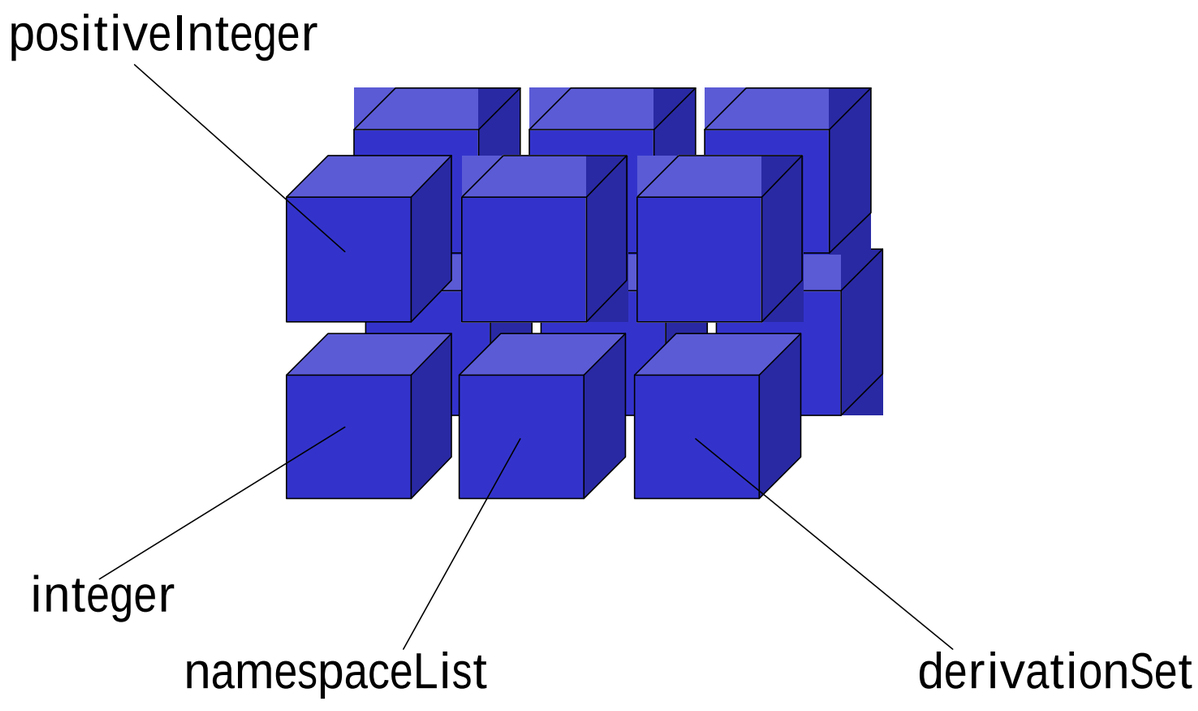




Wrappers for Extracting Data

Motivation:
- XML-encoded data is inherently offline,
  i.e. it is persistently stored in files or virtual files (a.k.a. XML database)
- To "execute" (i.e. create, render, or process) XML it must be loaded into memory
- writing parsers for specific XML vocabularies (e.g. XHTML, XML Schema, SVG) seems to be perfectly superfluous ...

Purpose:
- Since XML forms a meta-language and generic XML parsers are available there must be a *generic API* for processing XML within applications

Basic Ideas:
1. Orientate control flow along XML's structural primitives (i.e. element, attribute, etc.)
2. Create a generic data structure capable of representing all of XML's structural primitives in memory
3. Create a generic transformation capable of transferring the specific structures of an arbitrary XML vocabulary into problem specific memory structures

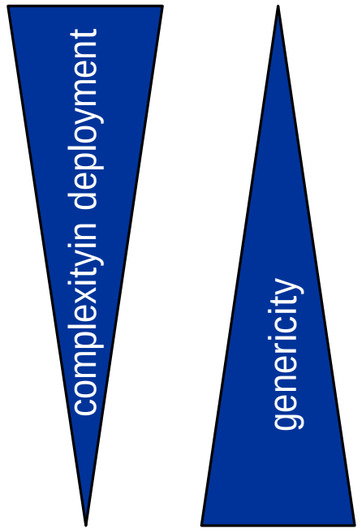
Wrappers for Extracting Data

Technology:

XML Data Binding

Document Object Model

Simple API for XML



Wrappers for Extracting Data

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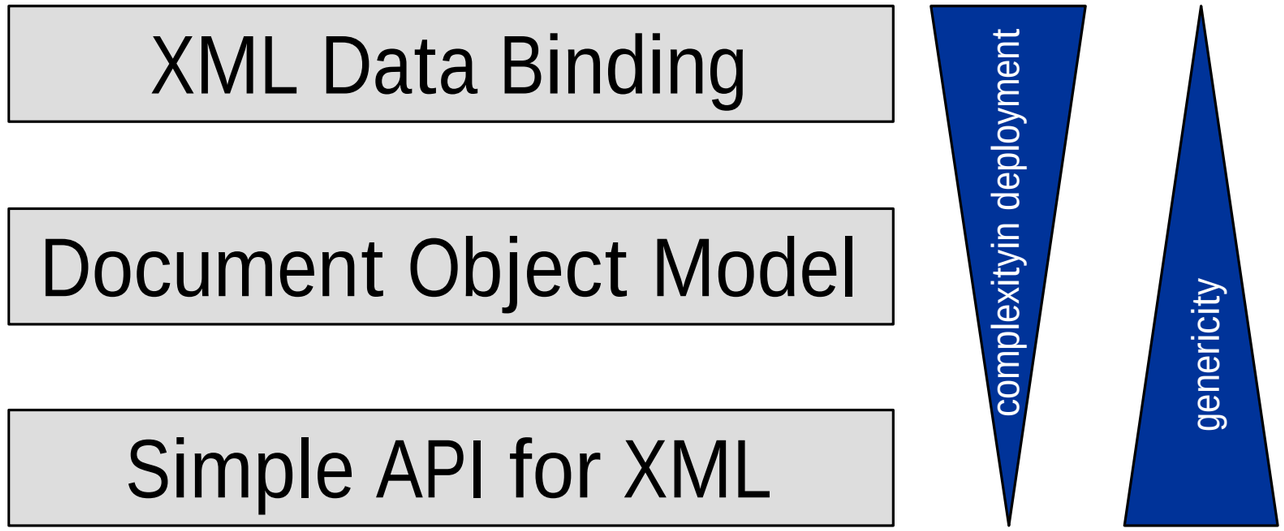

- SAX is ...
  - not a parser (but, it can be used to construct one)
  - a collection of programming language neutral interfaces
  - Available in various implementations
    (e.g. C(++), Python, Perl, Eiffel, Java ...)
  - an generic event-based push-model API
    realized with call-back functions

Wrappers for Extracting Data

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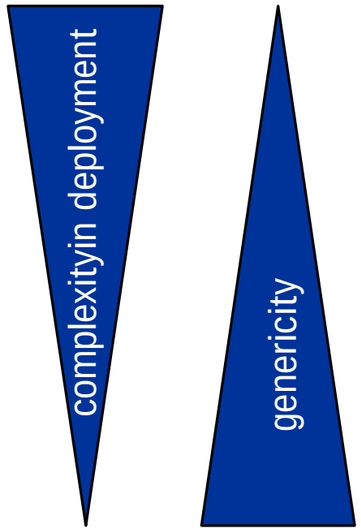

Example:

```
<?xml version="1.0"?>
<root>
  <foo bar="42"/>
</root>
```

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...
public void startDocument()
{ ... }
public void startElement(...)
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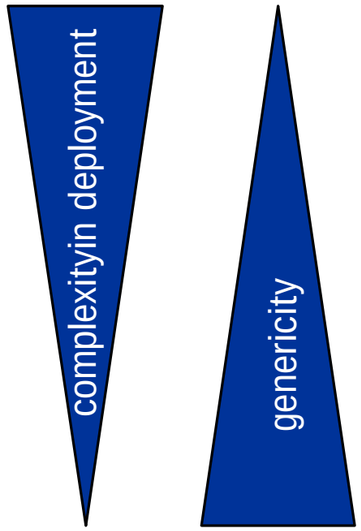

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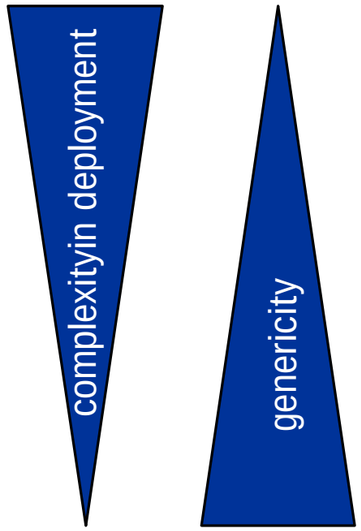

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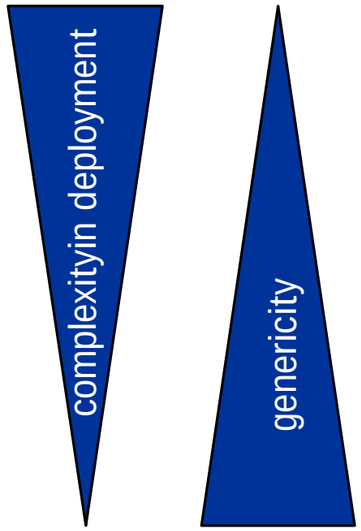

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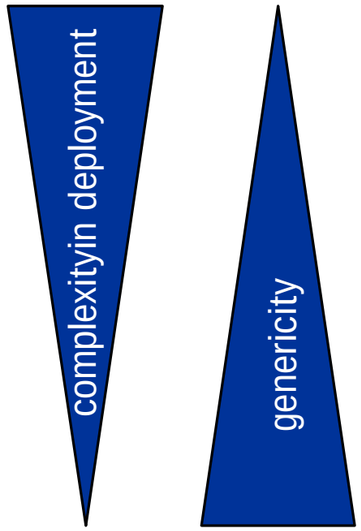

