Table of Contents (Detailed)

Chapter 1

.NET Framework XML Overview

.NET Framework XML Overview

Objectives

After completing this unit you will be able to:

- **Describe the role of parsing in XML applications.**
- **Identify the main parsing APIs in .NET, and describe the major differences between them.**
- **Describe the major .NET Framework XML classes.**
- **Describe XML serialization and its role throughout the Framework.**
- **Discuss the close relationship between XML and ADO.NET.**
- **Describe XPath and XSLT and the .NET Framework support for these XML technologies.**
- **Explain the use of Language Integrated Query (LINQ) in working with XML data sources.**

XML

- **The *eXtensible Markup Language*, or *XML*, has become a very popular choice for a wide array of software applications:**
  - Traditional web applications enhanced with XML as an HTML transformation source
  - XML as a portable format for data exchange and archiving
  - Business-to-business messaging and Web Services
  - Many more
- **It is surprising when learning the language how much can be accomplished using XML and related standards and generic, pre-built tools, without any traditional application code.**
  - **XML Stylesheet Language for Transformations**, or **XSLT**, enables moderately sophisticated document transformation.
  - Modern web browsers can present XML documents to users with the aid of XSLT, **XSL**, or **Cascading Style Sheets** (**CSS**), even including hyperlinks with the help of **XLink**.
  - Detailed document structure and content validation can be effected using **XML Schema** and a validating parser.

Parsing XML

- **At some point, however, the information in XML documents must be available to application code.**
- **At its most basic, the process by which an application reads the information in an XML document is known as *parsing* the document.**
  - Clearly, the literal meaning of the term refers to the gritty work of reading the document as a stream of characters, and interpreting that stream according to XML grammar.
  - Stated another way, the parsing task might be seen as that of abstracting the document content – often called its **information set** or **infoset** – from its lexical representation in XML proper.
  - This information set can then be read by application code, using any number of possible models.
  - Document validation can also be performed as part of parsing.
- **All these jobs are quite complex, but, thanks to the design of XML, also generic.**
- **Thus individual business applications do not have to write their own parsing code, instead leveraging prebuilt packages that offer APIs to their parsing capabilities.**

Using XML in .NET Applications

- **Microsoft is a big proponent of XML and is a major participant in the W3C.**
- **The .NET Framework has many areas which are enabled for XML processing.**
  - Database queries can be returned in an XML format with XML Schema definitions.
  - Many configuration files in .NET projects are stored in XML format.
  - Web Services uses the XML based SOAP protocol to remotely call objects on a server.
  - The Universal Description, Discovery, and Integration (UDDI) service uses XML to request and return data to clients.
- **XML support is built into the .NET Framework**
- **The many different types of .NET applications utilize services provided in the Framework.**
  - The XML services we are going to look at include .NET classes that interact with the CLR.

The Core .NET XML Namespaces

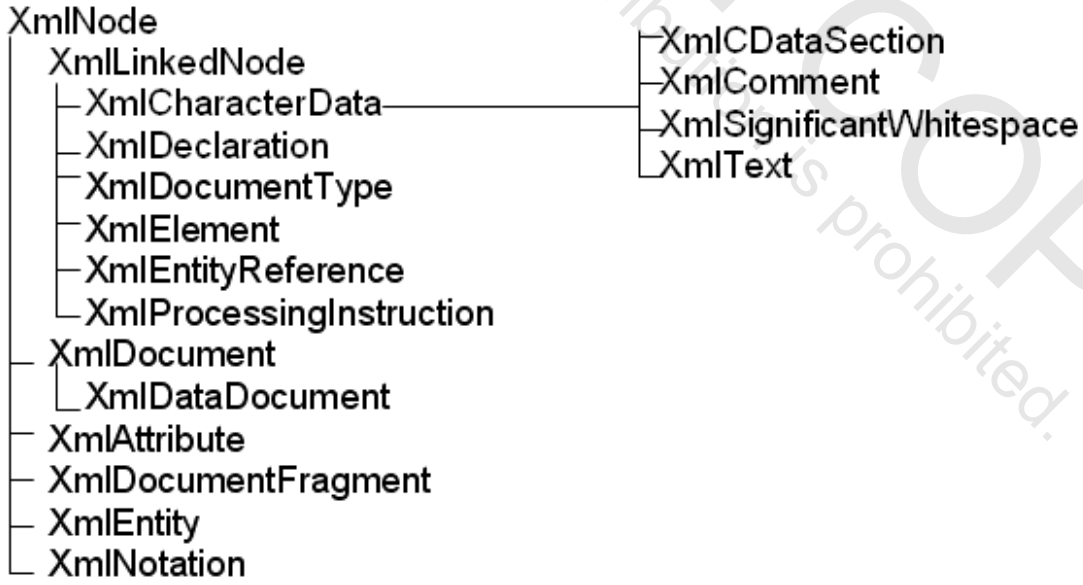
- **The *System.Xml* namespace and its subsidiary namespaces encapsulate the XML functionality in the .NET Framework.**
  - They contain the classes that parse, validate, traverse, and create XML streams.
  - The namespace classes support the following W3C XML standards.

