

moz://a

Firefox Quantum

Performance in Firefox

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Jean-Yves Perrier

I am part of Developer Outreach

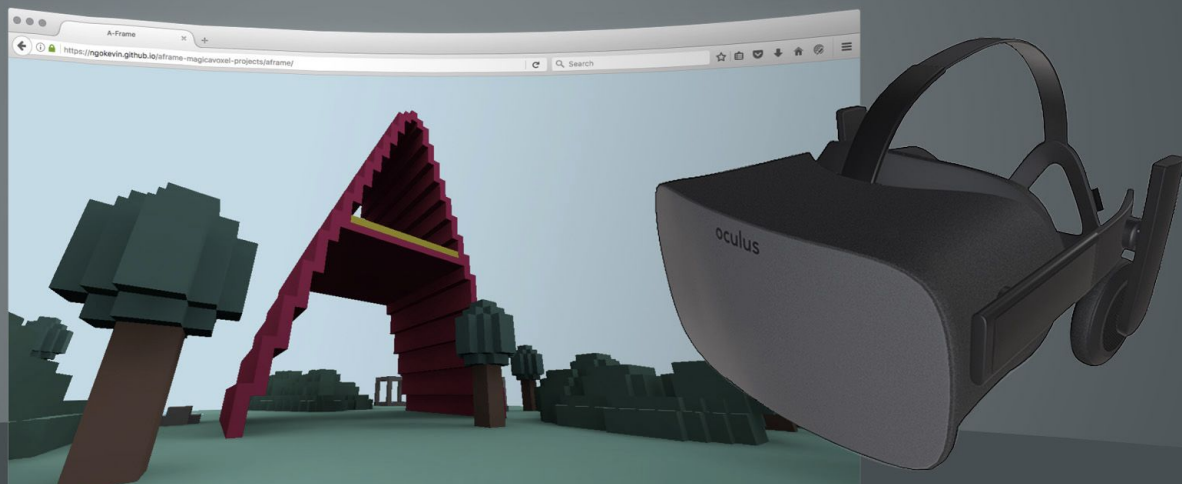
Twitter: [@teoli2003](https://twitter.com/teoli2003)

A detailed, high-magnification photograph of a multi-core processor die. The die is rectangular and densely packed with intricate circuitry, including various colored regions (blue, yellow, orange, green) representing different functional blocks and interconnects. The overall appearance is a complex, grid-like pattern of microscopic structures.

Processors have evolved

Increase in performance is achieved by increasing cores and concurrency, less by individual CPU improvement.

Expectations changed



In the 2000s we wanted pages with images;
today we want 60 fps **virtual reality**
with **HD videos**.

