



WebCompanion: A Friendly Client-Side Web Prefetching Agent

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Outline

- **Introduction**
- **WebCompanion Features**
- **Experimental Results**
- **Summary**

Introduction

- **Motive**
 - Deal with the Web latency and bandwidth issues
 - Web prefetching strategies
 - ✓ **client-side, proxy-side, server-side, hybrid**
 - Greedy prefetching strategy
 - ✓ **high network overheads and resource consumption**
- **Goal**
 - Reduce the round trip time of accesses to the Web
 - Client-side Java-implemented prefetching agent
 - ✓ **estimate the round trip times, limit the overhead**

P. 1

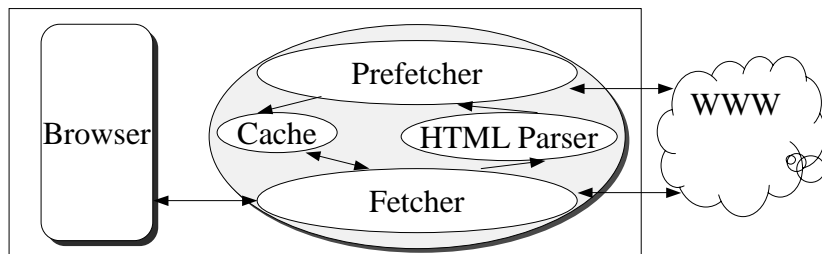
Introduction

- **Main Idea**
 - Estimate the round trip times of all documents referenced by embedded hyperlinks
 - Prefetch the documents with the longest times first
- **Estimated Round-Trip Time-based Prefetching**
 - Highly selective prefetching strategy
 - ✓ **only long retrieval latencies and low resource usage**
 - Sophisticated session control scheme
 - ✓ **adapt to changing network and server conditions**
 - Startup prefetching, DNS caching

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Introduction

- **Performance Gains**
 - Average speed-up > 50%
 - Average network byte overhead < 150%
- **Architecture**
 - HTTP Web proxy



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WebCompanion Features

- **Server Statistics Cache**
 - Linearly weighted averages for individual servers
 - ✓ setup time: t_s
 - ✓ waiting time: t_w
 - ✓ byte transmission time: t_b
 - ✓ resource size: s_r
 - ✓ round trip time: $t_r = t_s + t_w + t_b * s_r$

$$a_n = \frac{1 \times y_1}{n(n+1)/2} + \frac{2 \times y_2}{n(n+1)/2} + \dots + \frac{n \times y_n}{n(n+1)/2}$$

$$a_n = \frac{n-1}{n+1} \times a_{n-1} + \frac{2}{n+1} \times y_n$$

$$a_n = \omega \times a_{n-1} + (1-\omega) \times y_n$$

1 2 7 1 2
 $a_2=1.67$
 $a_3=4.33$
 $a_4=3$
 $a_5=2.67$

1 2 1 2 7
 $a_2=1.67$
 $a_3=1.33$
 $a_4=1.6$
 $a_5=3.4$

1 2 7 1 2
 $a_2=1.9$
 $a_3=6.49$
 $a_4=1.549$
 $a_5=1.9549$

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WebCompanion Features

- **Estimation of Round Trip Time (RTT)**
 - Identify embedded hyperlinks
 - Examine document cache
 - ✓ if found, no prefetching operation is activated
 - Access server statistics cache
 - ✓ if not found, fetch the referenced document and update both caches
 - Compare t_s+t_w with $t_s+t_w+ t_b*s_r$
 - ✓ if not significantly less, store the estimated t_r
 - Issue HEAD request to obtain status information
 - ✓ if size s is returned, compute and store $t_s+t_w+ t_b*s$

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WebCompanion Features

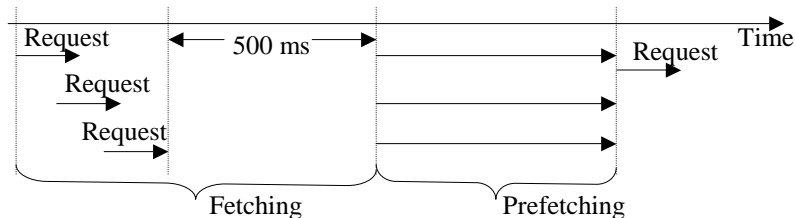
- **Hyperlink Filters (before prefetching)**
 - Protocol filter
 - ✓ compressed files, images, executables...
 - Dynamic resource filter
 - ✓ the output of CGI scripts
 - Size filter
 - ✓ maximum size threshold
 - Time filter
 - ✓ maximum/minimum RTT threshold
 - 75% linearly weighted average of previous accesses
 - (min, max): (3000 ms, 20000 ms)

