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World Wide Web Implementation of the Langley Technical Report Server

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9/5/94

Abstract

On January 14, 1993, NASA Langley Research Center (LaRC) made approximately 130 formal, "unclassified, unlimited" technical reports available via the anonymous FTP Langley Technical Report Server (LTRS). LaRC was the first organization to provide a significant number of aerospace technical reports for open electronic dissemination. LTRS has been successful in its first 18 months of operation, with over 11,000 reports distributed and has helped lay the foundation for electronic document distribution for NASA. The availability of World Wide Web (WWW) technology has revolutionized the Internet-based information community. This paper describes the transition of LTRS from a centralized FTP site to a distributed data model using the WWW, and suggests how the general model for LTRS can be applied to other similar systems.

Acronyms

CASI - Center for Aerospace Information
CERN - Conseil Europeen pour la Recherche Nucleaire
CNIDR - Clearinghouse for Networked Information Discovery and Retrieval
DFRC - Dryden Flight Research Center
FTP - File Transfer Protocol
HTML - Hypertext Markup Language
HTTP - Hypertext Transfer Protocol
ICASE - Institute for Computer Applications in Science and Engineering
LaRC - Langley Research Center
LTRS - Langley Technical Report Server
NAS - Numerical Aerodynamic Simulation
NCSA - National Center for Supercomputing Applications
NII -National Information Infrastructure
NREN -National Research and Education Network
NTIS - National Technical Information Service
NTRS - NASA Technical Report Server
RPPB - Research Publishing and Printing Branch
URL - Uniform Resource Locator
URN - Uniform Resource Name
URC - Uniform Resource Citation
WAIS - Wide Area Information Server
WATERS - Wide Area Technical Report Server
WWW - World Wide Web

1.0 Introduction

1.1 The Langley Technical Report Server

The initial work for the Langley Technical Report Server (LTRS) began on October 2, 1992. On January 14, 1993, LTRS began production, offering approximately 130 formal technical reports to the world via anonymous FTP. Reference (1) details the initial design of LTRS, requirements for preparation of the documents, and access statistics during the first 6 months. Shortly after the first 6 months, the FTP server began to register connections from a variety of clients with greater frequency. Not only was the FTP server being accessed by manual FTP sessions, but also through Gopher and World Wide Web (WWW) clients. The rapid progress in Internet resource access mechanisms, especially WWW and Mosaic, presented an opportunity for LTRS to expand beyond the basic initial functionality.

1.2 The World Wide Web

The World Wide Web (WWW) was originally developed at CERN, in Switzerland, by the English physicist Tim Berners-Lee as a method for sharing information (ref. 2). Central to WWW is the concept of hypertext, or text within a document that "points" to another document somewhere on the Internet. WWW enjoyed moderate popularity initially, as other systems such as FTP (ref. 3) and gopher (ref. 4) were in wide use. Reference (5) contains a good summary of the differences between the various Internet resource discovery applications. The use of WWW did not reach its current popularity until the proliferation of NCSA Mosaic.

1.3 NCSA Mosaic

NCSA Mosaic was developed at the National Center for Supercomputing Applications (NCSA), an NSF supercomputing facility at the University of Illinois at Urbana-Champaign (ref. 6). Mosaic is a client, or "browser" for WWW servers. While Mosaic is not the only WWW client available, it is currently the most popular and robust browser available. Mosaic expands upon the concept of hypertext, implementing "hypermedia." Hypermedia allows for the inclusion of text, images, audio and video within a document. Because Mosaic can seamlessly and transparently use resources anywhere on the Internet, it is has been labelled the first "killer application of network computing" (ref. 7). The popularity of Mosaic can be attributed to many factors:

- It is a multi-protocol client, allowing backward compatibility with other Internet information servers.
- It is freely available for Windows (PC), Macintosh, and X Window System/ UNIX platforms, with a consistent "look and feel."
- The Internet and its resources gaining recognition in the popular press through such legislative programs as NREN and NII.

These factors presented a good opportunity to expand the Langley Technical Report Server beyond its initial anonymous FTP implementation to a richer, more user friendly interface.

2.0 The Langley Technical Report Server

2.1 LTRS Design Goals

LTRS is a proof-of-concept service that strives to provide technical publications in the most cost-efficient manner using the best open systems technology available. The overall goal of LTRS is to quickly and easily provide information to researchers in aerospace and related disciplines and to demonstrate an Internet based solution to information dissemination needs. The following are the original design requirements.

2.1.1 Logically Central, Physically Distributed

LTRS should provide a single, logically central point of entry but allow for the inclusion of other information systems which may be physically distributed. The inclusion of separate, and possibly inter-institutional information systems should be largely transparent to the user. Information systems are often implemented along institutional boundaries; however, it should be possible for cooperating institutions to offer a single source for accessing reports, while ensuring that each retains authority and responsibility for its own data.

2.1.2 Low Maintenance

A system requiring constant attention by a systems administrator would negate the benefits of an electronic report distribution system. LTRS should be fully automated, and require no operator input during production. Highly reliable protocols and systems should be employed. Tools must be available or developed to minimize the time required for general maintenance and entering reports into LTRS.

2.1.3 Supports Multiple Architectures

A platform independent system insures that the widest possible customer base is reached. To limit access to information based upon the user's computer preference is to immediately deny a potential market for the information. There is a point of diminishing returns; not all potential customer system configurations can be supported; however, it is advantageous if a single system can simultaneously support a range of modern computing platforms. It is even better if a conceptually similar access method exists for multiple platforms.

2.1.4 "Better, Cheaper, Faster"

LTRS was intended as a rapid prototype, not an extended software development effort. The system should be made available when reasonably stable, but advertised with the appropriate caveats about being an experimental service. As such, all resources must be readily available at little to no cost. LTRS should quickly provide as much aerospace information as possible, and this implies the use of existing tools, methods and protocols where possible.

3.0 Evolution of LTRS

3.1 Pre-WWW LTRS

LTRS officially began serving reports on January 14, 1993. The initial stage consisted of only one server, an anonymous FTP server on `techreports.larc.nasa.gov`. This used the historical model of distributing reports, program codes and other information in the Internet environment. The reports that were available were only formal technical reports, in compressed PostScript format. Abstract lists were available in ASCII format, and could be browsed, or loaded into a text editor for searching.

On February 10, 1993, a WAIS server was added to LTRS that allowed interactive searching of the abstracts. This was in addition to the FTP server and the ASCII abstract lists; however, at this point searching the abstracts and retrieval of the reports were separate processes and were not integrated. The history, design and implementation of this version of LTRS is documented in Reference (1).

A gopher version of LTRS was never implemented. Many gophers soon started to "point" to the FTP and WAIS Servers of LTRS, but before LTRS could be implemented as a gopher server, the authors discovered Mosaic. It was decided to bypass a gopher implementation and move toward WWW.

3.2 A WWW Version of LTRS

The initial WWW version of LTRS began August, 1993. It consisted only of providing a WWW "wrapper" around the existing FTP and WAIS servers. This made the separate services easier to use, and collected them into a single location for convenience, but did not allow for the integration of search and retrieval.

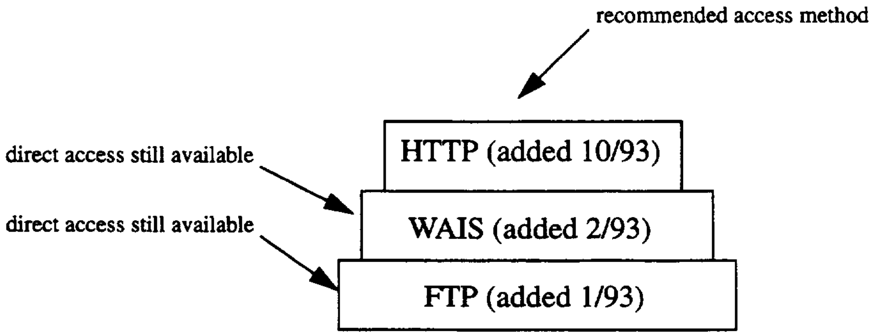

Figure 1: The Protocol Building Blocks of LTRS

The current WWW version of LTRS made its debut in October, 1993. LTRS is now a collection of servers, (HTTP, FTP and WAIS) (figure 1) which are combined in a manner transparent to the user (figure 2). Only functionality choices are presented to the user ("search", "browse") and the implementation details ("FTP" and "WAIS") are hidden. Perhaps most importantly, the current version of LTRS integrates the search and retrieve functions. It is now possible to search the citations and abstracts of reports, and then retrieve (view or save locally) the report. Also, it is now possible to retrieve the reports directly by browsing abstract lists.

