an overview of

SCROLLING IN BLINK

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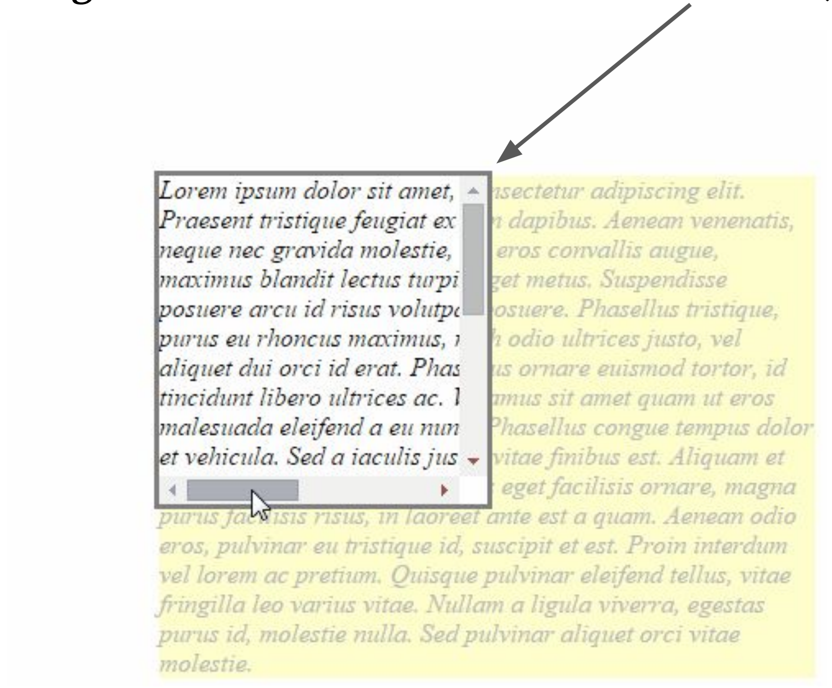
bit.ly/blink-scrolling

WHAT IS SCROLLING?

Scrolling moves **content** inside a **scrollable area** (or "scroller").



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Scrolling requires **overflow**.

The overflow is **clipped**.

Scrolling updates a **scroll offset**.

Most scrollable areas have **scrollbars** (or "overflow controls").

WHERE DO SCROLLABLE AREAS COME FROM?

Every **frame** has a scrollable area for its document.

`<iframe>`

`<frameset>`

[CSS 2.1]

default

```
overflow: visible
```

```
overflow: hidden
overflow: scroll
overflow: auto
```

scrollable area

Every **element** has "`overflow`" CSS style.

`<div style="overflow: scroll">`

Some **form controls** are scrollable.

`<input>` `<textarea>` `<select>`

Pinch zoom creates a special scrollable area.

WHAT CAUSES SCROLLING?

The **user** can scroll.

- *mouse wheel*
- *trackpad gesture*
- *touch screen drag*
- *scrollbar interaction*
- *keyboard up/down/...*

The **webpage** can scroll itself with JS.

```
window.scrollTo(...);
window.scrollBy(...);

element.scrollLeft = ...;
element.scrollTop = ...;
element.scrollIntoView();
```

Layout can scroll (by affecting min/max offset).

Navigation scrolls in two ways:

- *to a #hash fragment*
- *to restore a position from session history*

```
<a name="foo">Anchor</a>
```

Scrolling can be a **side effect** of a user action.