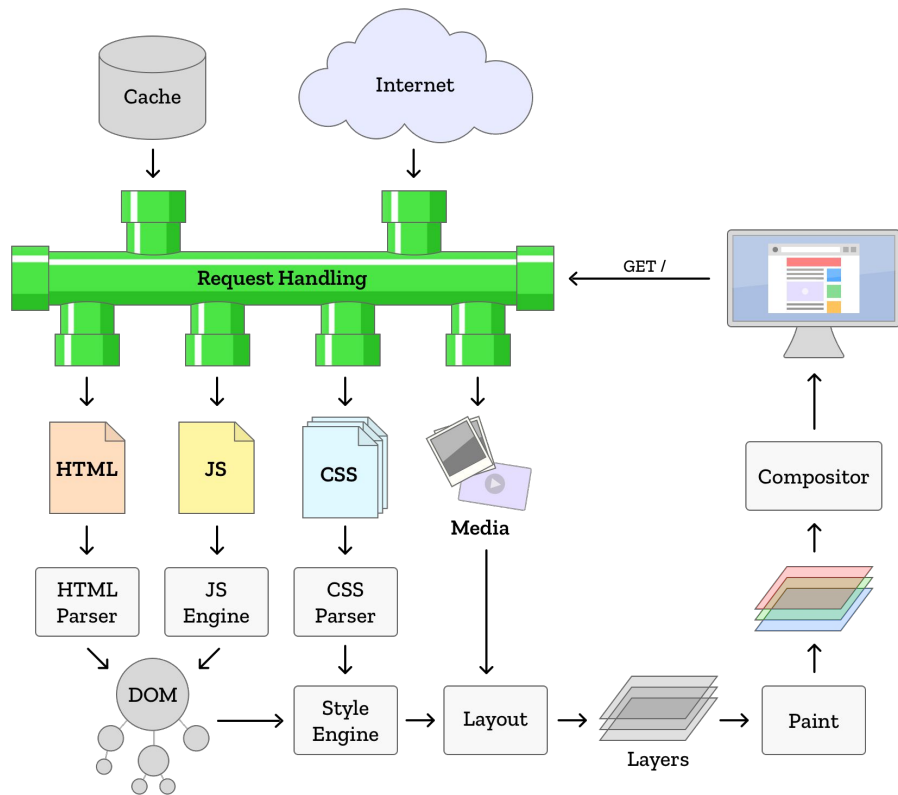
Mark 3



Mark 57

?

The rendering engine



Drawing by Potch



Our testbed: Servo

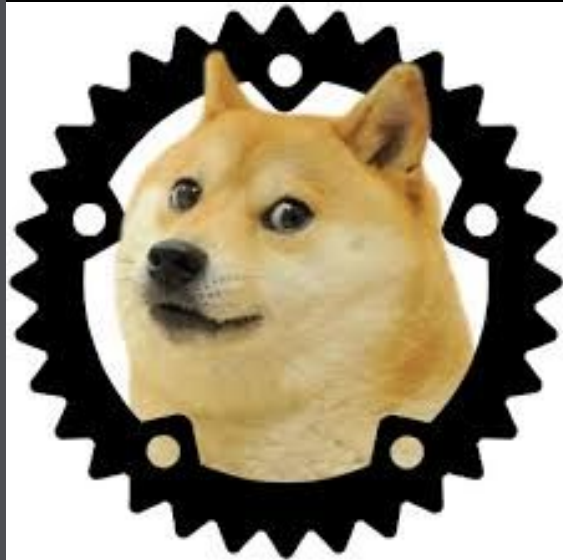
An experimental engine:

Written in Rust

Massive parallelism

No significant UI

Break the Web



Project Quantum



Problems to solve:

Stability

Old theme

UI jank

Integration of improvements from Servo

Project Quantum



Quantum Composer

Quantum CSS (Stylo)

Quantum Flow / Quantum DOM

Photon

Quantum Renderer (WebRender)

Quantum Composer



GPU does composition well: offload to GPU

On Windows, lots of **crashes** caused by graphic drivers

Idea: isolate the compositor in its own process

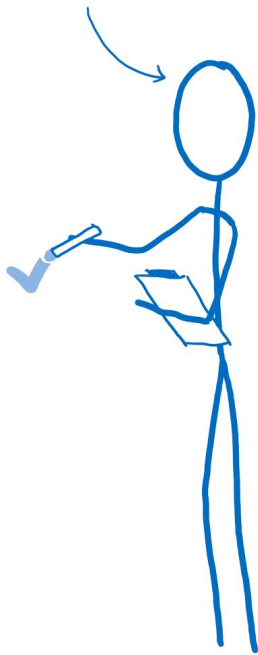
Improve: stability

Released: Firefox 53, April 19th, 2017

Quantum CSS (Stylo)



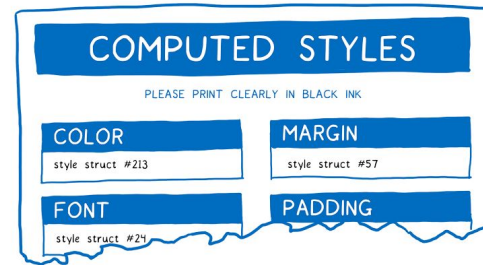
match selectors



sort declarations
by specificity

origin	selector	property	value	specificity
author	.message p	color	white	0,1,0,1
author	p	color	blue	0,0,0,1
user-agent	p	margin-top	1em	0,0,0,1
user-agent	p	margin-bottom	1em	0,0,0,1

