“Diffused Knowledge Immortalizes Itself”

Sir James Mackintosh 1765-1832

MOTIVATION

http://lockss.stanford.edu

LOTS OF COPIES KEEP STUFF SAFE

Paper Library System

Libraries act for their institution to

- Acquire copies of important “stuff”
- Keep copies on shelves
- Give access to local readers

Libraries cooperate to

- Supply copies to other libraries
  - a reader can easily to find *a* copy
  - a “bad guy” has trouble finding and destroying all copies

Paper Library System

Libraries ensure content persists simply by supporting their local communities

A cooperative, affordable, decentralized, 'archive system' with LOTS OF COPIES

LOCKSS “Library System”

Libraries act for their institution to

- Acquire copies of important “stuff”
- Keep copies in transparent web caches
- Give access to local readers

Libraries cooperate to

- Detect and repair damage
  - a reader can easily find *a* copy
  - a “bad guy” has trouble finding and destroying all copies

LOCKSS “Library System”

Libraries ensure content persists simply by supporting their local communities

A cooperative, affordable, decentralized, ‘archive system’ with LOTS OF COPIES

Long Lived: *slow, determined, indestructible*

LOCKSS

- Open source
- Peer to peer
- Persistent access preservation system
- Web delivered information

Production: Released April 2004

Support: Mellon, NSF, Stanford Libraries

Software: www.sourceforge.net

Teams: Production and Research

Research Team

Stanford, Harvard, HP Labs & Intel Labs

Award winning research: ACM 2004

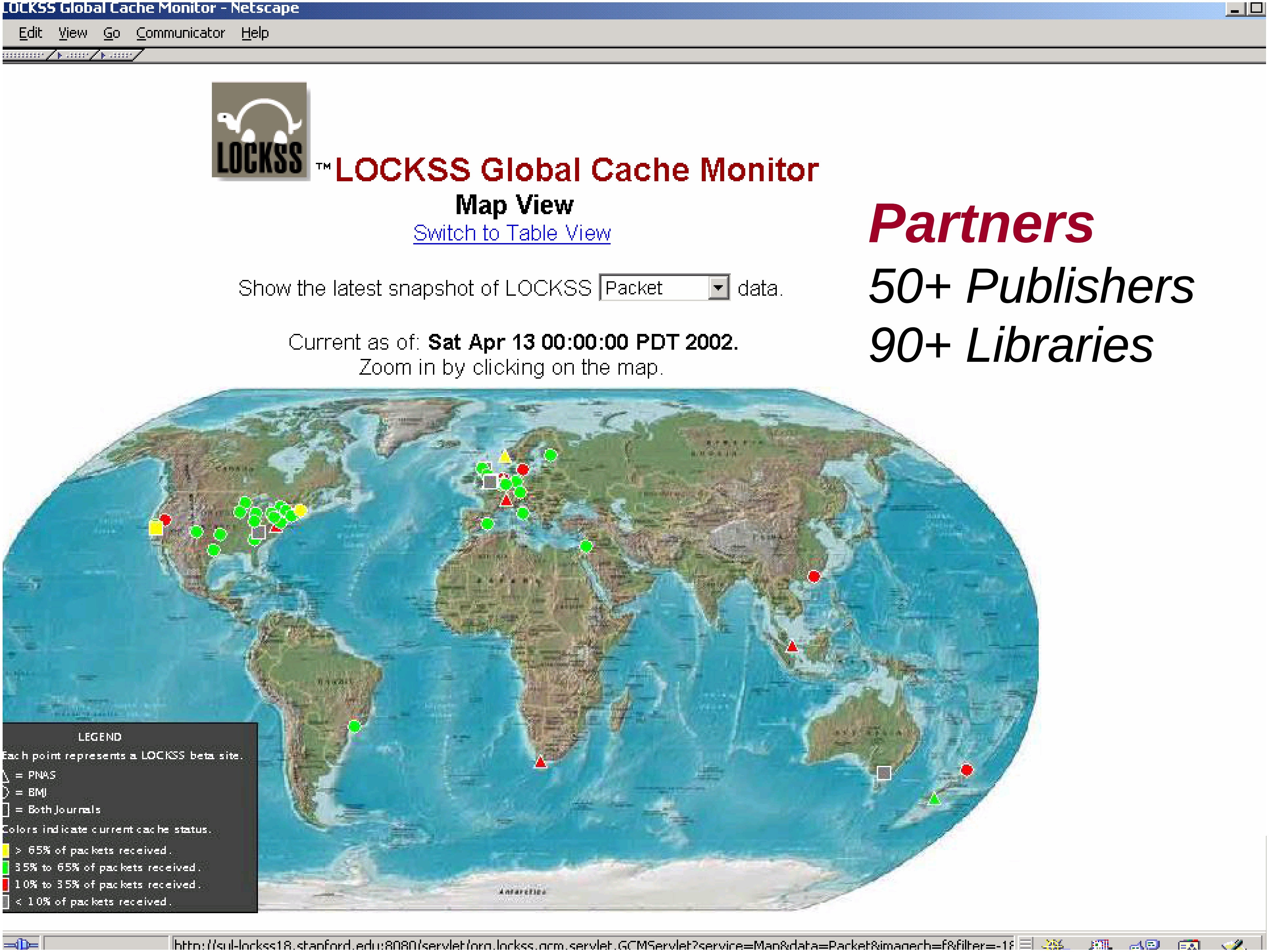
- Best Paper SOSP
- Grand Finals 2nd place all student research
- 7 other key research papers accepted so far

Investigating LOCKSS communication

- Scaling, attack resistance

Production Team:

deploys findings, builds system



™ LOCKSS Global Cache Monitor

Map View

Switch to Table View

Show the latest snapshot of LOCKSS Packet data.

Current as of: **Sat Apr 13 00:00:00 PDT 2002.**
Zoom in by clicking on the map.

LEGEND

ach point represents a LOCKSS beta site.

△ = PNAS
○ = BMJ
□ = Both Journals

olors indicate current cache status.

