Rendering Performance

Render your web app at 60fps

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About me

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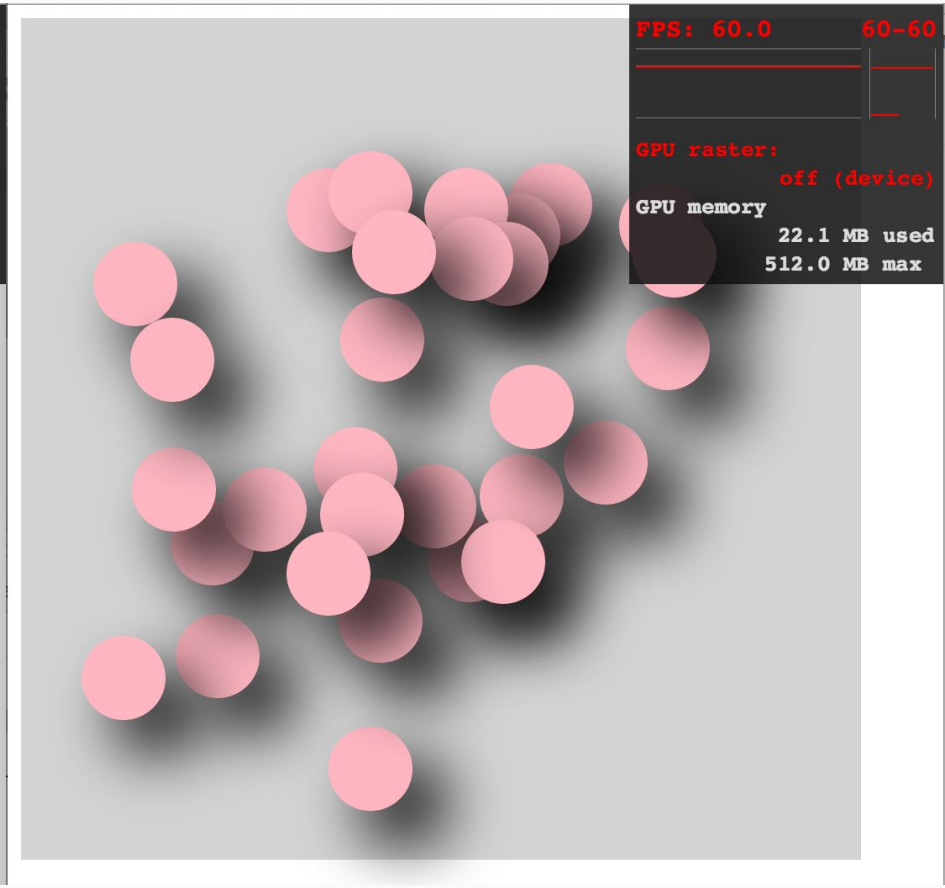
Rendering Performance

Overview

1. Understand how browser render web pages
2. Optimize the render process
3. Useful resources for Web Performance

60fps vs 30fps



16ms

16ms

60 frames / second

16ms

60 frames / second

1/60 second / frame

16ms

60 frames / second

1/60 second / frame

16ms / frame

16ms

60 frames / second

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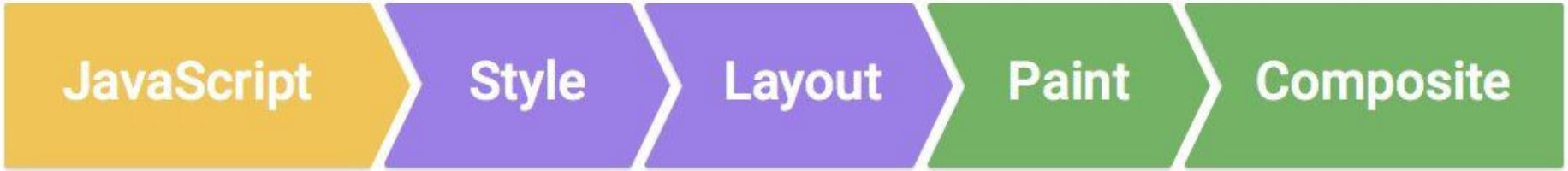
16ms / frame

The Pixel Pipeline



The Pixel Pipeline

```
box.style.width = '300px';
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```
<div style="300px">
```

The Pixel Pipeline

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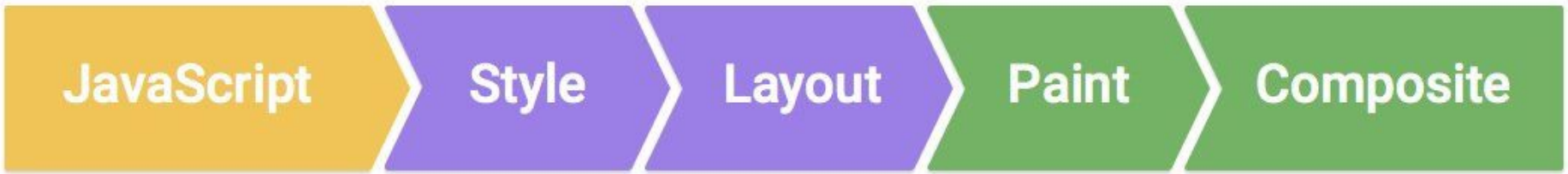
Recalculate element size, and other **affected elements** size.

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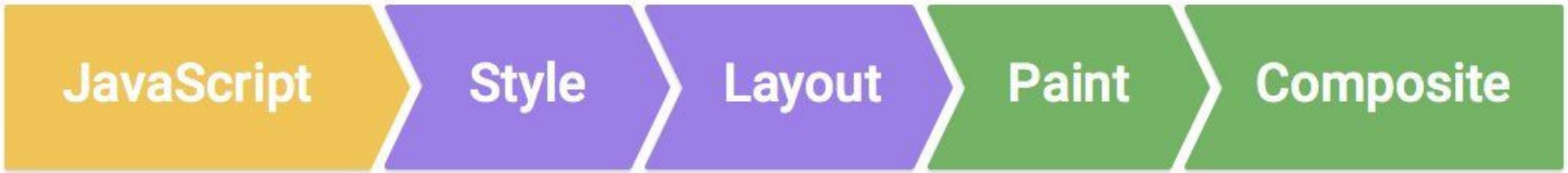


```
<div style="300px">
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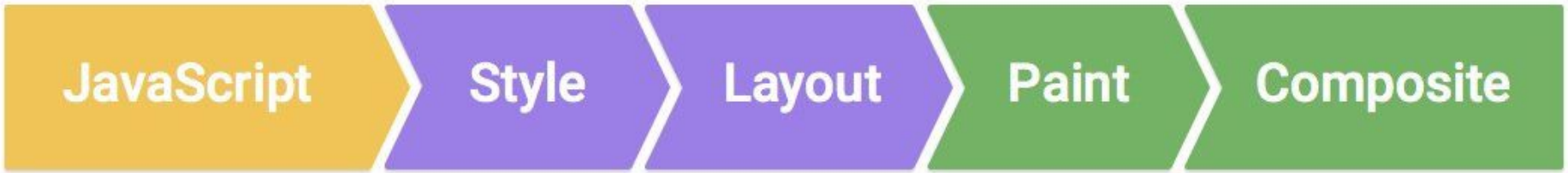
Filling pixels, render fonts, colors, borders, box shadows...

The Pixel Pipeline

