

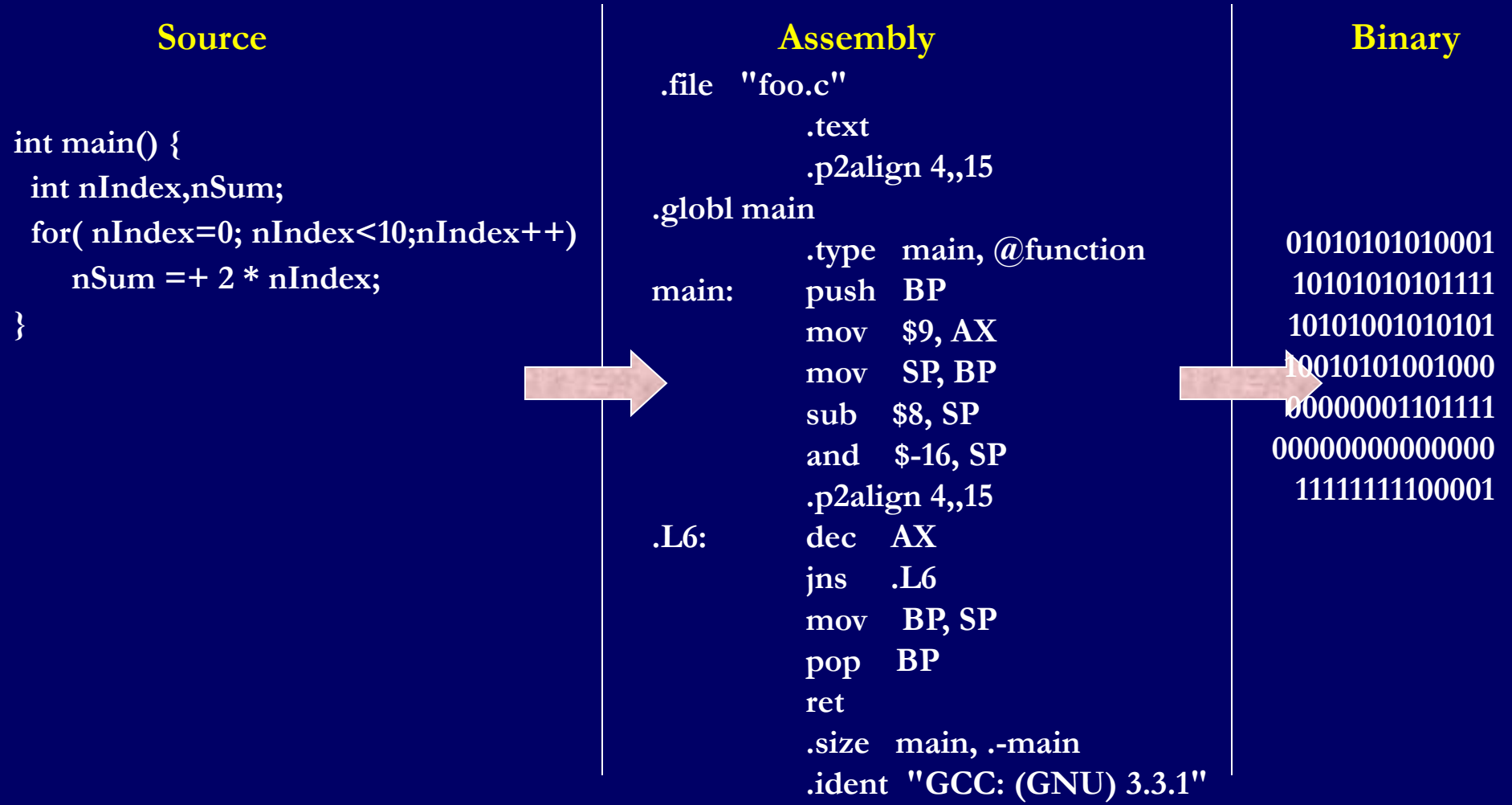


CSC324: Principles of Programming Languages Lecture 7B Java & Javascript

Wael Aboulsaadat



Imperative Languagesx (e.g. C/C++)



gcc -O2 -S -c foo.c



Java

Source

```
int main() {  
    int nIndex,nSum;  
    for( nIndex=0; nIndex<10;nIndex++)  
        nSum += 2 * nIndex;  
}
```