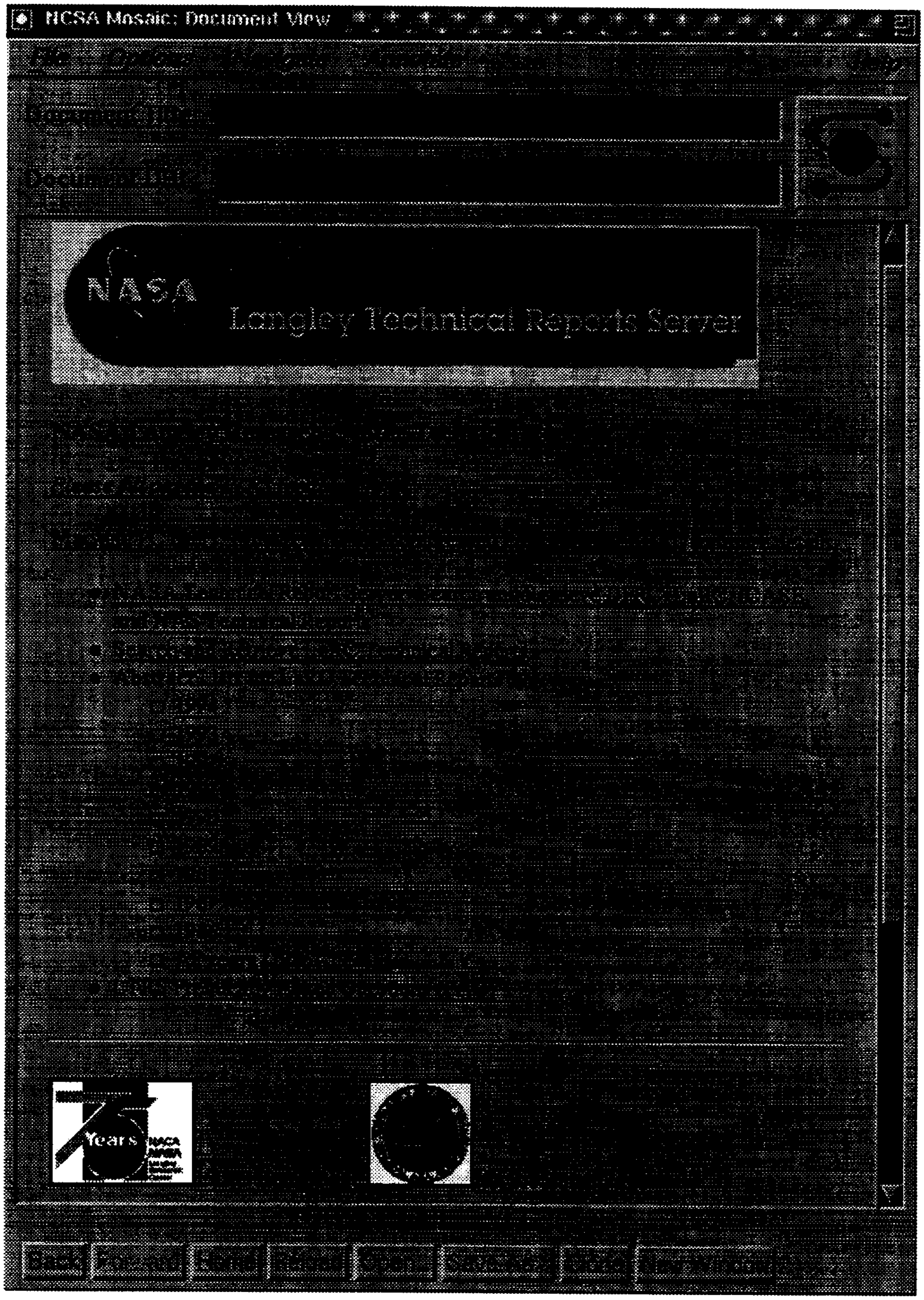

Figure 2: A Screen Shot of LTRS Viewed with NCSA Mosaic

The addition of new servers and their increasingly seamless integration does not obsolete the previous servers. For example, many users still access the technical reports via anonymous FTP or through a gopher gateway which points to the FTP server. The current version builds upon the prior work of the LTRS project. Even when a user accesses LTRS through the WWW page, for most of the reports a retrieval ultimately results in an anonymous FTP access to `techreports.larc.nasa.gov`. This building block approach insures that older systems will remain functional, even with rapid improvements in information servers, thus providing backwards compatibility.

While it is still possible to access LTRS via the previous methods, the use of WWW has allowed it to grow beyond the level of just serving reports from one machine. LTRS takes advantage of the distributed nature of WWW to catalog and provide access to reports that were once outside its domain. The compressed PostScript files available via anonymous FTP on `techreports.larc.nasa.gov` represent now only a subset of the reports that are available.

4.0 The Current System Design

4.1 New Model for Document Distribution

WWW and WAIS allow a simple model for indexing and distributing technical reports. The model is general enough to be used for a variety of applications, but is well suited for the distribution of reports in a variety of formats. Figure 3 illustrates the data access model of LTRS. A small amount of metadata, in this case an abstract, is indexed with WAIS. The abstract itself holds a pointer to its report. Because WWW can point anywhere on the network, the abstract can point to a report (or other data object) residing on a different machine, possibly even with a different type of server (HTTP, or gopher). Currently, the abstracts in LTRS only point to one copy of the report, but this would be easily extendable to so that the abstract could point to reports in multiple formats, different related reports, or even supplementary material such as photographs or video.

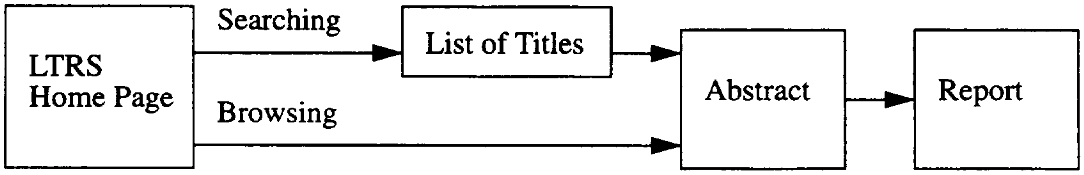

Figure 3: Data Access in LTRS

4.2 Report Storage in LTRS

Initially, the contents of the single anonymous FTP server defined the contents of LTRS. With the use of WWW, logical content and physical content can now be separated. All of the abstracts for the reports are stored centrally, and while all the reports appear to be stored centrally, some are now stored on other machines at LaRC. Table 1 shows the current location of reports in LTRS as well as the protocol by which they are available. While more distributed storage of reports is anticipated in the future, most reports are still stored in the original anonymous FTP server.

Table 1: Distributed Storage Status of LTRS

machine	protocol	number of reports available
techreports.larc.nasa.gov	FTP	297
ndb1.larc.nasa.gov	HTTP	6
shemesh.larc.nasa.gov	HTTP	2
air16.larc.nasa.gov	FTP	7

4.3 Report Indexing Method

A distinction is made between the archival format of the abstracts and the presentation format. Abstracts are accepted in refer format (ref. 3) (figure 4), and a script is used to translate the refer format into HTML. The "raw" HTML is shown in figure 5, and the user presentation of the HTML is shown in figure 6. The refer citations are either generated by hand, or extracted from the TeX source of the Report Documentation Page, attached at the end of each NASA report. While refer is a popular format and is easy to parse, it is generally not preferred by users. The only modification needed to employ refer as the archival medium is the inclusion of the previously unused "%U" field to store the report's URL. HTML is currently the obvious choice for presentation of the abstracts with pointers to reports The original ASCII WAIS database is still maintained and its contents are generated from the same refer citations with the use of another script. Additional translation scripts can be added if another popular format comes up in the future. Figure 7 depicts the citation conversion process. Appendix A details how reports are contributed by authors.