```
box.style.width = '300px';
```

Recalculate element size, and other **affected elements** size.

Composite the **painted layers**

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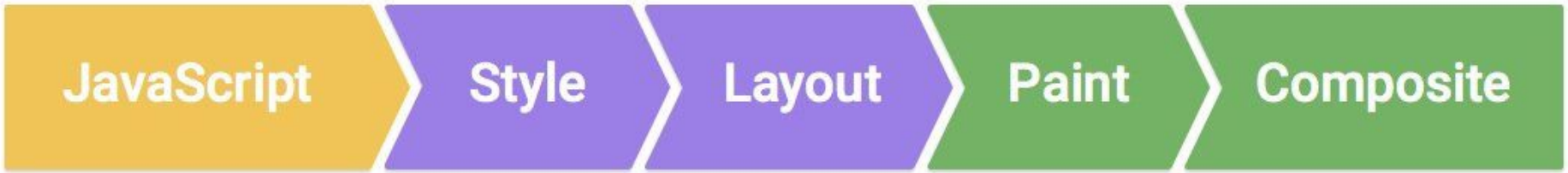
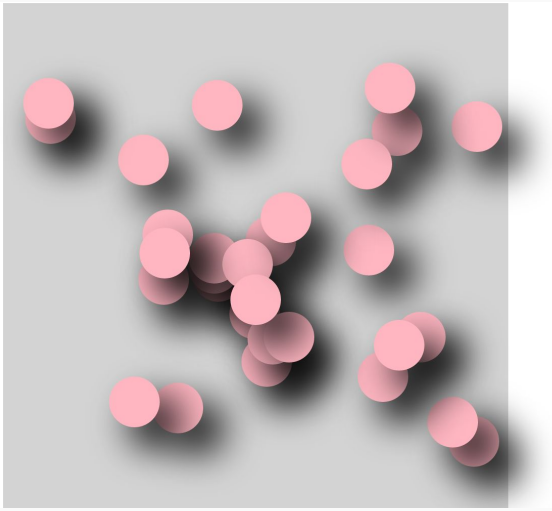
Filling pixels, render fonts, colors, borders, box shadows...

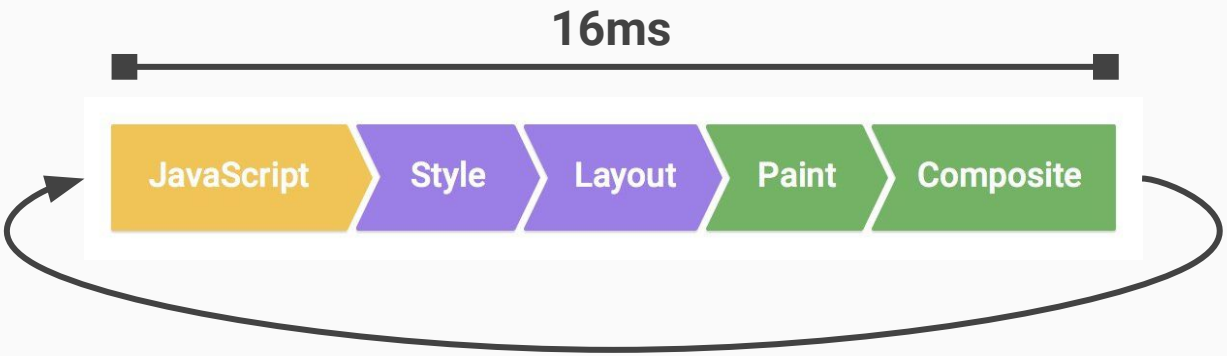
The Pixel Pipeline



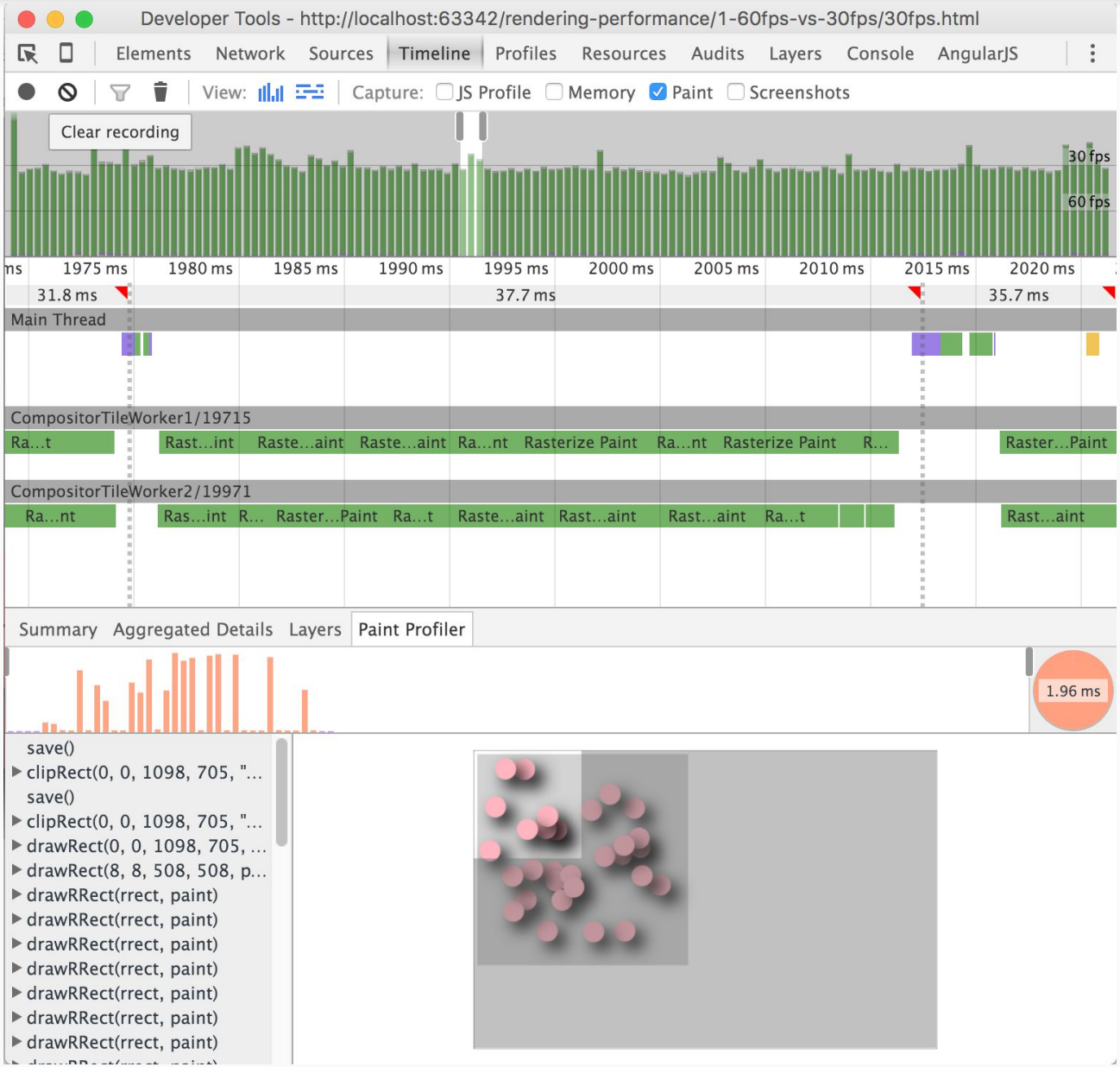
1 frame is created!

Every frame

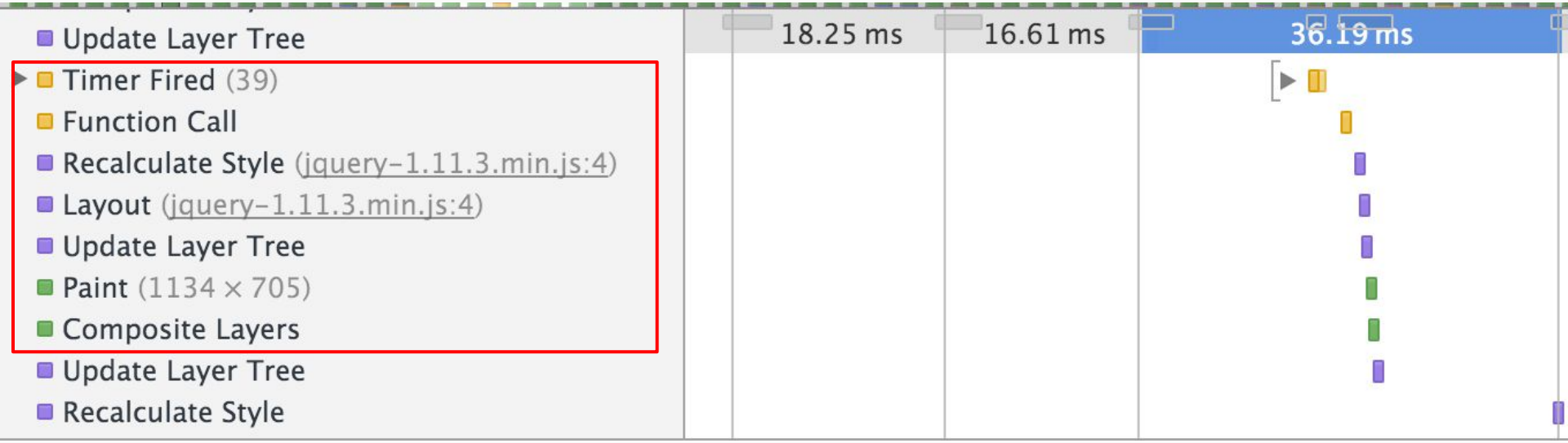




Understand the report



Use Chrome DevTools to inspect the steps



How to optimize?

“Performance is the art of avoiding work”

1. Try to optimize in every single step
2. Avoid going through all the steps

Step by step:

Optimize rendering performance

1 Paint — Paint is the most expensive work, avoid it as much as possible

2 Layout — Unnecessary layout triggers might cause performance issue

3 JavaScript — Don’t do hard works on UI thread