Machine Independent Assembly (bytecode)

```
.file "foo.c"  
    .text  
    .p2align 4,,15  
.globl main  
    .type main, @function  
main:  
    push    BP  
    mov     $9, AX  
    mov     SP, BP  
    sub     $8, SP  
    and     $-16, SP  
    .p2align 4,,15  
.L6:  
    dec     AX  
    jns     .L6  
    mov     BP, SP  
    pop     BP  
    ret  
    .size   main, .-main  
    .ident  "GCC: (GNU) 3.3.1"
```

```
javac foo.java
```

Java

Machine
Independent
Assembly
(bytecode)



Java Virtual Machine

01010101010001
10101010101111
10101001010101
10010101001000
00000001101111
00000000000000
11111111100001

Actual Hardware

java foo.class

Java



Java Virtual Machine

```
01010101010001
10101010101111
10101001010101
10010101001000
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```

Actual Hardware



Java Virtual Machine

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Java Virtual Machine

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Actual Hardware

```
java foo.class
```

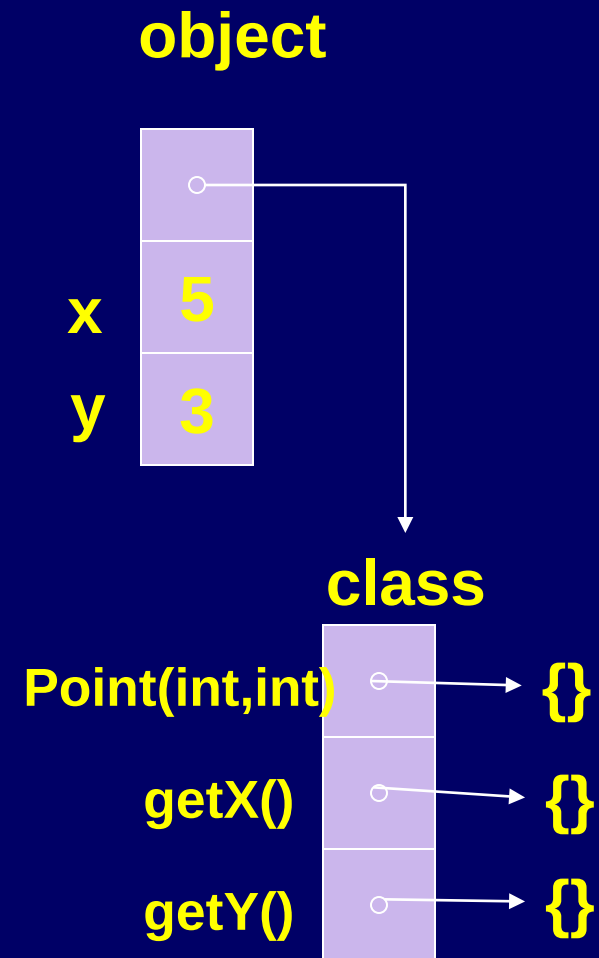


Background

- Turing's great insight: programs are just another kind of data
 - Source code is text
 - Manipulate it line by line, or by parsing expressions
- Compiled programs are data, too
 - Integers and strings are bytes in memory that you interpret a certain way
 - Instructions in methods are just bytes too
- No reason why a program can't inspect itself

How objects work

```
class Point {  
    public Point(int x, int y) {  
        x = 5; y = 10;  
    }  
    public int getX() {  
        return x;  
    }  
    public int getY() {  
        return y;  
    }  
    protected int x, y;  
}
```





The class Class

- Instances of the class Class store information about classes
 - Class name
 - Inheritance
 - Interfaces implemented
 - Methods, members, etc.
- Can look up instances:
 - By name
 - From an object

<http://java.sun.com/j2se/1.5.0/docs/api/java/lang/Class.html>



Showing a type