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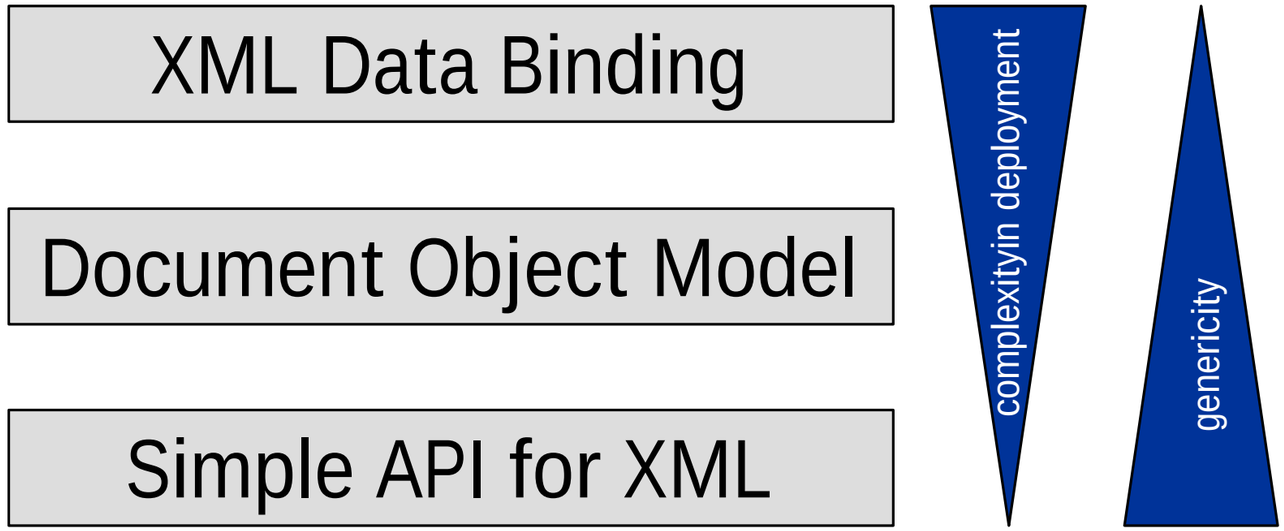

Pros and Cons:

- Pros:
  - Minimal constant memory consumption
  - As generic as it gets
- Cons:
  - Impossible (i.e quite difficulty to code) to track state
  - No modifications possible
  - Memory representation is only built-up transiently and is lost after method completion

Wrappers for Extracting Data

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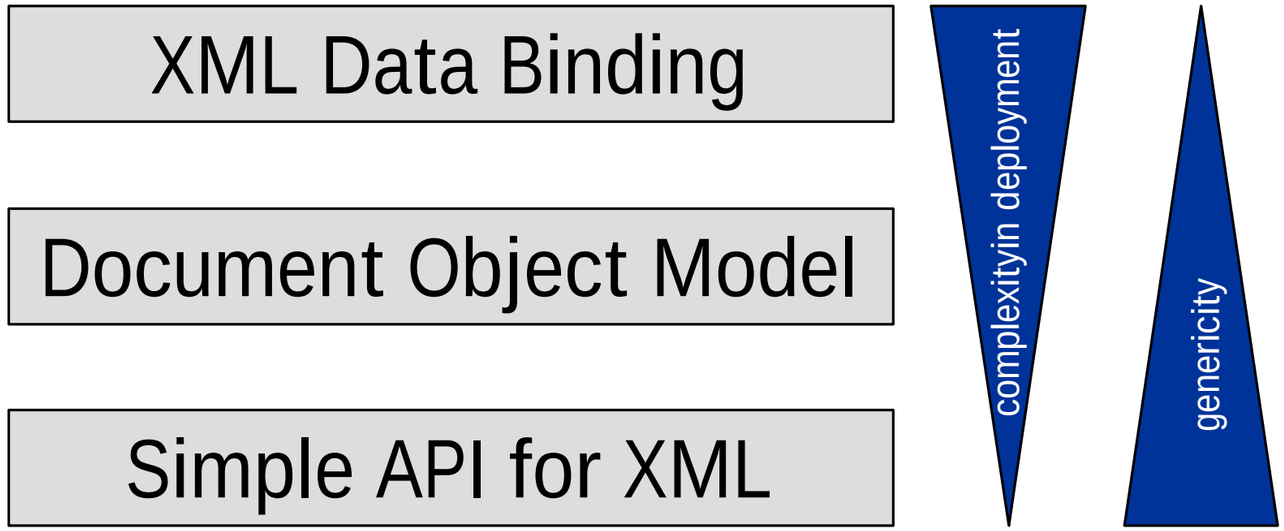


- DOM is ...
  - not a parser (but, it can be used to construct one)
  - programming language neutral,
    but prerequisites an object-oriented system
  - an abstract tree-based in-memory representation of a
    XML document
  - capable of reading in, modifying, and writing back XML structures
  - available in various implementations (e.g. C++, Java, Eiffel, ...)

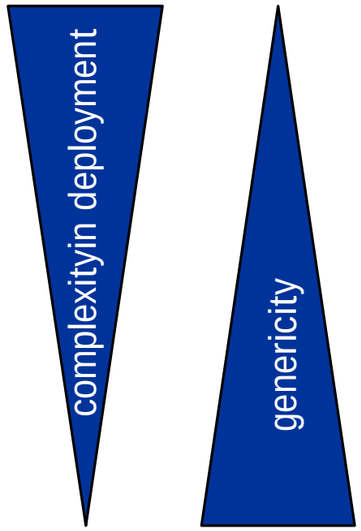
Wrappers for Extracting Data

Technology:

XML Data Binding

Document Object Model

Simple API for XML



Document Node

Example:

```
<?xml version="1.0"?>
<root>
  <foo bar="42"/>
      <baz>xyz</baz>
</root>
```

Wrappers for Extracting Data

Technology:

- XML Data Binding
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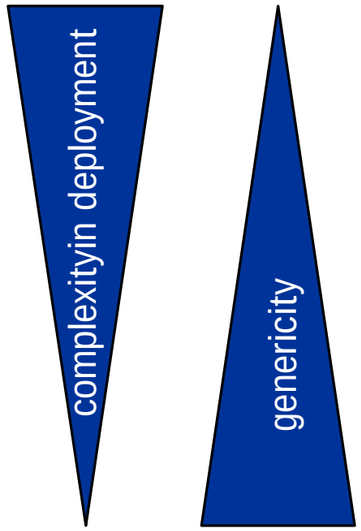

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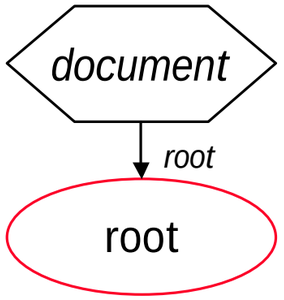

Element Node

Wrappers for Extracting Data

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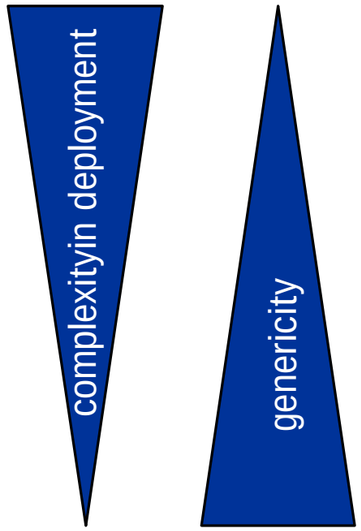

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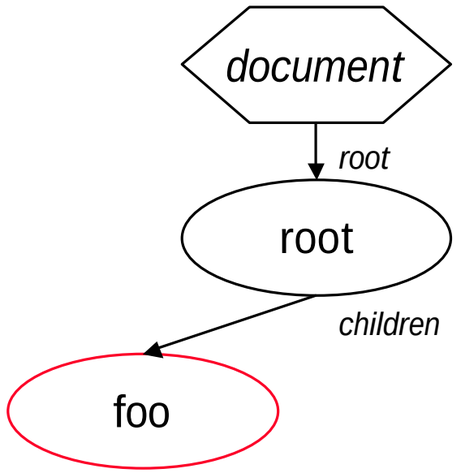

Wrappers for Extracting Data

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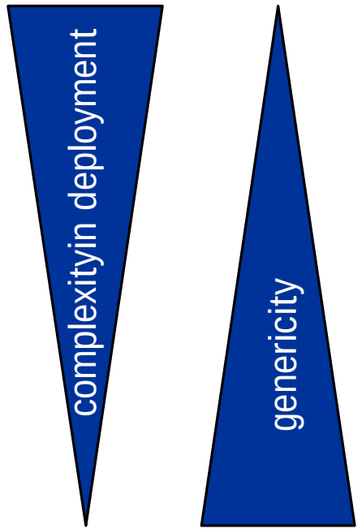

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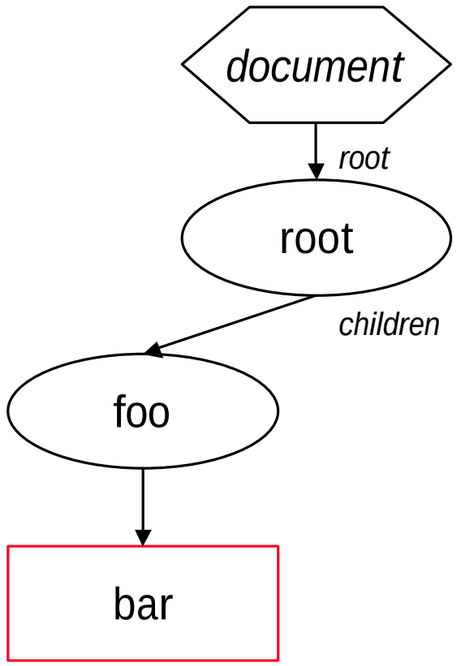

