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Abstract

Web Distributed Authoring and Versioning (WebDAV) is a set of extensions added to HyperText Transfer Protocol to support collaborative authoring on the Web. While HTTP as a reading protocol, WebDAV is a writing protocol created by a working group of the Internet Engineering Task Force (IETF). By keeping HTTP as the foundation of WebDAV, the developers maintained the strengths of HTTP and expanded its capabilities by adding new headers and methods to DAV. Since DAV is a single wire protocol like HTTP, it offers a more secure and faster method of file transfer than provided by the dual-channel File Transfer Protocol (FTP). The new protocol offers many other advantages with few disadvantages. Already WebDAV is incorporated into most current operating systems and applications where it performs seamlessly. It is also finding widespread usage in colleges and universities as well as businesses, but its future seems even brighter.

Introduction

If you use the Web or common applications such as Microsoft Office with operating systems such as Windows XP, you already have WebDAV at your fingertips whether you realize it or not. What, you ask, is WebDAV? Apple defines it as "a world of seamless teamwork. It's cross-country (or pan-planet) collaboration with a click. It's a whole new reason to love the Net. All contained in one potent little desktop icon" (www.apple.com/creative/webpro/technology/webdav).

Web Distributed Authoring and Versioning (WebDAV) is an Internet protocol that has been under development since 1998 by a working group of the Internet Engineering Task Force (IETF). More exactly, it consists of extensions to the common HTTP protocol and was originally conceived as a way to allow web-based collaborative authoring. As the IETP site describes it, "DAV is completing the original vision of the Web as a writable, collaborative medium. . . . HTTP gave [users] read access, while DAV gives them write access" (http://www.webdav.org/other/faq.html#Q2).

This article will review the motivation behind WebDAV, the technical aspects of how it works, and the opinions shown in the literature of the usefulness and future of this protocol.

HTTP: The Foundation of WebDAV

WebDAV is a protocol layered on top of the ubiquitous Hypertext Transfer Protocol (HTTP). Before we explore WebDAV, let's look at HTTP and examine how it works, along with its shortcomings that necessitated the new protocol.

HTTP provides a method to browse the web. Basically, the client sends a request message to the server and the server sends a response to the client. The HTTP request has three elements: the method, the URI, and the headers. Expressed as a verb, **method** determines the type of request being made. The protocol defines eight different methods, with the most common being GET. The **URI** then identifies the resource to be used, and the **headers** add any additional information that may be required for the request (www.apacheweek.com/features/moddav). In addition to GET, the other most commonly-used methods or verbs include POST and PUT. These three verbs make up about "95% of all HTTP traffic" (www.swdi.com/WebDAV-Report.pdf).

By using small frames, HTTP is appropriate for supporting "human-machine conversation." One of the reasons for the small packet size is to "keep the user's browser from appearing frozen." (www.swdi.com/WebDAV-Report.pdf). Obviously, HTTP requires more packets with small frames to send the same amount of data that larger packets, such as those used by FTP, could transport. Unlike FTP that requires two channels, however, HTTP combines control and data information into a single channel, "permitting an even more simple client implementation" (James E. Whitehead, Jr., and Yaron Y. Goland, www.ics.uci.edu/~ejw/papers/dav-ecscw.pdf).

In a *PC Magazine* article titled "*WebDAV: Work Together*," Michael Floyd calls HTML "an extremely simple protocol" that uses a "straightforward" model of passing messages. Floyd believes that the simplicity of HTTP accounts in great measure for the wide success of the Web. But, he adds, "simplicity also leads to limitations." Among these limitations, the stateless protocol HTTP requires the user to reconstruct each search from scratch because HTTP does not have any capability for remembering what the user was last doing at a site (Michael Floyd, www.pcmag.com/print_article/0,3048,a=23189,00.asp). E. James Whitehead points out another HTTP limitation: it lacks support for "multi-resource operations." HTTP applies an operation to only a single resource and has no way of extending headers to apply to different resources or to perform hierarchy operations (James E. Whitehead, Jr. *Lessons*, http://www.ics.uci.edu/~http-future/whitehead/http_pos_paper.html). Perhaps the major limitation of HTTP is that it is a read protocol and not a write protocol. It provides no way of doing web content management or collaboration, but Floyd believes that Web DAV is "likely to resolve these issues" (Floyd, www.pcmag.com/print_article/0,3048,a=23189,00.asp).

