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eXtensible Markup Language: A Tutorial

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Abstract

SGML (Standard Generalized Markup Language) is mother of all the markup languages. eXtensible Markup Language (XML) is a derivative of SGML. In the Internet arena Hypertext Markup Language (HTML) is found to be unsuitable particularly when it comes to attach semantics to the data. That is why XML was developed. XML is still not a completely matured technology and more and more specifications are coming up. Currently XML version 1.0 is released by W3C. This paper is written to give an overview about the designing of a XML based solution for library science professionals.

"If you use the original World Wide Web program, you never see a URL or have to deal with HTML. You're presented with the raw information. You then input more information. So you are linking information to information--like using a word processor. That was a surprise to me--that people were prepared to painstakingly write HTML."

--Tim Berners-Lee

Tim Berners-Lee had vision about the easy access to the data all round the world, when he first proposed about the WWW. Since then Internet has gone a long way, from text-based browser to the present completely GUI (Graphical User Interface) browser. The representation of information has also changed. We saw the development of HTML in 1980s and then its various versions in 1990s, then came the era of XML (Extensible Markup Language). This change also supports the vision of Lee though he would have never dreamt about the development of such system for the web content development. But finally it was he who had the vision about the use of semantic Internet because there is lot of information available over Internet & finding information has become as difficult as finding gold coin in a garbage heap. That is why the domain specific information interchange systems are thought of and it is there XML comes into picture.

1. FROM SGML TO XML

The markup languages that carry the instruction for text processing are known as *'Procedural Markup'*. The idea of markup was to format a particular kind of document. But later on it was felt that markup languages can be used for system to system information interchange also. This was first realized by Charles Goldfarb, Ed Mosher and Ray Lorie when they were working with legal documents. They designed the first markup language known as GML (Generalized Markup Language) based on the following observation:

- The document processing programs needed to support a common document format.
- The common format needed to be specific to their domain - for example legal documents.
- To achieve a high a degree of reliability, the document format would have to follow specific rules.

For example, take an example of memorandum,

To: Bishwanath Dutta
CC: Bibhuti Bhushan Sahoo
From: Aditya Tripathi
Date: 27.01,2003
Subject: Appointment order

We are extremely happy to inform you that you are selected as the coordinator of Knowledge management team.

If we look into this document we find that there are six fields in this document.

- Who the document is intended for (the To: field)
- Who has been sent a copy of document (the CC: field)
- Who sent the document (the From: field)
- The date of document written (the Date: field)
- The subject of document (the Subject: field)
- The document body

So, if we make a fixed structure of this document then whoever writes the document has to write it in the same structure. Thus if we try to port the information from one system to another it will not be a problem as the structure of document is always same. The definition of the structure of document is known as *'DTD (Document Type Definition)'*.

Once GML was designed, Goldfarb fine tuned his work and proposed the SGML (Standardized Markup Language) which was further approved by ISO (International Organization for Standardization) in 1986. SGML was not a language itself but it was a meta language to develop other markup languages. HTML (Hypertext Markup Language) is a derivative of SGML. HTML is more like a formatting language. Thus it is difficult to pull out what kind of data is stored inside a HTML document. Once this difficulty was understood, the need for domain specific tags was felt, for information interchange, which is not possible with HTML. Hence the XML was developed. It is always said that XML is more near to SGML when compared to HTML.

2. WHAT IS XML?

According to the abstract from the XML Specification version 1:
"The extensible Markup Language (XML) is a subset of SGML that is completely described in this document. Its goal is to enable generic SGML to be served, received, and processed on the Web in the way that is now possible with HTML. XML has been designed for ease of implementation and for interoperability with both SGML and HTML."

- XML stands for E**X**tensible **M**arkup **L**anguage.
- XML is a **markup language** much like HTML.
- XML was designed to **describe data**.
- XML tags are not predefined in XML. You must **define your own tags**.
- XML uses a DTD (**Document Type Definition**) to describe the data.
- XML with a DTD is designed to be **self-descriptive**.

XML is still under development, & the following goals are kept in mind while developing the specification for XML.