XML 1.0 and XML namespaces	XML schemas
XPath	XSLT
DOM level 1& 2 core	SOAP (object serialization)

- **The *System.Xml* namespace contains the essential and major classes for reading and writing.**
- **The *System.Xml* namespace contains five subsidiary namespaces.**
  - **System.Xml.Schema** –XML classes that provide support for XML Schemas definition language (XSD) schemas.
  - **System.Xml.Serialization** – classes that are used to serialize objects into XML streams.
  - **System.Xml.XPath** – contains the XPath parser and evaluation engine for querying XML data streams.
  - **System.Xml.Xsl** – these classes support the Extensible Stylesheet Transformation (XSLT).
  - **System.Xml.Linq** – classes supporting LINQ to XML

The .NET XML Classes

- **The parent class for the nodes found in an XML data stream is called *XmlNode*.**
- **Depending upon the specific type of node the *XmlNode* class has six derived classes. They are:**
  - System.Xml.XmlLinkedNode
  - System.Xml.XmlAttribute
  - System.Xml.XmlDocument
  - System.Xml.XmlDocumentFragment
  - System.Xml.XmlEntity
  - System.Xml.XmlNotation
- **Each of the derived classes contains the properties and methods that are suitable for that type of node.**



.NET XML Classes and Interfaces

- **In addition to specifying class hierarchy, the classes have three interfaces in common:**
  - **ICloneable** – Xml nodes can be copied to create a new instance.
  - **IEnumerable** – Xml nodes support the **foreach** loop for C#.
  - **IXPathNavigable** – gives the ability to retrieve data from the node using XPath queries.
  - We will use all of these when we start coding.
- **Parsers in the *System.Xml* namespace are found in several classes.**
  - **XmlReader** — this class is a fast non-cached forward-only parser.
  - **XmlReaderSettings** — this class can specify features for an XmlReader object, including validating an XML input using DTDs or W3C's XML Schema definition language (XSD).
  - **XmlWriter** — this class provides the methods to assist you in writing syntactically correct XML. It can write to a file, stream, console, and other output devices. Options can be specified using an **XmlWriterSettings** object.
  - **XmlDocument** — this class implements the W3C Core Document Object Model Level 1 and Level 2. It stores the XML tree in memory and allows you traverse and modify the nodes.

Parsing Techniques

- **There are two traditional methods for parsing XML streams, and each has advantages and disadvantages.**
  - The Document Object Model (DOM).
  - The Simple API for XML (SAX). This API is **not** supported by .NET and will not be discussed further.
- **The Document Object Model has the following characteristics:**
  - The DOM is a W3C standard caching parser and is widely adopted in many programming environments.
  - Good if you need to move forward and backward in the stream and if you need to modify the node values.
  - Bad choice if you're forward scanning only and not modifying the document.
  - The DOM keeps the entire parsed tree in-memory thereby consuming computer resources.

.NET Parsing Techniques

- **.NET provides three different techniques for parsing:**
  - XML readers and writers
  - XML document editing using the DOM
  - XML document editing using **XPathNavigator**
- **XML readers provide a more effective read-only, non-cached, forward-only parser.**
  - This pull-model parser allows the application to control parser by specifying which nodes are of interest.
  - Saves processing time because only requested nodes are sent to the application.
  - **XmlWriter** supports generating a stream of XML content.
- **The *XmlDocument* class implements DOM Level 2 functionality.**
- ***XPathNavigator* provides an editable, cursor-style API for reading and editing XML documents.**
  - In .NET 1.1, this class was read-only, but write capability is now available with .NET 2.0 and above.
  - This model is typically more useable than the DOM approach.

SimpleXML Programming Example

- **The example program *SimpleXML* in the *Chap01* folder illustrates a number of features of XML programming using .NET.**

```
using System;
using System.Xml;

namespace SimpleXML
{
   class Program
   {
      const string xmlPath =
         @"..\..\NewCarLot.xml";
      static void Main(string[] args)
      {
         WriteCars();
         ReadCars();
         ParseWithTheDom();
      }
      static void WriteCars()
      {
         ...
      }
      static void ReadCars()
      {
         ...
      }
      static void ParseWithTheDom()
      {
         ...
      }
   }
}
```

  - The constant string **xmlPath** specifies the XML file.

