XML

Objectives

- What is XML
- XML data model
- XML Namespace description
- XSL

What is XML

- EXtensible Markup Language
- A **framework** for defining other markup languages
- Defined by W3C http://www.w3.org/TR/xml11 standardized in 1998
- Useful as a mechanism to transport and store data
- XHTML is an XML variant of HTML
- Platform independent, license-free, and internationalized (Unicode)
- Basically a meta-language - XML tags are not predefined. You define your own tag names.
- Self describing and human-readable
- Uses a DTD (Document Type Definition) to formally describe and validate the data

XML and HTML

- XML is not a replacement for HTML
- XML and HTML have different goals:
  - XML **describes data** and focuses on what the data represent
  - HTML **structures browser content**

XML is extensible

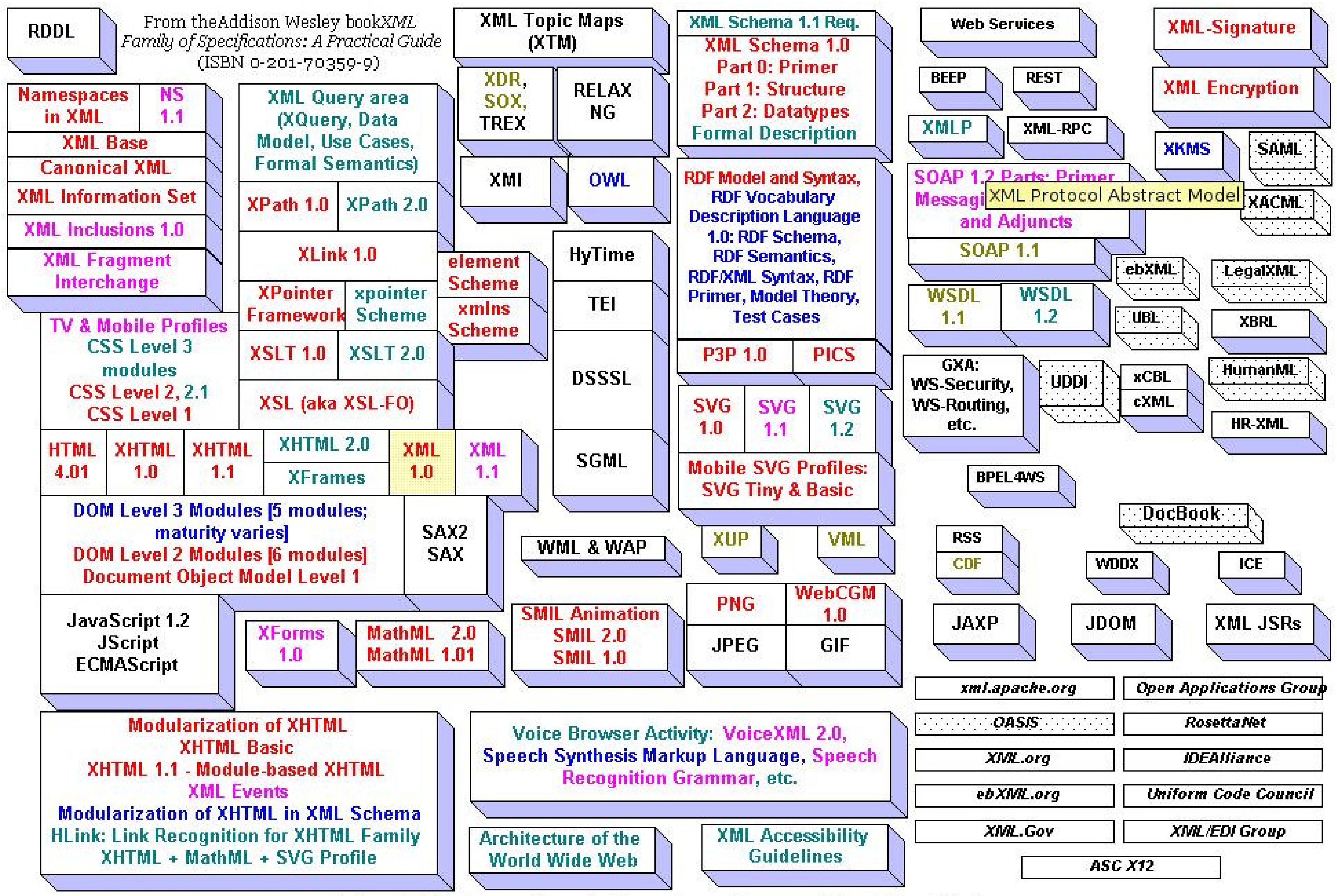
- Tag names which markup HTML documents and the structure of HTML documents are **predefined**. The author of HTML documents can only use tag names that are defined in the HTML standard (e.g. body, p, a)
- XML allows you to define your own tag names and your own XML document structure
- XML is a complement to HTML, a descendant of SGML (standard generalized markup language)
- XML can be used to structure and describe data used by web technologies

