

Exploitation of Web Technologies for C2

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Abstract

The family of Web Technologies presents a number of new opportunities for applications. These technologies include the variety of machines from handheld PCs to large systems and the software to give them web accessibility. Without question, the Web has captured the interest and support of the commercial software communities. We present some ideas based on findings from our ongoing work that will portray the opportunity that exists for C2 applications, important technology considerations, and a viable approach for incorporating and integrating web technologies. We address some major issues related to the use and relevance of these technologies for C2 such as *Scalability*, *Multi-Site Collaboration*, *Software Migration*, *Legacy Integration*, *Obsolescence*, and *Extensibility*. Web links to sites containing further information are also provided.

1. The Opportunity

As C2 environments become ever more complex in dimensionality and response criticality, technology needs to be applied to reduce latency between observation and action, minimize the chance of misinterpretation of sensor data, and generally improve the overall quality of decision-making capability available to the warfighter.

One suite of technologies that has emerged in the commercial Information Technology (IT) industry sector and is maturing very rapidly is colloquially referred to as *web technologies*, alluding to the utilization of the World Wide Web on the Internet Backbone as a telecommunications media.

Web Technologies (WT) encompass commercial IT quality software enabling the creation, viewing and management of multi-media data consisting of text, audio, video, images, graphics

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and animations. Transmission of these data sets can be accomplished using commercially available networks and protocols, in open and secure modes, and on public or private communication networks. Data sets can vary from simple “e-mail” style messaging to robust, secure multi-user collaboration sessions enabling shared whiteboards and similar mechanisms.

The implication to traditional C2 systems may be significant during both design and operation phases. Commonality of user interfaces provided by Web browsers across platforms serves to reduce the cost of operator training and minimizes transaction errors. System designers can use commercial hardware and software components to their advantage thereby reducing development costs, reducing the number of system variants, and simplifying modification and maintenance procedures.

Because of their widespread acceptance, web technologies are spawning a new generation of technical developers familiar with a broad range of tools for building and integrating web applications. The new approaches the web developers take depend highly upon re-usable objects, commercial or otherwise, available in vast degree. Web developers seldom build from scratch, but instead integrate components developed with re-usability in mind.

2. Technology Considerations

A web approach to application development consists predominantly of *digital content*, which includes HTML-linked web pages, imagery, sound bytes, video segments, and 3-D objects with varying degrees of detail from simple color models to photo-realistic objects with intrinsic behaviors and lifelike attributes. These elements can be easily combined into a relevant application design scenario, depicting portions of the target customer's working environment. Pages can contain behavioral scripts written in JavaScript to enable event handling, error capture, and animations. This custom behavioral code is included implicitly within the digital content and does not leak through to the user except as a means to click and otherwise interact with the objects on the page. C2 applications that typically involve real-time multi-site collaboration can benefit from many of these attributes. In addition, the applications tend toward simplified maintenance, co-existence with legacy applications, and even enhancement of these legacy applications.

The remainder of this paper documents some of our experience and our conclusions regarding use of web technologies for applications.

3. Approach

Our approach using web technologies consists of a number of new considerations that previously were in the domain of specialized custom applications. Particularly, highly interactive graphical user interfaces (GUIs) consumed a dominant part of custom application development. The notions of network distribution of applications, shared resources, iterated development ongoing from a truly usable prototype, and a focus on packaged re-usable objects, all shed new light on how to develop or enhance applications rapidly, at reduced overall cost, in a commercially supported setting.

We highlight below several major considerations that are important for web-centric C2 application development.

- Examine the use of web-centric technologies to rapidly prototype significant C2 applications. Many web components of varying degrees of complexity are available in the public domain or, in the case of 3-D models, from the user's own CAD, CAM or similar archives.
- Determine the utility of web technology in solving remote collaboration problems; real time data acquisition can be straightforwardly embedded.
- Produce an iterated prototype that can be extended quite easily rather than undergo complete redesign; Complex hyperlink systems can be developed in man-weeks or man-months.
- Make the software product easy for domain personnel to use; the "look-and-feel" approximates that of popular business or office system software. Where possible, test components in the field with military users.
- Produce a body of re-usable object components for new extensions and modifications; tools for development, modification and maintenance are widely available.

