XMl and XSLT

- XML and DTD
- XSLT
- Simple mapping example (books)

'Web Services Made Easier', Sun Microsystems Technical White Paper, http://java.sun.com/xml/webservices.pdf

The Java Web Services Tutorial, http://java.sun.com/webservices/tutorial.html

XML Document Example

```
<?xml version="1.0"
encoding="ISO-8859-1" standalone="yes"?>

<!DOCTYPE AddressList SYSTEM
"AddressList.dtd" >

<!-- Simple Address Example -->

<AddressList>
  <Address Name="Fred Bloggs" >
    <Work>
      <Street>70 Symonds St</Street>
      <City>Auckland</City>
    </Work>
    <Work>
      <Street>38 Princes St</Street>
      <City>Auckland</City>
    </Work>
  </Address>
```

```
<Address Name="Myra Smith" >
    <Work>
      <Street>55 The Terrace</Street>
      <City>Wellington</City>
    </Work>
    <Home>
      <Street>18 Adams Terrace</Street>
      <City>Wellington</City>
    </Home>
  </Address>
</AddressList>
```


XML Document Structure

- The XML Declaration
- Document Type Declaration
- Document Body
  - Elements
  - Attributes
  - Character Data
  - Comments

The XML Declaration - Processing instructions

- `<?xml version="1.0" encoding="ISO-8859-1" standalone="yes" ?>`
  - Processing instructions for the application consuming the document `<? target processing_instructions ?>`
  - Identifies as an XML file and specifies version conformance
  - Encoding to specify character set used in document
  - `standalone="yes"`
    - No external markup declarations which affect the XML information

Document Type Declaration

- `<!DOCTYPE doc_name SYSTEM “{uri}”>`
  - `<!DOCTYPE ADDRESSLIST SYSTEM “AddressList.dtd”>`
  - doc_name must be the root ELEMENT of the DTD
  - SYSTEM indicates the DTD is at the given URI
- `<!DOCTYPE doc_name PUBLIC “{catalog id}”>`
- `<!DOCTYPE doc_name PUBLIC “{catalog id}” “{uri}”>`
  - `<!DOCTYPE PERSON PUBLIC “//DSTC/PERSON”>`
  - PUBLIC indicates the application knows where to find the DTD
- Internal specification

```
<!DOCTYPE PERSON [
  <!ELEMENT PERSON (name, address, phone+, company?)>
  …
]>
```


XML and DTDs

- Define an instance of XML language (vocabulary)
- Good points
  - Define document organisation in an easily shared manner
  - Understand full structure for further manipulation
  - Validating parser can ensure correctness
  - Can define required and optional information
- Disadvantages
  - Different syntax from rest of XML
  - Validating parser required to read another file
  - Complexity of parsing with DTD is increased

XML DTD

- Identifies instance of XML language
- Meta information about a document’s contents
  - Valid elements
  - Valid attribute names and values
  - Nesting structure allowed
- DTD usually a separate document
- DTD describes syntax of document - not semantics
  - XMLSchema is the preferred method to describe complex data structures as it provides fine-grain control of structural specification of a schema (in an object-oriented manner).

XML DTD Example

```
<!ELEMENT catalogue (publisherDetails, (publication)+) >
<!ELEMENT publisherDetails (publisherName, phone?, fax?, email?) >
<!ELEMENT publication (title, creator, subject?, description?, cost) >
<!ELEMENT publisherName (#PCDATA) >
<!ELEMENT phone (#PCDATA) >
<!ELEMENT fax (#PCDATA) >
<!ELEMENT email (#PCDATA) >
<!ELEMENT title (#PCDATA) >
<!ELEMENT creator (#PCDATA) >
<!ELEMENT subject (#PCDATA) >
<!ELEMENT description (#PCDATA) >
<!ELEMENT cost (#PCDATA) >
```

XML Document

```
<?xml version="1.0" encoding="UTF-8" ?>
<!DOCTYPE catalogue SYSTEM "BookBroker.dtd" >
<catalogue>
  <publisherDetails>
    <publisherName>Amorzon</publisherName>
    <phone>83068</phone>
    <fax>82651</fax>
    <email>trebor@cs.auckland.ac.nz</email>
  </publisherDetails>
  <publication>
    <title>A Reader in Planning Theory</title>
    <creator>Faludi, A</creator>
    <cost>15.99</cost>
  </publication>
  <publication>
    <title>Gender, Planning and the Policy Process</title>
    <creator>LITTLE, JO</creator>
    <description>Planning has a central essential legitimacy in
addressing social goals.</description>
    <cost>14.99</cost>
  </publication>
```