The resulting files are then indexed using WAIS. The `waisindex` program as provided with WAIS was unable to index HTML documents. The indexer was modified by the authors so that it handled HTML documents appropriately. The resulting changes to waisindex have been submitted to the Clearinghouse for Networked Information Discovery and Retrieval (CNIDR), the organization which maintains the free version of WAIS. The resulting WAIS index is accessible through a direct WAIS URL, such as:

```
wais://techreports.larc.nasa.gov/ltrs_index
```

or a through any number of HTTP gateways:

```
http://www.larc.nasa.gov:81/techreports.larc.nasa.gov/ltrs_index
http://www.larc.nasa.gov/cgi-bin/NTRS
```

These gateways access the WAIS database, although they do so indirectly. It would be possible to access this database with other WAIS clients, although the clients would have to have HTML capability to correctly display and format the citations.

```
%T An Experimental Parametric Study of Geometric, Reynolds Number, and Ratio
of Specific Heats Effects in Three-Dimensional Sidewall Compression Scramjet Inlets at Mach 6
%A Scott D. Holland
%A Kelly J. Murphy
%I NASA Langley Research Center Hampton, VA 23681-0001
%D 1993
%R AIAA Paper 93-0740
%O AIAA 31st Aerospace Sciences Meeting, January 11-14, 1993, Reno, NV
%U ftp://techreports.larc.nasa.gov/pub/techreports/larc/93/aiaa-93-0740.ps.Z
%X Since mission profiles for airbreathing hypersonic vehicles such as the National Aero-Space Plane include single-stage-to-orbit requirements, real gas effects may
become important with respect to engine performance. The effects of the decrease in the ratio of specific heats have been investigated in generic three-dimensional side
wall compression scramjet inlets with leading-edge sweep angles of 30 and 70 degrees. The effects of a decrease in ratio of specific heats were seen by comparing data
from two facilities in two test gases: in the Langley Mach 6 CF4 Tunnel in tetrafluoromethane (where gamma=1.22) and in the Langley 15-Inch Mach 6 Air Tunnel in
perfect gas air (where gamma=1.4).   In addition to the simulated real gas effects, the parametric effects of cowl position, contraction ratio, leading-edge sweep, and
Reynolds number were investigated in the 15-Inch Mach 6 Air Tunnel. The models were instrumented with a total of 45 static pressure orifices distributed on the side-
walls and baseplate. Surface streamline patterns were examined via oil flow, and schlieren videos were made of the external flow field. The results of these tests have
significant implications to ground based testing of inlets in facilities which do not operate at flight enthalpies.
```

Figure 4: A "Refer" Citation

```
   <TITLE>An Experimental Parametric Study of Geometric, Reynolds Number, and Ratio of Specific Heats Effects in Three-Dimensional Sidewall Compression
Scramjet Inlets at Mach 6 </TITLE>
<LI><A NAME="">Scott D. Holland and Kelly J. Murphy,
<B>"<A HREF="ftp://techreports.larc.nasa.gov/pub/techreports/larc/93/aiaa-93-0740.ps.Z">An Experimental Parametric Study of Geometric, Reynolds
Number, and Ratio of Specific Heats Effects in Three-Dimensional Sidewall Compression Scramjet Inlets at Mach 6,</A>"</B>
AIAA Paper 93-0740, 1993, AIAA 31st Aerospace Sciences Meeting, January 11-14, 1993, Reno, NV. </A>
<P>
<B>Abstract: </B>
Since mission profiles for airbreathing hypersonic vehicles such as the National Aero-Space Plane include single-stage-to-orbit requirements, real gas effects may
become important with respect to engine performance. The effects of the decrease in the ratio of specific heats have been investigated in generic three-dimensional
sidewall compression scramjet inlets with leading-edge sweep angles of 30 and 70 degrees. The effects of a decrease in ratio of specific heats were seen by comparing
data from two facilities in two test gases: in the Langley Mach 6 CF4 Tunnel in tetrafluoromethane (where gamma=1.22) and in the Langley 15-Inch Mach 6 Air Tuni
in perfect gas air (where gamma=1.4).   In addition to the simulated real gas effects, the parametric effects of cowl position, contraction ratio, leading-edge sweep, anc
Reynolds number were investigated in the 15-Inch Mach 6 Air Tunnel. The models were instrumented with a total of 45 static pressure orifices distributed on the side
walls and baseplate. Surface streamline patterns were examined via oil flow, and schlieren videos were made of the external flow field. The results of these tests have
significant implications to ground based testing of inlets in facilities which do not operate at flight enthalpies.<P>
```

Figure 5: HTML Output from Refer -> HTML Converter

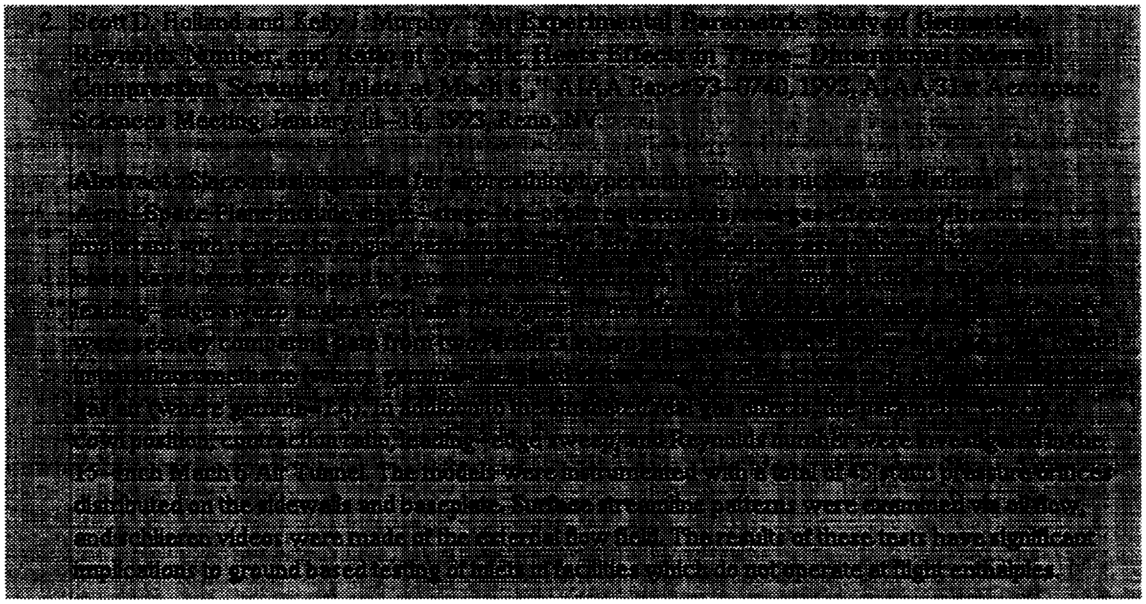

Figure 6: HTML Citation as Viewed by NCSA Mosaic

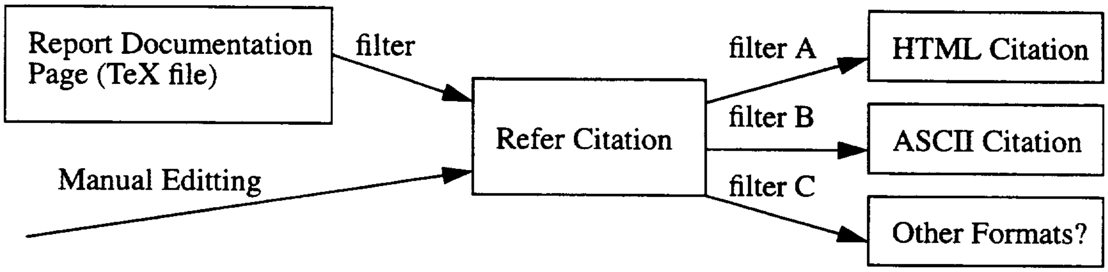

Figure 7: The Citation Conversion Process

4.4 Realization of Design Goals

4.4.1 Logically Central, Physically Distributed

LTRS achieves this goal by using the URL:

`http://techreports.larc.nasa.gov/ltrs/ltrs.html`

as the single entry point. LTRS consists of many units, some of which are constantly changing and can reside anywhere on the Internet, but the most recent version of LTRS is always accessible from this URL. The only aspect of LTRS that is physically centralized is the indexing of the abstracts. Currently, all LaRC abstracts are stored and indexed at one location. The reports do not have to be at one location. Even the restriction of the abstracts being centralized could be relaxed in the future, if the WWW community develops the URL syntax for expressing multiple wais servers in a single URL. This will allow for a more seamless integration of multiple WAIS servers and will allow for abstracts to be indexed locally instead of centrally.