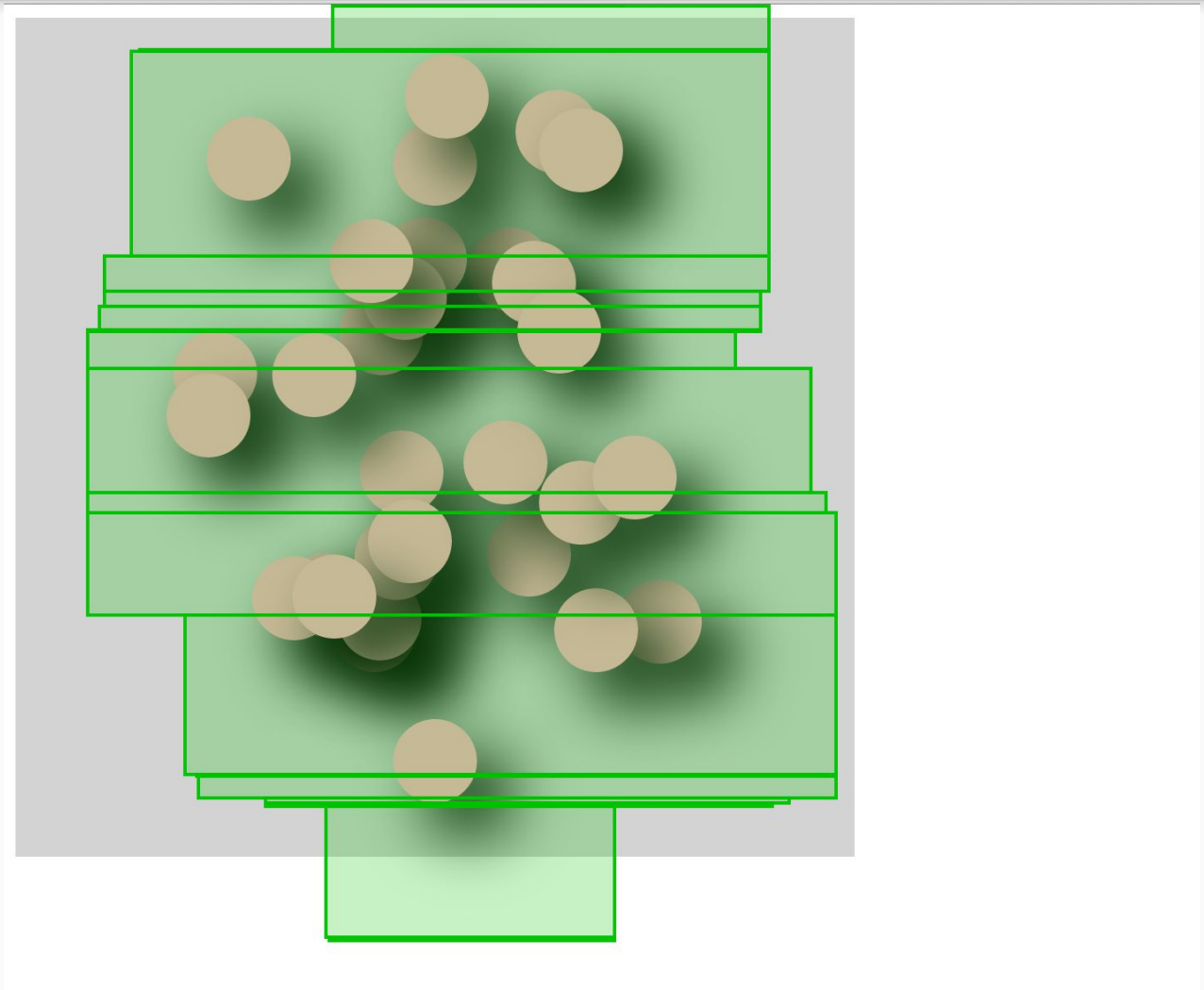
4 Style — Avoid complex selectors

5 Composite — Reduce unnecessary steps in the pixel pipeline

Paint

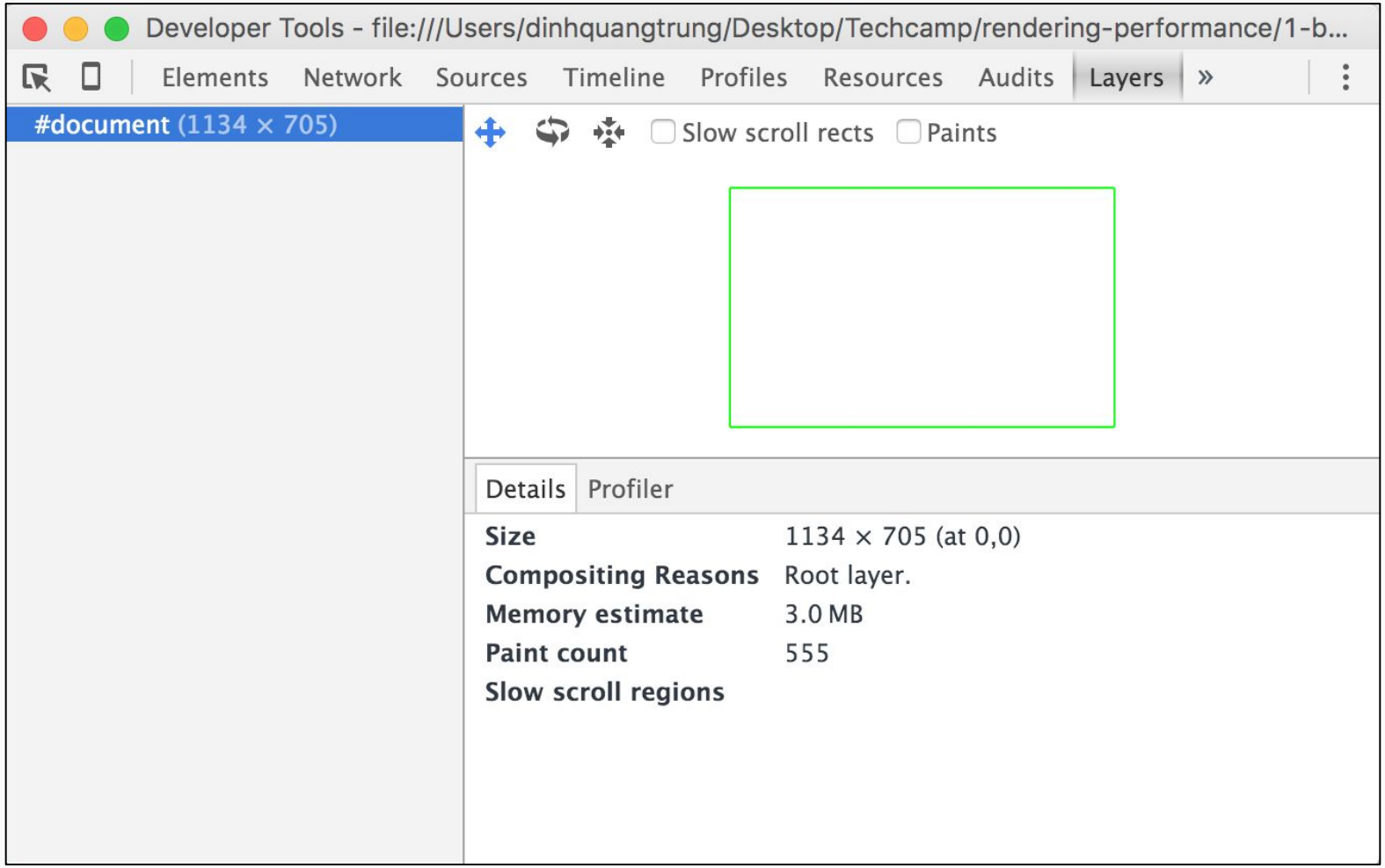
...is a hard work

Chrome DevTools



Use Chrome DevTools to see how browser draws

Chrome DevTools

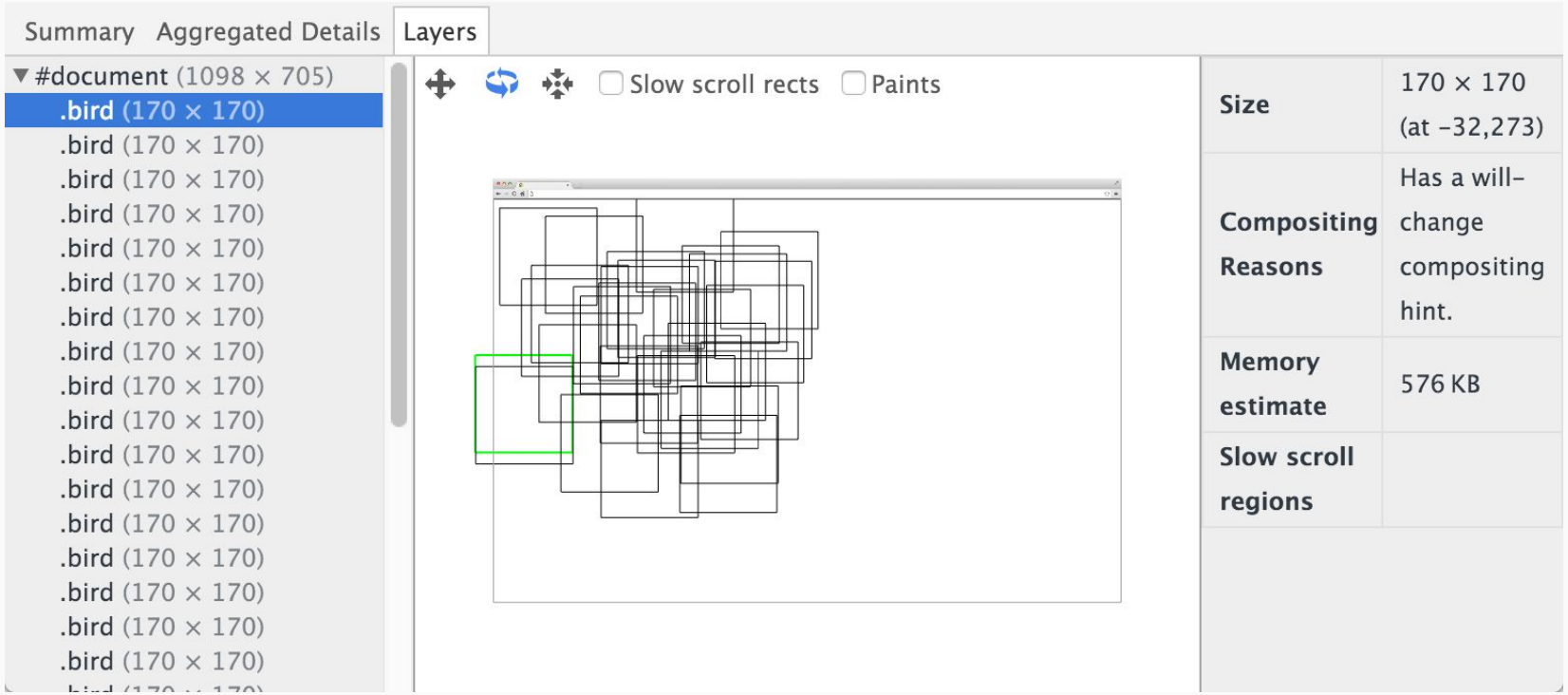


Use Chrome DevTools to see how browser draws

How to create layers?

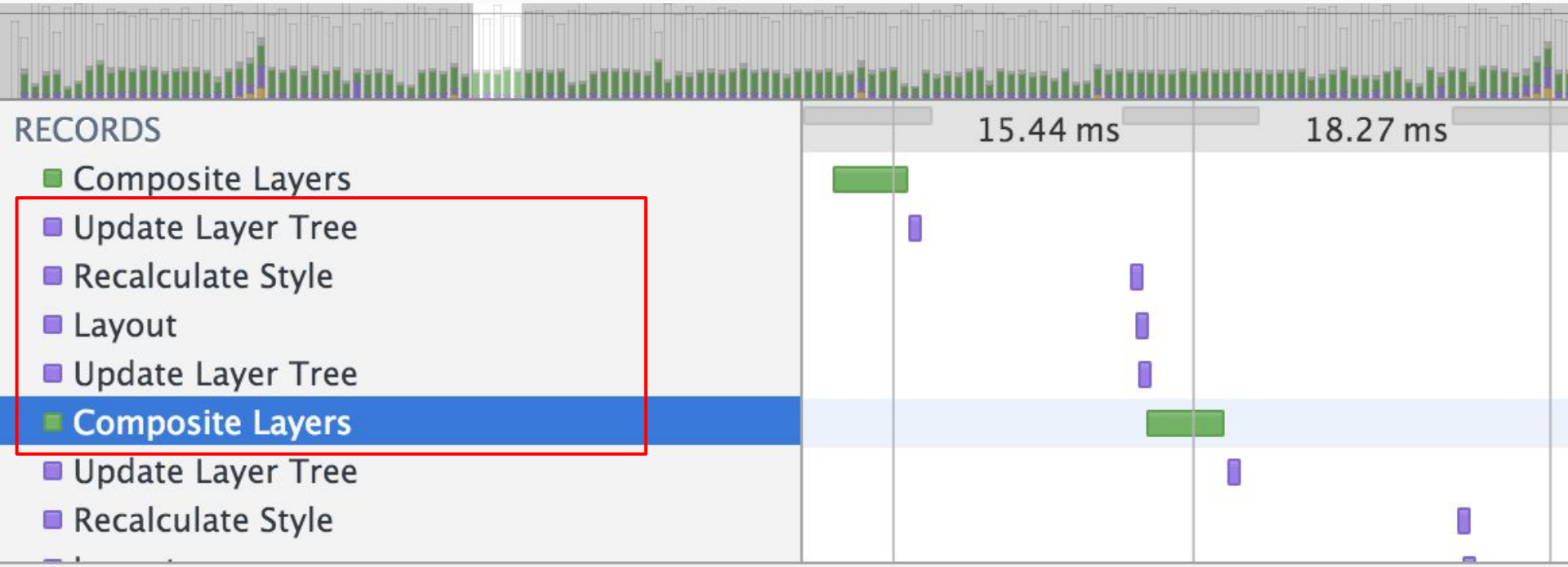
```
.bird {
  will-change: transform;
  transform: translateZ(0); // Old browsers
}
```

Layers

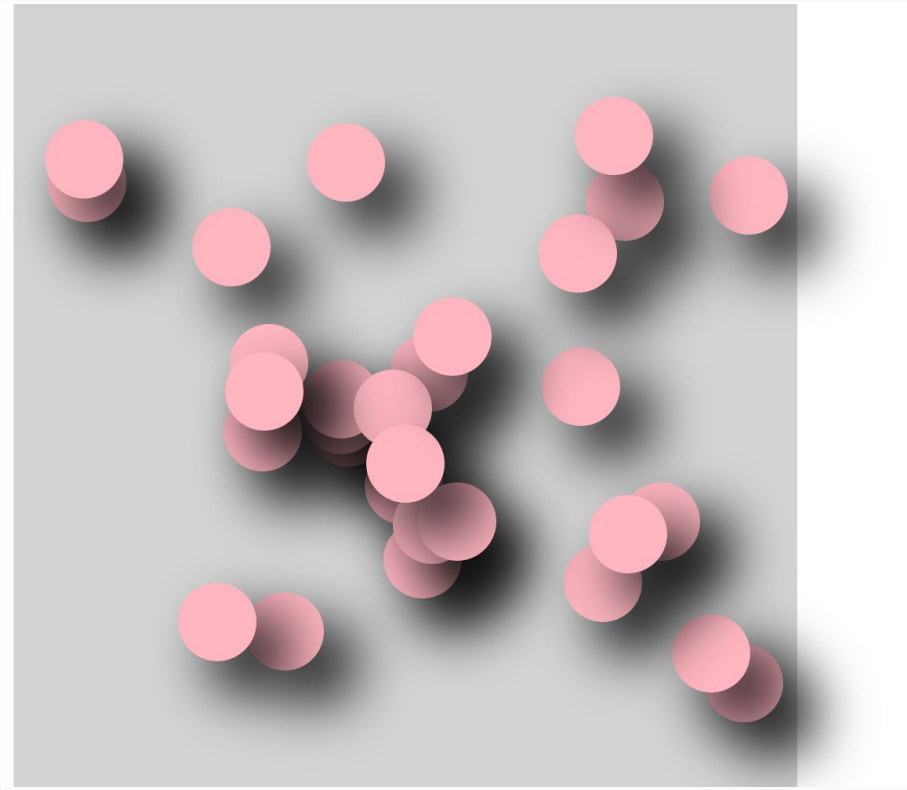


60fps

No more paint



Let’s see some examples

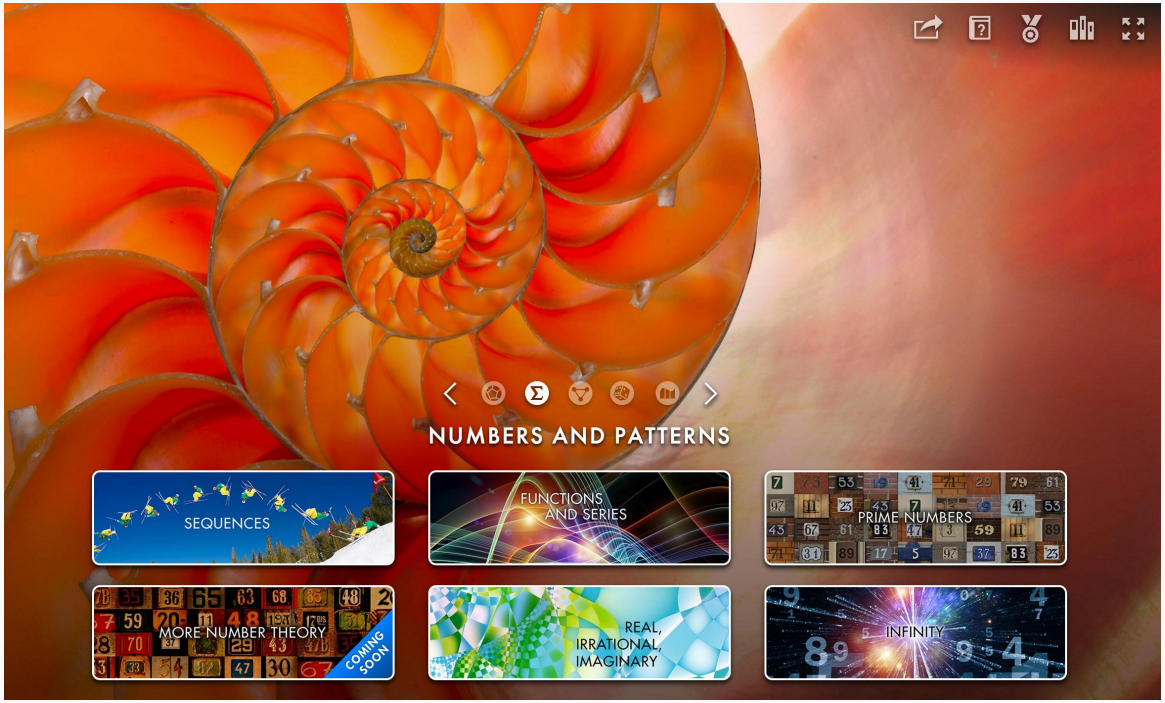


http://trungdq88.github.io/render-performance-demo/2-composite-layers.html

Let’s see some examples

http://matthew.wagerfield.com/parallax/

Let’s see some examples



http://world.mathigon.org/

Becareful!

- Composite layers require **memory and management**
- Create layer **efficiently**
- Avoid **layer explosions**

DON'T:

```
* {
  will-change: transform;
  transform: translateZ(0);
}
```

- Don't create layers without **profiling**

Layout

Avoid layout whenever possible

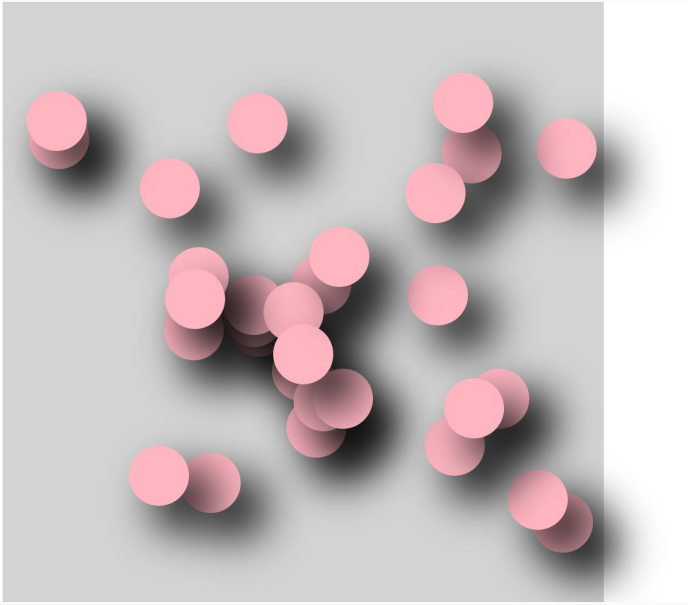
```
.box {
  top: 20px;
  left: 20px;
}

