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# A study of .net framework, SML wev services and supply chain management

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## ABSTRACT

*The primary purpose of this paper is to explore Microsoft's platform - .Net, Web services, and XML for supply chain management. The following topics are studied: 1) The development of scripting languages for a supply chain management application; 2) The use of XML to enhance compatibility of the scripted applications; and 3) The implementation issues of Microsoft .Net platform. To answer the research questions, a technique similar to content analysis is used in this study. Seventeen case studies regarding the implementation of the .Net Web Services are examined.*

## INTRODUCTION

Today, millions of people utilize the Internet for accessing information and e-business. Nowhere have the Internet and communications technology had a greater impact than upon computer programming paradigm. In the last few years, we have seen the flourishing of Internet languages such as HTML and Java. Traditional computer languages, such as COBOL and BASIC, which cannot support Internet applications, will become less important in business programming.

While Internet programming will continue to be one of the mainstreams of software engineering, there are two noticeable developments. The first one is the development of server side's programming, especially the interface between the Web pages and the database. When a customer places a purchase order, how can the order data be smoothly and securely sent to the server? Although HTML provides a standard tool for the Internet programming, it does not actually cover the server side's programming. Today there are several server-side programming

tools such as CGI, ASP, and Perl but they have certain limitations. There is no doubt that we will see better, faster, and safer software in the market. The second development is transferring business applications written in traditional language into ones written for Web applications. Many businesses have application programs which they want to convert to online applications.

To embrace this new development, Microsoft has promoted its recent product strategy - using the .Net Framework and XML Web Services for Internet development. The .NET Framework strives to simplify application development in the widely dispersed environment of the Internet. The .NET Framework includes two major components: Common Language Runtime (CLR) and the .NET Framework Class Library (FCL). FCL provides a collection of classes and tools to aid in the development and consumption of XML Web services applications. The .NET Framework is built on SOAP, XML, and WSDL to promote interoperability with non-Microsoft solutions (Microsoft, 2002g).

The primary purpose of this paper is to explore Microsoft's newest platform – the .Net platform and XML Web services. The secondary purpose of this paper is to discuss how the .Net platform and XML Web services can improve business applications in Supply Chain Management (SCM). This study will provide information related to the following research questions:

1. Which components are the most popular to use with .Net applications in a Web environment?
2. Can the .Net Framework be applied to the supply chain management applications in business?
3. Which implementation approach is the most appropriate to install the Microsoft .Net Framework?

In order to understand the relationship between .Net platform/XML and SCM, the next section provides a background of information systems for supply chain management.

## **INFORMATION SYSTEMS FOR SUPPLY CHAIN MANAGEMENT**

Supply chain management has become an important topic in the last decade due to globalization. Supply chain management is defined as, “a collection of physical entities such as manufacturing plants, distribution centers, conveyances, retail outlets, people and information, which are linked through processes such as procurement or logistics, to supply goods and services from source through consumption.” (Laudon & Laudon, 2002). Traditional supply chain management in large companies relies on the Electronic Data Interchange (EDI) to exchange information. EDI has been used for more than two decades and accounts for 80% of the business for large companies. However, there are several drawbacks to EDI. First, the communication cost and maintenance costs are very expensive (Martin et al., 2001). Second, EDI is a complex technology. In the early 1990's, enterprise resources planning (ERP) software packages began to replace EDI. These ERP software packages include SAP R/3, Oracle, and PeopleSoft. Although ERP systems can improve organization coordination and efficiency, they are very difficult to implement and costly to built (Laudon & Laudon, 2002).

