**Consistent Data Transfer**

- Transfer of data has become increasingly important
- Can't assume control of all ways data is created and used
  - Cross-platform, cross-system, etc.
  - People want to access data for their own purposes
  - People want to use data from several sources
- Data may be more complicated than "traditional" formats would support
  - E.g. ASCII text only good for some text documents
- Need a more universal means of transferring data

**Markup Languages**

- Idea is to “tag” information to give a sense of its meaning/semantics
- How that is handled is up to reader
- Usually separates presentation from structure
- Examples:
  - HTML: standard web page information, interpreted by browsers
  - TeX/LaTeX: document specification, style descriptions determine how it is laid out

**XML**

- eXtensible Markup Language
- Extensible: able to define additional “tags”
  - Specific tags and the semantics associated with them allow specifications of different languages
- Developed by the World Wide Web Consortium (W3C) to help standardize internet information transfer
- Now used as the basis for many specialized languages
  - Each has its own semantic requirements
**XML Characteristics**
- Straightforward to use on the internet
- Easily processed/parsed
- Human-readable
- Capable of expressing wide range of applications
  - Including hierarchies, tables
- Can be very large/verbose

**XML Document Text**
- Intermingled character data and markups
- Markups:
  - Start/End tags (and empty element tags)
  - Entity/Character references
  - Comments
  - CDATA delimiters
  - Processing Instructions
  - XML/Text declarations
  - Document type declarations

**Basic XML Syntax**
- Some prolog/header
  - Possibly describing/referring to type of XML
- Single root element
- More elements forming a tree
  - Elements fully “nest” inside each other
  - Can have any number of children elements
- Elements begin with a start tag, end with an end tag
  - `<Elem>Stuff in element</Elem>`

**Tag Format**
- Starting Tags can declare attributes
  - `<TagName Attr1="..." Attr2='...'>`
  - Note that attributes can use “ or ‘
- Ending Tags match starting tag name, but with a / preceding
  - `</TagName>`
- Character data (and maybe other elements) in between start/end tags
- Empty element:
  - `<Elem/>`
  - Equivalent to `<Elem></Elem>`
Entity/Character References
• Note: Some character patterns are “reserved”
  − <, >, &, ′, “
• An entity reference is a name given to a character or set of characters
  − Used for any other things to be repeated
    • General entity form: &Whatever;
  − Used for the “reserved” characters
    • &lt; <, &gt; >, &amp; &, &quot; “, &apos; 

Character References
• Character References are specialized
• Use the form &#...; where the ... is a reference to a character in an ISO standard
  − &#38; is an &

Comments
• Begin with <!--
• End with -->
• Everything in between is ignored
  <!-- This is a comment -->

CDATA sections
• Used to note a section that would otherwise be viewed as markup data
• <!--[CDATA[ ... ]]> <!--[CDATA[ <b>This <a>is</b>not</a>bad ]]>
### Processing Instructions
- Allow documents to contain instructions for applications reading them
  - “Outside” the main document
- `<? Target ... ?>`
- Target is the target application name
  - Any other instructions follow

`<? MyReader -o3 -f input.dat ?>`

### XML/Text Declarations
- Documents should start with declaration of XML type used, in a prolog:
  - `<?xml version="1.0" ?>`
- Other documents “included” should also have such a prolog, as the first line

### XML Semantics
- Semantics must be declared to determine what is valid syntax
  - Tags allowed and their attributes, entities
  - Does not say how it is processed
- Can be located in XML document itself
- Can be contained in separate Document Type Declaration (DTD)
- Newer XML Schema definitions, which capture semantics in an XML-like document
  - But drawbacks, including difficulty to use, not as universally implemented, large size, etc.