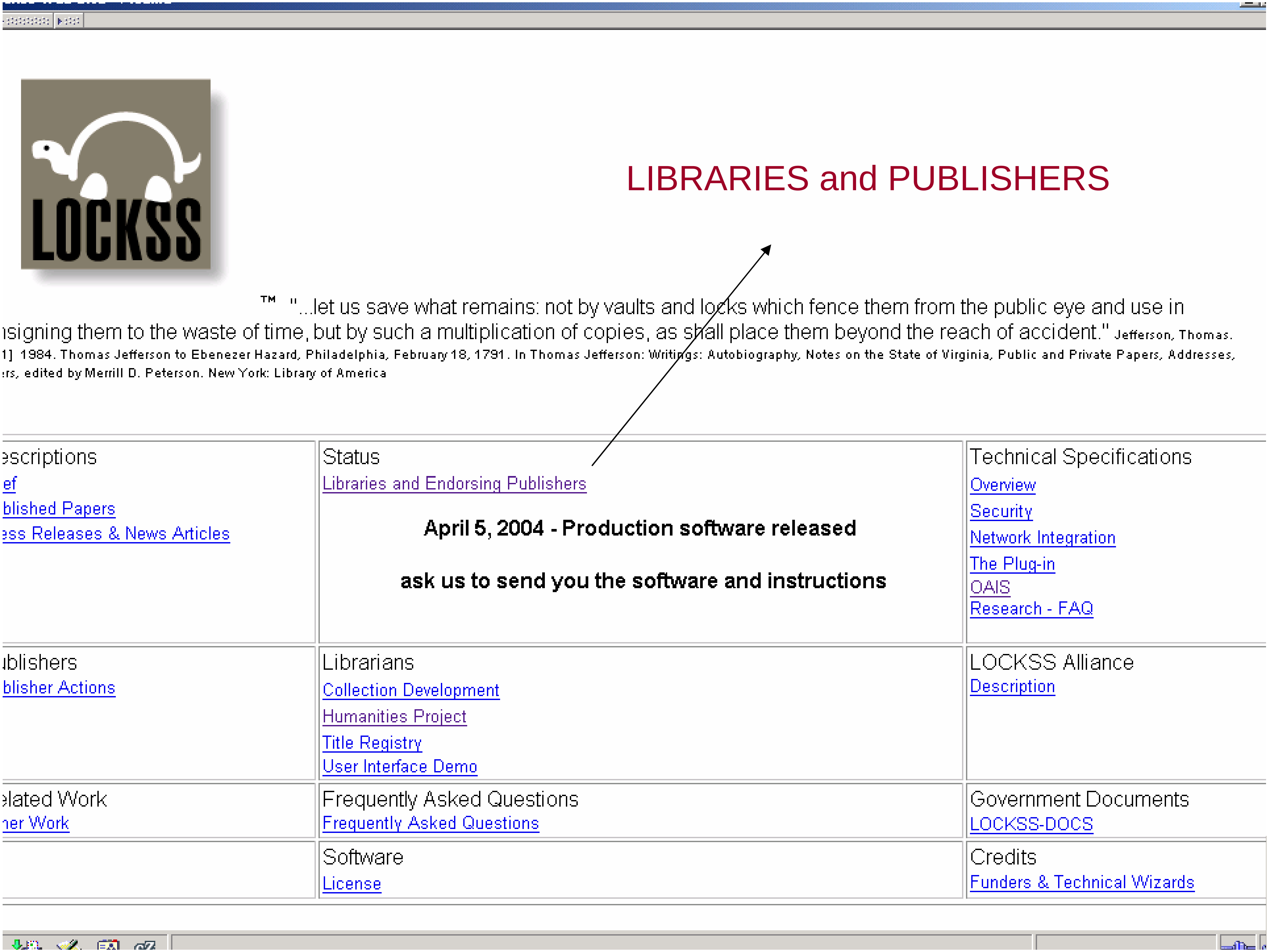
🟨 > 65% of packets received.
🟩 35% to 65% of packets received.
🟥 10% to 35% of packets received.
⬜ < 10% of packets received.

http://sul-lockss18.stanford.edu:8080/servlet/org.lockss.gcm.servlet.GCMServlet?service=Map&data=Packet&imagech=f&filter=-1f

Partners

50+ Publishers

90+ Libraries



LIBRARIES and PUBLISHERS

LOCKSS ™ "...let us save what remains: not by vaults and locks which fence them from the public eye and use in
ısigning them to the waste of time, but by such a multiplication of copies, as shall place them beyond the reach of accident." Jefferson, Thomas.
1] 1984. Thomas Jefferson to Ebenezer Hazard, Philadelphia, February 18, 1791. In Thomas Jefferson: Writings: Autobiography, Notes on the State of Virginia, Public and Private Papers, Addresses,
ırs, edited by Merrill D. Peterson. New York: Library of America

ɜscriptions ef blished Papers ɜss Releases & News Articles	Status Libraries and Endorsing Publishers **April 5, 2004 - Production software released** **ask us to send you the software and instructions**	Technical Specifications Overview Security Network Integration The Plug-in OAIS Research - FAQ
ıblishers blisher Actions	Librarians Collection Development Humanities Project Title Registry User Interface Demo	LOCKSS Alliance Description
ɜlated Work ıer Work	Frequently Asked Questions Frequently Asked Questions	Government Documents LOCKSS-DOCS
	Software License	Credits Funders & Technical Wizards