XmlReader Parsing Example

- **The following code example in the *ReadCars()* method shows parsing using the *XmlReader* class.**

```
XmlReader tr = XmlReader.Create(xmlPath);
Console.WriteLine("XmlReader Demo");
Console.WriteLine("============================");
while (tr.Read())
{
   if (tr.NodeType == XmlNodeType.Element)
   {
      Console.Write("Node Name:" + tr.Name);
      Console.WriteLine("  Attribute Count:" +
         tr.AttributeCount.ToString());
   }
}
tr.Close();
```

- **The output of the code is as follows**

```
XmlReader Demo
============================
Node Name:Dealership  Attribute Count:1
Node Name:Car  Attribute Count:0
Node Name:Make  Attribute Count:0
Node Name:Model  Attribute Count:0
Node Name:Year  Attribute Count:0
Node Name:VIN  Attribute Count:0
Node Name:Color  Attribute Count:0
Node Name:Price  Attribute Count:0
```

XmlWriter Example

- **In this example we use *XmlWriter* to create the XML file that we read in earlier code. This code is in the *WriteCars()* method.**

```
XmlWriterSettings settings =
   new XmlWriterSettings();
settings.Indent = true;
XmlWriter tw = XmlWriter.Create(xmlPath, settings);
//Opens the document
tw.WriteStartDocument();
//Write comments
tw.WriteComment("A lot of cars!");
//Write first element
tw.WriteStartElement("Dealership");
tw.WriteAttributeString("name", "Cars R Us");

tw.WriteStartElement("Car");
//Write the Make of the Car element
tw.WriteStartElement("Make");
tw.WriteString("AMC");
tw.WriteEndElement();

//Write one more element
tw.WriteStartElement("Model");
tw.WriteString("Pacer");
tw.WriteEndElement();

//... Shortened for brevity
tw.WriteStartElement("Price");
tw.WriteString("3998.99");
tw.WriteEndElement();

tw.WriteEndElement();     // end of car
tw.WriteEndElement();     // end of dealership
tw.WriteEndDocument();    // end of document
tw.Close();               // close writer
```

XmlWriter Example (Cont'd)

- **This example creates the *NewCarLot.xml* file in the *SimpleXML* directory.**

```
<?xml version="1.0"?>
<!--A lot of cars!-->
<Dealership name="Cars R Us">
  <Car>
    <Make>AMC</Make>
    <Model>Pacer</Model>
    <Year>1977</Year>
    <VIN>CZ7821</VIN>
    <Color>Blue</Color>
    <Price>3998.99</Price>
  </Car>
</Dealership>
```

.NET DOM Parser Features

- **The *XmlReader* and *XmlWriter* classes aren't resource demanding but they lack the ability to move around or modify the XML stream.**
- **The *XmlDocument* class is resource intensive because it stores the parsed XML internally offering you the advantages to navigate, modify, or create the data.**
- **The downside is the resources used on the machine will be proportional to the size of the entire XML stream you've read or are creating.**
- **The DOM is a language-independent W3C specification; Microsoft's *XmlDocument* class implementation has many of the same property and methods (with some extensions).**
- **The *XmlNode* class, like the DOM Node interface, specifies the basic functionality for the different types of nodes in an XML stream.**

XmlDocument Example

- **The following code, found in the method *ParseWithTheDOM()*, reads the XML file created in the previous example.**
  - This code uses the DOM parser with the **XmlNode** class.

```
XmlDocument doc =  new XmlDocument();
doc.Load(xmlPath);

XmlNode root = doc.DocumentElement;
XmlNodeList list = root.SelectNodes("//*");
foreach ( XmlNode elem in list )
{
   Console.WriteLine( elem.Name);
}
```

- **The output is:**

```
Dealership
Car
Make
Model
Year
VIN
Color
Price
```

Other XML Features in .NET

- **XML serialization converts the state of an object into an XML byte stream suitable for persisting or transporting.**
  - .NET supports XML serialization in the namespace **System.Xml.XmlSerialization**.
- **The foundation of XML serialization is XML Schema, which is a W3C Recommendation.**
  - XML Schema is a complete type system.
  - .NET supports reading and writing XML Schema in the namespace **System.Xml.Schema**.
- **ADO.NET is tightly coupled to XML.**
  - You can exchange both data and schema information between XML and DataSets.
  - Support is provided in the **System.Data** namespace.
  - Classes such as **DataSet** have explicit methods for working with XML data.
- **XPath provides a mechanism to query for content in an XML document.**
  - .NET support is provided in **System.Xml.XPath**.
- **XSLT enables transformation of XML into text, HTML or other XML.**
  - .NET support is provided in **System.Xml.Xsl**.