Element Declarations

- Map to tags in the final document
- `<!ELEMENT name content-model >`
  - content-model specifies terminal and non-terminal content
  - `?` optional (0 or 1)
  - `*` 0 or more
  - `+` 1 or more
  - `( a | b )` either a or b but not both
  - `( a , b )` a followed by b

Element Declarations

- No look-ahead in processors so content-model must be parsable without back tracking
  - `(a, b, c, d) | (b, c, d) | (c, d) | (d)`
  - `(a, b, c, d) | (a, b, c) | (a, b) | (a)`
- #PCDATA for terminal content
  - Parsed character data, allows text and markup
- EMPTY for no content
  - `<name></name>` or `<name />`
- ANY to match any content

DTD with attribute

```
<!ELEMENT AddressList (Address)* >

<!ELEMENT Address (Work|Home)+ >
<!ATTLIST Address Name CDATA #REQUIRED >

<!ELEMENT Work (Street, City) >
<!ELEMENT Home (Street, City) >

<!ELEMENT Street (#PCDATA) >
<!ELEMENT City (#PCDATA) >
```

```
<AddressList>
 <Address Name="Fred Bloggs" >
  <Work>
   <Street>70 Symonds St</Street>
   <City>Auckland</City>
  </Work>
  <Work>
   <Street>38 Princes St</Street>
   <City>Auckland</City>
  </Work>
 </Address>
```

Attribute Declarations

- Container for attributes associated with an element
- `<!ATTLIST element_name (att_name type default)+ >`
- Attribute types
  - `CDATA` character data (string)
  - `ID` unique ID within the document
  - `IDREF` a reference to a unique ID within the document
  - `IDREFS` a list of references to unique IDs
  - `ENTITY` a reference to an entity within the document
  - `ENTITIES` a list of references to entities
  - `NMTOKEN` a valid XML name token
  - `NMTOKENS` a list of valid XML name tokens
  - `NOTATION` an enumerated reference to a list of notation data types
  - `(value1 | value2 | …)` an enumerated list of possible values

Attribute Declarations

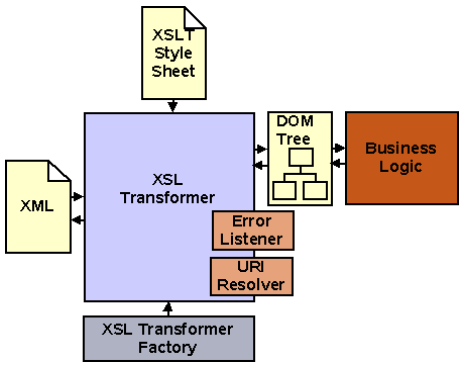
- Default types
  - `#REQUIRED` - must be specified for the element
  - `#IMPLIED` - attribute may not be specified, application will be able to calculate a value
  - `"default_value"` - if attribute is not specified then use this value
  - `#FIXED "constant_value"` - attribute will contain this value if specified
- References have some conventions
  - `<node ID="node101" >This is 101</node>`
  - `<start ref="node101" >`
  - also evolving standards Xlink, Xpointer
- Why use Entities rather than Attributes?

XSL/XSLT

- Extensible Stylesheet Language (XSL) and XSL Transformations (XSLT)
- XSL is a formatting language, for converting XML documents into formatted documents (building upon style sheets)
- JAXP includes XSLT implementation as part of javax.xml.transform package (actually wraps the Xalan XSLT implementation)

XSLT

- Basic approach, transform from DOM to DOM using XSL stylesheet to specify the transformation
- Resultant DOM represents formatted document which is then walked to produce output
- Some implementations handle SAX inputs directly (so don't need a DOM)



XML Example

- Coffee price list and DTD (from "Web Services Made Easier")

```
<priceList>
  <coffee>
    <name>Mocha Java</name>
    <price>11.95</price>
  </coffee>
  <coffee>
    <name>Sumatra</name>
    <price>12.50</price>
  </coffee>
</priceList>

<!ELEMENT priceList (coffee)+>
<!ELEMENT coffee (name, price) >
<!ELEMENT name (#PCDATA) >
<!ELEMENT price (#PCDATA) >
```


XSL Basic Approach

- XSL uses a rule-based template matching approach
- XSL uses a XML encoding so it has a tagged structure (which makes it difficult to read)
- Example with the coffee price list DTD from the web services paper:

```
<!ELEMENT priceList (coffee)+>
<!ELEMENT coffee (name, price) >
<!ELEMENT name (#PCDATA) >
<!ELEMENT price (#PCDATA) >
```