LOCKSS software turns a PC
into a persistent web cache
into a preservation tool

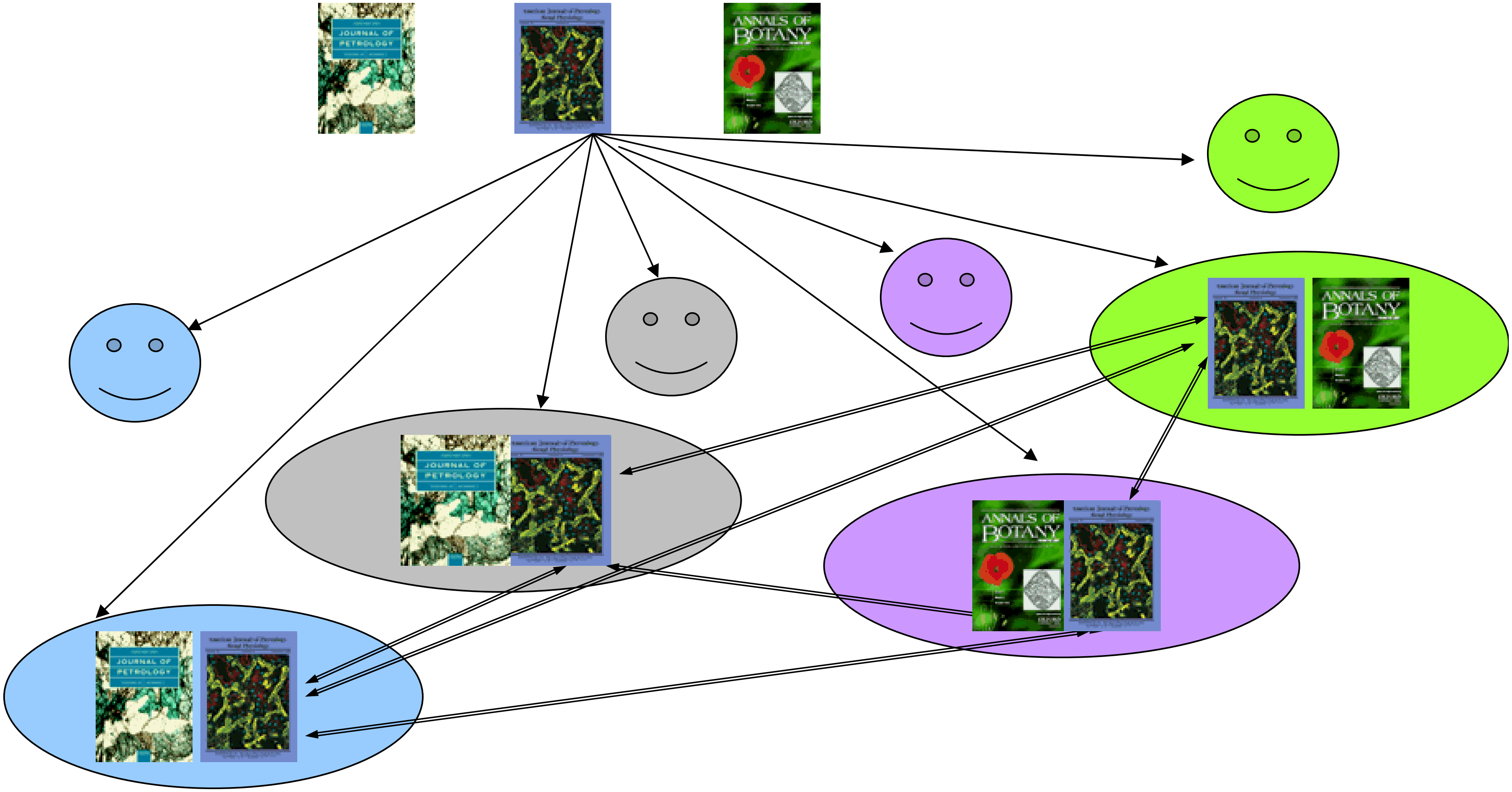
1 PC holds
~2,500 e-j
years

600MHz-128MB RAM-Bootable CD drive-Floppy disk drive

LOCKSS Caches

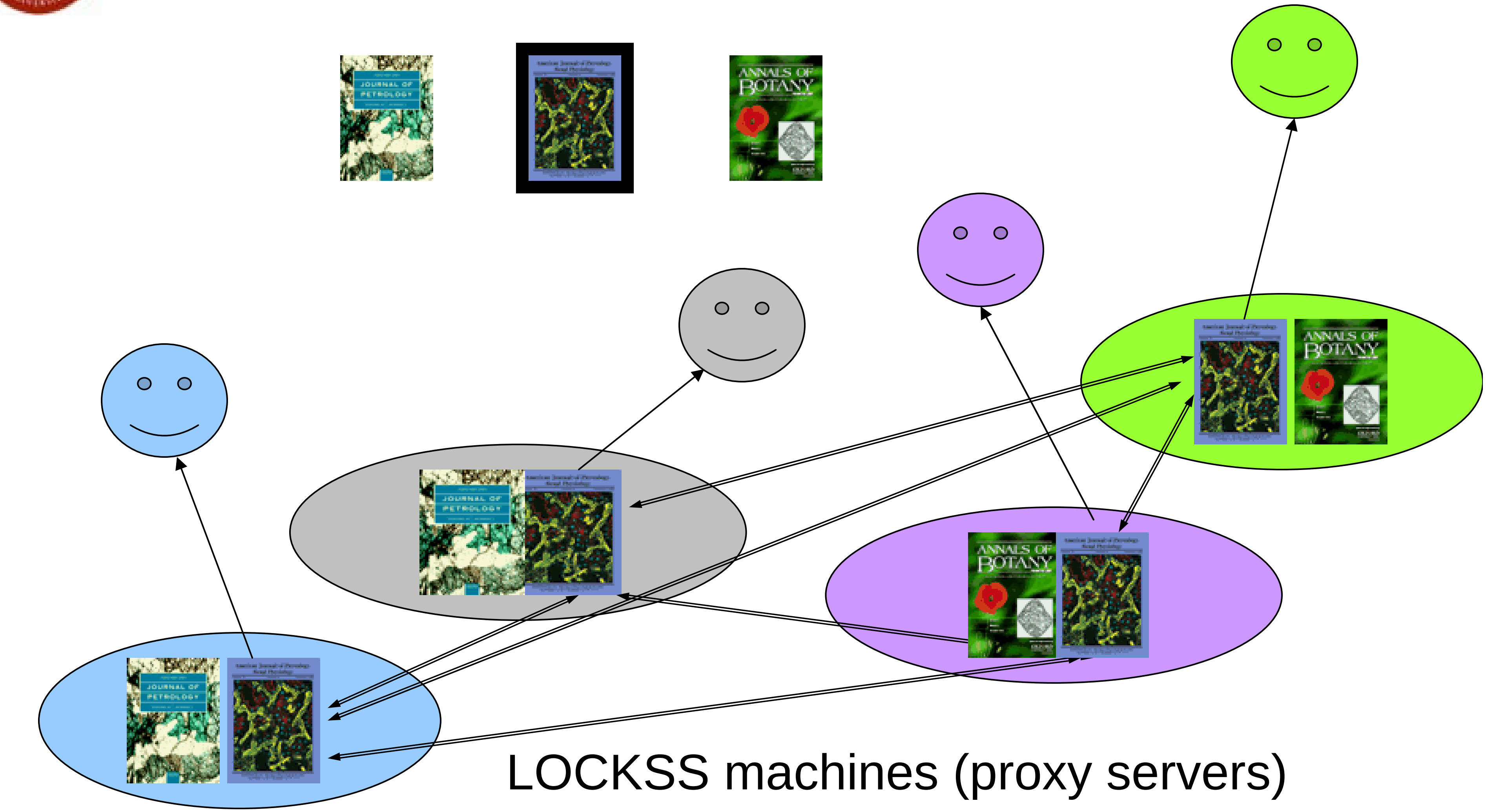
- Crawls and collects HTTP content
  - All formats (PDF, HTML, JPEG, TIF, Audio, Video)
- Preserves content integrity
  - Independent collection
  - Cooperate to audit and repair damage
- Provides access
  - Via web browser
  - Content is never “dark”

Approximate Data Flows



LOCKSS machines

Approximate Data Flows



LOCKSS machines (proxy servers)