1. XML shall be straightforwardly usable over the Internet.
2. XML shall be compatible with SGML.
3. It shall be easy to write programs which process XML.
4. The processors could read the XML document easily.
5. XML document should be human-legible and reasonably clear.
6. The XML design should be prepared quickly.
7. The design of XML should be formal and concise.
8. XML document shall be easy to create.
9. Terseness in XML is of minimum importance.

2.1. How XML is Different from HTML?

1. XML was designed to carry data.

2. XML is not a replacement for HTML.

3. XML was designed to describe data and to focus on what data is.
   HTML was designed to display data and to focus on how data looks.

4. HTML is about displaying information. XML is about describing information.

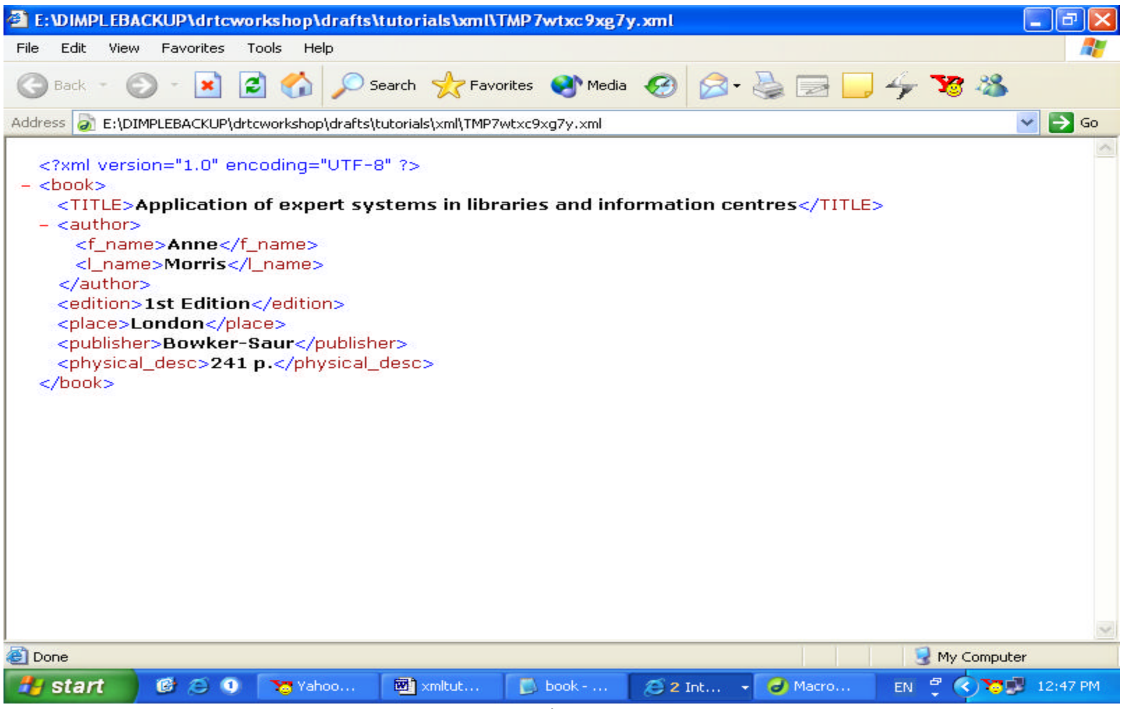
3. WHAT CAN BE DONE WITH XML?

3.1. XML does not DO Anything

XML was not designed to DO anything. Maybe it is a little hard to understand, XML was not made to DO anything. XML is created as a way to structure, store and send information. To look into more detail let us write our first XML documents *book.xml*:

```
<?xml version="1.0" encoding="UTF-8" ?>
- <book>
    <title>Application of expert systems in libraries and
      information centres</title>
  - <author>
      <f_name>Anne</f_name>
      <l_name>Morris</l_name>
    </author>
    <edition>1st Edition</edition>
    <place>London</place>
    <publisher>Bowker-Saur</publisher>
    <physical_desc>241 p.</physical_desc>
  </book>
```

The example shows the structure of a document which describes a book, titled '*Application of expert systems in libraries and information centres*'. The book will have a title, author, edition, place, publisher, physical description elements. Author will be further divided into first name (f_name) and last name (l_name). Inside these tags the actual data is stored. If one browses the document in the browser, data will appear embedded in the tag without having any kind of formatting (Figure 1).