Although it is based on the familiar HTTP protocol, "WebDAV uses HTTP to accomplish things the original authors of HTTP never imagined at the time of its invention" (www.swdi.com/WebDAV-Report.pdf).

WebDAV Development Motivation

In 1996, WC3 discussions started about the need for a network protocol to allow remote authoring. An IEPT working group was set up and headed by E. James Whitehead, Jr., of the University of California, Irvine (www.snuffybear.com/ucm_webdav.htm). In an article written jointly by Whitehead and Yaron Y. Goland (www.ics.uci.edu/~ejw/papers/dav-ecscw.pdf), the authors first explain the decision to focus on the network protocol itself as the best way to add collaborative authoring. They conclude that a Web authoring protocol must be able to do the following:

- Treat all content types equally.
- Mediate concurrent access by multiple authors.
- Provide "facilities to create, modify, read, and delete arbitrary properties (metadata) on all Web resources, irrespective of content type."
- Support both live and dead properties.
- Provide "operations to create, modify, read, and delete typed links (relationships) between Web resources of any content type."
- Provide "support to retrieve an authoring-suitable representation of the sources of a Web resource."
- Provide support for copying and moving Web resources.
- Provide support for "creating and deleting a collection, adding and removing members to/from a collection, and for listing the members of a collection" (Whitehead and Goland, www.ics.uci.edu/~ejw/papers/dav-ecscw.pdf).

With these ideas in mind, the IETP Working Group set about to create WebDAV. In 1998 the IETC accepted specifications for WebDAV. The following year RFC 2518 was issued, but it excludes versioning. In 2000, Delta-V or versioning extensions for WebDAV were explored, with WebDAV Versioning issued by the IETF in 2002 as RFC 3253 (www.snuffybear.com/ucm_webdav.htm). Today, work continues on the WebDAV project with several specifications ranging in stages from draft to near completion.

WebDAV as an Extension of HTTP

WebDAV adds new extensions to the familiar HTTP. These extensions take two forms: new headers and new methods. Moreover, additional semantics have been added for existing methods. The WebDAV working group has defined extensions for six capabilities: overwrite protection, properties, name-space management, version management, advanced collections, and access control. To clarify the discussion, the terms "Version management", "collection", and "access control" need to be reviewed.

- **Version management** automatically tracks successive modifications to a resource, thus allowing two or more authors to work on the same document in parallel tracks.
- A **collection** is a group of resources such as subdirectories; collections are hierarchically organized. Advanced collections provide support for collections that contain referential members. These "referential resources act like symbolic links in a file system, allowing the resource to be reused in multiple collections." In addition, collections can contain non-HTTP resources (E. James Whitehead, Jr., and Meredith Wiggins, http://ftp.ics.uci.edu/pub/ietf/webdav/intro/webdav_intro.pdf).
- **Access control** limits rights to a given resource. It supports HTTP Digest Authentication.

New HTTP Headers

Eight new HTTP Headers have been added to WebDAV:

- **DAV** – supports DAV schema and protocol levels to let applications use its features and functions.
- **If** – allows conditional operations.

- **Depth** – determines whether an operation applies only to the current collection or to its children or to all descendants.
- **Overwrite** – determines whether a MOVE or COPY operation is allowed to overwrite resources.
- **Destination** – specifies target directory for operations, such as COPY or MOVE, that require two URI parameters.
- **Lock-Token** – called the "magic cookie," it is used to lock a resource or to remove a lock from a resource.
- **Timeout** – determines how long to wait if a resource is not immediately available.
- **Status-URI** – allows a server to return status information on a resource-by-resource basis (www.swdi.com/WebDAV-Report.pdf).