How XML is used

- How can XML be useful?
- XML can:
  - keep data separate from HTML
  - serve as a mechanism to exchange information aka *data serialization* – *converting complex data objects into bit sequences*
  - store data in human readable files or in databases

XML technologies

- Define syntax of languages
  - DTD, XML Schema, XHTML, Office Open XML
- Display data in browsers
  - XPath, XSLT
- Store information in databases
  - XQuery, RDF
- Facilitate web services data, podcasting
  - WSDL, SOAP, RSS, Atom, AJAX, mashups
- Platform independent program configuration
  - Apache Ant
- Image formats
  - SVG (Scalable Vector Graphics)
- Online forms
  - XForms


RDDL
From the Addison Wesley book XML Family of Specifications: A Practical Guide (ISBN 0-201-70359-9)
XML Topic Maps (XTM)
XML Schema 1.1 Req.
XML Schema 1.0 Part 0: Primer Part 1: Structure Part 2: Datatypes Formal Description
Web Services
XML-Signature
XML Encryption
BEEP
REST
XMLP
XML-RPC
XKMS
SAML
XACML
Namespaces in XML
NS 1.1
XML Base
Canonical XML
XML Information Set
XML Inclusions 1.0
XML Fragment Interchange
XML Query area (XQuery, Data Model, Use Cases, Formal Semantics)
XPath 1.0
XPath 2.0
XLink 1.0
XPointer Framework
xpointer Scheme
element Scheme
xmlns Scheme
XSLT 1.0
XSLT 2.0
XSL (aka XSL-FO)
XDR, SOX, TREX
RELAX NG
XMI
OWL
HyTime
TEI
DSSSL
SGML
RDF Model and Syntax, RDF Vocabulary Description Language 1.0: RDF Schema, RDF Semantics, RDF/XML Syntax, RDF Primer, Model Theory, Test Cases
P3P 1.0
PICS
SVG 1.0
SVG 1.1
SVG 1.2
Mobile SVG Profiles: SVG Tiny & Basic
SOAP 1.2 Parts: Primer Messagi XML Protocol Abstract Model and Adjuncts
SOAP 1.1
WSDL 1.1
WSDL 1.2
ebXML
LegalXML
UBL
XBRL
GXA: WS-Security, WS-Routing, etc.
UDDI
xCBL
cXML
HumanML
HR-XML
BPEL4WS
DocBook
TV & Mobile Profiles
CSS Level 3 modules
CSS Level 2, 2.1
CSS Level 1
HTML 4.01
XHTML 1.0
XHTML 1.1
XHTML 2.0
XFrames
XML 1.0
XML 1.1
DOM Level 3 Modules [5 modules; maturity varies]
DOM Level 2 Modules [6 modules]
Document Object Model Level 1
SAX2 SAX
WML & WAP
XUP
VML
RSS
CDF
WDDX
ICE
JavaScript 1.2 JScript ECMAScript
XForms 1.0
MathML 2.0
MathML 1.01
SMIL Animation
SMIL 2.0
SMIL 1.0
PNG
WebCGM 1.0
JPEG
GIF
JAXP
JDOM
XML JSRs
xml.apache.org
Open Applications Group
OASIS
RosettaNet
XML.org
IDEAlliance
ebXML.org
Uniform Code Council
XML.Gov
XML/EDI Group
ASC X12
Modularization of XHTML
XHTML Basic
XHTML 1.1 - Module-based XHTML
XML Events
Modularization of XHTML in XML Schema
HLink: Link Recognition for XHTML Family
XHTML + MathML + SVG Profile
Voice Browser Activity: VoiceXML 2.0, Speech Synthesis Markup Language, Speech Recognition Grammar, etc.
Architecture of the World Wide Web
XML Accessibility Guidelines

The XML Family of Specifications: The Big Picture

Last Updated: April 19, 2003

Recommendation	Proposed Recommendation	Candidate Recommendation	Last Call Working Draft	Working Draft	Note submitted to W3C	Not a W3C specification

When to use XML-based format

- Data is structured into a hierarchy form
- Need for a wide range of tools on different platforms
- Need for data that can ‘outlive’ the applications that process it
- Supports internationalization
- Need for human-readable text content
- Possible use with other XML-encoded formats

Sample XML document #1

```
<?xml version="1.0"?>
<note>
  <to> John </to>
  <from> Sally </from>
  <heading> Reminder </heading>
  <body> Do you have my book?
  </body>
</note>
```

XML documents should begin with an XML declaration.

XML documents use the .xml file extension as in **`note.xml`**

XML content is **`free-format`**

Sample XML document #2

```
<?xml version="1.0"?>
<catalog>
 <book id="bk101">
   <author>Gambardella, Matthew</author>
   <title>XML Developer's Guide</title>
   <genre>Computer</genre>
   <price>44.95</price>
   <publish_date>2000-10-01</publish_date>
   <description>An in-depth look at creating applications with XML.</description>
 </book>
 <book id="bk102">
   <author>Ralls, Kim</author>
   <title>Midnight Rain</title>
   <genre>Fantasy</genre>
   <price>5.95</price>
   <publish_date>2000-12-16</publish_date>
   <description>A former architect battles corporate zombies, an evil sorceress,
    and her own childhood to become queen of the world.</description>
 </book>
<catalog>
```

XML data must start with a **single** "root" or **document entity**, here, it is <catalog>

XML consists of **elements** which are enclosed by its start tag and its end tag. e.g. author, title, genre, price, etc

The characters between the start and end tags, if any, are the element's **content**.