LINQ to XML

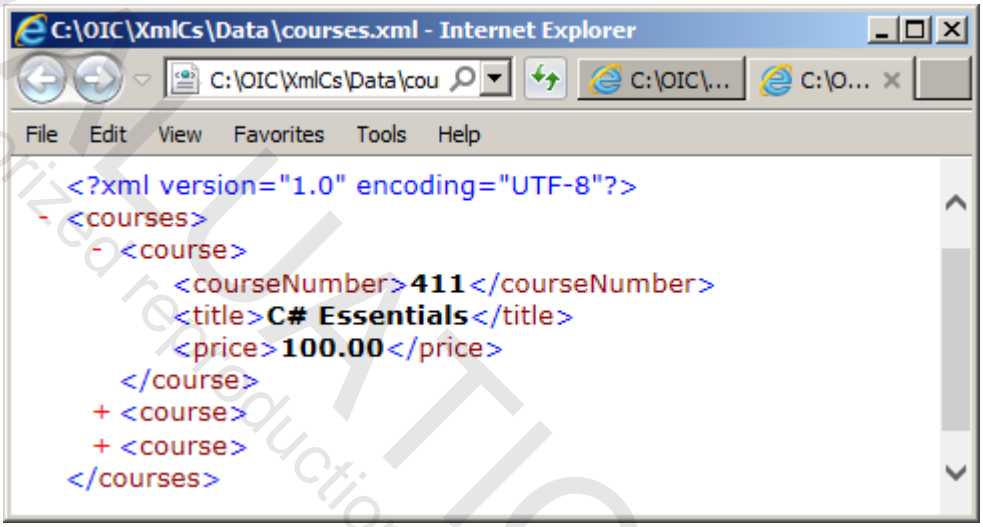
- **Language-Integrated Query (LINQ) provides an intuitive syntax for querying a variety of data sources using C# and Visual Basic.**
- **The query syntax is part of the programming language, giving the advantages of strong typing and tool support such as IntelliSense in Visual Studio.**
- **LINQ provides a consistent API that can be used with many different kinds of data, including .NET collections, SQL Server databases and XML documents.**
- **LINQ to XML is a programming model for manipulating XML documents using .NET languages.**
- **It is similar in goals to the Document Object Model (DOM) but lighter weight and easier to work with.**
  - With respect to query capability, the programming model is consistent with the model for other LINQ data sources.
- **The namespace is *System.Xml.Linq*.**
  - Important classes include **XDocument**, **XElement** and **XAttribute**.

XML and the Web

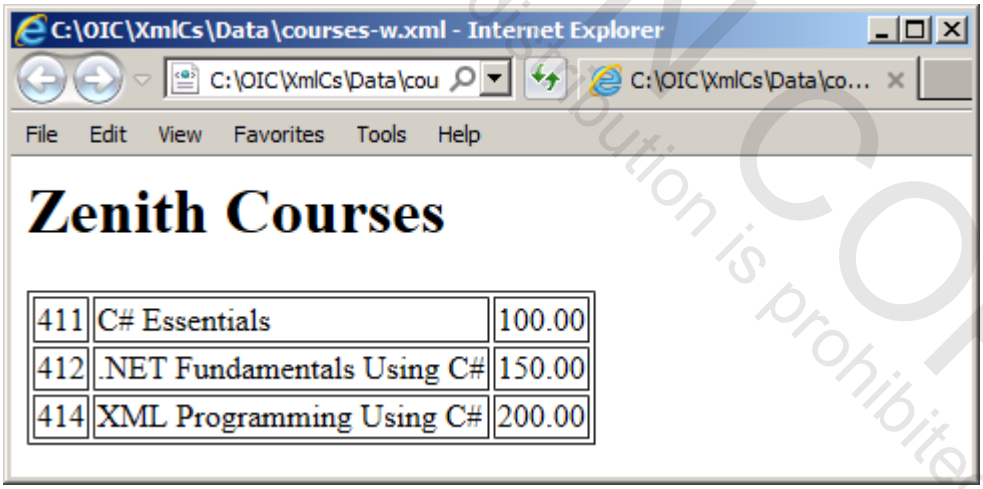
- **A major motivation for the development of XML was to support Web applications.**
- **Both XML and HTML are based on SGML, which was quite complex.**
  - HTML is quite simple, but is only concerned with *presentation*. Also, although similar to XML, it does not conform to precise XML syntax.
  - XML is also simple and is concerned with the information content of a document without regard to presentation.
  - XHTML is a markup language understood by modern browsers that is HTML with precise XML syntax.
- **A robust way to manage complex information in a Web site is through XML, with transformation to HTML as needed for presentation.**
  - XSLT is an XML technology that supports transformation of XML to HTML and other formats through a *stylesheet*.
  - There are many other ways to integrate XML with a Web site, including its use in data management, configuration, and Web services.

