Managing Versions of Web Documents in a Transaction-time Web Server

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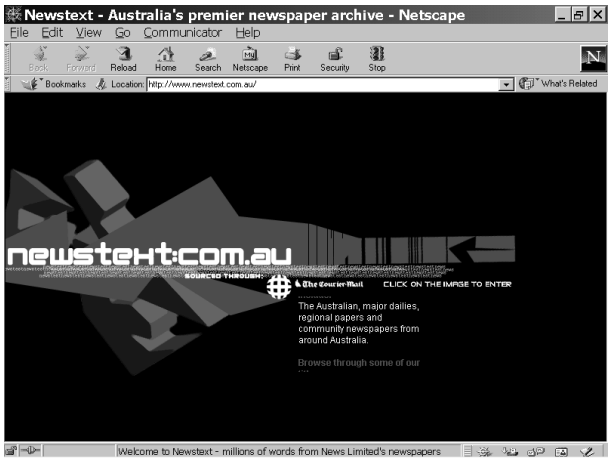
Outline

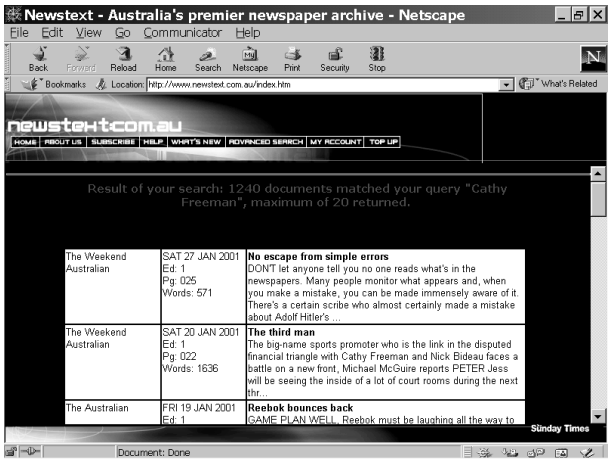
- Motivation
- Server extension
  - History of a site
  - Time travel queries
- Experiments
  - Turnaround time
  - Disk/memory usage

Motivation

Motivation

- Sep. 25, 2000 Cathy Freeman won the 400m
- Sep. 26, 2000, article in *The Australian*
- URL of the on-line newspaper (sports section)
  www.theaustralian.com.au/sports.html





Queries

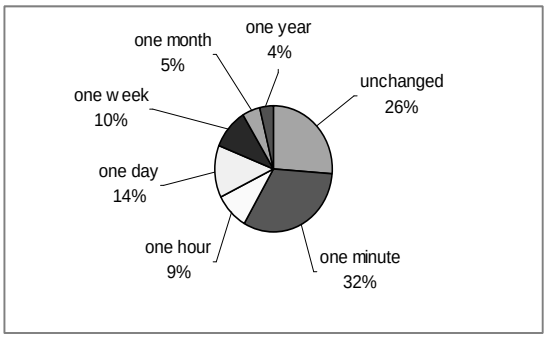
- URL of the on-line newspaper (sports section)
  www.theaustralian.com.au/sports.html
- URL understood by transaction-time server
  www.theaustralian.com.au/sports.html?26-Sep-2000

Motivation

- Historical access
  - Entertainment, government, educational, financial
  - Time travel queries
    - Timeslice
    - Next/previous versions
    - Document history
    - Show changes
      - HTMLdiff, XMLdiff (AT&T Bell Labs)
  - Statistics on frequency of page update
    - Ntoulas, Cho, and Olston (WWW 2004)
- Archives
  - A warehouse for old pages
  - No standard interface

eecs.wsu.edu Website

- 1 year study
- 20,240,822 hits, 10GB of data, 20GB of history



How long before resource was updated?