Web-centric technologies manifest themselves within development toolkits as well as products for the end user. That is, the benefits to the developer include inexpensive, reliable, code generators for HTML, VRML, Java, and JavaScript running on common platforms, UNIX and Microsoft NT/95/98. The benefits to the end user will be evident in cross-platform interoperability, common browser-based user interfaces, operational scalability from a single user to the worldwide enterprise, and platform scalability from laptop PCs to high performance workstations. Incorporating web-technologies compares very favorably over the use of proprietary technologies or custom platform-specific solutions.

4. Major Issues

In this section, we explore several of the major issues surrounding the use of web technologies and their relevance to the C2 environment. Dominant among these are *scalability*, *multi-site collaboration*, *software migration*, *legacy integration*, *obsolescence avoidance*, and *ability to readily extend or enhance an application*. The following paragraphs discuss these issues.

4.1 Scalability

Scalability relates to how well an application runs and serves its constituents as networks get faster, more nodes are added, computers and software get faster, and as more users are added. Our findings suggest that decision-making can often be enhanced considerably if users have the opportunity to instantly collaborate with others in their domain of experience. Collaboration on a network among an increasing number of users presents a considerable scalability issue.

From our work, a collaborative system operates using standard web-based protocols and requires no special hardware or software beyond the free browsers and plugins generally available publicly. It can function on an organization's local Intranet or standalone on an individual's workstation. Such systems will operate much more favorably over high-speed connections

provided by T1 or even ATM OCX services. The full potential of web technologies does not require ATM, but will capitalize on its features if available. The same is true of fast Ethernet or Switched Ethernet or whatever medium is able to handle TCP/IP and web protocols.

4.2 *Multi-Site Collaboration*

Collaboration to many web users today means sharing a common whiteboard for pasting documents into common view, perhaps while communicating over a voice/video link. This degree of document sharing is useful. However, our approach has the technological hooks already in place to conduct 3-D shared workspaces where avatars show user presence while objects in the shared space can be manipulated or sent events to cause an action or reaction.

The potential exists to connect a variety of interaction devices well beyond the common mouse/keyboard interface. Our preliminary collaborative 3-D environments show the simplest cases of *virtual reality* where a user's screen, keyboard and mouse are his entry into 3-D virtual space. Figure 1 shows a typical scenario where users collaborate in an equipment training and maintenance scenario.

