LOTS OF COPIES KEEP STUFF SAFE

Distributed Digital Preservation with LOCKSS

Nicholas Taylor (@nullhandle)
Program Manager, LOCKSS and Web Archiving
Stanford Libraries

Massive Storage Systems and Technology
14 May 2018

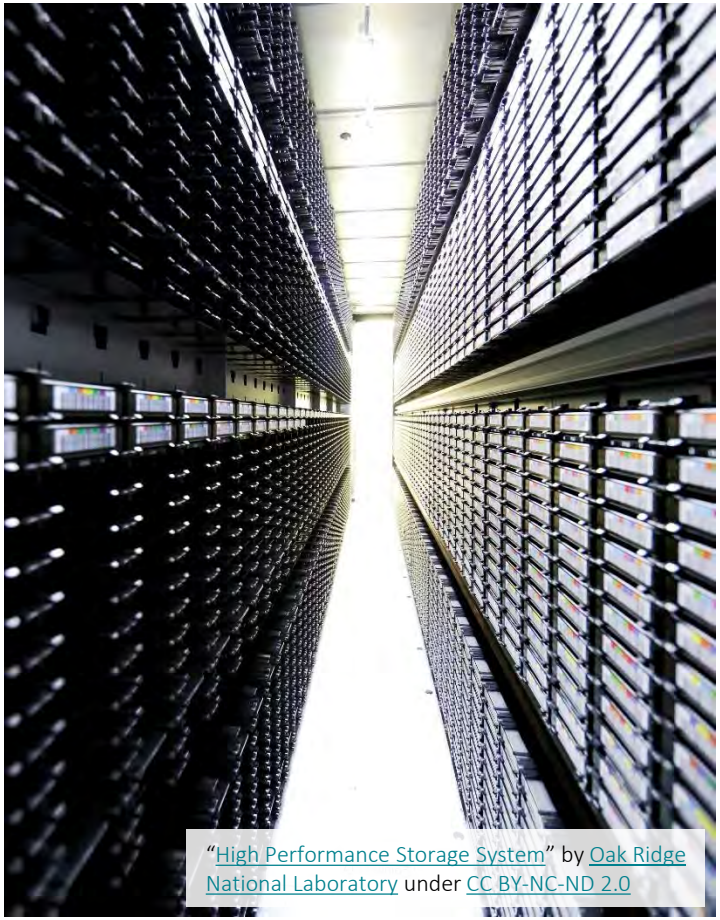
overview

- LOCKSS background
- preservation principles
- distributed preservation
- what's next for LOCKSS?

LOCKSS Background

(digital) libraries

"Boston University - Mugar Library" by Gino Roncaglia under CC BY-NC-SA 2.0



"High Performance Storage System" by Oak Ridge National Laboratory under CC BY-NC-ND 2.0

LOCKSS

lots of copies (were already) keeping stuff safe

- print journal holdings **incidentally resilient**:
  - distributed
  - decentralized
  - irrevocable
  - tamper-evident
  - publisher-independent

LOCKSS

move to online publishing

- own → lease
- local custody → contingent access
- lots of distributed copies → fewer, centralized copies
- net effect:
  - endanger scholarly record
  - obviate library role

POSTMODERN CULTURE

an electronic journal of interdisciplinary criticism

Volume 1, Number 1 — Fall, 1990

Editors: Kyal Amiran, Elaine Orr, John Unsworth, Issue Editor

Editorial Assistant: Gloria Maxwell

Editorial Board:

Kathy Acker, Sharon Barnett, Michael Berube, Marc Chenetier, Greg Dawes, H. Serge Denisoff, Robert Detweiler, Jim English, Henry Louis Gates, Jr., Joe Gomez, Robert Hodge, bell hooks, Susan Howe, E. Ann Kaplan, Neil Larsen, Jerome J. McGann, Laryea Nykyta, Chimalum Nwankwo, Phil Novak, Patrick O'Donnell, Susan Ohmer, John Paine, Marjorie Perloff, Mark Poster, Carl Raschke, Mike Reynolds, Avital Ronell, Andrew Ross, Jorge Ruffinelli, Susan N. Schultz, William Spanos, Tony Stewart, Gary Lee Stonum, Chris Straayer, Greg Ulmer

CONTENTS

Special thanks to Greg Dawes for his assistance in starting the journal and preparing the first issue, and to Chuck Kesler, systems programmer at NCSU, for technical support. We would also like to thank the NCSU Humanities Computing Lab, the NCSU Social Sciences Computing Lab, and the Connecticut College Computing Center.

