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A30
XML Tooling
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why "i"? it's simple.

Agenda

- XML Introduction
  - XML, DTD, XML Schema and XSLT
- Getting Started With the Tools
- XML Tools in Development Studio Client
  - The Editors - XML, DTD and XML Schema
  - XML to XML Mappings
  - XML JavaBeans
  - XML From SQL Query Wizard
  - Relational DB to XML Mapping
- Summary and References

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XML Introduction

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eXtensible Markup Language (XML)

Defines the grammar (rules), but Not the vocabulary

- Platform and language independent way to describe data
- Defines rules for creating a tag-based language
  - Not restricted to a predefined set of tags
  - Actual languages are typically defined in a domain
    - Program Call Markup Language (PCML)
    - Electronic Business using XML (ebXML)
    - Astronomical Markup Language (AML)
  - Or create your own
- Well formed vs. Valid
  - Well formed XML documents comply with all XML syntax rules
  - Valid documents are well formed and comply with a DTD or XML Schema

The XML specification outlines rules that an XML document must follow in order to be well formed. It does not specify any specific tag (element) names or attribute names. It specifies what a tag is and that it can have attributes and the syntax for specifying all of this.So, XML itself is not a language, but describes a class of languages. Each language will be domain specific (or even application specific) such as the examples given on this slide. The actaul tag and attribute names are specified in language specific DTD or XML Schema. If the tags, attributes and structure of an XML document comply with its associated DTD or Schema then the document is also valid.

Example XML Document

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

<invoice orderno="674728">

   <customer custno="19282">
         <customerName>Sporting Clothes Inc.</customerName>
         <address>100 Main Street, Toronto, ON</address>
   </customer>

   <product prodno="5"  unitprice ="47.00">
         <prodname>Bomber Jacket</prodname>
         <color>Black</color>
         <sqty>2</sqty>
         <lqty>4</lqty>
   </product>

   <amount terms="balance in 30 days">
         <subtotal>386.00</subtotal>
         <taxes>19.30</taxes>
         <total>405.30</total>
   </amount>
</invoice>
```

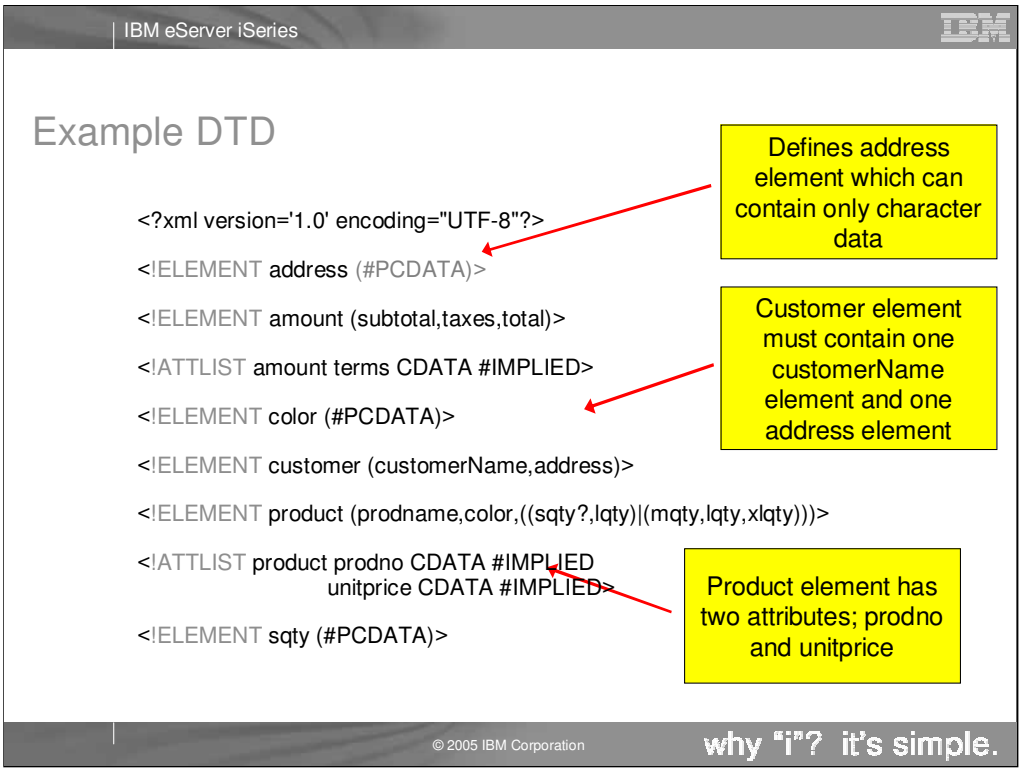

Here is an example XML document showing the XML declaration (very first line), some tags and attributes. One question that frequently comes up is when to use elements versus attributes. It is really upto the designer of the XML language. In the example shown the prodno attribute for product could just as well have been a prodno element within the product element.

Document Type Definition (DTD)

Defines the vocabulary

- XML documents can be associated with a DTD
- This is where you declare
  - What tag names are valid for your XML language
  - What attributes and data each tag can have
  - Which tags can be nested
  - Declare your own entities
  - Specifies the rules (metadata) for composition of an XML document

Document Type Definitions are used to specify a specific XML language. So for each of the examples shown on the first XML slide (PCML, ebXML, AML) will have a corresponding DTD which describes the language. So DTD's do not contain any data, they describe the tags and attributes that are then used to markup the actual data in an XML document. A DTD can be linked to an XML document either externally using the first DOCTYPE declaration shown or can be included within the XML document itself using the second declaration shown.



An example DTD. The thing to point out here is that DTDs do not use XLM syntax and therefore require a different set of skills (therefore increasing the learning curve.) The tooling can definitally help with this, but XML Schemas are a better alternative.

Problems with DTDs

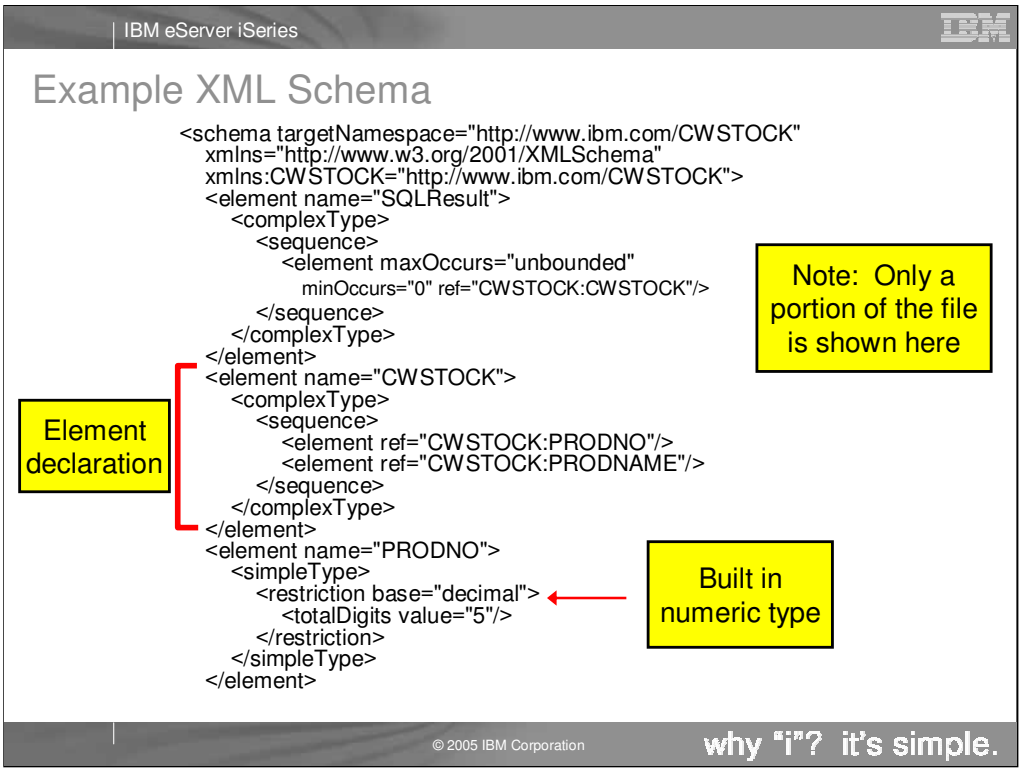
- Limited data types
  - Basically restricted to character data
- Does not use XML syntax
- Not very expressive
  - Can only restrict lists to
    - Zero or more
    - One or more
    - Zero or one
  - Cannot specify minimum and maximum values for numeric data types
- No support for XML namespaces
  - Namespaces provide a way to qualify tags, similar to package names in Java

Some problems with DTDs. Basically they only support character data type and are not able to express anything but very simple constraints.

XML Schema

- Fixes the problems with DTDs
  - Replacement for DTDs
- Written using XML syntax
- Lots of built in data types
  - String, boolean, byte, short, int, float, double, unsigned, date, time, ...
- Support for user defined types
- Ability to restrict and extend other types
  - Inheritance

XML Schema came out a couple of years after DTDs and addresses most (if not all) of the shortcomings of DTDs.



With the extra functionality provided by XML Schema comes additional complexity in the language. We won't get into the details of XML Schema here because of this complexity. Again this is where the tooling can really help out. The user only needs to understand the concepts and the tools will generate the XML code.