E:\DIMPLEBACKUP\drtcworkshop\drafts\tutorials\xml\TMP7wtxc9xg7y.xml
File Edit View Favorites Tools Help
Back Search Favorites Media
Address E:\DIMPLEBACKUP\drtcworkshop\drafts\tutorials\xml\TMP7wtxc9xg7y.xml
Go
Done
My Computer
start Yahoo... xmltut... book - ... 2 Int... Macro... EN 12:47 PM

```
  <?xml version="1.0" encoding="UTF-8" ?>
- <book>
    <TITLE>Application of expert systems in libraries and information centres</TITLE>
  - <author>
      <f_name>Anne</f_name>
      <l_name>Morris</l_name>
    </author>
    <edition>1st Edition</edition>
    <place>London</place>
    <publisher>Bowker-Saur</publisher>
    <physical_desc>241 p.</physical_desc>
  </book>
```

Fig.1

3.2. Define Your Own Tags

In the above mentioned example, <book> tag is defined by the person who is describing the document. Thus one can see that XML provides the facility to define your own tags. It is contrary to HTML where the tags are predefined. So the XML provides the facility to create domain specific tag set which facilitates the information interchange within a specific domain. For example, NewsML is developed for information interchange among the news agencies like Reuter and others.

3.3. XML is Not a Replacement for HTML

It is important to understand that XML is not a replacement for HTML. In future, it is most likely that XML will be used to describe the data, while HTML will be used to format and display the same data, using CSS (Cascading Stylesheets) or XSL (eXtensible Style-sheet Language).

3.4. XML is Used to Exchange Data

With XML, data can be exchanged between incompatible systems. In the real world, computer systems and databases contain data in incompatible formats. One of the most time-consuming challenges for developers has been to exchange data between such systems over the Internet.

Converting the data to XML can greatly reduce this complexity and create data that can be read by many different types of applications.

3.5. XML can be Used to Share Data

With XML, plain text files can be used to share data. Since XML data is stored in plain text format, XML provides a software as well as hardware-independent way of sharing data.
This makes it much easier to create data that different applications can work with. It also makes it easier to expand or upgrade a system to new operating systems, servers, applications, and new browsers.

3.6. XML can Make Data More Useful

With XML, your data is available to more users. Since XML is independent of hardware, software and application, you can make your data available to more than only standard HTML browsers.
Other clients and applications can access your XML files as data sources, like they are accessing databases. Your data can be made available to all kinds of "reading machines" (agents).

3.7. XML Can Be Used to Create New Languages

XML is the mother of WAP (Wireless Application Protocol) and WML (Wireless Markup Language). The Wireless Markup Language (WML), used to markup Internet applications for handheld devices like mobile phones, is written in XML.

4. XML SYNTAX

Let us do a little analysis of the example to understand the syntax of XML.
Let us consider the line one of book.xml,

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

This line opens and closes with an angular bracket and a question mark, which suggests to XML parser that this document follows XML version 1.0 specification given by W3C and the character encoding system is used for data representation is *UNICODE Transformation Format-8*. The second line is -<book>, which is nothing but collapsible tags which shows that this tag has child elements. For each starting tag there is a closing tag, as the <book> ends with closing tag

</book>. <book> has several child element like <title> <author>, <edition>, <place>, <publisher> and <physical_desc>. A child can have further sub-children as in case of <author>.

```
- <author>
    <f_name>Anne</f_name>
    <l_name>Morris</l_name>
  </author>
```

Inside the tags actual data is stored for example,

```
<title>Application of expert systems in libraries and information
centres </title>
```

4.1. XML Tags are Case Sensitive

Unlike HTML, XML tags are case sensitive. With XML, the tag <Author> is different from the tag <author>. Opening and closing tags must therefore be written with the same case. All XML elements must be properly nested. Improper nesting of tags makes no sense to XML. For example,

```
<edition>1st edition</edition>
<place>London
<publisher></place>Bowker-Saur</publisher>
```