Attribute Node

Wrappers for Extracting Data

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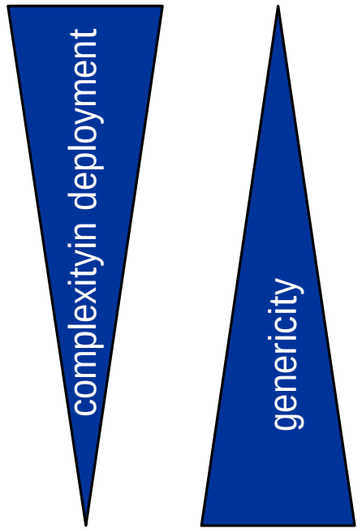

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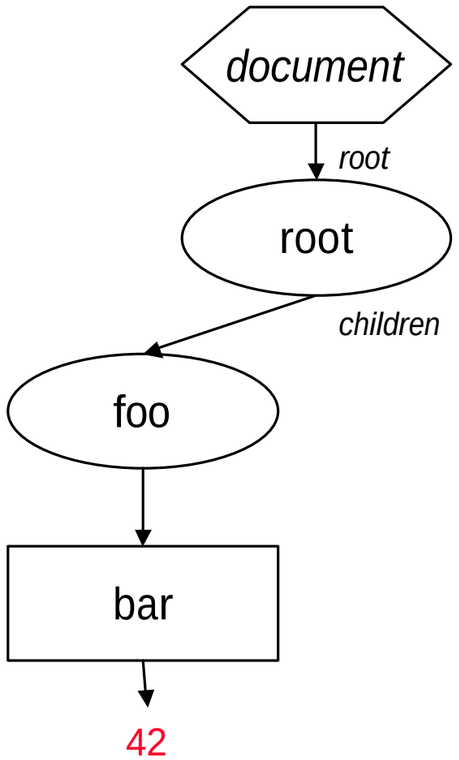

Text Node

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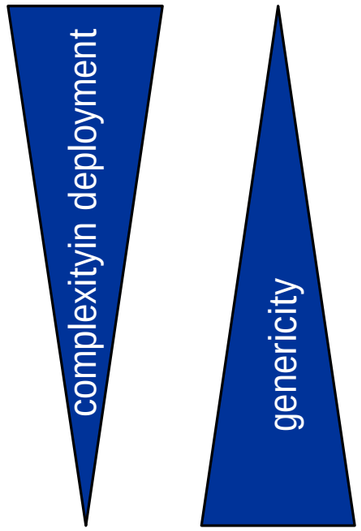

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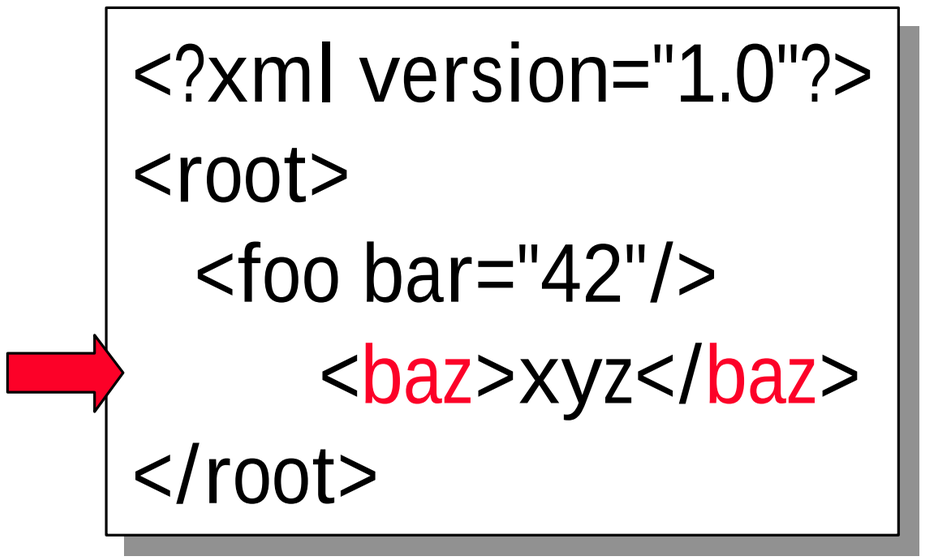

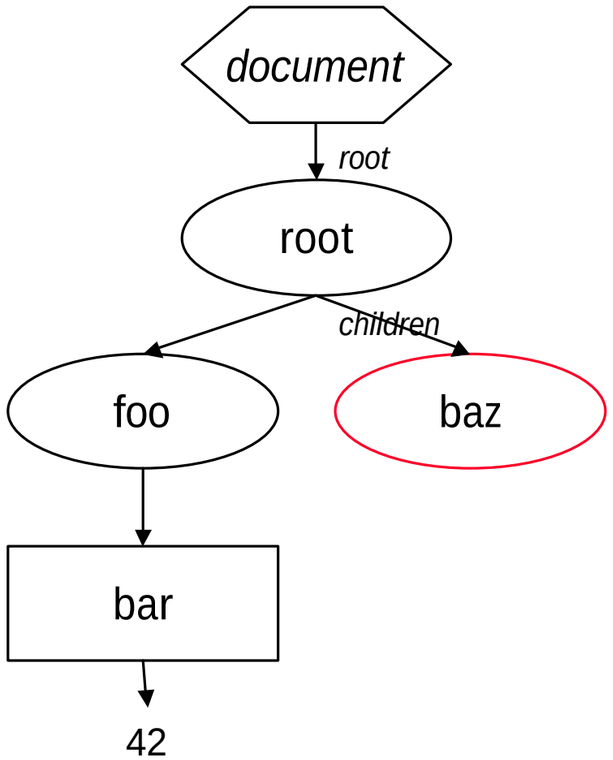

Wrappers for Extracting Data

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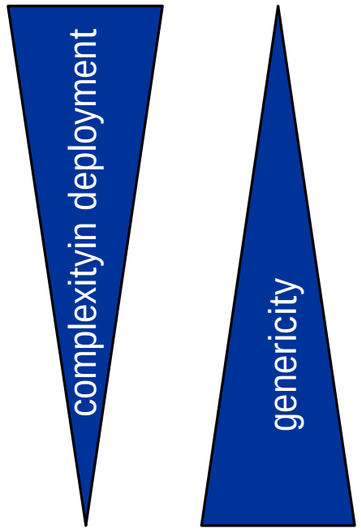

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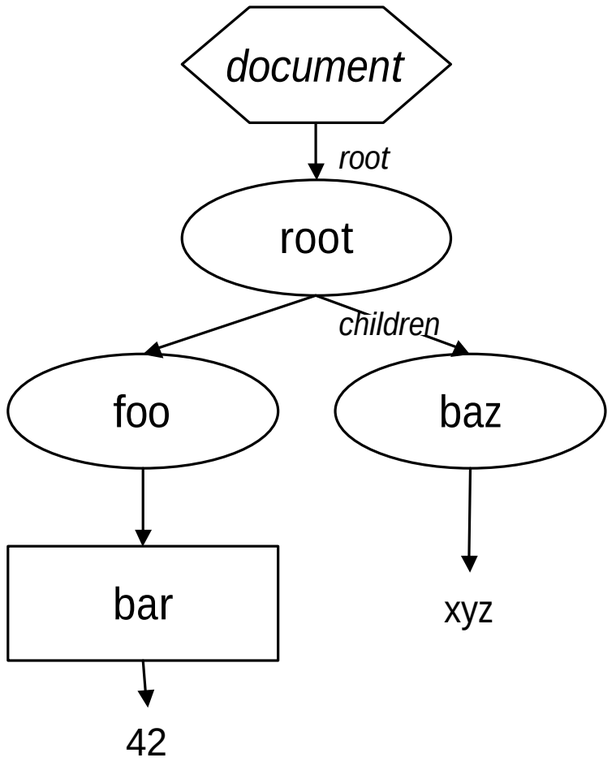

Wrappers for Extracting Data

Technology:

XML Data Binding

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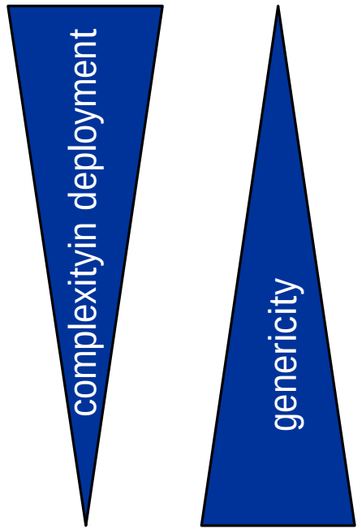

Pros and Cons:

- Pros:
  - In-memory representation of a whole XML document which allows arbitrary modifications
  - Still generic, w.r.t. specific XML vocabularies
- Cons:
  - Could become quite memory consuming
  - Costly navigation and information access
  - Often still too generic ...