The popularity and low cost of Internet transactions have fueled the demand of new information systems for supply chain management. In late 1999, we saw that most ERP software vendors had added the Internet as part of the solution. For example, SAP has added MySAP.com as its Internet component. However, the Internet-based ERP is still very expensive to medium-size companies. World Wide Web Consortium (W3C) created a standard for describing data in a portable format called Extensible Markup Language (XML), which can provide an economical solution for small and medium-size companies (Deitel et al., 2002). Internet programming can eventually establish a “virtual value chain network” for business-to-business (B2B) e-commerce. Several companies have provided products or services based on XML. The first one is the Sun Microsystems’ Java 2 Platform Enterprise Edition (J2EE) and the second one is Microsoft’s Net Framework. In the Microsoft .Net framework, a knowledge-based supply chain management system is made possible by building a powerful search engine using the UDDI (Universal Description, Discovery, and Integration) technology (Tabor, 2002). Table 1 shows the information technology used for supply chain management in a chronological order.

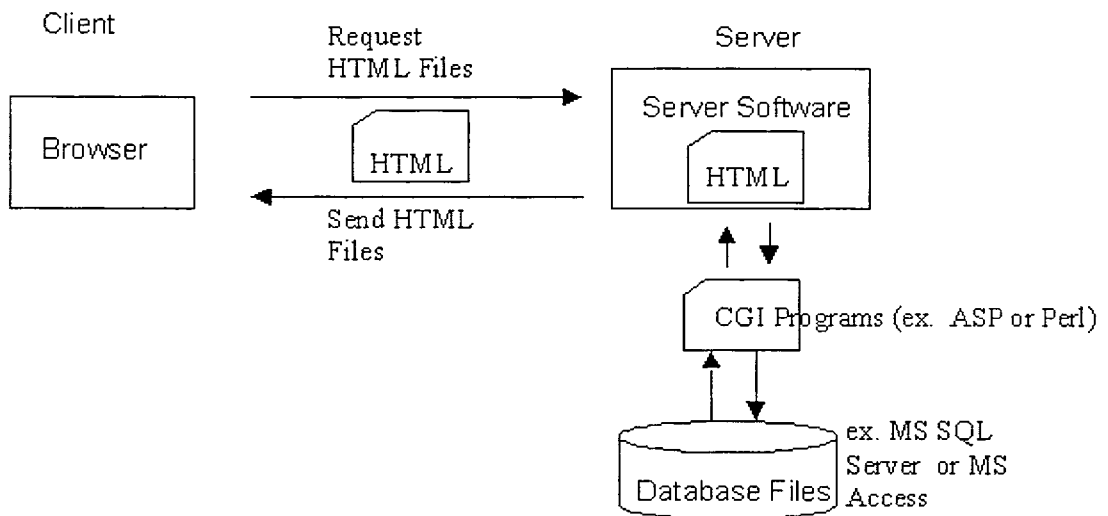
**Table 1. Information Technology for Supply Chain Management**

Time	Information Technology for SCM
1970	Electronic Data Interchange (EDI)
1990	Enterprise Resource Planning (ERP): SAP, Oracle, PeopleSoft.
1995-	Internet-based ERP
1994-	Internet Applications, HTML, Common Gateway Interface (such as Active Serve Page)
1999-	Advanced Server-side Applications, XML, XSL, Sun Microsystems' Java 2 Platform Enterprise Edition (J2EE)
-	Advanced Server-side Applications, Microsoft .Net Framework; UDDI
2002-	Virtual Supply Chain Network, Web-oriented knowledge-based systems

## CURRENT WEB APPLICATIONS AND SCRIPT LANGUAGES

HTML is a universal language for the Internet but it does not actually handle the data processing function. Common Gateway Interface (CGI) script is used as an interface between HTML and the database. CGI can be a program or a set of commands. CGI can be written in different languages. These languages include: the UNIX shell, C/C++, AppleScript, TCL, and Active Server Pages (ASP) (Carey, 2001). ASP is Microsoft's version of CGI in the PC environment. Figure 1 shows how the data are saved in the Web environment.