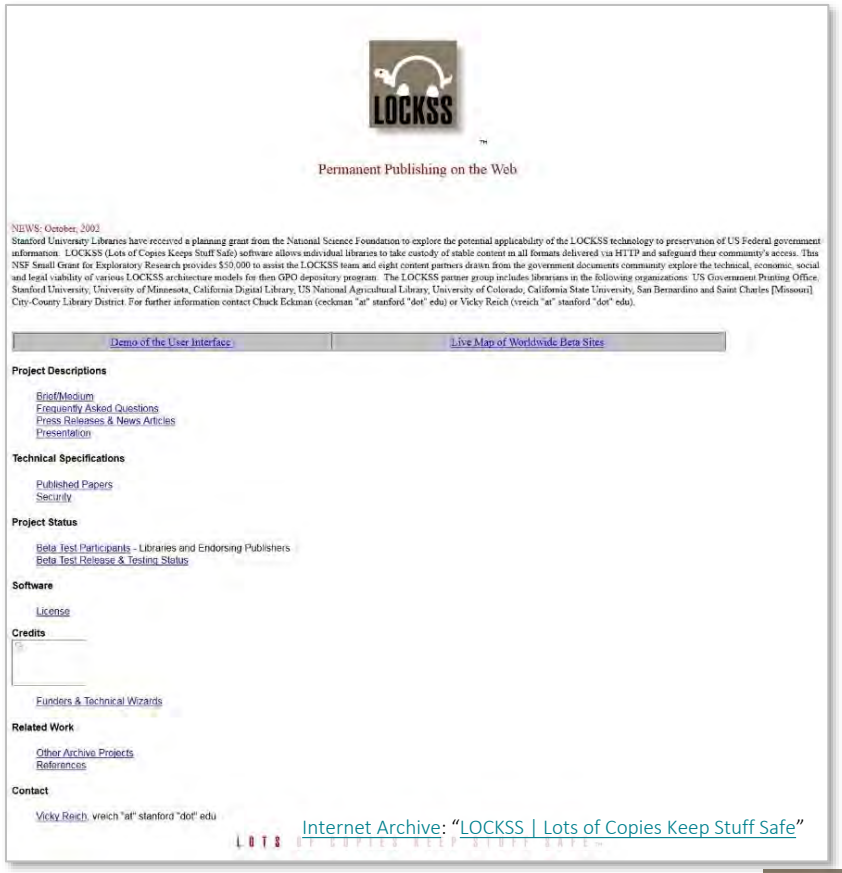
IATH WWW Servic

Last Modified:

Postmodern Culture: Volume 1, Number 1 under Fair Use

LOCKSS but for e-journals

- **p2p software** for e-journal preservation
- **restore preservation features** of print journal holdings for digital
- **re-empower libraries**, individually + communally
- **improve durability** of digital scholarly record



Internet Archive: "LOCKSS | Lots of Copies Keep Stuff Safe"

LOCKSS for more than e-journals

- set out to build **e-journal preservation** system
- ended up building **generic digital preservation core**
- growing number of communities use to **preserve other digital materials**

LOCKSS

community + digital preservation

- communities **complement** LOCKSS:
  - **resilience** against organizational failure
  - native **heterogeneity**
- preservation is an **active** community effort
- lots of **communities** keep stuff safe

LOCKSS

Preservation Principles

lots of copies

- intuitive **best practice**
- LOCKSS typically operates w/ **4+ copies**
- **enlist copies to attest** to expected integrity value
- lots of copies **enables**:
  - majority **votes w/ minority** of participating copies
  - **higher-confidence attestations** via landslide agreement

routine audit + repair

- ensuring **long-term bit integrity**
  - must **read data** to know it's good
  - easier to **repair data sooner**
- network nodes **conduct polls** to validate integrity of distributed copies
- more nodes = **more security**
  - more nodes can be **down**
  - more copies can be **corrupted**
  - …and polls will **still conclude**
- nonces **force re-hashing**
- peers are **mutually-distrusting**

LOCKSS

fail slowly

- fast-operating, tightly-coupled systems **fail quickly**
- LOCKSS is **conservative + sophisticated** about repairs
- polls run slow to enable **detection + mitigation** of cause of damage

threat model

- familiar threats:
  - media + hardware obsolescence
  - software obsolescence
  - natural disaster
- more typical threats:
  - economic failure
  - organizational failure
  - operator error
- security threats:
  - internal attack
  - external attack