New HTTP Methods

New HTTP methods have also been added to WebDAV to deal with the major functionality of the protocol:

- **Properties or** metadata – WebDAV properties consist of name, value pairs with the name the URL and the values as Extensible Markup Language (XML) elements. Links are provided to record metadata strings with small properties such as author's name inside the property's value and large values accessed through the URL. Two methods were added to WebDAV to manipulate properties.
  1. Used to retrieve properties, **PROPFIND** sends a single request and receives a single response.
  2. **PROPPATCH** sets or removes multiple properties (Whitehead and Goland www.ics.uci.edu/~ejw/papers/dav-ecscw.pdf).
- **Locking** – To prevent lost versions of collaboratively-edited documents and provide overwrite protection, WebDAV provides two types of write locks: **exclusive write locks** and **shared write locks**. The exclusive write lock has a single lock owner who is the only one authorized to write to the resource. On the other hand, a shared write lock can have several owners simultaneously, with each having write capabilities. Locking, as designed in WebDAV, is not affected by broken Internet connections, thus enabling off-line editing. Literally, when a server grants a lock token to the client, the client then stores the lock token and need not remain connected. When the client reconnects and is authenticated, it then passes the lock token to the server along with a request to write. In addition to **LOCK**, WebDAV also provides an **UNLOCK** method. Moreover, DAV offers a **lockdiscovery** property that allows any client to determine whether a resource is locked or not (Whitehead and Goland, www.ics.uci.edu/~ejw/papers/dav-ecscw.pdf).
- **Namespace** Management – WebDAV provides five methods for manipulating the namespace:
  1. As the name implies, the **DELETE** method deletes the named resource, but it can also be applied to collections.
  2. **MKCOL** creates a new collection resource.
  3. **COPY** copies a resource from a source to a destination. It can also be applied to a collection resource. By default, any properties on the source are also copied onto the destination. WebDAV supports both live and dead properties, with a live property being one that may be retained in the copy and a dead property being one that will not be retained, such as time. If a live property cannot remain live on the destination, it is copied as a dead property.
  4. **MOVE** combines logically a COPY followed by a DELETE. It may also be applied to a collection, and it handles properties the same way that COPY does.
  5. **PROPFIND** may be used to retrieve a listing of all members of a collection based on one or more properties (Whitehead and Goland, www.ics.uci.edu/~ejw/papers/dav-ecscw.pdf).

WebDAV Work in Progress

Work continues on extending the capabilities of WebDAV, including the following:

- **DAV Searching and Locating (DASL)** for developing "an interoperability means of searching a repository" (Whitehead and Wiggins, http://ftp.ics.uci.edu/pub/ietf/webdav/intro/webdav_intro.pdf).
- **WebDAV Bindings** that would allow a resource to appear at multiple URLs.
- **WebDAV Redirect Reference Resources** that provides for creation and administration of resources.
- **WebDAV Ordered Collections Protocol** for "creating and manipulating a persistent, server-defined ordering of a collection's member resources."
- **Access Control Extensions (ACLs)** that would limit rights to a given resource (www.webdav.org/specs).

WebDAV versus FTP

If HTTP is designed for "human to machine conversation," then File Transfer Protocol (FTP) is "oriented toward machine-to-machine conversation." Using large packets, this protocol is indeed "optimized for transfer speed," and it is certainly appropriate for transferring files over the Internet (www.swdi.com/WebDAV-Report.pdf). But each FTP session requires two network connections: a control channel that sends the requests from the client to the server and the data channel that is used to transfer files from one computer to another. WebDAV provides more efficient transfers than FTP.

A single TCP connection is able to "pipeline multiple transfers," unlike FTP that requires a new connection for each file transferred (www.webdav.org/other/faq.html). In other words, each time FTP "grabs or sends a file," it makes a new connection. On the other hand, WebDAV with its Keep Alive connection can reduce overhead and improve data transfer speed (www.upenn.edu/computing/eval/2002/webdav/faq.html).