Prevent the publisher from revoking access rights to back content

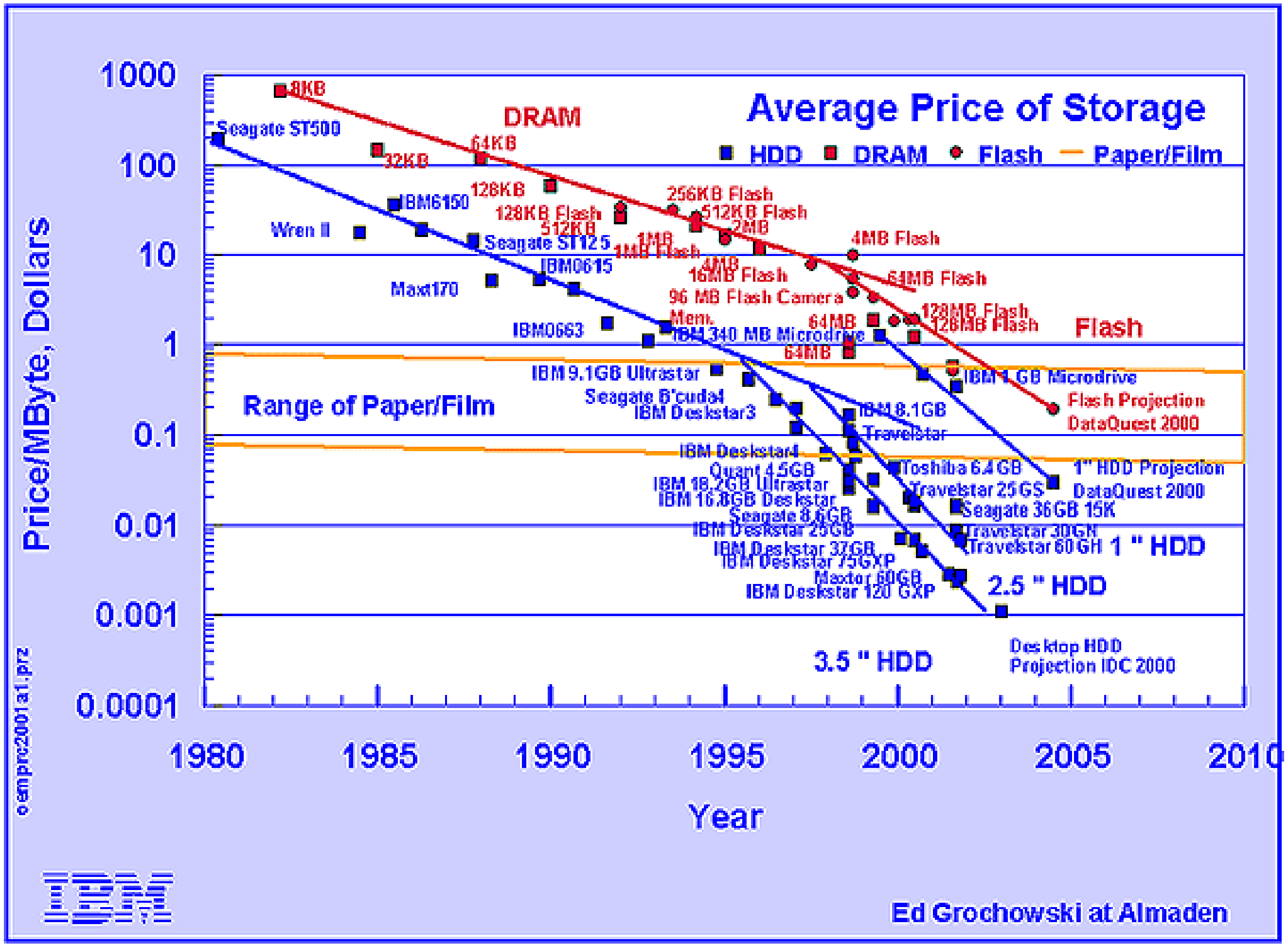
You’re Crazy

A research library’s serial collection on a PC

?

Hardware Costs

HDD prices decline by 50% a year



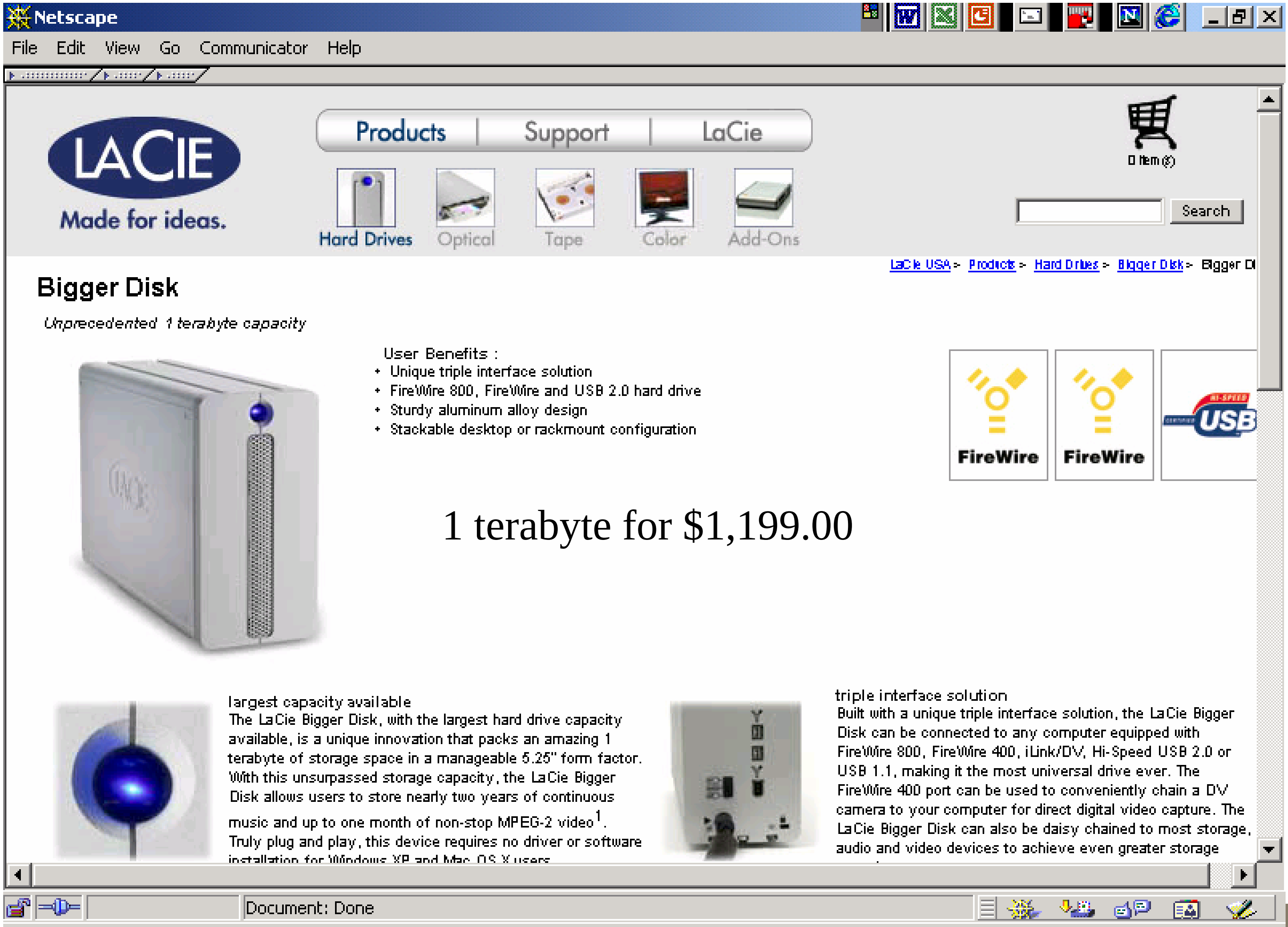
http://www.almaden.ibm.com/sst/html/leadership/g05.htm