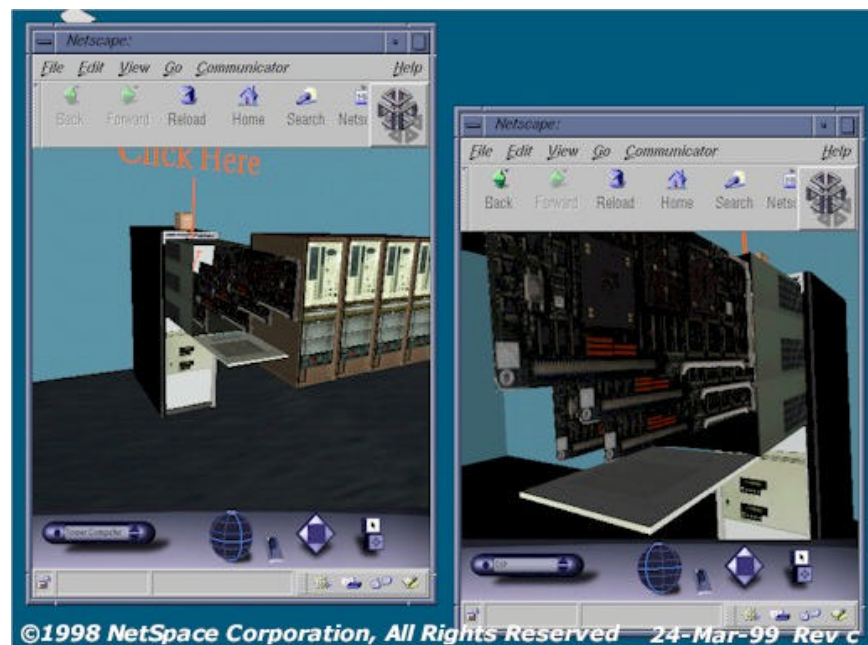


Figure 1. Collaborative 3-D browsing of equipment for training and maintenance

4.3 *Software Migration*

Typically and historically, software in general can be categorized as *source codes* (human accessible and readable in some language) and *compiled codes* (generated from source codes, these are machine readable and executable binary codes on a target machine). Today, it is fair to include among these categorizations the vast number of human readable sources among which C++, Java, JavaScript, HTML, XML, 3-D specifications such as VRML and Web3D, Perl, TCL, Visual Basic, Python, digital music specifications such as MIDI, and image specifications such

as PostScript, have particular relevance to web-centric development. The compiled products or interpreted products of these sources constitute the "binary software" that makes the web so useful.

Specific vendor hardware or software products do not limit web-oriented applications. As the applications need to become more complex and detailed, web applications will still be relevant on low-end hardware all the way up through the most powerful 3-D graphics workstations able to run the prescribed web browsers and plugins. As the web software technology improves, software scalability improves as well. Web-based software can be grown right along with new browser releases from the marketplace. Furthermore, the majority of modeling work constitutes re-usable digital content for further work, whether new or enhanced.