Because FTP uses two ports, one for control and the other for data, it is "unfriendly to firewalls." Moreover, FTP communications between client and server are sent in plaintext because FTP has no built-in encryption (www.upenn.edu/computing/eval/2002/webdav/faq.html). Many organizations are reluctant to offer FTP access to their servers since FTP does not provide a "very well-controlled environment" (www.interlog.com/~bcholmes/geek/slide-webdav.html). With FTP alone, writing files to the Web is a slow complex process with little security.

FTP has other problems that WebDAV eliminates. For one thing, FTP has "no metadata facilities" (Whitehead and Goland, www.ics.uci.edu/~ejw/papers/dav-ecscw.pdf). Searching using metadata was one of the priorities in the development of DAV. FTP also lacks the ability to use Access Control Lists. Although they can be used in conjunction with FTP, such ACLs are "operating system dependent and can be difficult to manage." The University of Pennsylvania further describes this situation by stating that FTP does not understand the concept of "realms" or areas on the server where privileges are assigned to groups of users (www.upenn.edu/computing/eval/2002/webdav/faq.html). An even more serious problem for collaboration involves FTP sessions that are "stateful." That would "lead to robustness problems for long-duration collaborative sessions." The final problem is FTP's lack of any form of overwrite protection. This problem, alone, causes Whitehead and Goland to declare that FTP is "unsuitable for authoring" (Whitehead and Goland, www.ics.uci.edu/~ejw/papers/dav-ecscw.pdf).

FTP still has an upper-hand over DAV when it comes to files that render themselves when published, such as templates or scripts. Unfortunately, with DAV, such files will be "rendered when accessed from a mounted WebDAV volume." To edit a file, users need the "source" version rather than the "rendered" version. No immediate solution seems available for this problem, although adding a data type field for source code-based documents may be the eventual solution (www.upenn.edu/computing/eval/2002/webdav/faq.html).

Will WebDAV replace FTP? Some authorities believe it will. George Demarest, director of database marketing at Oracle in Redwood Shores, CA, says, "'We see this protocol as an up-and-coming technology. It will likely someday surpass FTP because it has richer services'" (Cathleen Moore, http://archive.infoworld.com/articles/fe/xml/01/10/15/011015/feedge.xml). Sami Itkonen states that "The one advantage that FTP has –file upload— will be taken away by WebDAV." But this source goes on to say that FTP has such a broad usage base that it is "not going to go away anytime soon." Itkonen predicts a hybrid situation where existing FTP clients will support "both old FTP and newer WebDAV-based file transfer." Eventually, perhaps, new clients will use only WebDAV and take "full advantage of the features of HTTP" (Sami Itkonen, www.tml.hut.fi/Studies/Tik-110.350/1999/Essays/webdav.html).

WebDAV Advantages

WebDAV offers many advantages. Karan Dass calls it a "network file system suitable for the Internet" (Karan Dass, www.indiawebdevelopers.com/technology/java/webdav.asp). Another source thinks that it is so powerful that it "offers an integrated solution to replace all the older technologies" (Itkonen, www.tml.hut.fi/Studies/Tik-110.350/1999/Essays/webdav.html). Many authorities credit its HTTP base as the source of many of the protocol's strengths. First, because HTTP has such a "widely deployed infrastructure," WebDAV can take advantage of any server or client that already uses HTTP (Itkonen, www.tml.hut.fi/Studies/Tik-110.350/1999/Essays/webdav.html). All issues associated with a totally new protocol should be moot. Like HTTP, WebDAV is platform independent, both for the server and the browser. It is able to work with any operating system: UNIX, Windows, or Macintosh (www.apple.com/creative/webpro/technology/webdav).

It also appears to have been a wise decision on the part of the designers of WebDAV to retain the same basic message format and headers that HTTP uses. Certainly, this format permits the headers to "carry parameter information to the new WebDAV applications, allowing applications to access and set property information" and other parameters (Floyd, www.pcmag.com/print_article/0,3048,1=23189,00.asp).