- *selection dragging*
- *focus (Tab) movement*
- *finding text (Ctrl-F)*

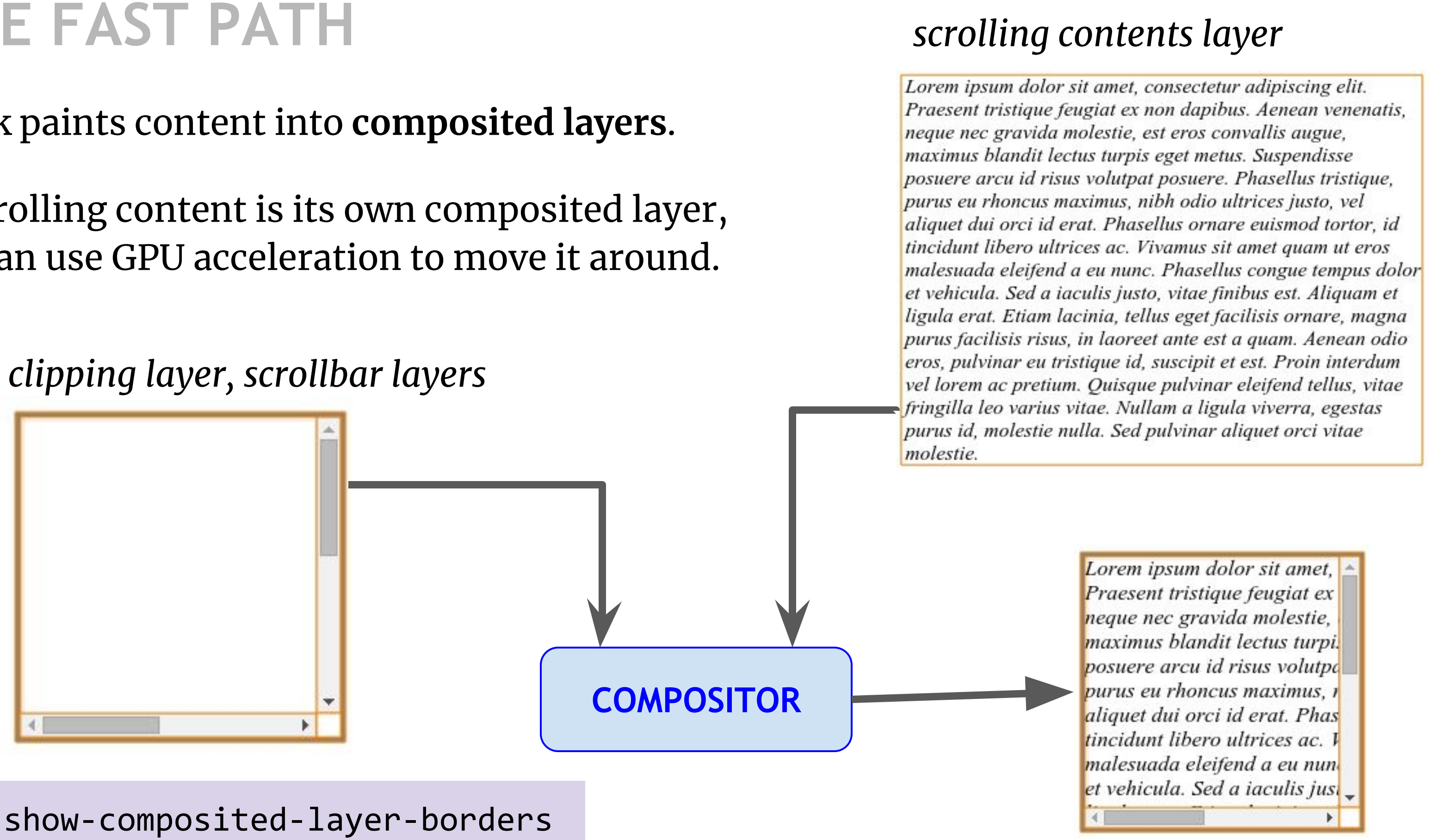
A **<WebView> embedder** can scroll.

```
android.webkit.WebView.scrollTo(x, y)
```

THE FAST PATH

Blink paints content into **composited layers**.

If scrolling content is its own composited layer, we can use GPU acceleration to move it around.



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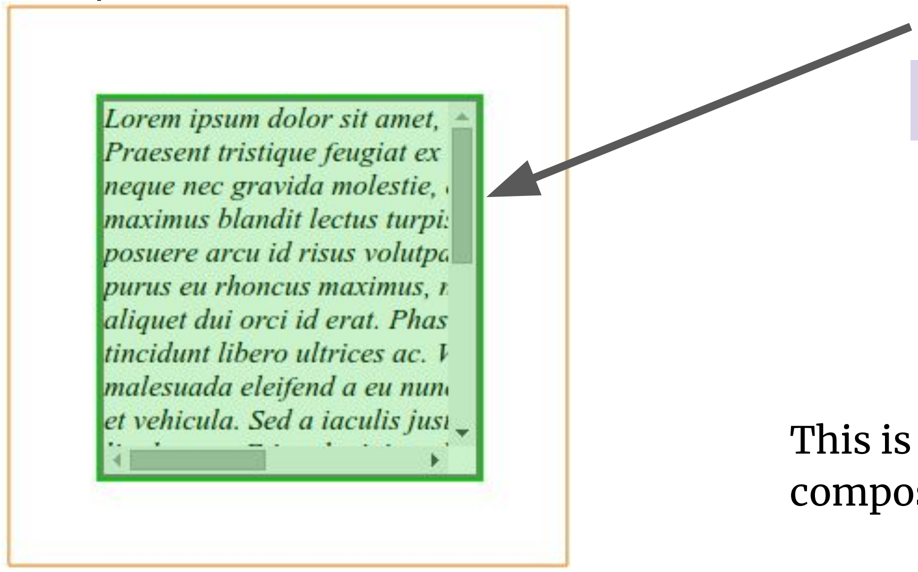
```
--show-composited-layer-borders
```