4.4.2 Low Maintenance

The bulk of the effort for LTRS has gone into development, user awareness and advertising. While it is continuously improving, little work is required to maintain or support LTRS in production mode. The first reason is that it is built up from robust, existing packages. The second reason is LTRS provides a service within a popular and easily understood context.

4.4.3 Supports Multiple Architectures

UNIX machines (many types), Windows, Macintosh and even VMS platforms have accessed LTRS so far. Though the host machine is a UNIX platform (a Sun SPARCstation IPX), the protocols being used are open and platform independent, thus any machine which understands these protocols can access LTRS.

While Mosaic is currently the most popular and powerful WWW client available, any client is sufficient. There are many WWW clients available as shown in Appendix B. The progress and proliferation of different clients will occur without impacting the operation of LTRS. Additionally, LTRS depends upon local viewers to read different report or data types. For example, if one wishes to preview a PostScript document from LTRS (instead of saving it and printing it locally), a PostScript previewer must be available on the user's machine. This places the responsibility of collecting additional software on the user, but it does allow for configuration flexibility.

4.4.4 "Better, Cheaper, Faster"

Besides the developers' time, LTRS has incurred no direct costs. LTRS has utilized WWW to integrate and expand upon the previous versions of LTRS. Because it is an experimental system, changes are made rapidly and feedback immediately received. Minimal time was spent modifying the `waisindex` program to recognize HTML documents. Adding reports to the system (local or remote) has been simplified with scripts to automate the procedure.

5.0 LTRS Status after 18 Months

5.1 LTRS Contents

There are currently 312 reports available via LTRS. Table 2 shows the various report types. Currently, LTRS is not representative of Langley's technical document output. This is because of how Langley processes the different report types. Research Publications (RPs), Technical Papers (TPs), and 4 digit Technical Memorandums (TMs) are peer reviewed publications intended for broad dissemination and are prepared by the Research Publishing and Printing Branch (RPPB) in TeX. Technical Translations (TTs) are also prepared by the RPPB. All of these report types are put directly into LTRS. The remaining report types: conference papers, 6 digit Technical Memorandums, 4 and 6 digit Contractor Reports (CRs), journal articles, and theses are prepared by the authors themselves. The inclusion of these reports currently depends on the authors submitting the report to LTRS, and their limited numbers reflect this.

Table 2: Number of Reports in LTRS by Year and Series Type as of 7/94

	1994	1993	1992	1991	1990	1989	Totals
TPs	21	51	70	8	0	0	**150**
TMs (4 digit)	17	37	37	5	0	0	**96**
TMs (6 digit)	2	6	2	1	2	0	**13**
RPs	0	0	4	0	0	0	**4**
TTs	0	0	1	0	0	0	**1**
CR (4 digit)	0	1	0	0	0	0	**1**
CR (6 digit)	0	1	0	0	0	0	**1**
Conference Papers	2	3	3	9	1	0	**18**
Journal Articles	0	3	1	0	0	0	**4**
AIAA papers	1	11	5	1	1	2	**21**
Ph.D. Theses	0	1	1	1	0	0	**3**
Totals	**43**	**114**	**124**	**25**	**4**	**2**	**312**

5.2 LTRS Accesses

There have been over 11,000 reports distributed by LTRS since January 1993. Table 3 contains the accessed by report type. Table 4 shows the report distributions by Internet domain hierarchy (see also Figure 8). Table 5 shows the distribution of the abstracts. Appendix C shows the top 25 most retrieved reports. Appendix D lists the organizations that have accessed LTRS.

Table 3: Number of Reports Distributed by LTRS 1/93 - 7/94

	1994	1993	1992	1991	1990	1989	Totals
TPs	257	1367	2676	269	0	0	**4562**
TMs	487	1237	1556	115	0	0	**3392**
High No. TMs	67	1299	2	0	20	0	**1388**
RPs	0	0	138	0	0	0	**138**
TTs	0	0	40	0	0	0	**40**
CR (4 digit)	0	22	0	0	0	0	**22**
CR (6 digit)	0	35	0	0	0	0	**35**
Conference Papers	209	154	2	36	39	0	**447**
Journal Articles	0	108	0	0	0	0	**108**
AIAA papers	0	546	154	0	42	158	**900**
Ph.D. Theses	0	12	15	5	0	0	**32**
Totals	**1020**	**4780**	**4583**	**425**	**101**	**158**	**11067**

Table 4: Reports Distributed by Internet Domain Hostnames 1/93 - 7/94

	foreign	.edu	.larc.nasa.gov	.com	.nasa.gov	.mil	unknown address	.gov
Reports Distributed	3781	3120	1358	1282	750	0287	213	207
Percentage of Total	34%	28%	12%	12%	7%	3%	2%	2%

There are several reasons why tracking the usage of LTRS is not as simple as it was during the initial 6 months. The first is that the reports that are "in" LTRS no longer reside on one central machine. In the current distributed model, reports reside on many different machines, so retrieval statistics are more difficult to track because the server logs are no longer immediately available. Thus, the usage figures reported here apply only to the reports that are stored on `techreports.larc.nasa.gov`.

Table 5: Abstract Distributed by Year and Protocol Type

Year	HTTP	FTP	Totals
All Years	1302	684	**1986**
1994	1438	461	**1899**
1993	1095	2523	**3618**
1992	303	2413	**2716**
1991	213	1055	**1268**
1990	189	88	**277**
1989	360	131	**491**
	4900	7355	**12255**

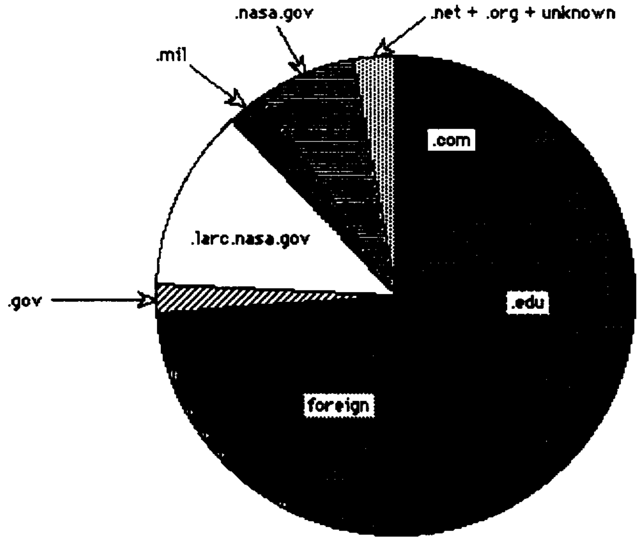

Figure 8: Report Accesses by Internet Domain

Another complication of tracking LTRS usage is the variety of servers that comprise LTRS. It is possible to access the HTTP or WAIS servers of LTRS, and not access the FTP server. Because most of the reports exist on the FTP server, and to keep usage tracking simple, only the FTP accesses of technical reports are given. Additionally, the number of FTP accesses are not reported as in (ref. 1) since the increasing number of gopher and WWW client accesses to the FTP server can artificially drive up the number of accesses. Thus, only the number of actual reports distributed are given. No attempt has been made to track secondary distribution.

Even with these limitations, the usage figures yield some interesting observations. The usage profile of LTRS is roughly the same as reported in (ref. 1). An interesting difference is the much higher access from `.larc.nasa.gov` hosts. This probably reflects the success of several LTRS and Internet awareness activities hosted at Langley. Although the `.edu` accesses dropped from 37% to 28%, this probably reflects the relative increased usage of other sites. Universities are still the largest domestic customer of LTRS. Foreign usage dips slightly, from 36% to 34%. It is interesting to note that the foreign electronic access of technical reports matches the current distribution of hard copy reports to foreigners. In subject category 01 (Aeronautics General), 35% of the hard copy distribution list consists of foreign addresses.[1] Figure 9 shows a breakdown of foreign access.