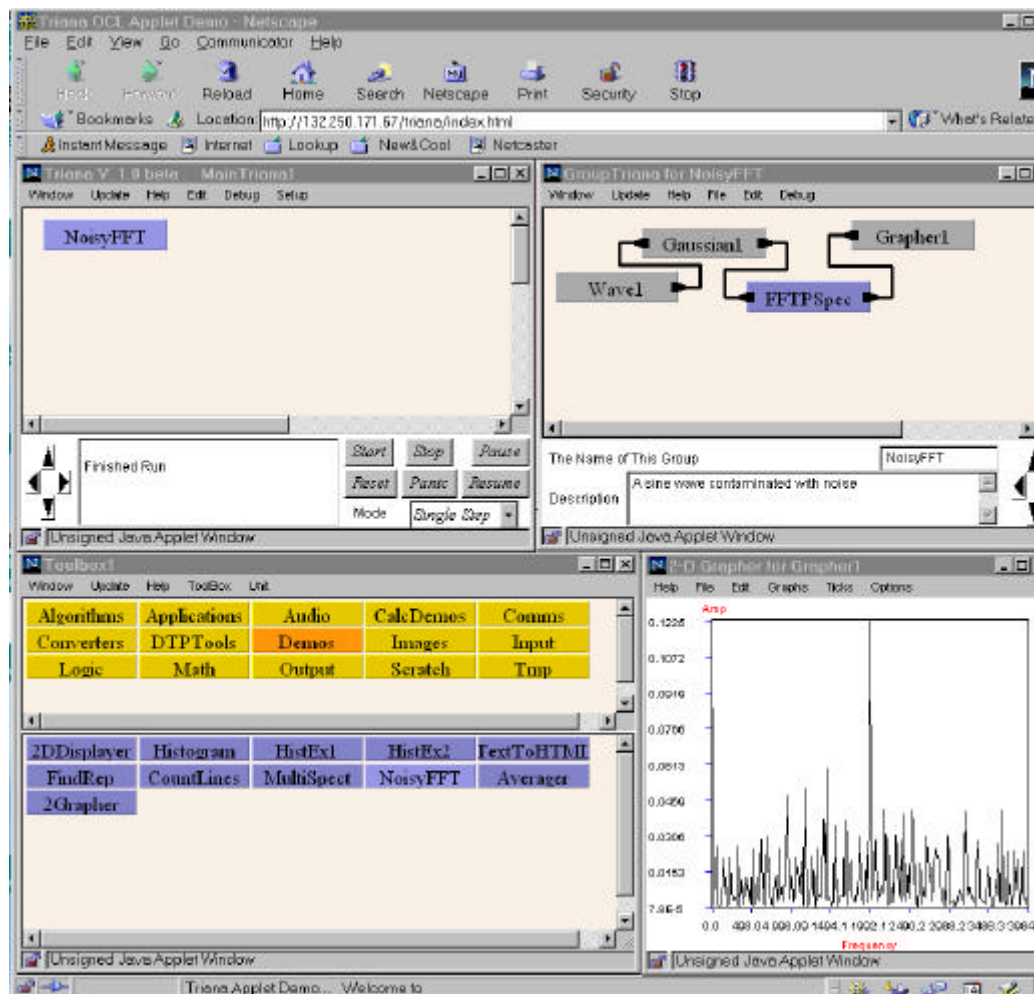


Figure 2. *TrianaWeb* Signals Analysis Environment

Figure 2 shows *TrianaWeb* a browser-based analysis environment written in 100% Java. Initially a graduate student project, *TrianaWeb* provides for wiring common analysis modules together based on their Java interfaces. *TrianaWeb* is as platform independent as the Java version upon which it is built. The *Triana* analysis environment can also be used without modification for other kinds of applications, such as image processing, as shown in Figure 3.

