Surfing the Web through OceanStore

Patrick R. Eaton
University of California, Berkeley
eaton@cs.berkeley.edu

January 16, 2002

Motivation

- We believe that it is important to study how OceanStore interacts with *real* applications.
- OceanStore must support legacy interfaces.
  - see the rise of web browsers and HTTP
- Legacy interfaces can be enhanced by OceanStore features.
  - archival storage
  - time travel
  - promiscuous caching
  - tolerance to machine failure

Goal

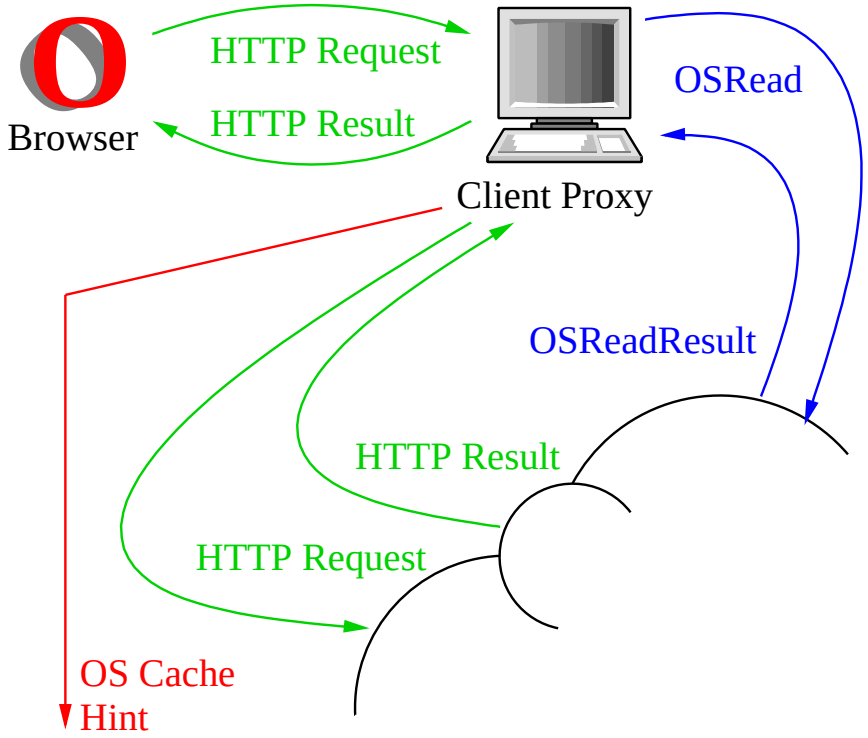
- Develop an OceanStore web caching architecture.
- The architecture should
  - support legacy HTTP interface and web clients
  - provide a migration path to an OceanStore-native web
  - use OceanStore features to enhance the web experience

Components of the OceanStore Web Caching Architecture

- Client proxy.
  - provide a user's web browser with a connection to cached content
- Passive caching agent.
  - retrieve "hot" documents and cache them in OceanStore
- Active caching agent.
  - cache content pro-actively directly from content provider on all updates
- Spidering caching agent.
  - crawl the web in search of documents to add to the cache
- Reverse proxy.
  - allow "ancient" web clients to access data in the native OceanStore web