XSL Rules

- XSL is a rule-based language. Rules (template rules) have:
  - A match pattern, to match against XML elements specified as an Xpath expression
  - A template which specifies the form of the document to produce if an element matches
  - A template may cause further rules to be applied

```
<xsl:stylesheet version="1.0" xmlns:xsl="http://www.w3.org/1999/XSL/Transform">
  <xsl:template match="name">  Matches elements with tag name
    <tr><td>                   Constructs a html table row
      <xsl:apply-templates/>   Apply a stylesheet to bits of name element
                               Result goes in this place
    </td></tr>                 Completes the html table row
  </xsl:template>
```


XSL for Coffee Pricelist

```
<xsl:stylesheet version="1.0" xmlns:xsl="http://www.w3.org/1999/XSL/Transform">
  <xsl:template match="priceList">
    <html><head>Coffee Prices</head>
      <body>
        <table>
          <xsl:apply-templates />
        </table>
      </body>
    </html>
  </xsl:template>
  <xsl:template match="name">
    <tr><td>
      <xsl:apply-templates />
    </td></tr>
  </xsl:template>
  <xsl:template match="price">
    <tr><td>
      <xsl:apply-templates />
    </td></tr>
  </xsl:template>
</xsl:stylesheet>
```

Application to an example

```
<priceList>

  <coffee>
    <name>Mocha Java</name>


    <price>11.95</price>

  </coffee>
  <coffee>
    <name>Sumatra</name>


    <price>12.50</price>

  </coffee>
</priceList>
```

```
<html><head>Coffee Prices</head>
  <body>
    <table>

      <tr><td>
        Mocha Java
      </td></tr>
      <tr><td>
        11.95
      </td></tr>


      <tr><td>
        Sumatra
      </td></tr>
      <tr><td>
        12.50
      </td></tr>

    </table>
  </body>
</html>
```

Xpath and More Complex Matching

- See the handout from Java Web Services Tutorial for a more complete description of Xpath expressions
  - "/" The root element
  - "/priceList/name" name elements of priceList
  - "SECT|PARA|NOTE" Only SECT, PARA, or NOTE elements
  - "LIST/@type" The type attribute of LIST elements
- Using these can pull a XML structure apart and reorder the results to give a very different tree shape as a result

Phases

- What does it mean for an application to be XML-based or to be a Web Service?
- Typically three phases
  - XML input processing
    - Parsing and validating
    - Recognising/searching/extracting information
    - Binding information to business objects
  - Business logic
    - Processing information
  - XML output processing
    - Constructing a model of document to be produced
    - Applying XSLT or directly serialising to XML

Processing Models

- SAX
  - Serial access with the Simple API for XML
  - Parser generates events as it encounters tokens (callback)
  - Need to do everything in a single cycle
  - Low memory use
- DOM
  - Document Object Model
  - Constructs a parse tree of objects
  - Can walk through a tree multiple times extracting information
    - Ie random access but more memory intensive
  - Also JDOM – DOM tuned for Java – different and simpler construction and access protocol

Processing Models

- XSLT
  - Extensible Stylesheet Language Transformations
  - Higher level approach
    - Codes transformations as rules
    - Condition patterns specified using Xpath expressions
    - Little Java coding needed – a scripting approach
  - XSLT is itself an XML-based grammar (as is Xpath)
- JAXB
  - New Java API for XML/Java Binding
  - Produces object structure (as does DOM) but has compiler that generates classes based on XML DTD
    - Children and attributes accessible as properties
    - Can subclass to provide behaviour

Comparison

Processing Phase	SAX	DOM	XSLT
XML input processing			
Parsing and validating	Built in	Built in or based on SAX	Based on SAX or DOM
Recognizing / searching	Catching events with event handlers	Searching the tree with tree walkers	Xpath patterns
Extracting	Catching events	Getting attribute values, node content: API methods	Getting attribute values, node contents: Xpath statements
Mapping / binding	Creating business objects from the extracted information	Creating business objects from the extracted information	If ever, through DOM or SAX (pipelining)

Comparison

Processing Phase	SAX	DOM	XSLT
XML output processing			
Constructing	No default support but can be done by generating a properly balanced sequence of method calls to event handlers	Implicitly part of the model: API factory methods	Implicitly part of the model: XSL statements
Serializing	No default support but can be done with a custom event handler	Implementation specific support, or through XSLT identity transformation	Implicitly part of the model: XSL output method statement

