

# Web Application Development Service

## *Database Access Through the Web*

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### Introduction

In the fast-paced history of computing and technology, certain events can be identified as turning points. The invention of the transistor, the development of the integrated circuit, and the mass production of inexpensive personal computers are a few of the more recent ones. The proliferation of the World Wide Web is another.

Having achieved mass acceptance, the Web has changed the ways in which people communicate and conduct business. Electronic transactions and instant access to information are not only a reality but a requirement for business survival. What developers at the European Laboratory for Particle Physics (CERN) in Geneva initially conceived as a way to organize and link information has grown into a communications technology that is shaping the future of businesses. In a world of electronic commerce, where 128-bit encryption has become an issue that governments at the highest levels have had to address, it is hard to imagine a movement that has had more impact on our commercial, social and personal behaviors.

As with databases in the early 1990s, web-based computing has become an asset that companies leverage in order to compete. This paper analyzes the new technologies that combine databases and the Web. Since this is a broad subject, it will be limited to the tools that allow a web user to reach-through to a database. To “reach-through” means to use a web browser for access to information stored in a database – information that would normally require a proprietary report writing tool used within a database management system. Since web site development is widely discussed elsewhere, this paper focuses on the approaches and tools specific to database access in the Microsoft Windows environment. Background information about the Internet and the World Wide Web is provided as necessary.

### Mosaic

Not until 1993 did the Web gain a graphical face – Mosaic. Although other GUIs (graphical user interfaces) preceded it, Mosaic caught the eye of the common information consumer. John Markoff in the New York Times called it the Internet’s killer app. A killer app is the application that finally justifies a system. Mosaic did for the Internet what Lotus 1-2-3 did for DOS and Word did for the Macintosh: it made the Internet a viable and popular system.

Originating at NCSA (National Center for Supercomputing Applications) at the University of Illinois, Mosaic provided a user-friendly interface into the vast world of the Internet. Although Internet users at the time — mostly universities and research organizations — were already enjoying the benefits of linked information through telnet, ftp, WAIS, Gopher and text-based browsers, Mosaic brought sound, graphics, menus, and pictures into one easy-to-use tool.

Almost overnight, the Internet was discovered by millions of individuals through a spinning globe. The spinning globe communicated what the Internet was all about and what Mosaic was able to do – bring multimedia communications to information access. And the spinning action reassured the Internet user that a connection was being made. (Long wait times for responses on the Internet had, at that time, become common and annoying.) Soon, Unix and PC versions for Mosaic became widely available and were distributed free of charge. (Reflecting the Microsoft/Apple operating system wars, Mosaic moved the spinning globe from the top left corner to the top right for its Macintosh version.)

### Web Basics

If Mosaic is an interface to the Web, it can be said that the Web itself is actually an interface to the Internet (and to internal networks built with Internet protocols, called Intranets). It is also a combined interface. It provides access to information whether it was built using Internet protocols (such as telnet, Gopher, WAIS, and ftp) or according to the rules of a web browser.

The Web consists of three basic elements – hypertext, the Internet protocol, and multimedia presentation. The original idea behind hypertext was to link the various documents that are available on the Internet. When you select a hypertext link in a web document, you are taken directly to the document it points to.

The Internet is a global matrix of computers with its roots in the Department of Defense and National Science Foundation networks. No one knows precisely how big the Internet is because it is constantly growing. This brings up another way in which the Web has been empowering: Although web applications are built using Internet technology, you do not need the Internet to enable them. In fact, corporations have designed private networks or individual PCs using this technology and as such have built Intranets.

The combination of sound, graphics, animation, and video – that is, multimedia – has made the Web even more appealing to average users. Not only have they made a connection with the world, they can experience it together.

The intricacies of the Web, however, are not trivial. Although web tools have made it easier to publish information, the fundamental infrastructure is still complex and costly to implement. As with other technologies, the investment in this infrastructure had to be justified. With a web browser deployed in most corporations and many homes, the commercial possibilities of this technology began to attract attention. If documents can be linked, why not provide a link to information built from databases? The combination of the web browser – which provides access to a vast but heterogeneous array of information – and the database – specialized data organized for retrieval – has become a powerful business tool. Information can be only a mouse-click away.

