Accessing NASA Technology
with the
World Wide Web

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ABSTRACT

NASA Langley Research Center (LaRC) began using the World Wide Web (WWW) in the summer of 1993, becoming the first NASA installation to provide a center-wide home page. This coincided with a reorganization of LaRC to provide a more concentrated focus on technology transfer to both aerospace and non-aerospace industry. Use of WWW and NCSA Mosaic not only provides automated information dissemination, but also allows for the implementation, evolution and integration of many technology transfer and technology awareness applications. This paper describes several of these innovative applications, including the on-line presentation of the entire Technology OPportunities Showcase (TOPS), an industrial partnering showcase that exists on the Web long after the actual 3-day event ended. The NASA Technical Report Server (NTRS) provides uniform access to many logically similar, yet physically distributed NASA report servers. WWW is also the foundation of the Langley Software Server (LSS), an experimental software distribution system which will distribute LaRC-developed software. In addition to the more formal technology distribution projects, WWW has been successful in connecting people with technologies and people with other people.

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Manuscript received January 30, 1995.

0885-8985/95/ $4.00

INTRODUCTION

Internet-based information tools have changed the communication and work models of many organizations. Individuals now have the capability to search and retrieve information on their own, without having to leave their personal work environment. This paper will not discuss the history, implications, or mechanics of the Internet; readers are referred to [1-3] for good introductions to the Internet.

The applications that made Internet access a reality for many people are the World Wide Web (WWW, or "the Web") [4] and NCSA Mosaic [5]. The World Wide Web was developed at CERN in Switzerland and defines a multi-media

Table 1. Some NASA Technology Transfer World Wide Web Resources

Resource	URL
NASA Langley Research Center	http://www.larc.nasa.gov/
NASA - (agency home page)	http://www.nasa.gov/
Technology Opportunities Showcase (TOPS)	http://www.larc.nasa.gov/TOPS/
Langley Technical Report Server (LTRS)	http://techreports.larc.nasa.gov/ltrs/ltrs.html
NASA Technical Report Server (NTRS)	http://techreports.larc.nasa.gov/cgi-bin/NTRS
NASA LaRC 1994 Internet Fair	http://ice-www.larc.nasa.gov/FAIR/
1993 LaRC Research and Technology Highlights	http://sti.larc.nasa.gov/RandT/Contents.html
NASA LaRC Technology Applications Group	http://tag-fileserver.larc.nasa.gov/
NASA Commercial Technology Network	http://nctn.oact.hq.nasa.gov/nctnHome.html

information environment that allows for the inter-linking of data objects on the network. But it was not until the arrival of NCSA Mosaic, developed at the National Center for Supercomputing Applications at the University of Illinois Urbana-Champaign, that the popularity of the WWW was firmly established. NCSA Mosaic is a client, (or reader) that allows users to seamlessly browse the various information servers that comprise the WWW. While there are many different clients that allow one to access the WWW (including commercial versions), NCSA Mosaic has the most functionality and support. To get a copy, perform an anonymous FTP session to:

ftp.ncsa.uiuc.edu
directory "We b/Mosaic"

This area contains executables for all popular machines (PC/Windows, Macintosh, UNIX / X Window System). Further installation directions can also be found at this site.

Prior to the arrival of the World Wide Web and the availability of NCSA Mosaic, the bulk of NASA's on-line information services consisted of a scattered number of FTP, gopher and WAIS servers. While these servers often contained useful information, they were often not "officially" supported and the number and scope of the servers was frequently unclear. More importantly, they served only a small number of people, since few knew they existed and fewer still knew how to extract data from them. NCSA Mosaic changed the situation entirely. Its availability on all three popular platforms (UNIX/X Window System, Mac, Windows) allowed computer users to access working lists, or "home pages," of all those obscure telnet, FTP, and gopher servers, and access these services in the "same place" using the same tool.

The NASA World Wide Web Home Page became publicly accessible Fall 1993. Shortly thereafter, people at various NASA centers sought each other out and the NASA Web began to take shape. As the NASA Web developed, it enabled more NASA personnel to become involved in the highly successful grass roots NASA WWW effort. It became clear that if the Web allows NASA personnel to find each other, then the Web is a natural vehicle for NASA to attract and interact with industrial and research partners. Table 1 lists some interesting NASA technology access and transfer resources.

The World Wide Web and NCSA Mosaic have become part of the information dissemination architecture for many LaRC projects, including fulfilling LaRC's commitment to technology transfer. It is part of NASA's mission to "research, develop, and transfer advanced aeronautics, space and related technologies." However, technology transfer is not as simple as placing computer codes, reports and telephone numbers on the Web. Before technology transfer can occur, there must be technology awareness. Advertising and displaying available LaRC technologies on the Web has proven to be a highly effective tool in demonstrating the national relevance of Langley Research Center's mission.