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WebCompanion Features

- **Session Control**

- Start prefetching
 - ✓ first request arrives ⇒ the beginning a new session
 - ✓ new request arrives ⇒ examine the ongoing session
- Stop prefetching
 - ✓ restart a new session with a short delay (500 ms)
 - wait for requests to reconsider the end of session



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WebCompanion Features

- **Implementation**

- Memory cache with compression
 - ✓ 2MB cache with LRU replacement policy
 - ✓ 65.44% cache hit ratio
 - RTT vs. priority to be displaced
- DNS caching
 - ✓ influence on the pessimistic scenario
- Parallel prefetching
- GUI on statistics and cache

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Experimental Results

- **WebWatch**
 - Workload generator (browser emulator)
 - ✓ **URL list with a configure probability distribution**
 - no duplicate requests/no cache
 - ✓ **switch between WebCompanion and direct access**
 - Performance measurement
 - ✓ **pessimistic access pattern**
 - simulate user idle time: fixed interval (5 sec)
 - ✓ **average-case access pattern**
 - simulate user idle time: Poisson distribution ($\lambda=10$)
 - randomly select hyperlinks: equal probability (80%)

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Experimental Results

- **Comparison**
 - Speedup
 - Percentage of faster accesses
 - Network overhead

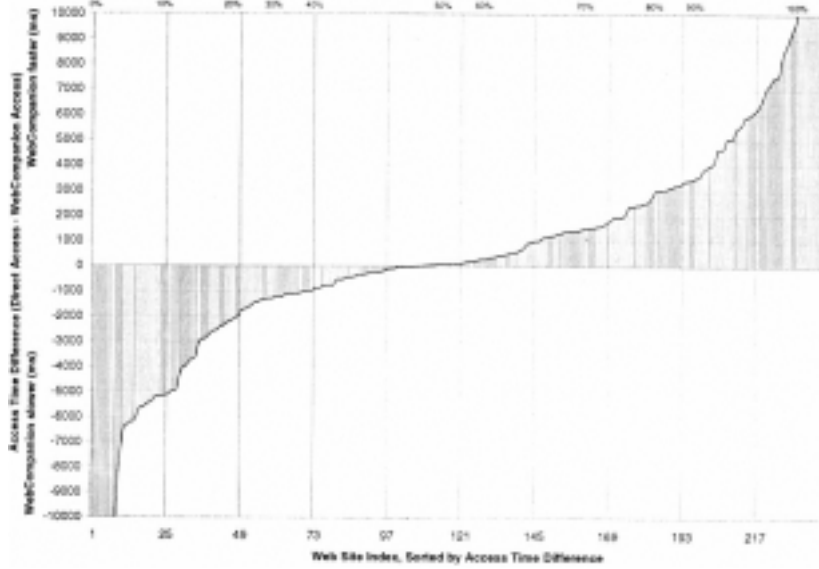
Comparison Between Direct Access and WebCompanion Access: Averages Are Per Web Resource

Experiment	Average Direct Access Time (ms)	Average WebCompanion Access Time (ms)	Speedup (%)	% of Accesses Faster with WebCompanion Access	Network Overhead (bytes)%
Pessimistic Scenario	6711	6207	7.5	56.1	82.5
Average Case:					
1. Direct Access First	4901	1939	60.43	80.8	205.22
2. WebCompanion Access First	2630	1514	42.42	74.3	112.76