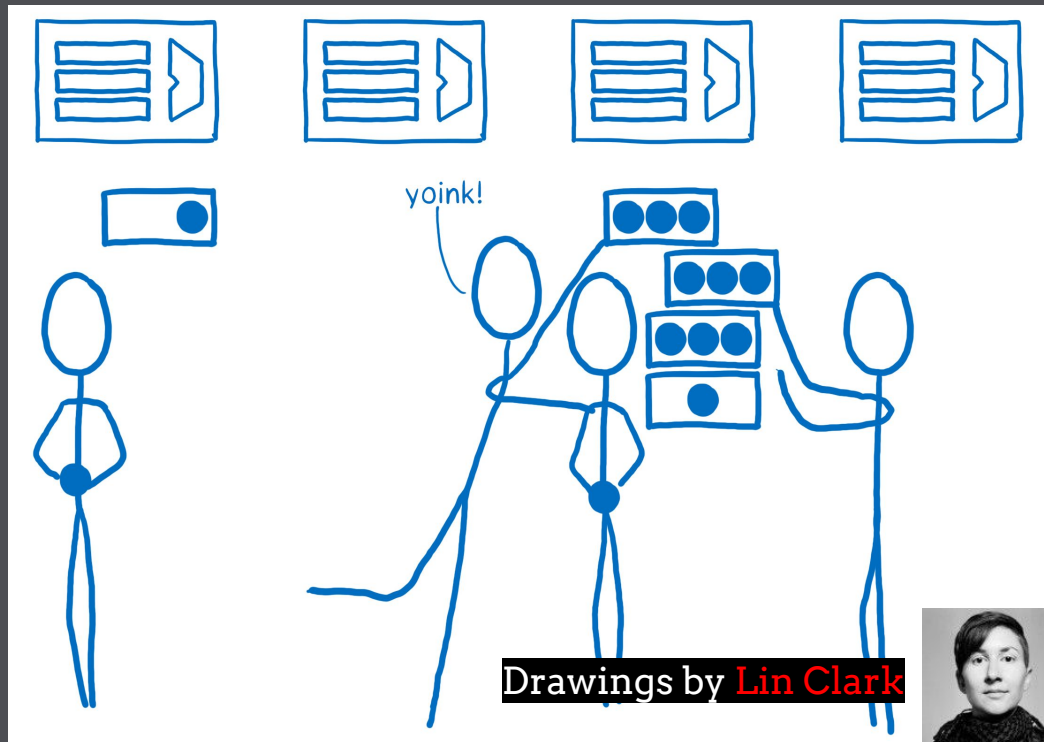
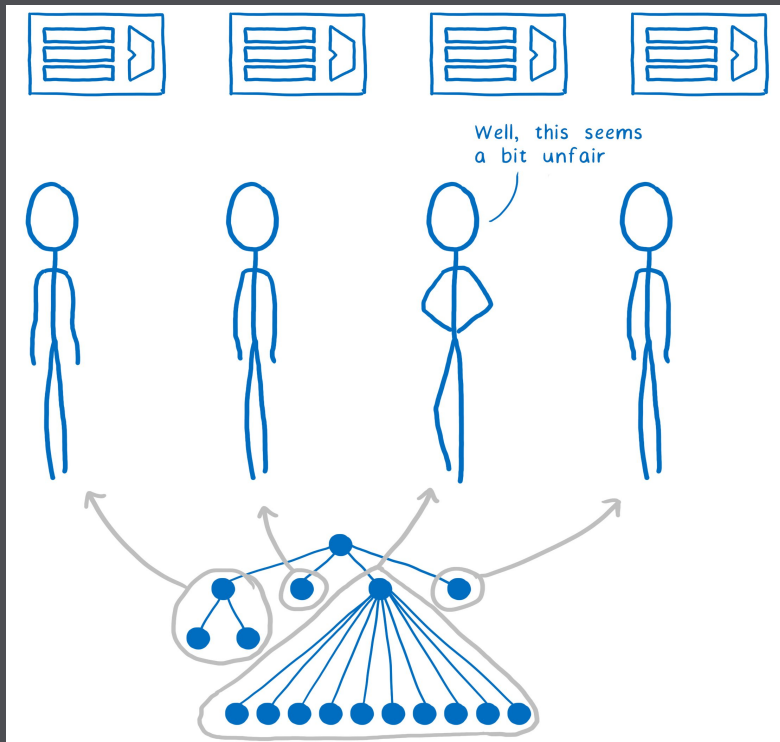
compute property values