TECHNOLOGY OPPORTUNITIES SHOWCASE

The Technology OPportunities Showcase (TOPS '93) was held October 19-21, 1993. The purpose of TOPS was to showcase critical LaRC technology, expand potential dual-use opportunities, and strengthen existing and cultivate new strategic industrial partnerships. The initial conference had approximately 850 attendees from 400 organizations visit 185 exhibits. Attendees were given 1-page Technical Information Sheets for each exhibit and additional overview material to take back. However, when the showcase was over and the displays were broken down, access to the technology showcase ceased.

To address this issue, the center director asked that an on-line repository be constructed to preserve this information

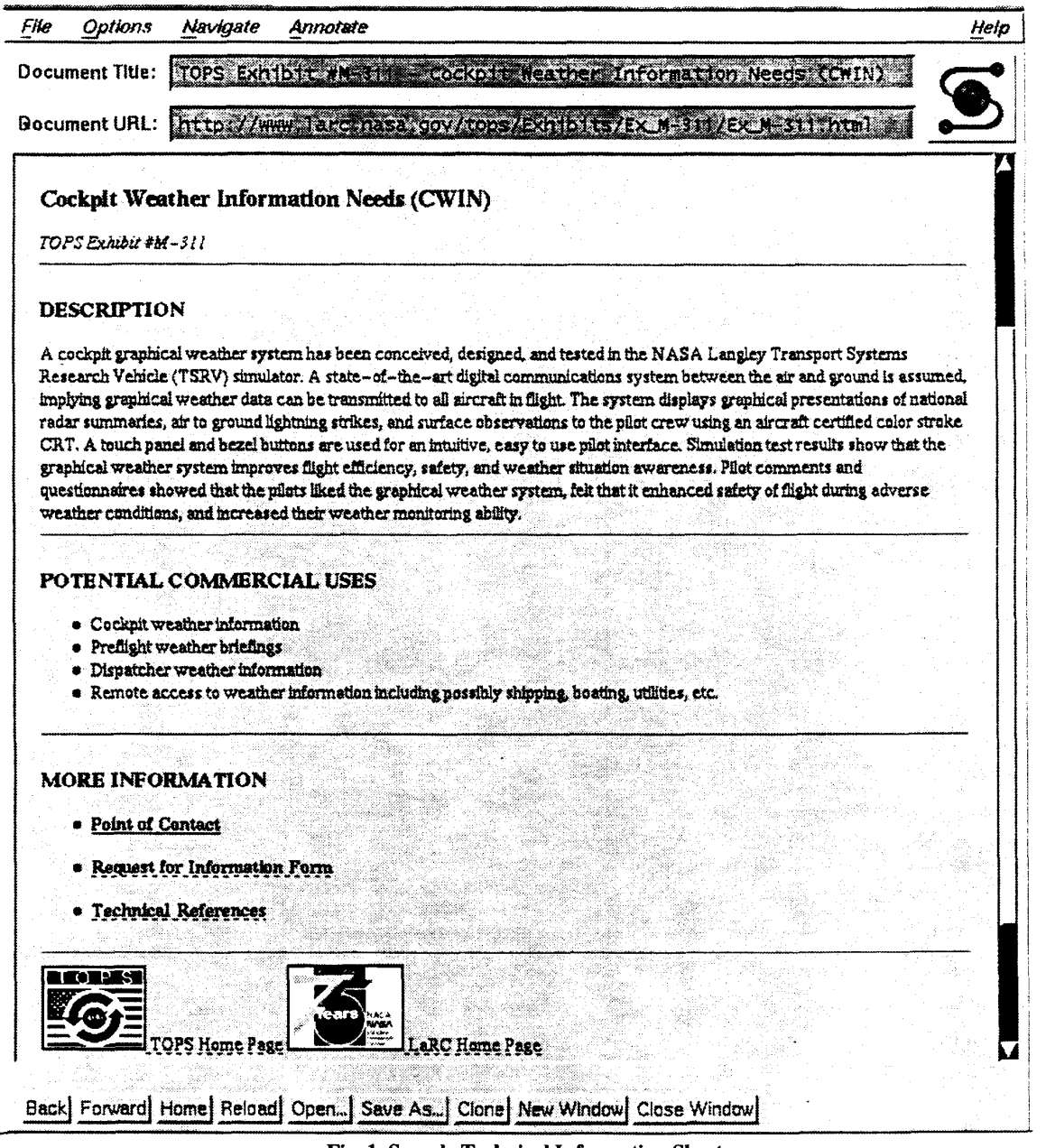

Fig. 1. Sample Technical Information Sheet

and allow for the continued use and display of this tremendous institutional investment. At that point, WWW and NCSA Mosaic were just beginning to enjoy wide popularity at LaRC, so WWW was a natural choice for implementing the TOPS database. Creating a TOPS database involved maintaining both textual and multimedia information. At a minimum, the technical information sheets plus the photographs of each booth had to be available. Other information would be added if available and appropriate. Figure 1 shows a sample technical information sheet. The full process for the conversion of the showcase from paper form to electronic form is covered in [6].