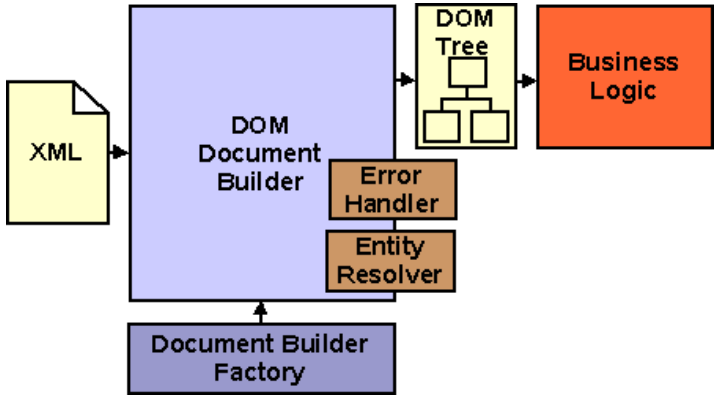
DOM

- Document Object Model (DOM)
  - The DOM specification defines how a XML document can be represented as a hierarchical object structure
  - Also specifies mechanisms for accessing elements within the tree
    - Allows for complex processing/manipulation of the document
  - More memory expensive than SAX as the whole document is in memory (but memory is cheap)
- Sun's JAXP includes a DOM implementation with an API defined in javax.xml.parsers

DOM Construction

- See example in “Web Services Made Easier”, pg 6
- DocumentBuilderFactory instance created
- Configuration variables set
- DocumentBuilder instance created using newDocumentBuilder()
- DocumentBuilder object’s parse() method used to read in the XML document and construct the parse tree
- You then use the Node access methods to traverse or manipulate the tree
  - Can access by tree walk or by search on tag name

DOM Processing



DOM API

- The DOM API defines interfaces for each of the entities of a XML document
- org.w3c.dom.Node interface: a single node in the document tree
  - Defines methods to access, insert, remove, replace the child nodes
  - Defines methods to access the parent node
  - Defines methods to access the document
- org.w3c.dom.Document interface is a Node that represents the entire XML document
- org.w3c.dom.Element interface is a Node that represents a XML element
- org.w3c.dom.Text interface is a Node that represents the textual content of a XML document

Invoking a DOM parser using JAXP

```
import javax.xml.parsers.*;
import org.xml.sax.*
import org.w3c.dom.*;
import java.io.*;

DocumentBuilderFactory factory = DocumentBuilderFactory.newInstance();
DocumentBuilder builder = factory.newDocumentBuilder();
Document document = builder.parse("priceList.xml");
```

DOM Manipulation

```
Node rootNode = document.getDocumentElement();
NodeList list = document.getElementsByTagName("coffee");

// Loop through the list.
for (int i=0; i < list.getLength(); i++) {
  thisCoffeeNode = list.item(i);
  Node thisNameNode = thisCoffeeNode.getFirstChild();
  if (thisNameNode == null) continue;
  if (thisNameNode.getFirstChild() == null) continue;
  if (! thisNameNode.getFirstChild() instanceof org.w3c.dom.Text)
continue;
  String data = thisNameNode.getFirstChild().getNodeValue();
  if (! data.equals("Mocha Java")) continue;
  //We're at the Mocha Java node. Create and insert the new
  //element.
  …
}
```


DOM Manipulation

```
    …
    //We're at the Mocha Java node. Create and insert the new
    //element.
    Node newCoffeeNode = document.createElement("coffee");

    Node newNameNode = document.createElement("name");
    Text tnNode = document.createTextNode("Kona");
    newNameNode.appendChild(tnNode);

    Node newPriceNode = document.createElement("price");
    Text tpNode = document.createTextNode("13.50");
    newPriceNode.appendChild(tpNode);

    newCoffeeNode.appendChild(newNameNode);
    newCoffeeNode.appendChild(newPriceNode);

    rootNode.insertBefore(newCoffeeNode, thisCoffeeNode);
    break;
  }
```


Outputting XML

- Can generate XML document from a DOM using a Transformer
- Eg suppose coffee processor modified to output results as a new XML document

```
Document document = builder.parse("priceList.xml");
// code that modifies the DOM in here

TransformerFactory transFactory = TransformerFactory.newInstance();
Transformer transformer = transFactory.newTransformer();
DOMSource source = new DOMSource(document);
File newXML = new File("newPriceList.xml");
FileOutputStream fos = new FileOutputStream(newXML);
StreamResult result = new StreamResult(fos);
transformer.transform(source, result);
```



```
<priceList>
  <coffee>
    <name>Kona</name>
    <price>13.50</price>
  </coffee>
  <coffee>
    <name>Mocha Java</name>
    <price>11.95</price>
  </coffee>
  <coffee>
    <name>Sumatra</name>
    <price>12.50</price>
  </coffee>
</priceList>
```