Related Work

- Web Archiving
  - The Internet Archive (www.archive.org)
    - Wayback machine
  - iPROXY
    - Rao, Chen, and Chen (Middleware Symposium, 2000)
  - Author-requested archiving
    - Douglis (Workshop on Web-site Evolution, 1999)
- XML
  - Change detection
    - Marian, Abiteboul, Cobena, Mignet (VLDB 2001)
    - Buttler, Rocco, and Liu (WWW 2004)
  - Transaction-time querying of XML with *TT*XPath
    - Dyreson (WISE, 2001)
- Fabio Grandi's temporal web bibliography

A Transaction-time Web Server

Transaction Time in Databases

- Interval representation - DBMS maintained

		Transaction Time	
Stock	*Price*	*start*	*end*
IBM	34	Sep/8/2002	*now*
Microsoft	72	Sep/9/2002	*now*
TriGEO	54	Sep/4/2002	Sep/8/2002
TriGEO	105	Sep/9/2002	*now*

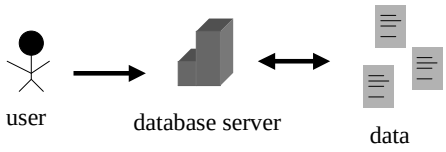
- On Sep/9/2002

```
DELETE FROM Stocks WHERE Stock='TriGEO';
INSERT INTO Stocks ('TriGEO', '105');
```

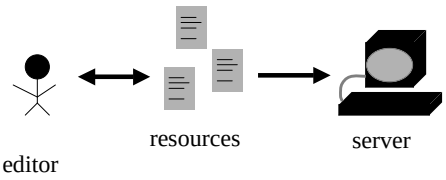
- Schema evolution (e.g., Roddick and Snodgrass, *TSQL2*, 1995)

Web vs. Database

- Must use DBMS to modify data

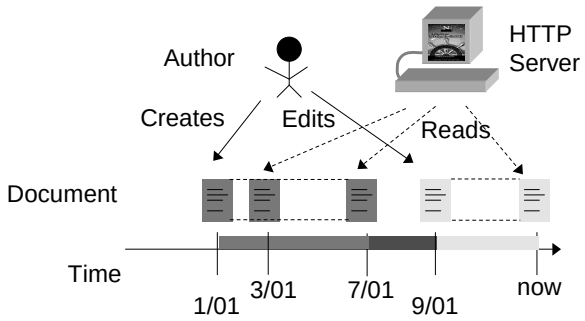


- On the web, updates are independent of server



An Observant System

- Each edit creates a version
- Read-only (read-mostly) access to the data
- Known vs. assumed



Observant Systems

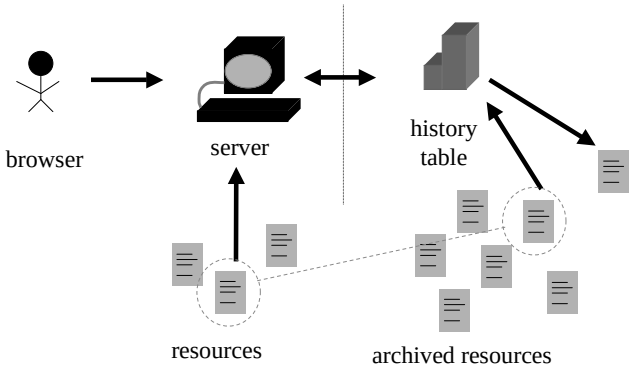
- Lots of Observant Systems
  - Web browsers, HTTP servers, portals, search engines
- HTML/XML
  - No temporal semantics
  - Few user-defined timestamps
- Goal: Implement transaction time in an Observant System
  - No transactions
  - No explicit timestamps in data
  - Implicit
    - System time of observer
    - File modification time

Constraints on Our Design

- Backwards compatible
  - Minimal changes to HTML, HTTP, servers, browsers
  - No changes to legacy pages
  - No changes to page maintenance culture
- Coexistence compatible
  - Partial migration
- Simplify problem
  - Ignore *dynamic* pages
    - ASP
    - CGI-bin
  - Ignore processing changes
    - Javascript bug fixes