Another wise decision from the WebDAV designers is choosing Extensible Markup Language (XML) to encode request and response messages. This decision "facilitates adding features like new property fields at a later time" (Floyd, www.pcmag.com/print_article/0,3048,1=23189,00.asp). In essence, WebDAV can encode method parameter information either in XML or in an HTTP header. The selection of XML builds on the ability to add "extra XML elements to existing structures, providing extensibility." It also provides "internationalization support" since XML can encode information in ISO 10646 character sets (www.idealliance.org/XMLRoadmap/WEB/WebDAV.htm).

By choosing a single-wire protocol (HTTP) with multiple application-level features," (www.webdav.org/other/faq.html), the designers of WebDAV also selected a protocol that is faster and more secure than FTP (Charity Beck, www.unt.edu/benchmarks/

archives/2001/october01/webdav.htm). In addition, WebDAV can take advantage of the benefits of HTTP. Among these are "cryptographically strong authentication, proxying, caching, and encryption with SSI" (Itkonen, www.tml.hut.fi/Studies/Tik-110.350/1999/Essays/webdav.html).

By maintaining port 80 for transport, WebDAV can "piggyback" traffic between client and server, "circumventing firewall and proxy issues that would arise from using a nonstandard protocol and port assignment" (www.upenn.edu/computing/eval/2002/webdav/faq.html).

WebDAV Disadvantages

If HTTP is criticized as being too simple a protocol and too limited in its capabilities, the opposite charges have been lodged against WebDAV. Pointing to the extensive number of drafts and specifications that DAV has gone through, Sami Itkonen of the Helsinki University of Technology, charges that WebDAV is "not a simple protocol. Instead of using one method for one function, WebDAV essentially re-invented the HTTP request/response format in XML, so it could glue a bunch of requests together." Calling the new protocol "complex and bloated," Itkonen points to its requirement for "middleware and application level support" (Itkonen, www.tml.hut.fi/Studies/Tik-110.350/1999/Essays/webdav.html).

Other disadvantages range from DAV's potential to overload "port 80 on servers that were never designed" for the level of file transfer traffic that will result from widespread usage of DAV (www.swdi.com/WebDAV-Report.pdf). to warnings about security issues with the new protocol. In an article entitled "WebDAV: Work Together," published in *PC Magazine*, Michael Floyd criticizes DAV for not directly addressing security issues. He urges users to "observe common-sense rules and look to the existing infrastructure for protection" (Floyd, www.pcmag.com/print_article/0,3048,a=23189.00.asp). Pointing out that there is no "straightforward way to use the standard Unix password authentication," the University of Oregon website also expresses concerns about security and adds that the protocol requires increased maintenance of a WebDAV server to provide security through htaccess files and passwords. This site also states that files created by the WebDAV server have "insecure permissions as well, making access and modification a problem" (Spencer Smith, http://cc.uoregon.edu/cnews/winter2003/webdav.html).

A document from Penn State University suggests that ACLs provide some drawbacks, citing a scenario where an employee with authority can change the ACL so that only that employee will have access to a resource. The same site has a less malicious scenario where an employee becomes ill during an editing session and is unable to work for a few days. Such a situation, Penn State suggests, would bring work to a halt because of the exclusive locking that WebDAV provides (www.personal.psu.edu/staff/d/s/dsg3/emergingtechnologies/dav.htm).

Several sites indicate problems with WebDAV applications or operating systems. It appears, however, that these problems are the result of the developer of the application or operating system and not of DAV itself. For example, sambar.com points out that WebDAV support in Internet Explorer 5 is "fairly buggy" requiring "enabling the Share User Logins flag" since IE 5 does not send "cookies when using 'Open as WebFolder.'" The site points out that IE 6 should repair these limitations (www.sambar.com/syshelp/webdav.hrm).

