



# Towards Parallelizing the Layout Engine of Firefox\*

# HotPar'10

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## Motivation

## **Parallelizing the Firefox Layout Engine - Motivation**

### Mozilla Firefox\*

 ~24% market share of all the total web browsers

 Improved performance since the recent adoption of the tracing JIT JavaScript\* engine (TraceMonkey\*)



### Layout Engine

- heavy performance hitter component
  - 40% of the total execution time VTune\* experiments on Intel platforms

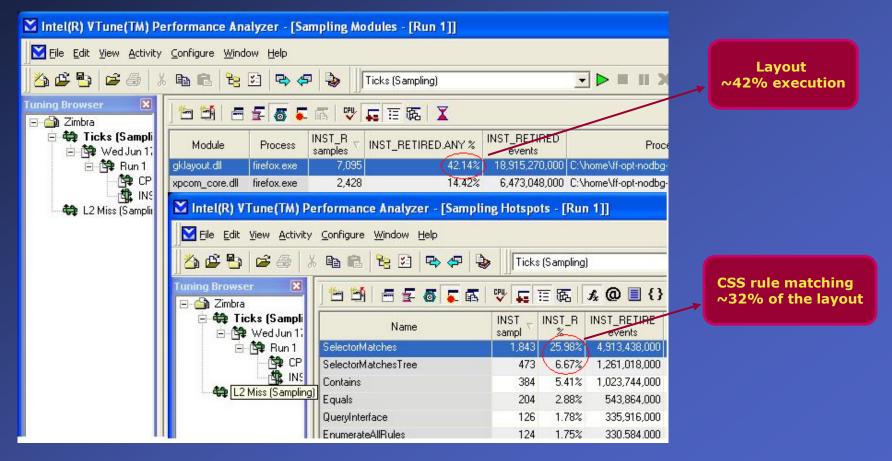
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#### Source: Net Applications (Browser Market Share) http://marketshare.hitslink.com/

## **Parallelizing the Firefox Layout Engine - Motivation**

### **Firefox Layout Engine**

- Cascading Style Sheets (CSS) rule matching
  - hot part of layout
  - amenable to parallelization



## **Cascading Style Sheets: A bit of background**

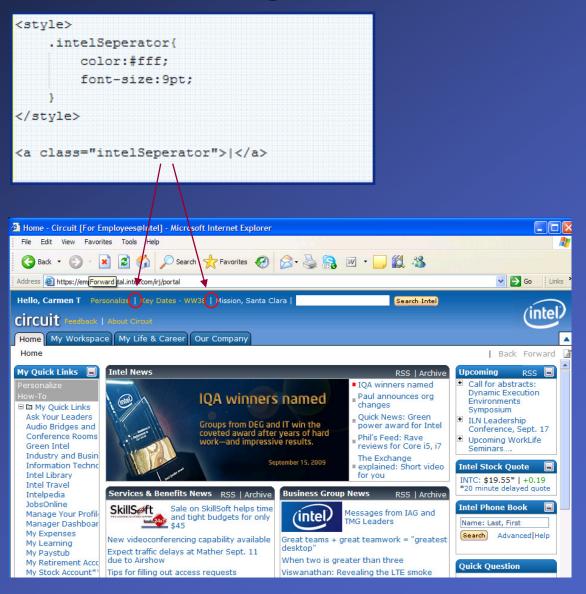
- CSS: designed to allow the separation between webpage content (HTML) and presentation (e.g. colors, fonts, etc.)
- Enables multiple pages to share formatting features and reduces the amount of repetition in specifying layout styles

#### **CSS rule structure**

selector_declaration block						
declaration		declaration				
	property value	property value				
body	{ color: black	; padding: 1em;	}			

Simple selector Combination of simple selectors

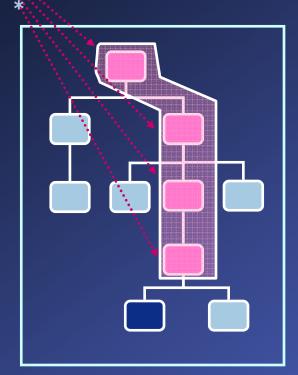
\* Image source: http://css.maxdesign.com.au/