The TOPS home page offers several levels of functionality, including: browsing the entire collection of technical information sheets, browsing by subject category, or searching by keyword. A map of the exhibit layout is also available, and allows the user to choose an exhibit and view the associated technical information sheet. Additionally, all of the photographs taken at TOPS '93 are available. They can be browsed through small subject oriented collections of inlined

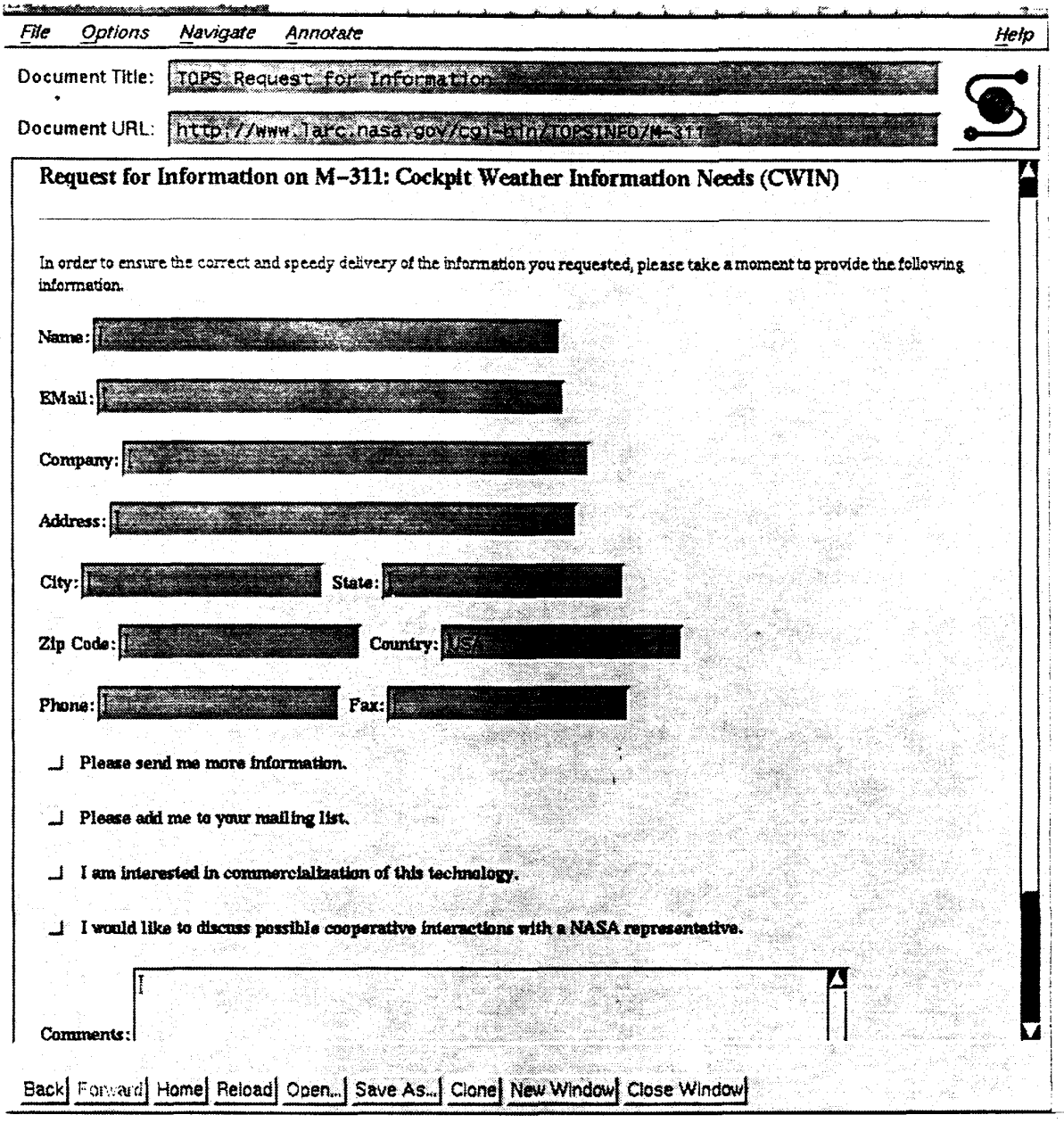

Fig. 2. Automated Feedback Form

JPEG images. Additionally, TOPS provides for automated tracking of metrics. When a customer wishes to request more information about a certain exhibit, an HTML form is filled out and the information is mailed to the appropriate POCs and to a central repository. Figure 2 is the automated feedback form of the technical information sheet shown in Figure 1.