## **Web Tools**

Constructing a web application presents the developer with a number of design challenges. For example:

1. The choices available to a web user are far more diverse than those offered by traditional forms of information delivery. For this reason, the constraints of time and space must be taken into consideration.
2. Although individual web browsers share common delivery mechanisms, each one displays information in its own way – and there are thousands of web browsers in use.
3. Access to information is non-linear. Multiple users have access to the same information, sometimes simultaneously. In some cases, information may change within seconds of one's attempt to access it. And because the Web addresses a global user community, language differences and cultural implications must be considered.
4. Although the open and dynamic nature of the Web is perhaps its greatest strength, proprietary and confidential information must be secured. In response to this need, programs and standards have been developed to provide secure channels and transactions, secure sites, and encryption.

The spread of the Web has expanded user expectations beyond the traditional forms of information access (such as databases). The next generation of web tools that enable browser/server applications are designed to address these expectations.

## **HTML**

HTML stands for Hyper Text Markup Language, which is the standard meta-language used to build web documents. Documents built using Level 1 of HTML can be read by all browsers, regardless of how they were authored. There are, however, additional layers of HTML, and this can cause compatibility problems. Level 2 adds Forms, which allow for multiple window and field displays, and Level 3 incorporates tables, figures, and mathematical equations. Standards for these levels are continually being redefined, and the ability to display documents based on them has become the browser battleground.

The philosophy behind HTML is simple – all HTML files need to be in plain text without special control characters or embedded binary code. HTML documents are stored in an http (Hyper Text Transport Protocol) server. Formatting, links, graphics, and other HTML elements are stored in tags that can be interpreted by the display engine in any browser. (These tags can also be used to index information.) An HTML document consists of the following elements:

1. **Head.** The head contains the properties that affect the whole document, including its title.
2. **Body.** The rest of the web document (text, tags, graphics and hypertext links, including URLs – Uniform Resource Locators) is contained in the body.
3. **Graphics.** Logos, animation, and pictures are examples of these embedded files. (Alternate tags can be used to indicate the presence of a graphic to browsers that do not display these files.)
4. **Forms.** Forms, like Windows dialog boxes, prompt users to type text in fields or make selections using radio buttons, check boxes, or lists. Using scripts or a programming language, forms display result sets that are received from database management systems. The information is passed between systems by using the CGI (Common Gateway Interface) component of an http server. Within Windows systems, it is often called the WinCGI engine. In addition to this interface, web server and browser vendors have implemented APIs (Application Programming Interfaces) to enhance and/or replace the functionality provided by CGI.

Various HTML editors are available in the market. A good tool is one that will support Forms to enable database reach-through. A WYSIWYG editor is also a must for the demanding requirements of web developers and users. As of this writing, HotMetal Pro from Softquad is the tool preferred by developers.

## WinCGI

WinCGI is the Windows implementation of the Common Gateway Interface. This interface was developed to execute traditional programs (in particular, those that handle data) within an HTML document. Database management systems have since provided robust tools to handle data stored in relational and multi-dimensional tables. The WinCGI gateway is hosted on an http server based on Windows (usually Windows NT Server). WinCGI runs application processing that is passed to it by an HTML document. This processing includes calculations, database queries (SQL) and even communications to the servers on a network. WinCGI uses Templates that are filled by the CGI processes with data to be displayed in an HTML document. Depending on the program logic, WinCGI can, for example, control the next HTML form or document that is presented to a user. Although CGI processes can be developed using a variety of languages, they are commonly done in C, C++ and the PERL scripting language.

Access to databases is provided through C libraries supplied by the database vendor or through SQL interfaces that can be accessed by a scripting language. Fortunately database management and client/server development tools have matured beyond this potentially time-consuming form of information access. The object orientation of current client/server development platforms enables it to access multiple database management systems. The cross-over of these tools into browser/server applications became a natural extension. However, extensions to HTML and the proliferation of program libraries to access databases have made WinCGI both attractive and complex. While vendors have attempted to simplify this with APIs that provide database connections using proprietary tools, the perceived best solution is still a Web Application Development Platform. This platform should be able to generate HTML and WinCGI scripts that can be accessed by multiple browsers and executed on any target database. The ability to develop native browser/server applications, free of vendor-provided APIs and proprietary extensions, has become a tool requirement for most developers.