4.2. All XML Documents Must Have a Root Tag

The first tag in an XML document is the root tag. All XML documents must contain a single tag pair to define the root element. All other elements must be nested within the root element. All elements can have sub elements (children). Sub elements must be correctly nested within their parent element. In the above mentioned example <book> is the root element all the other tags are child to it.

```
<root>
  <child>
    <subchild>.....</subchild>
  </child>
</root>
```

4.3 XML Elements

An element is a component of a document. Elements can be made up of other elements, other types of data, or a descriptive representation that tells the XML parser about a resource that exists in document. Thus,

- XML Elements have simple naming rules.
- XML Elements are Extensible. XML documents can be extended to carry more information.
- XML elements have relationship. All the elements inside the <book> are child elements for <book>. This relationship indicates that <title> <author>, <edition>, <place>, <publisher> and <physical_desc> are describing an element *book*.

Thus the tags used like <book>, <author>, <place>, <publisher> etc. are elements.

4.4 Element Naming

XML elements must follow these naming rules:

- Names can contain letters, numbers, and other characters
- Names must not start with a number or other punctuation characters
- Names must not start with the letters xml (or XML or Xml ..)
- Names cannot contain spaces
- Any name can be used, no words are reserved, but the idea is to make names descriptive. Names with an underscore separator are nice.
  Examples: <f_name>, <l_name>.
- Avoid "-" and "." in names. It could be a mess if your software tried to subtract name from first (f-name) or think that "name" is a property of the object "first" (f.name).
- Element names can be as long as you like but names should be short and simple, like this: <book_title> not like this: <the_title_of_the_book>.
- Non-English le tters like éòá are perfectly legal in XML element names, but watch out for problems if your software vendor doesn't support them.
- The ":" should not be used in element names because it is reserved to be used for something called namespaces (more later).

4.5 XML Attributes

Attributes are used to provide additional information about elements. In good old HTML we often use attribute to get extra effect while formatting. For example,

```
<font size= “12” color= “red”>Hello World</font>
```

will show the “Hello World” text in 12 font size and red color. The size and color used are nothing but pre-defined attributes to the <font>.
Similarly, in XML also one can define the attributes. Attribute values must always be quoted. With XML, it is illegal to omit quotation marks around attribute values. XML elements can have attributes in name/value pairs just like in HTML. In XML the attribute value must always be quoted. Let us extend file *book.xml*:

```
1---<?xml version="1.0" encoding="UTF-8" ?>
2---- <book>
3--- <title> Application of expert systems in libraries and
information centres </title>
4---- <author authorship="primary">
5--- <f_name>Anne</f_name>
6--- <l_name>Morris</l_name>
7--- </author>
8--- <edition>1st edition</edition>
9--- <place>London</place>
10-- <publisher>Bowker-Saur</publisher>
11-- <physical_desc>241 p.</physical_desc>
12-- </book>
```

Line 4 - `<author authorship="primary">` has an attribute called as *authorship* which has value “*primary*”. You can have any number of attributes associated with a single element.

There are some problems associated with using attributes:

- attributes cannot contain multiple values (child elements can)
- attributes are not easily expandable (for future changes)
- attributes cannot describe structures (child elements can)

- attributes are more difficult to manipulate by program code
- attribute values are not easy to test against a DTD

So it is always good to use child elements in spite of using attributes to describe an object.

5. DTD (DOCUMENT TYPE DEFINITION): WELL-FORMED AND VALID DOCUMENT

One can define his own structure of XML document and give others to write the XML document against his own schema to avoid the mistakes. A schema is nothing but the logical structure of document. This schema is called as DTD (Document Type Definition). When the XML document is prepared against DTD is called as a *Valid document* and when there is no DTD for the document and the syntax of document is correct, it is known as *Well-formed* document.