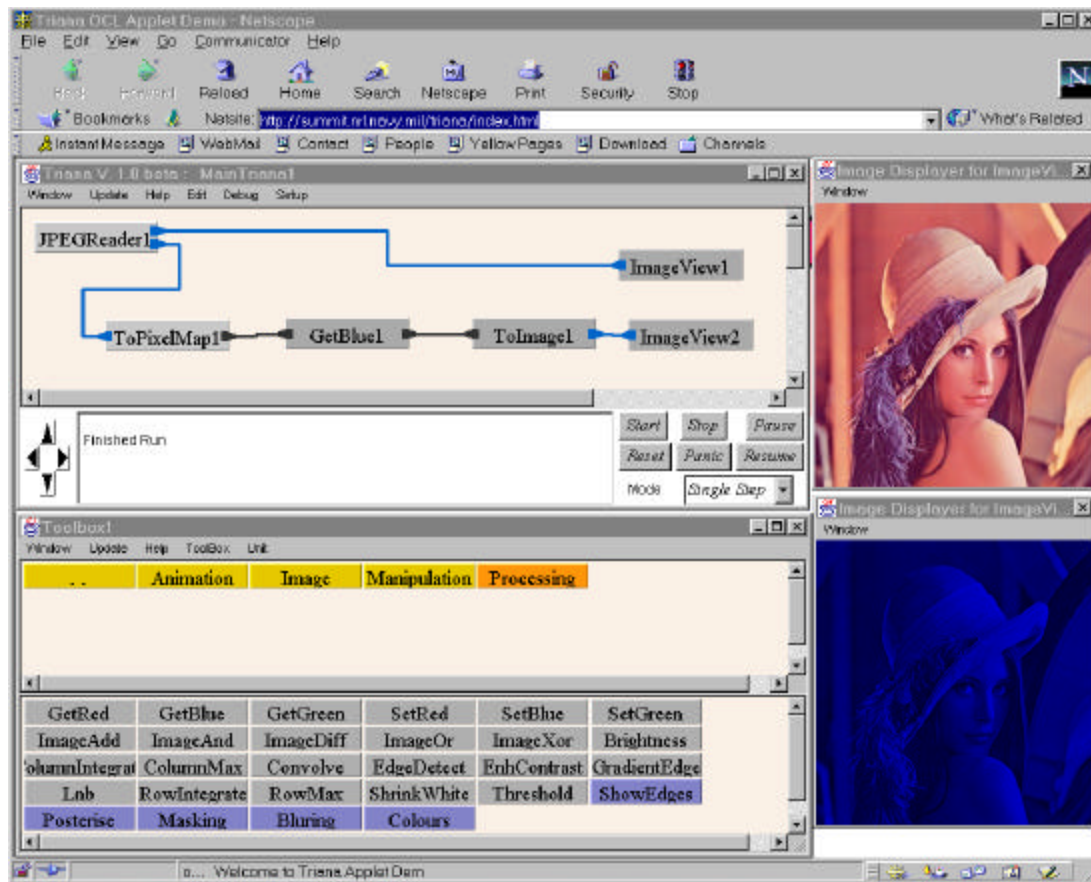


Figure 3. *TrianaWeb* Image Analysis Environment

4.4 *Legacy Integration*

A web approach can be used to start up legacy applications. Often legacy applications require tedious, error-prone command line entry by users. Web applications can easily embed these commands into its objects. For example, a simple click on an object can fire a complex command to a remote device. Likewise, remote events can autonomously direct the activity of synthetic visual objects quite like remote cameras or sensors are now able to perform in a rather complex scenario. A common commercial activity by vendors centers on making a legacy application *web-centric*. The idea is to incorporate a web GUI initially, but strive toward integration of databases and client/server environments that exploit the web orientation.

Figure 4 shows how we incorporated legacy flat file databases into a web framework using an Oracle Database. The legacy information relevant to the query is converted on-the-fly for storage in Oracle where it is subsequently accessed by the application rather than returning to access the legacy database. In this way, complete time-consuming conversion is avoided and only the data of interest is converted on-the-fly and saved.