Wrappers for Extracting Data

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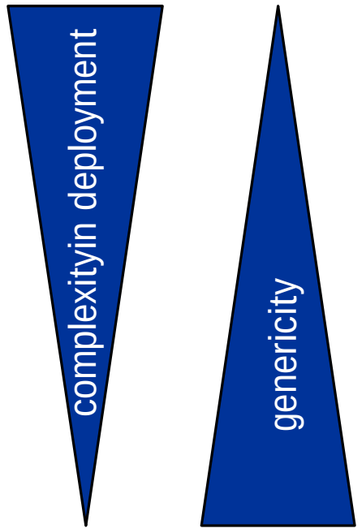

- XML Data Binding is ...
  - not a parser (but, it could be used to construct one, even if I would not recommend it)
  - programming language bound, in fact the idea came from the Java community
  - an algorithm for transferring arbitrary XML vocabularies into Java class structures
  - capable of reading in, modifying, and writing back XML structures
  - available only in Java implementations so far

Wrappers for Extracting Data

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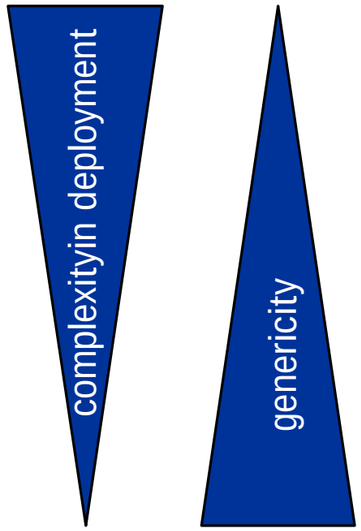

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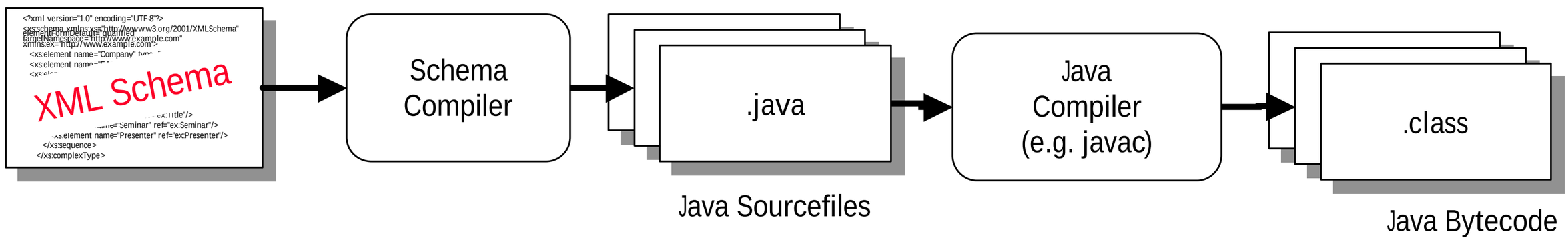

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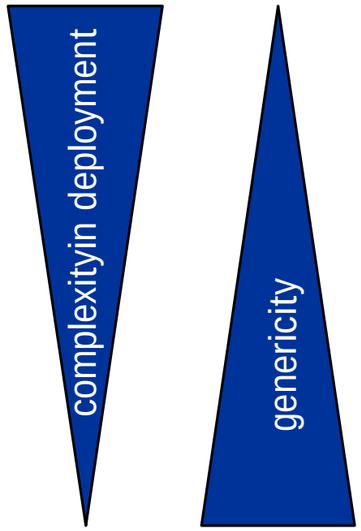

Example:

```
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified">
  <xs:element name="baz" type="xs:string"/>
  <xs:element name="foo">
    <xs:complexType>
      <xs:attribute name="bar" type="xs:integer" use="required"/>
    </xs:complexType>
  </xs:element>
  <xs:element name="root">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="foo" ref="foo"/>
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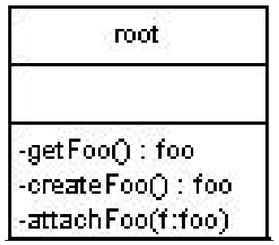

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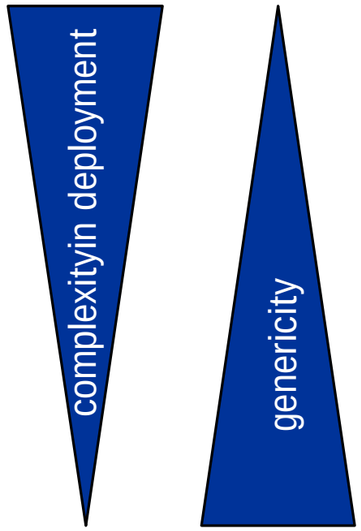

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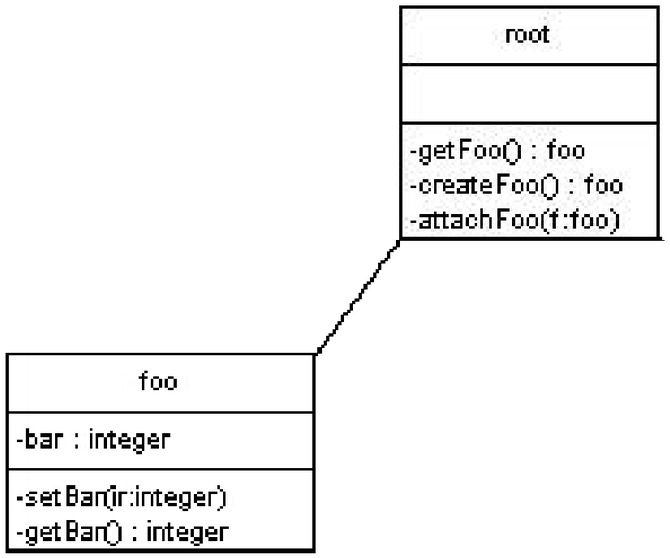

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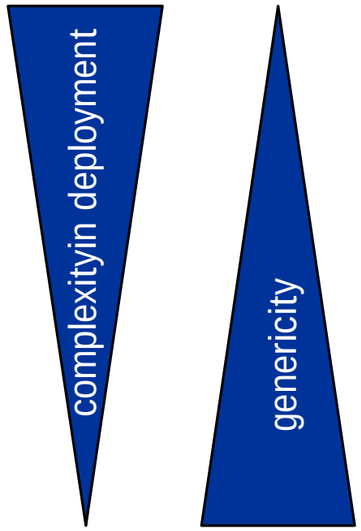

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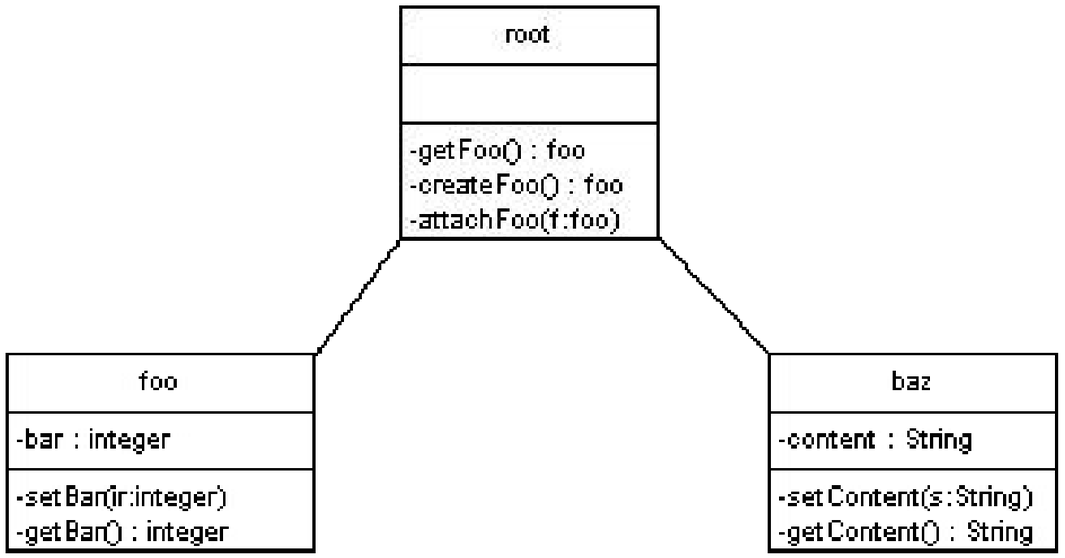
```
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified">
  <xs:element name="baz" type="xs:string"/>
  <xs:element name="foo">
    <xs:complexType>
      <xs:attribute name="bar" type="xs:integer" use="required"/>
    </xs:complexType>
  </xs:element>
  <xs:element name="root">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="foo" ref="foo"/>
        <xs:element name="baz" ref="baz"/>
      </xs:sequence>
    </xs:complexType>
  </xs:element>
</xs:schema>
```



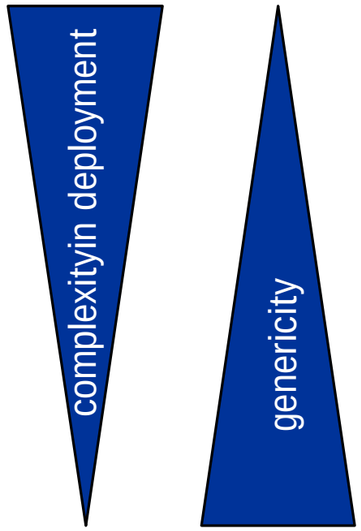
Wrappers for Extracting Data

Technology:

XML Data Binding

Document Object Model

Simple API for XML



Pros and Cons:

- Pros:
  - Most appropriate way to transfer specific XML vocabularies into in-memory representations
  - No genericity left (no overhead in processing)
- Cons:
  - No genericity left (needs re-built cycle every time schema changes)
  - Only available for the Java programming language

Mediators (for Transferring Data)

Motivation:

- (Prerequisite: XML is everywhere
  and becomes as the ASCII of the 21st century ubiquitous)
- XML and XML Schema make it quite easy to create new vocabularies
- The internet makes it quite easy to spread them
- Since XML is a meta-format it must be possible to establish a meta-transformation mechanism

Purpose:

- Transferring XML streams into XML streams
  (it is also possible to create arbitrary Unicode sequences)

Technology:

- Orientated on well known concepts, such as functional programming
- Provides an easy to use (XML-) language to encode these transformations
- Relies on the existence of generic transformation engines
- Provides a Turing-complete XML-style programming language

Mediators (for Transferring Data)

Example:

```
<?xml version="1.0"?>
<root>
  <foo bar="42"/>
      <baz>xyz</baz>
</root>
```