### Document Type Declaration: DTD
- Defines constraints on the structure of the XML
- Comes before first element
- Either defines or points to external definition of Document Type Definition (DTD)
  - External: `<!DOCTYPE Name SYSTEM url>`
  - Internal: `<!DOCTYPE Name [...]>`
- The DTD can be standalone (no further external references) or not
Element Declarations

- Define elements and allowed content (character data, subelements, attributes, etc.)
- `<!ELEMENT Name Content>`
  - Name is the unique name
  - Content describes that type of element
- Options for Content:
  - EMPTY – nothing allowed in the element
  - ANY – no restrictions
  - Children elements only
  - Mixed character and children elements

Element Declarations: Child element content

- When an element has (only) child elements within it
- Specify using:
  - Parentheses ( ) for grouping
  - The , for sequencing
  - The | for “choice of”
  - The + (one or more), * (zero or more), or ? (zero or one) modifiers.
    - If no modifier, means “exactly once”

Example of Child elements

```xml
<!Element book (title, coverpage, tableofcontents?, editionnote*, preface?, (chaptrenumber, chaptertitle, chaptertext)+, index?)>
```

Element Declarations: Mixed element content

- When an element can contain both character and child elements
- The character text is denoted as a kind of special element name: `#PCDATA`

```xml
<!ELEMENT story (#PCDATA|a|b|c)*>
```
Attribute Declarations

- Define allowed attribute names, their types, and default values
- `<!ATTLIST ElementName Attribute*>
  - ElementName is the name of the element those attributes belong to
  - Repeat attribute definition as many times as needed

Attribute Declaration: Types

- Name Type DefaultValue
- Name is the attribute name
- Type:
  - CDATA: string
  - Enumerated: specified via a comma-separated list in parentheses
  - Tokenized: a limited form, specified by some other rule defined in the DTD
  - Several variations

Attribute Declaration: Defaults

- Specify a default value
  - Also specify whether attribute is needed in the element
  - #REQUIRED
    - This attribute must be specified each time (no default)
  - #IMPLIED
    - No default is specified
  - Otherwise, use the default value given
    - Precede by #FIXED if it must always take that default

Attribute Declaration Example

```
<!ATTLIST Book
title     CDATA  #REQUIRED
author    CDATA  "anonymous"
publisher CDATA  #IMPLIED
category  (fiction,nonfiction) "fiction"
language  CDATA  #FIXED 'English'
>
```
Entity Declarations
- Entity References should be declared
- Internal Entity:
  - `<!ENTITY Name ReplacementText >`<ENTITY CR "Copyright 2008">
  ...&CR;
- External Entity:
  - `<!ENTITY Name SYSTEM url >`<ENTITY BP SYSTEM "http://this.com/BP.xml">
  ...&BP;
- There are also other variations on external entities

Parameter Entities
- Like general entities, but refer to entities to be used in the Document Type Declaration
- Use a % instead of an &
  `<!ENTITY % newdef SYSTEM “http://this.com/newdef-xml.entities”>`
  ...
  %newdef;

Conditionals (in the DTD)
- Used in the DTD to apply different rules
- `<![Condition[…]]>`
  - If Condition is INCLUDE then keep
  - If Condition is IGNORE then skip
- Combine with parameter entities:
  `<!ENTITY % addborder ‘INCLUDE’>`
  ...
  `<![%addborder;[
  ... (stuff to draw border) ...]]>

XML Namespaces
- Different XML definitions could define the same element name.
- If we want to use both, could have conflict.
- Can distinguish using namespaces.
  `<a:book>…</a:book>
Defining XML Namespaces

• xmlns attribute in definition of element
  xmlns:prefixname="URL"
  <a:book
    xmlns:a=http://this.com/adef>
• Can be defined in first use of element or in XML root element.
• Can define a “default”
  - No prefix needed, leave off : also

Summary/More Information

• XML has become a standard way of transferring information, especially over the internet
• Provides flexibility to represent a wide range of data.
• Many texts/online tutorials about XML
• W3C “official” pages:
  http://www.w3.org/XML/
  See in particular the XML 1.0 specs (more than the 1.1 specs)