Drawing by Lin Clark



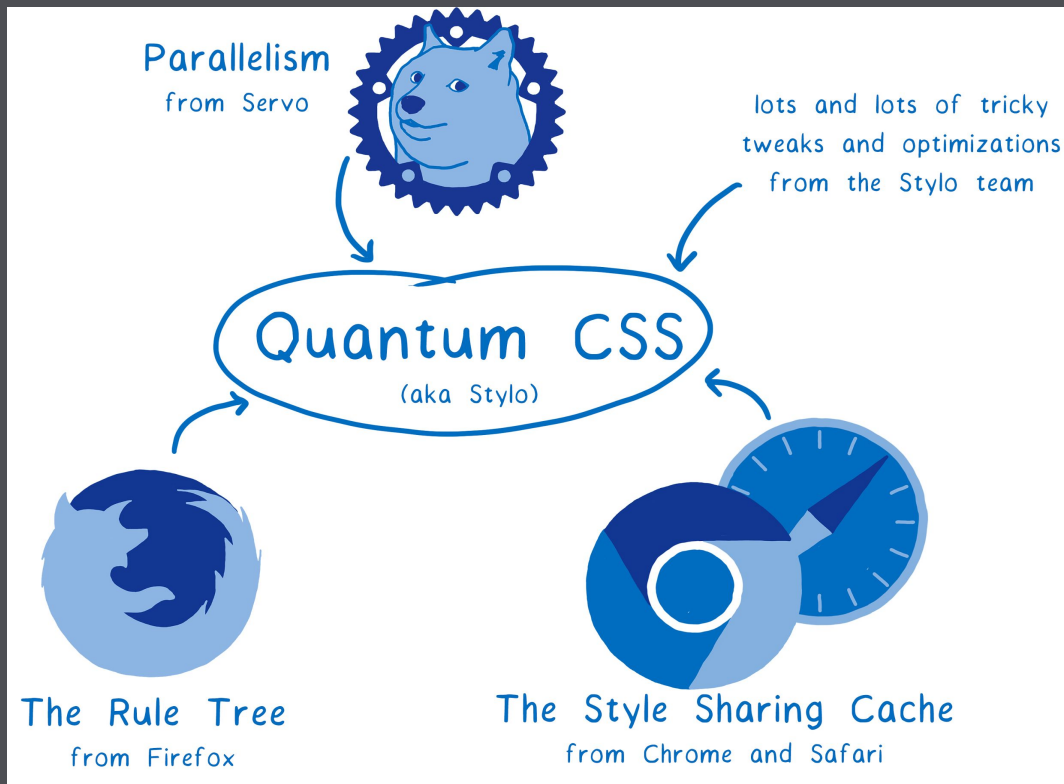
Quantum CSS (Stylo)



Drawings by Lin Clark



Quantum CSS (Stylo)



Style Sharing Cache

Same ids, classes, ... ?

Same inline styles ?

Same parents ?

Same "oddities",
like `:first-child()`?

Drawing by Lin Clark



Quantum CSS (Stylo)



First technology transfer from Servo

Embarrassingly parallel problem

Works best for complex pages.