```
<?xml version="1.0"?>
<foo>
  <bar>42
    <baz content="xyz"/>
  </bar>
</foo>
```

Mediators (for Transferring Data)

Example:

```
<?xml version="1.0"?>
<root>
  <foo bar="42"/>
      <baz>xyz</baz>
</root>
```

```
<?xml version="1.0" encoding="UTF-8"?>
<xsl:transform version="1.0"
xmlns:xsl="http://www.w3.org/1999/XSL/Transform">
  <xsl:template match="root">
    <foo>
      <xsl:apply-templates select="foo"/>
    </foo>
  </xsl:template>
  <xsl:template match="foo">
    <bar>
      <xsl:value-of select="@bar"/>
      <xsl:apply-templates select="//baz"/>
    </bar>
  </xsl:template>
  <xsl:template match="baz">
    <baz content="{.}"/>
  </xsl:template>
  <xsl:template match="text()"/>
</xsl:transform>
```

```
<?xml version="1.0"?>
<foo>
  <bar>42
    <baz content="xyz"/>
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```

Mediators (for Transferring Data)

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  </xsl:template>
  <xsl:template match="baz">
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```

```
<?xml version="1.0"?>
<foo>
  <bar>42
    <baz content="xyz"/>
  </bar>
</foo>
```

Communication -- Web Services

Characteristic Attributes of Web Services:

- **Immaterial**

  Services do not produce physical goods

- **Transient**

  Services cannot be stored to consume them at a later point in time

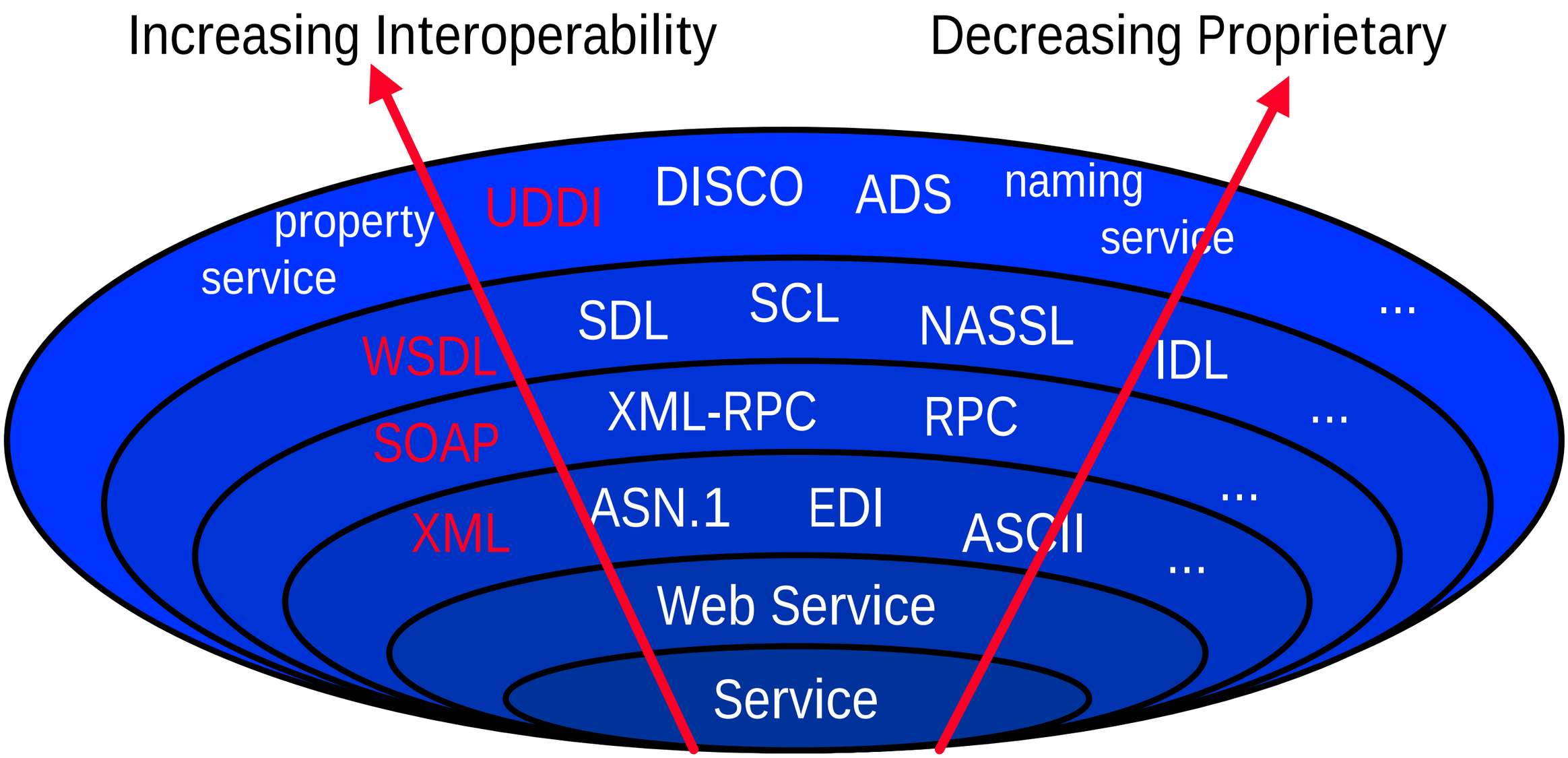
- **Location Dependant**

  Services cannot be transferred to another location

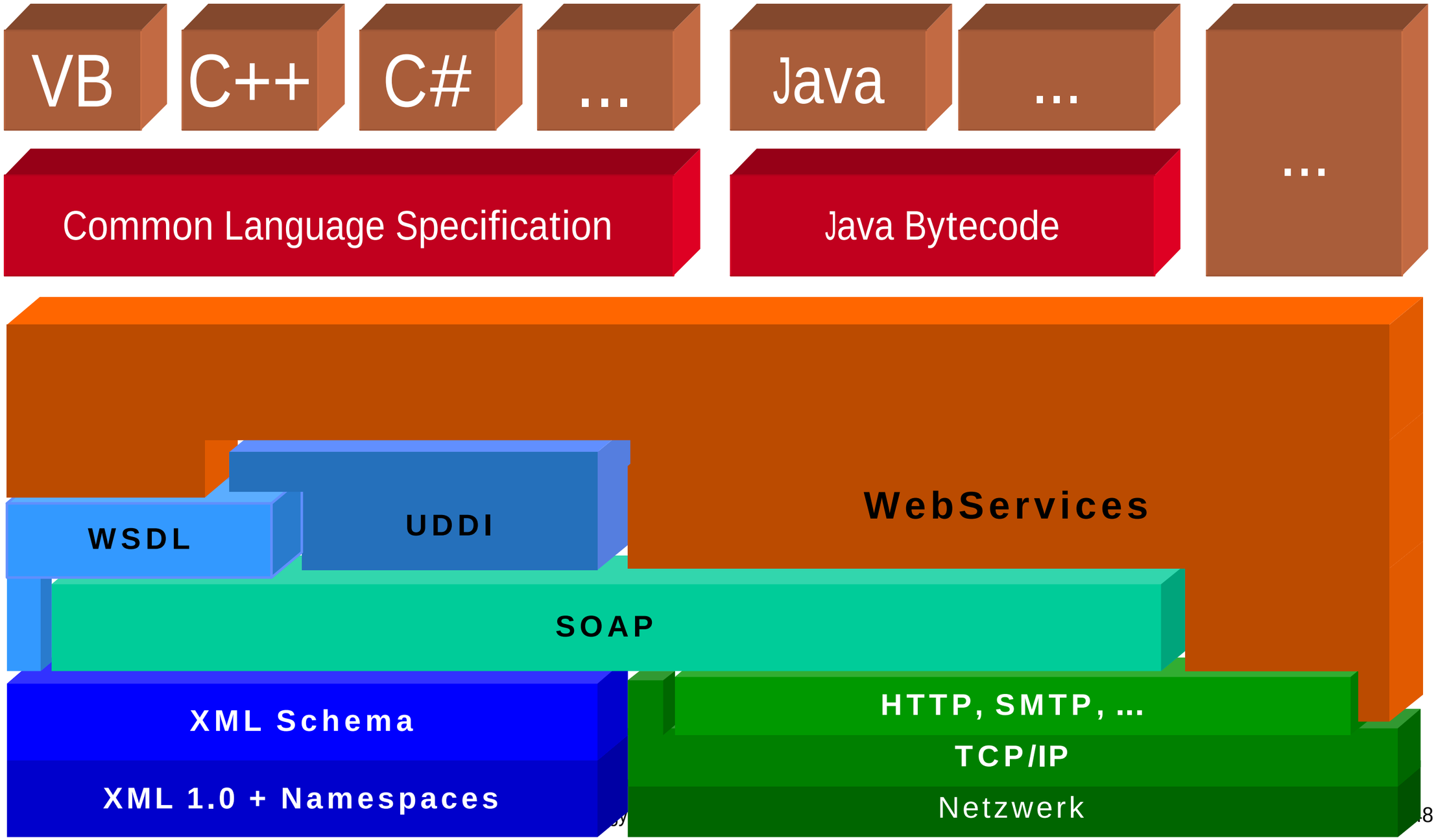
- **Production Consumption Synchronicity**