## Web Application Development Ensemble

The tool kit for browser/server development has thus become an ensemble – a collection of tools that were meant to work together but still need to be orchestrated at the developer's desktop. Each task, as is often the case with development projects, requires different tools depending on the business requirement. The process of developing a web application can be summarized as follows:

1. Author the HTML document using a tool such as HotMetal Pro. The authoring process includes the creation of HTML Forms and Templates. Ideally, the authoring tool will be integrated into the web application development tool. An emerging trend is differentiating between an HTML editor (like Microsoft FrontPage) and an authoring tool (like Microsoft Internet Studio). In addition to document editing, an authoring tool provides a wide range of multimedia extensions that result in professional-quality web sites.
2. Create the database application. This can take the form of stored procedures, dynamic SQL statements, or executables. These can be stored as objects in a web application development tool and then accessed later as part of a script.
3. Combine the HTML document with specific objects created in the database application. This step requires a tool that can handle HTML tags and embedded application processes. The ability of the web development tool to generate the HTML and the application at the same time is critical.
4. Generate the C or C++ code that can be executed by WinCGI. Web development tools can now generate this code for you. The idea, however, is to generate this code together with the appropriate HTML document stored in the http server.

Depending on the complexity of the database application, the C or C++ code, or the database structure may have to be modified for optimal performance. A tool like Sapphire/Web from Bluestone allows for the development of a web application from a single workbench. It can integrate the authoring tool of your choice, support existing stored procedures, and use native SQL or vendor-specific SQL implementations like PL/SQL (Oracle) or TransactSQL (Sybase). It also works with HTML extensions such as Frames, Tables, Java, and ActiveX. Sapphire/Web, however, departs from normal scripting. Since the code is generated in C or C++, the processing logic is performed as you develop the application. It also requires you to identify the target database. It is different from Microsoft dbWeb and Cold Fusion in that both of these products use ODBC (Open Database Connect) to provide database connectivity. You will also get inherently better performance on compiled C code as opposed to scripts. Scripts are processed first by an Interpreter in an http server. Only after this step is completed are the actual instructions executed.

## Security, Version Control, Directory Services and Other Issues

Secure channels over the Internet have been a widely discussed topic. Standards for securing transactions from both sender and recipient and across networks are currently being developed. Most of these standards are based on the public and private key system developed by Whitfield Diffie in the 1970s. In this scheme, a public key is used by the sender to encrypt a transaction and a private key is used to decrypt the transaction by the intended recipient. Rivest-Shamir-Adleman (RSA) provided a way of extending this method to provide security not just at both ends, but also while data is travelling along communication lines. Currently US versions of browsers use 128-bit encryption, while international versions use 40-bit encryption as required by US law. This restriction has been bitterly fought by US software vendors and may likely be reversed, based on the idea that US government agencies can have access to special keys whenever necessary.

Security presents worrisome issues to corporate IS professionals. Developers commonly exchange data and reuse software. And companies are increasingly transmitting sensitive material, including credit card transactions, over the Internet. This raises concerns about privacy, transaction security, the possibility of transmitting software viruses, and the need to safely encrypt data.

In general, security issues fall into three categories:

1. **General Internet Communications.** This area includes Internet exchanges such as e-mail, postings on bulletin boards, and “chat” groups. Private Communication Technology (PCT) is a general-purpose mechanism for secure access as well as business and personal communications over the Internet. This technology includes features such as privacy, authentication, and mutual identification. PCT enhances the Secure Sockets Layer (SSL) by separating authentication from encryption to maximize the security of each. PCT allows applications to use 128-bit key encryption for authentication within the United States, and 40-bit key encryption as allowed by the U.S. government for export use.

To operate in Secure SSL mode, you must obtain a Certificate from a certifying authority such as VeriSign (<http://www.verisign.com/>).

In addition, public and private key technology is emerging that allows users to transfer their personal electronic property between computers and browsing environments. The Internet Engineering Task Force (IETF) is an initiative to merge SSL and PCT into a standard protocol called Secure Transport Layer Protocol (STLP) as an improved channel protocol.

2. **Sharing of code or application software.** For downloading software from the Internet, a restricting or “sandbox” approach prevents malicious damage to users’ systems. This is done by keeping software from coming into contact with any operating system resources (like files, databases, graphic hardware, or computer memory). ActiveX scripting (Visual Basic Script and JavaScript™) and Java applets are similarly protected environments in that all capabilities that might carry viruses are removed from these languages.

The second approach is digital signatures. Using digital signatures, developers can “sign” their code by embedding an encrypted key, so that recipients of this “autographed” software can know where it came from and that it has not been tampered with.

3. **Credit card transactions and commerce on the Internet.** The Secure Electronic Transactions (SET) specification is designed to provide a secure method of handling credit card transactions across unsecured transports like the Internet. SET is a converged protocol that merges STT (Secure Transaction Technology) and SEPP (Secure Electronic Payment Protocol), which were independent initiatives with the same objective.