Extensible Stylesheet Language Transformations

- XSLT
  - Extensible Stylesheet Language for Transformations
  - Language (rules) for transforming XML documents into other XML documents
    - Converting XML document to an HTML document for displaying in a browser
    - Converting address format used by company A to address format used by company B
  - Requires an XSLT processor
    - Xalan from Apache is commonly used

XSL and XSLT provide the fourth key XML technology (the first three are the XML language itself, DTDs and XML Schema.) Remember that XML is used to describe the data not how the data should be rendered in a user interface. This is the job of XSL. It is similar to CSS and is used to specify the presentation of an XML document. Although part of XSL, XSLT can be used independently to perform any XML to XML transformation. This is very useful if two applications are communicating via XML but each uses a slightly different XML syntax. XSLT can be used to transform one syntax into another. For example:

•To change element or attribute names

•To changes attributes into elements and vice versa

Parsers: Reading and Writing An XML Document

- XML parsers are used for reading and writing XML documents
- The XML parser
  - Reads the document
  - Makes sure it is well formed
  - Checks if it is valid (only if a DTD or XML Schema is specified)
  - Builds a tree structure out of the data
- Your program then uses the method calls in the parser to access the data
- Xerces is the most commonly used XML parser for Java
  - Open Source
    - Managed by the Apache Software Foundation
  - IBM ships XML parsers for RPG, COBOL, C and C++

When you use XML with your application you do not need to write the code to read the XML document and parse out the actual data from the elements and attributes. This is handled for you by an XML parser. The parser will check that an XML document is well formed and valid and will build a tree strucutre out of the data contained in the document. Your application then uses the parser APIs to retrieve the data.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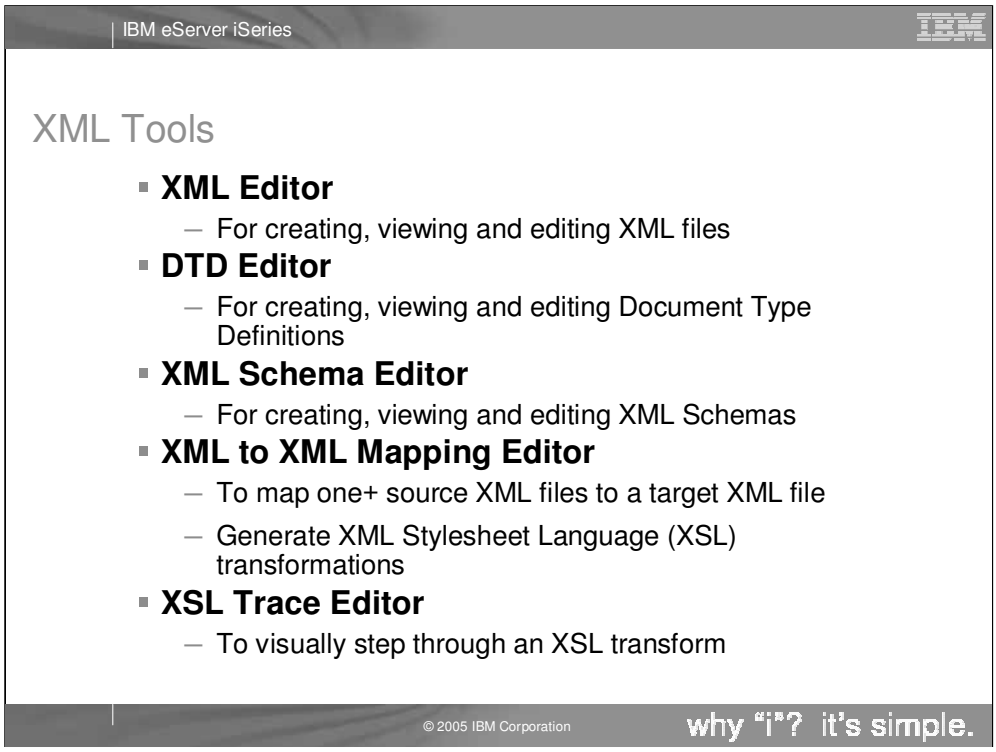
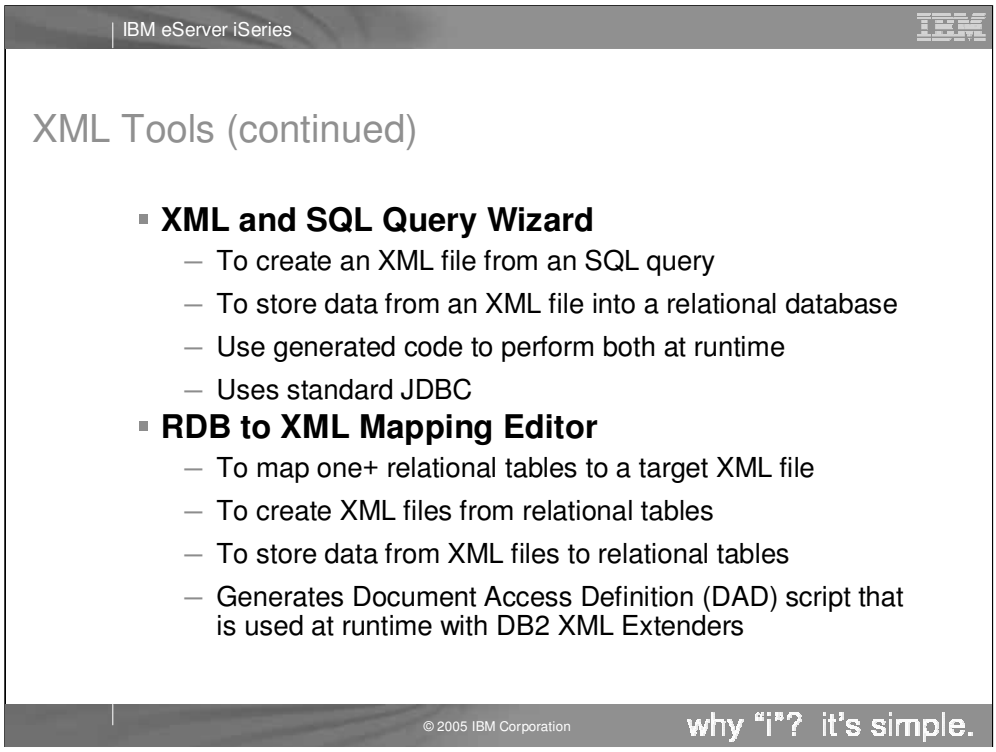


This is the full list of XML tools available in Development Studio Client. As you can see, it is extremely rich.

- An editor for creating and visualizing XML files. This editor includes a wizard to generate a Java Bean to parse and generate the XML.
- An editor for creating Document Type Definitions, with minimal Document Type Definition (DTD) skills. DTDs can be deduced from sample XML files. This editor includes a wizard to generate a Java Bean to parse and generate any XML conforming to the DTD.
- An editor for creating XML Schemas, which are replacing the older DTD's, with minimal XML Schema skills. Schemas can be deduced from sample XML files or DTD's. This editor includes a wizard to generate a Java Bean to parse and generate any XML conforming to the schema.
- A mapper tool that takes two XML DTDs or Schemas and allows you to map the tags and attributes from one to the other. The result is an XSLT file, that when run in an XSLT engine will map an XML file to an output XML file. XSLT is a standard language for defining XML mappings, and there are many engines that can "run" XSLT. Such an engine is supplied in Development Studio Client and WebSphere Application Server.
- An XSLT trace editor. This will "run" and XSLT and map one XML file to another. You can single-step through the transformation and see the output being generated.



•A wizard that will generate an XML file from an SQL query. This can be a static one-time only operation, or you can generate a Java bean that will do this at runtime.

- •The SQL query wizard generates code that uses JDBC drivers, therefore it will work with any database that supports JDBC

•A wizard that maps database tables to target XML tags and attributes. This then generates code that turns queries into XML and turns XML into database updates.

- •The Relational database to XML mapping editor uses DAD scripts with DB2 XML Extenders, this means the generated code will only work with a DB2 database
- •However the RDB to XML mapping editor provides more flexibility in specifying mappings between XML elements and attributes and columns in the relation tables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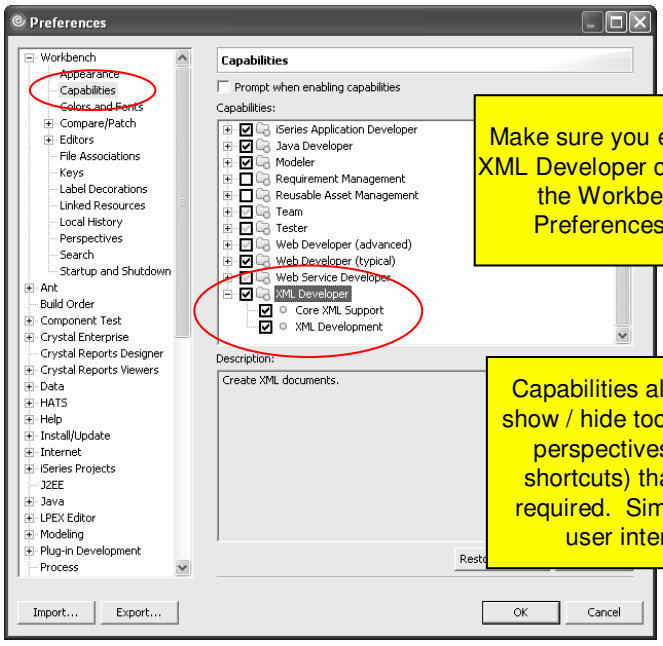
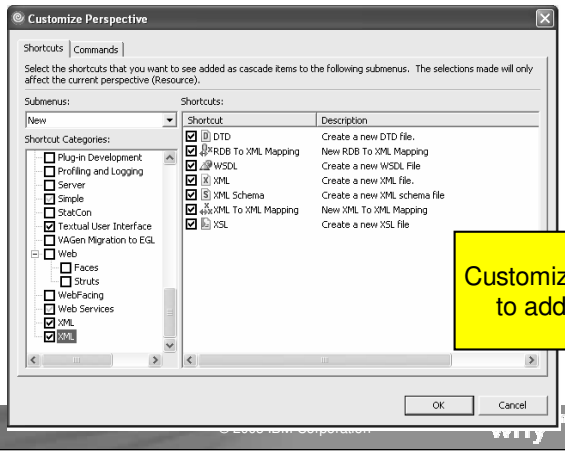


Make sure you enable the XML Developer capability in the Workbench > Preferences page

Capabilities allow you to show / hide tools (actions, perspectives, views, shortcuts) that are not required. Simplifies the user interface!

