

Embedded Web Technology: Internet Technology Applied to Real-Time System Control

The NASA Lewis Research Center is developing software tools to bridge the gap between the traditionally non-real-time Internet technology and the real-time, embedded-controls environment for space applications. Internet technology has been expanding at a phenomenal rate. The simple World Wide Web browsers (such as earlier versions of Netscape, Mosaic, and Internet Explorer) that resided on personal computers just a few years ago only enabled users to log into and view a remote computer site. With current browsers, users not only view but also interact with remote sites. In addition, the technology now supports numerous computer platforms (PC's, MAC's, and Unix platforms), thereby providing platform independence.

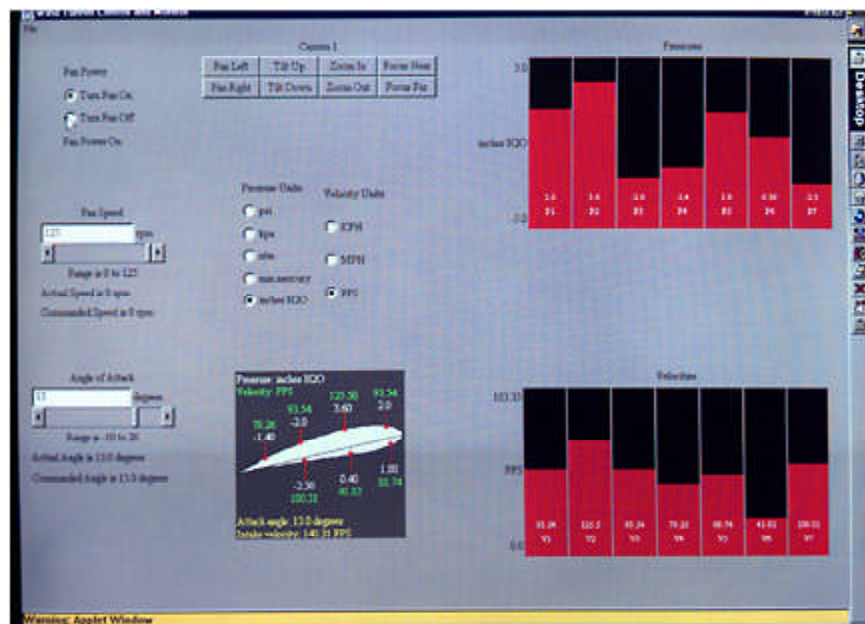


Small wind tunnel (6- by 6-in. test section) controlled over the Internet.

In contrast, the development of software to interact with a microprocessor (embedded controller) that is used to monitor and control a space experiment has generally been a unique development effort. For each experiment, a specific graphical user interface (GUI) has been developed. This procedure works well for a single-user environment. However, the interface for the International Space Station (ISS) Fluids and Combustion Facility will have to enable scientists throughout the world and astronauts onboard the ISS, using different computer platforms, to interact with their experiments in the Fluids and Combustion Facility. Developing a specific GUI for all these users would be cost prohibitive. An innovative solution to this requirement, developed at Lewis, is to use Internet technology, where the general problem of platform independence has already been partially solved, and to leverage this expanding technology as new products are developed. This approach led to the development of the Embedded Web Technology (EWT) program at Lewis, which has the potential to significantly reduce software development costs for both flight and ground software. However, applying this solution to the Fluids and Combustion Facility, or any other embedded control, would require

technological breakthroughs.

The Lewis team proceeded to develop the first real-time embedded hypertext transfer protocol server software designed for space flight. This software, when loaded into a control processor, allows the processor to act as a "remote site." Authorized users, using a browser, can interact with the control processor to retrieve data and control the experiment. Another innovation is to serve Java applets (executable programs written in Java and embedded in Web pages). When users download the desired applets to their browsers, the applet produces a graphic of the sensor and the current sensor reading. Users can thus develop their own GUI's. This innovation alone has the potential for enormous cost savings over the alternative of developing many specific GUI's, and it is directly applicable to our original problem of how to support many undefined users on multiple platforms.



Graphical user interface screen developed using Java applets for controlling the small wind tunnel.

The Embedded Web Technology program also has commercial and nonspace applications in products where a microprocessor is used for control. The developed software has been loaded into a control computer for a small wind tunnel. The wind tunnel, which is controlled via the Internet, will demonstrate the technology at an Embedded Web Technology workshop sponsored by the Great Lakes Industrial Technology Center, a NASA Technology Center managed by Batelle. The workshop will foster technology transfer to commercial businesses in the Great Lakes Region.

Lewis contacts: Carl J. Daniele, (216) 433-5325, Carl.J.Daniele@grc.nasa.gov; Richard A. Tyo, (216) 433-8619, Richard.A.Tyo@grc.nasa.gov; and David W. York, (216) 433-

3162, David.W.York@grc.nasa.gov

Author: Carl J. Daniele

Headquarters program office: OLMSA

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