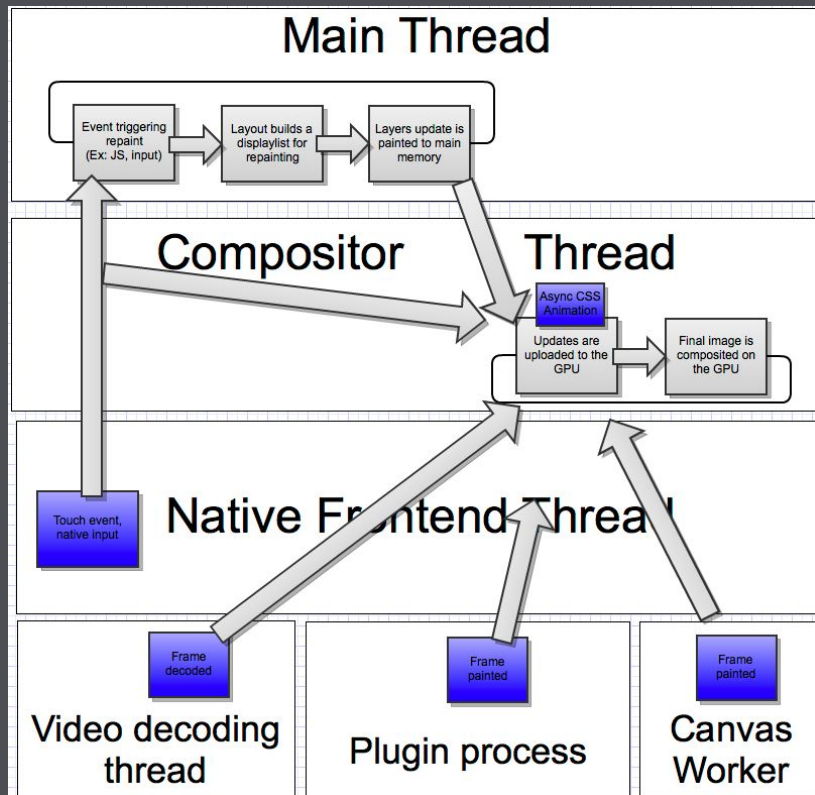
More info:

<https://hacks.mozilla.org/2017/08/inside-a-super-fast-css-engine-quantum-css-aka-stylo/>
by the amazing **Lin Clark** who did the great drawings.

Improve: performance

Desktop: in Firefox 57, November 14th, 2017

The Main Thread Challenge



Quantum Flow



Approach performance in Firefox as a **system**

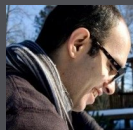
Measure all the things!

then triage, prioritize and (re)-measure

Goal: Fight **jank**

Hundreds of improvements

“Death by a million cuts”



Read Ehsan Akhgari blog posts:

<https://ehsanakhgari.org/blog/2017-09-15/quantum-flow-engineering-newsletter-24>

Improve: overall performance

Release: Bits by bits (Firefox 57), November 14th, 2017

QFlow: Better scrolling



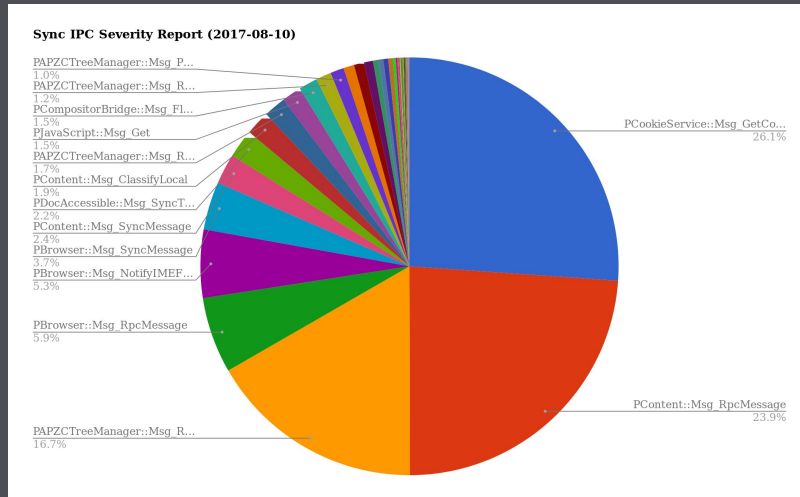
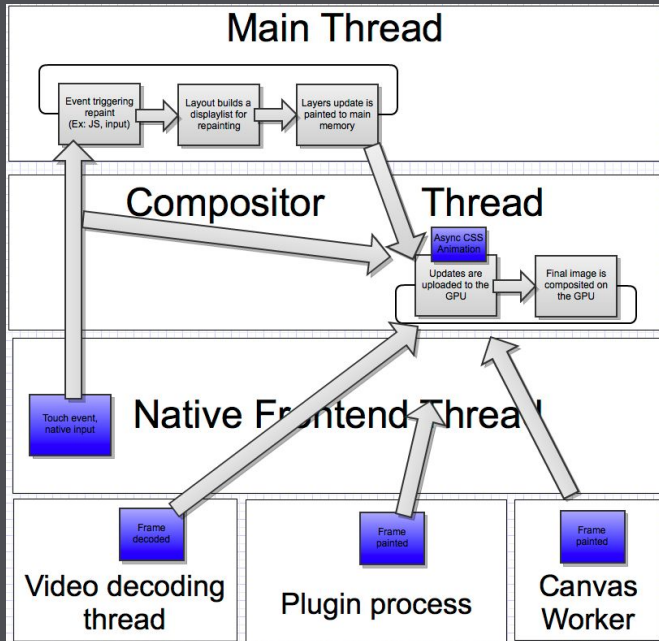
Never pause it, the user gets confused