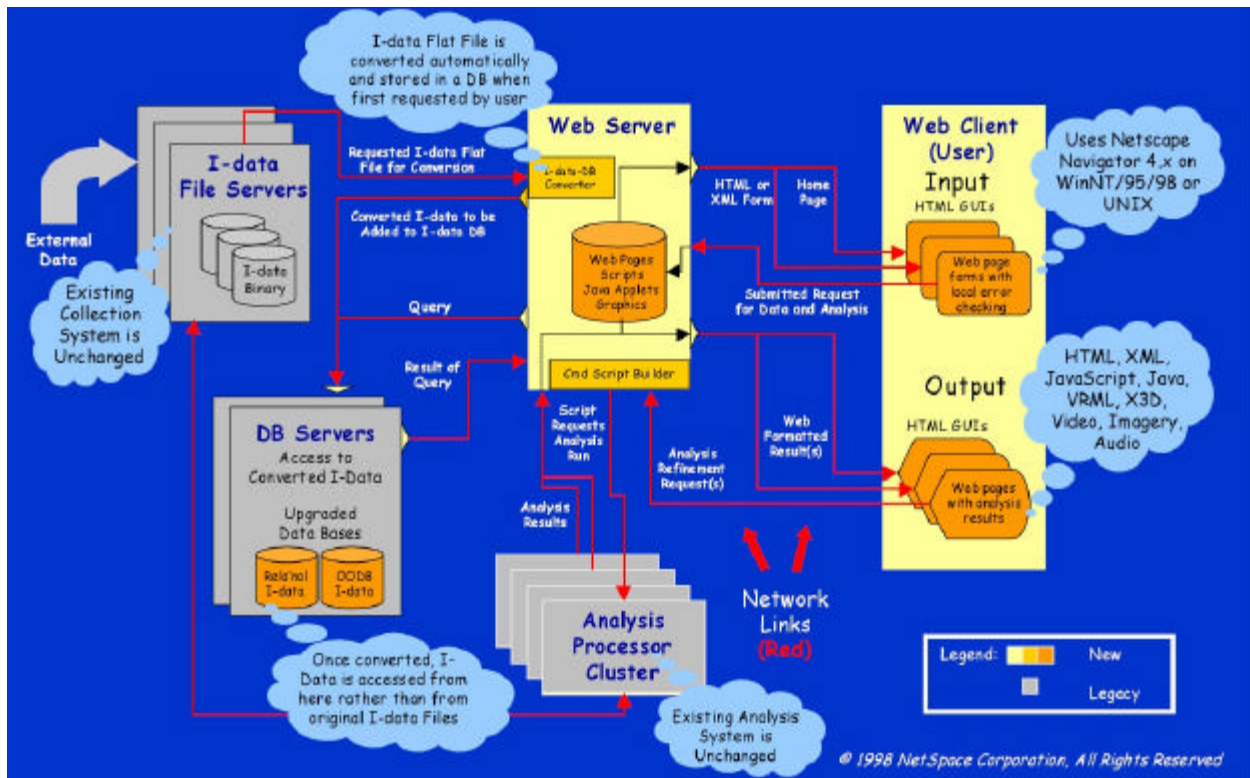


Figure 4. Legacy Inclusion in a Web Framework

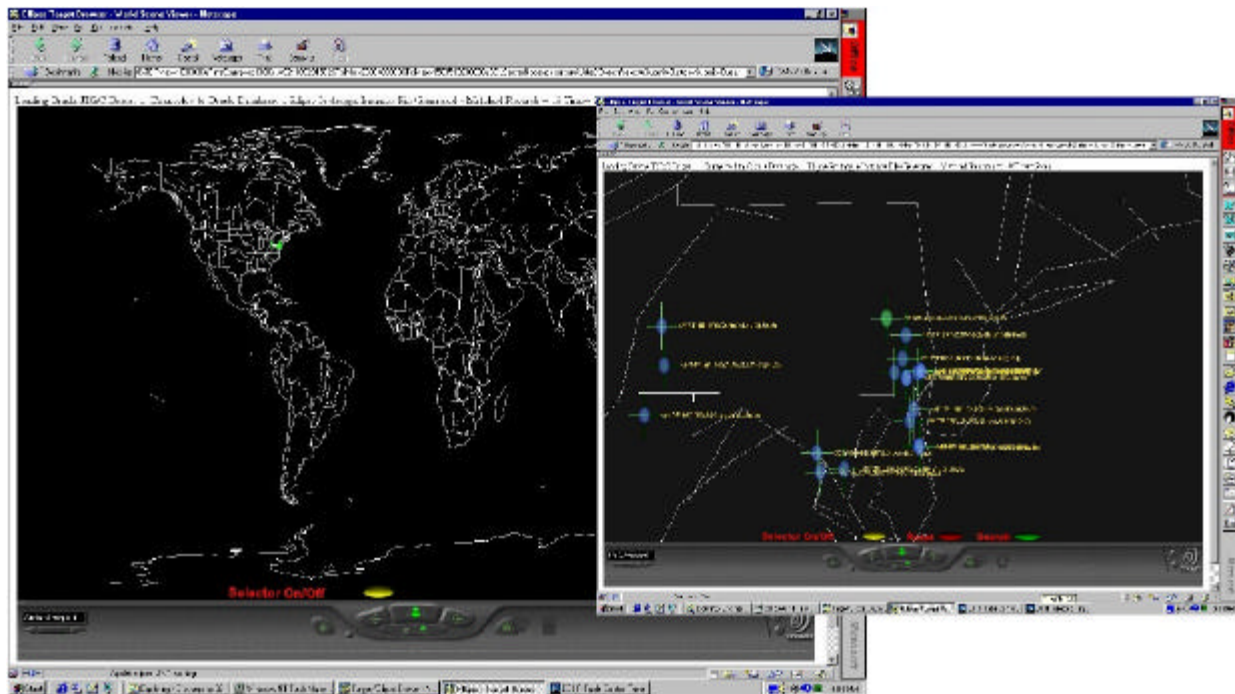


Figure 5. 3-D Signals Application Using Converted Legacy Database Information

This work was done in the context of a signal analysis application in 3-D that is shown in Figure 5. Here the maps are in 3-D and contain continuous zoom capability with higher levels of detail revealed automatically. Java was used to show detailed auxiliary data regarding the sampled points of interest from the Oracle database. Java Swing component tables accompany the 3-D views although not shown here. Swing tables provide an elegant set of properties and manipulators to enhance usability of the tables.