A DTD can be defined for a Valid-document. The declaration of DTD used for the validation is given in the processing tag of XML file. Let us further extend *book.xml* and make it a catalog for the description of book:

```
1---<?xml version="1.0" encoding="UTF-8"?>
2---<!DOCTYPE catalog SYSTEM "C:\hydra\book.dtd">
3---<catalog>
4---   <book>
5---      <title>Mastering XML</title>
6---      <author authorship="primary">
7---         <f_name>Ann</f_name>
8---         <l_name>Navaroo</l_name>
9---      </author>
10--      <author authorship="secondary">
11--         <f_name>Chuck</f_name>
12--         <l_name>White</l_name>
13--      </author>
14--      <author authorship="secondary">
15--         <f_name>Linda</f_name>
16--         <l_name>Burman</l_name>
17--      </author>
18--      <edition>First edition</edition>
19--      <place>New Delhi</place>
20--      <publisher>BPB</publisher>
21--      <physical_desc>xxxiv, 882p.</physical_desc>
22--   </book>
23--</catalog>
```

In this example, the second line,

```
<!DOCTYPE catalog SYSTEM "C:\hydra\book.dtd">
```

Indicates that this XML file should use *book.dtd* for the validation of document. The path of the DTD file is mentioned; even the relative path can also be mentioned as the case may be. The tag starting from <! > contains processing instruction for parser. Comments are given inside <!-- -->.

Let us examine the content of *book.dtd*:

```
1---<?xml version="1.0" encoding="UTF-8"?>
2---<!ELEMENT catalog (book+)>
3---<!ELEMENT book (title, author+, edition, place, publisher, physical_desc)>
4---<!ELEMENT title (#PCDATA)>
5---<!ELEMENT author (f_name, l_name?)>
6---<!ELEMENT edition (#PCDATA)>
7---<!ELEMENT place (#PCDATA)>
8---<!ELEMENT publisher (#PCDATA)>
9---<!ELEMENT physical_desc (#PCDATA)>
10--<!ELEMENT f_name (#PCDATA)>
11--<!ELEMENT l_name (#PCDATA)>
```

First line shows the version of XML specification used for the generation of file. The second means the element *catalog* will have atleast one or more occurrence of element *book*. That means the element book is mandatory and repeatable field. The sign plus (+) represents the field in question is mandatory and repeatable. There are other notations for different kind of repeatability.

No sign	Element is mandatory and non-repeatable
Plus (+)	Element is mandatory and repeatable
Star (*)	Element is optional and repeatable
Question mark (?)	Element is optional and non-repeatable

Third line means the element *book* has the child elements title, author (which is repeatable and mandatory), place, publisher and physical_desc (physical description). The element which contains data is known as leaf element. A leaf element is repr esented by either #PCDATA i.e. parsed character data (the data will be parsed by XML parser) or #CDATA i.e. character data (XML parser will not parse the data). Parsed character data or Character data are nothing but the actual data content of the element. For example,