  Service provider and service consumer cannot be decoupled

Communication -- Web Services



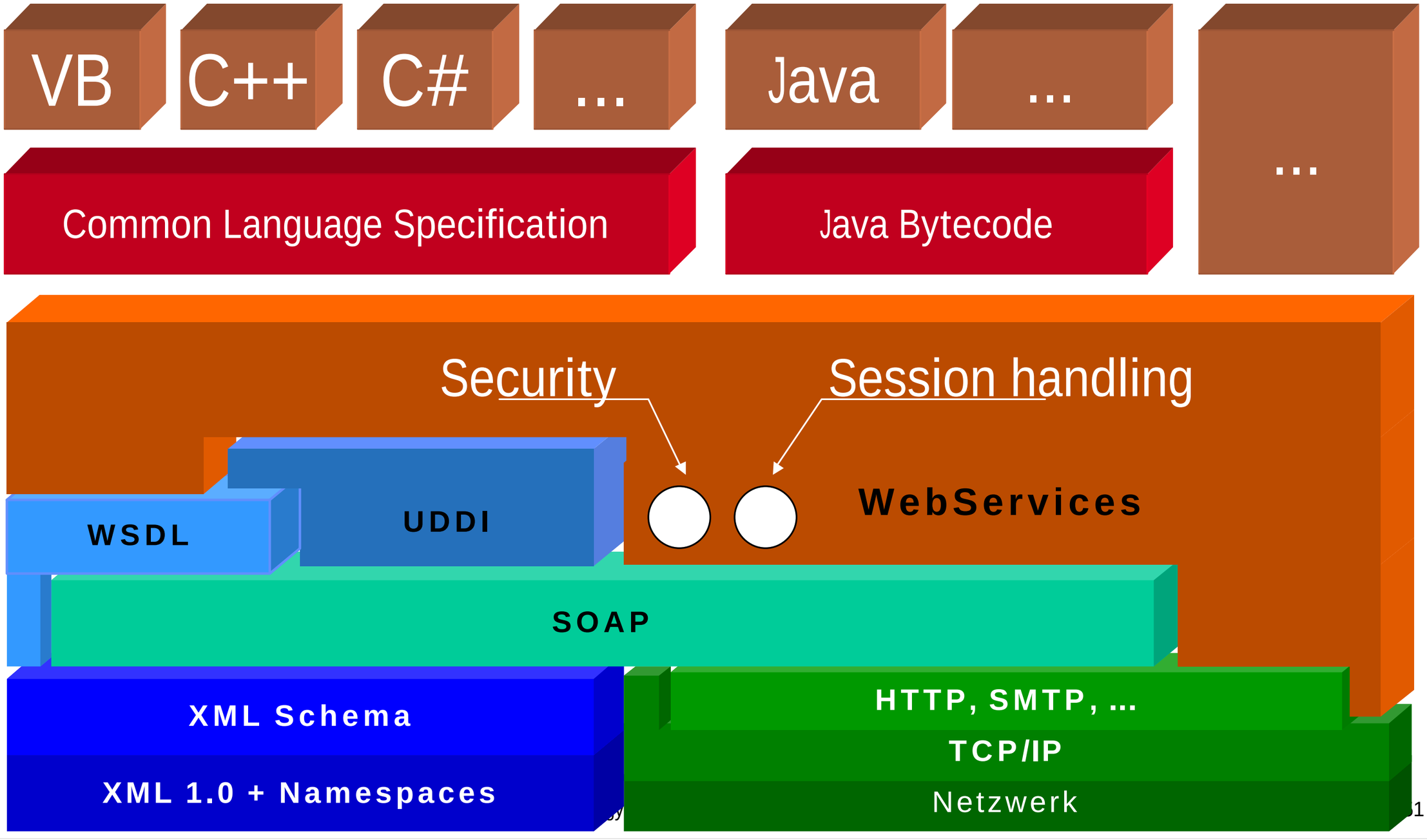
Communication -- Web Services



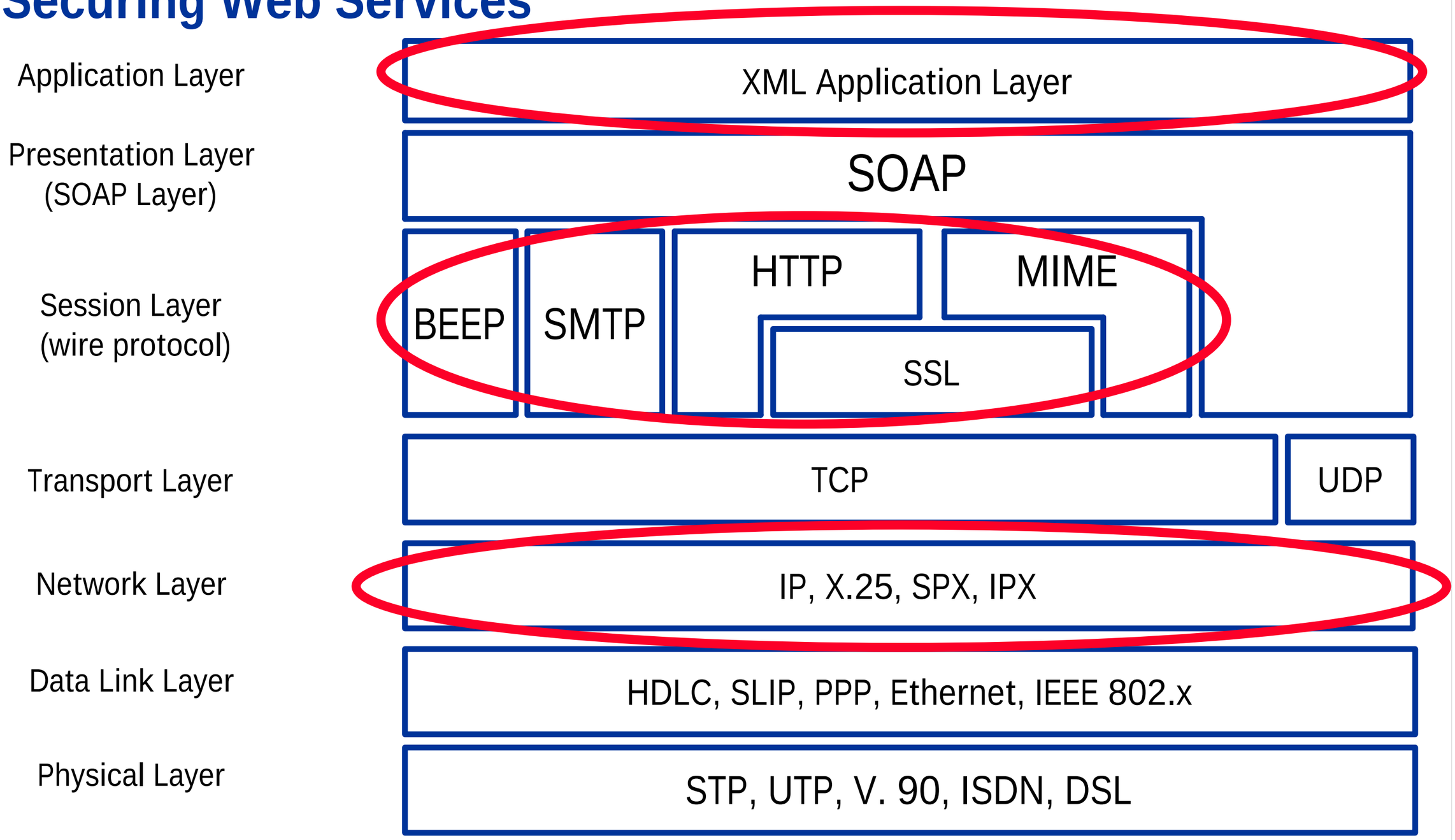
Communication -- Web Services

A Web Service is a piece of server-site software that provides a certain functionality (as a black box) and is accessible through Internet protocols using XML/SOAP messages with a described and published interface (typically by means of WSDL). Those interface descriptions should be registered in a (global) registry like UDDI.

Communication -- Web Services



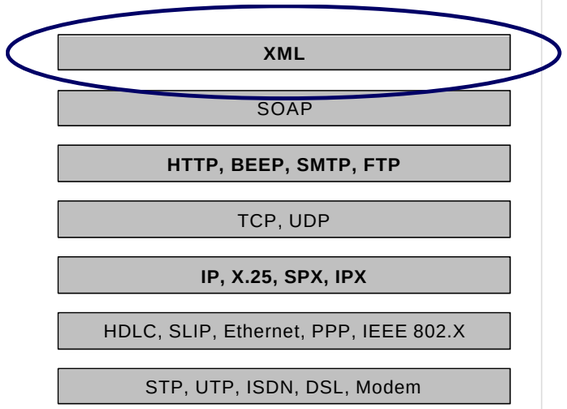
Securing Web Services



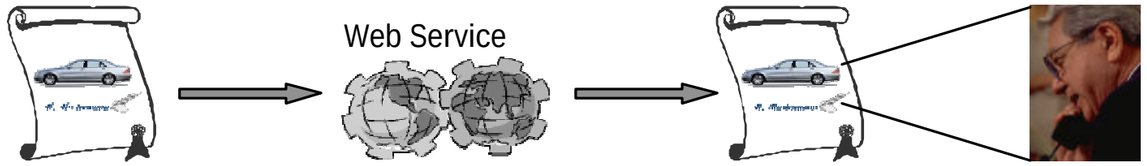
Securing Web Services -- XML Digital Signatures

Purpose: Modular, application-level signature mechanism

- Data Integrity
- Non-Repudiation
- Authorization
- Authentication



Basic Idea:



Technology:

- Message Digest, one-way-function
- Cryptographic signature of message digest
- Scalable

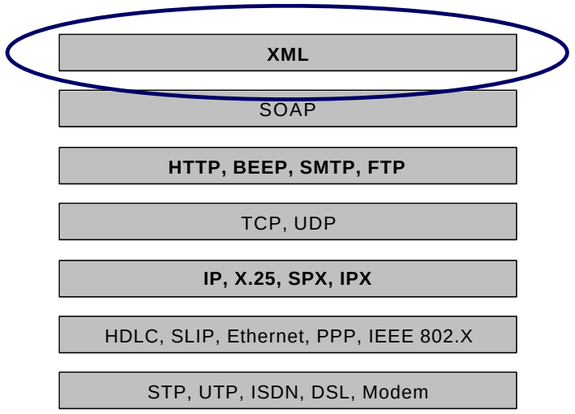
Standards:

- XML-Signature Syntax and Processing (W3C Recommendation since 2002-02-12 also IETF RFC 3072)

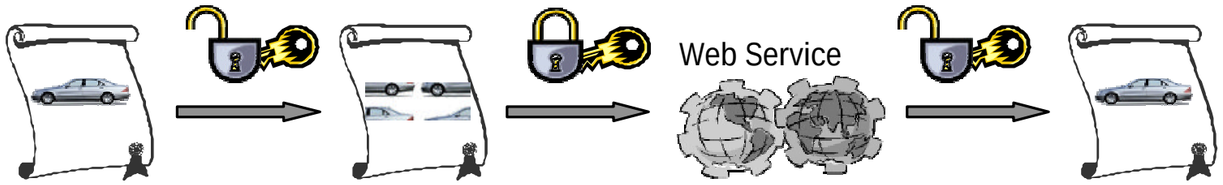
Securing Web Services -- XML Encryption

Purpose: Modular, application-level encryption mechanism

- Confidentiality
- Authorization



Basic Idea:



Technology:

- Cryptographic encryption algorithms
- Symmetric and asymmetric encryption
- Key management needed
- Interoperable with digital signatures

Standards:

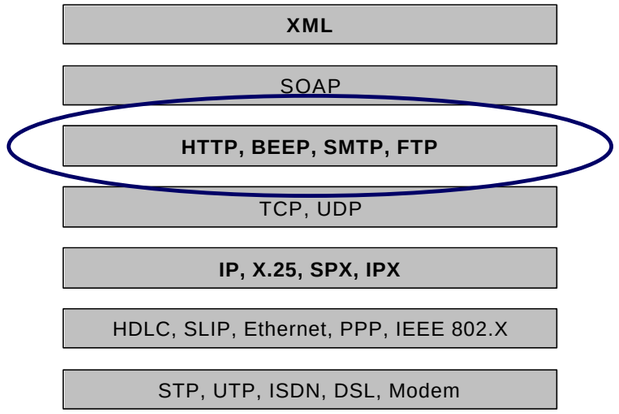
- XML Encryption Syntax and Processing
  (W3C Candidate Recommendation since 2002-03-04)

Securing Web Services -- Securing Web Content

Purpose:

Application-transparent content encryption

- Confidentiality
- Data Integrity
- Non-Repudiation
- Authorization
- Authentication



Basic Idea:

Technology:

- Adaptive security negotiation
- Certificate exchange
- Combines signature and encryption mechanisms

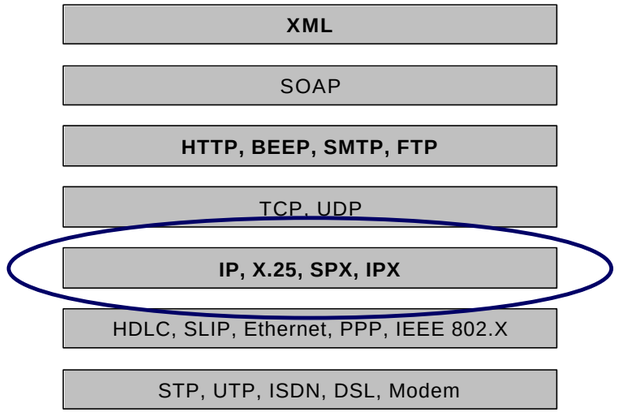
Standards:

- The TLS Protocol Version 1.0 (RFC 2246)
- The Secure HyperText Transfer Protocol (RFC 2660)
- Netscape's SSL / HTTPS

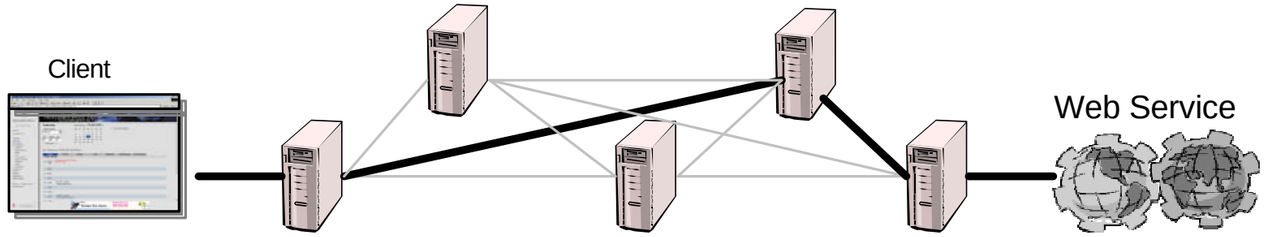
Securing Web Services -- Securing Network Content

Purpose: Session-transparent content encryption

- Confidentiality
- Data Integrity
- Non-Repudiation
- Authorization
- Authentication



Basic Idea:



Technology:

- Operates solely on IP Layer
- Allows encryption of payload and / or packet headers
- Two-way authentication via key management protocol

Standards:

- Security Architecture for IP (RFC 2401, 1998-11)

Efficient and Flexible Queries

Motivation:

- More and more data is stored using XML ...
  - in files
  - in so-called "XML databases" (a.k.a. virtual documents)
- Considering XPath a query language could be quite harmful ...
  - as a locator language it actually does not extract any data
  - it's calculus-based expressions are pretty handy for smaller queries, but only for those ...
  - Additionally, there are extensions to XPath needed, which are not standardized among vendors

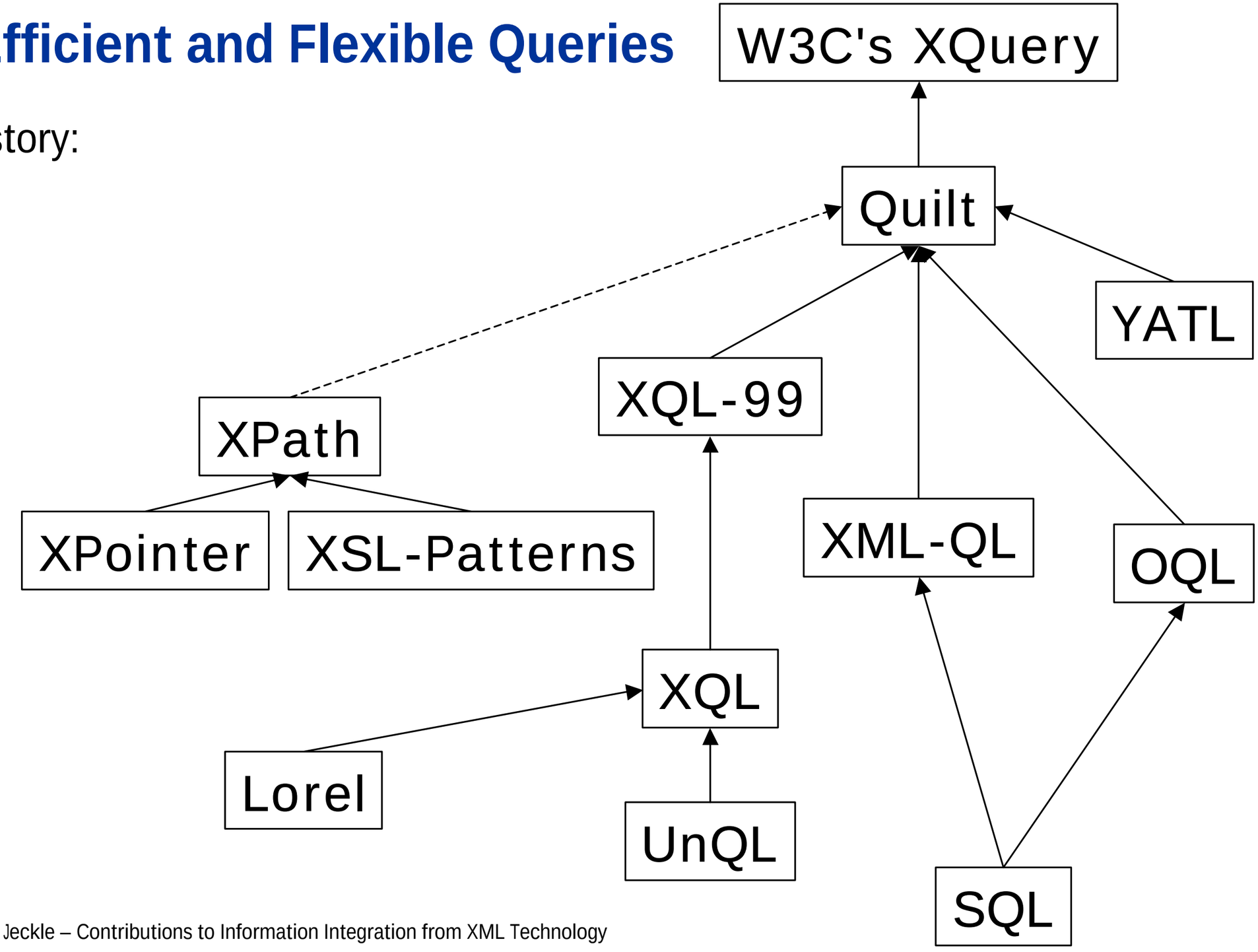
=> What we need is an SQL for XML

Purpose:

- Creating and extracting XML data primarily from XML data sources, but not limited to them