Workbench Perspectives

- Perspectives define which views, menus and wizards are shown in the Workbench
- There is no XML Perspective [anymore]
  - XML tools can be used in any perspective
  - XML is typically used in some larger development project
    - Java, Web, RPG / COBOL, EGL



Customize any perspective to add XML shortcuts

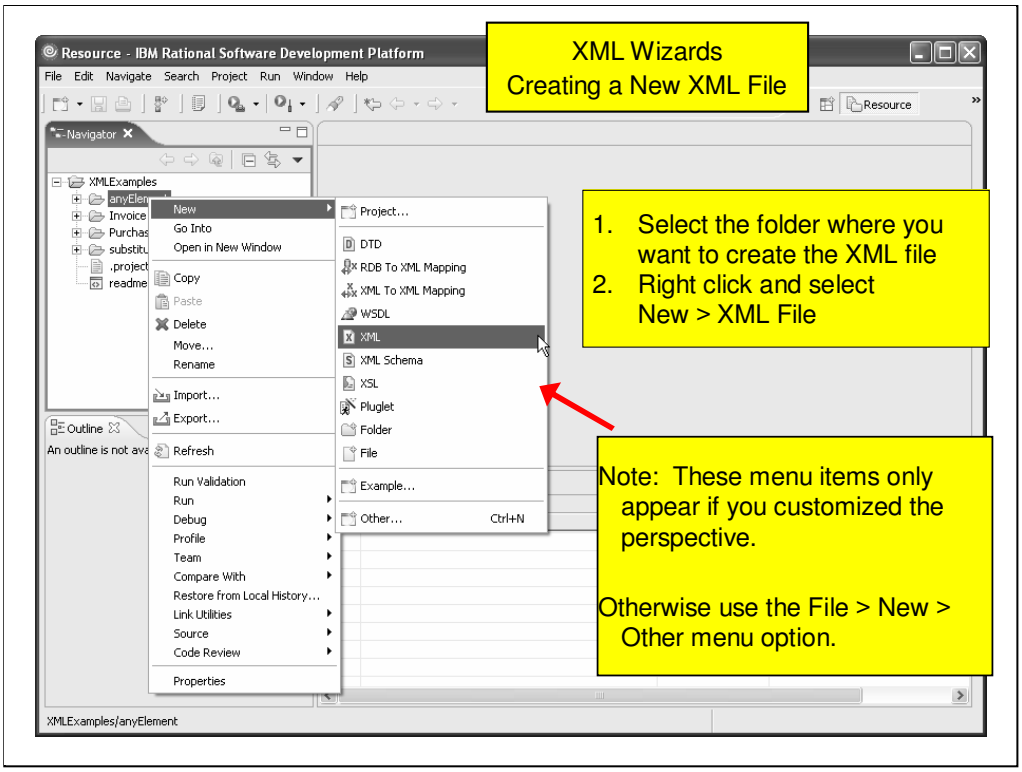
Perspectives are used in the Workbench to provide a coherent selection and layout of views related to a specific type of development (Java, XML, WebFacing, ...)

By default the XML perspective shows the Navigator, outline and tasks views. The navigator view shows all resources in the user's workspace. The outline view is a standard Workbench view for showing the outline of the resource currently opened in the editor. It works for XML and other resource types like Java and SQL scripts. The tasks view is another standard workbench view and shows all errors, warnings and tasks in the workspace.

Projects

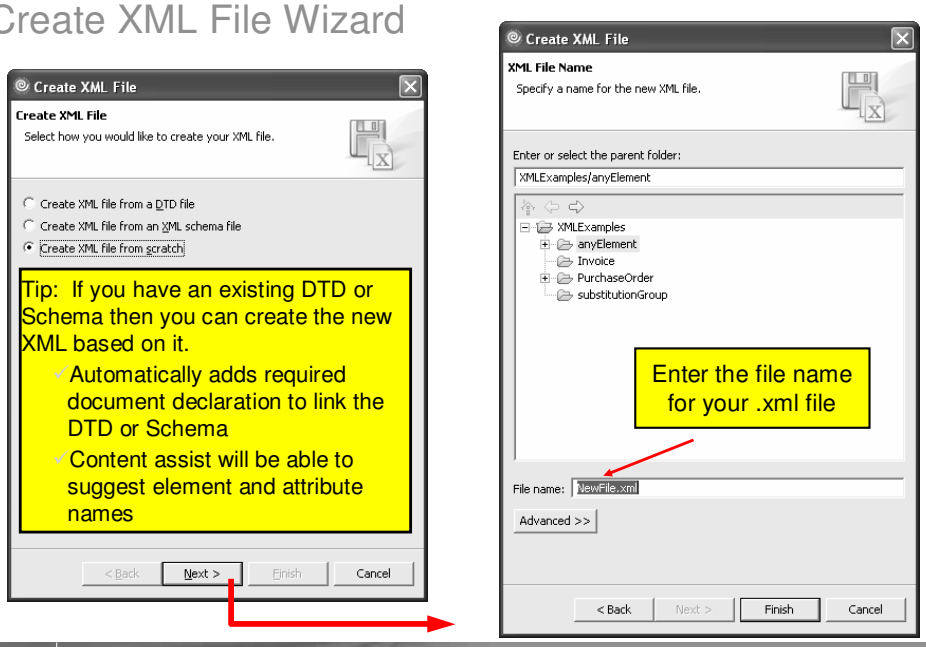
- Highest level of organization for resources in the Workspace
- Contains files and folders
  - All file and folders must be inside of a project
- Projects can have
  - A type (Java, iSeries, Server, Web, Simple)
  - Properties
- There is no XML project
  - XML is typically not used by itself
  - Store your XML resources in another type of project:
    - Web, Java, …
    - Use the simple project type for learning the XML tools

Projects provide the highest level of grouping resources (source files, graphics, executables, ...) in the workspace. Projects always have a type such as Java, WebFacing, Web. Those projects that are not linked to a specific type of development should use the "Simple" type. By default projects map to a subdirectory of the workspace directory on the local file system with the same name as the project. However, there is no XML project because XML resources are usually used in the context of some bigger application should as a Java or Web application.



The first thing we are going to look at is generating an XML file. Typically XML files are generated by applications not manually, however if you are creating a DTD or XML Schema it may be easier to first create a sample XML document the way it should look and then generate the DTD or Schema from the XML document. To create a new XML document first select the project (or folder) where the document will be created, right click and select new -> XML File

Create XML File Wizard

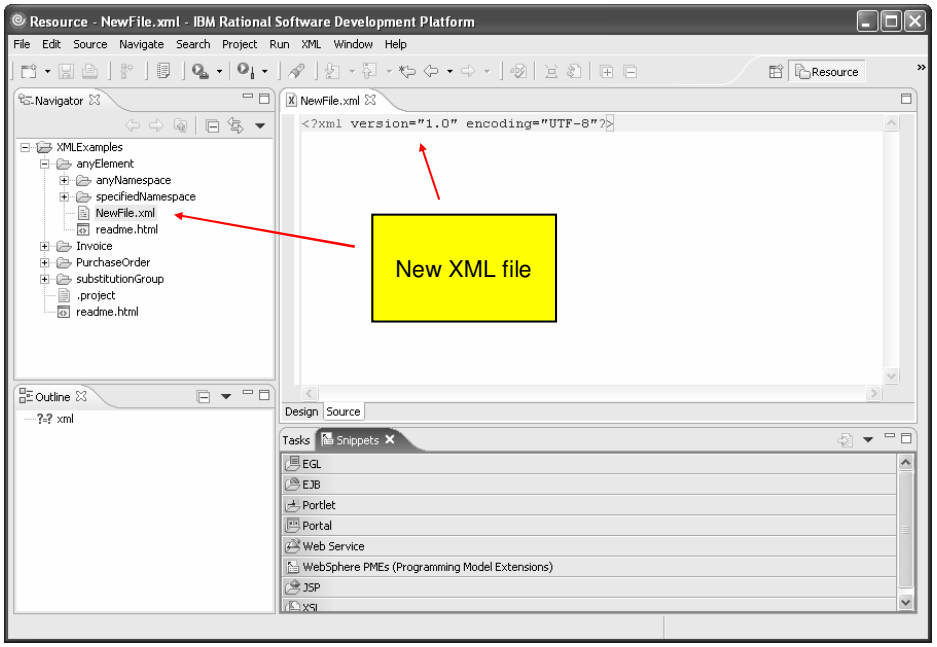


The first page of the new XML File wizard asks if you are creating this file from a DTD, Schema or from scratch. If you have an existing DTD or Schem it is a good idea to specify that here. This will:

•Allow the wizard to generate the XML code to link the XML file to the DTD / Schema

•Allow the content assist in the XML editor to provide you will a better list of options

The second page of the wizard just asks for the XML file name. The target project /folder is already selected based on what was selected when the wizard was launched.