```
public static void showType(PrintStream out,  
                           String className)  
    throws ClassNotFoundException  
{  
    Class thisClass = Class.forName(className);  
    String flavour  = thisClass.isInterface() ? "interface" : "class";  
    out.println(flavour + " " + className);  
    Class parentClass = thisClass.getSuperclass();  
    if (parentClass != null) {  
        out.println(" extends " + parentClass.getName());  
    }  
    Class[] interfaces = thisClass.getInterfaces();  
    for (Class interf : interfaces) {  
        out.println(" implements " + interf.getName());  
    }  
}
```



Output for type example

```
class java.lang.Object
```

```
class java.util.HashMap
```

```
  extends java.util.AbstractMap
```

```
  implements java.util.Map
```

```
  implements java.lang.Cloneable
```

```
  implements java.io.Serializable
```

```
class Point
```

```
  extends java.lang.Object
```



Examining class contents

```
public static void showContents(PrintStream out,  
                                boolean hideObject,  
                                String name)  
    throws ClassNotFoundException {  
  
    Class cls = Class.forName(name);  
  
    out.println(name);  
  
    showMembers(out, hideObject, name + " fields",    cls.getFields());  
  
    showMembers(out, hideObject, name + " constructors",cls.getConstructors());  
  
    showMembers(out, hideObject, name + " methods",    cls.getMethods());  
}
```



Examining class contents

```
public static void showMembers( PrintStream out,  
                                boolean hideObject,  
                                String title,  
                                Member[] members) {  
  
    out.println(" " + title);  
    for (Member mem : members) {  
        if (mem.getDeclaringClass() == Object.class) {  
            if (hideObject) {  
                continue;  
            }  
        }  
        out.println("\t" + mem);  
    }  
}
```



Point *(somewhat edited)*

Point fields

Point constructors

```
public Point(java.lang.String,int,int)
```

```
public Point(int,int)
```

Point methods

```
public java.lang.String Point.toString()
```

```
public java.lang.String Point.getName()
```

```
public void Point.setName(java.lang.String)
```

```
public int Point.getX()
```

```
public void Point.setX(int)
```

```
public int Point.getY()
```

```
public void Point.setY(int)
```



Getting at members

- How to access members of a specific object?
 - Without making raw pointers into memory part of the language
 - (Raw pointers are a rich source of errors in C/C++)
- Introduce a class Field
 - Encapsulates access to a particular field of instances of a class
 - Knows "where the field is" in objects of that class
 - Use its `get()` and `set()` methods to inspect and modify the object



Examining fields

```
public static void main(String[] args) {  
    PublicPoint p = new PublicPoint("center", 3, 3);  
  
    showField(System.out, p, "fName");  
    showField(System.out, p, "fX");  
    showField(System.out, p, "fY");  
    showField(System.out, p, "fZ");  
}
```



```
public static void showField(PrintStream out,
    Object obj, String fieldName) {
    try {
        Class cls    = obj.getClass();
        Field field  = cls.getField(fieldName);
        Object value = field.get(obj);
        out.println(fieldName + ": " + value);
    }
    catch (NoSuchFieldException e) {
        System.err.println(e);
    }
    catch (IllegalAccessException e) {
        System.err.println(e);
    }
}
```




Output

- fName: center
- fX: 3
- fY: 3
- java.lang.NoSuchFieldException: fZ



```
public static void showMethods(  
    PrintStream out, Object obj)  
    throws NoSuchMethodException,  
           IllegalAccessException,  
           InvocationTargetException {
```

```
    Class cls = obj.getClass();  
    out.println(cls.getName());  
    for (Method meth : cls.getMethods()) {  
        if (meth.getDeclaringClass() == cls) {  
            showMethod(out, meth);  
        }  
    }  
}
```



Calling methods

1. Look up a method based on its signature: the name and list of parameter types
2. Specify signature as a comma-separated list of Class objects
 - Specifies the types of arguments
 - Special values for types like int and boolean
3. Call the method, passing in parameters and capturing return value



```
Class myClass = Class.forName("Mystery");  
Object o = myClass.newInstance();
```

```
Method m = myClass.getMethod("euclidean",  
    Double.TYPE, Double.TYPE);  
double result = (Double) m.invoke(o,  
    new Double(5.0), 12.0);
```