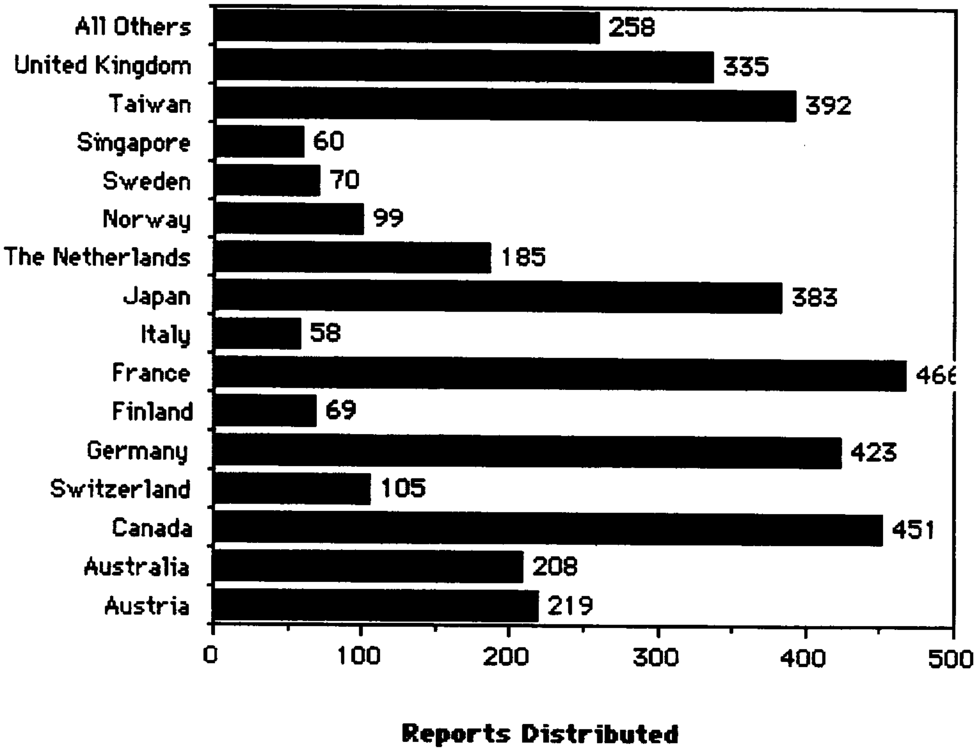

Figure 9: Foreign Report Accesses

5.3 Possible Cost Savings

LTRS has reached many customers that otherwise would not have access to Langley's scientific output. While not all of the reports that have been distributed during the 18 month period would have been distributed in paper form if LTRS did not exist, for the purposes of argument, the impact of distributing 11,067 paper copies will be examined.

The cost of printing a report varies depending on market conditions and other factors, but the following approximation was obtained from the RPPB:

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[1] Thomas E. Pinelli, "The U.S. Government Technical Report and the Transfer of Federally Funded Aerospace R&D: Results of an On-Going Investigation," briefing paper for NASA LaRC senior staff, June 1992, p. 14.

$$\left(\frac{copies \times pages}{1,000}\right) \times 12.47 = cost$$

Assume that each report has approximately 50 pages (actually, the length of Langley reports varies greatly, but 50 is a good approximation). Also assume that the number of copies normally produced for regular distribution is increased for each report to match the 11,067 distributed electronically. Substituting, we find that to produce paper copies of the 11,067 reports would cost Langley approximately $6,900.

The cost savings become more interesting if the scenario is expanded. Langley produces approximately 140 formal reports a year (TPs and 4 digit TMs). Approximately 250 copies of each report are made. If Langley were to cease hard copy production of these reports alone and distribute its formal reports electronically only, assuming the 50 page average holds, then Langley would save on the order of $22,000 annually on reproduction costs alone.

These figures are not intended as a formal cost analysis, but are provided as ball park figures for report printing costs. Other factors, such as the cost of color figures, postage to send reports through the U.S. mail, time spent on report preparation, and other report series are not considered. But the monetary savings, both real and projected, are less significant when compared with the customer's time saved by LTRS.

For researchers at Langley, getting a known technical report from the library can produce a variety of results. The best case is that the library has an extra copy, and if the researcher takes the time to walk to the library, they can walk out with a copy in a few minutes. If the personal copies have all been distributed, then the circulation copy can be checked out. If that is not available, the reference copy can be photo-copied by the researcher. If only microfiche is available, the researcher has the option of producing a paper copy from this, or filling out a form and have the library do this at a later date. So retrieval from the library can take minutes to possibly days.

Now if a customer does not have the benefit of access to such a rich library resource, they will have to get the report from either NASA Center for Aerospace Information (CASI) or National Technical Information Service (NTIS), in which the turnaround can take weeks. Measuring the total cost of the time lost while waiting for relevant technical information to arrive would be difficult; however, it is clearly undesirable to wait several weeks for a paper copy when an electronic copy can be accessed and printed in minutes.

6.0 The Future of LTRS

6.1 Better Integration of WWW and WAIS

LTRS would benefit through better integration of WWW and WAIS, and having both servers more knowledgable of the other so information can be shared more freely. This includes WAIS better understanding, indexing and returning URLs. WWW clients such as Mosaic also need to have a provision for relevance feedback (ref. 8), a popular searching mechanism that WAIS implements, but is not currently available in a WWW/WAIS environment. Additionally, the WWW community should determine the necessary syntax for allowing HTML to express multiple search URLs with a given set of keywords. A possible format would be:

```
URL_1&[URL_2]&...&[URL_N]?keyword[+keywords]
```

```
wais://larc.nasa.gov/flowviz&wais://dfrc.nasa.gov/datasets&wais://arc.nasa.gov/reports?CFD+1994
```

Such a URL syntax would provide for quick and easy recombination of existing, separate databases. This could allow for full integration of databases about a specific topic (searching the `foo` photo database, the `foo` reports database, the `foo` video database...) and it could facilitate multidisciplinary database sharing (search both the `foo` and `bar` databases for "O(n) general sorting algorithms").

6.2 Beyond URLs

Reference (9) describes the current status of URLs, Uniform Resource Names (URNs) and Uniform Resource Citaitons (URCs). A URN is a static name for a resource on the Internet, which remains the same but could possibly be resolved to a different URL at any given time. The idea is that a URN should remain stable when a service is moved from machine to machine, or from directory to directory.

URNs are resolved to the more dynamic URLs through a URL server. A uniform URC is simply another level of metadata that can be retrieved prior to retrieving a data object itself and without incurring the potential cost of retrieving the object. The use of URNs and URCs will allow LTRS (and other WWW services) greater development freedom by separating the logical and physical placement of networked resources.

6.3 Other Similar Systems

The Wide Area Technical Report System (WATERS), a joint effort between Old Dominion University, Virginia Tech, University of Virginia, and SUNY-Buffalo, has adopted a similar "look and feel" for the distribution of technical reports (ref. 10). The WATERS and LTRS teams share toolsets to maintain a level of interoperability.

The National Computer Science Technical Report Library (CSTR) is a joint effort between MIT, Carnegie-Mellon, Cornell, Stanford, and Berkeley (ref. 11). The CSTR project is unique in its manner of presenting the user with multiple presentation formats for a report and parallel searching of multiple sites. See Appendix E for a list of known report and abstract servers by subject area.

6.4 Extending LTRS

Information on the Internet is growing faster than the tools and methodologies for indexing, cataloging and searching. If LTRS or a similar system could serve as the foundation for the standardization of Internet based technical report distribution, information access and interchange would be made easier. A first step could be a NASA Technical Reports Server (NTRS). To date, three additional sites, the Institute for Computer Applications in Science and Engineering (ICASE) at LaRC, the Numerical Aerodynamics Simulation (NAS) Division of NASA Ames Research Center, and Dryden Flight Research Center (DFRC) have adopted a similar toolset for putting technical reports on-line. Via a gateway, it is possible to search LaRC, DFRC, ICASE, and NAS abstracts concurrently. However, this method is not scalable, and is simply a temporary measure while waiting for the emergence of a better method, such as that described in section 6.1.