XML terminology

- Markup
  - XML documents are divided into markup and content
  - Markup is any text that either:
    - starts with **<**
    - or, ends with **>**
    - or, begins with **&** and ends with **;**
  - Content is anything else (basically the data within the markup)

XML terminology

- Element
  - A logical component of an XML document which either begins with a start-tag and ends with its matching end-tag (e.g. <price>13.50</price), or consists only of an empty element tag, (e.g. <toppings />)
  - The content within the element may contain markup, including other elements, which are then called child elements.

XML terminology

- Attribute
  - A markup construct consisting of a name/value pair existing inside the tag (e.g. for the start tag <book bookid= ‘bk101’ > the name/value pair attribute is bookid/ ‘bk101’)
  - Attributes may be optional
  - Attribute value must be in matching single or double quotes
  - More than one attribute may be defined
    - order of attribute definitions does not matter

XML terminology

- Encoding
  - Defines the character set used in the XML document
  - Usually it is UTF-8 (8-bit Unicode Transformation Format) see www.unicode.org
    - Backward-compatible with ASCII (one byte per character e.g. ‘a’ is encoded as U+0061)
    - Variable length character encoding
    - Can encode any Unicode character, such as those used by other languages e.g. U+8349 is 草 or “grass” in “Mandarin (simplified)”

XML terminology

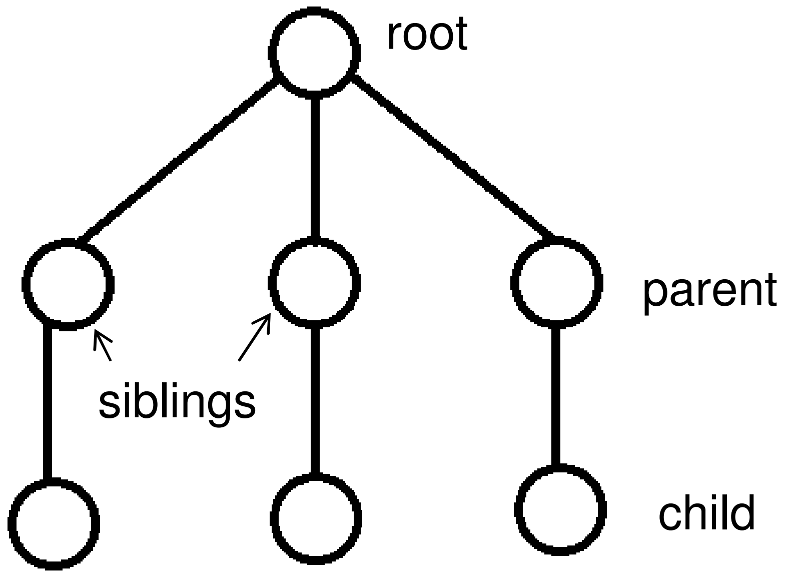
- Processing Instruction (PI)
  - tells a program to perform a specific task
  - a PI begins with “<?” and ends with “?>”
  - the XML declaration is also a processing instruction

```
<?xml version=“1.0” encoding=“UTF-8”?>
```

I &#x2665;
XML Character
References

XML Tree

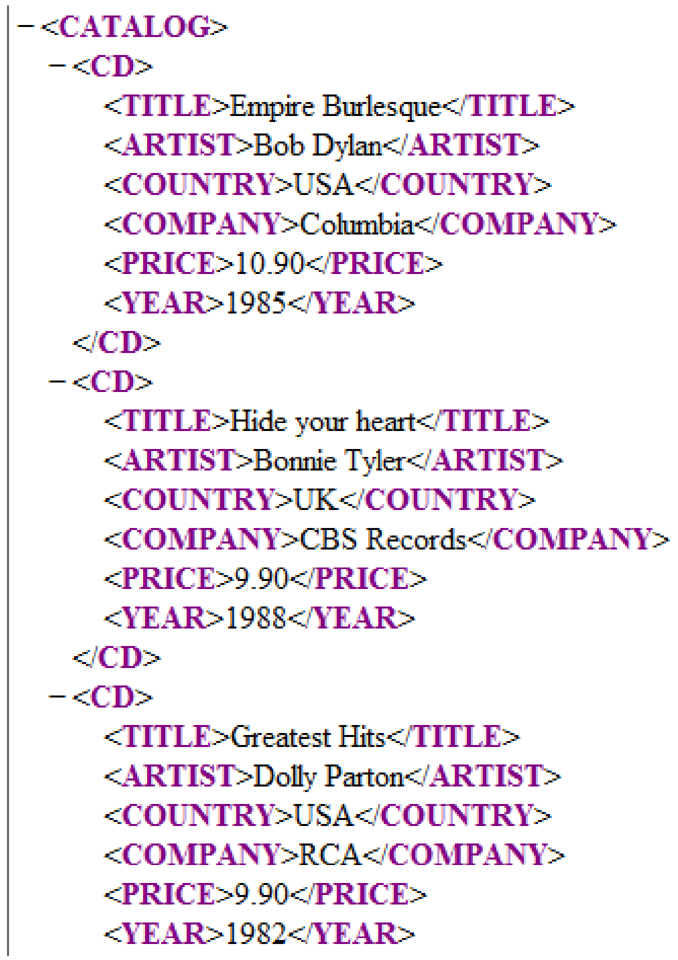
- Conceptually, an XML document is structured like a tree
  - Node
  - Root
  - Child, parent
  - Sibling