Another Microsoft related problem with WebDAV and Windows 2000 involves an "unchecked buffer" that handles the DAV protocol. Microsoft Security bulletin MS03-007 points out that this buffer could "enable an attacker to cause a buffer overflow on a machine running IIS." As a result, attackers could "mount a denial of service (DoS) attack…or execute their own malicious code in the security context of the IIS service, giving them unfettered access to the vulnerable system." By sending "malformed WebDAV requests" to a machine running IIS v5, attackers are able to establish a connection with the Web server using Port 80 (Paul Roberts, www.infoworld.com/article/03/03/17/HNmsiisflaw_1.html?security). Microsoft provides a patch for Windows 2000 and points out that their Windows NT and Windows XP operating systems are immune to such problems (www.microsoft.com/technet/treeview/default.asp?url=technet/security/bulletin/MS03-007.asp).

Finally, let's examine a criticism that also offers a possible future enhancement to WebDAV. Bita Shadgar and Ian Holyer of Bristol University pointed out at the IADIS International Conference WWW/Internet 2002 that WebDAV authoring involves file system resources and operations. As it currently exists, Shadgar and Holyer find it "hard to tailor other kinds of resources like databases in the WebDAV framework." They go on to state that they believe "WebDAV can help to provide a standard way of accessing and authoring databases via the WWW." Pointing to WebDAV's metadata, they believe it can be used to extract metadata from databases as well. To do so, they propose viewing each database record as a "separate resource, and each table as a collection within WebDAV." Believing that DAV offers "an opportunity to define a standard way of accessing . . . metadata via properties," they propose that a new method called **BATCH** be added to WebDAV that would "treat the sequence of methods relevant for each [database] operation as a single resource" or a single transaction. Not only would a new BATCH method make it possible to use DAV's metadata capabilities for databases, but it would also improve DAV's speed. Most commercial databases already have WebDAV support at the file level. By using a primary key or row identifier for each record, Shadgar and Holyer say that individual records can be

"treated as separate resources." After all, both databases and WebDAV share the main idea of treating Web resources as a collection of records or objects. With the new BATCH method, they see WebDAV properties as a way of presenting "database metadata as a standardized way" to provide database authoring via the Web. Shadgar and Holyer conclude that eventually they "expect all database manipulation to be carried out using standard request methods" in WebDAV (Bita Shadgar and Ian Holyer, www.cs.bris.ac.uk/Tools/Reports/Abstracts/2002-shadgar.html).

Current WebDAV Use

Support for WebDAV continues to grow. Among the clients that already use WebDAV are Microsoft, Adobe, Apple, and Macromedia. It's incorporated in Windows operating systems and Microsoft Office applications. With a WebDAV redirector incorporated into the file system of Windows XP, a user can "use any existing Windows application to access a WebDAV file share." Combined with XP's file encryption, DAV makes it possible to store personal files "securely on a public place." Although DAV writes an entire file, when the user opens the file from the Web, it is copied to the cache of the local computer, and when the user closes the file, Windows XP automatically puts the modified file back to the original Web location (http://www.extremetech.com/article2/0,3973,554847,00.asp). "The world's leading provider of e-learning solutions to higher education," WebCT, also supports WebDAV (www.webct.com).

A quick search revealed that WebDAV is used at the University of Oregon (Smith, http://cc.uoregon.edu/cnews/winter2003/webdav.html), St. Petersburg College (http://it.spcollege.edu/webcttutorial.webdav), the University of North Texas (Philip Baczewski, www.unt.edu/benchmarks/archives/2001/october01/wwwuntedu.htm), California State University, Chico (www.csuchico.edu/tlp/webct/reference/webdav), the University of Pennsylvania (www.upenn.edu/computing/eval/2002/webdav), Eastern Illinois University (www.eiu.edu/vce/faculty/webdav), Simon Fraser University in British Columbia (Jeff Bryer, www.sfu.ca/acs/focus/02-2/webdav.htm), Penn State University (www.personal.psu.edu/staff/d/s/dsg3/emergingtechnologies/dav.htm), the University of Illinois at Urbana-Champaign (http://w3.ed.uiuc.edu/oet/supportfileserviceswebdavoverview), and even for maintaining the website at Central Carolina Community College (Brent Brafford, interview, April 9, 2003).