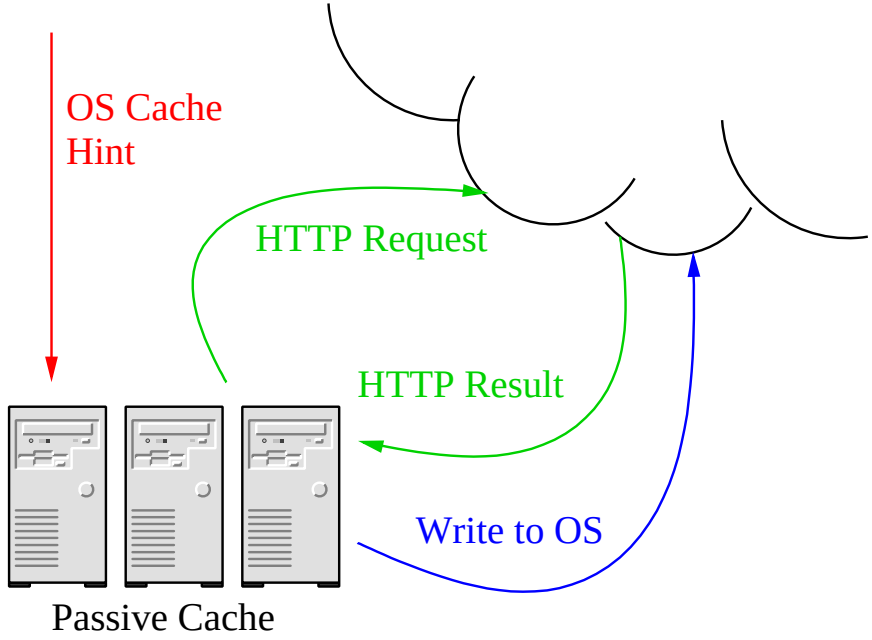
Client Proxy

- Serve as translator to convert HTTP messages into OceanStore messages.
- Check the OceanStore web cache for requested documents.
- Retrieve uncached documents via the legacy protocol.
- Provide the passive caching agent with hints on popular documents.



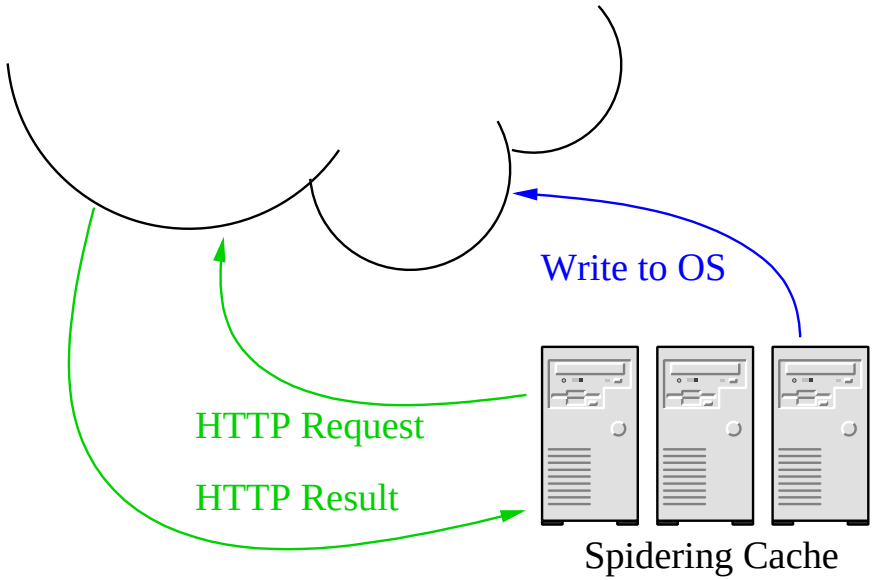
Passive Caching Agent

- Use hints from client proxies to determine popular content.
- Retrieve popular content using standard HTTP protocols.
- Store the content in the OceanStore cache.



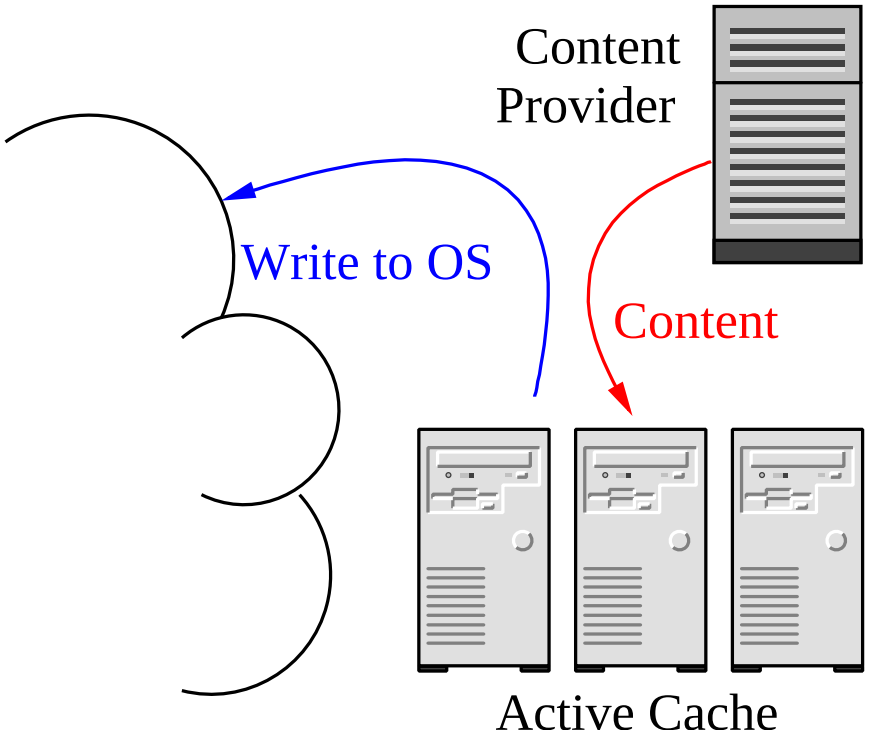
Spidering Caching Agent

- Obvious extension to the passive caching agent.
- Crawl the web searching for content that can be added to the cache.