```
Method m2 = myClass.getMethod("play",  
    Class.forName("java.lang.String"), String.class);
```

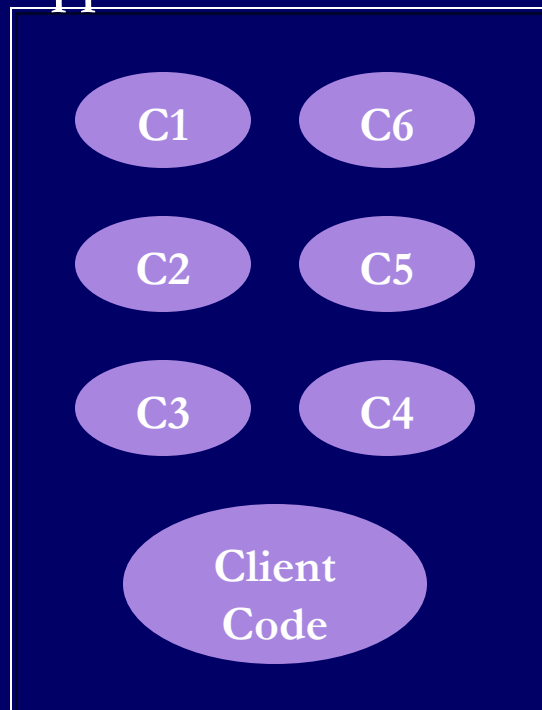
```
m2.invoke(o, "Che", "Karl");
```



Revisiting OOD: cohesion and coupling and the Use of Components

Component-based Software

App A



CSC324: Principles of Programming Languages

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• [Java](#) (116)
• [JavaScript / AJAX](#) (69)
• [Flash / Flex](#) (9)
• [C++ / MFC](#) (58)
• [DLL](#) (242)
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• [Visual Basic 2005](#) (825)
• [Visual Basic .NET](#) (750)
• [Visual Basic](#) (483)
• [Visual C# 2008](#) (548)

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ZipCode (10)	Email Address	Resizing (17)
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Artificial Intelligence (4)	Encryption (14)	Search (21)
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Component standards

- Sun: JavaBeans
- Microsoft: ActiveX, COM, DCOM



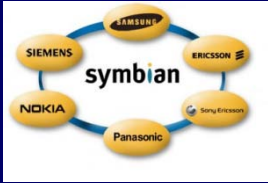
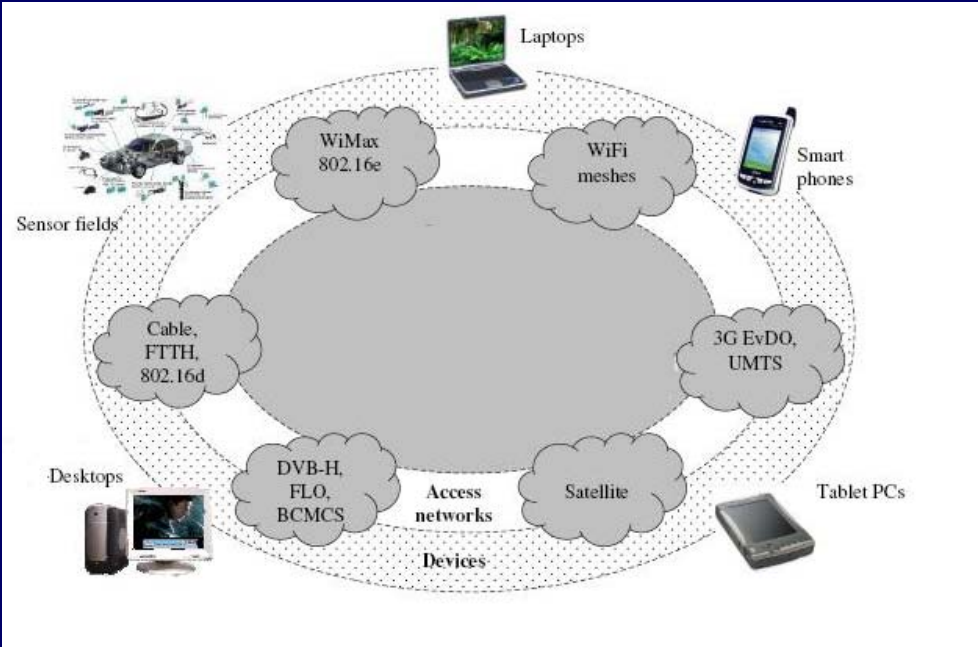
Java Beans

- Reusable components for visual programming
 - Standard constructor
 - No arguments
 - Standard ways of editing parameters
 - Set methods
 - Property editors
 - Customizers
 - Standardized event handling
 - Including property change notification and control



Revisiting OOD: cohesion and coupling and the Use of XML

How can we exchange data between heterogeneous systems?





Message in the Bottle (or: towards the Digital

Rosetta Stone
not quite

Degree of "self-description":