Nodes in XML Trees

- Text nodes: the content between tags
- Element nodes: the start and end tags
- Attribute nodes: any name= “value” inside a start tag
- Comment nodes: ignored by the processor
- Processing instructions: <?target value?>
- Root node: the XML tree has one root node

Sample XML file #3



```
- <CATALOG>
  - <CD>
      <TITLE>Empire Burlesque</TITLE>
      <ARTIST>Bob Dylan</ARTIST>
      <COUNTRY>USA</COUNTRY>
      <COMPANY>Columbia</COMPANY>
      <PRICE>10.90</PRICE>
      <YEAR>1985</YEAR>
    </CD>
  - <CD>
      <TITLE>Hide your heart</TITLE>
      <ARTIST>Bonnie Tyler</ARTIST>
      <COUNTRY>UK</COUNTRY>
      <COMPANY>CBS Records</COMPANY>
      <PRICE>9.90</PRICE>
      <YEAR>1988</YEAR>
    </CD>
  - <CD>
      <TITLE>Greatest Hits</TITLE>
      <ARTIST>Dolly Parton</ARTIST>
      <COUNTRY>USA</COUNTRY>
      <COMPANY>RCA</COMPANY>
      <PRICE>9.90</PRICE>
      <YEAR>1982</YEAR>
```

- http://www.w3schools.com/XML/cd_catalog.xml

XML Syntax

- Proper XML documents are *well-formed* (breaks no tag rules) and *valid* (XML data checked against its own DTD rules).
- An XML file must be well-formed before it can be validated. A well-formed XML document obeys the syntax of an XML document.
- A *broken* XML file is either not well-formed or not valid or both.

XML Syntax

- In HTML some elements are not required to have a closing tag. The following is legal in HTML v4:

  <p>It was a dark and stormy night.

  <p>Susan went to the kitchen.

- But in XML all elements must have a closing tag :

  <p>It was a dark and stormy night.</p>

  <p>Susan went to the kitchen.</p>

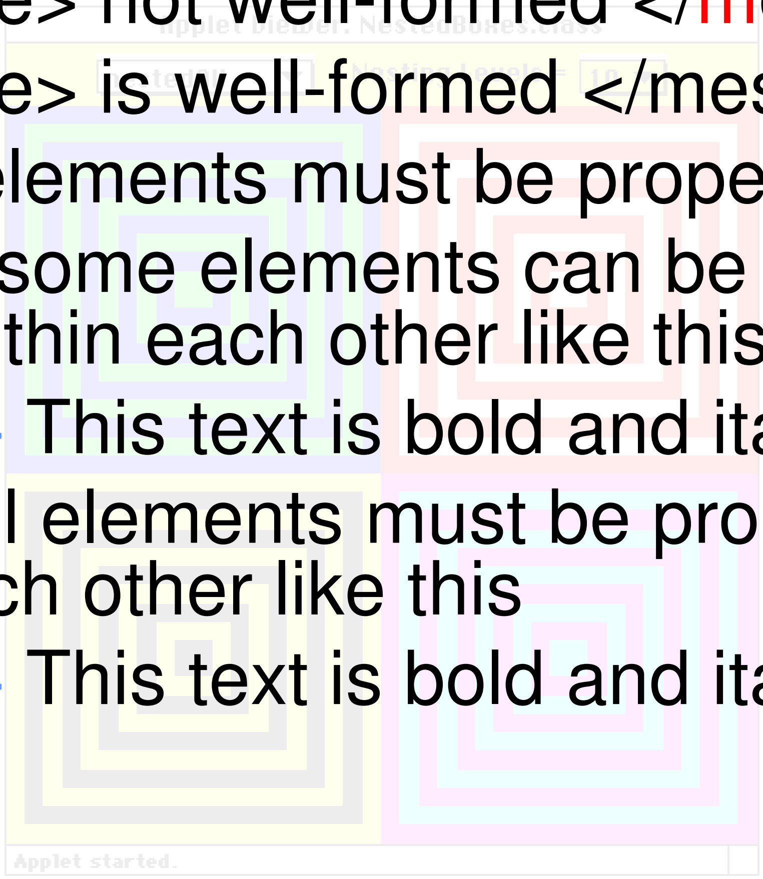
- XML tags are case sensitive.