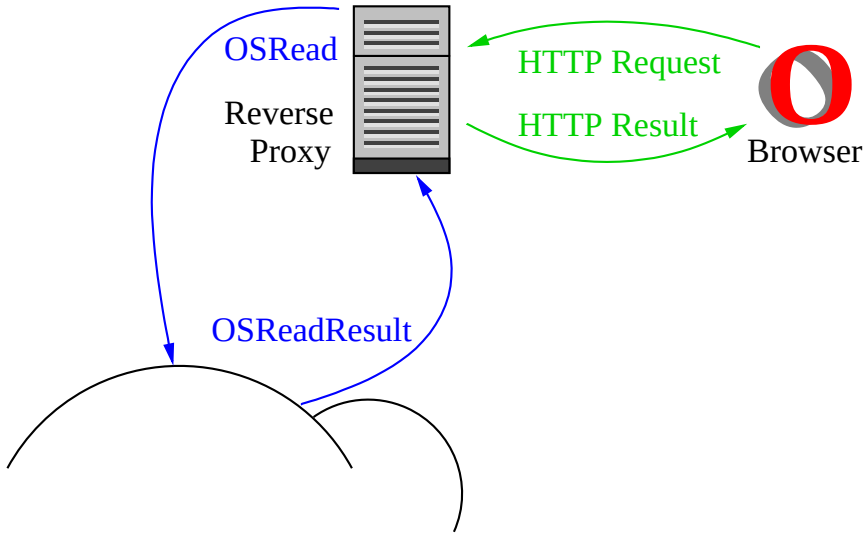
Active Caching Agent

- Used by content providers who want to ensure that their content is cached in OceanStore and available to their users.
- Providers proactively push content updates to the agent.
- Agent stores content in OceanStore web cache.
- Service could be based on contractual agreement.
  - content can be signed to prevent spoofing
  - contract could specify minimum number and location of replicas