Internet Explorer and XML

- **The basic Microsoft Web tool is the Internet Explorer Web browser.**
  - It will display well-formed XML in a collapsible tree view.



  - Through a style sheet it can format XML.



  - The example files are **courses.xml** and **courses-w.xml** in the **Data** folder.

Summary

- **XML parsing is the cornerstone of .NET Framework application development. Many higher-level application capabilities can make use of XML enabled features:**
  - Cached/Non-cached, push model, syntax/validating type parsers available
  - XML object serialization
  - XML messaging, for instance using SOAP
- **Also, there are a number of XML-related specifications that define their own "languages," or really their own XML vocabularies – examples are XSLT and XML Schema.**
  - Each of these allows some information to be defined in an XML document: an XSLT style sheet or transform, an XML Schema.
  - Because these each leverage basic XML, the style sheets and schema can themselves be parsed and manipulated, just like any other XML document.
- **XML is tightly integrated with ADO.NET.**
- **Language-Integrated Query (LINQ) provides an intuitive syntax for querying a variety of data sources, including XML documents, from a programming language.**

Chapter 6

Manipulating XML Information with the DOM

Manipulating XML Information with the DOM

Objectives

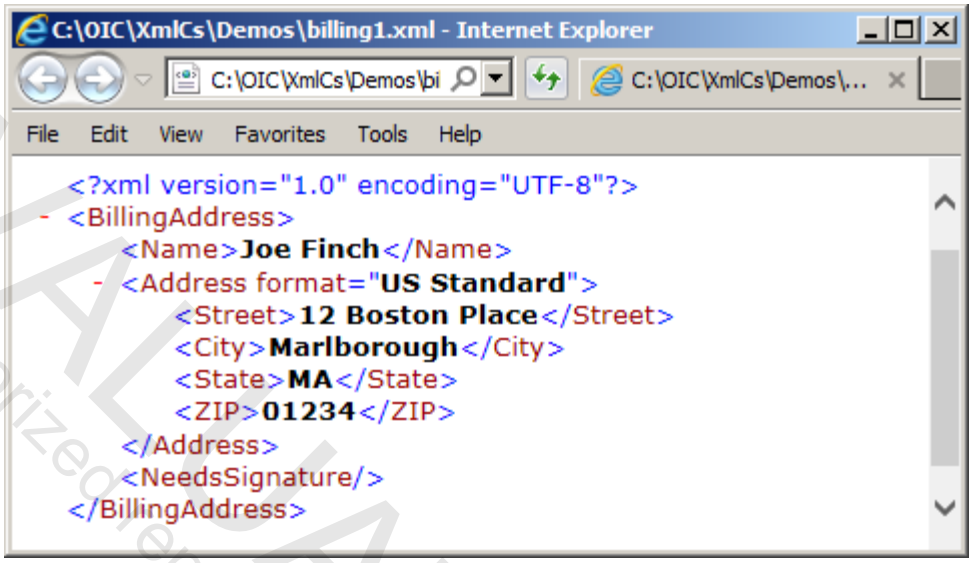
After completing this unit you will be able to:

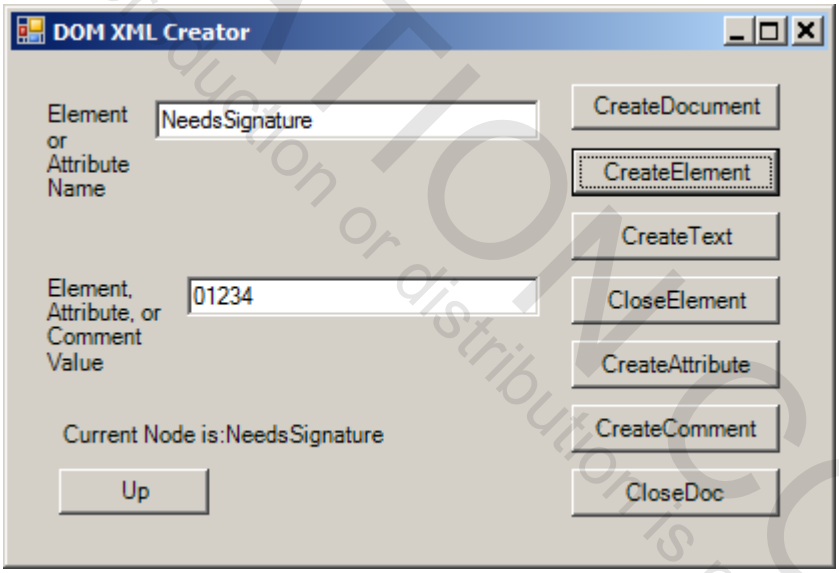
- **Build entirely new documents using the DOM, and populate them with desired information to create a new XML document.**
- **Add, remove, and replace nodes as children of other nodes in a DOM tree.**
- **Clone nodes and subtrees for processing or document modification.**
- **Change element and attribute values.**