  The tag <Letter> is different from the tag <letter>

Element name

- Element names can contain letters, numbers, periods, underscores, hyphens, but not spaces
- Element names must be defined uniquely within the XML document (i.e. no name duplication)
- Element name must start with a letter or underscore, but cannot start with reserved words such as `xml`
- Acceptable element name: bookstore
  Unacceptable: 100book, $author, cost per

XML Syntax



- Start and end tags must be written with the same case:

  <Message> not well-formed </message>

  <message> is well-formed </message>
- All XML elements must be properly nested
- In HTML some elements can be improperly nested within each other like this:

  <b> <i> This text is bold and italic </b> </i>
- In XML all elements must be properly nested within each other like this

  <b> <i> This text is bold and italic </i> </b>

XML Syntax

- Empty tags may use the backslash (similar to XHTML <hr /> and <br />
- It is legal in XML to use a start-tag/end-tag pair for empty tags <note></note>
- XML comments similar to HTML

  <!−−   −−>   cannot use −−

Broken XML document

```
<?xml version="1.0"?>
<note>
<heading>
<to> John
<from> Sally
 Reminder </heading> </from>
<body>Do you have my book?</body>
<date sent>May 30, 2010</date sent>
</Note>
```

Missing end tag </to>

Improper tag nesting

Element name contains space

Unmatched tag name

Well-formed XML

- The main reason you need well-formed XML is that an XML parser program reads the XML and generates a structure like a tree which represents the XML document
- Each “branch” of the tree must be properly defined so it can be examined
- If a tag is missing or unbalanced, the XML parser cannot create the tree

XML Validation

- A valid XML document is a Well Formed XML document which conforms to the rules and constraints of a Document Type Definition (DTD)
- Also called a schema or a grammar
- The purpose of a DTD is to define the legal building blocks of an XML document
- XML does not require a DTD but it defines the document structure with a list of legal elements.
- A DTD can be declared inline in your XML document, or as an external reference.

Internal DTD

```
<?xml version="1.0"?>
<!DOCTYPE note [
<!ELEMENT note    (to,from,heading,body)>
<!ELEMENT to      (#PCDATA)>
<!ELEMENT from    (#PCDATA)>
<!ELEMENT heading (#PCDATA)>
<!ELEMENT body    (#PCDATA)>
]>
<note>
<to>John</to>
<from>Sally</from>
<heading>Reminder</heading>
<body>Do you have my book?</body>
</note>
```

Element note must contain the following children in this specific order.

PCDATA means parsed character data – text found between the start and end tags – tags inside the text will be treated as markup and entities will be expanded.

External DTD

```
<?xml version="1.0"?>
<!DOCTYPE note SYSTEM "note.dtd">
<note>
<to>John</to>
<from>Sally</from>
<heading>Reminder</heading>
<body>Do you have my book?</body>
</note>
```

The file note.dtd contains

```
<?xml version="1.0"?>
<!ELEMENT note
(to,from,heading,body)>
<!ELEMENT to      (#PCDATA)>
<!ELEMENT from    (#PCDATA)>
<!ELEMENT heading (#PCDATA)>
<!ELEMENT body    (#PCDATA)>
```

Invalid XML file example

```
<?xml version="1.0"?>
<!DOCTYPE note [
<!ELEMENT note    (to,from,heading,body)>
<!ELEMENT to      (#PCDATA)>
<!ELEMENT from    (#PCDATA)>
<!ELEMENT heading (#PCDATA)>
<!ELEMENT body    (#PCDATA)>
]>
<note>
<from>Sally</from>
<to>John</to>
<heading>Reminder</heading>
<sent>Today</sent>
<body>Do you have my book? </body>
</note>
```

Start and end tags for <to>…</to> appear after <from>…</from> tags.

Tag <sent> not declared in the note element

Element Type Declarations

- Element type declarations identify the names of elements and the nature of their content

```
<!ELEMENT meal (appetizer+, entree, dessert?)>
<!ELEMENT appetizer     (#PCDATA)>
<!ELEMENT entree        (#PCDATA)>
<!ELEMENT dessert       (#PCDATA)>
```

The commas between element names indicate that they must occur in succession.
The plus after appetizer indicates that it may be repeated more than once but must occur at least once.
The question mark after dessert indicates that it is optional (it may be absent, or it may occur exactly once). An asterisk * means 0 or more.
A name with no punctuation, such as entree, must occur exactly once.

Attribute List Declarations

- Identify which elements may have attributes, what attributes they may have, what values the attributes may hold, and what value is the default

```
<!ATTLIST dessert
  name      ID    #REQUIRED
  label     CDATA #IMPLIED
  category ( cake | pie | ice-cream ) 'pie'>
```

#IMPLIED means label does not have to be included

category choices for dessert – pie is the default

Attribute declarations

- Another example:

```
<!ATTLIST  IMG
      src      %URI;     #REQUIRED
      name     CDATA     #IMPLIED
      id       ID        #IMPLIED
      class    CDATA     #IMPLIED
      alt      %Text;    #REQUIRED
  >
```

XML Entities

- Entities are shortcuts to content text

```
<!ENTITY  restaurant  “ABC Steak House”>
<!ENTITY  owners   “Bill and Sue Smith”>
<!ENTITY  menu  SYSTEM
  “http://www.abcSteakHouse.com/entities/
                entities.xml”>

  <dining> &restaurant; &owners; &menu;
  </dining>
```

Why use a DTD?