THE SLOW PATH

If scrolling content is **not** in its own composited layer, a region of the parent layer must be repainted when the scroll offset changes.

composited container



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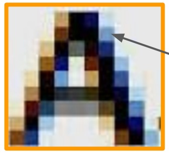
paint invalidation

```
--show-paint-rects
```

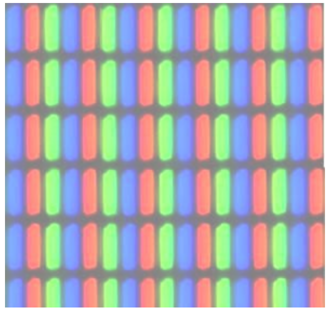
This is more work than a composited scroll.

LCD TEXT

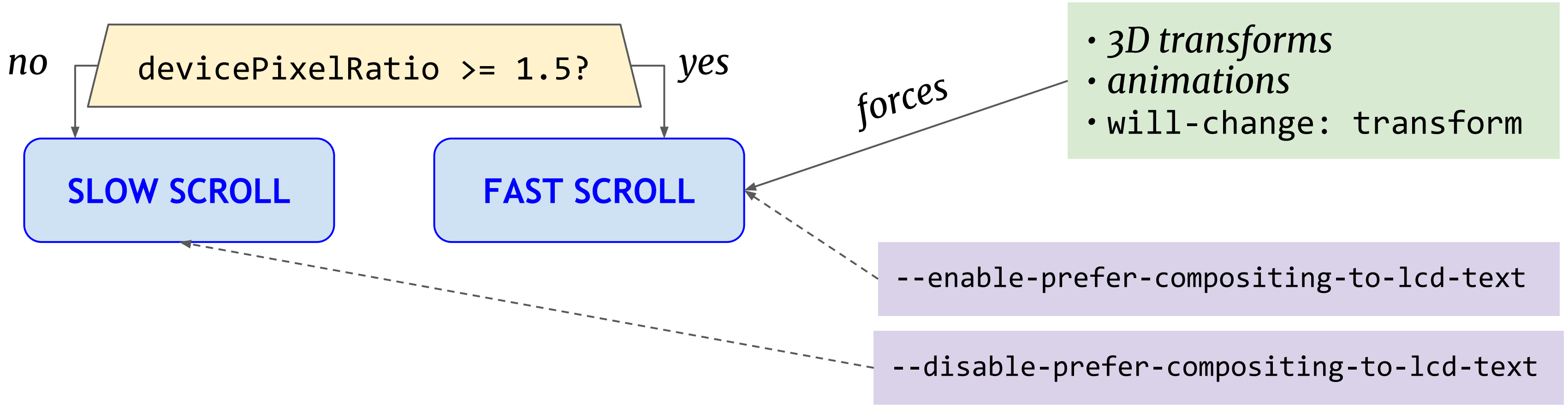
Compositing a **transparent** scroller affects **subpixel antialiasing**.



Edge pixels depend on background color.