Checkerboard: When no data ready, display a default pattern.

Same overall performance, but **user feeling** completely different.

This was standard for mobile (touch interface),
but we now use it for all input type, even on desktop.

QFlow: No sync IPC

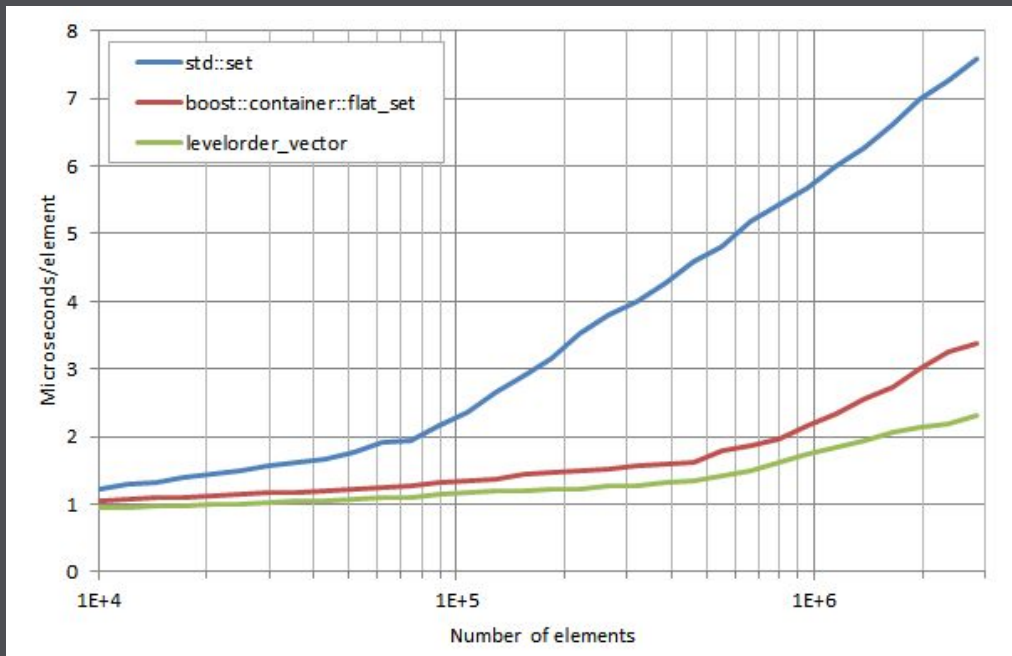


Annoying offenders: XUL extensions, plugins, cookies.

QFlow: Locality



E.g.
cache-friendly
binary tree search



QFlow: Controlling GC



Garbage collection is critical to memory control,
but if it is too long, it creates **jank**.

Evolution over the years; now it is:

generational, to prioritize area likely to be released

more **incremental**, to control how long it runs.