Figure 1. ASP or CGI



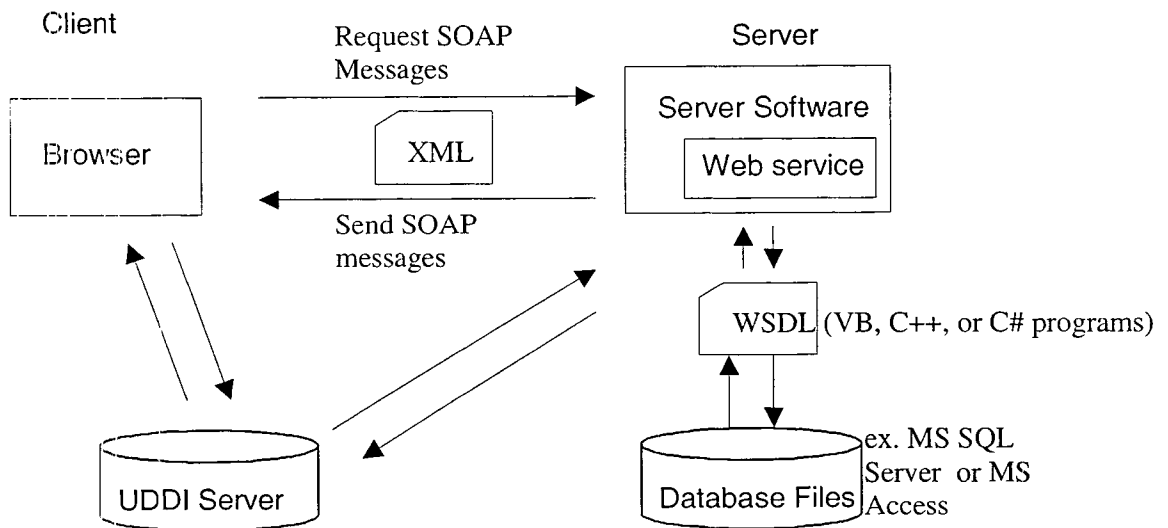
ASP can be tested and run on the Personal Web Pages on Windows 98 and the Internet Information Services (IIS) on Windows NT, 2000, and XP. While ASP applications can be written in VB script and Javascript, Netscape Navigator only recognizes Javascript. One of the advantages of ASP is the ease of use since everyone has grown up with the DOS/Windows environment. However, ASP is primarily designed for a small or medium server. It does not fit into a complex system.

## XML WEB SERVICES AND MICROSOFT VISUAL STUDIO .NET

What are Web services? A Web service is a server-side application stored on one computer that can be accessed on another computer over a network. Web services include a group of

classes and methods and can be called on by Internet clients (Petroutsos, 2002). Under the object-oriented programming logic, a Web service is an object that has changeable properties and a group of methods. Web services are not exclusive to Microsoft (Tabor, 2002). Other companies have also created Web services. Java 2 Platform Enterprise Edition (J2EE) is Sun Microsystems' version of a Web service (Vawter & Roman, 2001). XML Web services, Microsoft's version of this, is built on standards such as SOAP (Simple Object Access Protocol), XML (eXtensible Markup Language), and WSDL (Web Services Description Language) (Microsoft, 2002g). Figure 2 shows the relationship between SOAP messages, XML, and WSDL under the Microsoft .Net framework. XML is used to handle the data interchange among applications on the Web (Martin, et al., 2001). SOAP is a relatively simple protocol which utilizes request and response models. Figure 3 shows a SOAP messages in the XML format in a supply chain management application. Similar to HTML, XML programs use tags to define the format. Unlike HTML, XML can define its own tags. The first line of a typical XML program starts with a header that says "xml version="1.0" (Panko, 2002).