- XML provides an application independent way of sharing data.
- With a DTD, independent groups of people can agree to use a common DTD for interchanging data.
- Your application can use a standard DTD to verify that data that you receive from the outside world is valid.
- You can also use a DTD to verify your own data

DTD Alternative

- XSD (XML Schema Document) is a W3C technology for defining XML schemas
- Unlike DTD XSD has namespace awareness and can use data types such as string, boolean, float, date, time, etc – 25 derived data types in all
- All the named schema components belong to a target namespace, and the target namespace is a property of the schema

XSD Example

```
<?xml version="1.0" encoding="utf-8"?>
<xs:schema elementFormDefault="qualified“
      xmlns:xs="http://www.w3.org/2001/XMLSchema">
   <xs:element name="Address">
     <xs:complexType>
        <xs:sequence>
            <xs:element name="Recipient" type="xs:string" />
            <xs:element name="House" type="xs:string" />
            <xs:element name="Street" type="xs:string" />
            <xs:element name="Town" type="xs:string" />
            <xs:element name="PostCode" type="xs:string" />
        </xs:sequence>
     </xs:complexType>
   </xs:element>
</xs:schema>
```

Displaying XML

- IE and Firefox have differing approaches to displaying XML.
- Can display XML data inside an HTML page by using JavaScript to import data from an XML file.
- Can also use CSS files with XML, but XSL files (Extensible Style Language) are the better way to go

XML format

- Notice that at this point nothing has been said about the format of the final document.
- From the neutral format provided by XML users can either chose to display the memo:
  - on a screen, the size can be varied to suit user preferences,
  - to print the text onto a pre-printed form,
  - or to generate a completely new form, positioning each element of the document where needed

XML validation

- http://www.xmlvalidation.com
- Other XML schema validators

  http://www.w3schools.com/dom/dom_validate.asp

  http://www.validome.org/xml/

Namespace

Microsoft Windows

- Windows
- Visio
- NotePad
- Paint
- Word

Acme Hardware

- Windows
- Nails
- Screws
- Paint
- Tape

Microsoft.Windows
Microsoft.Paint

AcmeHardware.Windows
AcmeHardware.Paint

XML namespace

- You may want to use the same tag name or attribute for different types of information
- HTML tag <table> vs something else that uses the same tag name
- XML uses *namespace* to differentiate
- Defining the namespace:

xmlns:*prefix = ‘namespace identifier’*

XML namespace

```
<meal xmlns:d='http://www.mandl.com/'>

  <appetizer> salad </appetizer>
  <appetizer> calamari </appetizer>
  <entree> pepperoni pizza </entree>
  <dessert> vanilla ice cream </dessert>

</meal>
```

XML namespace

```
<d:meal xmlns:d='http://www.mandl.com/'>

  <d:appetizer> salad </d:appetizer>
  <d:appetizer> calamari </d:appetizer>
  <d:entree> pepperoni pizza </d:entree>
  <d:dessert> vanilla ice cream </d:dessert>

</d:meal>   (same meaning as prev slide)
```

XML namespace identifiers

- XML namespace identifiers must conform to a specific syntax—the syntax for Uniform Resource Identifier (URI) references.
- A URI is defined as a compact string of characters for identifying an abstract or physical resource. In most situations, URI references are used to identify physical resources (Web pages, files to download, etc), but in the case of XML namespaces, URI references identify abstract resources, specifically, namespaces.

XML namespace identifiers

- Two general types of URIs: URL and URN
- URL: http://www.pizza.com/menu
- URN: urn:www-pizza-com:menu
- Most important aspect is that they must be unique or the namespace will be confused

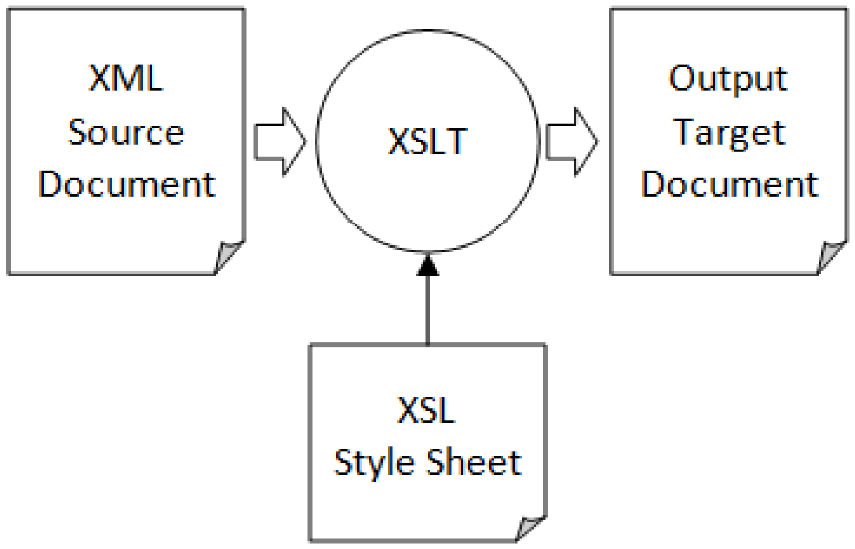
XML namespace

```
<mandl>
   <m:menu xmlns:m='http://www.mandl.com/menu'>
     <m:name> Daily Special </m:name>
     <m:cost> 12.50 </m:cost>
  </m:menu>
  <serv:Server xmlns:serv =
   "http://www.mandl.com/servers">
  <serv:name>Smith, John</serv:name>
  <serv:address>11 North Rd</serv:address>
  </serv:Server>
</mandl>
```