Modifying Documents

- **In the previous chapter we focused exclusively on using the *XmlDocument* as a parser.**
- **The *XmlDocument* is actually a read/write class.**
  - Nodes of all types have both accessors and mutators, and can be modified, added and removed as children of other nodes.
  - In some cases content can be modified; some node types have certain immutable properties that can only be "changed" by removing the original node with a partially-modified copy.
  - To create a new XML document, simply create an instance of **XmlDocument** and start adding element, attribute or other node(s). The DOM tree will be maintained in memory and can be written to a file using the **save** method.
- **In this chapter we'll learn how to use the DOM classes to modify existing XML documents, and to create new ones.**

Build A DOM Tree – Demo



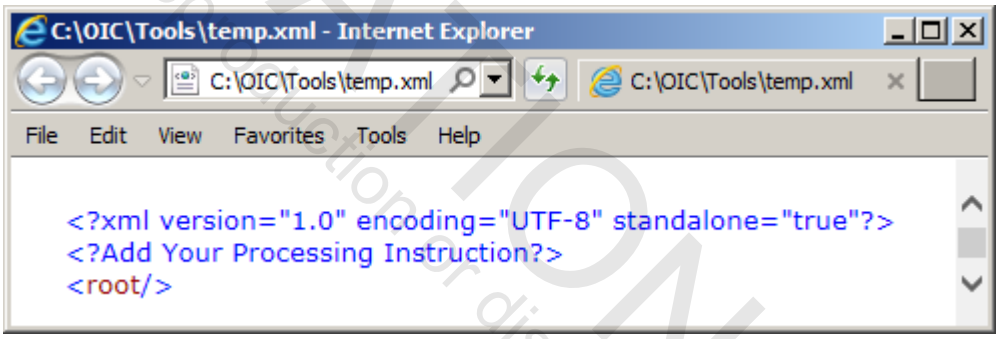


Build A DOM Tree – Demo

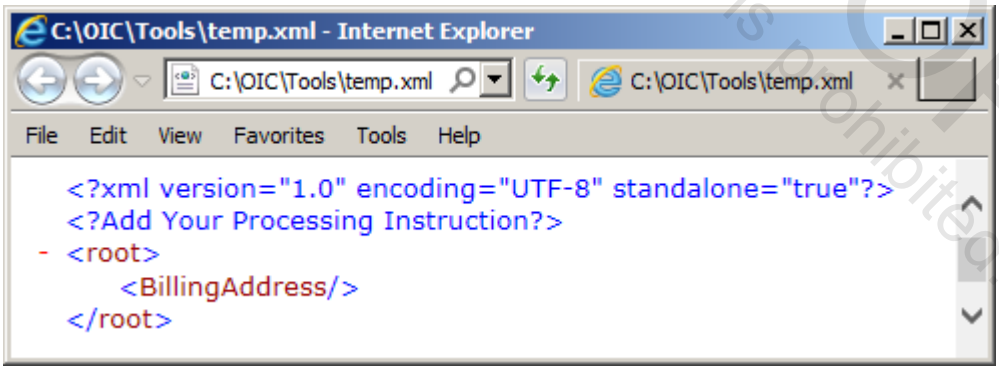
- **In this demo you will create and navigate a DOM tree. The source code is in the *DOMWriterDemo* folder in the chapter directory.**

1. Locate the executable file **DOMWriterDemo.exe** in the folder **\OIC\Tools**. Run this program, which will create a file **temp.xml**, which you can view with Internet Explorer.

2. Once the program starts, press the **CreateDocument** button and you should see the following XML in Internet Explorer. Refresh after each operation. Current node is "root."