# **CSS** Rule matching implementation in Firefox

#### **CSS style rule examples**

h1 + h2 {font-size: 9pt} <- adjacent sibling selector ul em { color: blue} <- descendant selector



#### **HTML sample document tree**

\* Samples courtesy of http://css.maxdesign.com.au/

### **CSS Rule matching process in Firefox**

- Does a style rule applies to a certain HTML element ?
- Series of iterations
  - each iteration executes a SelectorMatches call
  - One for each ancestor up the tree

## **Profiling/Tracing Strategy**

## **Firefox CSS Rule matching process**

- Algorithm split into two main branches
  - Sibling selector
  - Descendant selector

### Four exit points

Which is the most often taken?

Which is most executed?

- Implemented an extensive tracing algorithm
- Execution patterns of the CSS rule matching process

VProf

Library

## **Profiling/Tracing Results**

### Benchmarks

- Mozilla Firefox Page Load Tests
  - A collection of 390 web pages from all over the world
  - Test the page loading process in Firefox

### Zimbra\* Collaboration Suite

AJAX-based rich-browser integrated suite of email, calendar, contacts, VoIP, etc.

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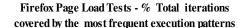
### **Profiling/Tracing Results for Mozilla Page Load Tests**

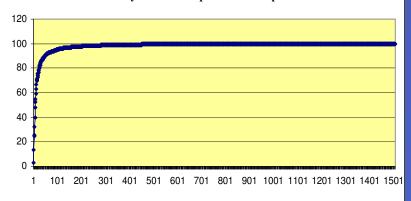
- Selector matching process heavily biased towards descendant selectors
  - 99% of the time for both benchmarks
- One exit point taken in the majority of cases
  - Dominant pattern: rule non-match
  - Zimbra Collaboration Suite : ~ 89%
  - Mozilla Page Load Tests : ~ 66%

#### Mozilla Page Load Tests

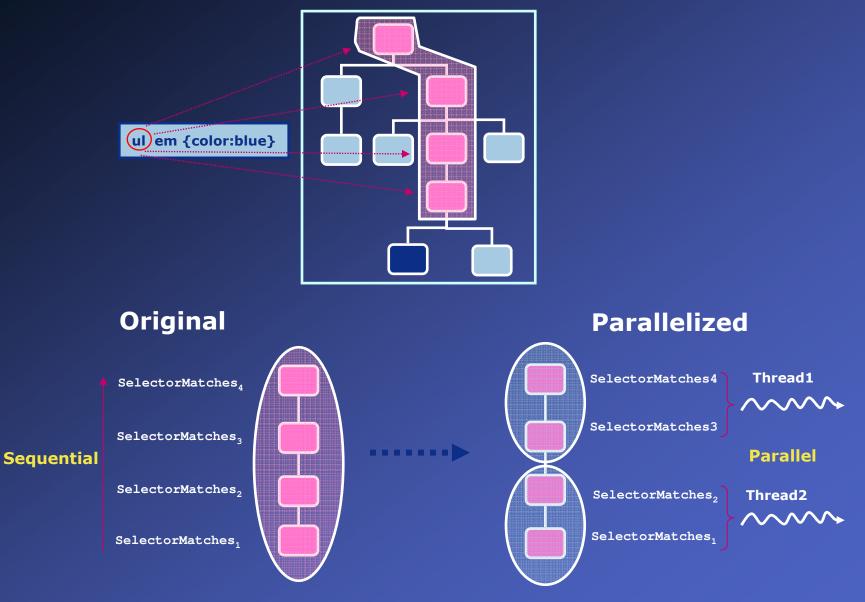
top 25 most frequent execution patterns
 cover ~ 80% of all executed iterations

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3	1997994	pppppppppn1	10	13.43					
4	1977238	ppppppppppn1	11	24.88					
5	1846126	pn3	1	25.85					
6	1599769	pppppppn1	8	32.58					
7	1530957	ppppppppn1	9	39.83					
8	1293911	pppppppppppn1	12	47.99					
9	1187742	ppppppn1	7	52.37					
10	840304	pppppn1	6	55.02					
11	619361	ppppppppppppn1	13	59.25					
12	550482	pppppppppppppn1	14	63.31					
13	418940	ppppppppppppppn1	15	66.61					
14	382272	pppppppppppppppn1	16	69.83					
15	310138	pppppn1	5	70.65					