LTRS could be expanded so that it serves as a basis for NASA wide Internet based report distribution. NTRS could include databases from different NASA centers, and databases that are centered around certain projects or disciplines, such as the Long Duration Exposure Facility (LDEF) archival system. NTRS could also be a component of a NASA wide technology transfer database. Furthermore, such a system could easily be expanded so that it includes additional data beyond reports, such as photos, videos, and project summaries.

The general LTRS model is being considered for the proposed Langley Software Server (LSS) and a general aviation server. There is nothing specific to technical reports in the design of LTRS. Any system that consists of data objects (reports) that can be described and indexed by meta-data (abstracts) can use the LTRS framework for distribution.

6.5 Remaining Challenges

While LTRS has proved successful during its initial 18 months, there are a number of areas that should be continuously improved. This includes both the documents in LTRS, and the awareness and acceptance of LTRS in the aerospace community.

6.5.1 Improving the Reports

Currently, some reports do not have all of their figures and photographs. In such cases, the figure legends are present to indicate what it missing. While most reports are either fully complete or complete enough to be useful, finishing the remaining documents will probably require scanning of paper copies.

The current searching functionality only searches the citations and abstracts; there is no full-text searching of the report itself. This could be implemented, however it is not clear that the benefit gained would justify the additional expense in the extra storage required, additional search time and extended development effort.

Most of the current reports are compressed PostScript. They are the same files used to generate the paper copies. As such, only a few of the reports currently in LTRS take advantage of the hypermedia capabilities of WWW. Some researchers at LaRC have already expressed interest in producing full multimedia reports, complete with visualizations of their data. Other report formats, such as Adobe Acrobat, could be included as they become prevalent in the scientific community.

6.5.2 Increased Aerospace Internet Awareness

Some scientific fields are already comfortable with Internet based technology exchange. These fields include Biology (ref. 12), Astronomy (ref. 13), Physics (ref. 14) and Computer Science (ref. 10,14). Unfortunately, electronic dissemination is not as common in the aerospace community. While LTRS has successfully transferred NASA technology to non-aerospace institutions and companies, unfortunately it has not made a great penetration into the aerospace community.

7.0 Conclusion

The Langley Technical Report Server (LTRS) has experienced significant usage during the initial 18 months, over 11,000 technical reports distributed. It has incrementally transitioned from an FTP server, to separate FTP and WAIS servers, to a complete WWW implementation utilizing integrated FTP, WAIS and HTTP servers. The use of WWW technology enables a single server type to respond to requests, regardless of the architecture of the originating machine (Mac, PC, UNIX, etc.) LTRS can serve any format of report, because the WWW implementation simply "points" to a file on the network, and it is the local user's responsibility to have the necessary viewers to appropriately interact with the file. Thus, LTRS can point to reports, images, video, data, binary files, and other information servers in an orthogonal manner. LTRS's use of WWW allows it to grow and accommodate the anticipated trend of hypermedia reports, which can be stored and accessed in a geographically distributed fashion. LTRS proves the feasibility of and interest in a wide-area, distributed, Internet based information server.

Future plans include expanding the number of reports in LTRS, completing the reports in LTRS, and the inclusion of technical reports from other centers to create a NASA Technical Report Server. Future plans of the WWW community that will make LTRS more useful are the inclusion of relevance feedback in WWW browsers, the extension of HTML so that the syntax can support richer contracts for searching multiple databases and the addition of URNs and URCs to WWW allowing for more robust naming and retrieval of information.

LTRS provides one method for NASA to distribute unrestricted scientific and technical information to the widest possible audience in an automated and low cost method. Estimated cost savings include several thousand dollars for reproduction, and much greater time savings for Langley customers. The growing popularity and accessibility of the Internet should make LTRS and similar systems easily available, regardless of geographic location.

Acknowledgments

The authors would like to thank: Luc Ottavj of INRIA, France, for the sharing of WAIS code; Sharon Paulson and Tom Keefer of ICASE, for putting ICASE documents on-line; David Kensiski, Al Globus, and Chris Beaumont (NASA Ames Research Center), for the NAS documents; Rob Brinkely and Yvonne Kellog (Dryden Flight Research Center) for the DFRC documents; Tad Guy (NASA Langley Research Center), for continued UNIX support; Marc VanHeyningen of Indiana University for design advice early on, and Angus Duggan, Harlequin Ltd., UK, for PostScript help.

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11. Davis, James R., Lagoze, Carl; "A Protocol and Server for a Distributed Digital Technical Report Library," Cornell University Technical Report TR94-1418, June 1994.

12. Green, David. G., "Databasing Diversity - a Distributed, Public-Domain Approach,", Taxon, v. 43, 1994, pp 51-62.

13. Fulton, Jim, "Distributed Astronomical Data Archives," ADASS Conference Proceedings, 1993.

14. Ginsparg, P.; "First Steps Towards Electronic Research Communication," Computers in Physics, vol. 8, no.4, Jul/Aug 1994, pp. 390-396.

Appendix A

How LaRC Authors Contribute Their Reports and Papers to LTRS

(also see *http://techreports.larc.nasa.gov/ltrs/ltrs-online.html*)

File can transmitted to LTRS by e-mailing files to m.l.nelson@larc.nasa.gov, placing on Mass Storage, placing on /scr on {eagle|mustang|voyager|sabre}.larc.nasa.gov, or by e-mailing a list of URLs to m.l.nelson@larc.nasa.gov.

If you intend to permanently store the report on your own machine:

1. Transmit a "refer" citation, using the one of the templates below. The %U field must reflect the "correct" URL for the paper.

If you wish the report to be stored on the central machine (techreports.larc.nasa.gov)

1. Transmit a "refer" citation, using the one of the templates below.
2. If the report is in HTML, a tar file of all necessary files must be transmitted.
3. If the report is in PostScript, transmit a single PostScript file only after you have verified its functionality locally.

Sample Citations in Refer Format

(note that the order of the tags (%A, %T, %X, etc.) does not matter)

A sample conference paper:

```
%A Jamshid Samareh-Abolhassani
%T Triangulation of NURBS Surfaces
%B 4th International Conference on Numerical Grid Generation in Computational Fluid Dynamics and Related Fields
%C Swansea, Wales, UK
%D April 1994
%P 377-388
%K Computational Fluid Dynamics, Unstructured Grid, Grid Generation, Surface Modeling, NURBS
%U ftp://techreports.larc.nasa.gov/pub/techreports/larc/94/conf-nurbs.ps.Z
%X A technique is presented for triangulation of NURBS surfaces.
This technique is built upon an advancing front technique combined
with grid point projection. This combined approach has been successfully
implemented for structured and unstructured grids.
```

A sample High Number (Quick Release) TM:

%D June 1993
%T Subjective response to simulated sonic booms with ground reflections
%A Brenda M. Sullivan
%A Jack D. Leatherwood
%R NASA TM-107764
%K Sonic boom; Subjective response; Loudness; Simulator; Shaped Boom; Minimized Boom
%P 33
%U ftp://techreports.larc.nasa.gov/pub/techreports/larc/93/tm107764.ps.Z
%X The Sonic Boom Simulator at NASA Langley Research Center was used
to (1) quantify subjective loudness of simulated composite sonic booms,
each of which was comprised of a simulated direct (non-reflected) boom
combined with a simulated reflection of the direct boom, and (2)
evaluate several metrics as estimators of loudness for these composite
booms. The direct booms consisted of selected N-wave and minimized
signatures having front-shock rise times of 3, 6, and 9 milliseconds and
durations of 300 milliseconds. Delay times of the reflected booms ranged
from 0 to 12 milliseconds. Subjective loudness results indicated that
composite booms formed using reflections with nonzero delay times were
generally rated as being less loud than composite booms containing
non-delayed reflections. The largest reductions in loudness occurred when
delay times were equal to the front shock rise times of the direct booms
and were, in some cases, equivalent to reductions in Perceived Level of
6 to 7 dB. Results also showed Perceived Level to be an effective metric
for assessing subjective loudness effects for the composite signatures.
This was confirmed by statistical analysis, which showed that, for equal
Perceived Level, no significant differences existed between the
subjective loudness responses to composite booms containing reflections
with zero delay and those containing reflections with non-zero delays.