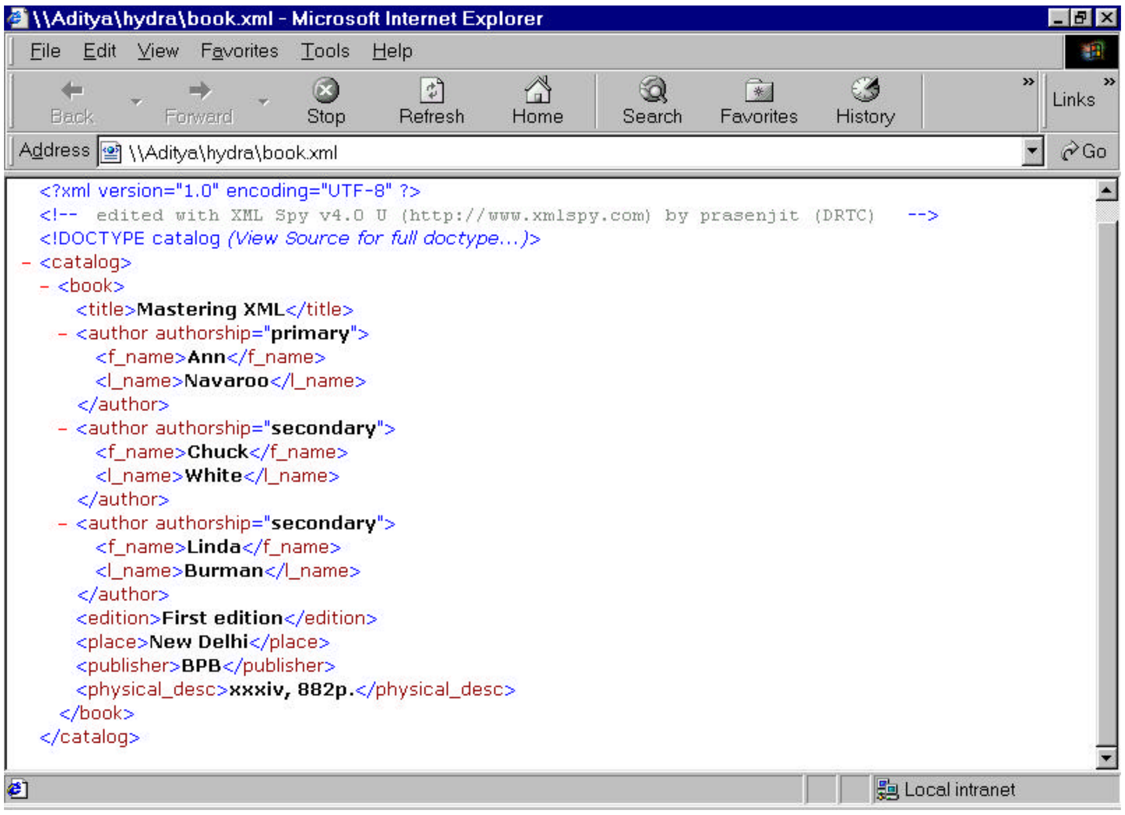
```
<title>Mastering XML</title>
```

the data "*Mastering XML*" is parsed character data according to our DTD. The use #CDATA is done to represent the formulae or data which contains restricted characters for example, angular brackets (<) and so on. So in our example, all the leaf elements are represented as #PCDATA. One can use DTD in the same XML file but it is always good to use a separate DTD file for your XML file.

Once you define a DTD, any non-conformity with the structure during the generation of XML document will be complained at the time of validation.

6. DISPLAYING XML WITH XSL (EXTENSIBLE STYLESHEET LANGUAGE)

We know that the objective of XML document is to store data, so when we see a XML file in a browser it appears as Fig. 1.


\\Aditya\hydra\book.xml - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Forward Stop Refresh Home Search Favorites History
Links
Address \\Aditya\hydra\book.xml
Go
Local intranet

```
  <?xml version="1.0" encoding="UTF-8" ?>
  <!--  edited with XML Spy v4.0 U (http://www.xmlspy.com) by prasenjit (DRTC)   -->
  <!DOCTYPE catalog (View Source for full doctype...)>
- <catalog>
  - <book>
      <title>Mastering XML</title>
    - <author authorship="primary">
        <f_name>Ann</f_name>
        <l_name>Navaroo</l_name>
      </author>
    - <author authorship="secondary">
        <f_name>Chuck</f_name>
        <l_name>White</l_name>
      </author>
    - <author authorship="secondary">
        <f_name>Linda</f_name>
        <l_name>Burman</l_name>
      </author>
      <edition>First edition</edition>
      <place>New Delhi</place>
      <publisher>BPB</publisher>
      <physical_desc>xxxiv, 882p.</physical_desc>
    </book>
  </catalog>
```

Fig. 2: Displaying plain XML file in browser

To see a formatted file in the browser we require to process the XML file and then display. There are two ways of formatting a file for display, one is use of CSS (Cascading Style Sheet) and second is XSL (eXtensible Stylesheet Language). XSL (eXtensible Stylesheet Language) is far more sophisticated than CSS. One way to use XSL is to transform XML into HTML before it is displayed by the browser. XSL is in itself a huge language.