XSL Languages

- XSL = Extensible Stylesheet Language
- Need for an XML-based stylesheet
- XSL is to XML what CSS is to HTML
- But XSL is more ... consists of three parts:
  - XSLT – transform XML documents
  - XPath – navigating in XML documents
  - XSL-FO – formatting XML documents

XSL – Style Sheet



XSLT Transformation

- Most important part of XSL is XSLT
- Transforming XML into XHTML

```
<xsl:stylesheet  version=“1.0”
  xmlns:xsl=“http://www.w3.org/1999/XSL/Transform”>
... xsl style ...
<xsl:stylesheet>
```

Create an XSL Style Sheet

```
<?xml version="1.0"  encoding="“UTF-8"?>

<xsl:stylesheet version="1.0”  xmlns:xsl="http://www.w3.org/1999/XSL/Transform">

<xsl:template match="/">
  <html>
  <body>
  <h2>My CD Collection</h2>
  <table border="1">
      <tr bgcolor="“yellow">
        <th>Title</th>
        <th>Artist</th>
      </tr>
      <xsl:for-each select="catalog/cd">
      <tr>
        <td><xsl:value-of select="title"/></td>
        <td><xsl:value-of select="artist"/></td>
      </tr>
      </xsl:for-each>
  </table>
  </body>
  </html>
</xsl:template>

</xsl:stylesheet>
```

Saved in a file named cdcatalog.xsl

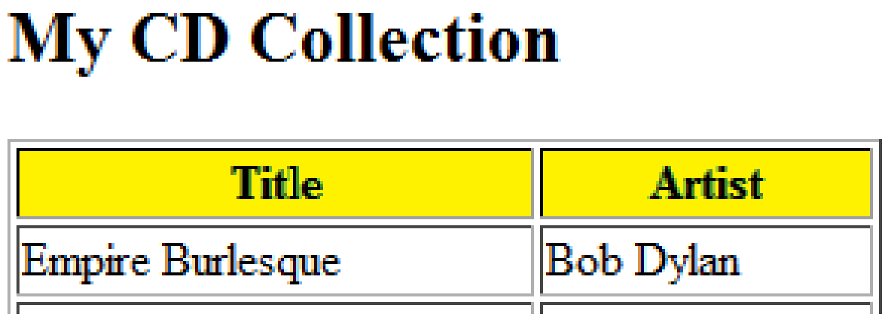
Sample XML to transform

```
<?xml version="1.0" encoding=“UTF-8"?>
  <catalog>
    <cd>
      <title>Empire Burlesque</title>
      <artist>Bob Dylan</artist>
      <country>USA</country>
      <company>Columbia</company>
      <price>10.90</price>
      <year>1985</year>
    </cd>
</catalog>
```

Link XSL Style Sheet to XML

```
<?xml version="1.0" encoding=“UTF-8"?>
<?xml-stylesheet type=“text/xsl” href=“cdcatalog.xsl”?>
    <catalog>
      <cd>
        <title>Empire Burlesque</title>
        <artist>Bob Dylan</artist>
        <country>USA</country>
        <company>Columbia</company>
        <price>10.90</price>
        <year>1985</year>
      </cd>
</catalog>
```

Load XML file in browser



My CD Collection

Title	Artist
Empire Burlesque	Bob Dylan

XSL template Element

- The <xsl:template> element builds templates
- The match attribute associates a template with an XML element via an XPath expression

<xsl:template match="/"> associates the template with the root of the XML

XSL value of Element

- The <xsl:value-of> element extracts the value of an XML element and add it to the output of the transformation (to browser)
- The select attribute contains an Xpath expression where the forward slash is used similarly to selecting subfolders

<xsl:value-of select=“catalog/cd/title”/>

XSL for each Element

- The <xsl:for-each> element enables ‘looping’ through each element in the xml
- The select attribute is an XPath expression

```
<xsl:for-each select =“catalog/cd”>
  …
</xsl:for-each>
```