4.5 *Obsolescence Avoidance*

Common among the software industry vendors is the rapidity with which applications are enhanced and new versions appear. Where formerly, release schedules were at best annual affairs, we now see complete new versions appearing almost on a monthly basis. The web approach addresses these issues and is a clear means of reducing rapid obsolescence. For example, a common practice by major browser providers now offers a web user the opportunity to completely upgrade his machine's browser software and attendant plug-ins merely upon a visit to the vendor's web site. Because these are based on component delivery using *channels*, the components will continue to be relevant and can be changed quite readily. Many vendors are moving toward this rather painless way of keeping resident software up-to-date along with other automatic means of updating software over the web.

Web technology is advancing more rapidly than any other single software technology today. The methods used will be relevant to C2 as long as there are web pages, graphics, imagery, videos, and remote sensors.

4.6 *Application Extension*

Web applications employ industry standard methods for development of digital content for web-based use. These development packages permit creation and editing of *HTML* documents, *gif*, *jpg*, *png* images, *mpeg2*, *avi*, and *wrl* documents and can be used quite easily. There are a plethora of *web-page builders* and automatic HTML source code builders available in the marketplace. EarthWeb provides a broad array of access to these resources for free at <http://www.earthweb.com>. Here are some other useful Universal Resource Locators (URLs)

<http://www.javascripts.com>
<http://www.developer.com>
<http://www.htmlgoodies.com>
<http://www.datamation.com>
<http://www.intranetjournal.com>
<http://www.gamelan.com>
<http://www.javascripts.com>
<http://www.gocertify.com>
<http://www.jars.com>
<http://www.roadcoders.com>
<http://www.earthwebdirect.com>
<http://www.itknowledge.com>
<http://www.y2kinfo.com>

<http://www.itlibrary.com>
<http://www.dice.com>
<http://www.opensourceit.com>
<http://www.erphub.com>

Web browsers are freely downloadable and upgradable from these sources.

Internet Explorer for PCs and MACs at <http://www.microsoft.com>
Netscape Navigator/Communicator at <http://home.netscape.com>
HotJava browser from <http://www.javasoft.com>
A neat new complement for IE Explorer called NeoPlanet at <http://www.neoplanet.com>

3-D browser plug-ins and add-ons are freely available from these sites.

CosmoPlayer 2.1 VRML add-on for IE Explorer 4.0 at <http://www.cosmosoftware.com>
CosmoPlayer 2.1 VRML plug-in for Netscape Navigator at
<http://www.cosmosoftware.com>

Additional flexibility with dynamic content can be provided through the use of the Extensible Markup Language (XML) that significantly enhances HTML-like tagging for broad use. More information is available from this site. <http://www.xml.com>

Commercial product offerings for building specialized web applications are available from these sites.

3-D applications integrated into HTML web pages at <http://www.sgi.com>
Java application builders and resources at <http://www.javasoft.com> and
<http://java.sun.com>

5. Summary

The use of web technology in a C2 environment is in its infancy. In this paper, we have discussed emerging web technologies in the context of C2. In the near future, intelligence collections and collateral data will be available to decision-makers as dynamic 'objects' to be analyzed, distributed and shared at will. Logging on to a C2 website will include collaboration in a 3-D virtual environment. These capabilities are expected within the next few years. This technology will have a profound effect on the future of network-centric warfare.