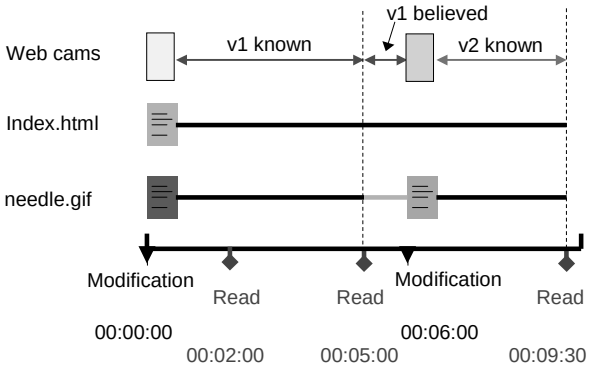
Lazy Transactions

- Perform transaction during HTTP get



Computing Resource Versions

- Known vs. believed versions



*TT*Queries

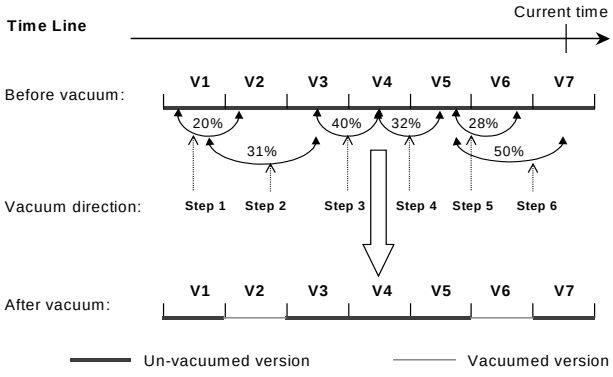
- Syntax: a.htm?< q_{tt} >,< p_{tt} >
  - A selection query(q_{tt}) and restructuring query(p_{tt})
- Examples
  - Show current version, but links are to previous
    `a.htm?now,pre`
  - Show all versions of seattle.html
    `a.htm?history`
  - Grab version on 26 April, links are to current
    `a.htm?26-Apr-2002/02:15:04,now`
  - Two versions ago
    `a.htm?pre.pre`

Vacuuming

- Remove versions
  - Vacuuming policies
    - time-window, version-window, periodic, percent-difference
    - e.g., Vacuum versions that differ by less than 5%
  - Never vacuum the current version
- Remove history
  - Obliteration
- Query repair

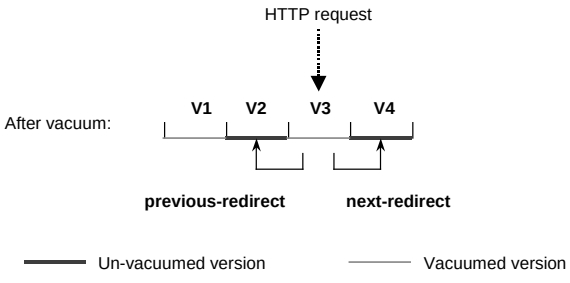
Percent-difference Vacuuming Policy

- Vacuum versions less than 30% difference



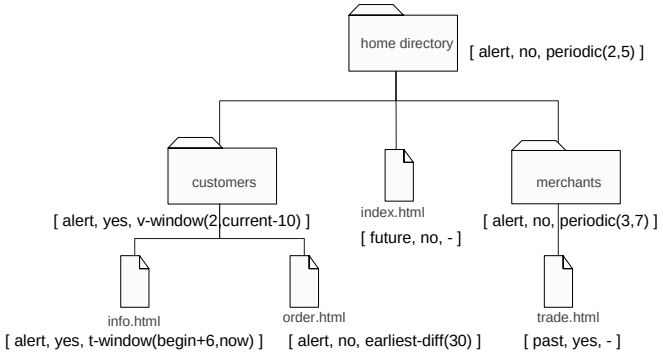
Query Repair

- What happens on query to vacuumed version?
  - E.g., redirect to previous/next “good” version