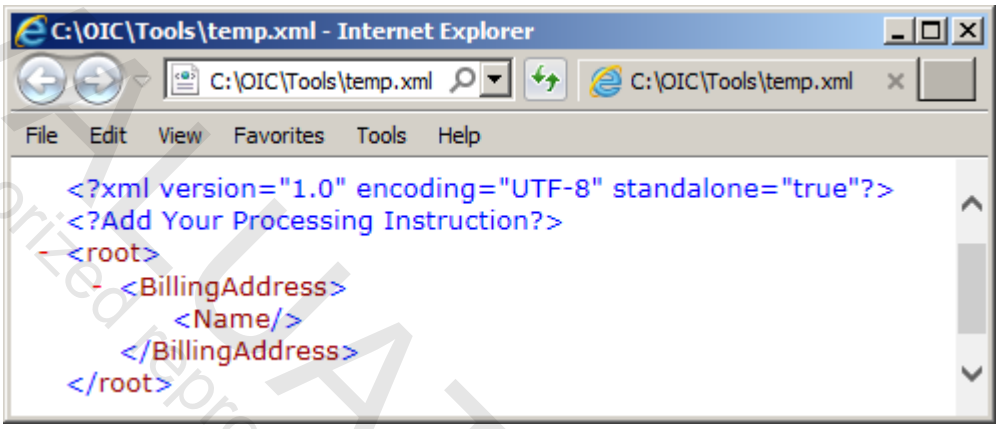


3. Now type in "BillingAddress" in the **Element or Attribute Name** text box and then press the **CreateElement** button. Notice your Current Node is now "BillingAddress."



Build A DOM Tree – Demo

4. Now type in “Name” in the **Element or Attribute Name** text box and then press the **CreateElement** button. Your Current Node is now “Name.”



5. Next we create a **Text** node. Type in your name into the **Element, Attribute, or Comment Value** text box and then press the **CreateText** button. The current node is still “Name” so press the **CloseElement** button, and the current node moves up the tree to “BillingAddress.”

6. Next add the “Address” node and the “format” attribute. In adding an attribute you should specify both the name and value.

7. Add the rest of the nodes to the tree using the buttons. The Current Node will always indicate which element you are going to add a child or attribute to. Closing the element always moves you up one level. You can also press the **Up** button to move up one level.

8. Experiment as you like.

Modifying Documents

- **The *XmlDocument* class is key to this capability, since it has all the factory methods for various node types (the important ones are listed as follows) :**

```
XmlElement CreateElement(string name);

XmlAttribute CreateAttribute(string name);

XmlText CreateTextNode(string text);

XmlComment CreateComment(string data);

void Save(destination);
    // string, Stream, TextWriter, XmlWriter
```

The XmlNode Class – Modifications

- **Here is yet another slice of the larger *XmlNode* class, this one including the main mutators:**

```
XmlNode InsertAfter(XmlNode newChild,
   XmlNode refChild);

XmlNode InsertBefore(XmlNode newChild,
   XmlNode refChild);

XmlNode ReplaceChild(XmlNode newChild,
   XmlNode oldChild);

XmlNode RemoveChild(XmlNode oldChild);

XmlNode AppendChild(XmlNode newChild);

XmlNode CloneNode(bool deep);

XmlDocument OwnerDocument {get;}

string Value {get; set;}

string OuterXml {get;}

string InnerXml {get; set;}
```

  - Much of this interface is concerned with managing the child list: insert, append, remove, and replace operations.
  - Note also that from any node one can get the owning document. This is important when creating new content.
  - The **Xml** properties will give you a string that represents the XML content of the node and its subtree.

Legal and Illegal Modifications

- **Obviously, not all combinations and orderings of nodes as parents and children are legal: an attempt to add an element to a comment, for instance, must fail.**
- **The *XmlException* class encapsulates exceptional conditions in DOM programming, many of which have to do with making changes to existing nodes.**
  - But be aware that some exceptions may be fit into another exception class. The code below throws an **InvalidOperationException**.

```
try
{
   XmlDocument doc = new XmlDocument();
   XmlNode commentNode, elementNode;
   commentNode = doc.CreateComment("my comment");
   elementNode = doc.CreateElement("myElement");
   doc.AppendChild(commentNode);
   doc.FirstChild.AppendChild(elementNode);
}
catch (XmlException e)
{
   Console.WriteLine(e.GetType() + " " +
                     e.Message);
}
catch (Exception e)
{
   Console.WriteLine(e.GetType() + " " +
                     e.Message);
}
```

  - See **IllegalDOM** in the chapter directory.