/**
 * Changing top and left
 * triggers layout.
 */
.box--moved {
  top: 200px;
  left: 350px;
}
```

- Layout is normally scoped to the whole document.
- Changes to “geometric properties”, such as widths, heights, left, or top all require layout.

How to know which CSS properties trigger layout? Check out **CSS Triggers**.

http://csstriggers.com/

Avoid layout whenever possible



Improve the example

Avoid layout whenever possible

Self Time		Total Time		Activity
534.7 ms	100.00 %	534.7 ms	100.00 %	(unattributed)
226.6 ms	42.38 %	226.6 ms	42.38 %	Composite Layers
132.9 ms	24.86 %	132.9 ms	24.86 %	Update Layer Tree
114.8 ms	21.47 %	114.8 ms	21.47 %	Recalculate Style
48.6 ms	9.08 %	48.6 ms	9.08 %	Layout
11.8 ms	2.21 %	11.8 ms	2.21 %	Major GC

Change **top**, **left** triggers layout

View Costly Functions ▼ Group by Domain ▼

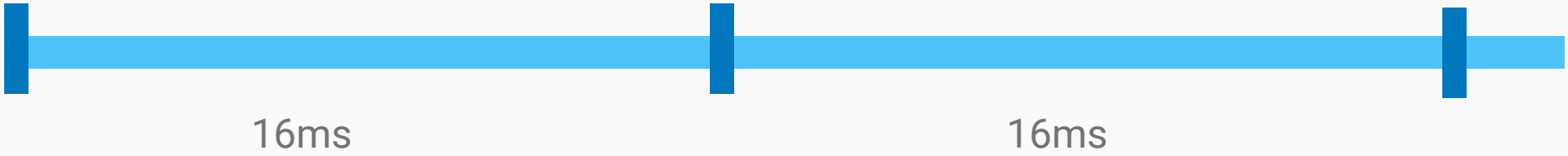
Self Time		Total Time		Activity
318.8 ms	100.00 %	318.8 ms	100.00 %	(unattributed)
142.9 ms	44.83 %	142.9 ms	44.83 %	Composite Layers
122.0 ms	38.27 %	122.0 ms	38.27 %	Recalculate Style
42.6 ms	13.36 %	42.6 ms	13.36 %	Update Layer Tree
11.3 ms	3.55 %	11.3 ms	3.55 %	Major GC

Change **transform: translate3d** does not trigger layout

JavaScript

Use requestAnimationFrame