Vacuuming Policy Tree

- Policy can be set for directory or document

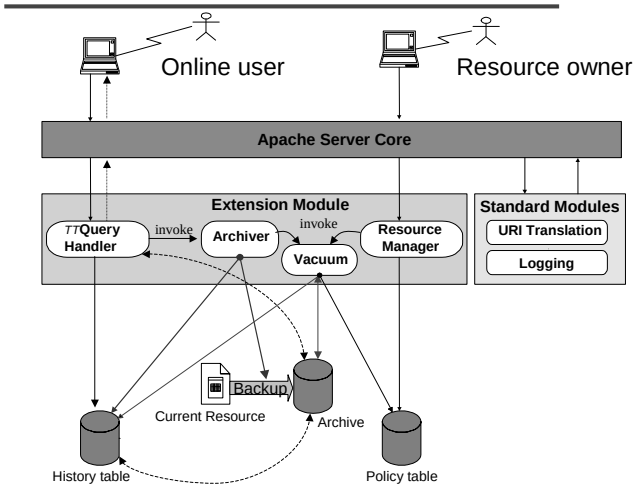


Experiments

Implementation

- Apache
  - Popular, open source server
  - Pre-forking model (child processes handle requests)
    - DB must have concurrency control
  - "inner-loop" – additional disk I/O on every request
- BerkeleyDB

*TT*Apache Architecture



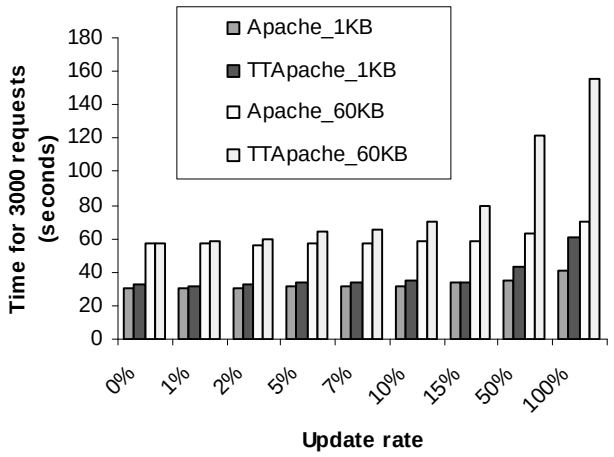
Cost

- Time
  - Overhead on I/O
    - Minimum – One DB read and write
    - Maximum - Many DB reads and writes, many file copies
  - Milliseconds are important (disk read approx. 11msec)
- Space
  - Disks are cheap
  - Vacuuming
  - Store diffs
    - RCS

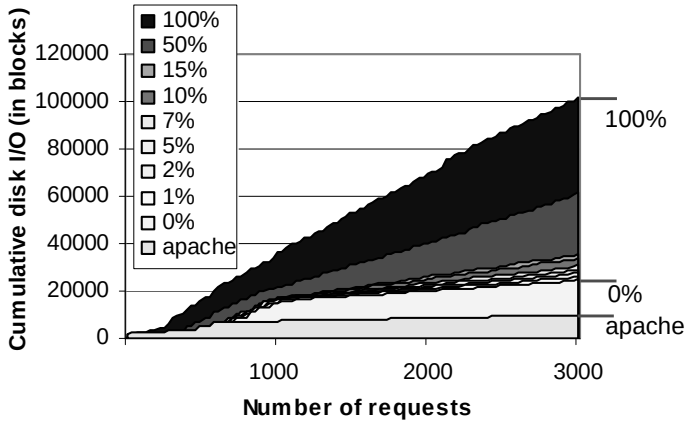
Experiments

- Factors
  - Page size (1KB vs. 60KB)
  - Update rate (0%, 1%, 2%, 5%, 7%, 10%, 15%, 50%, 100%)
  - Ratio of *TT*Queries (0%, 1%, 5%, 20%, 80%)
    - "pre", "a timestamp", "pre.pre.pre", "history"
- Design of the experiments
  - Step1. Start *TT*Apache
  - Step2. Pre-fetch 3000 pages
  - Step3. Perform multiple runs
    - Measure turnaround times (3000 requests/run)
  - Step4. Shut down *TT*Apache