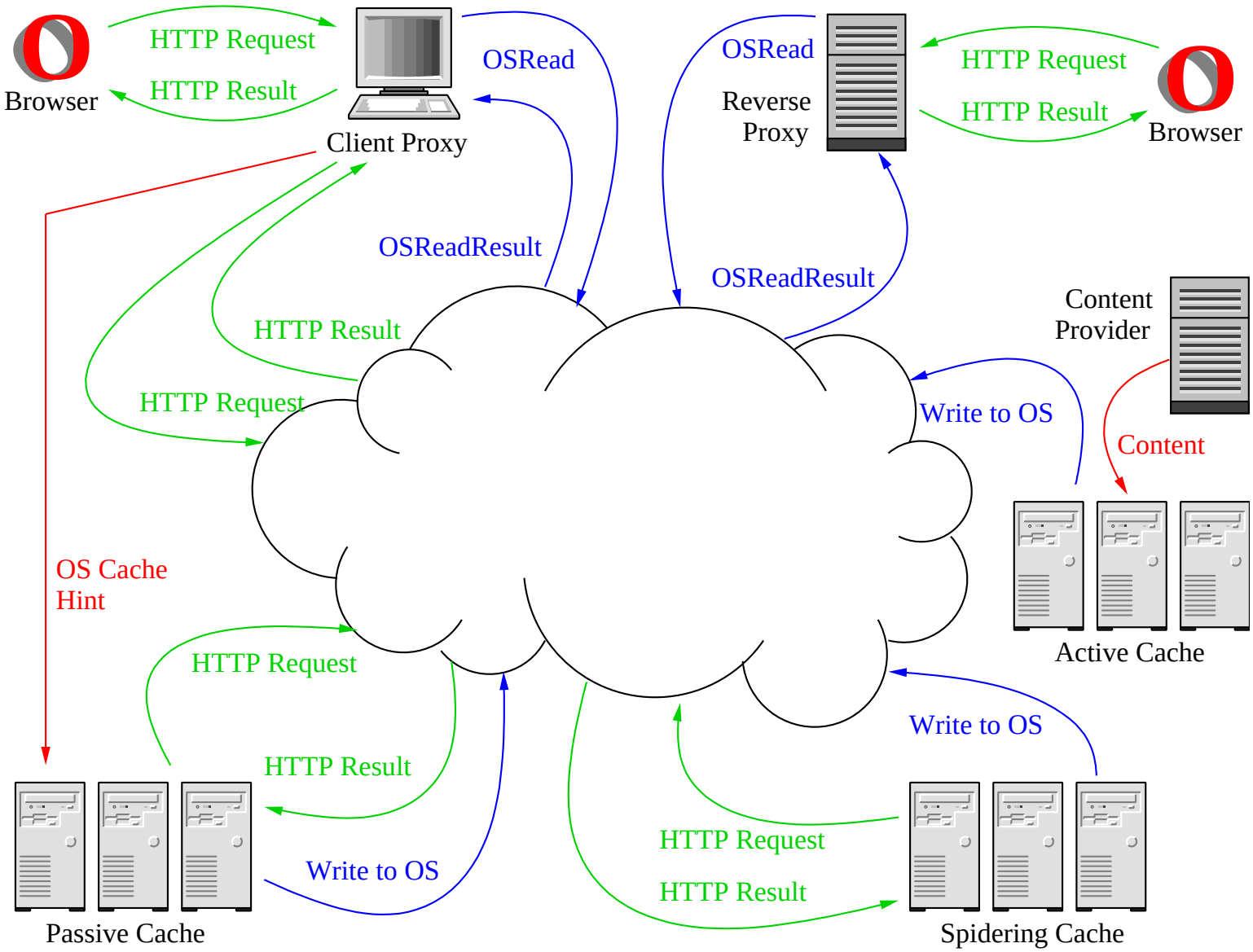


Reverse Proxy

- Allow traditional web clients to access documents that are published natively to OceanStore.
- Sit at the IP address published for a server.
- Translate incoming HTTP request to OceanStore requests.
- Convert the OceanStore content to an HTTP response to serve to the user.



The Whole Web Cache Architecture



Success Metrics

- Improved browsing experience.
  - lower latency for end user
- Reduce server load.
  - reduce load on the web servers of content providers
- Technical metrics.
  - amount of cache sharing
  - effectiveness of caching content close to users

Issues - Document Freshness

- OceanStore stores all versions of a document that has ever been cached.
- **Issue:** How do we request a version that is still fresh enough (by HTTP cache requirements) without extra round-trips or reading unnecessary data.
- **Solution:** Include *version predicates* in read requests.
  - this parallels the predicates sent with updates

Issues - Negative Tapestry Results

- When Tapestry delivers a result, it can be checked because all data is verifiable.
- **Issue:** What does a negative result mean?
  - document does not exist
- **Answer:** Negative results are only hints.
- **Issue:** Are non-verifiable hints useful?
- **Answer:** Yes, negative hints simplify the application programming task and are vital for application performance.

Status

- Client proxy and passive caching agent prototypes are functioning.
- Client proxy
  - accepts HTTP requests from user's browser
  - searches the OceanStore cache for a fresh copy of the document
  - converts the OceanStore result into a HTTP response
  - retrieves uncached documents from the origin server using HTTP
  - delivers HTTP response to user's browser
- Passive caching agent
  - accepts hints from client proxies
  - retrieves documents from origin servers using HTTP
  - creates OceanStore objects for content being cached for first time
  - updates the cache with the current content of the document

Status (continued)

- What is missing?
  - strict adherence to HTTP caching directives
  - Tapestry timeouts and negative hints
  - multiple client tests

Preliminary Results

- I present these numbers only emphasize that we have a working system. The system is not yet widely deployed or tuned for performance.

Time to Retrieve a Document

	1K	4K	16K
Department Web Server	160 ms	982 ms	751 ms
OceanStore Web Cache (remote reads)	286 ms	647 ms	438 ms
OceanStore Web Cache (local reads)	4.3 ms	7 ms	7 ms

Future Work

- Implement all of HTTP's caching policies.
- Perform larger scale usability tests using others in the department.
- Use an active caching agent to push content from the department's web server into the OceanStore cache.
- Crazy Idea: Initial results indicate sub-10 ms cache hit times for content on the local node. Could the OceanStore web cache replace the local browser cache?