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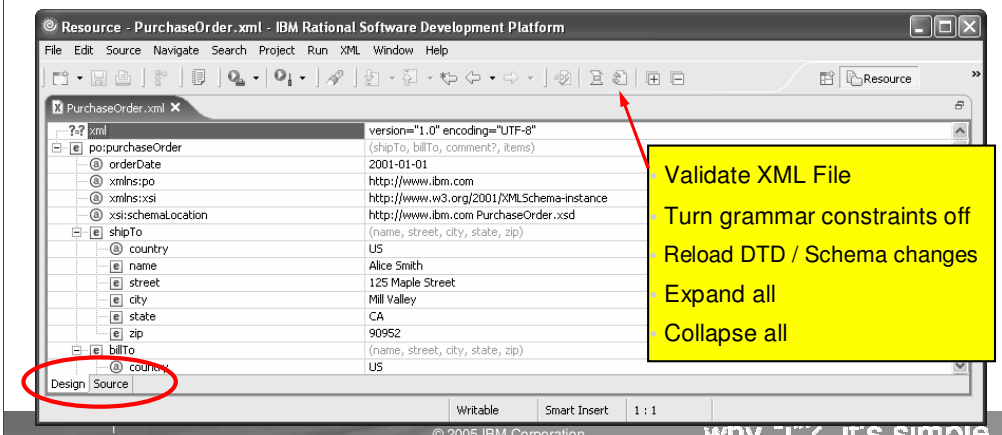
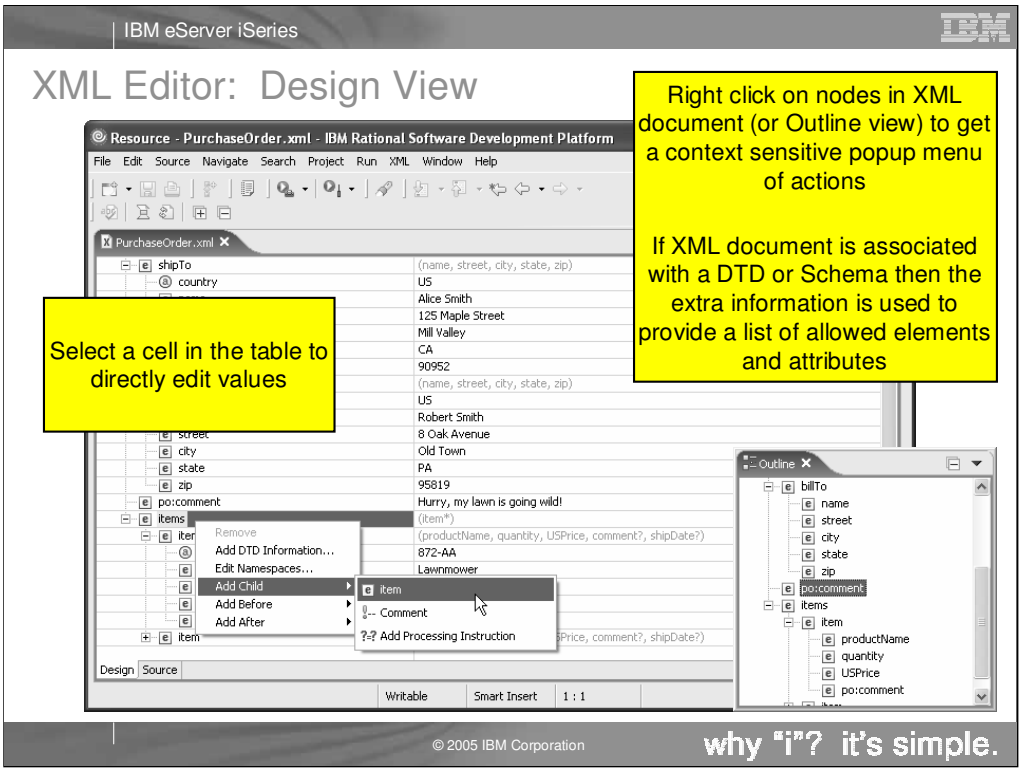
XML Editor

- Edit and validate XML files
- Create XML test documents
- Import existing XML files for structured viewing
- Associate XML files with DTDs or XML schemas
- Two views - the Design view and the Source view
  - Views are kept synchronized – easily switch between them while editing!

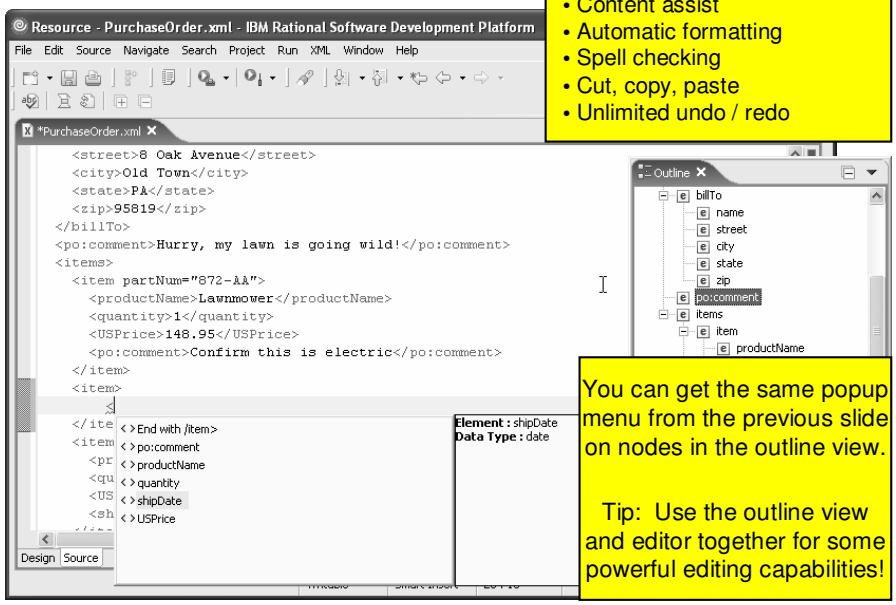


The XML Editor has many uses. The first thing to note about the XML editor is that is has two different views; design and source. These views are kept synchronized so you can switch between them while editing without having to save the file first. The XML editor adds some actions to the workbench toolbar. If performance becomes an issue when editing XML documents you can turn off the grammar contstraint checking. This will prevent the editor from performing live grammar checking. To check grammar you can then either save the file or use the validate XML file action.



The XML editor's design view gives you a tabular tree view of the XML document. This view allows you to edit an XML document without having to worry about the underlying XML syntax. Each element and attribute is represented by a single row in the table. You can expand and collapse elements to see their contents. To change the value of an element / attribute click the cell in the right and column of the table and simply enter the new value. To create / delete elements and attributes click on the target node and select the appropriate action from the popup menu.

XML Editor: Source View



- Token highlighting
- Content assist
- Automatic formatting
- Spell checking
- Cut, copy, paste
- Unlimited undo / redo

You can get the same popup menu from the previous slide on nodes in the outline view.

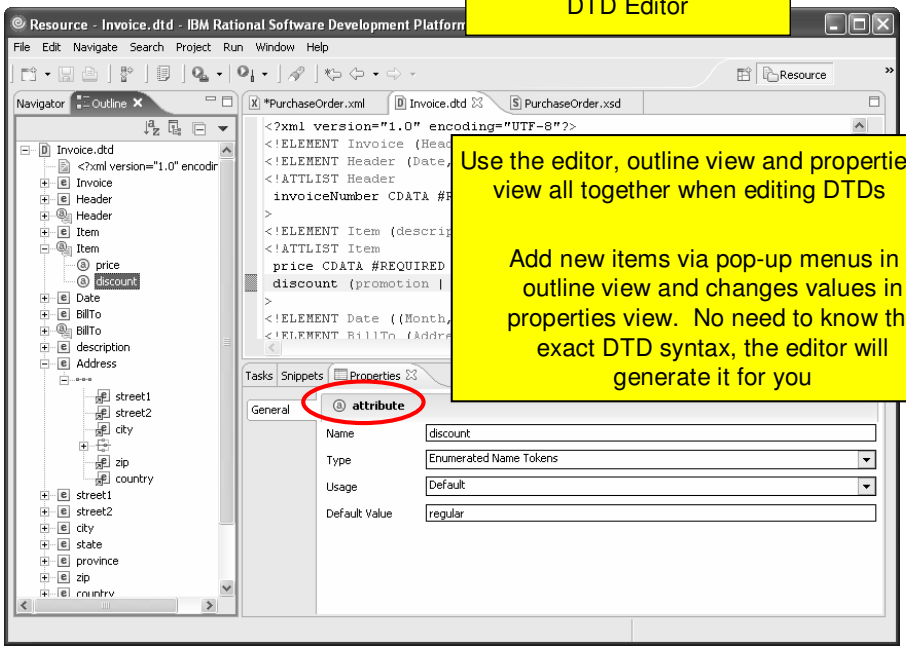
Tip: Use the outline view and editor together for some powerful editing capabilities!

The source view of the XML editor lets you directly edit the XML source code. Just like the Java editor in WDSc, the XML editor provides content assist to help you with element and attribute names. Use the popup menus in the content view to quickly insert / delete elements and attributes (just like the popup menus in the design view.)