Terabytes of E-Journals

Median e-journal size is less then 0.5 GB/ year

1 Terabyte (1000 GB) = 2000 journal years

	J-yr storage	TB/PC	J-yrs/PC
2004	$0.35	1.44	2,880
2005	$0.28	2.88	5,760
2006	$0.14	5.76	11,520
2007	$0.07	11.52	23,000



Bigger Disk

Unprecedented 1 terabyte capacity

User Benefits :

- Unique triple interface solution
- FireWire 800, FireWire and USB 2.0 hard drive
- Sturdy aluminum alloy design
- Stackable desktop or rackmount configuration

1 terabyte for $1,199.00

largest capacity available
The LaCie Bigger Disk, with the largest hard drive capacity available, is a unique innovation that packs an amazing 1 terabyte of storage space in a manageable 5.25" form factor. With this unsurpassed storage capacity, the LaCie Bigger Disk allows users to store nearly two years of continuous music and up to one month of non-stop MPEG-2 video[1]. Truly plug and play, this device requires no driver or software installation for Windows XP and Mac OS X users.

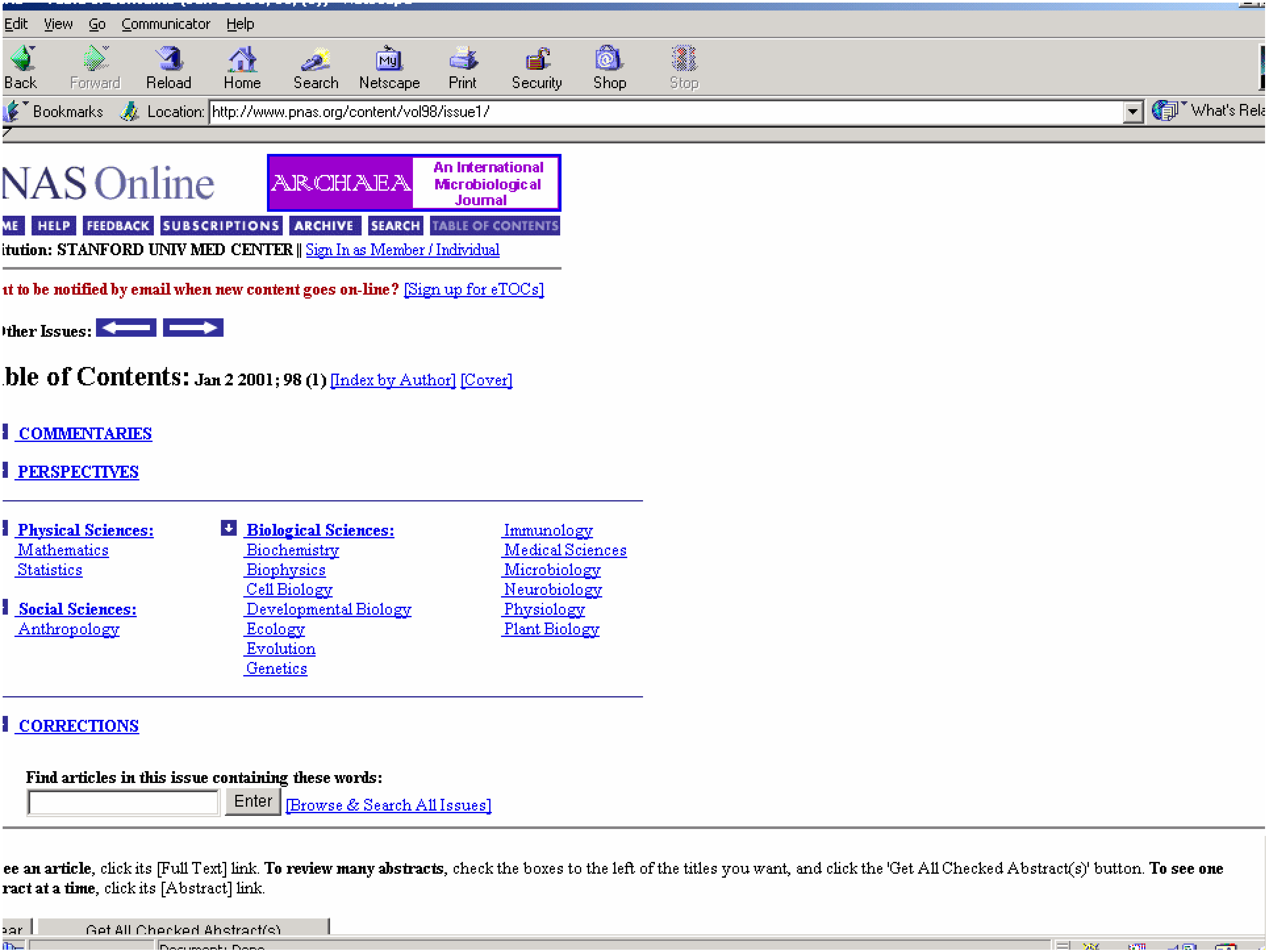
triple interface solution
Built with a unique triple interface solution, the LaCie Bigger Disk can be connected to any computer equipped with FireWire 800, FireWire 400, iLink/DV, Hi-Speed USB 2.0 or USB 1.1, making it the most universal drive ever. The FireWire 400 port can be used to conveniently chain a DV camera to your computer for direct digital video capture. The LaCie Bigger Disk can also be daisy chained to most storage, audio and video devices to achieve even greater storage

Look and Feel to Readers

Configure LOCKSS as a web proxy

Example:

- PNAS table of contents page
  - from web (9/11/02)
  - from LOCKSS cache



NAS Online

itution: STANFORD UNIV MED CENTER || Sign In as Member / Individual

it to be notified by email when new content goes on-line? [Sign up for eTOCs]

ther Issues:

ble of Contents: Jan 2 2001; 98 (1) [Index by Author] [Cover]