A sample Journal Article:

%A Lin C. Hartung
%A H. A. Hassan
%T Radiation Transport Around Axisymmetric Blunt Body Vehicles Using a Modified Differential Approximation
%J Journal of Thermophysics and Heat Transfer
%V 7
%N 2
%D April-June, 1993
%P 220-227
%O presented as paper 92-0019 at the AIAA 30th Aerospace Meeting, Reno, NV, Jan. 6-9, 1992
%U ftp://techreports.larc.nasa.gov/pub/techreports/larc/93/jtht-7-2-93.ps.Z
%X A moment method for computing 3-D radiative transport is applied to
axisymmetric flows in thermochemical nonequilibrium. Such flows are
representative of proposed aerobrake missions. The method uses the P-1
approximation to reduce the governing system of integro-differential equations
to a coupled set of partial differential equations. A numerical solution
method for these equations given actual variations of the radiation properties
in thermochemical nonequilibrium blunt body flows is developed. Initial
results from the method are shown and compared to tangent slab calculations.
The agreement between the transport methods is found to be about 10~percent in
the stagnation region, with the difference increasing along the flank of the
vehicle.

A sample Contractor Report:

```
%D February 1993
%T Modeling the Transition Region
%A Bart A. Singer
%I High Technology Corporation 28 Research Drive Hampton, VA  23666
%R NASA CR-4492
%K transition; transition region; transition modeling; turbulence modeling
%P 88
%U ftp://techreports.larc.nasa.gov/pub/techreports/larc/93/cr4492.ps.Z
%X  The current status of transition-region models is reviewed
in this report. To understand modeling problems, various flow
features that influence the transition process are discussed first.
Then an overview of the different approaches to transition-region
modeling is given. This followed by a detailed discussion of turbulence
models and the specific modifications that are needed to predict flows
undergoing laminar-turbulent transition. Methods for determining the
usefulness of the models are presented, and an outlook for the future
of transition-region modeling is suggested.
```

A sample thesis:

```
%T Design and analysis techniques for concurrent blackboard systems
%A McManus, John W.
%D April 1992
%P 354
%I College of William and Mary
%C Williamsburg, VA.
%R Ph.D. Thesis; Sponsored by NASA. Langley Research Center
%U ftp://techreports.larc.nasa.gov/pub/techreports/larc/93/phd-92-mcmanus.ps.Z
%X Blackboard systems are a natural progression of knowledge-based systems
into a more powerful problem solving technique. They provide a way for
several highly specialized knowledge sources to cooperate to solve large,
complex problems. Blackboard systems incorporate the concepts developed
by rule-based and expert systems programmers and include the ability to
add conventionally coded knowledge sources. The small and specialized
knowledge sources are easier to develop and test, and can be hosted on
hardware specifically suited to the task that they are solving. The
Formal Model for Blackboard Systems was developed to provide a consistent
method for describing a blackboard system. A set of blackboard system
design tools has been developed and validated for implementing systems
that are expressed using the Formal Model. The tools are used to test and
refine a proposed blackboard system design before the design is
implemented. My research has shown that the level of independence and
specialization of the knowledge sources directly affects the performance
of blackboard systems. Using the design, simulation, and analysis tools,
I developed a concurrent object-oriented blackboard system that is
faster, more efficient, and more powerful than existing systems. The use
of the design and analysis tools provided the highly specialized and
independent knowledge sources required for my concurrent blackboard
system to achieve its design goals.
```

Sample AIAA conference papers:

%T Thermoelastic Formulation of Stiffened, Unsymmetric Composite Panels for Finite Element Analysis of High Speed Aircraft
%A Craig S. Collier
%B AIAA/ASME/ASCE/AHS/ACS 35th Structures, Dynamics, & Materials Conference
%C Hilton Head, SC
%D April 18-20, 1994
%I Lockheed Engineering & Sciences Co., NASA Langley Research Center Hampton, VA 23681-0001
%R AIAA Paper 94-1579
%U ftp://techreports.larc.nasa.gov/pub/techreports/larc/94/aiaa-94-1579.ps.Z
%X An emerging technology need for capturing 3-D panel thermoelastic response
with 2-D planar finite element models (FEMs) is aided with an equivalent plate
stiffness and thermal coefficient formulation. The formulation is general and
applies to all material types and stiffened and sandwich panel concepts.
Included with the formulation is the ability to provide membrane-bending
coupling of unsymmetric sections and calculation of all thermal expansion and
bending responses from in-plane and through-the-thickness temperature
gradients. Thermal residual strains for both the laminates and plies are
included. The general formulation is defined and then applied to a hat-
shaped, corrugated stiffened, metal matrix, fiber-reinforced composite panel.
Additional formulations are presented where required to include all of the
hat's unique characteristics caused by the cell shear flow in the closed
section such as the in-plane shear and bending-twisting response. Each
formulation is validated independently with 3-D FEA.

%T An Experimental Parametric Study of Geometric, Reynolds Number, and Ratio of Specific Heats Effects in Three-Dimensional Sidewall Compression Scramjet Inlets at Mach 6
%A Scott D. Holland
%A Kelly J. Murphy
%I NASA Langley Research Center Hampton, VA 23681-0001
%D 1993
%R AIAA Paper 93-0740
%O AIAA 31st Aerospace Sciences Meeting, January 11-14, 1993, Reno, NV
%U ftp://techreports.larc.nasa.gov/pub/techreports/larc/93/aiaa-93-0740.ps.Z
%X Since mission profiles for airbreathing hypersonic vehicles such as
the National Aero-Space Plane include single-stage-to-orbit requirements,
real gas effects may become important with respect to engine performance.
The effects of the decrease in the ratio of specific heats have been
investigated in generic three-dimensional sidewall compression scramjet
inlets with leading-edge sweep angles of 30 and 70 degrees. The effects
of a decrease in ratio of specific heats were seen by comparing data from
two facilities in two test gases: in the Langley Mach 6 CF4 Tunnel in
tetrafluoromethane (where gamma=1.22) and in the Langley 15-Inch Mach 6 Air
Tunnel in perfect gas air (where gamma=1.4). In addition to the simulated
real gas effects, the parametric effects of cowl position, contraction
ratio, leading-edge sweep, and Reynolds number were investigated in the
15-Inch Mach 6 Air Tunnel. The models were instrumented with a total
of 45 static pressure orifices distributed on the sidewalls and baseplate.
Surface streamline patterns were examined via oil flow, and schlieren
videos were made of the external flow field. The results of these
tests have significant implications to ground based testing of inlets
in facilities which do not operate at flight enthalpies.

Appendix B

An Incomplete Listing of Available World Wide Web Browsers.

(see *http://sunsite.unc.edu/boutell/faq/www_faq.html*, the WWW Frequently Asked Questions (FAQ) list for a complete, up-to-date list).