Managing Children

- **Use of the *XmlNode* class to add or remove child elements is simple enough.**
- **Additions can be managed using either *AppendChild()*, *InsertAfter()*, or *InsertBefore()*.**
  - The choice between them is really a question of convenience in a particular algorithm.
  - Each will assure uniqueness in the child list by first removing the node if it is already in the list somewhere.
- **To simply remove a child, call *RemoveChild()*.**
- **The *ReplaceChild()* method has the effect of an *InsertBefore()* combined with a *RemoveChild()*.**
  - There is a subtle difference having to do with error recovery.
  - **ReplaceChild()** is typically implemented to assure atomicity and consistency of the operation: if the new child node is rejected for any reason, the entire replacement will fail.
  - Sometimes this is the desired behavior, and sometimes not. Choose your approach to node replacement carefully in case of unexpected failure: should the existing node be removed regardless, or should it stay if the new node is unacceptable?

Cloning

- **The *XmlNode* class also provides the *CloneNode()* method.**
  - The DOM recommendation calls it a “generic copy constructor,” imprecisely echoing C++ terminology.
- **The method returns a new node of the same type and content as the source on which the method was called.**
- **The lone parameter, *deep*, affects the resulting node by directing the clone operation to make either a *shallow* or *deep copy*.**
  - If this parameter is true, the node and all its descendant nodes will be cloned into a new subtree.
  - If it is false, only the target node will be cloned; it will have no children.
  - Shallow-copied element clones will have the attributes of the source element, but none of the true child nodes.
- **Especially when used to make deep copies, the *CloneNode()* method can save quite a lot of code!**

Modifying Elements

- **There are several possible changes to an element.**
  - The tag name is immutable; to change it you must replace the element with a new one.
  - The character content of an element is captured in a separate text node as a child of the element. Thus, changing this means setting a new value on the child element.
  - The **XmlCharacterData** class includes a number of mutators that allow the text to be modified:

```
string Data {get; set;}

void AppendData(string strData);

void InsertData(int offset, string strData);

void DeleteData(int offset, int count);

void ReplaceData(int offset, int count,
   string strData);
```

  - Alternatively, a new text node can be emplaced or replaced.

Splitting Text and Normalizing

- **The *XmlText* class has the method *SplitText()*, which breaks the node in two at a given offset.**
  - The target of the call retains the text information up to the offset.
  - A new **XmlText** node is created which holds the information after the offset, and this node is returned by the method.
  - The new node is automatically inserted as a child of the target node's parent, right after the target node in the child list.
- **Separately, the *XmlNode* class offers the *Normalize()* method.**
  - This affects the entire subtree.
  - It rearranges text nodes as necessary to assure that there are no empty text nodes and no consecutive text nodes.
  - Most parsers will create a document in normal form, but after modifications, especially using **SplitText()**, it is possible that normalization will be necessary to support further processing by certain algorithms.
  - Once normal form is broken, text-processing algorithms must take care to accumulate text information from adjacent text nodes. If an applications need to gather contiguous character data to get the whole picture of an element's content it should call this method.

Modifying Attributes

- **Many of the *XmlElement* class mutators concern management of the element's attributes.**

```
void SetAttribute(string name, string value);

void RemoveAttribute(string name);

XmlAttribute SetAttributeNode(
   XmlAttribute newAttr);

XmlAttribute RemoveAttributeNode(
   XmlAttribute oldAttr);
```

  - **SetAttribute()** will assure that the desired attribute has the given value. If such an attribute already exists, the value is overwritten, and if not it is created.
  - **RemoveAttribute()** acts pretty much as advertised.
  - Note that one can choose to work directly with attribute values or to derive, create, manipulate, and use **XmlAttribute**-type nodes to capture the appropriate information.
  - **XmlAttribute** objects can be unwieldy by comparison, but have some advantages as separate node objects, such as being collectable and cloneable.

Lab 6

Shipping Information for Zenith Courseware

In this lab you will continue the **PrintShipDOM** program from the previous chapter to create an XML file that specifies shipping and handling charges for each destination. Very simple algorithms are used for determining shipping and handling costs. You are supplied a file **Ship.cs** that encapsulates these algorithms.

Detailed instructions are contained in the Lab 6 write-up in the Lab Manual.

Suggested time: 60 minutes

Summary

- **We've seen the DOM from both sides, now.**
  - The DOM offers quite a lot as a parsing technology.
  - Now we've learned how to use it to modify existing documents, and even to create new documents from scratch.
- **With the DOM API, application can be written to read and write XML documents of any complexity.**
- **As of DOM Level 2, and looking only at the Core recommendation, we can see a few shortcomings.**
- **There is no support yet for XML Schema in the DOM specification.**
  - In many ways DOM parsing is independent of type information, by design.
  - However, it would be very helpful to capture metadata for application use, and certainly for the parser to validate against an associated schema before returning the DOM tree.
  - Microsoft's DOM implementation does provide extensions that support XML Schema and DTD.