This technology will help prevent fraudulent use of credit cards. It will also help prevent interception of credit card information while a transaction is in progress.

Version control systems that manage both code and projects will be essential to the developer’s tool kit. Tools like PVCS or ClearCase are market leaders in client/server application development and can be used to manage browser/server development projects.

Another trend in web development is the support of Profiles. Profiles give a browser the ability to display messages, content, or alerts based on user preferences. These preferences can be entered into a profile database or learned by tracking usage. This an active form of publish and subscribe that is supported in the latest versions of browser and authoring tools. Processes can conceivably be spawned by an http server and then passed or staged for a particular user and displayed using a browser.

Another issue is the availability of directory services that address the anticipated growth in Internet and Intranet destinations. The next-generation directory server is expected to provide a general-purpose directory service that reduces the administrative costs associated with maintaining multiple name spaces for all users, services and network resources. The ability to administer more than 10 million objects in a single network domain, with an unlimited number of domains being possible, is the kind of scalability and simplicity that enterprises are likely to require.

# Appendix 1: The Microsoft Intranet Tools Strategy

*Excerpted from the Microsoft Intranet Strategy Whitepaper*

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## Productivity Applications: Microsoft Office

Today's intranets, for the most part, are being used as a publishing medium that greatly speeds up how quickly users are able to share information. Moving forward, there will be a new generation of intranets with richer content and more dynamic collaborative solutions. The key ingredient to making this happen is providing the broadest set of users with the tools to easily create rich content for broad distribution and collaboration within an intranet. Microsoft Office is at the heart of that content creation and collaboration process. With over 22 million users worldwide today, Microsoft Office is the most extensively used desktop business productivity tool within organizations. Critical to that success has been Office's ease of use, tight integration and powerful analytical tools. Each day millions and millions of Office documents are created to facilitate communication within an organization. Microsoft Office 97 combines the best of the desktop with best of the web to provide users with the best tools for easy creation, analysis and collaboration within an intranet. Microsoft Office will be the essential tool for knowledge workers within an intranet in the following ways:

- ✓ **Tight Integration:** The Web has introduced some important new metaphors that make it dramatically easy to locate relevant information. Office 97 tightly integrates the page and link metaphors of the Web throughout the Office applications. This integration includes linking, searching, browsing, and publishing.
- ✓ **Easy Creation:** The key to regular creation of rich content for an intranet is by providing a wide range of users with easy to use tool to create that content. Office provides the best tool for easy creation. Microsoft Office enables users to have one tool for publishing information in a variety of formats choice anything from Office file formats to HTML.
- ✓ **Analysis and Data Access:** With tools such as a Microsoft Excel PivotTable, users can analyze information in the way they need, when they need to, in order to make timely business decisions. As a universal client to many data sources, such as ODBC, SGML, and Web Queries, users can use Office, a tool they are already familiar with, to work with all sorts of data.
- ✓ **Collaboration:** Office 97 provides tools for multiple users to share and work on the same Word and Microsoft Excel documents at the same time. Revisions, conflict histories, comments, and versioning are all tools that give the author ultimate control over a shared document. Microsoft Outlook can be used for powerful workflow and communication solutions.

Finally, with Visual Basic for Applications in all of the Office 97 applications, including support for ActiveX controls, users can create powerful workgroup solutions that are specific to business needs.

## Integrating Web Technologies in Office 97

The navigation metaphor of the Internet is one of its greatest attractions over traditional file systems. Click on a hyperlink to go to another document. Click on back arrow to backtrack. Click on forward arrow to advance, and so on. Further, it enables users to locate specific information with searching capabilities across multiple servers. In addition users can link to related sources of information that the user may have never known existed. They simply follow the hyperlink to related information. Microsoft has integrated these technologies into each Office 97 application file format so users can realize the benefits of the Web as well as Office.

## **Hyperlinks**

Most documents do not exist in a vacuum — they are part of a history or a group of related files. Providing hyperlinks between documents makes it easier for the reader (or author) to easily access related information. For example, the specification for a new bike might include hyperlinks to the descriptions of individual parts that make up the bike. Or, an Annual Report distributed online as a Word document could have hyperlinks to a Microsoft Excel spreadsheet containing the year end balances so users can do their own detailed analysis.

Office 97 includes a simple dialog box that is shared across all Office applications to make it easy for any user to create and edit hyperlinks. These hyperlinks can go virtually anywhere — to other Office documents, HTML documents or any file with a recognized address via fully qualified path, URLs, UNC's, or FTP. Office 97 users can attach a hyperlink to a variety of objects including: text, graphics, OLE objects, tables, presentation slides, spreadsheet cells, and custom database form fields.