```
/**
 * If run as a requestAnimationFrame callback, this
 * will be run at the start of the frame.
 */
function updateScreen(time) {
  // Make visual updates here.
}

requestAnimationFrame(updateScreen);
```



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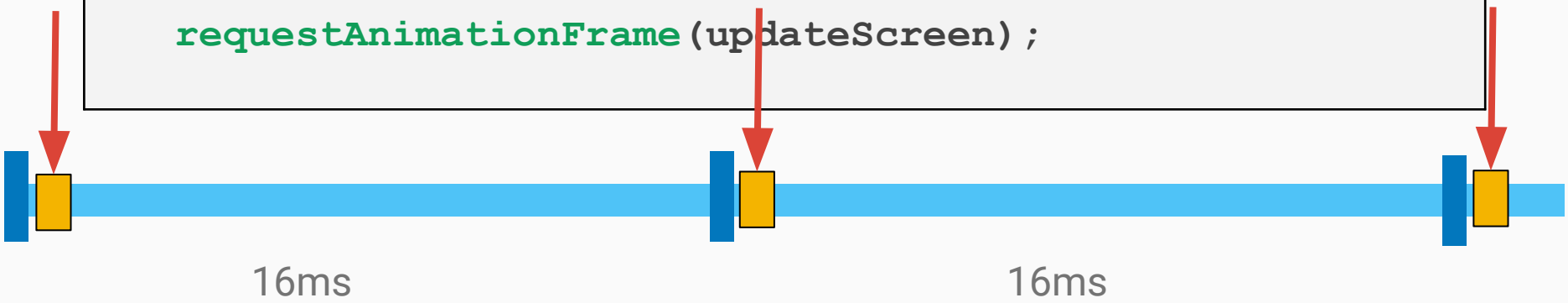

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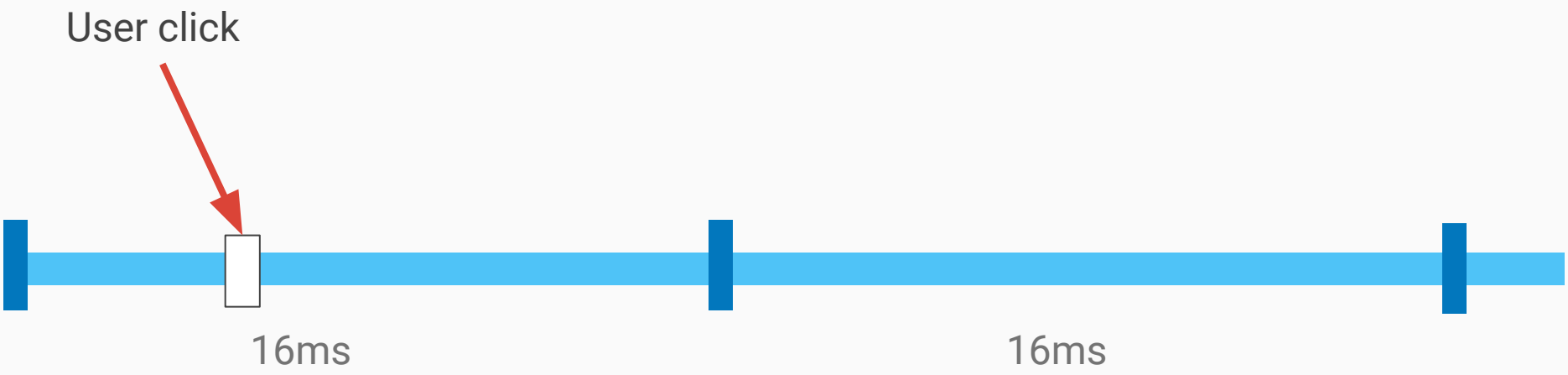

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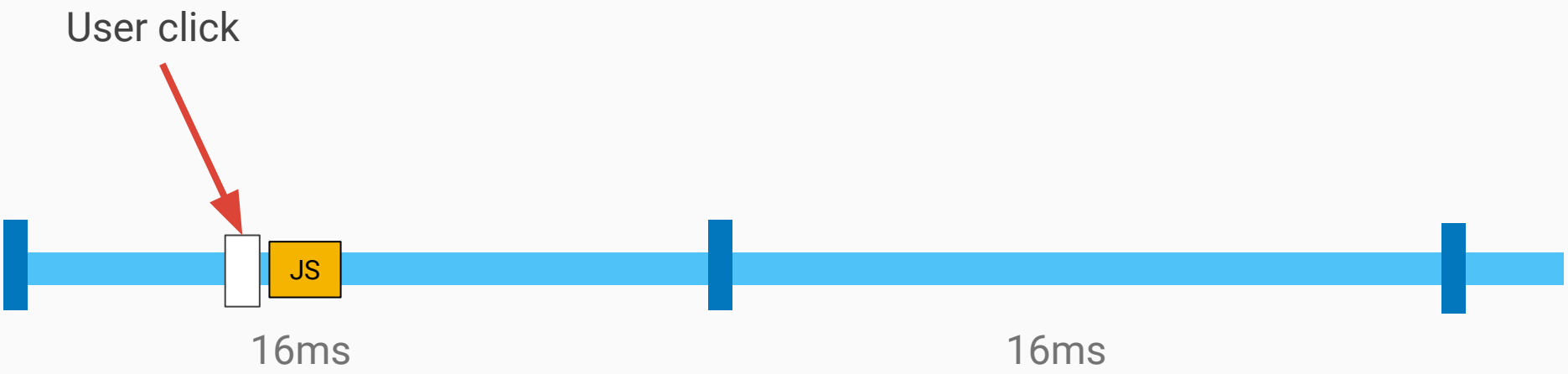

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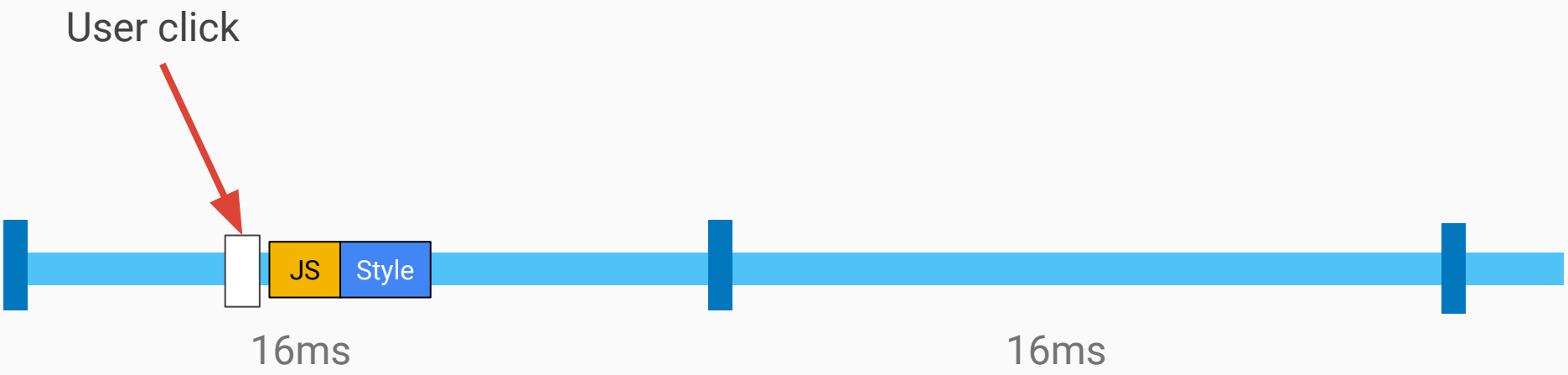

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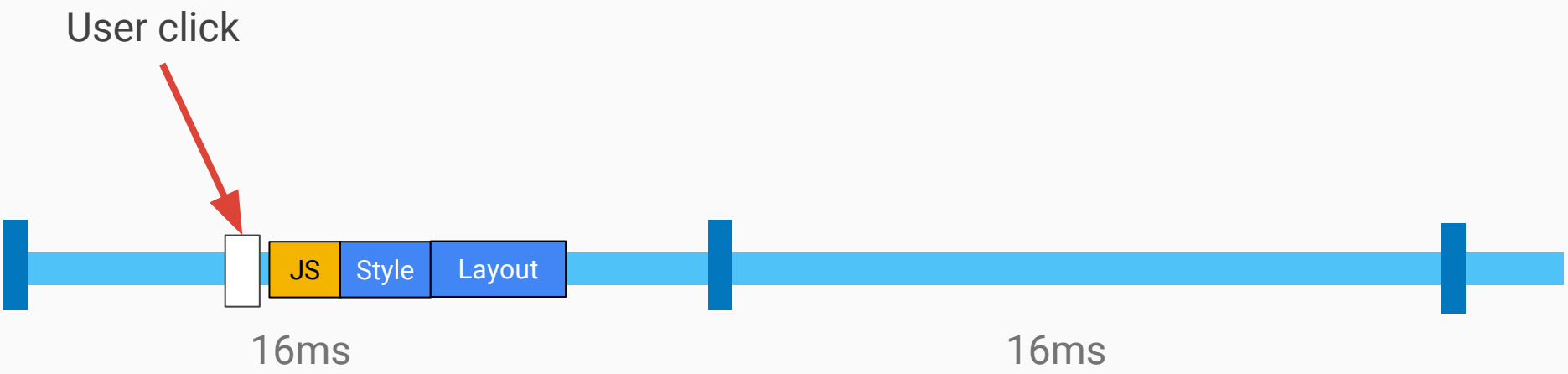

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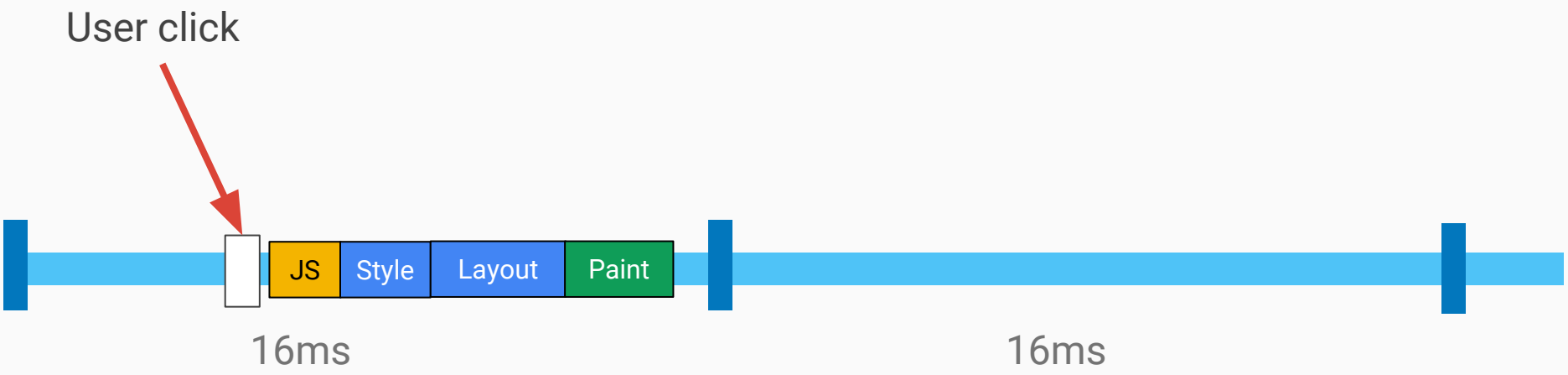

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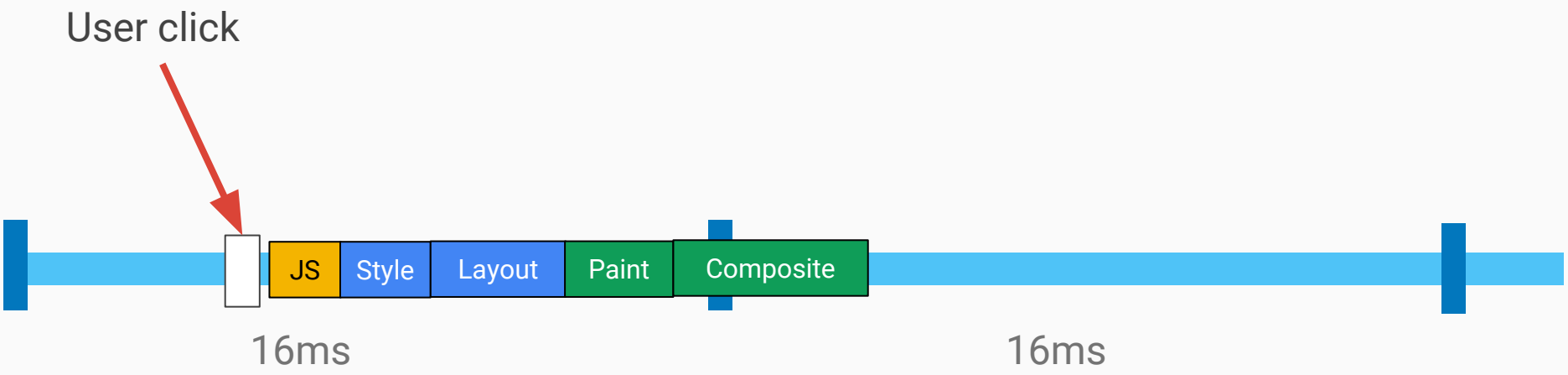