THE NASA TECHNICAL REPORT SERVER

On January 14, 1993, LaRC made approximately 130 formal, "unclassified, unlimited" technical reports available via the anonymous FTP Langley Technical Report Server (LTRS) [7, 8]. LaRC was the first organization to provide a significant number of aerospace technical reports for open electronic dissemination. Building upon the experiences of LTRS, the NASA Technical Report Service (NTRS) is an inter-center effort to provide uniform access to various distributed publication servers residing on the Internet [9].

The two main design requirements of NTRS were 1) be "Logically Centralized, Physically Distributed" and 2) reuse existing resources whenever possible to provide

maximum functionality with minimum development. NTRS presents a unified view to the user, but takes advantage of the distributed nature of WWW to allow for flexible construction. It currently provides access to documents from 10 different NASA organizations and projects:

Serving Abstracts + Reports

- Langley Research Center
- Lewis Research Center
- Dryden Flight Research Center
- Numerical Aerodynamic Simulation Division (NAS) of NASA Ames Research Center
- Goddard Institute for Space Studies (GISS)
- Institute for Computer Applications in Science and Engineering (ICASE)

Serving Abstracts Only

- SCAN (Selected Current Aerospace Notices) (maintained by NASA STI)
- RECON (maintained by NASA STI)
- STELAR (Study of Electronic Literature in Astronomical Research) (maintained by Goddard Space Flight Center)
- Astrophysics Data System (ADS) Abstract Service (maintained by Smithsonian Astrophysical Observatory)

The emphasis of NTRS is ease of use and conceptual simplicity. Figure 3 (see next page) shows the NTRS page. Keywords are entered in the dialog box and the user submits a search. NTRS then returns a list of documents matching the specified search terms, from which the user selects abstracts to view. If, after viewing an abstract, users are interested in reading the associated paper, they can choose either to view or to download a PostScript file. If an on-line copy of the paper is for some reason unavailable, they are told how to order the printed document through more traditional means. Detailed instructions for using NTRS are available on-line.

FUTURE DIRECTIONS AND SERVICES

These initial systems have been well received. Customer feedback and the lessons learned from the implementation and operation of TOPS, LTRS and NTRS will ensure more robust, data-rich and easily accessible systems in the future.

Langley Software Server (LSS)

The usage statistics for the Langley and NASA Technical Report Servers are clear indicators that the public is interested in the results of NASA's research. The sustained success of Oak Ridge National Lab's NETLIB software distribution server indicates that there is a demand for network accessible computer programs [10]. The experimental LSS will allow quick and easy access to the body of LaRC developed source code and binary distributions.

Research and Technology Highlights

An annual compendium of research highlights is produced each year by the Research Publications and Printing Branch (RPPB) and is intended to provide to LaRC customers an overview of the breadth of LaRC's research involvements. Documents of this nature pose an interesting dilemma: if the presentation quality of the document is upgraded to make it attractive for general consumption, the accompanying rise in production costs limits the number of copies that LaRC can afford to print and distribute.

The solution was for RPPB to produce an accompanying WWW version of the report. This solves the problem of distribution costs, since Web access is both convenient and "free." Some presentation problems are also overcome. For example, now color images can be included at no additional direct cost. Other services can also be provided that increase the usefulness of the electronic version of the document beyond that of the paper version. For example, now keyword searching is included within the document. Multi-media data, such as the provision of sample data sets, representative videos, and audio narrations are now possible.

Langley On-line Research Explorer

It is often the case that a paper contains a reference to an associated software package, and that the software in question contains references to other papers. Many customers also want access to the data sets, visualizations, and other assorted materials. Thus, there is value in having a unified index to search for multiple representations of a technology. A proposed project, the Langley On-line Research Explorer (LORE), will serve as a central interface for any type of Langley-generated information: technical reports, conference papers, software packages or even multimedia experimental datasets will all be accessed from the same logically central point.

Other NASA Technology Awareness Servers

The NASA Commercial Technology Network home page contains pointers to many other technology information services, including SBIR information, industrial programs and NASA partnering opportunities. Many of the various NASA installations also have WWW servers with information about their local technology transfer initiatives.

IMPLICATIONS OF ELECTRONIC TECHNOLOGY TRANSFER

The availability of network technology services not only benefits the existing class of technology transfer efforts, but also introduces a number of new considerations. Among these are the opportunity for more meaningful metrics, new