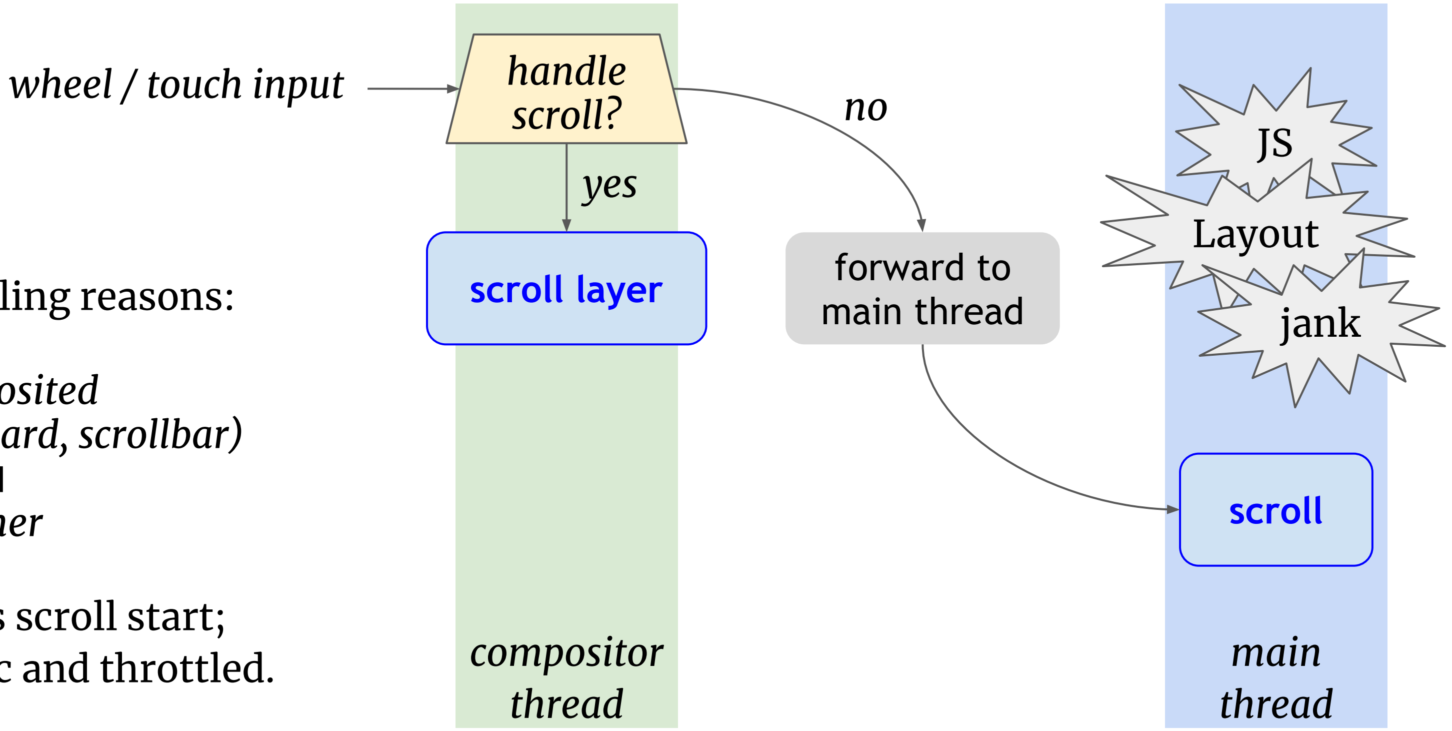


So, we only composite `overflow:scroll` on high-DPI devices.



THREADED SCROLLING

The **compositor thread** can handle some types of scroll input.



Main thread scrolling reasons:

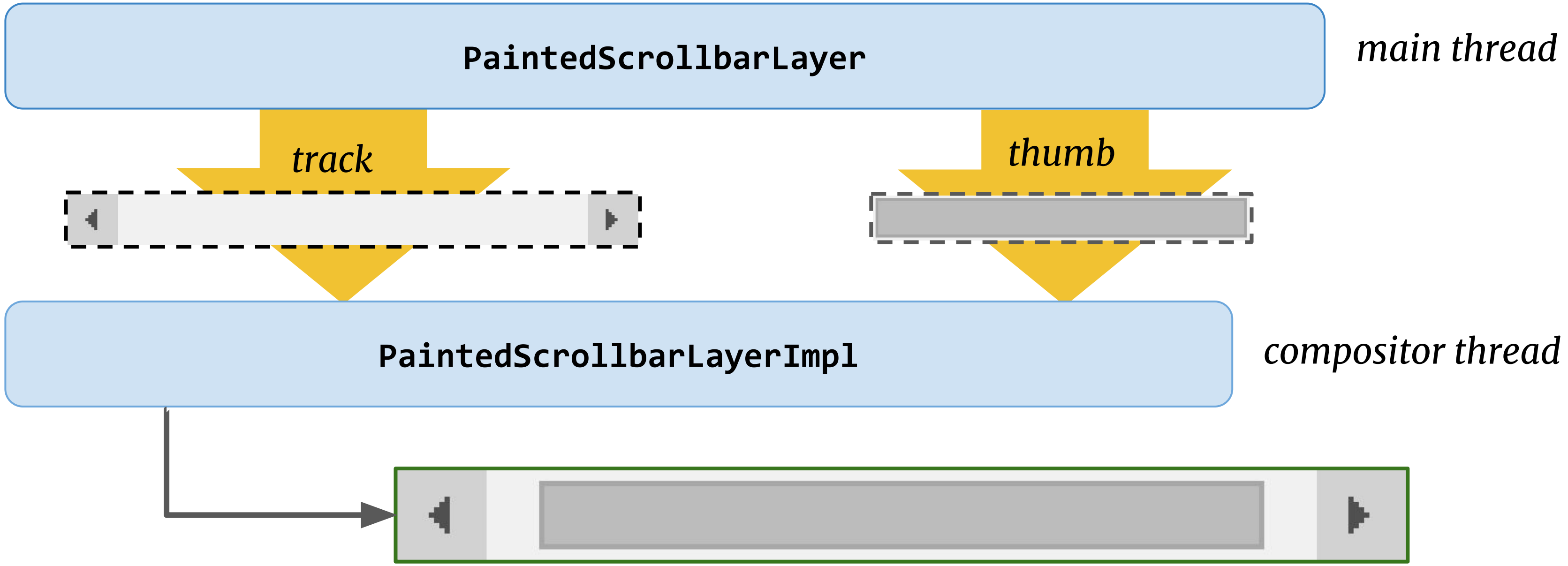
- *scroller not composited*
- *input type (keyboard, scrollbar)*
- `position: fixed`
- `wheel` *event listener*

`touchstart` blocks scroll start;
`touchmove` is async and throttled.