```

^@Some Quotations from the Universal Library^M1
Famous Quotes^M1.1 By William I^M[2,
Sonnet XVIII]^MSHall I compare thee to a
summer's day?^MThou art more lovely and
more temperate.^MRough winds do shake the
darling buds of May,^MAnd summer's lease
hath all too short a date.^MSometime too hot
the eye of heaven shines,^MAnd often is his
gold complexion dimmed.^MAnd every fair
from fair some declines,^MBy chance or
nature's changing course untrimmed.^MBut thy
eternal summer shall not fade,^MNor lose
possession of that fair thou owest,^MNor shall
Death brag thou wander'st in his
shade^MWhile in eternal lines to time thou
growest.^MSo long as men can breathe, or
eyes can see,^MSo long live this, and this
gives life to thee.^M1.2 By William II^M[1,
p.265]^M\223The obvious mathematical
breakthrough would be development of^Man
easy way to factor large prime
numbers.^MReferences^M[1] W. H. Gates.
The Road Ahead. Viking Penguin, 1995.^M[2]
W. Shakespeare. The Sonnets of
Shakespeare.609.^M^@^@^@^@^@^@^@^@^@
^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@

```



Two Important Ideas: (1) Markup?

- Information added to a text to make its structure comprehensible
- Pre-computer markup (punctuational and presentational)



Two Important Ideas: (2) declarative

- Names and structure
- Finer level of detail (most human-legible signals are overloaded)
- Independent of presentation (abstract)
- People often call this “semantic”



Message in the Bottle (or: towards the Digital Rosetta Stone)

Degree of "self-description" →

not quite *not bad*

```

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^@^@^@^@^@^@^@^@^@^@^@^@^@^@^@
  
```

```

\documentclass{article}
\begin{document}
\title{Some Quotations from the
Universal Library}

...
\section{Famous Quotes}
\subsection{By William I}
\textbf{\cite{Sonnet
XVIII}}{shakespeare-sonnets-
1609}}

\begin{verse}
Shall I compare thee to a summer's
day?\\
Thou art more lovely and more
temperate. \\
Rough winds do shake the darling buds
of May, \\
And summer's lease hath all too short a
date. \\
Sometime too hot the eye of heaven
shines, \\
And often is his gold complexion
dimmed. \\

...
\quad So long as men can breathe, or
eyes can see,\\
\quad So long live this, and this gives
life to thee. \\
\end{verse}