## **Web Toolbar**

To make it easier for users to navigate hyperlinks between documents, the Office Web toolbar is shared across all Office 97 applications. The Office Web toolbar is very similar to standard Web browsers with common buttons for navigating forward, backward, and to the home page. A search page button lets users do full content index searching. A drop down list box allows the user to type in a file location or URL, and even tracks the most recently visited sites. Similar to the File Open dialog in Office, there is a Favorites location for easy access to your most often visited sites. Rounding out the rest of the toolbar are: one click access to creating your own hyperlinks and a button that optimizes the screen for online document viewing.

## **Searching: Web FindFast**

Microsoft Office for Windows® 95 introduced FindFast technology to perform content indexing and searching on Office documents stored on a users local hard drive or a network drive. Office 97, extends FindFast technology with the introduction of Web FindFast, which performs full content indexing and searching on both HTML and Office documents across an entire server or group of servers.

The user experience is similar to using an Internet search engine such as Lycos or AltaVista. The user navigates to a search page and types in the keyword and clicks Search. This triggers the submission of the search to the server which returns the search results in an HTML page. The search page contains document properties, such as the title, author, a brief summary of the document or other standard properties. A hyperlink for each document is also provided in the list so it can be opened immediately.

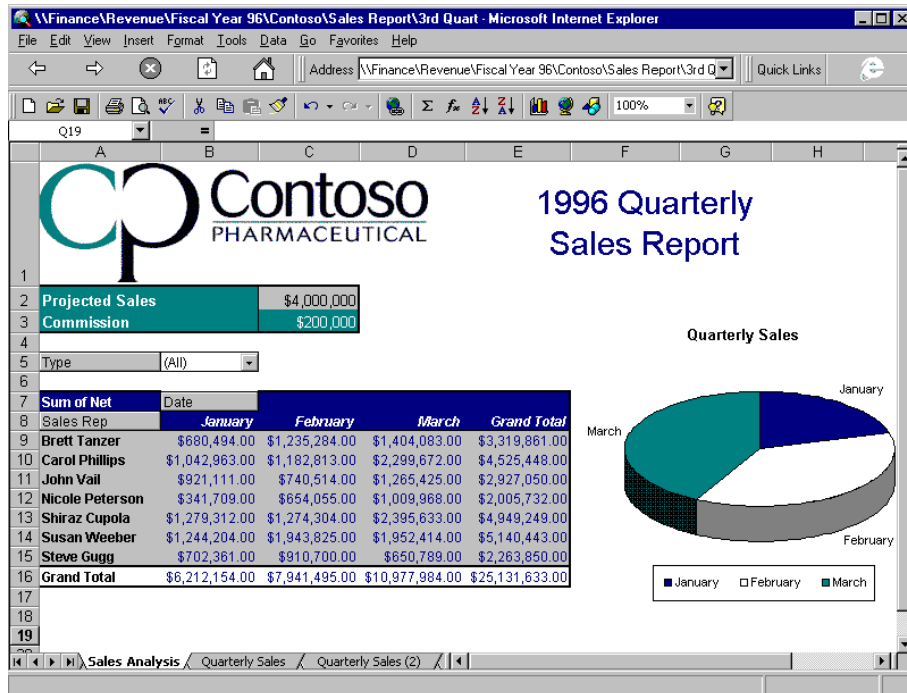
In addition, administrators can easily create a catalog of saved documents at regular intervals. Users can peruse this catalog, looking for particular subjects or new documents.

## **Browsing**

### ***Web Browser Integration***

Microsoft Office was designed to seamlessly integrate with the most common Web browsers like Netscape Navigator, Microsoft Internet Explorer, and N.C.S.A. Mosaic via a technology called ActiveX documents. ActiveX documents enable container applications, such as a Web browser, to open native Office files in-place.

ActiveX document technology provides users with navigation capabilities of their Web browser combined with the ease and flexibility of Microsoft Office, complete with toolbars and menu commands. For example, someone could open a Microsoft Excel worksheet with a Pivot Table and manipulate that data using all the power of Microsoft Excel.



The integration between Microsoft Office and Microsoft Internet Explorer is particularly tight, ensuring a seamless browsing experience. The products are designed with consistent toolbars, caches, favorites lists, and history.