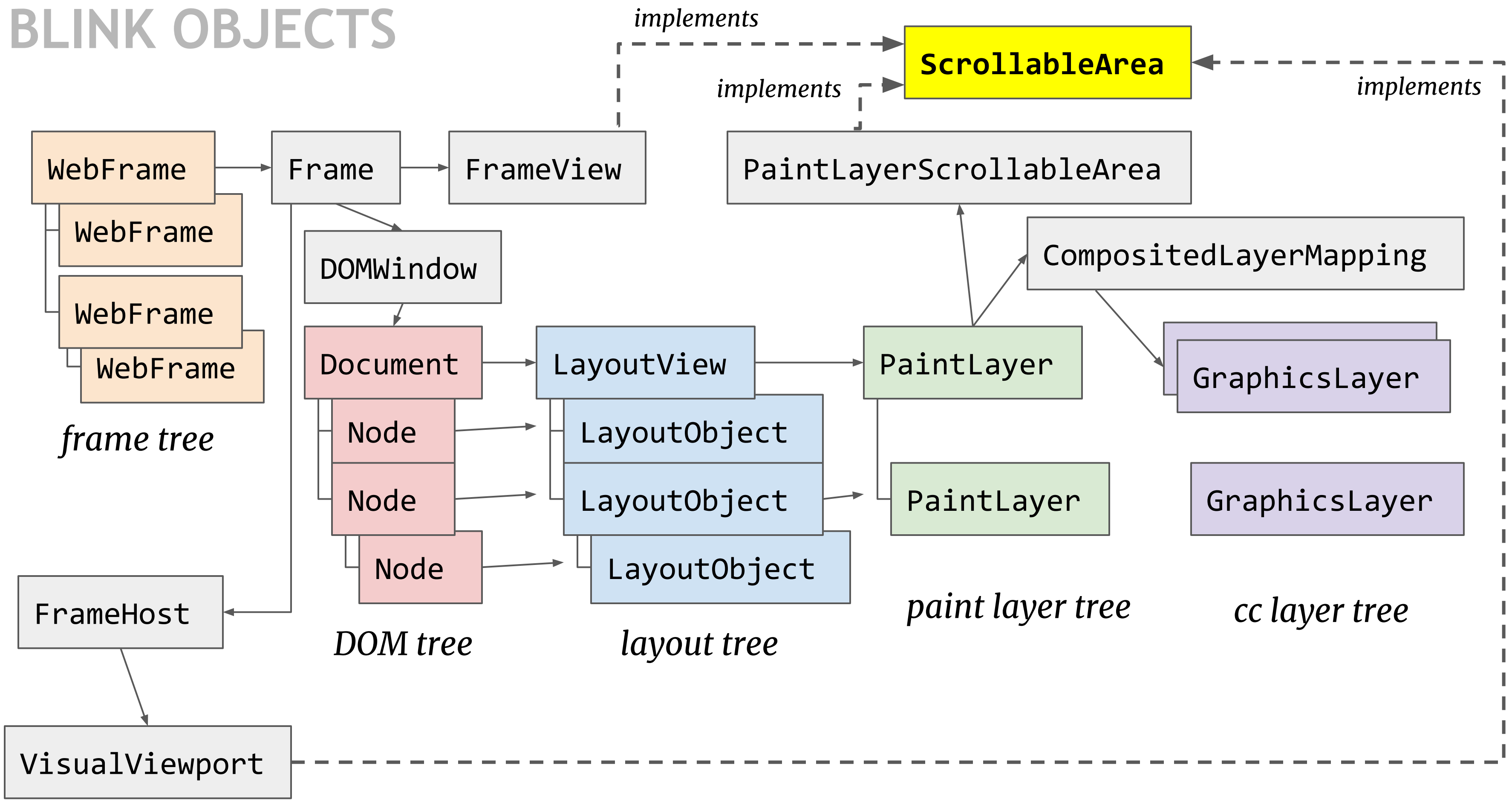
COORDINATED SCROLLBARS

When a scroller is composited, so are its scrollbars.

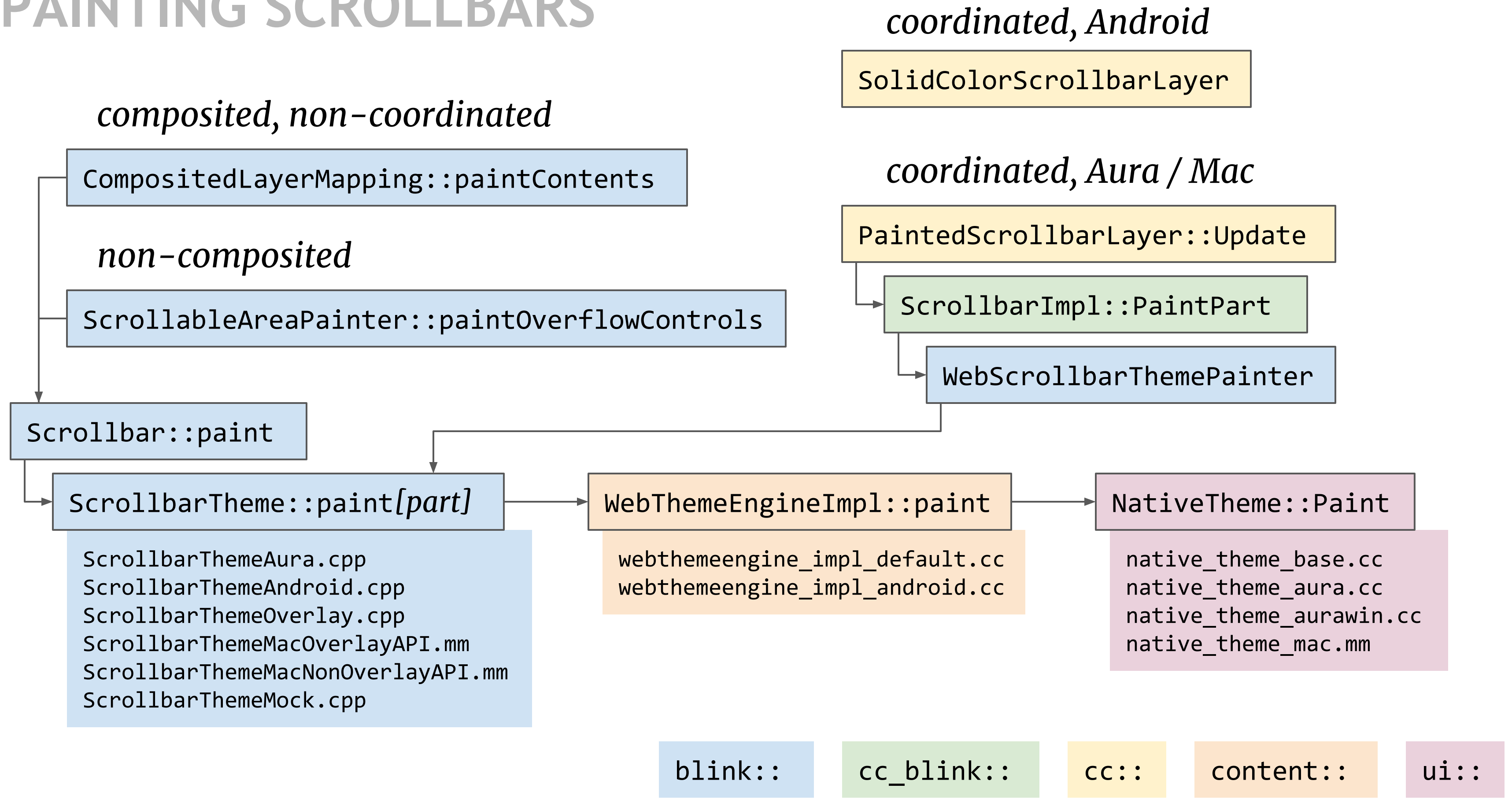
A **coordinated scrollbar** can be updated on the compositor thread.