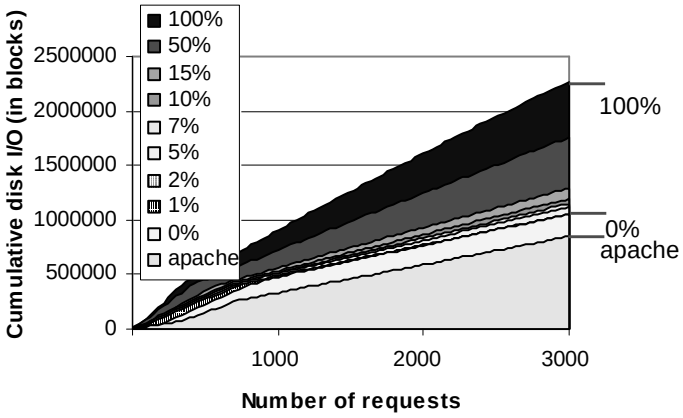
Turnaround Time



Disk I/O (1KB Document Size)

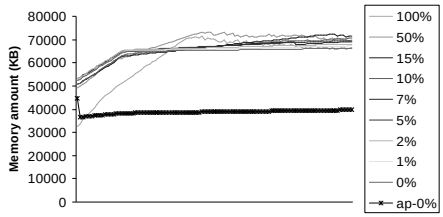


Disk I/O (60KB Document Size)

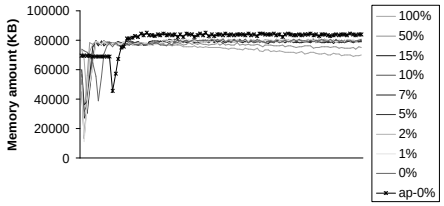


Disk Cache

1KB Documents

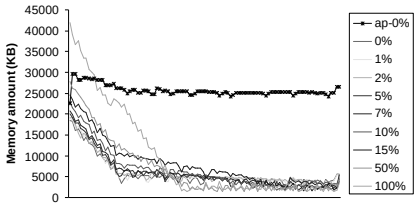


60KB Documents

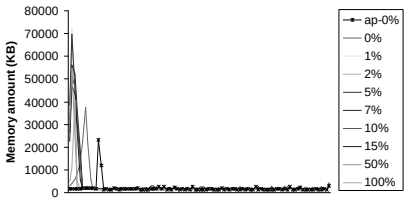


Free Memory

1KB Documents

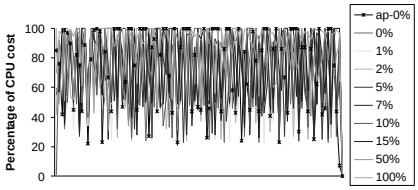


60KB Documents

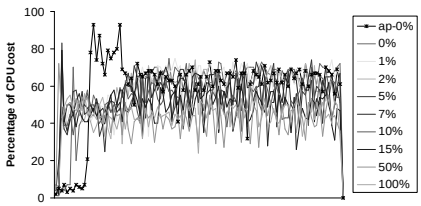


CPU

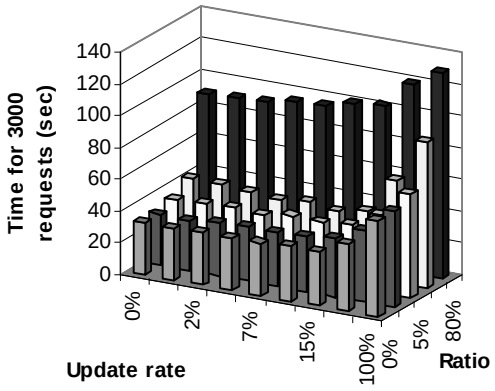
1KB Documents



60KB Documents



Turnaround Time (*TT*Query)



Summary of Results

- Little overhead for low update rates
  - No significant difference for rates under 5%
  - EECS web site - .009%
- A large page size is a significant factor.
  - Increases memory use and disk I/O
    - EECS web site
      - 71% - less than 1K
      - 23% - 1K to 10K
      - 4% - above 10K
  - *TT*APache “stress test”
    - 60KB page at 100% update => 20 requests per second
    - EECS web site
      - 0.68 requests per second (on average)
      - EECS - 73% of peaks > 20

Conclusions

- Local server extension
  - Archives documents
  - Supports
    - Time travel queries
    - Link rewriting
    - Vacuuming
    - Obliteration and forwarding of resource histories
  - Distinguishes known vs. assumed versions
- Compatible
  - HTTP, HTML, URLs
  - Page maintenance “culture”
- Cost
  - Modest overhead