# **CSS Rule Matching – Parallel Implementation**



## **Parallelized CSS Rule Match in Firefox - Performance Results**

Flexible and configurable

### Parallel configuration parameters

- Default iteration chunk size
- # of worker threads available
- Threshold on the # of ancestors necessary to enable parallel CSS matching

## We have tested

- 7 configurations for the Zimbra Collaboration Suite
- 12 configurations for the Firefox Page Load Tests
- Kept first two parameters fixed and varied the last one
  - 2 threads w/ default 4-iterations chunk

## Parallelized CSS Rule Matching: Mozilla Tests Performance Results

#### Mozilla Firefox Page Load Tests

- Comprise ~ 400 distinct web page load tests
- Experiments carried out using 2 worker threads

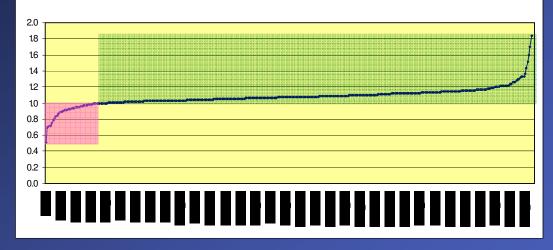
# Mozilla Page Load Tests performance results on Nehalem

- ~ 87% benchmarks show speedups
- ~ 1.8x maximum speedup observed

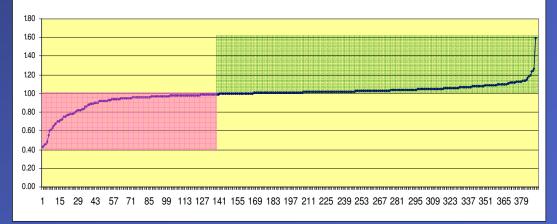
# Mozilla Page Load Tests performance results on Atom

- ~ 60% benchmarks show speedups
- ~ 1.6x maximum speedup observed
- Hyper-threaded

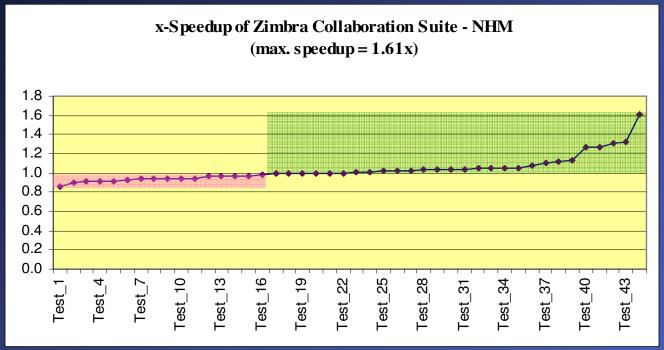
x-Speedup of Firefox Page Load Tests - NHM (max speedup = 1.84x)



x-Speedups of Firefox Page Load Tests - ATOM (max speedup = 1.6x)



## Parallelized CSS Rule Matching: Zimbra Suite Performance Results



The experiments were carried out on a Nehalem machine, with 2 worker threads

### Zimbra performance results on Nehalem

- ~ 50% benchmarks show speedups
- 14% of the benchmarks are not affected performance-wise
- ~1.6x maximum speedup observed

# Summary

- Implemented a fully-functional, parallelized CSS rule matching component in Firefox
  - Mozilla Page Load Tests
    - ~ 1.8x maximum speedup on NHM
    - ~ 1.6x maximum speedup on Atom
  - Zimbra Collaboration Suite: ~ 1.6x maximum speedup on NHM

Submitted the parallel CSS rule matching code to Mozilla

- Excellent feedback from Firefox layout engine component owners
- Incorporated their suggestions into the existing parallelized code
- Awaiting adoption in a future release

## References

- Mozilla Project [http://www.mozilla.com/en-US/]
- Zimbra Collaboration Suite [http://www.zimbra.com/]
- Cascading Style Sheets (CSS) [http://www.w3.org/Style/CSS/]
- Intel VTune Performance Analyzer [http://software.intel.com/en-us/intel-vtune/]
- VProf Value Profiling Library [*Mozilla Source Code*]
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# Thank you!