BLINK OBJECTS



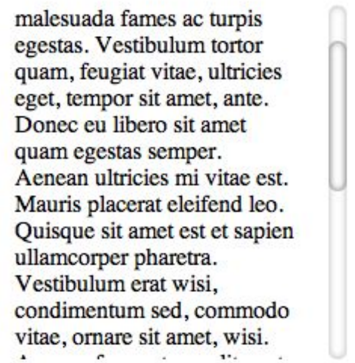
PAINTING SCROLLBARS


composited, non-coordinated
CompositedLayerMapping::paintContents
non-composited
ScrollableAreaPainter::paintOverflowControls
Scrollbar::paint
ScrollbarTheme::paint[part]
ScrollbarThemeAura.cpp
ScrollbarThemeAndroid.cpp
ScrollbarThemeOverlay.cpp
ScrollbarThemeMacOverlayAPI.mm
ScrollbarThemeMacNonOverlayAPI.mm
ScrollbarThemeMock.cpp
coordinated, Android
SolidColorScrollbarLayer
coordinated, Aura / Mac
PaintedScrollbarLayer::Update
ScrollbarImpl::PaintPart
WebScrollbarThemePainter
WebThemeEngineImpl::paint
webthemeengine_impl_default.cc
webthemeengine_impl_android.cc
NativeTheme::Paint
native_theme_base.cc
native_theme_aura.cc
native_theme_aurawin.cc
native_theme_mac.mm
blink::
cc_blink::
cc::
content::
ui::

CUSTOM SCROLLBARS

Scrollbars can be styled in CSS.

```
::-webkit-scrollbar { ... }
::-webkit-scrollbar-track { ... }
::-webkit-scrollbar-thumb { ... }
```



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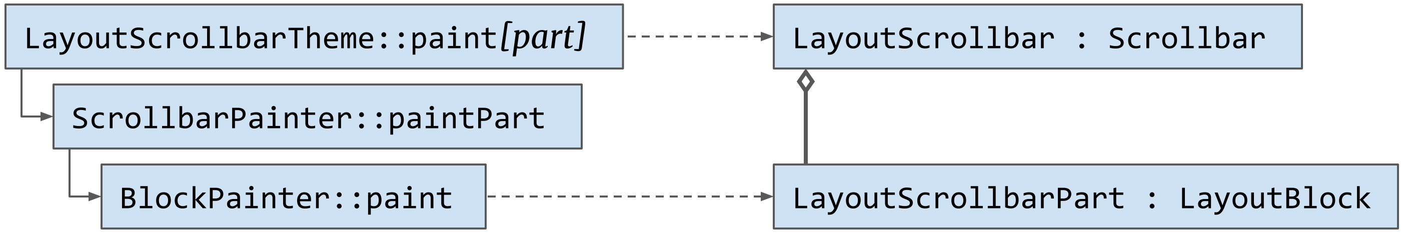
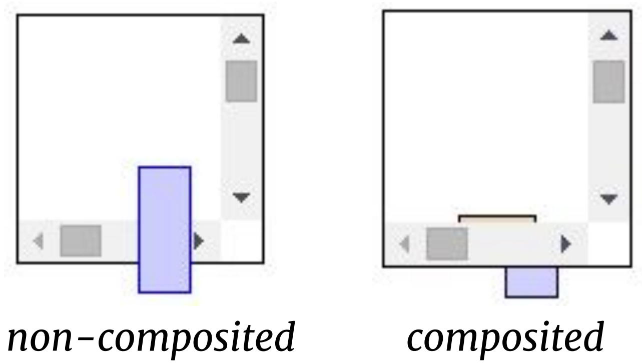
Each piece is a `LayoutBlock`.