Conclusions

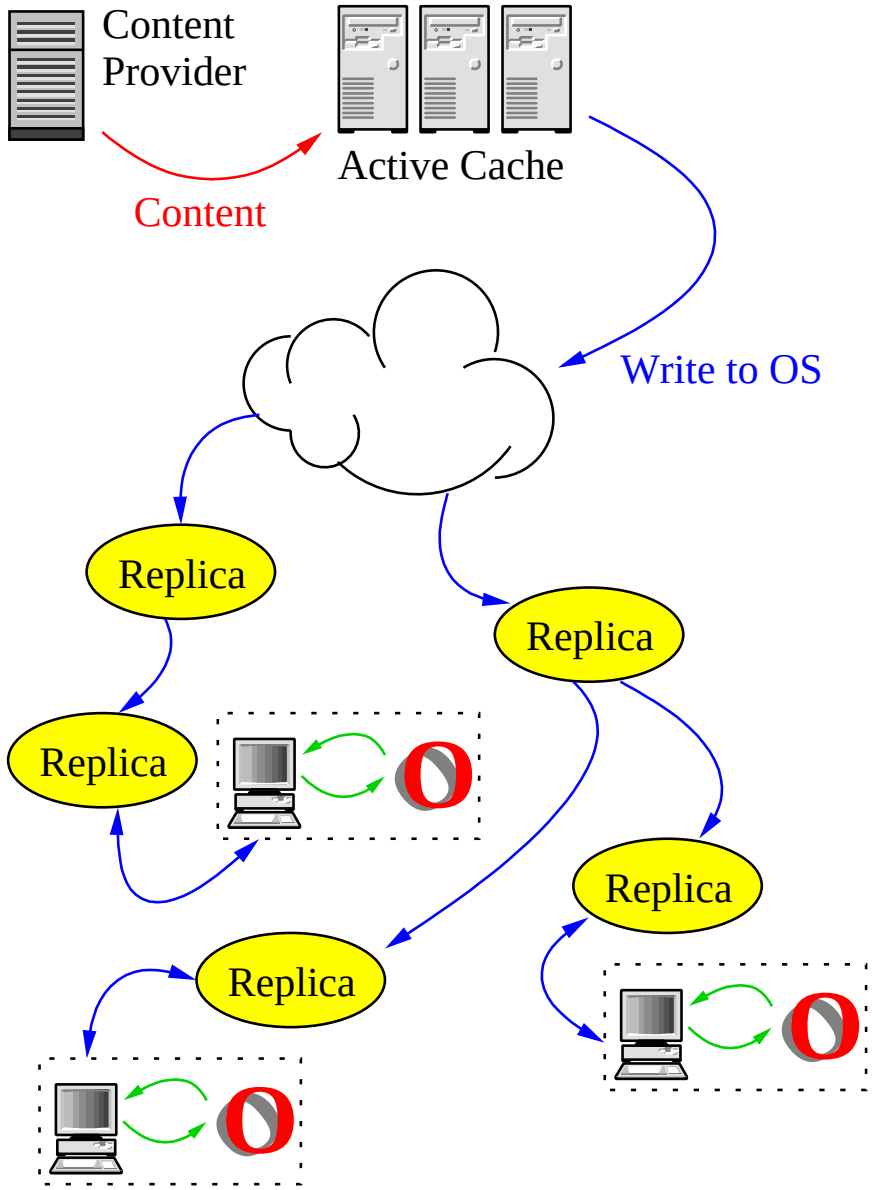
- We have presented an architecture for the OceanStore web cache.
- A prototype implementation of the OceanStore web cache has been developed.
- It is productive to examine the interaction of applications with OceanStore during the design of the system.

Issues - Key Management

- Every principal who stores data must have an identifying key. Any client that has a key to decode data can read an object.
- **Issue:** How are the keys organized in the web caching architecture?
- A *passive caching agent* needs a key to cache the content.
  - passive caching agent is billed for storing content
  - difficult to bill users
  - perhaps it is OK to avoid billing users since this matches the HTTP/web paradigm
- An *active caching agent* needs a key to cache the content.
  - active caching agent is billed for storing content
  - active cache can bill content providers who wish to push their content out - similar to paying for bandwidth

Pushing Content

- Scenario: A Super Bowl web cast of the plays and stats (not video) for each play. Content is updated every 25 seconds and needs to be pushed to several million viewers.
- Caching content in OceanStore has several advantages.
- Key feature is a number of mobile replicas arranged in a tree for rapid dissemination.



Pushing Content (continued)

- Advantages of caching fast-changing content in OceanStore:
  - no client starvation
  - replicas are created and moved to service hot spots
  - no load on server
  - rapid dissemination of updates via optimized dissemination tree
  - cache communication is implicit in the dissemination tree
  - no over-provisioning required (Victoria's Secret fashion show)