**Figure 2. Microsoft .Net Web Services**



```
<?xml version = "1.0"?>
<order>
  <car id = "783">
    <name>Hyundai</name>
    <customer> Mary Lee </customer>
    <duedate>05/04/2003</duedate>
  </car>
</order>
```

```
<car id = "418">
  <name>Windstar</name>
  <customer> Diana Smith </customer>
  <duedate>05/07/2003</duedate>
</car>
</order>
```

A WSDL program is used to generate XML messages. WSDL is defined as “an XML format for describing network services as a set of endpoints operating on messages containing either document-oriented or procedure-oriented information.” (Christensen et al., 2001) Figure 4 shows a C# version’s WSDL file, order.asmx, which includes a purchase class and a Web method. The Microsoft .Net framework supports several languages: Visual Basic, C++, and C# (sharp). These languages are implemented within Visual Studio .Net. A program written in these languages can be transformed to an XML format.

---

```
<%@ WebService Language="C#" Class="order" %>
```

```
using System;  
using System.Web.Services;
```

```
[WebService()]  
public class purchase : WebService  
{  
    [WebMethod()]  
    public double developerEstimate(int xintHours)  
    {  
        return (xintHours * 3) + 20;  
    }  
}
```

(This program is revised from Tabor, 2002)

#### **Figure 4. Examples of Web Services File in C# (order.asmx)**

---

Using the .Net as the centerpiece of the initiative, Microsoft also created a number of development tools and servers to allow companies to implement Web services. An example of servers is the BizTalk server, which is a Microsoft application server based on .NET Web Services (Panko, 2002). BizTalk includes a repository of standard documents, which defines how industries can exchange information using the same structure (Tabor, 2002).

#### ***The Use of Visual Studio .Net***

Visual Studio .Net is a rapid applications development tool for Web application in the .Net Framework. Without Visual Studio .Net, one can still use a series of DOS commands to execute a program. For example, if one uses C# as the developing language, the manual process includes the following steps:

---

1. Use the editor to create a C# file with an extension of .asmx. For instance, type the content as Figure 4 and save as the file name, "order.asmx".
2. Generate the source file in the DOS command by typing:  
wsdl/language:cs http://localhost/order/order/.asmx?wsdl  
An "order.cs" proxy file will be generated (see Appendix A).
3. Compile the source file, "order.cs", for the proxy server by entering the following commands:  
csc /out:bin\order.dll /target:library  
/reference:system.xml.serialization.dll/ reference:system.Web.services.dll order.cs

A file, "order.dll", will be generated and it will work with an ASP. Net file to become a Web application.

If one uses the Visual Studio .Net to do the same thing, the job is much easier. By using the Integrated Development Environment (IDE), one can create a new project "order". One only needs to type the content of order.asmx, then other files such as order.cs, order.wsdl and order.dll will be created automatically.

## AN EXAMPLE OF .NET FOR SUPPLY CHAIN MANAGEMENT

Tabor (2001, p.15) described an example of a supply chain management system for an auto parts distributor in a .Net environment. In this paper, we provide similar principles to a chemical equipment manufacturer/distributor. According to Lee et al.(2002), the traditional document system supporting the operations of a typical chemical plant is very labor-intensive, time-consuming, and inaccurate. As a result, plant engineers typically spend more than 25% of their time looking for the correct information, such as vendors' process equipment specifications. A chemical equipment distributor sells the chemical equipments and parts to chemical plants. Like other companies, it maintains a group of employees to handle telephone and mail orders. The distributor decides to launch a new Internet Web site using Web services to achieve the following goals:

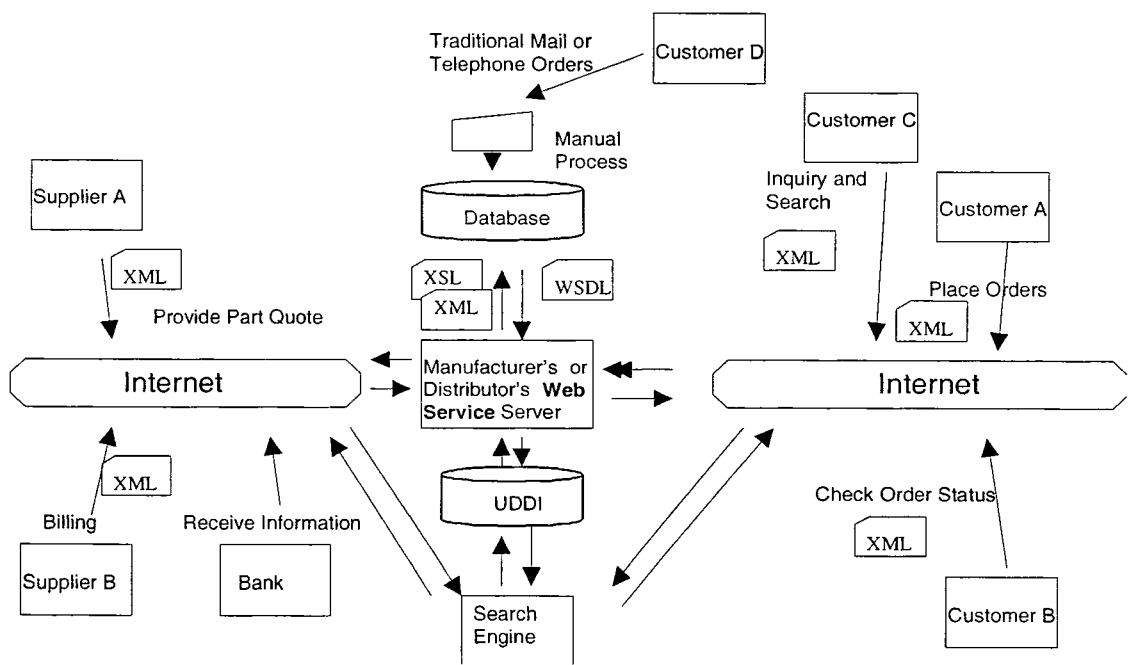
1. Improve operation efficiency. Online ordering can cut down the order lead-time because computer power simplifies the order process.
2. Explore new opportunities and provide better service. The Internet can provide a 24-hour service. Its existing customers can order online and check order status using Web services. Search engineering can be used to help the customer locate the parts.
3. Cost saving. Some employees used to handle telephone calls and order handling processes can be relocated to other departments.
4. Potential contact with consumers (B2C). Normally there is an agreement between the distributors and retailers that distributors cannot sell products directly to consumers. How-



ever, this is not always true. An Internet-based system helps distributors directly contact consumers and eliminates the middle man. Airline companies once relied on travel agents, but today every airline has its own Web site.

The framework of the supply chain management is shown as Figure 5. The central part of this figure is the manufacturer's or the distributor's web service. Through web service, the distributor can put all the order formats and part information in a UDDI database, which supports a search engine. Customers then can use the search engine to find product number and pricing information. Suppliers can also use the same engine to find part information.

**Figure 5. The Supply Chain Management Framework Using .Net**



(This figure is revised from Tabor, 2003)

## RESEARCH METHOD

To achieve the research objectives, a technique similar to content analysis was used in this study. "Content analysis is a research tool used to determine the presence of certain words or concepts within texts or sets of texts. Researchers quantify and analyze the presence, meanings and relationships of such words and concepts, then make inferences about the messages within the texts, the writer(s), the audience, and even the culture and time of which these are a part." (Palmquist, 2002) Texts can be defined broadly as books, articles, advertising, or really any occurrence of communicative language. Content Analysis is used extensively in communications research (Palmquist, 2002). Seventeen case studies posted in the Microsoft Web site regarding the implementation of the .Net Web Services are examined (Microsoft, 2002h).