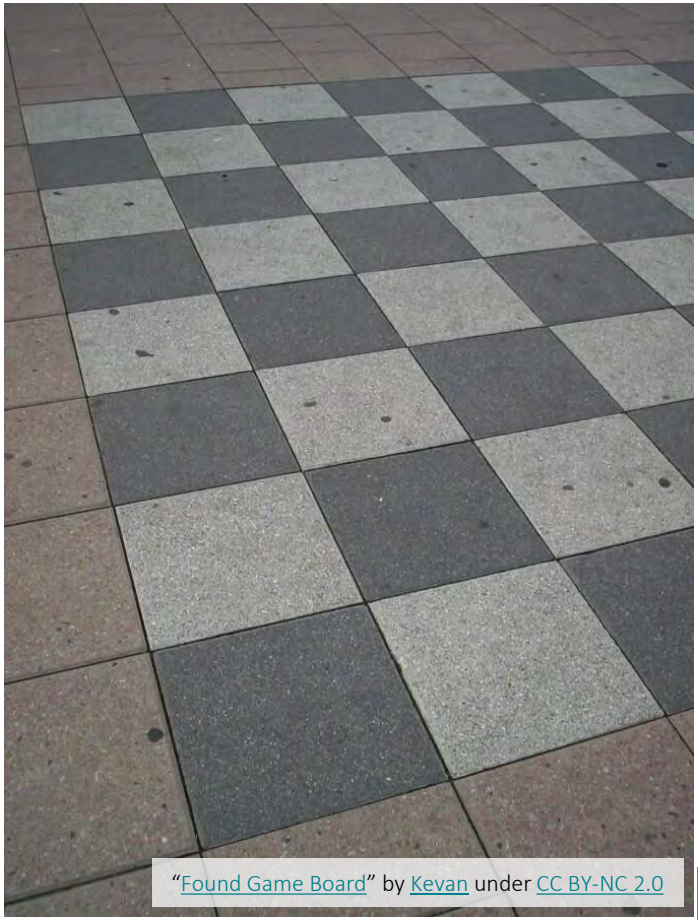
distributed + decentralized

- no monopoly on copy-making
- more copies doesn't mitigate **correlated risk**
- independent, **de-correlated copies**
- minimize central points of failure or vulnerability

LOCKSS

no centralized fixity store

- fixity data **subject to same threats** as data whose integrity it assures
- fixity data is **more vulnerable**, in fact, since more valuable + more centralized
- LOCKSS uses fixity data in **limited ways**



local custody

- if preserving data is **core to mission**, LOCKSS helps maintain that competency + commitment in-house
- **unencumbered access** for use by designated community
- **conserving autonomy** + leverage w/ content + service providers
- **jurisdictional transparency** + control

Distributed Preservation

where does distributed preservation fit?

- may be **integrated into own infrastructure** (e.g., offsite replication)
- as a wholly **hosted service**:
  - for some, may be **main preservation solution**
  - for others, may **supplement local preservation**

LOCKSS

use cases

- scholarly record
- government documents
- web archives
- collaborative collections
- any types of content **valued in common** by a community

LOCKSS

distributed preservation providers

- **hosted services** w/ varied architectures, service tiers, levels of assurance, replication factors
- replication nodes include **memory orgs + cloud**
- none (including LOCKSS) require **local preservation infrastructure**
- LOCKSS provides **opportunity for co-preservation**