COMMENTARIES

PERSPECTIVES

Physical Sciences:
Mathematics
Statistics

Social Sciences:
Anthropology

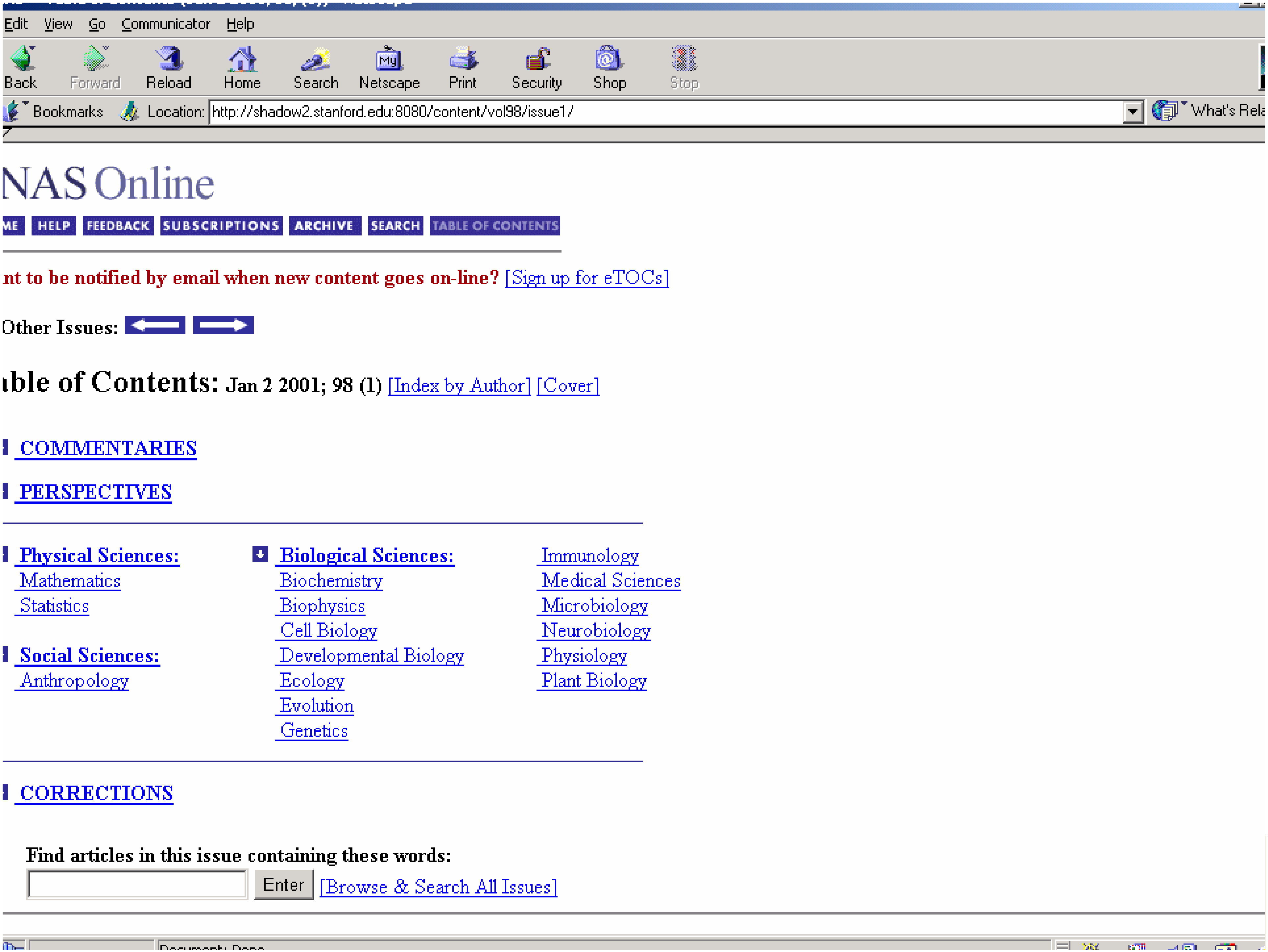
Biological Sciences:
Biochemistry
Biophysics
Cell Biology
Developmental Biology
Ecology
Evolution
Genetics
Immunology
Medical Sciences
Microbiology
Neurobiology
Physiology
Plant Biology

CORRECTIONS

Find articles in this issue containing these words:

[Browse & Search All Issues]

ee an article, click its [Full Text] link. To review many abstracts, check the boxes to the left of the titles you want, and click the 'Get All Checked Abstract(s)' button. To see one ract at a time, click its [Abstract] link.



Location: http://shadow2.stanford.edu:8080/content/vol98/issue1/

NAS Online

nt to be notified by email when new content goes on-line? [Sign up for eTOCs]

Other Issues:

ıble of Contents: Jan 2 2001; 98 (1) [Index by Author] [Cover]

COMMENTARIES

PERSPECTIVES

Physical Sciences:
Mathematics
Statistics

Social Sciences:
Anthropology

Biological Sciences:
Biochemistry
Biophysics
Cell Biology
Developmental Biology
Ecology
Evolution
Genetics
Immunology
Medical Sciences
Microbiology
Neurobiology
Physiology
Plant Biology

CORRECTIONS

Find articles in this issue containing these words:

Enter [Browse & Search All Issues]

What to Collect and Preserve?

- E-Journals
  - Titles you've paid for and are leasing
  - Freely available titles
- Other genres
  - Newspapers, Gov Docs

http delivered - serial - stable URLs – authoritative version

Easy for publishers to participate

Publisher give permission (copyright materials) to:

- Libraries
- LOCKSS crawler

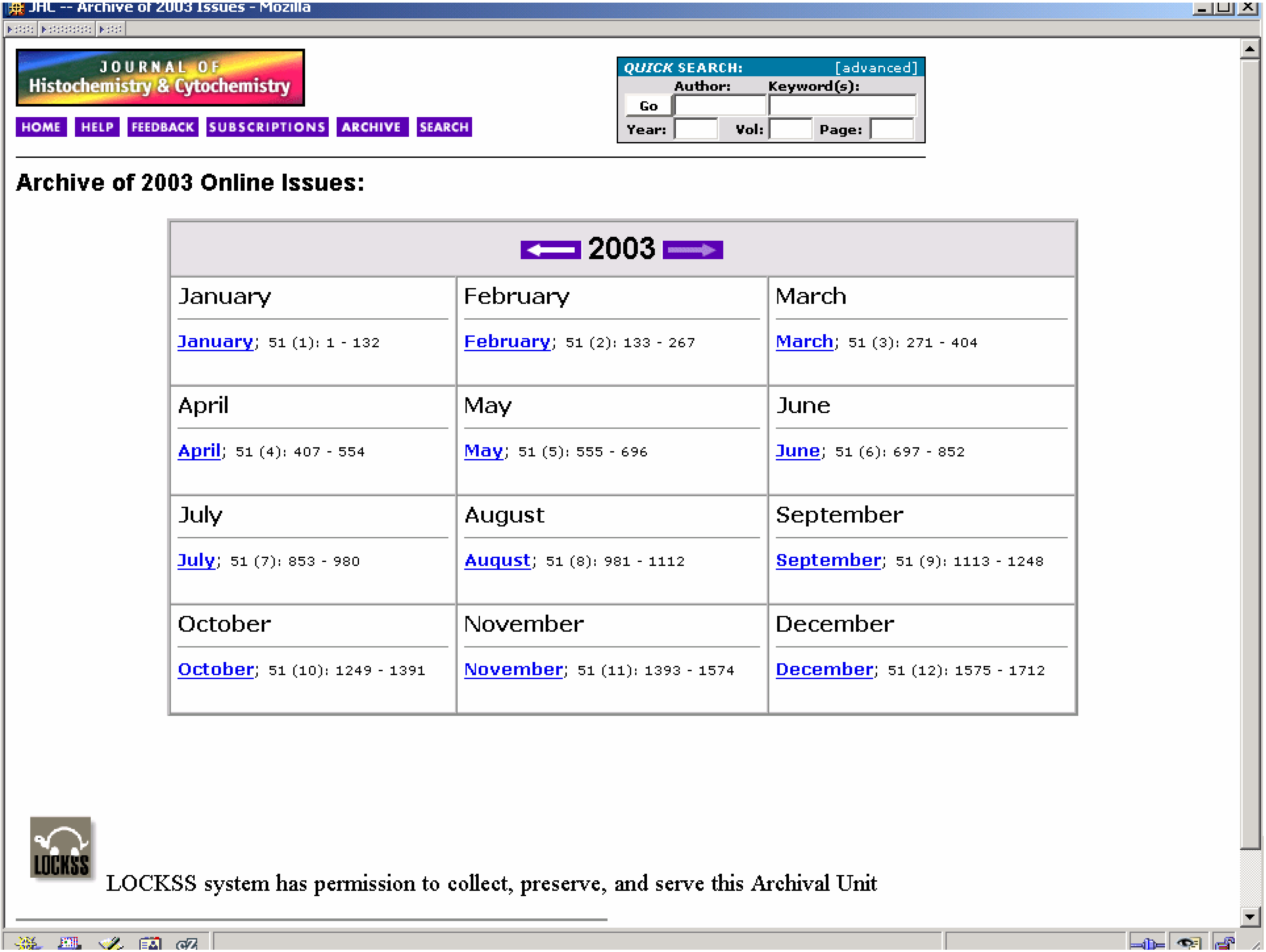
Blanket license permissions

no individual library negotiations

Publisher License

Permit libraries

- Collect materials as published for preservation
- Use material consistent with original license terms
- Provide copies for audit and repair to other caches only if they’ve had copy in the past



Archive of 2003 Online Issues:

2003		
January January; 51 (1): 1 - 132	February February; 51 (2): 133 - 267	March March; 51 (3): 271 - 404
April April; 51 (4): 407 - 554	May May; 51 (5): 555 - 696	June June; 51 (6): 697 - 852
July July; 51 (7): 853 - 980	August August; 51 (8): 981 - 1112	September September; 51 (9): 1113 - 1248
October October; 51 (10): 1249 - 1391	November November; 51 (11): 1393 - 1574	December December; 51 (12): 1575 - 1712

LOCKSS system has permission to collect, preserve, and serve this Archival Unit

Distributed Repository Model Technology

Uses many “unreliable repositories” (PCs)

- Robustness through redundancy
- Inexpensive consumer hardware
- Low sys admin overhead (less 1 hour/mo)

Leverages web technology

- HTTP delivered and displayed content, all formats
- No need to replicate publisher’s system
- Automated content ingestion over time

No single point of failure

Distributed Repository Model Business

Costs shared widely

- Total system is never a line item
- Low management overhead
- Low capital cost

IP issues simplified

- Straight forward blanket license terms
- No “negotiated” access
- Locally owned collections

No single point of failure

Budget cuts = key threat to long term access

LOCKSS and “Central Repositories”

Benefits

- System stability improves with some reliable peers
- Diversity improves reliability and attack-resistance

Requirements

- Implement LOCKSS repository interface
- Run system on mega-servers
- More metadata may be needed for access

LOCKSS Alliance

Publishers and libraries work together

- Define policies and best practice
- Develop and share technology
- Share core team costs
  - For limited time, to give model a chance
  - Contributions not required to participate, but
  - Critical amount of support required
  - Suggested contributions on web site

Taking Action

LOCKSS Program

- is in a nascent stage of development
- needs the community's support to go forward
- shows great promise

There are few actions librarians can take now to preserve digital information for future generations.

The risks of going forward are few. The risks of doing nothing are extremely high.

LOCKSS

http://lockss.stanford.edu

LOTS OF COPIES KEEP STUFF SAFE

Frequent Questions

OAIS

Formal statement of Conformance to ISO 14721:2003 May 2004

Format Migration

Format Migration

Replacing web format takes a long time

- – Both servers and browsers to be updated
- – Society pays conversion for popular formats

During this long time we can

- – Update cache software with converter
- – Preserve content in original format
- – Convert on output from old to new format
- – Rewrite intra-journal links on output

.jpg to .png test conversion mid 2004

Metadata

Format metadata

- Collected from HTTP headers and the HTML
- Sufficient for browsers (now & near term)
- Demonstrate format migration based on this metadata
- Incorporate Harvard's JHOVE

Bibliographic metadata

- For Ingest OAI metadata crawler.
- For Export OAI metadata export capability
- Exploring automatically extracting OAI bibliographic metadata from the text

