A First Look at XML

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Overview

• XML Basics
• Documents and Document Type Definitions
• Related and Companion Standards for XML
  • Schemas, namespaces, and datatypes
  • XPath
  • XML Linking Language (XLL)
  • XML Style Language (XSL)
  • XSL Transformation (XSLT)
Background

• XML is both simplified and extended SGML
  • Complex features defined for SGML that no are longer needed were eliminated
  • New capabilities, particularly related to datatypes were added
• XML has an extensive set of companion standards
  • The XML companion standards are in a state of flux
• The XML tools and standards are still in transition
• Suggested Readings
  • XML Standard -- [www.w3c.org/XML](http://www.w3c.org/XML)
  • Goldfarb and Prescod, The XML Handbook
  • Harold, The XML Bible
The Basic Idea

- XML, and SGML, are languages that define the rules for describing classes of documents.
  - Under SGML these definitions were called Document Type Definitions or DTDs
  - Under XML, DTDs were used initially, but have now given way to Schemas
- There are syntactic rules for writing documents generally and additional rules imposed by the DTD or Schema
  - A document that meets the syntactic rules defined for writing XML documents is said to be “well formed”
  - A document that complies with the constraints set out in a DTD or Schema is said to be valid
XML Family of Standards

- Schemas provides a number of new capabilities:
  - Document schemas allow DTDs to be defined as XML documents – requiring only a single parser.
  - Namespaces allow for modular document definition, multiple inheritance, and collision avoidance
  - Data types can be defined to allow for attribute value and content value controls
- Companion standards
  - XPath or the XML Path Language allows navigation of the document tree
  - The XPointer allows tree components as targets
  - The XML Linking Language defines linking capability
  - The XML Style Language defines presentation capability
  - XSLT provides for the transformation of documents
Basic XML Syntax

• An XML document is made up of:
  • a prolog
    ```xml
    <?xml version="1.0" encoding="UTF-8" standalone="yes"?>
    <!DOCTYPE MYBOOK SYSTEM "mybook.dtd"> (DTD form)
    ```
  • an instance
    • a nested set of elements beginning with the root element which has the same name as the DTD (Using Schema, the root element is associated with the schema name space.

• An element begins and ends with tags
  • The start tag is of the form `<NAME>`
  • The end tag is of the form `</NAME>`

• Tag names:
  • Are case sensitive (75% of XML errors are related to case sensitivity)
  • begins with a letter or underscore and may include letters, digits, hyphens, underscores, colons and periods
Additional XML Syntax

• The characters in an XML document are Unicode
• Whitespace is any combination of spaces, tabs, carriage returns, and line feeds, and is generally ignored
• Tags, processing instructions, comments and entity references are all considered markup
  • Entity references are of the form &NAME;
  • Comments are of the form <!-- message -->
  • A processing instruction is included using <? ?> delimiters
• In a DTD or Schema, additional forms appear, called declarations. These include:
  • Element declarations or content models
  • Attribute declarations
  • Entity definitions
“Escaping” Markup in Content

- XML has five predefined entities which may be used to allow markup symbols to be included in the content:
  - &lt; ::= <  &gt; ::= >
  - &apos; ::= ‘  &quot; ::= “
  - &amp; ::= &
- CDATA sections may also be used to include data that would confuse a parser
  - <![CDATA[ content ]]>
Developing a DTD

• A formal XML document complies with a document type definition, or a schema
• This is accomplished by the DOCTYPE element, which may be defined locally:
  ```xml
  <!DOCTYPE note [
  <!ELEMENT note (to, from, date, message)>
  <!ELEMENT to (#PCDATA)>
  <!ELEMENT from (#PCDATA)>
  <!ELEMENT date (#PCDATA)>
  <!ELEMENT message (#PCDATA)> ]>
  ```
• The DOCTYPE may also be referenced:
  ```xml
  <!DOCTYPE note SYSTEM "note.dtd" ]>
  ```
• The two methods may be combines
  ```xml
  <!DOCTYPE note SYSTEM "note.dtd" [!
  <!ENTITY DOLLAR "$"> ]>
  ```
The Content Model of and Element

- The content of an element may be
  - a set of subelements
  - text
  - a set of subelements and text
  - An empty element
  - an element with “ANY” content
    - normally used only for development