The Future of WebDAV

While work on WebDAV continues and more and more operating systems and applications incorporate support for it, Whitehead and Goland declare that WebDAV is a "well-engineered protocol adapted to the Internet environment" (Whitehead and Goland, www.ics.uci.edu/~ejw/papers/dav-ecscw.pdf). However, in September 2002 Goland admits that the "transition to WebDAV will take a long time but support is there and growing" (Yaron Y. Goland, www.goland.org/webdav.htm).

In spite of growing support for WebDAV, some dissenters remain. In an article titled "WebDAV Arrives, authors Bernard Chester and Dennis E. Hamilton express different views about WebDAV's future. Hamilton, a NuovoDoc systems architect and technical coordinator for the AIIM DMware Interoperability Exchange, thinks that WebDAV is "irresistible for integration of collaborative authoring and management of documents into the Web model." Believing that WebDAV is the "filing system of the Web," Hamilton calls it "simply a matter of time" before WebDAV is recognized as the way to manage documents. He urges people to "get on the learning curve" and figure out how the protocol's capabilities will serve their organization. On the other hand, coauthor Chester of IMERGE Consulting and co-chair of the AIIM Standards XML Committee, has a different opinion. At the very least, Chester is "guarded in his enthusiasm," pointing out that much of WebDAV's interface is new and "needs to be shaken out in real world practice." He has a further concern that WebDAV will "force implementers to build on the lowest common level, or adhere to one predominant repository model, to the exclusion of other schemes" (Bernard Chester and Dennis E. Hamilton, http://nfocentrale.net/NuovoDoc/analysis/WebDAV-Arrives-2002-03-28.doc).

Sami Itkonen of the Helsinki University of Technology, wonders if WebDAV is "just another case of reinventing the wheel." While expressing the opinion that current technology is working well, Itkonen admits that WebDAV potentially has much to offer and will be the "main focus of new developments" in any kind of distributed computing (Itkonen, www.tml.hut.fi/Studies/Tik-110.350/1999/Essays/webdav.html).

Pointing to WebDAV's use of XML to store resource properties, Andrew Fuqua and Justin Sovich of the University of New Mexico call DAV a versatile architecture that "opens the door to customization and innovation." They conclude that it is "left entirely up to the imagination of the developers and users of WebDAV enabled software" to determine how to use the new resource properties of DAV (Andrew Fuqua and Justin Sovich, http://www.unm.edu/~hamjavar/item/webdav3).

As a result of WebDAV, Whitehead foresees a "whole new class of Web-enabled devices" that can write to the Web. For example, he images a WebDAV-enabled digital camera with a built-in cellular modem that can transfer a picture to a Web server as soon as the photo is taken (E. James Whitehead, Jr., *Collaborative*, http://www.asis.org/Bulletin/Oct-98/webdav.html).

Perhaps you never heard of WebDAV before today. If so, you are not alone. Rael Dornfest speculates that people don't often talk about WebDAV

because it is "just silently working in the background and not needing much tending." He then offers an amusing reason for WebDAV's low profile: "Possibly it's never seemed sexy enough to demand much hype" (Rael Dornfest, www.oreillynet.com/lpt/a/1663). When you know about WebDAV and what it can do, you may agree with Dornfest's conclusion and also be "impressed by the places WebDAV shows up – baked right into popular operating systems (Mac OS X, Windows), well-integrated into authoring tools and content management systems for collaborative content editing and management, and available for just about every programming environment" (Dornfest, www.oreillynet.com/lpt/a/1663).

What is WebDAV's future? In our opinion, it's here to stay and will only get better and more pervasive with time. We agree with Greg Stein who calls WebDAV a "great standard" that "replaces many protocols with a single protocol." Indeed, as Stein predicts, WebDAV may "change the very nature of how people interact with the Web" (Greg Stein, www.webdav.org/papers/ApacheCon-2002-US-TH01.ppt). WebDAV is not merely a web-writing protocol, but it is much more. Perhaps we'll wonder someday how we ever used the Web without DAV.

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