DTD and XML Schema Editors

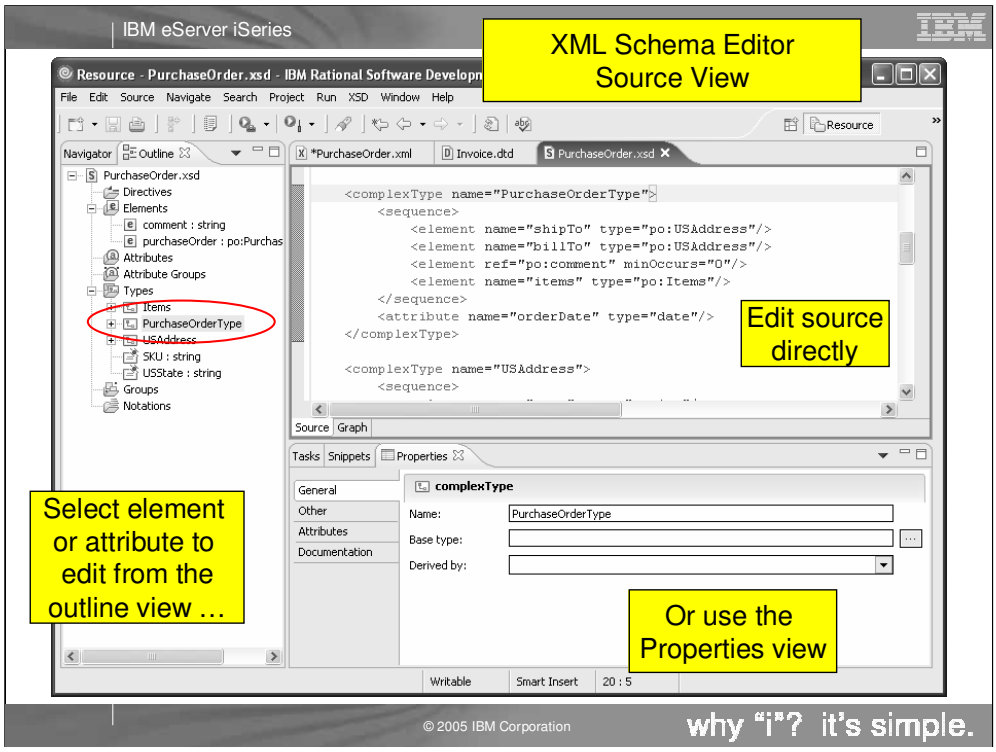
- Provide many of the same capabilities as the XML editor
  - Source views
  - Graphical editing
  - Context sensitive popup menus for adding new items
  - Display a high level structure of the file in the Outline view
  - Use the properties view for modifying attributes of the selected element
- DTDs and XML Schemas can be created from
  - Scratch
  - Existing XML documents
    - Reverse engineers DTD or Schema by examining the structure of the existing XML document
  - Each other

DTD Editor



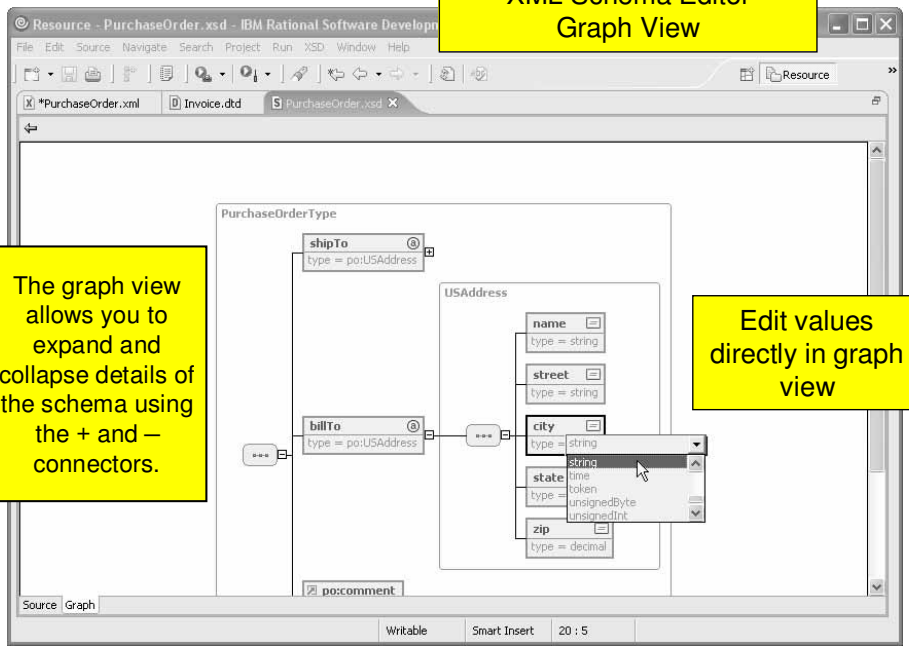
Use the editor, outline view and properties view all together when editing DTDs

Add new items via pop-up menus in outline view and changes values in properties view. No need to know the exact DTD syntax, the editor will generate it for you



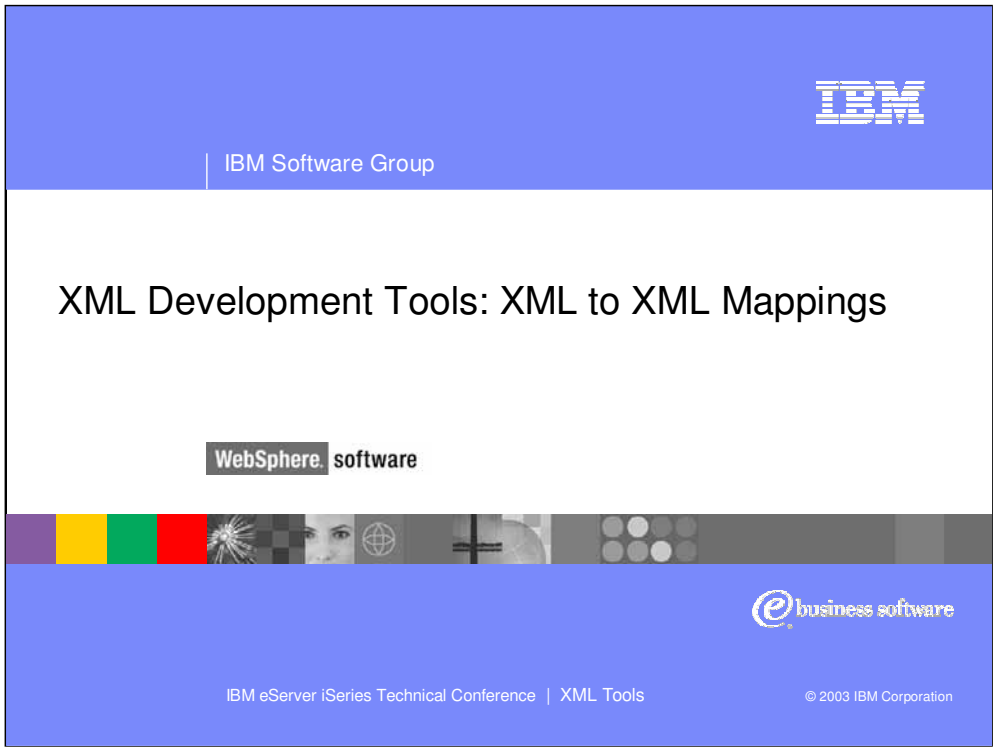
This is the XML schema editor. The outline of the XML file is shown on the left. The right is the XML schema editor that allows editing of the XML schema, either in visual mode or source mode. The editor also has a graph view that shows a graphical view of the XML schema

XML Schema Editor Graph View



The graph view allows you to expand and collapse details of the schema using the + and – connectors.

Edit values directly in graph view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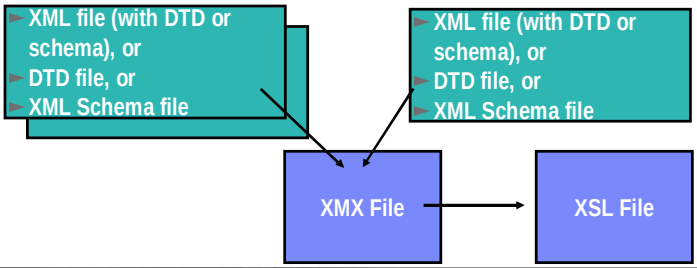
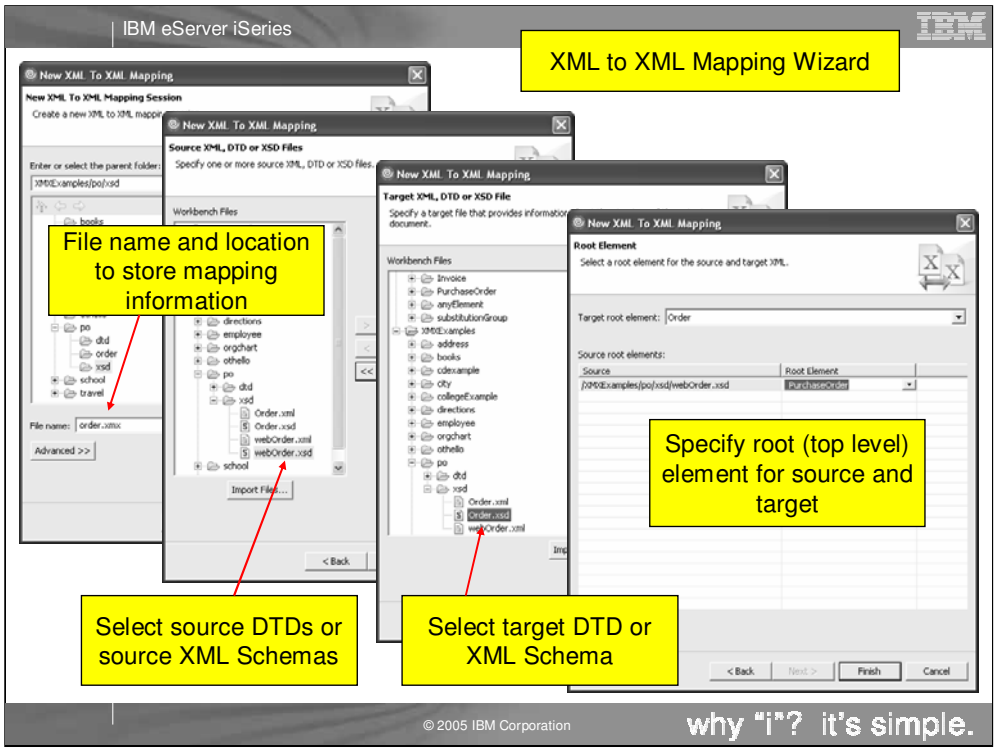
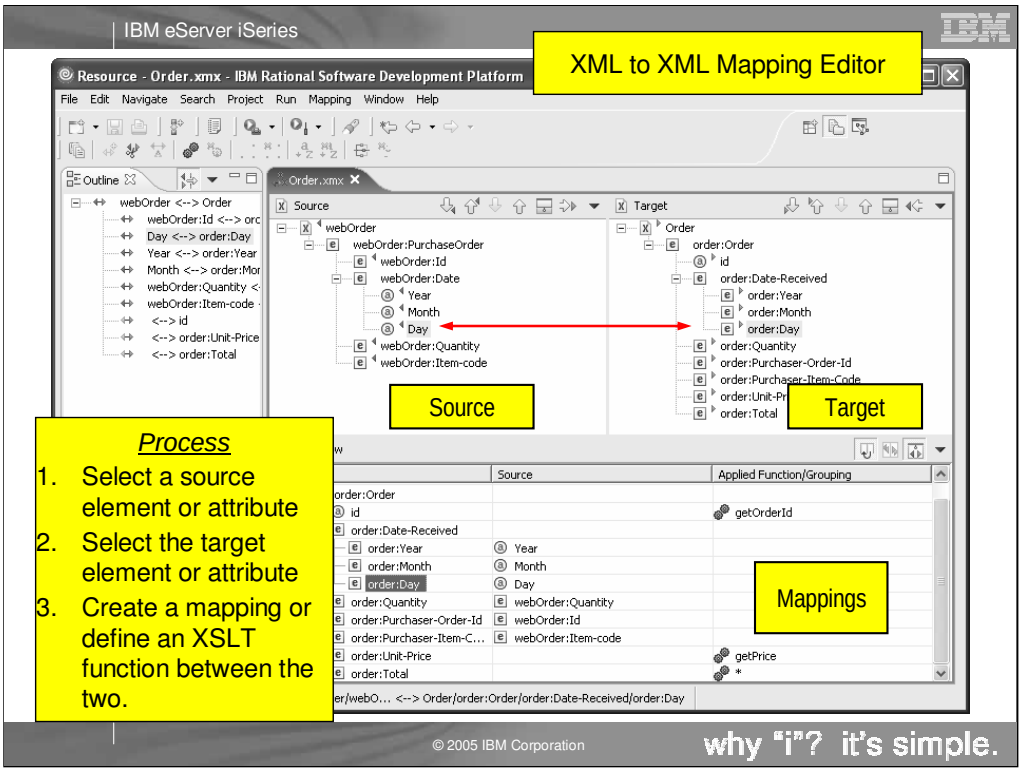
XML to XML Mapping Editor

- Input files
  - One or more *source* DTDs or XML Schemas
  - A *target* DTD or XML Schema
- Input information (using the XML to XML mapping editor)