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Experimental Results

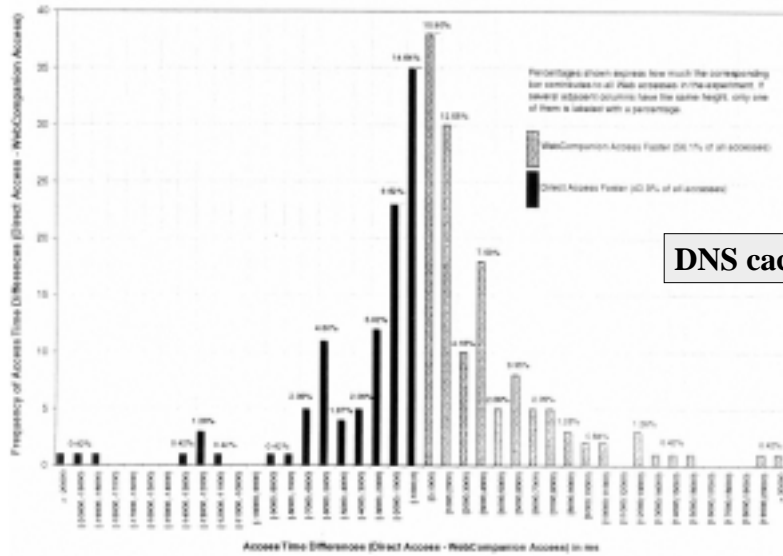
Access Time Differences in Pessimistic Scenario



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Experimental Results

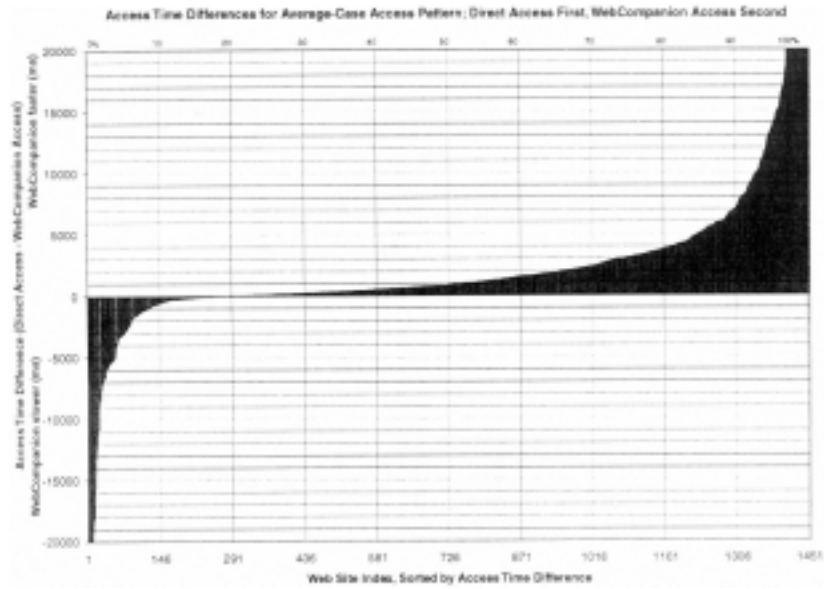
Distribution of Access Time Differences in Pessimistic Scenario



DNS caching

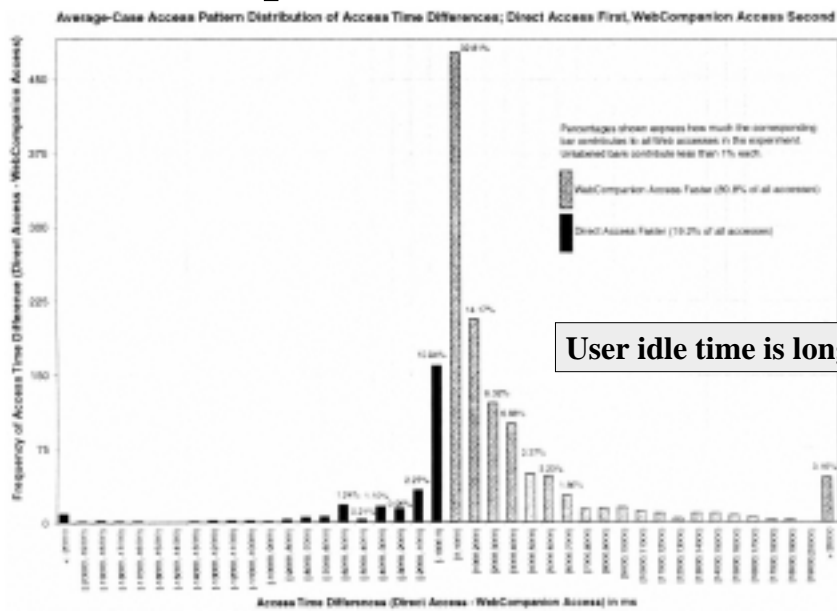
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Experimental Results