### Office File Viewers

To make it easy for all users to navigate to and share Office documents, Microsoft provides freely distributable file viewers for Word, Microsoft Excel and PowerPoint. These viewers enable users to view and print Office documents with the same fidelity as the full applications (without requiring the applications to be installed). They also expose certain application features like document views in Word, or AutoFilter in Microsoft Excel. Office viewers are available for 16-bit and 32-bit Windows-based systems, as well as the Macintosh.

### Easily Create HTML Content

Microsoft Office is designed to provide the flexibility to publish information in a variety of formats. Every Office 97 application provides built-in support for viewing and creating HTML. Now, users can create rich content for the Internet and the intranet using the tools with which they are most familiar. Versions of Internet Assistant are available for all of the Office 95 applications on 32-bit Windows-based systems.

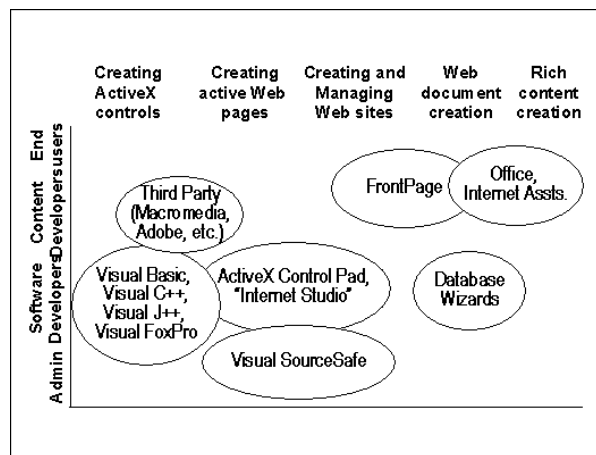
Microsoft Access Publish to the Web Wizard allows users to move their existing LAN database solutions to their intranet with a few clicks of the mouse. Most database forms are converted to HTML, and linked to the Access database residing on a Microsoft Internet Information Server. Users now have the ability to seamlessly query, input, and update the data residing in the database from any browser.

## Tools: Developing Applications with Active Content

As a medium with interactive capabilities, the Internet will appeal to a wider range of users than it does now. An "active Internet" will help to bring Web visitors back, because users will be able to do more than read information on a screen; they'll hear and view material that is displayed in exciting ways and they can do ad hoc analysis on the data. The Internet's continued growth depends on the availability of increasingly compelling and useful content.

Because ActiveX technologies are language- and vendor-independent, developers and content creators can continue to use and integrate their varied investments in tools, training, and source code.

ActiveX supports developers' choice of programming languages and tools, including Java, the Microsoft Visual Basic programming system, the Visual C++® development system, Microsoft FrontPage™ Web authoring and management tool, and third-party tools. Through the ActiveX strategy, developers can make use of their experience with the Windows operating system, ActiveX controls (the faster, smaller descendent of OLE controls), and Microsoft Office applications, as well as a range of third-party development tools for Windows, including PowerBuilder™ from the Powersoft division of Sybase, Inc., Symantec® C++, and Borland® Delphi®.



In addition to the traditional software development tools with expanded capabilities for the Internet, an altogether new category of publishing tools is being used to create Web content:

### 1. **Publishing Tools for Active Content**

Microsoft offers a range of publishing tools for creating active Web content. These particular tools are designed to meet the needs of various end users, from mainstream consumers and business users to power users, professional content creators, and application developers. The tools include Internet Assistants for Microsoft Office, FrontPage, Microsoft "Internet Studio", and add-on components to Microsoft's databases for automatic Web page creation.

- ✓ **Internet Assistants**, currently available in versions for Word, Microsoft Excel, PowerPoint® presentation graphics program, and Schedule+, automatically convert application files to HTML format and provide users with an interface for inserting hyperlinks, images, and forms in their documents. Users easily create richly formatted Internet documents without having to understand the complexities of HTML. This functionality will be built into Microsoft Office 97.