Microsoft Windows browsers

Cello - ftp://ftp.law.cornell.edu/pub/LII/cello

NCSA Mosaic for Windows - ftp://ftp.ncsa.uiuc.edu/PC/Windows/Mosaic

WinWeb - ftp://ftp.einet.net/einet/pc/winweb

Macintosh browsers

NCSA Mosaic for Macintosh - ftp://ftp.ncsa.uiuc.edu/Mac/Mosaic

MacWeb - ftp://ftp.einet.net/einet/mac/macweb/

Commodore Amiga browsers

Amiga Mosaic - ftp://max.physics.sunysb.edu/pub/amosaic

NeXTStep browsers

OmniWeb - ftp://ftp.omnigroup.com/pub/software/

X Window System browsers

NCSA Mosaic for X - ftp://ftp.ncsa.uiuc.edu/Mosaic/Unix

NCSA Mosaic for VMS - ftp://ftp.ncsa.uiuc.edu/Mosaic/Contrib

MidasWWW - ftp://freehep.scri.fsu.edu/freehep/networking_news_email/midaswww

Chimera - ftp://ftp.cs.unlv.edu/pub/chimera

Text-only browsers

Lynx - ftp://ftp2.cc.ukans.edu/pub/WWW/lynx

Emacs w3-mode - ftp://moose.cs.indiana.edu/pub/elisp/w3

Appendix C

Top 25 Retrieved Reports

#	Retrievals	Paper
1.	854	Joseph A. Kaplan Michael L. Nelson, "A Comparison of Queueing, Cluster and Distributed Computing Systems,"NASA TM-109025, August 1993, pp. 48.
2.	299	Michael L. Nelson and Gretchen L. Gottlich, "Electronic Document Distribution: Design of the Anonymous FTP Langley Technical Report Server ," NASA TM-4567 , March 1994 , pp. 17 .
3.	232	John N. Shoosmith, "Introduction to the LaRC Central Scientific Computing Complex," NASA TM 104092 (Revised), November, 1993.
4.	210	Kathryn Stacy, Kurt Severance and Brooks A. Childers , "Computer-Aided Light Sheet Flow Visualization," AIAA Paper 93-2915, 1993.
5.	157	Trey Arthur and Michael L. Nelson , "Intel NX to PVM3.2 Message Passing Conversion Library ," NASA TM-109038 , October 1993 , pp. 13 .
6.	154	W. Kyle Anderson , "Grid Generation and Flow Solution Method for Euler Equations on Unstructured Grids ," NASA TM-4295 , April 1992 , pp. 18 .
7.	144	Dave E. Eckhardt Jr., Michael J. Jipping, Chris J. Wild, Steven J. Zeil and Cathy C. Roberts , "Open Environments To Support Systems Engineering Tool Integration: A Study Using the Portable Common Tool Environment (PCTE) ," NASA TM-4489 , September 1993 , pp. 15 .
8.	140	Pao, Juliet Z. and Humes, D. Creig., "NASA Langley Research Center's Distributed Mass Storage System," Third NASA Goddard Space Flight Center Conference on Mass Storage Systems and Techologies, College Park, Maryland, October 19-21, 1993, pp. 207-216.
9.	132	Pamela S. Belton and Richard L. Campbell , "Experimental Study of a Generic High-Speed Civil Transport ," NASA TM-4382 , September 1992 , pp. 113 .
10.	125	Joanne L. Walsh, Katherine C. Young, Jocelyn I. Pritchard, Howard M. Adelman and Wayne R. Mantay, "Multilevel Decomposition Approach to Integrated Aerodynamic/Dynamic/Structural Optimization of Helicopter Rotor Blades," American Helicopter Society Aeromechanics Specialists Conference, San Francisco, California, January 19-21 1994, pp. 5.3-1 to 5.3-24.
11.	125	Ronald D. Joslin, Craig L. Streett and Chau-Lyan Chang , "Validation of Three-Dimensional Incompressible Spatial Direct Numerical Simulation Code ," NASA TP-3205 , July 1991 , pp. 47 .
12.	121	Peter W. Protzel, Daniel L. Palumbo and Michael K. Arras , "Fault Tolerance of Artificial Neural Networks With Applications in Critical Systems ," NASA TP-3187 , April 1992 , pp. 49 .

#	Retrievals	Paper
13.	104	Jamshid S. Abolhassani, "Unstructured Grids on NURBS Surfaces," 11th AIAA Applied Aerodynamics Conference, AIAA Paper AIAA-93-3454, Monterey, California, August 9-11, 1993.
14.	97	John E. Stewart and Jamshid S. Abolhassani, "A Graphically Interactive Approach to Structured and Unstructured Surface Grid Quality Analysis," Computational Fluid Dynamics Conference, AIAA Paper AIAA-93-3351, Orlando, Florida, July 6-9, 1993, pp. 589-597.
15.	94	Raymond L. Barger and Mary S. Adams , "Automatic Computation of Wing-Fuselage Intersection Lines and Fillet Inserts With Fixed-Area Constraint ," NASA TM-4406 , March 1993 , pp. 17 .
16.	89	Goodrich, Kenneth H. and McManus, John W. , "Development of A Tactical Guidance Research and Evaluation System (TiGRES)," AIAA Flight Simulation Technologies Conference , AIAA Paper # 89-3312, August 14-16, 1989 , pp. 350-356.
17.	87	Peiman G. Maghami, Suresh M. Joshi and Ernest S. Armstrong , "An Optimization-Based Integrated Controls-Structures Design Methodology for Flexible Space Structures ," NASA TP-3283 , January 1993 , pp. 44 .
18.	84	Jamshid Samareh-Abolhassani, "Triangulation of NURBS Surfaces," 4th International Conference on Numerical Grid Generation in Computational Fluid Dynamics and Related Fields, Swansea, Wales, UK, April 1994, pp. 377-388.
19.	81	Paul S. Miner , "Verification of Fault-Tolerant Clock Synchronization Systems ," NASA TP-3349 , November 1993 , pp. 142 .
20.	78	Russell V. Parrish, Anthony Holden and Steven P. Williams , "Correction Techniques for Depth Errors With Stereo Three-Dimensional Graphic Displays ," NASA TP-3244 ATCOM TR-92-B-011 , October 1992 , pp. 17 .
21.	78	Aaron J. Ostroff and Melissa S. Proffitt , "Longitudinal-Control Design Approach for High-Angle-of-Attack Aircraft ," NASA TP-3302 , February 1993 , pp. 28 .
22.	76	Storaasli, Olaf O., Nguyen, Duc. T. , Baddourah, Majdi. A. and Qin, Jiangning, "Computational Mechanics Analysis Tools for Parallel-Vector Supercomputers," International Journal of Computing Systems in Engineering, vol. 4, no. 4-6, Dec. 1993, pp. 1-10
23.	75	George M. Ware and Charles H. Fox Jr. , "Subsonic Aerodynamic Characteristics of a Proposed Advanced Manned Launch System Orbiter Configuration ," NASA TM-4439 , February 1993 , pp. 28 .
24.	75	Scott D. Holland, "Computational Parametric Study of Sidewall-Compression Scramjet Inlet Performance at Mach 10 ," NASA TM-4411 , February 1993 , pp. 12 .
25	73	H. S. Mukunda, B. Sekar, M. H. Carpenter, J. Philip Drummond and Ajay Kumar , "Direct Simulation of High-Speed Mixing Layers ," NASA TP-3186 , July 1992 , pp. 61 .

Appendix D - Organizations That Have Accessed LTRS

".com" Internet sites

3Com Corporation
ARCO Oil and Gas
ASK/Ingres Products Division
AT&T Bell Laboratories
AT&T Global Information Solutions
Adobe Systems Inc.
Adroit Systems, Inc.
Advance Geophysical Corp.
Advanced Decision Systems
Advantis
Alcatel Network Systems
Allied-Signal, Inc.
Anasazi, Inc.
Apple Computer Corporation
Asea Brown Boveri
Aware, Inc.
BP
Bailey Controls Company
Ball Aerospace, Inc.
Beckman Instruments, Inc.
Bob Gustwick & Associates, Inc.
Bolt Beranek and Newman Inc.
Box Hill Systems Corporation
Bull HN Information Systems Inc.
Byte Information Exchange
CAE-Link Corporation
CFD Research Corporation
CLAM Associates
Calspan Advanced Technology Center
Centerline Software
Centric Engineering Systems
Charles Stark Draper Laboratories
Chevron Information Technology Co.
Chicago Title & Trust
Cisco Systems, Incorporated
Compaq Computer Corporation
Computervision Corp
Concurrent Computer Corporation
Concurrent Technologies Corporation
Connected, Inc.
Convergent Technologies, Inc.
Convex Computer Corporation
Cray Research, Inc.
DHL Systems, Inc.
Data General Corporation
Dell Computer Corporation
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  - o DTRS - Dryden Technical Report Server(NASA/DFRC)
  - o LTRS - Langley Technical Report Server(NASA/LaRC)
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On January 14, 1993, NASA Langley Research Center (LaRC) made approximately 130 formal, "unclassified, unlimited" technical reports available via the anonymous FTP Langley Technical Report Server (LTRS). LaRC was the first organization to provide a significant number of aero space technical reports for open electronic dissemination. LTRS has been successful in its first 18 months of operation, with over 11,000 reports distributed and has helped lay the foundation for electronic document distribution for NASA. The availability of World Wide Web (WWW) technol ogy has revolutionized the Internet-based information community. This paper describes the tran sition of LTRS from a centralized FTP site to a distributed data model using the WWW, and suggests how the general model for LTRS can be applied to other similar systems.

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