...
\bibliographystyle{abbrv}
\bibliography{msg}

\end{document}
  
```



XML: Basic format

1) *Element*: `<tag>content</tag>`

- basic unit
- tag name defines what the content is
- opening and closing tags enclose content

2) *Attribute*: Information about the data

- Attribute names are usually adjectives
- Stored as `attribute="value"` pairs:
 - `<tag attribute="value">`
 - `content`
 - `</tag>`



Rules for well-formed XML

- Elements that contain data must have `<start>` and `</end>` tags!
- Empty tags must be closed `<some-tag/>`
- Elements should not overlap
Bad Nesting:
`<trunk> <branch> </trunk> </branch>`
- All attribute values must be wrapped in quotes
`<a href="newpage.html">`
- XML is case sensitive: `<TAG>` and `<Tag>` are treated differently.
(Standard: use lower case.)



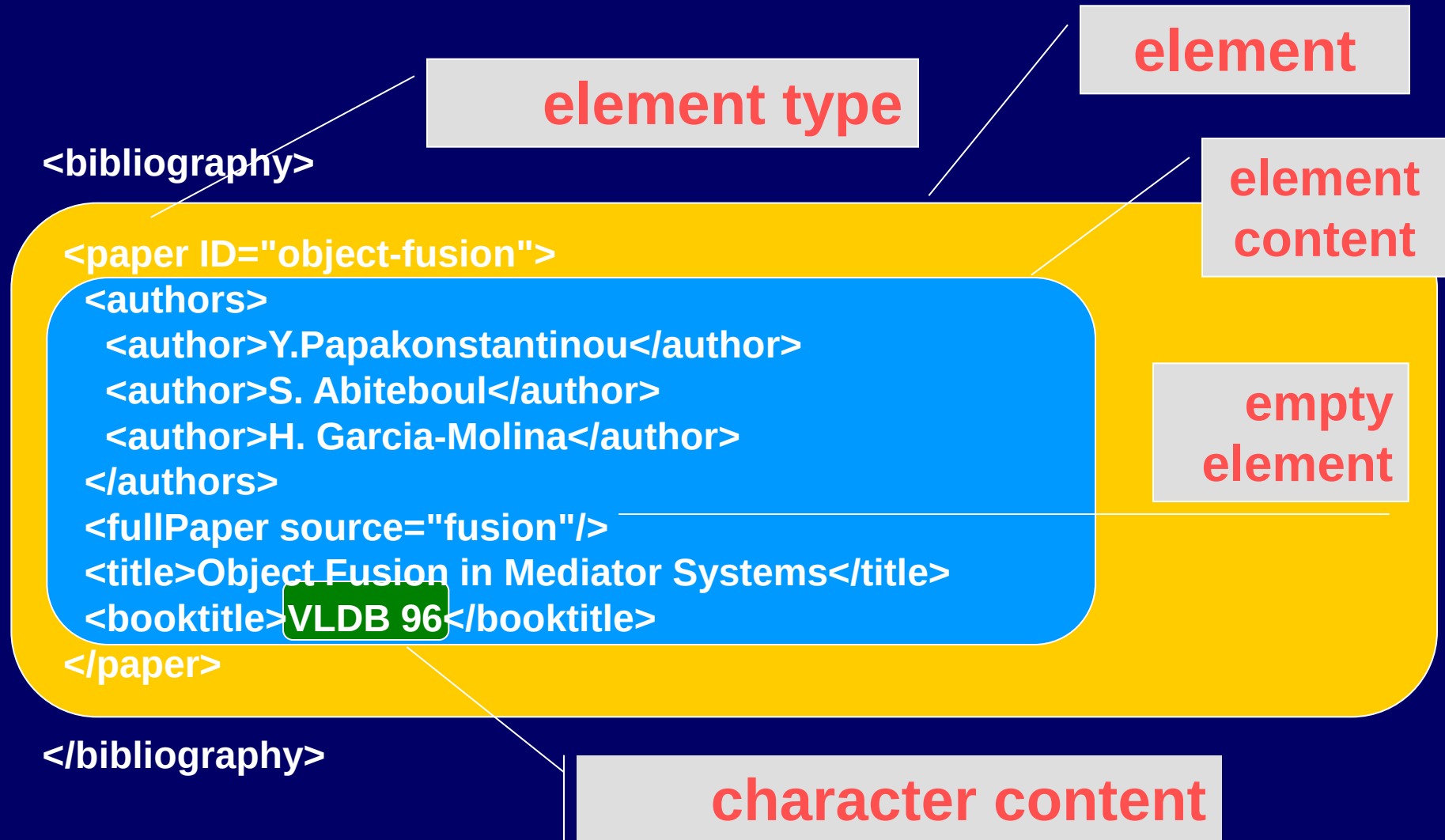
More XML Rules

- A document begins with:
 - an *XML Declaration*
`<?xml version="1.0" encoding="UTF-8"?>`
- *Root element* immediately follows; encloses entire content of the document.

