2.3 JAXP: Java API for XML Processing

- How can applications use XML processors?
  - A Java-based answer: through **JAXP**
  - An overview of the JAXP interface
    - » What does it specify?
    - » What can be done with it?
    - » How do the JAXP components fit together?

[Partly based on tutorial "An Overview of the APIs" at http://java.sun.com/xml/jaxp/dist/1.1/docs/tutorial/overview/3_apis.html, from which also some graphics are borrowed]

JAXP 1.1

- Included in Java since JDK 1.4
- An interface for "plugging-in" and using XML processors in Java applications
  - includes packages
    - » `org.xml.sax`: SAX 2.0
    - » `org.w3c.dom`: DOM Level 2
    - » `javax.xml.parsers`: initialization and use of parsers
    - » `javax.xml.transform`: initialization and use of transformers (XSLT processors)

Later Versions

- JAXP 1.2 (2002) adds property-strings for setting the language and source of a schema used for (non-DTD-based) validation
- JAXP 1.3 included in JDK 5.0 (2005)
  - more flexible validation (decoupled from parsing)
  - support for DOM3 and XPath
- We'll restrict to basic ideas from JAXP 1.1

JAXP: XML processor plugin (1)

- Vendor-independent method for selecting processor implementation at run time
  - principally through system properties

```
javax.xml.parsers.SAXParserFactory
javax.xml.parsers.DocumentBuilderFactory
javax.xml.transform.TransformerFactory
```

  - Set on command line (for example, to use Apache Xerces as the DOM implementation):

```
java
-Djavax.xml.parsers.DocumentBuilderFactory=
org.apache.xerces.jaxp.DocumentBuilderFactoryImpl
```


JAXP: XML processor plugin (2)

  - Set during execution (–> Saxon as the XSLT impl):

```
System.setProperty(
"javax.xml.transform.TransformerFactory",
"com.icl.saxon.TransformerFactoryImpl");
```

- By default, reference implementations used
  - Apache Crimson/Xerces as the XML parser
  - Apache Xalan as the XSLT processor
- Supported by a few compliant processors:
  - Parsers: Apache Crimson and Xerces, Aelfred, Oracle XML Parser for Java
  - XSLT transformers: Apache Xalan, Saxon

JAXP: Functionality

- Parsing using SAX 2.0 or DOM Level 2
- Transformation using XSLT
  - (We'll study XSLT in detail later)
- Adds functionality missing from SAX 2.0 and DOM Level 2:
  - controlling validation and handling of parse errors
    - » error handling **can** be controlled in SAX, by implementing ErrorHandler methods
  - loading and saving of DOM Document objects

JAXP Parsing API

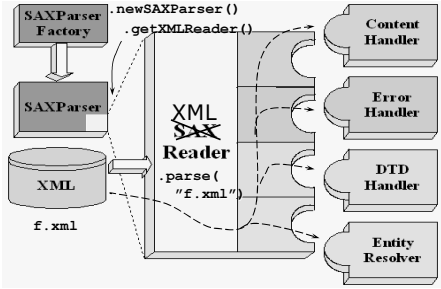
- Included in JAXP package
  `javax.xml.parsers`
- Used for invoking and using SAX …

```
SAXParserFactory spf =
   SAXParserFactory.newInstance();
```

and DOM parser implementations:

```
DocumentBuilderFactory dbf =
   DocumentBuilderFactory.newInstance();
```


JAXP: Using a SAX parser (1)

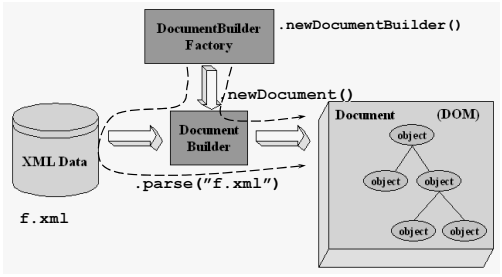


JAXP: Using a SAX parser (2)

- We have already seen this:

```
SAXParserFactory spf =
        SAXParserFactory.newInstance();
  try {
        SAXParser saxParser = spf.newSAXParser();
        XMLReader xmlReader =
                  saxParser.getXMLReader();
        ...
        xmlReader.setContentHandler(handler);
        xmlReader.parse(fileNameOrURI); ...
      } catch (Exception e) {
            System.err.println(e.getMessage());
            System.exit(1); };
```


JAXP: Using a DOM parser (1)



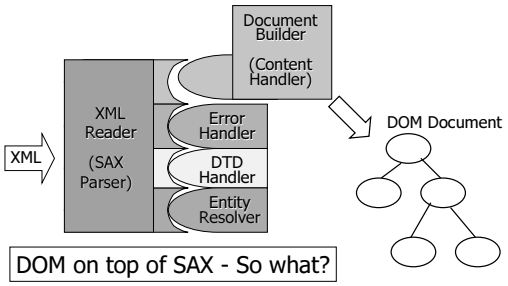
JAXP: Using a DOM parser (2)