- Elements in a content model may be
  - Required (default if no modifier)
  - Optional (?)
  - Repeatable (*, +)

- Elements in a content model may be
  - ordered ()
  - ored ()
  - (Schemas only) – an unordered set
Attributes

• An attribute definition defines the attributes of an element. It takes the general form
  • <!ATTLIST element name value/range default>
    <!ATTLIST memo status ("draft"| "final") "final”>
• The element memo would appear as follows:
  <memo status = "draft”>
• The value range must either be a group or a reserved word.
• The default must be either a reserved name or a user supplied value. Default values may include the following:
  • #REQUIRED -- must be supplied
  • #IMPLIED -- optional (will be supplied by the system if absent)
  • #CURRENT -- is the most recent value
Reserved Words for Values

- The reserved words can be:
  - CDATA -- character data
  - NUMBER (NUMBERS) -- a number or numbers
  - NAME (NAMES) -- one or multiple name strings
  - NMTOCKENS -- names that can begin with a number
  - NUTOKENS -- names that must begin with a number
  - ID -- a valid SGML name unique within the scope of a document
  - IDREF -- must match an ID in the document.
Entities

- Entities may be of any number of forms -- consistent with SGML.
- The keywords INCLUDE and IGNORE may be used to allow conditional sections.
  - `<![INCLUDE [ stuff to include ]]>`
  - `<![IGNORE [ stuff to ignore ]]>`
- An entity may be defined that makes this more flexible.
  - `<![ENTITY % notes "IGNORE">`
  - `<![%notes; [ stuff to include ]]>`
- Character references use the form `&#ddd;` where `ddd` are decimal digits that specify the Unicode character.
  - to reference the hex number use `&#xddd;`
Processing Instructions

• A processing instruction begins with <? and ends with ?>
  • the <? is followed by a target processor name
  • after the target processor name is any processing instructions followed by ?>

• The xml processing instruction for stylesheets looks as follows
  <?xml:stylesheet href="url" type="text/xsl"?>
XML Companion Standards

- Schemas provide new capabilities beyond DTDs
  - Namespaces provide a mechanism for multiple inheritance
  - The content model (aka DTD) is a normal XML document
  - Datatypes allow more formal typing of data
- XPath or XML Path Language describes documents
- The XML Pointer Language allows paths as anchors
- The XML Linking Language provides extended linking capability
- XSL -- the XML Style Language provides presentation control
- XSLT provides for the transformation of documents
Schemas

• XML Schemas replace DTDs
  • Schemas are recursively defined – i.e., a Schema is an XML document that is defined by a Schema that is an XML document …
  • Schemas recognize and allow for datatypes both for attribute values and element content
  • Schemas recognize “namespaces”, a relaxation of the one DTD/document constraint
  • Schemas allow additional new features to be defined at a later date

• The Schema debate has been clouded by the simultaneous development of datatypes (Schema part 2) and RDF – Schema of a different color
Namespaces

- Namespaces provide
  - namespaces are being widely used, but they are controversial
  - a way to expand the scope of XML elements
  - a mechanism for multiple inheritance
- Namespaces allow two different elements with the same name
  - the basic idea is to provide a qualifier for the element
    - thus sis.pitt.edu:para could be distinguished from gsia.cmu.edu:para
  - domain names could work but it would require a registered name for a namespace
Namespace rules

- The attribute xmlns defines the default namespace for an element
  
  `<html xmlns="http://www.w3.org/TR/WD-HTML40">`
  
  - The attribute name xmlns is reserved
  - This attribute defines the default namespace
  - The subelements of this element are defined within the namespace
  - A subelement with a different default namespace attribute is allowed – all subelements must be defined within that namespace
  - Attribute names are also defined in the namespace
  - The advantage of this form of namespace declaration is that it allows element names to be used without a prefix
Qualified Namespaces

• An attribute name composed of xmlns: followed by a name is called a qualified namespace

  <mbs:email xmlns:mbs="http://….">
  • The namespace is called mbs
  • Subelements of this namespace must be prefaced by mbs:
  • This allows multiple namespaces to be used simultaneously. Thus:

    <html:html xmlns:spring="href1" xmlns:html="href2"
               xmlns:math="href3">
    • allows the children of html to be:
      <html:xxx>
      <math:yyy>
      <spring:vv>
Datatypes Under DTDs

- SGML, and XML under DTDs, put content outside the scope of the standard.
  - Element content was only checked related to syntax – i.e. PCDATA, CDATA, NDATA.
  - Attribute values allowed some “datatypes” checking, but it was minimal as well
    - ID
    - IDREF
    - NMTOKEN
    - NOTATION
- For e-commerce applications, XML required stronger data type capabilities
Schema Datatypes

- The datatype work under schemas adds more primitive types, which can be applied not only to attribute values but to element content.
  - string
  - number
  - binary
  - Boolean
  - DateTime
  - uri

- Additional system datatypes, called generated are defined based on the primitive types.
  - integer
  - real
  - time
  - decimal
  - date
timePeriod
Defining and Using a datatype

• The user may also define datatypes. For example:
  
  ```xml
  <xsd:simpleType name="pubyear">
    <xsd:restriction base="xsd:gYear">
      <xsd:minInclusive value="1000"/>
      <xsd:maxInclusive value="3000"/>
    </xsd:restriction>
  </xsd:simpleType>
  ```

• An attribute declaration could now be defined:
  ```xml
  <attribute name = "Date" type = "pubyear"/>
  ```

• An element declaration could be defined:
  ```xml
  <xsd:element name="publishdate" type = "pubyear"/>
  ```
XPath

- XPath is a kind of SQL for XML
- XPath views a document as a tree of nodes
- The XML Path language identifies parts of an XML document tree
  - XPath is used by XPointer to build a web address
  - XPath is used by XSLT to transform a document
- The topmost part of the tree is the root
  - it is not the same as the root element
  - a node contains all the comments, elements, text, attributes and PI
Examples of XPaths

• An XPath identifies a set of nodes in a document tree:
  • /mydoc/chap/section
    • would select the section elements of the chap elements in mydoc
  • /mydoc/chap/para[7]
    • would get the seventh para elements of all chap elements
  • /mydoc/chap[@stat="draft"]
    • would select all chaps whose stat attribute has a value of “draft”
XPath Expression

• An instance of an XPath is called an expression
  • Applications processes the expression returning a node set which the application then processes
  • An expression can be absolute or relative
  • An expression can traverse the tree in a number of different directions – called axes
  • An expression can include a variety of tests in the form of functions and predicates
Axes and Tests

• Axes specify how the tree is traversed
  • There are actually 13 different axes. For example:
    • The child axis, the default, looks down the tree one step
    • The parent axis looks up the tree one step
    • The attribute axis allows the attributes of a node to be explored

• Functions and predicates can be used to filter nodes
  • text() and comment() are examples of functions that would allow only one kind of node
  • para[7], para[last()], para[footnote] are examples of predicates that select the seventh, last, and paragraphs with footnotes respectively
HTML Anchors

- HTML linking is currently based on URL, URI, and URN's
- It is important to know what is what
  - URL's and URN's are URI
  - URI is an abstract concept
  - URN's will probably manifest themselves in new forms
  - What we commonly put in an href is a URL
  - A fragment identifier is an addition to the URL
  - It is based on fixed semantics -- <A NAME="lit">
- XML linking is much more robust than HTML linking
- XML linking will require/allow radically new kinds of applications
Paths and Pointers

- Path information allows a link to be made to a specific location within a document using Xpointer
- Xpointer extends the capabilities of URI, URL, URN, and fragment identifier
- In some ways, Xpointer is a shell for Xpath
  - consider the following url:
    - http://www/c/g/xyz.xml#xptr(/mydoc/chap[3])
XLINK

• xlink is an example of one namespace
  • `<mbslink xmlns:xlink=http://www.w3.org/XML/Xlink/0.9 xlink:type = "simple">`
  • XML does not know about namespaces, therefore care has to be taken in using them
  • the namespace abbreviations must be hardcoded in the dtd
The XML Linking Language (XLL)

- XLL provides more linking capability
- simple linking, like that in html would look as follows
  - `<citation xlink:type="simple">
  - xlink:href=URL>text</citation>
- use of the xlink attributes requires the xlink namespace
  - `<rootname xmlns:xlink="http://www.w3.org/XML/Xlink/0.9">
XLINK Attributes