ACADEMIC PRESERVATION TRUST

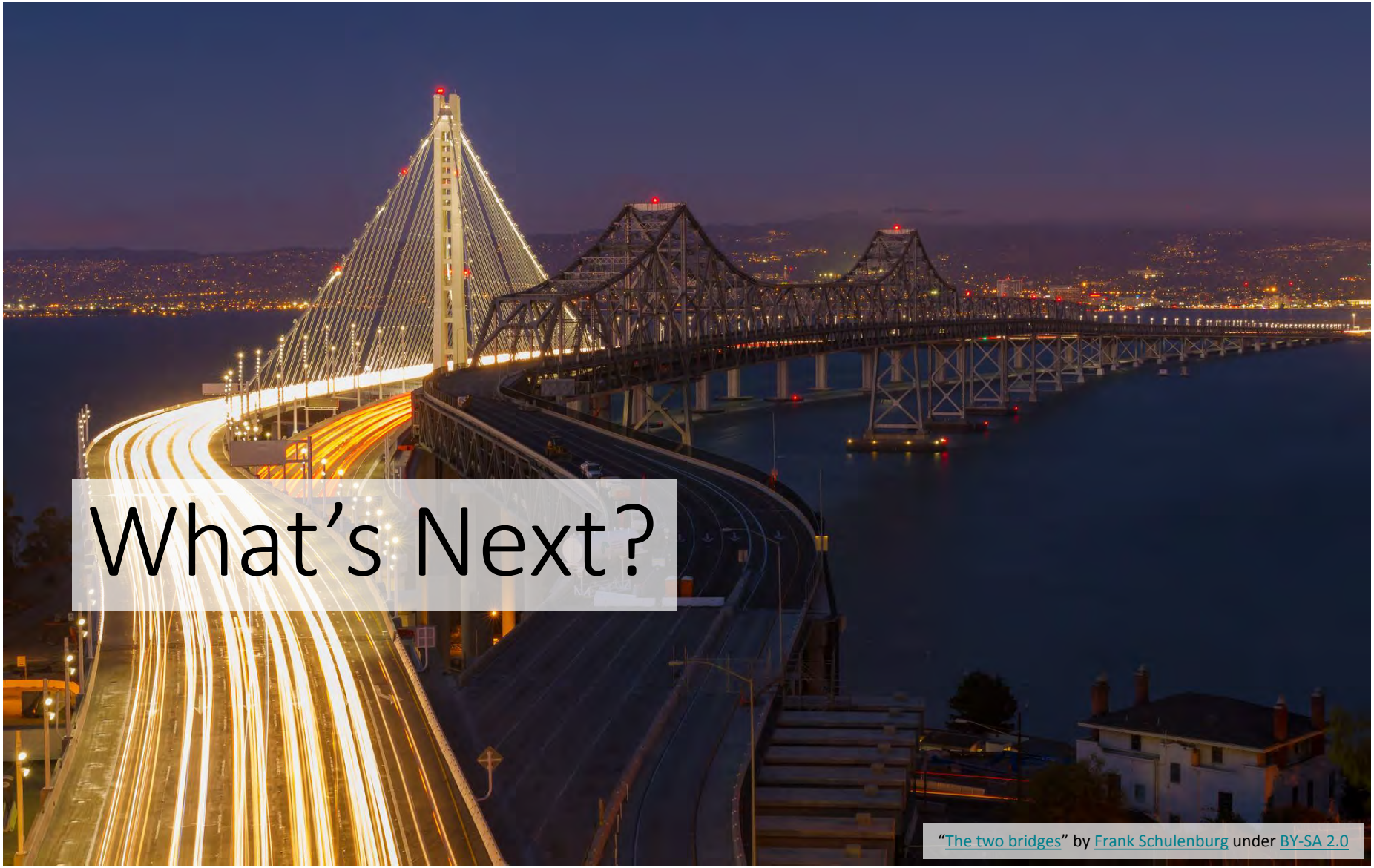
CHRONOPOLIS

DPN

THE DIGITAL PRESERVATION NETWORK

DURACLOUD™

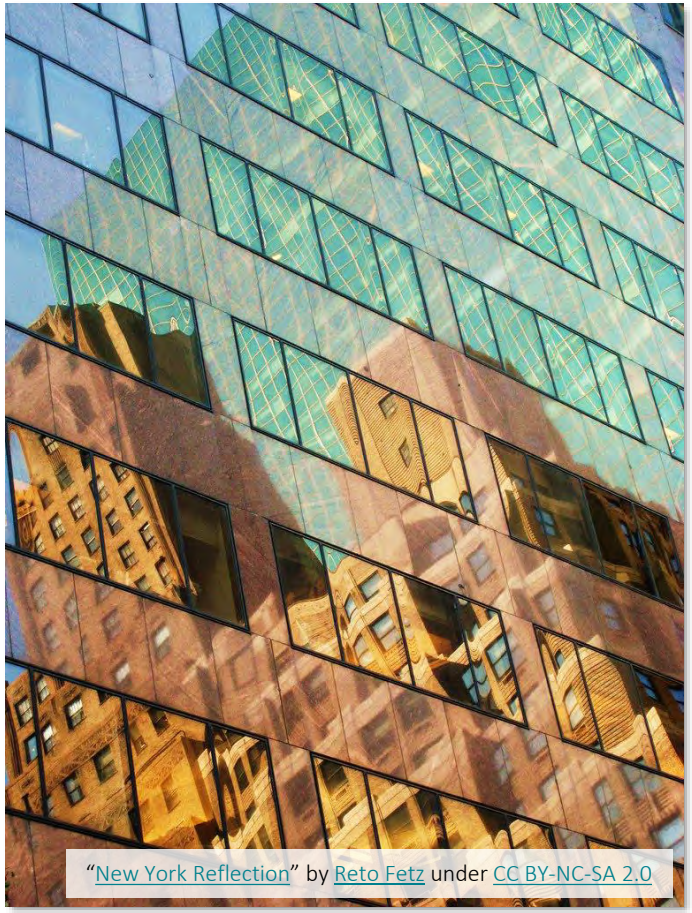
LOCKSS



What's Next?

re-architecture rationale

- de-silo + enable **external integrations**
- foster **developer community**
- capitalize on **work of broader communities**
- create space for **system enhancements**
- evolve w/ web + **digital preservation ecosystem**



LOCKSS

anticipated outcomes

- functional parity + **backward compatibility**
- **components providing value** outside of end-to-end system
- **better integration** + data hand-offs w/ other apps
- increased use to **preserve repository content**
- increased use to preserve content managed by **non-memory institutions**

LOCKSS