  - What ***source*** elements map to what ***target*** elements
- Output
  - An **XSLT** file that captures the mapping



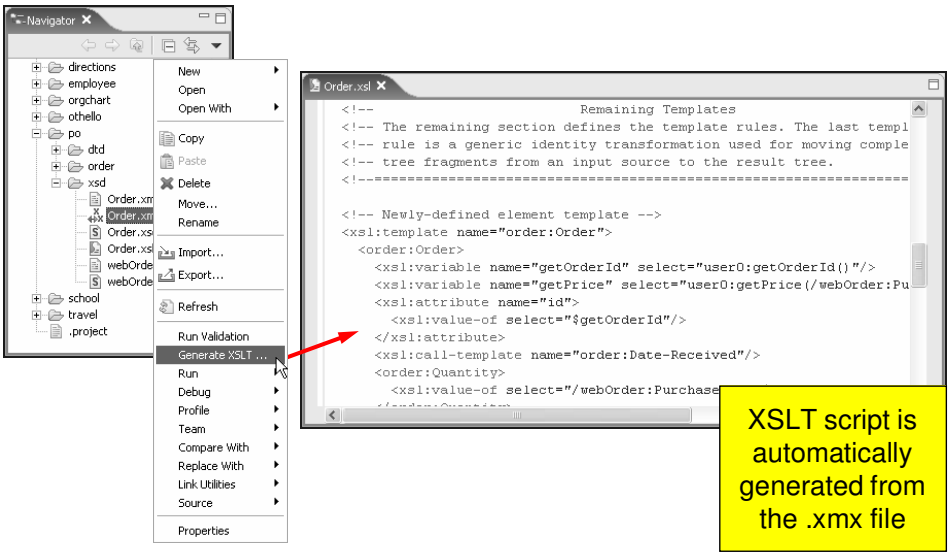




Here we see the XML-to-XML mapping editor. In the upper right we see an outline of the mappings. In the middle we see the input xml on the left, and the output xml on the right. To map two tags or attributes, select one on the left, and one on the right, and select the map button from the toolbar in the view at the bottom.

That bottom view shows the mappings so far. Once the nodes have been mapped, right click and select "Generate XSLT" to generate the XSLT that captures the mapping data.

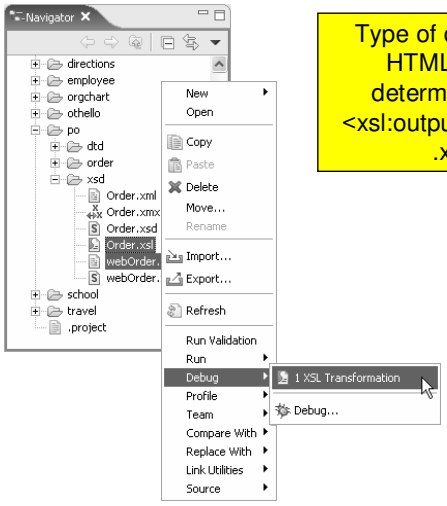
Generating XSLT From XMX File



XSL Debug

- Playback tool designed to work with XML-to-XML mapping editor
  - To test the generated XSLT transformation file
    - Apply the XSLT to an input XML file
    - Verify the output XML or HTML file is valid
    - Records the transformation made by the XALAN XSLT processor
  - Steps through the transformation
    - Highlights the transformation rules as they are fired
    - View the output XML or HTML in "real time"

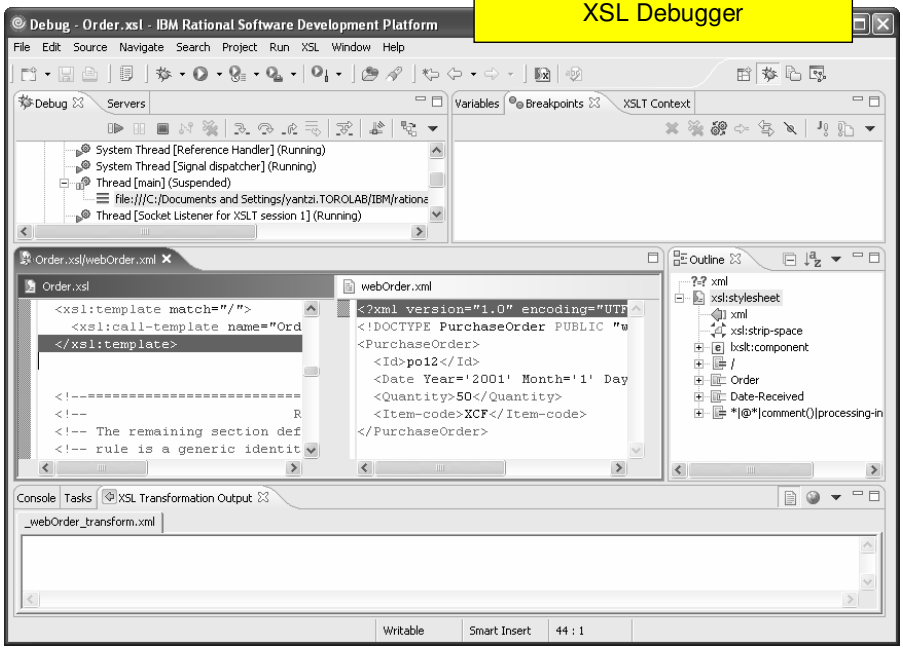
XSL Debug

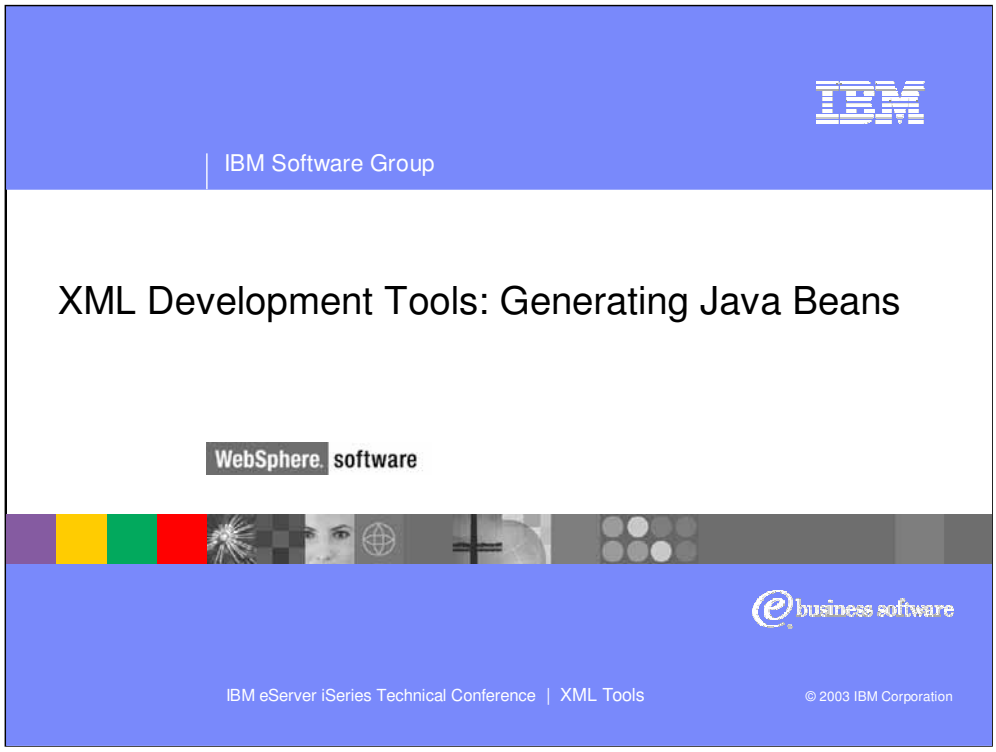


Type of output (XML, HTML, text, …) determined by the <xsl:output> element in .xsl file

Select the source XML and XSL files in the navigator view and select Apply XSL from the popup menu

XSL Debugger

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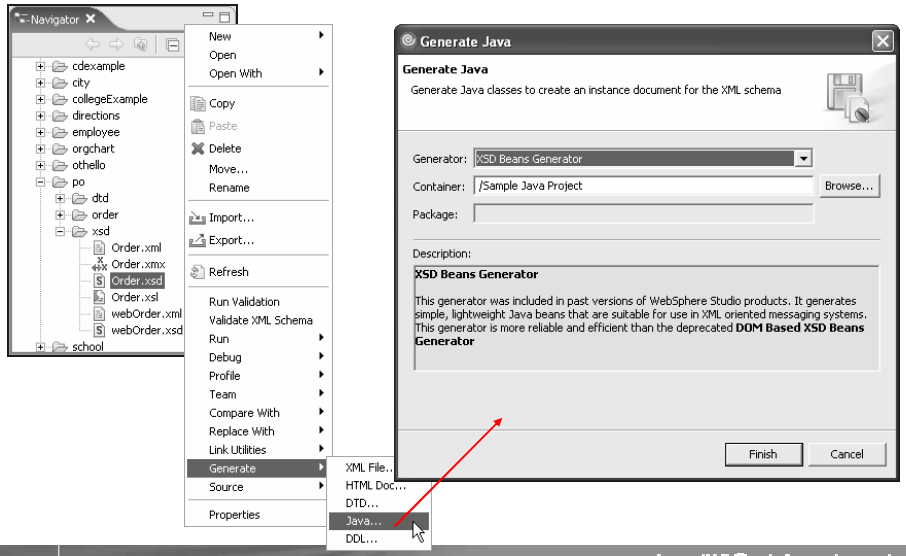
Generating JavaBeans from DTD or XML Schema

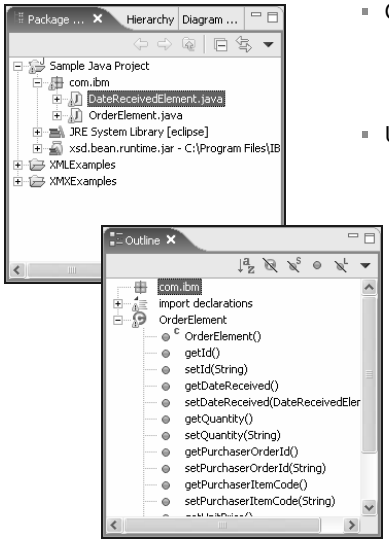
- Generated JavaBeans handle the XML parsing for you!