```
<book>  
    everything else  
</book>
```



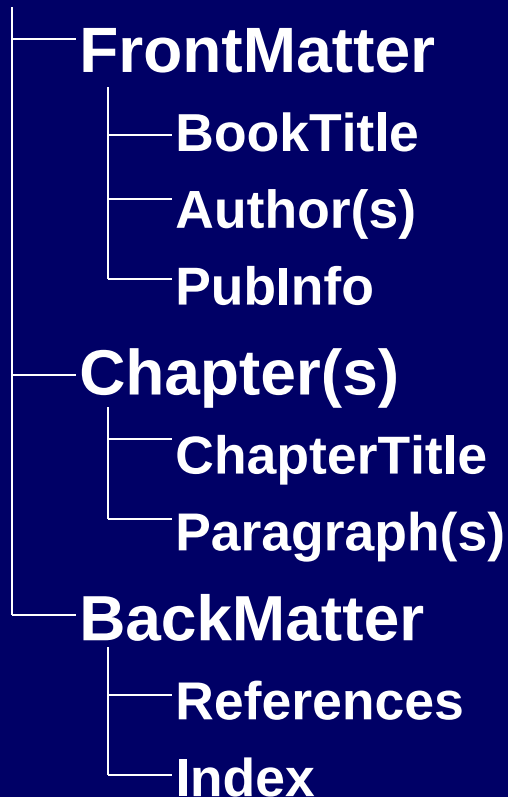
Elements and their Content





XML Example: content objects in a book

Book





A simple XML fragment

```
<Book>
  <FrontMatter>
    <BookTitle>XML Is Easy</BookTitle>
    <Author>Tim Cole</Author>
    <Author>Tom Habing</Author>
    <PubInfo>CDP Press, 2002</PubInfo>
  </FrontMatter>
  <Chapter>
    <ChapterTitle>First Was SGML</ChapterTitle>
    <Paragraph>Once upon a time ...</Paragraph>
  </Chapter>
</Book>
```



This is NOT XML, why?

<PoemFragment>

<Stanza>

<Line><Sentence>It was six men of Indostan</Line>

<Line>To learning much inclined,</Line>

<Line>Who went to see the Elephant</Line>

<Line>(Though all of them were blind),</Line>

<Line>That each by observation</Line>

<Line>Might satisfy his mind </Sentence></Line>

</Stanza>

</PoemFragment>



Message in the Bottle (or: towards the Digital



```

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W. Shakespeare. The Sonnets of
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And often is his gold complexion
dimmed. \\
...
\qqquad So long as men can breathe, or
eyes can see,\\
\qqquad So long live this, and this gives
life to thee. \\
\end{verse}
...
\bibliographystyle{abbrv}
\bibliography{msg}

```

\end{document}