- Parsing a file into a DOM Document:

```
DocumentBuilderFactory dbf =
            DocumentBuilderFactory.newInstance();

try { // to get a new DocumentBuilder:
       DocumentBuilder builder =
            dbf.newDocumentBuilder();
      Document domDoc =
            builder.parse(fileNameOrURI);
    } catch (ParserConfigurationException e) {
            e.printStackTrace());
            System.exit(1);
    };
```


DOM building in JAXP



JAXP: Controlling parsing (1)

- Errors of DOM parsing can be handled
  - by creating a SAX ErrorHandler
    - » to implement error, fatalError and warning methods

  and passing it to the DocumentBuilder:

```
builder.setErrorHandler(new myErrHandler());
domDoc = builder.parse(fileName);
```

- Parser properties can be configured:
  - for both SAXParserFactories and DocumentBuilderFactories (before parser/builder creation):

```
factory.setValidating(true/false)
factory.setNamespaceAware(true/false)
```


JAXP: Controlling parsing (2)

- Further DocumentBuilderFactory configuration methods to control the form of the resulting DOM Document:

```
setIgnoringComments(true/false)
setIgnoringElementContentWhitespace(true/false)
setCoalescing(true/false)
```

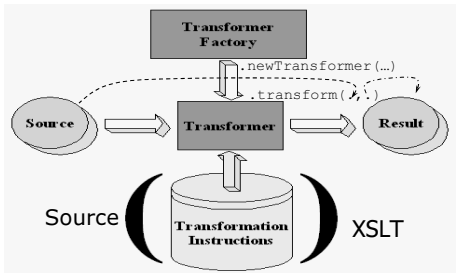
  - combine CDATA sections with surrounding text?

```
setExpandEntityReferences(true/false)
```


JAXP Transformation API

- earlier known as TrAX
- Allows application to apply a Transformer to a Source document to get a Result document
- Transformer can be created
  - from XSLT transformation instructions (to be discussed later)
  - without instructions
    - » gives an identity transformation, which simply copies the Source to the Result

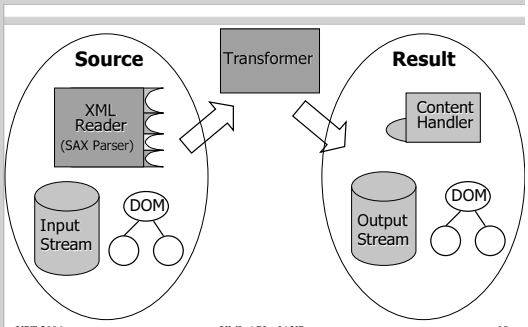
JAXP: Using Transformers (1)



JAXP Transformation APIs

- `javax.xml.transform`:
  - Classes `Transformer` and `TransformerFactory`; initialization similar to parsers and parser factories
- Transformation Source object can be
  - a DOM tree, a SAX XMLReader or an input stream
- Transformation Result object can be
  - a DOM tree, a SAX ContentHandler or an output stream

Source-Result combinations



JAXP Transformation Packages (2)

- Classes to create Source and Result objects from DOM, SAX and I/O streams defined in packages
  - `javax.xml.transform.dom`, `javax.xml.transform.sax`, and `javax.xml.transform.stream`
- Identity transformation to an output stream is a vendor-neutral way to serialize DOM documents (and the only option in JAXP)
  - "I would recommend using the JAXP interfaces until the DOM's own load/save module becomes available"
    - » Joe Kesselman, IBM & W3C DOM WG

Serializing a DOM Document as XML text

- By an identity transformation to an output stream:

```
TransformerFactory tFactory =
      TransformerFactory.newInstance();
// Create an identity transformer:
Transformer transformer =
      tFactory.newTransformer();
DOMSource source = new DOMSource(myDOMdoc);
StreamResult result =
      new StreamResult(System.out);

transformer.transform(source, result);
```


Controlling the form of the result?

- We could specify the requested form of the result by an XSLT script, say, in file `saveSpec.xslt`:

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

  <xsl:output encoding="ISO-8859-1" indent="yes"
              doctype-system="reglist.dtd" />

  <xsl:template match="/">
  <!-- copy whole document: -->
    <xsl:copy-of select="." />
  </xsl:template>

</xsl:transform>
```


Creating an XSLT Transformer

- Then create a tailored transfomer:

```
StreamSource saveSpecSrc =
      new StreamSource(
            new File("saveSpec.xslt") );
Transformer transformer =
      tFactory.newTransformer(saveSpecSrc);
// and use it to transform a Source to a Result,
// as before
```

- The Source of transformation instructions could be given also as a DOMSource, URL, or character reader

DOM vs. Other Java/XML APIs

- JDOM (`www.jdom.org`), DOM4J (`www.dom4j.org`), JAXB (`java.sun.com/xml/jaxb`)
- The others may be more convenient to use, but …

  "The **DOM offers** not only the **ability to move between languages** with minimal relearning, but to **move between multiple implementations** in a single language – which a specific set of classes such as JDOM can't support"

  - » J. Kesselman, IBM & W3C DOM WG

JAXP: Summary

- An interface for using XML Processors
  - SAX/DOM parsers, XSLT transformers
- Supports pluggability of XML processors
- Defines means to control parsing, and handling of parse errors (through SAX ErrorHandlers)
- Defines means to write out DOM Documents
- Included in Java 2