QFlow: No timers



Advantage:

Delay execution: it allows to improve start-up times, or specific operation performance.

Disadvantage:

Fire at a given time, that may not be the *right* time.

Solution

```
Window.requestIdleCallback()
```

Hint: also works for Web Content!

Photon



Refresh the Firefox front end to be the user facing component of Quantum

Visual Re-Design

How it looks

Motion

How it feels

Perceived Performance

How it feels

Structure

How it works / Where things live

Content

How we talk to users

Improve: user experience

In Firefox 57, November 14th, 2017

Mark 3



Mark 57

?

Mark 3

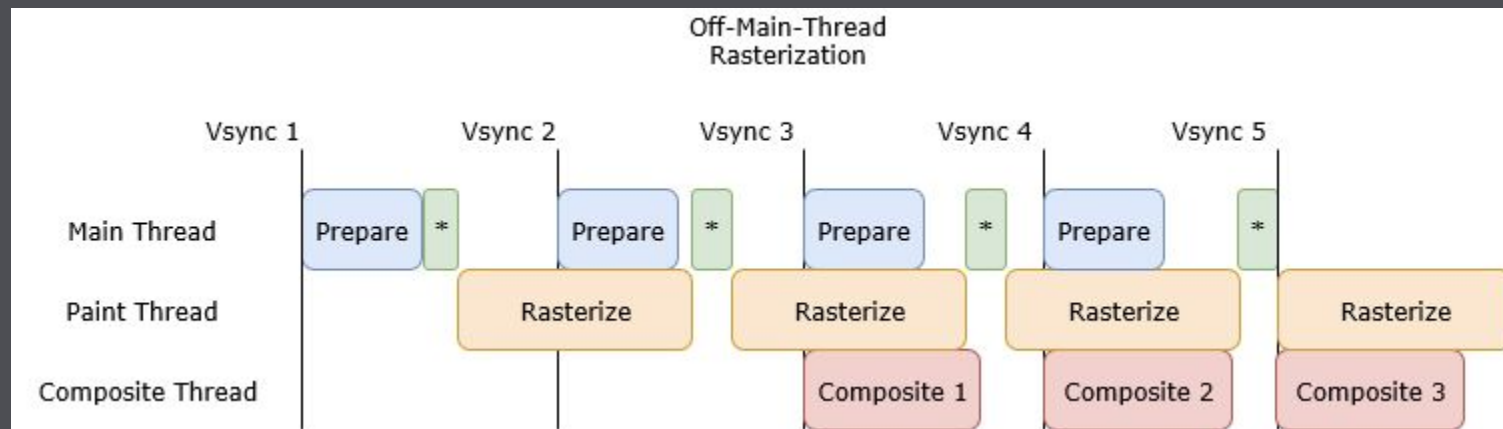


Firefox Quantum





Off Main Thread Painting



More details in this blog post by David Anderson:

<https://mozillagfx.wordpress.com/2017/12/05/off-main-thread-painting/>

Improve: performance

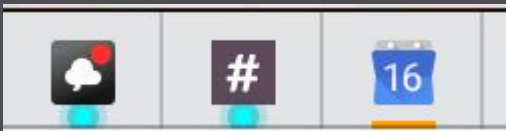
In Firefox 58, January 23rd, 2018

Background Tabs



Pause them or throttle them!

Not always possible, they may do something useful:



Be **defensive**, and experiment.

Details on MDN:

https://developer.mozilla.org/en-US/docs/Web/API/Page_Visibility_API#Policies_in_place_to_aid_background_page_performance

Improve: performance

In Firefox 58, January 23rd, 2018

More to come



- Long tail of improvements (especially Quantum flow, sync IPC fight)
- Quantum Render
- Specific process for Web Extensions
- Stricter JS budget

Firefox Quantum is a new foundation to build upon.

It isn't the end, it is a new beginning.



Firefox Quantum

Thank you!

Help by:
Installing Firefox Nightly

Reporting problems.

Spreading the word.

Stay informed:
Follow @FirefoxNightly

Firefox Quantum 58

released on Nov 14th