## RESEACH RESULTS

Among seventeen case studies posted on Microsoft's Web site, most of these companies are fairly large companies but belong in the category of service industries. However, there is no doubt that the same implementation principles can be applied to manufacturing companies. Seven of these companies are actually software consultant companies. The rest of them are companies that utilize .Net software/products or technology. Some of these companies are well known to the general public: Dollar Rent A Car (Microsoft, 2002c), MSNBC.com (Microsoft, 2002e), Nasdaq.com (Microsoft, 2002f) and others. In one of the examples, Dollar Rent A Car (referred to as "Dollar Rental") received the majority of its reservations through Global Distribution Systems and paid a fee for each transaction. Dollar Rental wanted to provide its partners with direct access into its mainframe reservation system through the Internet to lower costs and create more business opportunities. Dollar Rental's Advanced Technology group identified five possible alternatives: CORBA/IIOP, Java RMI, DCOM, socket programming, and Microsoft XML Web Service. Among these five options, CORBA/IIOP was simply too expensive. The implementation time for the Java RMI or socket programming was judged to be too uncertain and DCOM was judged not appropriate. Therefore, Dollar Rental chose XML Web Services. In 45 days, Dollar Rental's team used ASP to create a palm-friendly user interface, relying on the existing XML Web service interface to provide real-time connectivity with the application program running on the mainframe. After several month's effort, the system was up and running. This capability has resulted in millions of additional rate requests, millions of dollars in additional revenue, and significant transaction fee savings (Microsoft, 2002c).

Table 2 shows a summary of those companies that use .Net technology. Table 3 shows a summary of the companies that provide .Net software and services. Zagat Survey, Inc. not only uses .Net software and products, but also provides a software consulting service. Therefore, Zagat Survey was put into both tables.

As shown in Table 2, it has been found that nine out of twelve companies use Visual Studio .Net. It confirms the author's belief that Visual Studio will become a popular tool to work with .Net. Ten out of the twelve companies use Microsoft SQL Server 2000. It indicates the impor-

tance of the relationship between database and Web design software. There are two or three companies which use special components of .Net service such as .Net Passport, .Net Alerts, .Net Contact, and .Net Calendar.

Because these case studies are posted on the Microsoft Web site, they may have certain biases in promoting the Microsoft .Net. It is understandable that Microsoft will not reveal the shortcomings of ASP.Net in each of these cases. For example, security is not widely discussed in these cases. However, the cases illustrate the facts related to the positive side of Microsoft .Net. Major advantages of using .Net from these case studies include: Easy implementation, and short implementation lead-time. As mentioned by a director at Centerpost, "We considered Solaris and Oracle, but they wouldn't have allowed Centerpost to get to the market nearly as fast. (Microsoft, 2002a)"

From analyzing these cases, some of the suggestions for .Net implementation are:

- 1) Understand the business need and what the .Net can do. Different networking software has different strengths and weaknesses. Therefore, it is important to choose one which is appropriate for your own business environment,
- 2) Utilize newsgroups for possible questions. Because Microsoft .Net is relatively new software, it may have many unexpected problems. These questions may be answered by someone in the Internet newsgroup
- 3) Understand the function of each component in Microsoft .Net. Without first installing Internet Information Servers (IIS), ASP.Net will not work. Some components work more effectively with other systems. As mentioned by a senior developer in Harris Interactive, "Our existing system is based on the Microsoft SQL Server 7, ... But without the .Net framework, we were not getting the optimal benefits in terms of our integration and interoperability efforts. Moving to .Net and SQL Server 2000, we are able to share data across multiple systems reliably and consistently." (Microsoft, 2002d)

One of the concerns is that Microsoft has announced that it will sell a service-oriented software rather than product-based one. That means Microsoft will periodically charge a license fee for Web services in the future. Anyone who uses the SPSS or SAS statistical packages might have experienced problems with this type of fee arrangement. For example, one day you turn on your computer for some routine research, but you cannot retrieve your data because the software license has expired.