  - You don't have to learn how to code XML parser API calls!
  - More natural way of working with XML documents
- Use the JavaBeans in your Java applications, Servlets or EJBs to:
  - Read existing XML documents and retrieve the information
    - The XML file is read from an input stream (disk, socket, …), parsed and returned as instances of the JavaBeans
  - Create a new XML file
    - Use the Factory class to create a new XML document by creating instances of the JavaBeans

Generating JavaBeans

JavaBeans can be generated from either a DTD or XML Schema



Generated JavaBeans



- Generated JavaBeans
  - One Java class for each complex element type
  - Each class has getter / setter methods for attributes
- Use the XML Schema beans runtime to
  - Load XML files into generated JavaBeans
  - Save JavaBeans back to XML file

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XML Development Tools: XML and SQL Wizard

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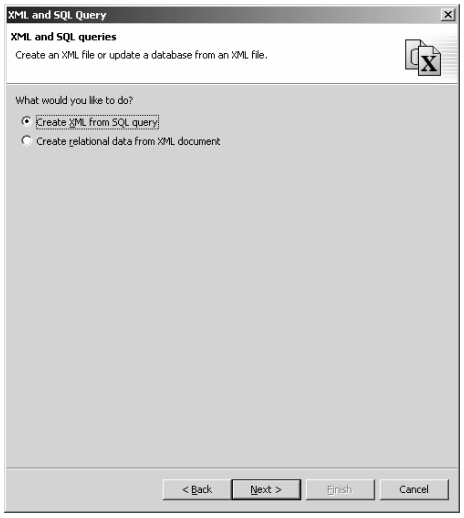
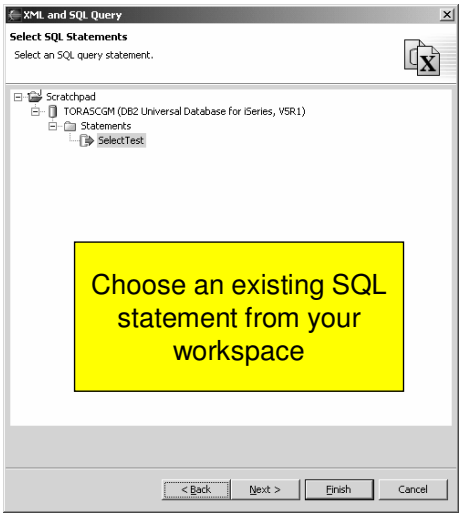
XML and SQL Query Wizard

- Generate the following from an SQL query:
  - XML file and HTML file - Both contain the query results
  - DTD or XML Schema - Describes format of the resulting XML file
  - XSLT - For transforming resulting XML document to HTML
  - XST
    - XML query template file
    - Use XST file in your application to generate the XML file from the SQL query at runtime
    - Requires the following runtimes (all shipped with WDSc)
      - Xerces XML parser and Xalan XSL processor (Apache)
      - SQLToXML (IBM)
- Can also be used for writing XML documents to a relational database
- First you need to create an SQL query either manually or using the Data perspective

XML and SQL Query Wizard



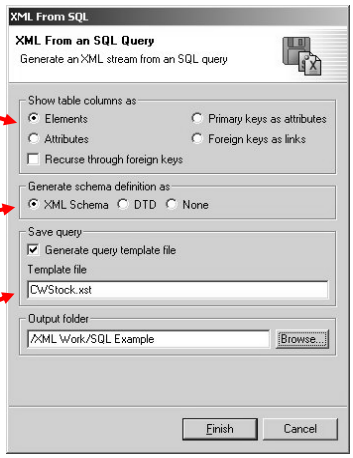


XML and SQL Query Wizard

In the resulting XML file each column in the database table will be stored as either a separate element or as an attribute (with one element per row)

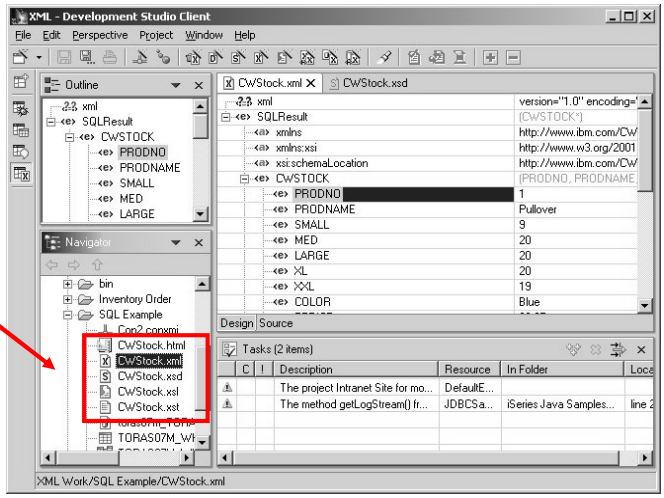
Optionally generate a DTD or XML Schema for that describes the results of the query

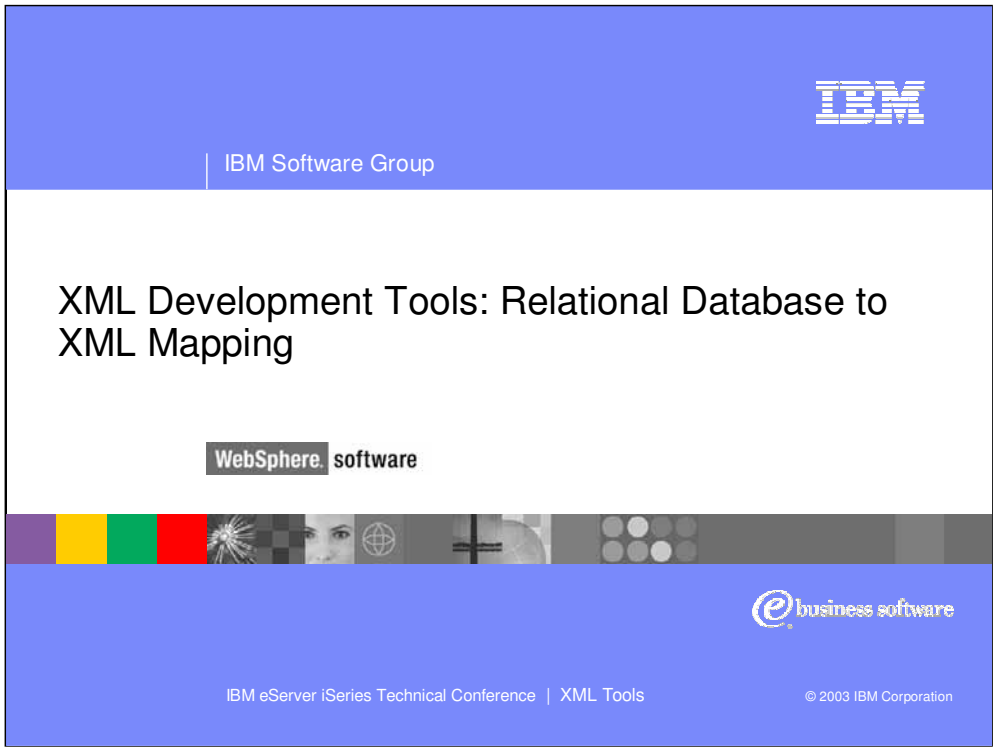
Generate the query template file if you will be rerunning the query at runtime in your Java application



Result

- HTML and XML files with results of running the SQL query
- XML Schema file which describes format of results
- XSL file for transforming XML result to HTML
- XST query template file for executing the query at runtime

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XML Development Tools: Relational Database to XML Mapping
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Relational DB to XML Mapping

- Map XML data to a relational data
  - And relational data to XML data
- Generate a Document Access Definition (DAD) file
  - Use DAD file with DB2 XML Extender to
    - Retrieve relational data into XML files
    - Store XML files to a relational database
  - Also generates a test harness
- How is this different from XML-SQL Wizard?