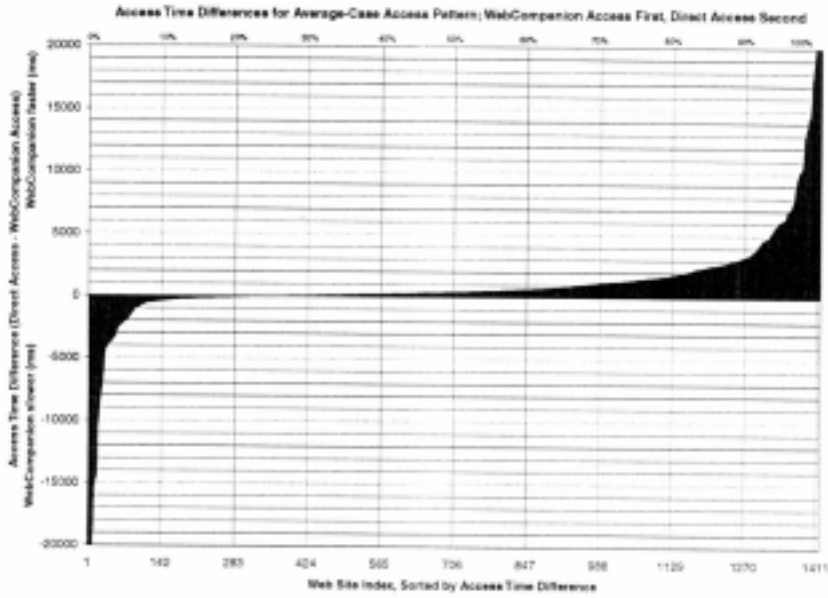
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Experimental Results



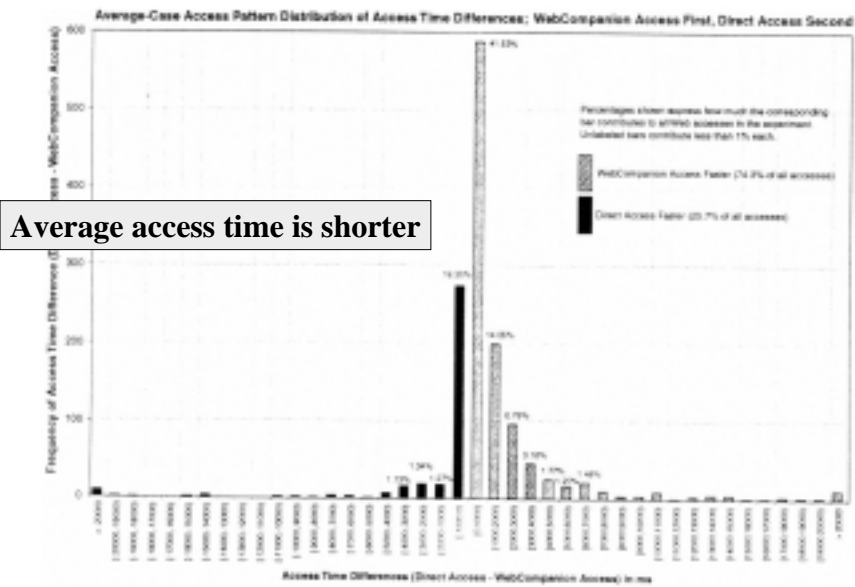
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Experimental Results



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Experimental Results



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Summary

- **Advantage**
 - It can deal with pages that have not been visited
 - It takes the round trip time into consideration
 - It exhibits 7.5% speedup in the pessimistic case
 - It exhibits 50% speedup in the average case
- **Weakness**
 - Average deviation of RTT=54.9%
 - Error-prone decision of a new session
 - Local cache on the browser must be turned off
 - Network and server caching effects cannot be isolated

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