Let us take new example, for formatted display in browser. Let us look the content the content of book2.xml,

```
1---<?xml version="1.0" encoding="UTF-8"?>
2---<!-- edited with XML Spy v4.0 U (http://www.xmlspy.com) by prasenjit (DRTC) -->
3---<!DOCTYPE catalog SYSTEM "book2.dtd">
4---<?xml-stylesheet type="text/xsl" href="book2.xsl"?>
5---<catalog>
6---    <book>
7---        <image>proleg.gif</image>
8---        <alt>Prolegomena to library classification</alt>
9---        <link>http://www.isibang.ac.in/drtc/srr/index.htm</link>
10--        <title>Prolegomena to library classification</title>
11--        <author authorship="primary">
12--            <f_name>Ranganathan</f_name>
13--            <l_name>S.R.</l_name>
14--        </author>
15--        <edition>3rd Reprint</edition>
```

```
        <place>Bangalore</place>
        <publisher>Sarada Ranganathan Endowment</publisher>
        <physical_desc>640p.</physical_desc>
    </book>
    <book>
        <image>xml.gif</image>
        <alt>Mastering XML</alt>
        <link>http://www.ibiblio.org/xml/books/bible2/chapters/ch17.html</link>
        <title>Mastering XML</title>
        <author authorship="primary">
            <f_name>Ann</f_name>
            <l_name>Navaroo</l_name>
        </author>
        <edition>First edition</edition>
        <place>New Delhi</place>
        <publisher>BPB</publisher>
        <physical_desc>xxxiv, 882p.</physical_desc>
    </book>
</catalog>
```

Following is the XSL file (book2.xsl) for the display of book.xml. This XSL file transforms book.xml to a tabular form and represents it as shown in Fig 2.

```
<?xml version="1.0" encoding="UTF-8"?>
<xsl:stylesheet version="1.0" xmlns:xsl="http://www.w3.org/1999/XSL/Transform" xmlns:fo="http://www.w3.org/1999/XSL/Format">
<xsl:template match="/">
<html>
<xsl:apply-templates/>
</html>
</xsl:template>
<xsl:template match="catalog">
<body>
<xsl:apply-templates select="book"/>
</body>
</xsl:template>
<xsl:template match="book">
<img src="{./image}" alt="{./alt}" height="125" width="100"></img>
<table >
<tr>
<td><font color="red">Author</font></td>
<td><a href="{./link}"><xsl:value-of select ="author/f_name"/>&#32;<xsl:value-of select="author/l_name"/>
</a></td>
</tr>
<tr>
<td><font color="red">Title</font></td>
<td>
<xsl:value-of select="title"/>
</td>
</tr>
```

```
27--<tr>
28--<td><font color="red">Edition</font></td>
29--<td><xsl:value-of select="edition"/></td>
30--</tr>
31--<tr>
32--<td><font color="red">Publisher</font></td>
33--<td>
34--<xsl:value-of select="publisher"/>
35--</td></ tr>
36--<tr>
37--<td><font color="red">Place</font></ td>
38--<td>
39--<xsl:value-of select="place"/>
40--</td>
41--</tr>
42--<tr>
43--<td><font color="red">Physical Description</font></ td>
44--<td>
45--<xsl:value-of select="physical_desc"/>
46--</td>
47--</tr>
48--</table>
49--<br></br>
50--<br></br>
51--</xsl:template>
52--</xsl:stylesheet>
```

The first line is version declaration as usual. The second line is the processing instruction for the parser to use the schema for XML transformation. The third line shows that parser matches with the root (/) node and then writes <html> to the virtual output file. The eight line shows that parser now matches with node called “catalog” than writes <body> inside the <html> of virtual output file. It further selects the node called “book”. It has to be min d that each

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

has to be closed by

```
<xsl:template>
```

6.1. Putting Image

The line 13 matches with <book> node. Then it puts

```
<img src="{./image}" alt="{./alt}" height="125" width="100"></img>
```