- The definition of Xlink allows a variety of different link types to be developed.
- Many of these are defined by the show attribute of xlink; xlink:show may be set to the following values:
  - "replace" does what we see on the WWW
  - "new" causes a new window to be opened
  - "parsed" causes the href to be parsed and included
- Another attribute of xlink is actuate which can take the following values:
  - "user" indicates that traversal is based on user action
  - "auto" specifies that traversal should be automatic
Extended Links

- extended links include links that make use of the locator element
  - `<mylink xlink:type="extended">`
    - `<locator xlink:type="locator" xlink:href = "url" xlink:role="type of link">`
    - `<locator xlink:type="locator" xlink:href = "url" xlink:role="type of link">`
  - `</mylink>`

- link groups allow sets of documents to be linked together
- behavior and processing of these is undefined
  - `<xlink:group>`
    - `<xlink:document href="url"/>`
    - `<xlink:document href="url"/>`
    - `<xlink:document href="url"/>`
  - `</xlink:group>`
The XML Style Language

- XSL provides more presentation capability
- XSL is a rendition language
  - it provides an alternative to the CSS as a style sheet
  - it makes use of the xmlns:xsl and xmlns:fo
    - fo stands for formatting object
    - this looks very similar to the layout hierarchy specified for interpress and ODA
  - the layout root is fo:root
    - the root has one or more fo:page-sequences
    - within the page sequences are flow elements fo:flow
Flow Elements

- the fo:flow elements contain other blocks
- fo:block
- fo:inline-graphic
- fo:display-graphic
- fo:display-rule (a ruling line)
- fo:display-sequence a set of attributes for a set of blocks
- fo:table
- fo:list-block
- fo:list-item-body
- fo:list-item-label and fo:list-item
- fo:simple-link
- fo:page-number
XSLT

- XSLT provides for the transformation of documents
- We can select, match, choose, filter, get the value of, etc.
- XSLT has two main functions
  - an intermediate language for making HTML documents from XML
  - an ultimate processor for taking XML documents to multiple forms
XSLT Processors

• Keep in mind that the XSL processor in ie5 is not fully conforming
• XSLT makes use of XSL style sheets
  • formally, the style sheet would begin:
    • <xsl:stylesheet xmlns:xsl=http://www.w3.org/Transform/1.0
    • xmlns:html=http://www.w3.org/TR/REC-html40
    • result-ns="html">
    • …. rules…
    • </xsl:stylesheet>
  • for ie 5 use
    • <xsl:stylesheet version="1.0“
    • xmlns:xsl="http://www.w3.org/TR/WD-xsl">
  • The rules are template rules
Style Sheets and Templates

• A style sheet is made up of a set of templates
• The template contain instructions on how to process the element they match
  \[
  <\text{xsl:template match="book"}>
    \text{... information on how to format book}
  </\text{xsl:template}>
\]
• A template does three things:
  • It outputs the literal content of the template element
  • It selects content from the input document and outputs it
    \[
    <\text{xsl:value-of select="relative Xpath"}>
    \]
  • It applies additional templates
    \[
    <\text{xsl:apply-templates select="relative Xpath"}>
    \]
• Apply-templates provides for recursive handling of the templates
An Example

• There are a whole series of structures and tests available as well. For example:
  
  `<xsl:if select="relative Xpath">`
  
  do something
  
  `</xsl:if>`

• Within a template, the order of subelements can be changed, in this case processing the paragraphs of a section before the title.
  
  `<xsl:template match="section">`
  
  `<xsl:apply-templates select="para"/>`
  
  `<xsl:value-of select="title"/>`
  
  `</xsl:template>`
XML Tools

• There are lots of different XML tools out there.
• Two new commercial offerings that now incorporate schema and datatypes are:
  • XMLSpy
  • TurboXML
• To play with validation and wellformedness as well as XSLT
  • IE5
  • xt by James Clark
• To code XML programmatically:
  • jaxp
  • xerces and xlan
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In the News
- TIBCO Extensibility Solutions receive 6 XML Journal Readers Choice Awards in 5 categories including Best DTD Editor, Best XML Utility and Best Conversion Tool.
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