  - More flexible
  - More work
    - Mappings must be specified in the mapping editor
  - Must be used in conjunction with DB2 XML Extenders

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XML Development Tools: Summary

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Summary

- Lots of great XML Tools
  - XML, DTD, XML Schema and XSLT wizards and editors
  - Generate JavaBeans to easily read, write and create XML documents in Java
  - Tools for creating XML documents from and writing XML documents to relational databases
- Plus, as an integrated tool in the Workbench the XML Tooling inherits:
  - Searching
  - Team development (CVS, Rational ClearCase, iSeries SCM vendors)
  - Integration with other tooling
    - Java development tools
    - Web development tools
    - WebSphere test environment
    - iSeries development tools
  - Integrated, online help
  - Easy to use import and export wizards


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XML Development Tools: Additional Resources
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XML and the iSeries

- How do I access XML on the iSeries
- XML Toolkit for iSeries
  - licensed program 5733-XT1
  - Contains two XML parsers
    - XML4C 4.0
      - Use with C++
    - XML4PR 4.0 (PR -> Procedure Languages)
      - Use with ILE C, ILE RPG and ILE COBOL
- XML Parser for Java
  - Shipped as part of OS/400
    - /QIBM/ProdData/Os400/xml/lib
    - Includes Xerces parser and Xalan processor

Lots of Information on the Web

- w3c.org
  - XML Standards
- ibm.com/developer/XML
  - Links to online articles
- xml.org
  - Links to online articles
- xml.apache.org
  - XML Xerces parser
  - XSLT Xalan processor
- xfront.com
  - Tutorial on XML Schema

Reference

XML Syntax

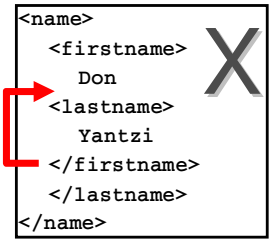
- Elements (tags)
  - **<tagName>data</tagName>**
  - Main building blocks of an XML document
  - Data goes between the start and end tags
  - All start tags must have an end tag
  - Elements can be nested
    - But they must be properly nested
  - Empty element

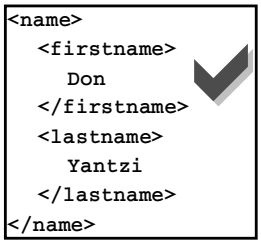
    <tagName></tagName>

    or

    <tagName/>
- Comments

  <!-- This is a comment -->
  - Can appear almost anywhere in an XML document





Some of the basic rules of XML

XML Syntax - 2

- Attributes
  - **<tagName attribute="value" attribute2="value2">**
  - Specified in the start tag of an element
  - Value must be in double quotes
- Processing Instructions
  - **<?target ... ?>**
  - Allows you to embed processing instructions for parsers, external software
  - All XML files begin with an optional XML declaration PI
  - <?xml version="1.0"?>

The syntax of attributes and comments. All data in XML is assumed to be parsed character data. This means that it cannot contain any markup or else the XML parser will try to intrepret the markup and likely cause the XML validation to fail. If you need to include markup or other special characters in your XML documents you can use a CDATA section which is not paresed by the XML parsers. It is important to know what the terms are, not so much the specific syntax because the tools can help with that!

Document Type Definition - Declaring an element

- <!ELEMENT elementName content-model>
  - Content model determines what the element can contain
  - Allowable values:
    - EMPTY
      - Element cannot contain anything, but may still have attributes
    - #PCDATA
      - Element can contain only character data
    - Element content
      - Element can contain only elements
      - Specified by listing all possible children elements and their allowed multiplicity (* zero or more, + one or more, ? zero or one)
    - Mixed content
      - Element can contains both #PCDATA and element content
    - Any
      - Essentially mixed content with no restrictions on the elements

This slide shows the DTD syntax for declaring an element. The elementName is simply the name of the tag that will be used in the corresponding XML documents.

For each element you specify the what the element can contain (between the start and end tags). This is known as the content model as the possible values are listed on this slide.

Document Type Definition – Declaring an attribute

- <!ATTLIST elementName attributeName type default>
- Type values
  - CDATA - Character data used for attribute
  - Enumeration - All allowed values are explicitly enumerated
- Defaults
  - #REQUIRED - A value for this attribute must be provided
  - #IMPLIED - Value is optional, there is no default if no value is specified
  - *Value* - Value is optional, if no value is specified in element then *value* is the default
  - #FIXED value - Attribute value must be *value*, attribute does not have to be explicitly specified in the XML element

This slide shows the syntax for declaring an attribute. The delcaration includes the element name the attribute is associate with and the attributes name.

You also specify a type for an attribute (character or an enumeration) as well as its default value. DTDs really only support character data types. This is one of the reasons that XML Schema is a better alternative.

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XML Development Tools: XML Security

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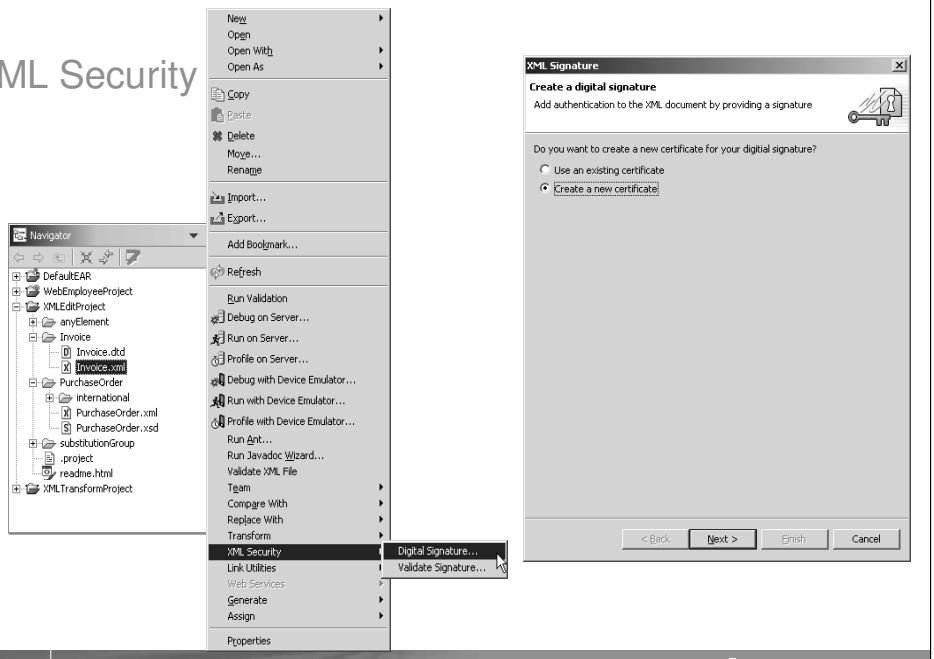
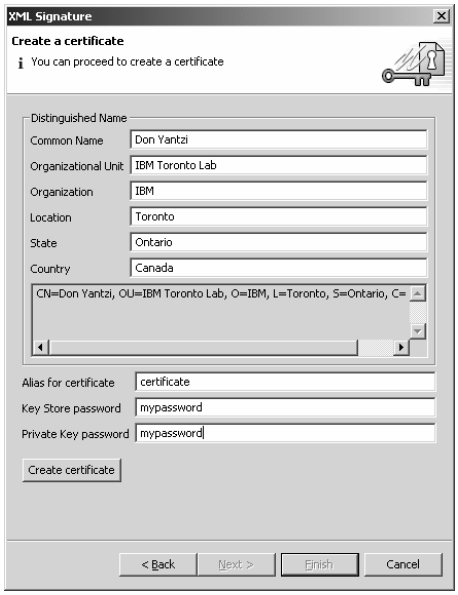
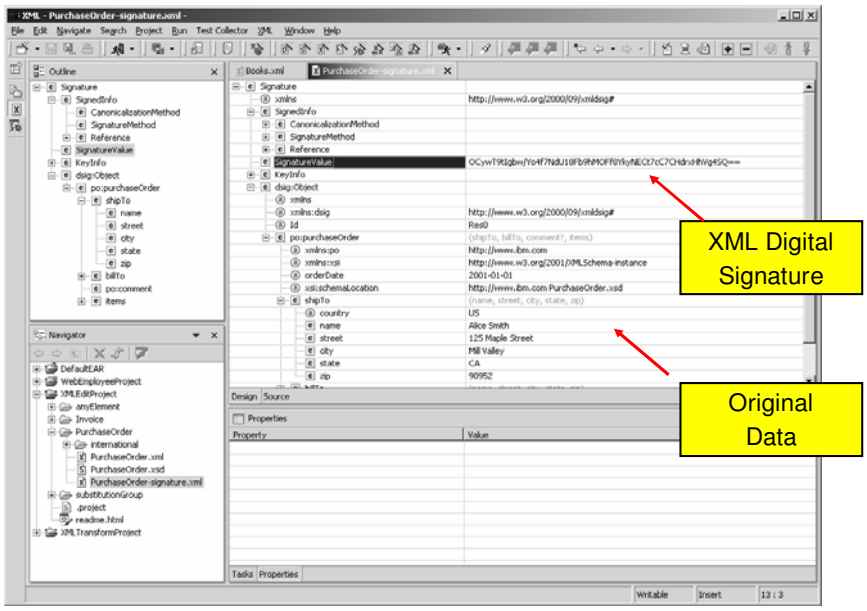
XML Security

- WDSc includes tools for creating and verifying XML digital signatures
  - Digital signature ensures contents of a document are not tampered with
  - Sender: Data and tags in a document are used to create a signature, signature is then encrypted using an encryption key
    - Encryption key is contained in a certificate
  - Receiver: Computes same signature using received data and tags, also decrypts signature contained in xml document and compares the two
    - If they match then document was not tampered with
- Related information:
  - http://www.w3.org/TR/2002/REC-xmldsig-core-20020212/

XML Security







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