- ✓ **FrontPage** is designed for the millions of word-processing and spreadsheet users who wish to author Web sites for their corporate intranets or the Internet. Microsoft acquired FrontPage as part of its purchase of Vermeer Technologies, Inc. The user interface of FrontPage is consistent with Microsoft Office, making it easy to use. Its client/server architecture supports Web page authoring, scripting, and Web-site management from a user's desktop, across a corporate network, or over the Internet. With its wizards and templates, FrontPage makes it is easy for departmental users to create their own Web sites, or it can be used to enforce a standardized look throughout an intranet.
- ✓ Currently in development, "**Internet Studio**" is an integrated publishing system aimed at a different audience — professional online publishers who want to create sophisticated interactive Web applications offering high-end functionality. For example, Microsoft Internet Studio will enable high-quality, professional, two-dimensional layout enhanced with multimedia, as well as provide the ability to easily integrate small software components such as ActiveX controls directly into HTML pages. Content developed with Internet Studio will be viewable from any standard Internet browser.
- ✓ **Automatic Web pages.** Companies interested in publishing large amounts of information at low cost can look to relational databases for help. It is now possible to manage large amounts of data in a relational database which, when queried, automatically converts into an HTML-based Web page. In this way, companies can avoid the cost of creating numerous Web pages by hand.
- ✓ **Microsoft Access**, the **Microsoft Visual FoxPro™** database management system, and **Microsoft SQL Server** each have an add-on software component that enables automatic Web pages. These add-ons may be downloaded from Microsoft's Web site. The feature to convert ODBC data to Web pages is incorporated into Microsoft **Internet Information Server** as the Internet Database Connector.

## 2. **Development Tools for Active Content**

Developers can fully apply their favorite client/server development tools to Internet development, because ActiveX technology is language-independent. These tools include Visual C++, Java, and Visual Basic, as well as third-party tools. The development tools, which are used to create applets or ActiveX controls, provide the application-like functionality integrated by the publishing tools to produce active Web pages.

- ✓ As part of its strategy to utilize and broaden the capabilities of existing standards, Microsoft is supporting **Java and JavaScript** and enabling ActiveX technologies to integrate with Java. This year, Microsoft will provide a visual development environment for Java, called **Visual J++**, as part of this effort.
- ✓ Existing and new Windows-based applications have full access to the Internet protocols via **ActiveX controls**. With these controls, along with wizards, sample code, and templates, Microsoft Visual Tools support Internet-based application development. Many third-party Windows development tools can fully use these ActiveX controls as well.
- ✓ A pure subset of Visual Basic for Applications, **Visual Basic Script** has been optimized for scripting active content inside Web pages. VBScript is immediately usable by the more than three million developers already familiar with Visual Basic for Applications. Developers can use VBScript to link ActiveX controls or Java applets as part of the HTML document that users download when they access Web pages. In light of this, VBScript and Java complement one another.

Microsoft is making available, at no charge over the Internet (connect fees may apply), the source code for the Visual Basic Script interpreter. Thus, third-party developers writing Internet browser software and other applications can use VBScript in a wide variety of ways. Microsoft will provide VBScript for the full Windows family and the Apple Macintosh. Third-party vendors have announced their intent to port VBScript to various UNIX-based platforms.

Microsoft has also recently begun to offer the full Visual Basic for Applications to third party application providers. This will enable the use of ActiveX controls in a broad variety of applications – on both clients and servers. Some of the companies licensing Visual Basic for Applications include Adobe, Autodesk, and SAP AG.

- ✓ **Visual SourceSafe™** version control system is typically applied to managing software source-code in a team environment. Web site administrators face a similar dilemma managing multiple versions of a changing Web site. Because Visual SourceSafe can handle files that make up a Web site today, it can aid significantly in administering different versions of a Web site. Planned enhancements will make Internet-related management tasks even easier.

## An Open Approach

Business solutions crafted using open standards often lead to lower costs due to competition and commodity pricing for a mass market. Microsoft has demonstrated an open approach overall that applies to Internet-based computing. The evidence is compelling:

- ✓ **Adoption of industry standards:** Microsoft has embraced the Internet standards in its products. The Microsoft Internet Explorer 3.0 handles all HTML standards including ones introduced by Netscape. Microsoft has licensed Java and JavaScript in support of new Internet innovations. Microsoft Office, the Windows operating systems and suites, and Microsoft's visual tools all incorporate Internet standards for easy usage by developers and end users.
- ✓ **Published formats and interfaces:** Openly documented technology is a key step leading to broad market adoption. Microsoft actively participates in the formal organizations setting Internet standards like the Internet Engineering Task Force, the Internet Architecture Board, the International Multimedia Teleconferencing Consortium, and the World Wide Web Consortium (W3C). Microsoft also goes to great lengths to publish new innovations so that they may be broadly used in the industry. For example, Microsoft has published its file formats for its Office applications. The source code for the Visual Basic Script interpreter is available on Microsoft's Web site. The COM-based enterprise services (e.g., Distributed COM, OLE Transactions, OLE DB, OLE Management Services) have been shared with all interested industry players. And Visual Basic for Applications is being openly licensed.
- ✓ **Open Standards Process: Unique within the computer industry,** Microsoft regularly shares plans for new technologies and application programming interfaces, through open design reviews, with business partners and competitors alike. For example, this openness has led to the broad adoption of ODBC for standard access to relational data. And this has led to numerous COM-based applications and ActiveX controls to be available on the open market from hundreds of companies worldwide.
- ✓ **Cross-platform products:** Microsoft Internet Explorer is available on Windows and Macintosh platforms and will be available on UNIX platforms. Visual Basic Script will also be available on these platforms. Along with partners Software AG, Bristol, MainSoft, Macromedia, and Metrowerks, Microsoft has been working to have the Component Object Model available on all platforms commonly used in enterprises from mainframes, mid-range systems like the VAX and AS/400, UNIX systems as well as the Macintosh and Windows-based systems. MainSoft and Bristol have been delivering cross-platform COM products since 1995.