```

<?xml version="1.0"?>
<universal_library>
  <books>
    <book> <title>Some Quotations from the Universal
Library</title>
    <section> <title>Famous Quotes</title>
    <subsection> <title>By William I</title>
    <quote bibref="shakespeare-sonnets-1609">
      <title>Sonnet XVIII</title>
      <verse>
        <line>Shall I compare thee to a summer's
day?</line>
        <line>Thou art more lovely and more
temperate. </line>
        <line>Rough winds do shake the darling buds of
May, </line>
      </verse>
    ...
    <subsection> <title>By William II</title>
    <quote bibref="gates-road-ahead-1995">
      <title>Page 265</title>
      <line>`The obvious mathematical breakthrough
would be development of an easy way to factor
large prime numbers.`</line>
    </quote>
    </subsection>
    </section>
  </books>
  ...
</universal_library>

```



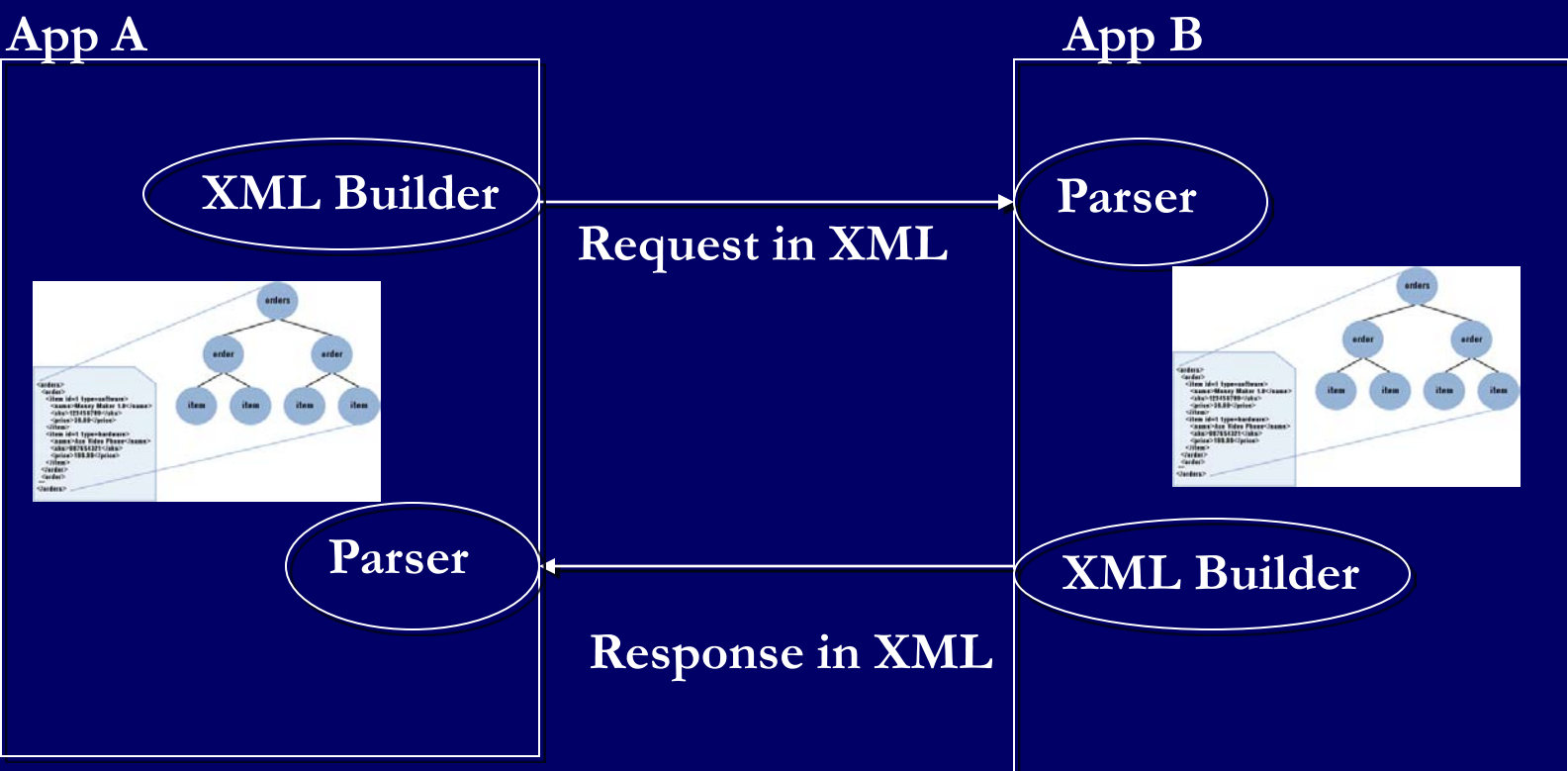
XML Industry Initiatives

- Every community is building it's own XML protocols, for example:
 - Advertising: adXML place an ad onto an ad network or to a single vendor
 - Literature: Gutenberg convert the world's great literature into XML
 - Web Servers: apacheXML parsers, XSL, web publishing
 - Travel: openTravel information for airlines, hotels, and car rental places
 - News: NewsML creation, transfer and delivery of news
 - Voice: VoxML markup language for voice applications
 - Wireless: WAP (Wireless Application Protocol) wireless devices
 - Weather: OMF Weather Observation Markup Format (simulation)
 - Geospatial: ANZMETA distributed national directory for land information
 - Banking: MBA Mortgage Bankers Association of America --> credit report, loan file, underwriting...
 - Healthcare: HL7 DTDs for prescriptions, policies & procedures, clinical trials
 - Math: MathML (Mathematical Markup Language)
 - Surveys: DDI (Data Documentation Initiative) "codebooks" in the social and behavioral sciences

[Http://www.oasis-open.org/cover/xml.html#applications](http://www.oasis-open.org/cover/xml.html#applications)



Two Applications Communicating





Revisiting OOD: cohesion and coupling and the Use of Message Queues

Two Client Applications communicating with a server