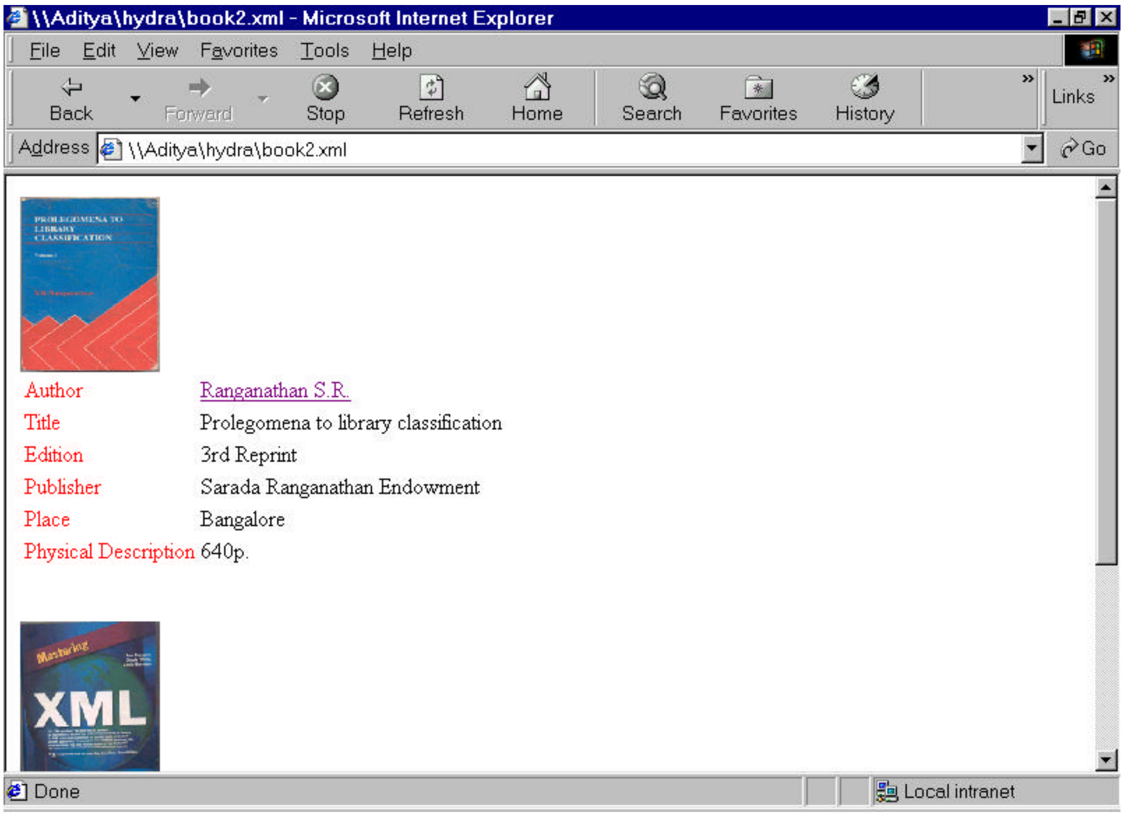
<img> tag, where the source of image (src) is defined by defining the path of <image> in the XML document. The relative path should be given for the finding the data. Than further attributes like height and width is defined. Alternative caption is stored in <alt> of book2.xml file. XSL extracts value of <alt> from the XML file.

6.2 Creation of Link

Line 18 represents how the links to other document can be given in XML document. To link the pages anchor <a> tag is used. Similar to image tag here also link file is mentioned in XML document <link> tag. *./link* represents the relative path of the node <link>.

```
<a href="{./link}"><xsl:value-of select ="author/f_name"/>&#32;<xsl:value-of
select="author/l_name"/>
```

Line 19 onwards each node is selected from book2.xml and formatting is applied to it.
Basically the output is generated in a tabular form.


\\Aditya\hydra\book2.xml - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Forward Stop Refresh Home Search Favorites History Links
Address \\Aditya\hydra\book2.xml Go
Done Local intranet

Author	Ranganathan S.R.
Title	Prolegomena to library classification
Edition	3rd Reprint
Publisher	Sarada Ranganathan Endowment
Place	Bangalore
Physical Description	640p.

Fig.3: XSL display of book2.xml

With XML we can define the tags. These tags have the semantic value such that author tag contains the name of author. But for machine still it is difficult to understand that is why domain specific tags are generated. NewsML is a very good initiative as lot of news information have to be transferred from one place to other. The NewsML tag set provides a standard for data interchange among the news agencies. Currently Reuter is taking care of NewsML. More information regarding NewsML is available at **http://newsml.org**.

Many think that with XML formatted display is a tedious job. It is true but the objective of XML is not the display in browser but to store data in a more meaning full manner.

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