One of the observations from the case study is that the application of mobile information systems has become popular. For example, Continental Airlines developed a new mobile travel-planning application with the .Net Framework (Microsoft, 2002b). In an auto or airline reservation system, customers can use the mobile computer system to check the reservation. Microsoft has spent years of effort on the development of its mobile operating systems - Windows CE, will fly when the time comes.

## CONCLUSIONS AND FUTURE RESEARCH

The purpose of this paper is not only to explore Microsoft's .Net Framework but also to examine the general role of the XML Web services framework for supply chain management applications. As mentioned in previous paragraphs, Sun Microsystems also provides a similar framework – J2EE. While many research questions remain unanswered, XML Web services, either .Net Framework or similar products (such as J2EE), will become a new paradigm for Internet applications development. Future research needs to investigate both the implementation issues and the measures of success. Plans for future research include 1) Devising a questionnaire and sending it to the companies who use the .Net framework to survey the implementation satisfaction of .Net. 2) Testing of the supply chain management (SCM) application program by different groups of students. Selected students will be asked to evaluate the appropriateness of the scripted application and the implementation model. 3) Comparing the differences between J2EE and .Net Framework in the supply chain management applications.

**Table 2. Technology/Product Used in the Case Studies**

Company	Type of industry	Technology/Product Used																			
		DN	AD	AP	SS	CL	VS	IS	SQ	S2	AS	BI	MI	NS	EX	SO	CO	CS	UE	AC	
Continental Airlines	Airlines	1	1			1	1	1	1	1		1									
Cyber-Watcher	Developer of Web personalization services, business-intelligence monitoring	1	1		1		1	1	1	1		1									
Dollar Rent A Car	Car rental	1				1	1	1			1	1									
Expedia, Inc.	Online travel agency								1	1			1	1							
Fiedesic Corp.	Electronic payment service for small businesses								1	1					1						
Harris Interactive	Market research, polling, and consultant	1	1	1		1	1		1	1											
LiveVault	Provider of on-premise backup and restore service	1				1	1	1		1	1			1	1			1			
MSNBC .com	Cable (Joint venture between Microsoft and NBC News	1		1		1				1	1										

Nasdaq.com	Electronic stock market	1	1		1		1													
Scandinavian Airlines	Airlines	1	1		1	1	1			1					1	1			1	
Trans World Entertainment	Specialty music and video retailers	1	1			1			1	1			1	1						
Zagat Survey	Provider of restaurant rating guides		1	1			1			1					1				1	
Total		9	4	6	2	4	9	5	3	10	6	3	2	3	3	2	2	1	1	1

**\* Technology/Product Used:**

- DN: Microsoft .Net Frame Work
- AD: ADO .NET (part of Microsoft .Net Framework)
- AP: ASP .NET(part of Microsoft .Net Framework)
- SS: SQL Server Managed Provider(part of Microsoft .Net Framework)
- CL: Common Language Runtime (part of Microsoft .Net Framework)
- VS: Microsoft Visual Studio .Net
- AS: Microsoft Windows 2000 Advanced Server with IIS 5.0 and Microsoft Message
- IS: Microsoft Windows 2000 Server with IIS 5.0 and Microsoft Message
- SQ: Microsoft SQL Server 7.0
- S2: Microsoft SQL Server 2000
- BI: Microsoft Biztalk Server 2000
- MI: Microsoft Mobile Internet Toolkit
- NS: Microsoft .Net Service (.Net Passport, .Net Alerts, .Net Contact, .Net Calendar)
- SO: Microsoft SOAP Toolkit 1.0
- CO: Microsoft COM+
- CS: Microsoft Consultant Service
- AC: Application Center
- UE: Microsoft .Net User Experiences