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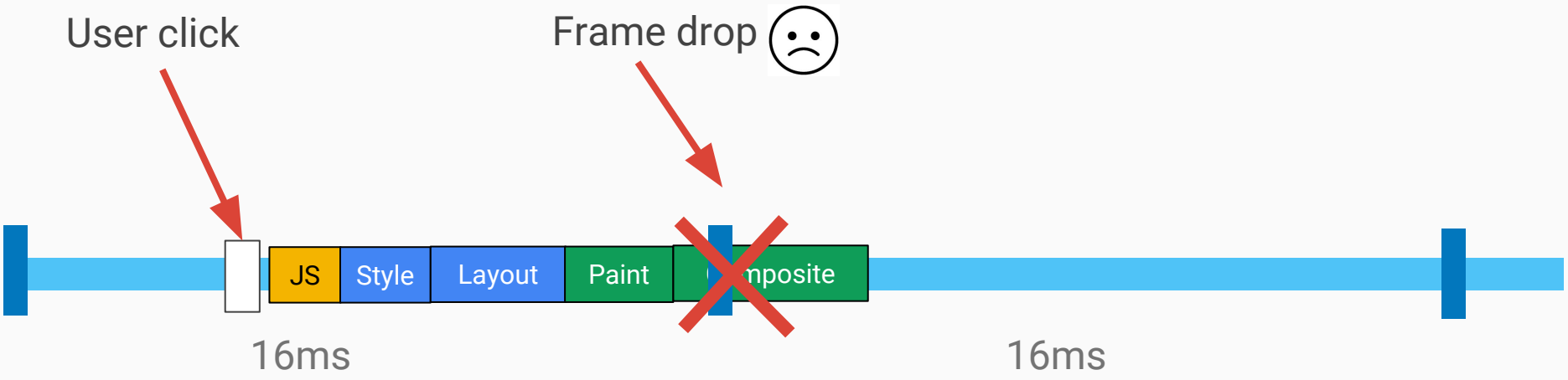

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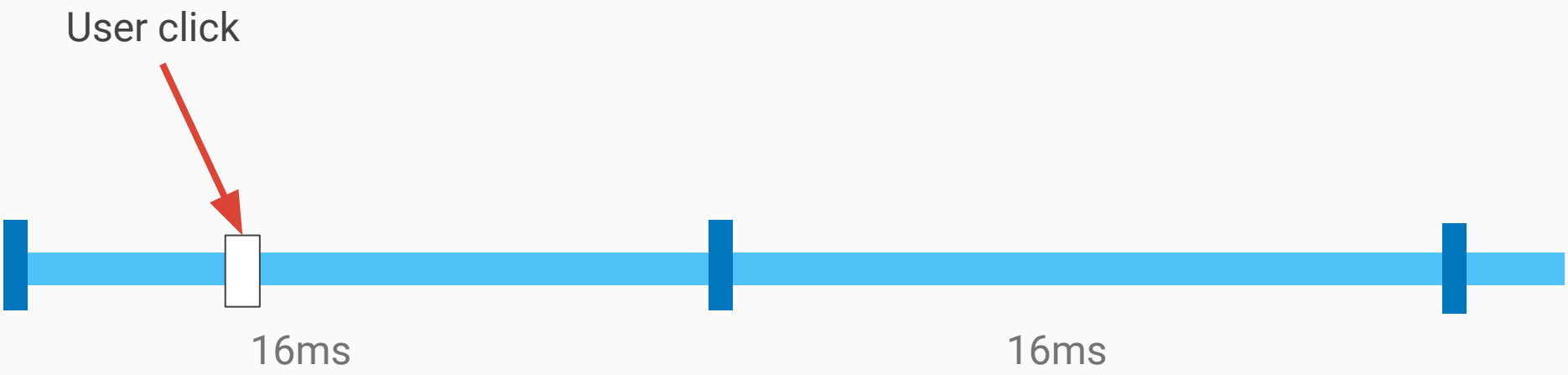

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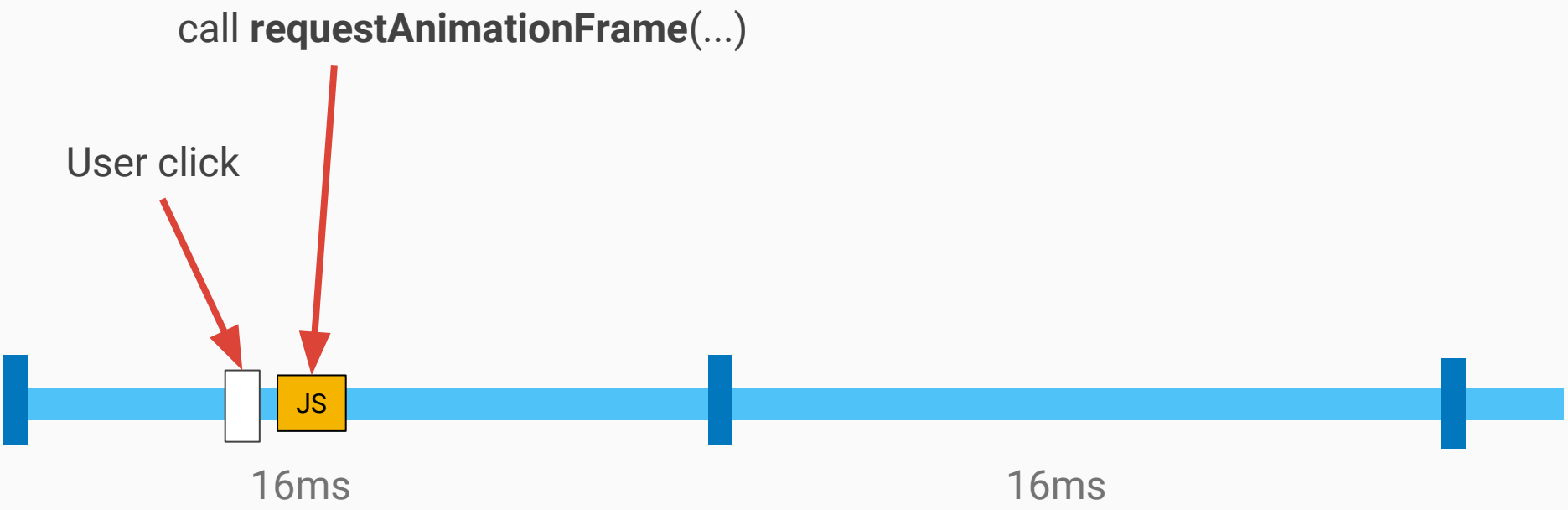

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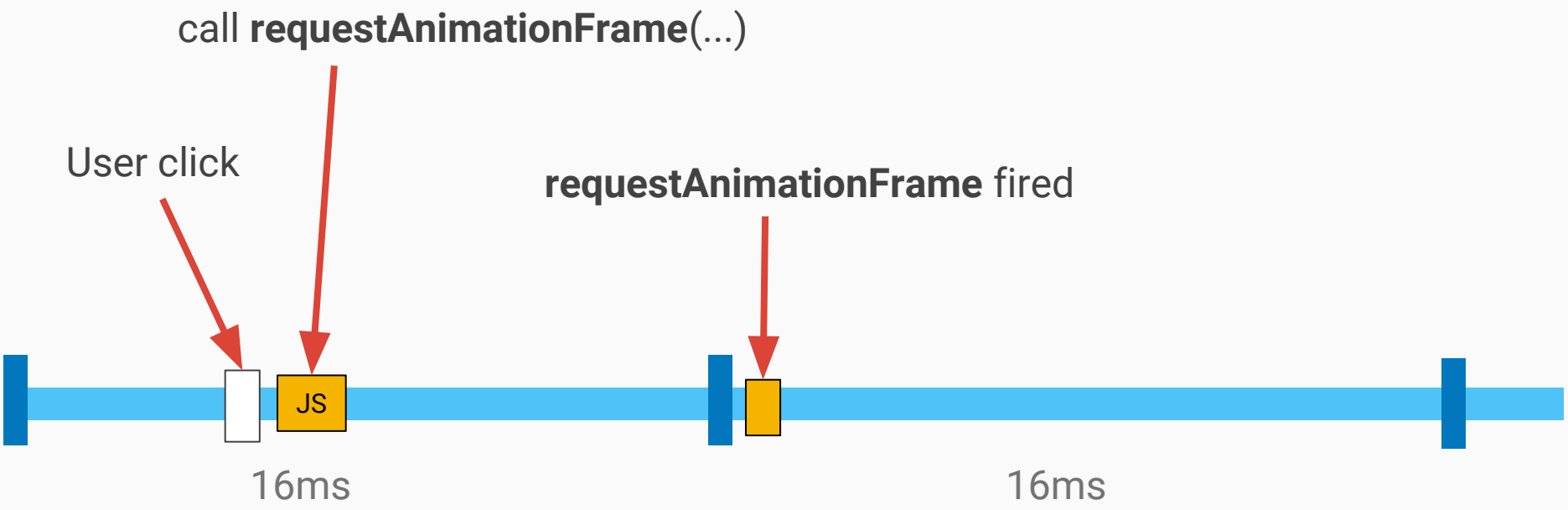

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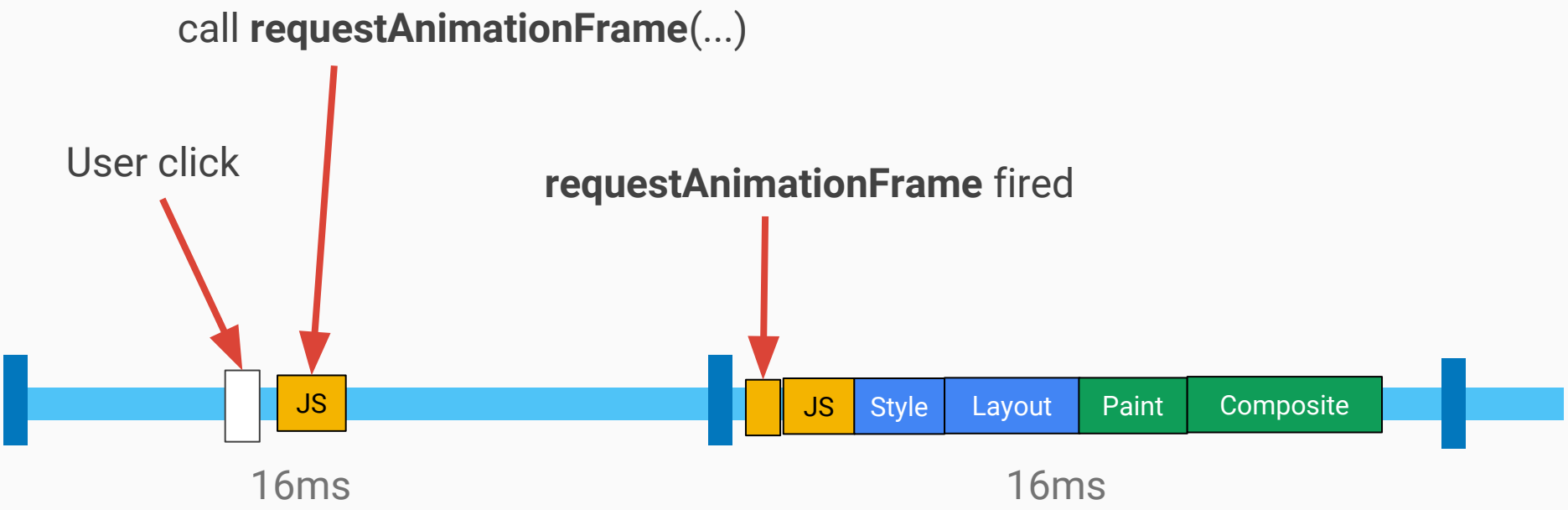

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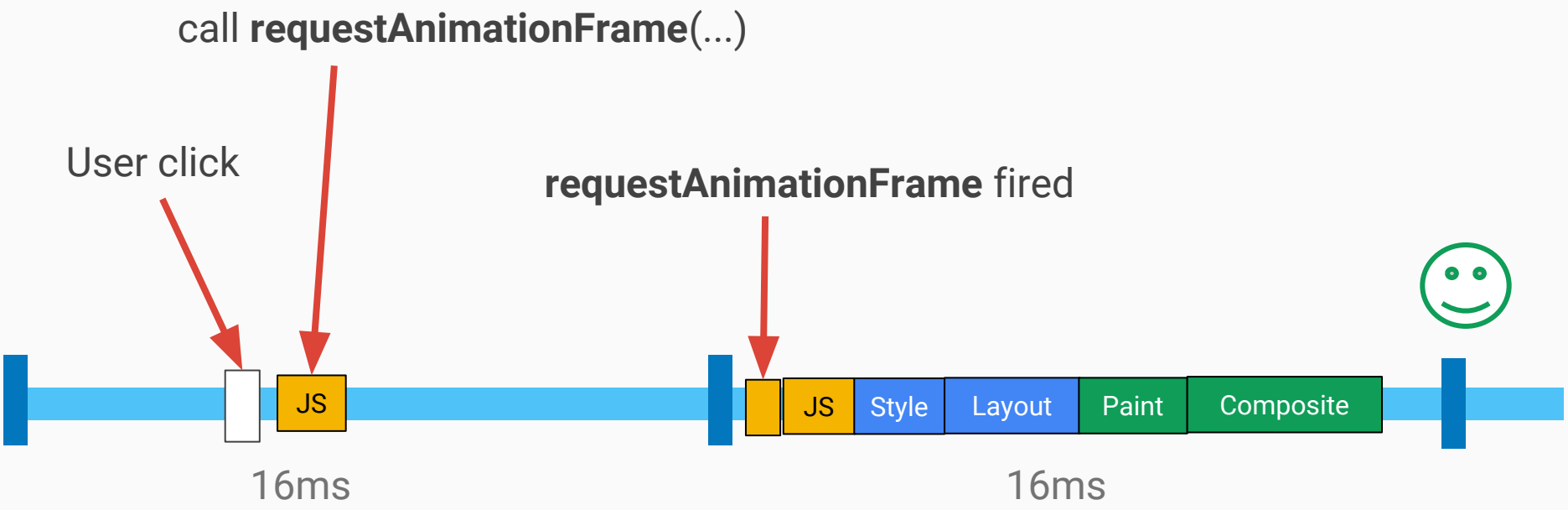

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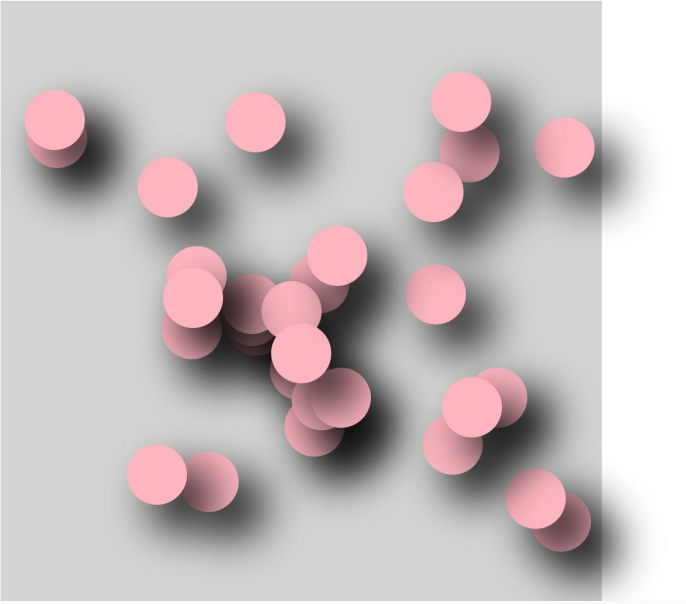
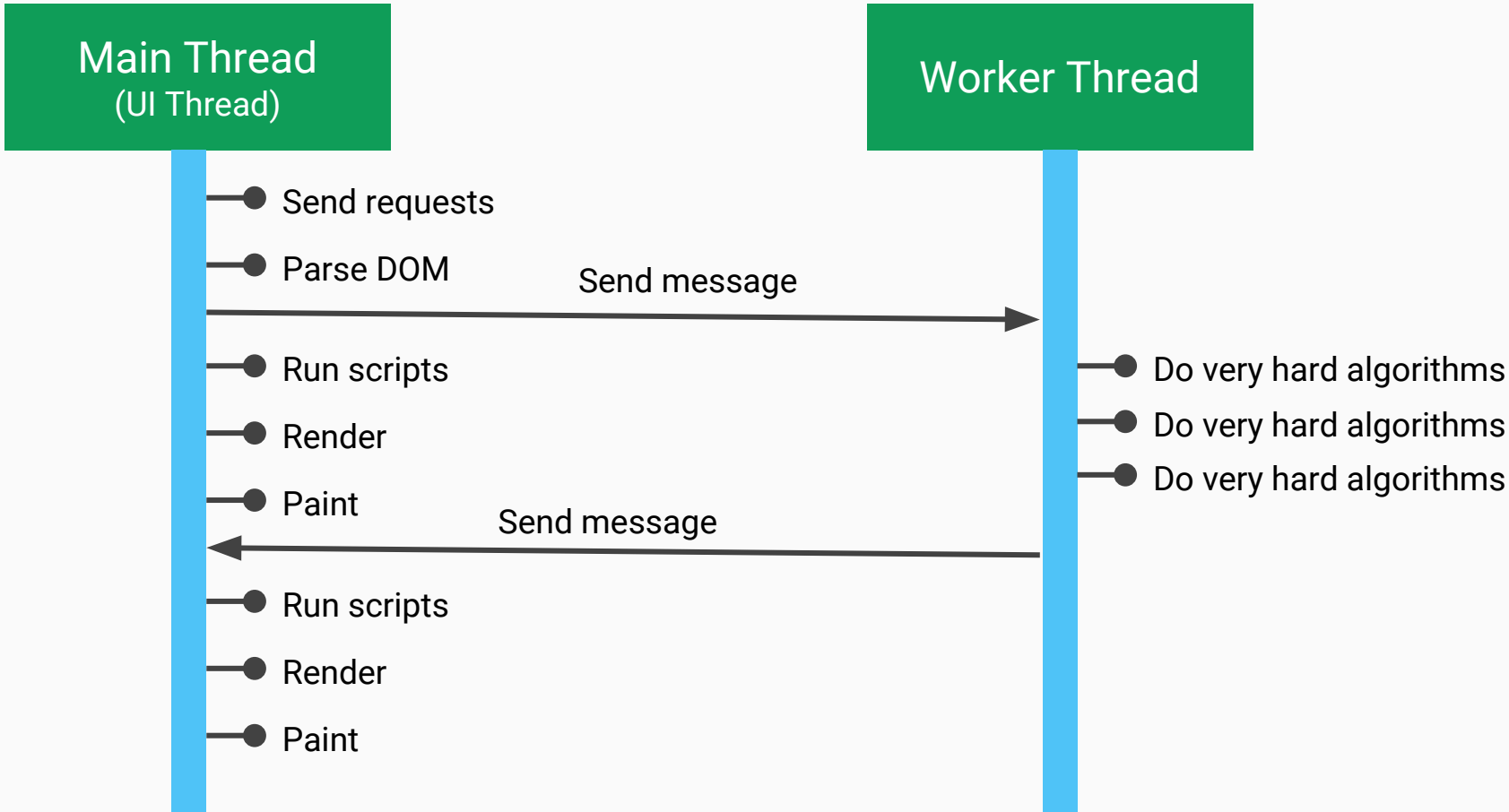


Improve the example

Use Web Workers for hard works



Use Web Workers for hard works