$\leftarrow$ loop for each cd element within the root catalog element

XSL sort Element

- The <xsl:sort> element sorts output

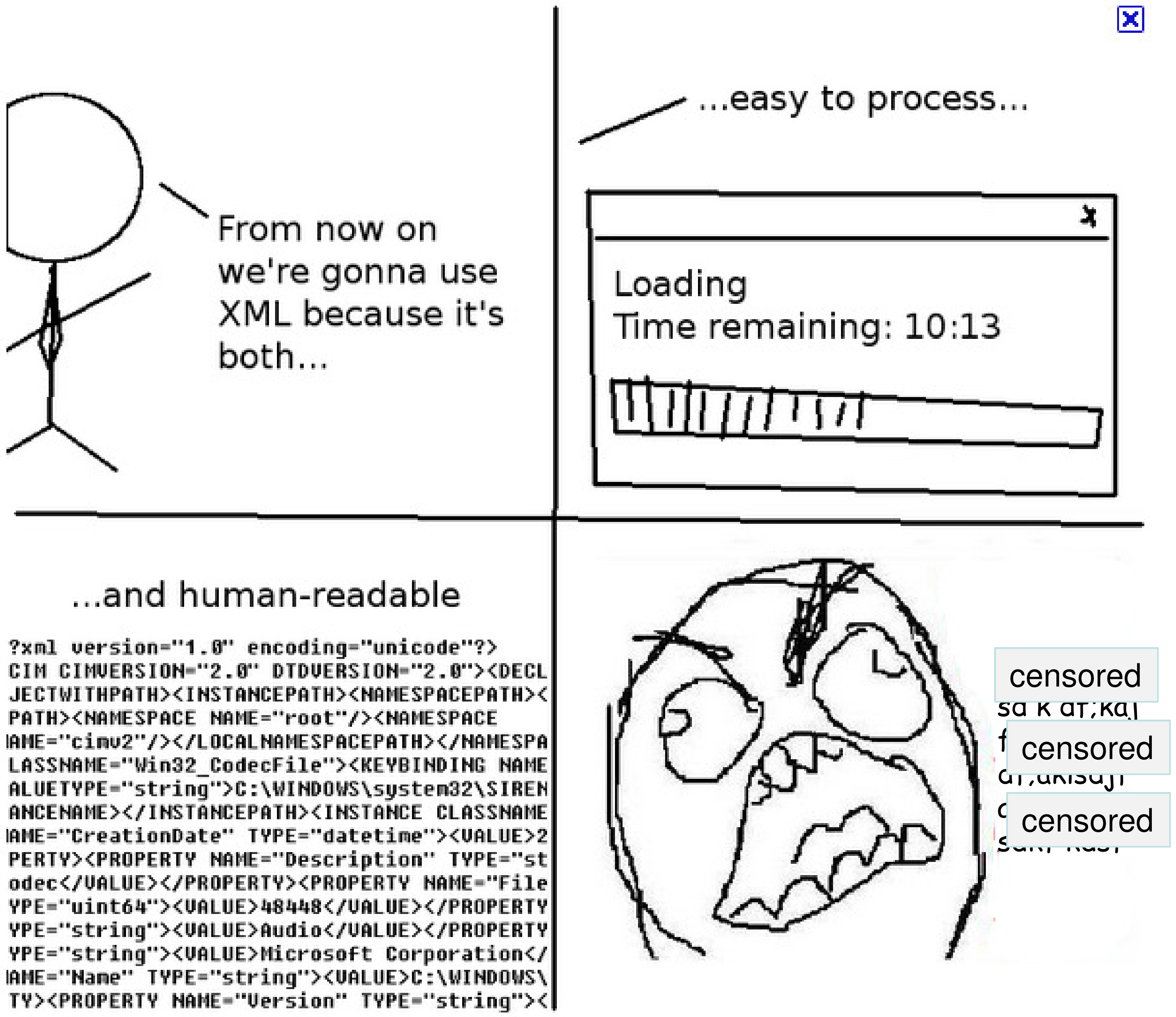
```
<xsl:for-each select=“catalog/cd”>
    <xsl:sort  select=“artist”/>
    ...
</xsl:for-each>
```

XSL if Element

- The <xsl:if> element provides a conditional test of the transformed XML content
- The test attribute contains the logical expression to evaluate

```
<xsl:if test=“price &gt; 20”>
  <tr>
   ...
  </tr>
</xsl:if>
```

Display the cd row
if this cd’s price value
is greater than 20.



```
?xml version="1.0" encoding="unicode"?>
CIM CIMVERSION="2.0" DTDVERSION="2.0"><DECL
JECTWITHPATH><INSTANCEPATH><NAMESPACEPATH><
PATH><NAMESPACE NAME="root"/><NAMESPACE
IAME="cimv2"/></LOCALNAMESPACEPATH></NAMESPA
LASSNAME="Win32_CodecFile"><KEYBINDING NAME
ALUETYPE="string">C:\WINDOWS\system32\SIREN
ANCENAME></INSTANCEPATH><INSTANCE CLASSNAME
IAME="CreationDate" TYPE="datetime"><VALUE>2
PERTY><PROPERTY NAME="Description" TYPE="st
odec</VALUE></PROPERTY><PROPERTY NAME="File
YPE="uint64"><VALUE>48448</VALUE></PROPERTY
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