**Table 3. Software and Service Provided by the Software/Service Company in the Case Studies**

		Software and Service																	
Company	Type of industry	DN	AD	AP	SS	CL	VS	IS	SQ	S2	AS	BI	MI	NS	EX	SO	CO	CS	UE
Allegis	Software vendor								1	1	1								
Centerpost	Applications provider of wireless communications								1		1								
CertifiesMail.com	Service provider of Web applications							1	1	1				1	1		1		
InterKnowlogy LLC	Software engineering									1	1						1	1	
SolidWorks Corp.	Develop and market 3D mechanical design solution						1			1	1								
Zagat Survey	Provider of restaurant rating guides	1	1				1			1	1								
<b>Total</b>		<b>1</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>2</b>	<b>1</b>	<b>2</b>	<b>5</b>	<b>6</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>0</b>	<b>0</b>

\* Software/Service Provided:

- DN: Microsoft .Net Frame Work
- AD: ADO .NET (part of Microsoft .Net Framework)
- AP: ASP .NET (part of Microsoft .Net Framework)
- SS: SQL Server Managed Provider (part of Microsoft .Net Framework)
- CL: Common Language Runtime (part of Microsoft .Net Framework)
- VS: Microsoft Visual Studio .Net
- AS: Microsoft Windows 2000 Advanced Server with IIS 5.0 and Microsoft Message
- IS: Microsoft Windows 2000 Server with IIS 5.0 and Microsoft Message
- SQ: Microsoft SQL Server 7.0
- S2: Microsoft SQL Server 2000
- BI: Microsoft Biztalk Server 2000
- MI: Microsoft Mobile Internet Toolkit
- NS: Microsoft .Net Service (.Net Passport, .Net Alerts, .Net Contact, .Net Calendar)
- SO: Microsoft SOAP Toolkit 1.0
- CO: Microsoft COM+
- CS: Microsoft Consultant Service
- AC: Application Center
- UE: Microsoft .Net User Experiences

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## APPENDIX A The File Order.cs

```
//-----  
// <autogenerated>  
// This code was generated by a tool.  
// Runtime Version: 1.0.3705.209  
//  
// Changes to this file may cause incorrect behavior and will be lost if  
// the code is regenerated.  
// </autogenerated>  
//-----  
  
//  
// This source code was auto-generated by wsdl, Version=1.0.3705.209.  
//  
using System.Diagnostics;  
using System.Xml.Serialization;  
using System;  
using System.Web.Services.Protocols;  
using System.ComponentModel;  
using System.Web.Services;  
  
/// <remarks/>  
[System.Diagnostics.DebuggerStepThroughAttribute()]  
[System.ComponentModel.DesignerCategoryAttribute("code")]  
[System.Web.Services.WebServiceBindingAttribute(Name="ordercsSoap",  
Namespace="http://tempuri.org/")]  
public class ordercs : System.Web.Services.Protocols.SoapHttpClientProtocol {  
  
    /// <remarks/>  
    public ordercs() {  
        this.Url = "http://localhost/ordercs/ordercs.asmx";  
    }  
  
    /// <remarks/>  
    [System.Web.Services.Protocols.SoapDocumentMethodAttribute("http://  
tempuri.org/developerEstimate", RequestNamespace="http://  
tempuri.org/", ResponseNamespace="http://tempuri.org/",  
Use=System.Web.Services.Description.SoapBindingUse.Literal,  
ParameterStyle=System.Web.Services.Protocols.SoapParameterStyle.Wrapped)]  
    public System.Double developerEstimate(int xintHours) {  
        object[] results = this.Invoke("developerEstimate", new  
object[] {  
            xintHours});  
        return ((System.Double)(results[0]));  
    }  
}
```

```
    /// <remarks/>
    public System.IAsyncResult BegindeveloperEstimate(int xintHours,
System.AsyncCallback callback, object asyncState) {
        return this.BeginInvoke("developerEstimate", new object[] {
            xintHours}, callback, asyncState);
    }

    /// <remarks/>
    public System.Double EnddeveloperEstimate(System.IAsyncResult
asyncResult) {
        object[] results = this.EndInvoke(asyncResult);
        return ((System.Double)(results[0]));
    }
}
```