```
var dataSortWorker = new Worker("sort-worker.js");
dataSortWorker.postMesssage(dataToSort);

// The main thread is now free to continue working on other things...

dataSortWorker.addEventListener('message', function(evt) {
   var sortedData = evt.data;
   // Update data on screen...
});
```

Web Worker Guide: https://developer.mozilla.org/en-US/docs/Web/API/Web_Workers_API/Using_web_workers

Other tips

Avoid complex style

```
.title {
  /* styles */
}
```

DO ☺

```
.box:nth-last-child(-n+1) .title {
  /* styles */
}
```

DON'T ☹

Manage your CSS

- Use Block, Element, Modifier
- PostCSS

```
.list { }
.list__list-item { }
```

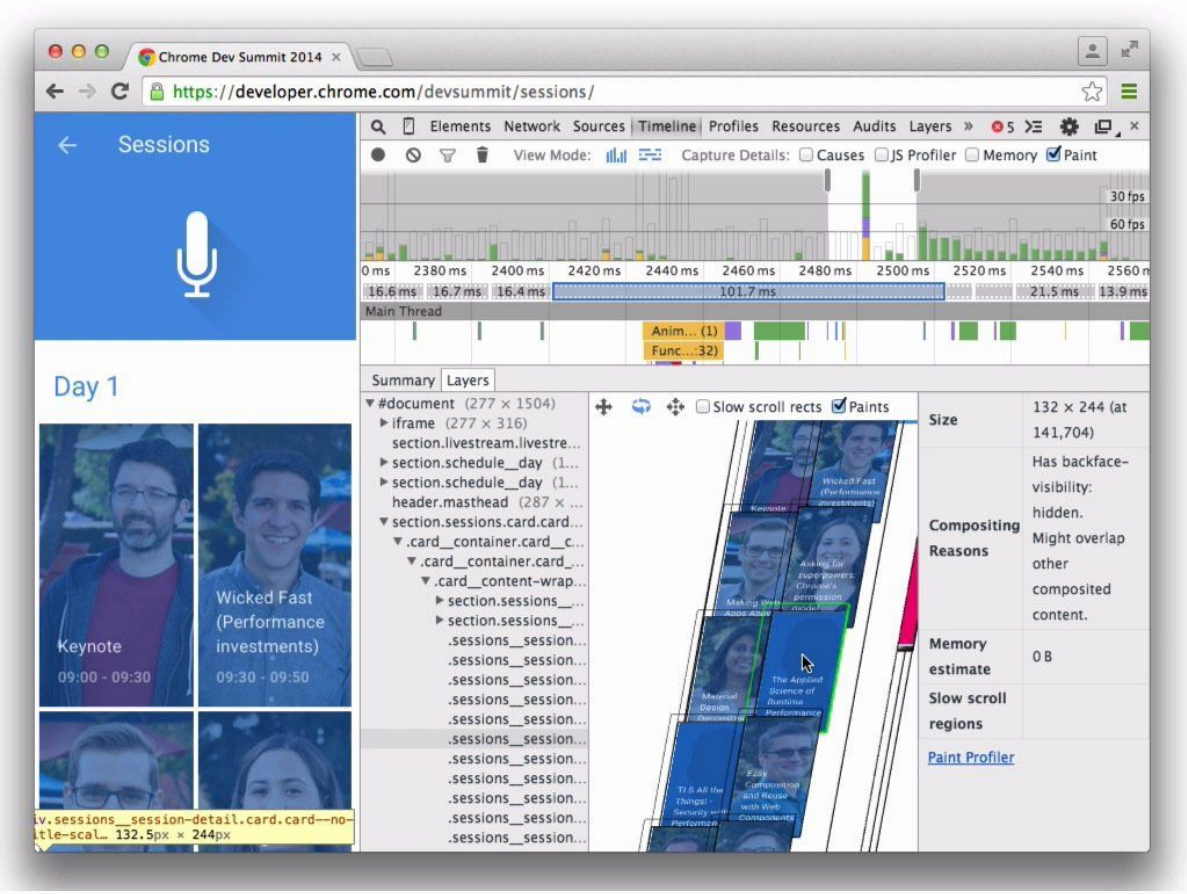
```
.list__list-item--last-child {}
```

Avoid going through all the steps

Position	`transform: translate(npx, npx);`
Scale	`transform: scale(n);`
Rotation	`transform: rotate(ndeg);`
Skew	`transform: skew(X|Y)(ndeg);`
Matrix	`transform: matrix(3d)(...);`
Opacity	`opacity: 0...1;`

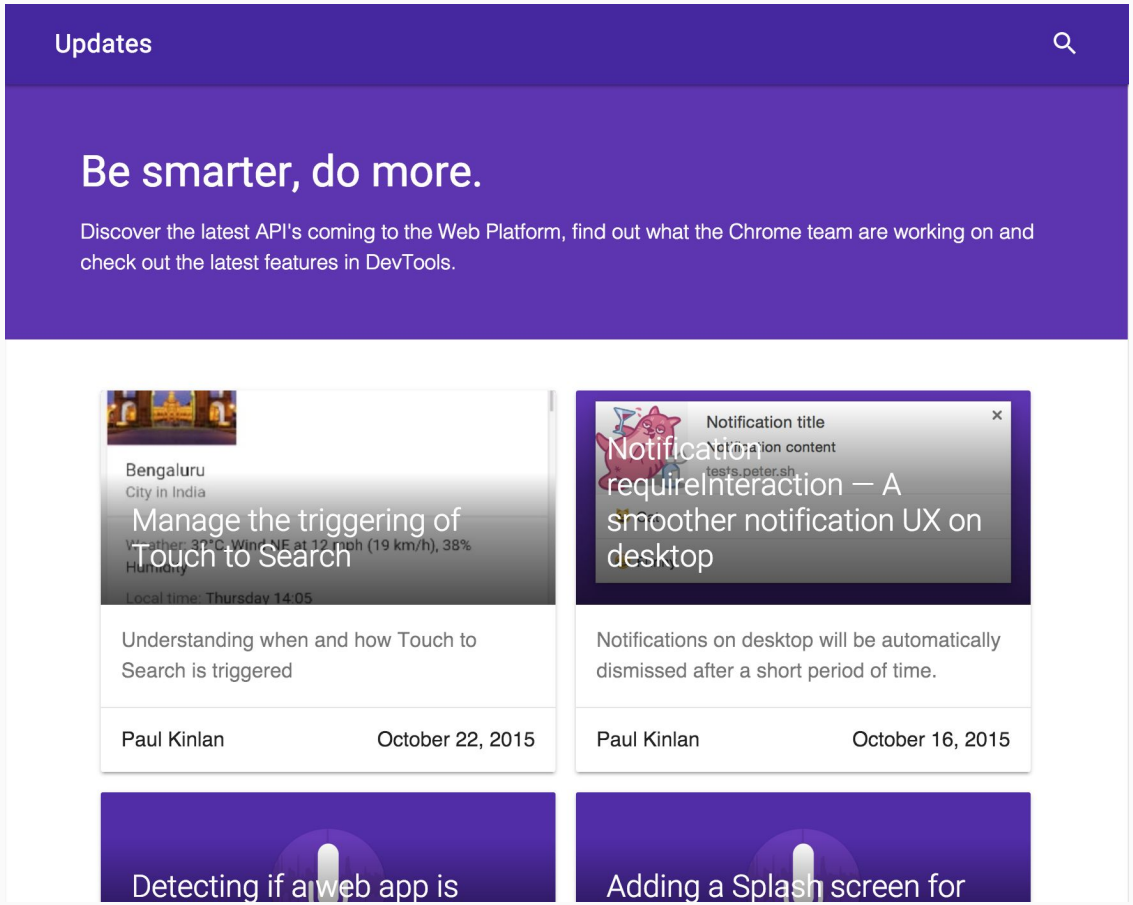
(The element will need to be on its own compositor layer.)

Use Chrome DevTools to profile your app



Keep your knowledge up to date!

https://developers.google.com/web/updates/



Recap

Paint

- Paint is the **most expensive work**
- Manage your **composite layers**

Layout

- Avoid **trigger layout**
- Use **Flexbox**
- Avoid **forced synchronous layout**

JavaScript

- Use **requestAnimationFrame**
- Use **Web workers** for hard works

Style

- Reduce selector **complexity**
- Reduce **number of element affected** by styles

Composite

- Use **compositor-only properties**

Useful resources for Web Performance

This presentation:

- This slide: http://j.mp/web-performance-slide
  - Full article: http://j.mp/web-performance-trungdq88
  - Example source code: https://github.com/trungdq88/render-performance-demo

Guides

- Google Developer: https://developers.google.com/web/fundamentals/performance/
- Preventing Layout Thrashing: http://wilsonpage.co.uk/preventing-layout-thrashing/

Course

- Udacity Course: Browser Rendering Optimization - Building 60 FPS Web Apps: https://www.udacity.com/course/browser-rendering-optimization--ud860

Nice webs

- http://world.mathigon.org/
- http://matthew.wagerfield.com/parallax/

Other resources

- Web Workers: https://developer.mozilla.org/en-US/docs/Web/API/Web_Workers_API/basic_usage
- BEM: https://bem.info/
- PostCSS: https://github.com/postcss/postcss
- CSS Trigger: http://csstriggers.com/
- Guide to Flexbox: http://css-tricks.com/snippets/css/a-guide-to-flexbox/

Thank you

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