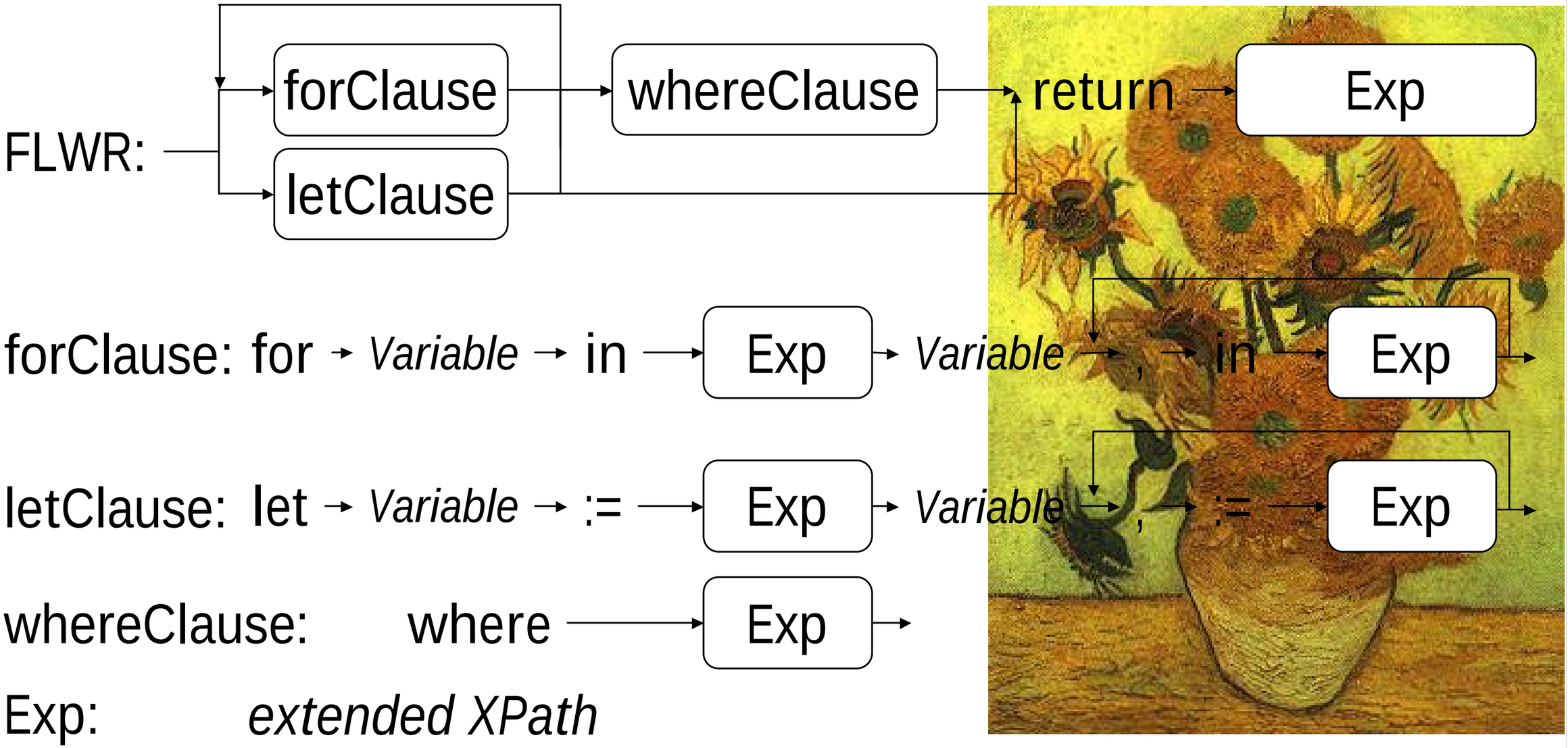
Efficient and Flexible Queries

History:



Efficient and Flexible Queries

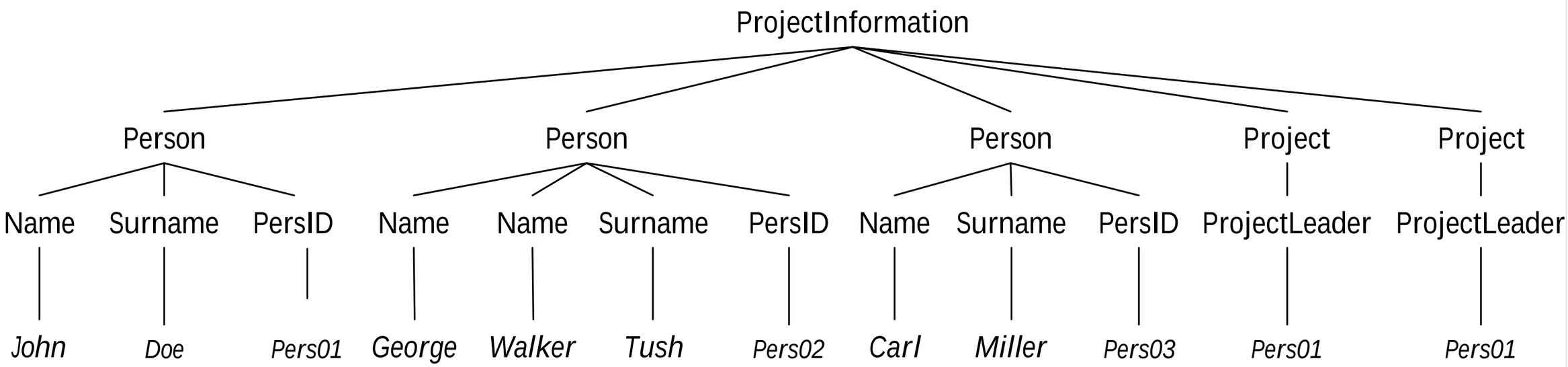
Syntax:



Efficient and Flexible Queries

Example:

```
FOR $persons IN //Person
LET $projects := //Project
WHERE $projects/@ProjectLeader = $persons/@PersID
RETURN $persons/Name
```



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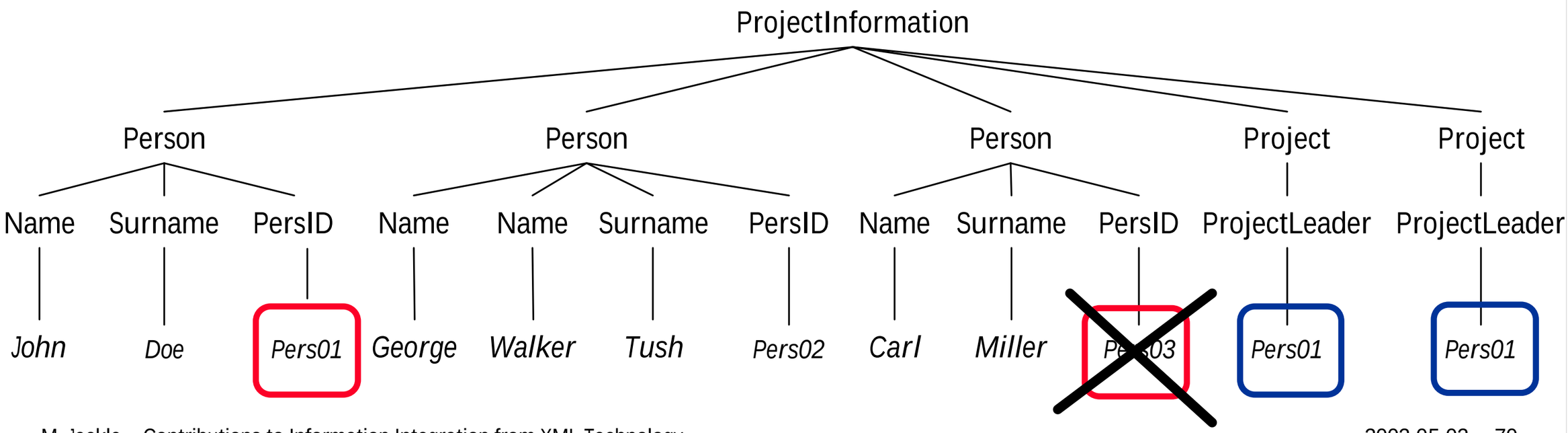

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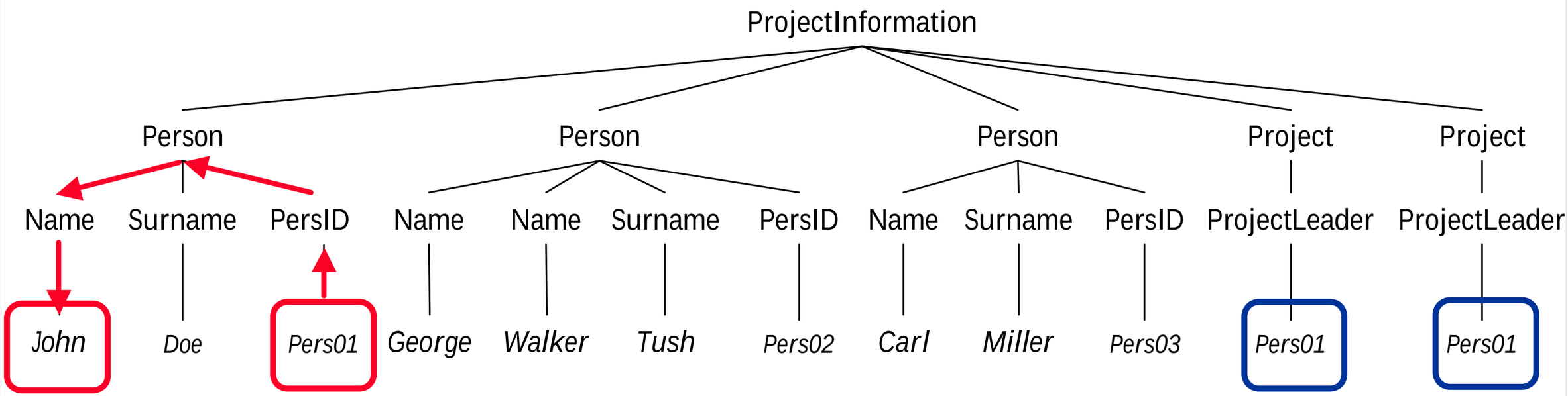

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