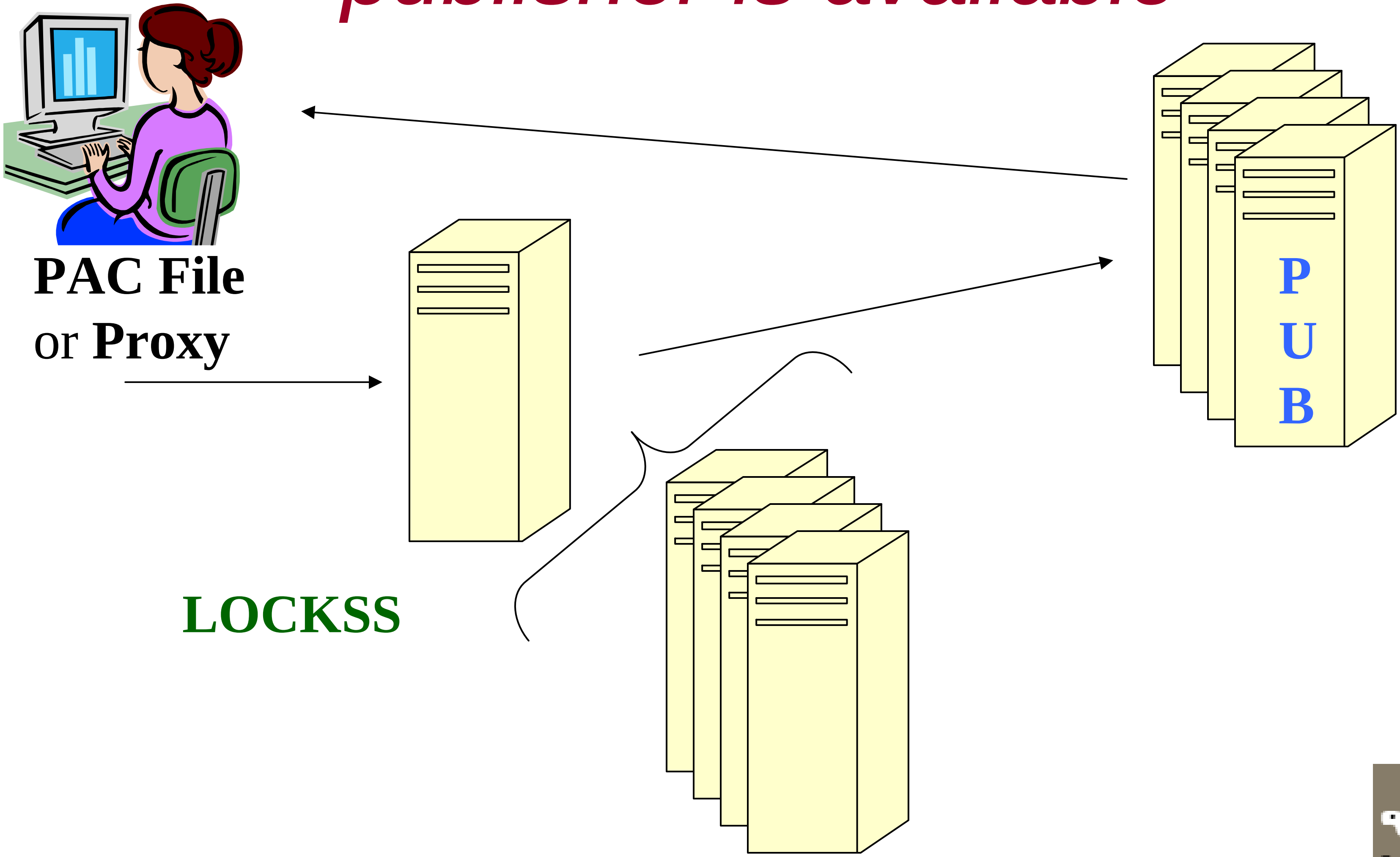
When HTTP is no longer supported as a protocol?

- Servers will export content using old and new transport protocol.
- LOCKSS caches can be upgraded to support both old and new transport protocols

No “flag day on web”

Long period of format overlap for common formats

Collection Access
LOCKSS and Local Networks
publisher is available

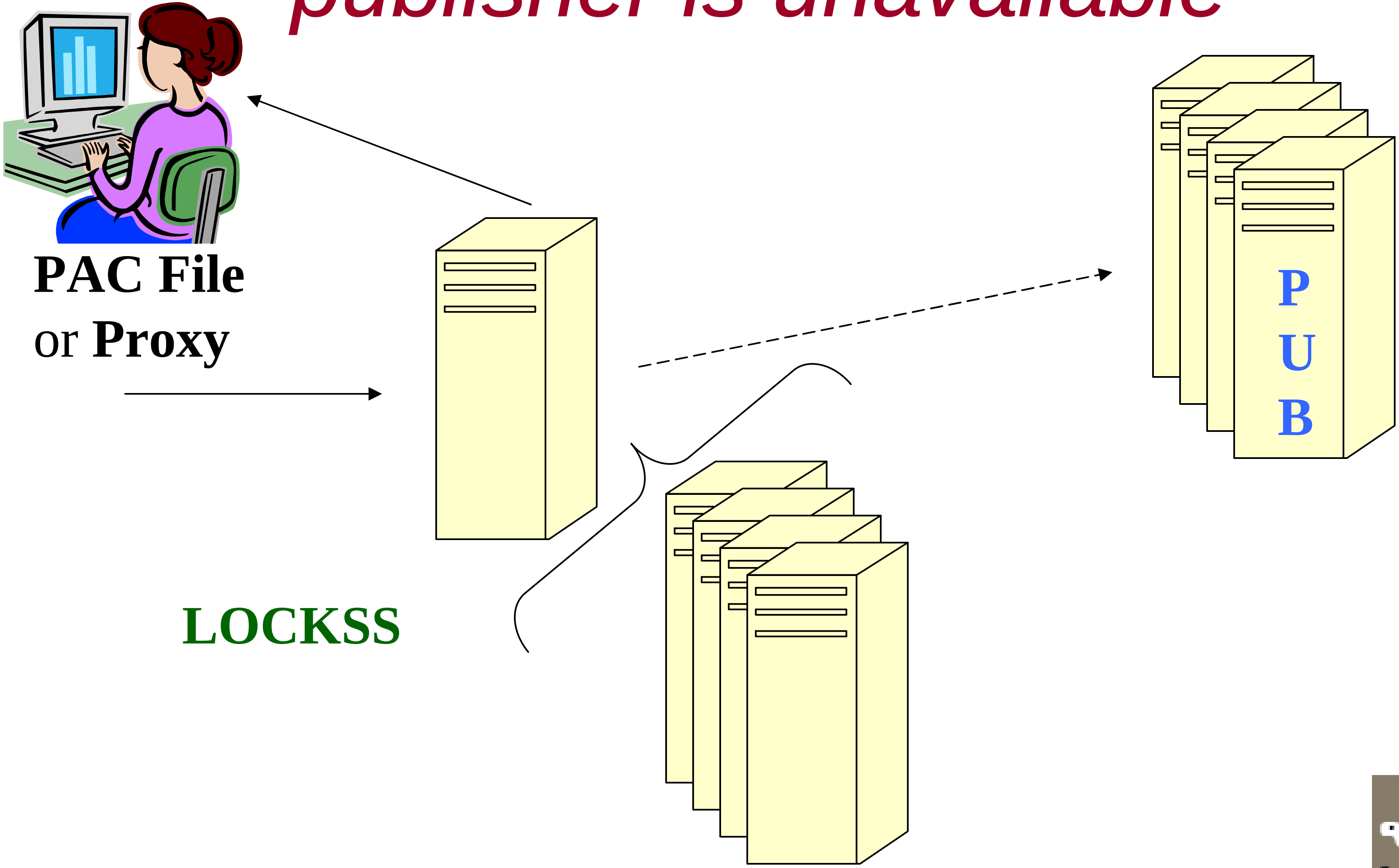


PAC File
or **Proxy**

LOCKSS

P
U
B

Collection Access
LOCKSS and Local Networks
publisher is unavailable



PAC File
or **Proxy**

LOCKSS

P
U
B