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## Appendix 2: Denali: Next Generation Server-Side Scripting Tool

*Excerpted from Microsoft Web Page*

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### Denali Technology Overview

Organizations are looking to web-based business solutions to help improve productivity and reduce costs. The challenge is to find a technology that is easy to use and leverages existing investments. Moreover, organizations are looking for solutions that don't require a web-centric development environment - such as CGI - and ensure that the solutions and components can be built quickly.

"Denali", the code-name for Microsoft's new ActiveX scripting environment for Internet Information Server, is a set of technologies that make it easy to develop and manage powerful, web-based business solutions. Organizations, ISVs, and Internet Service Providers will use Denali to not only create dynamic web sites, but also to put a web front-end on legacy applications, and create new a generation of business applications for the Internet and corporate intranets.

- ✓ **Open and extensible.** Denali allows web developers to use almost any scripting language when creating dynamic web sites - VBScript, JavaScript, Perl, Python, and REXX. And Denali extends the power of Web pages through support of ActiveX components running on the server. These components can be developed using Visual Basic, Java, and Visual C++, and more.
- ✓ **Wide reach.** Denali provides a "browser-neutral" approach to web-based applications so that organizations do not have to worry about the specifics of which Internet browser components are installed on the client. For example, with the "browser capabilities" component, the web server can easily determine whether or not a browser has support for a particular feature, such as frames, and offer alternate representations of the output.

### What does Denali do?

Denali is all about making it easier to do business on the Web. For organizations that are using Windows NT Server and Internet Information Server, Denali provides an ideal environment that allows you to re-use existing investments, find turn-key solutions, or build new business solutions from the ground up.

- ✓ **Dynamic web pages made easy.** CGI has long been the standard for building web-based applications and dynamic Web pages - but it has always required elements of content (text, layout, graphics, etc.) to be embedded in a CGI script. This makes development difficult as HTML content developers are faced with wading through lines of program source code when making changes. Moreover, fixing a typo, taking advantage of a new HTML tag, or changing the layout of a web page requires recompiling when using CGI and many existing web development environments. With Denali, web developers can freely intermix HTML with in-line script using any tool. And by separating application logic from HTML layout and content, Denali enables simple, "just-in-time-compilation", making it easy to update web page content and applications.

- ✓ **Leverage existing investments.** With Denali, developers are not forced to use a unique scripting language to create powerful web applications. Denali includes native support for VBScript and JavaScript, and supports other scripting languages such as REXX, Python and Perl through Active Scripting plug-ins. Denali also supports ActiveX components developed in any language, such as C++, Visual Basic, Java, COBOL, and more. While Internet Information Server will continue to support CGI and ISAPI programs for web-specific applications and filters, Denali offers a powerful, approachable alternative for network application development. The resulting applications are compatible with any Web browser running on any operating system.
- ✓ **Application infrastructure for the future.** Denali provides a platform to create dynamic, personalized Web sites today, and an infrastructure for delivering sophisticated business applications in the future. Microsoft is already using Denali to provide the customization and user-defined views offered on the Microsoft, MSN, and MSNBC home pages.

Denali includes the core objects and basic components web developers need to get up-and-running quickly. These include database access, state management, form processing, file access, dynamic billboards, browser capability determination, and a content linking component that specifies previous and next links. This component allows authors to maintain links between pages separate from the individual pages. A table of contents and previous/next navigation is generated dynamically, so new content can be added, deleted or the order changed without touching each page's HTML. Third parties will quickly round-out these component offerings with both applications like customer service, inventory management and human resources, and solutions for many vertical industries such as healthcare, manufacturing, and finance.