LayoutScrollbarTheme::paint[part]
ScrollbarPainter::paintPart
BlockPainter::paint
LayoutScrollbar : Scrollbar
LayoutScrollbarPart : LayoutBlock

- *not standardized*
- *propagates into iframes*
- *state changes can relayout*

PAINT ORDER

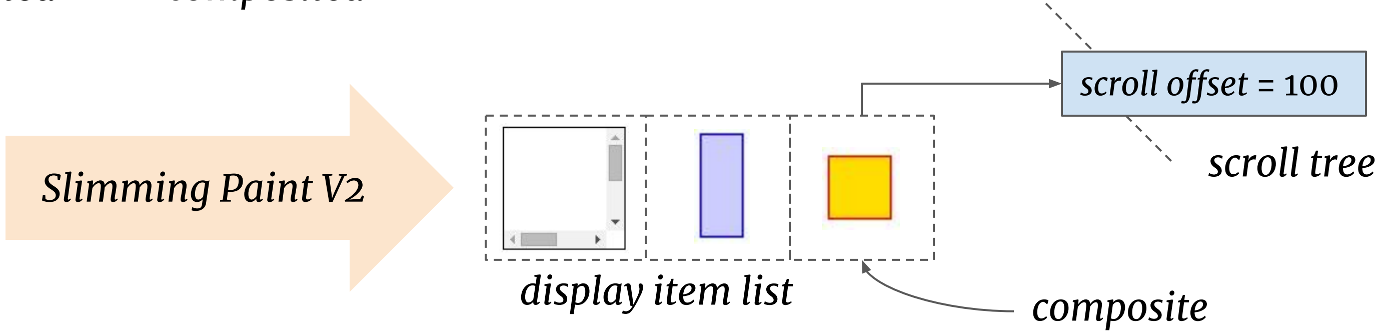
If a scroller is not a **stacking context**, outside content can be interleaved in z-order.



This scroller paints differently when composited.

One example of the **fundamental compositing bug**.

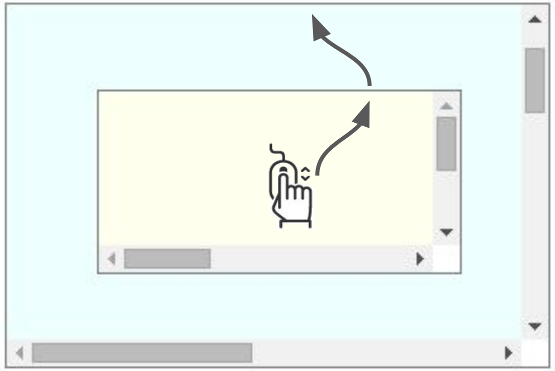
The **slimming paint** project will fix it by making compositing decisions more granular.



CHAINING

Scrollers can nest.

Scroll chaining walks up the **containing block** chain until the delta is consumed.



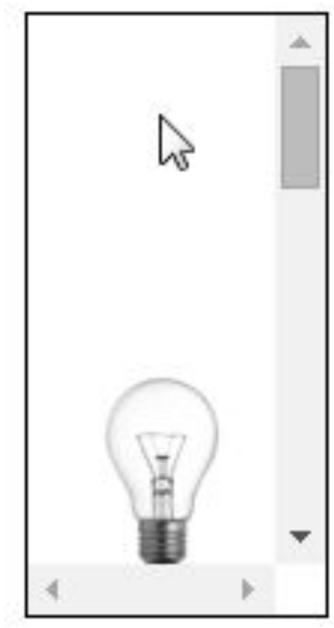
*(Separate from **event bubbling**, which walks up the DOM to invoke listeners.)*

Recent change: **latch** to a single scroller during a touch gesture (chain only at start).

Coming soon: latching for touchpad scrolls.

HOVERING

Elements may enter or exit the **hover state** after a scroll.

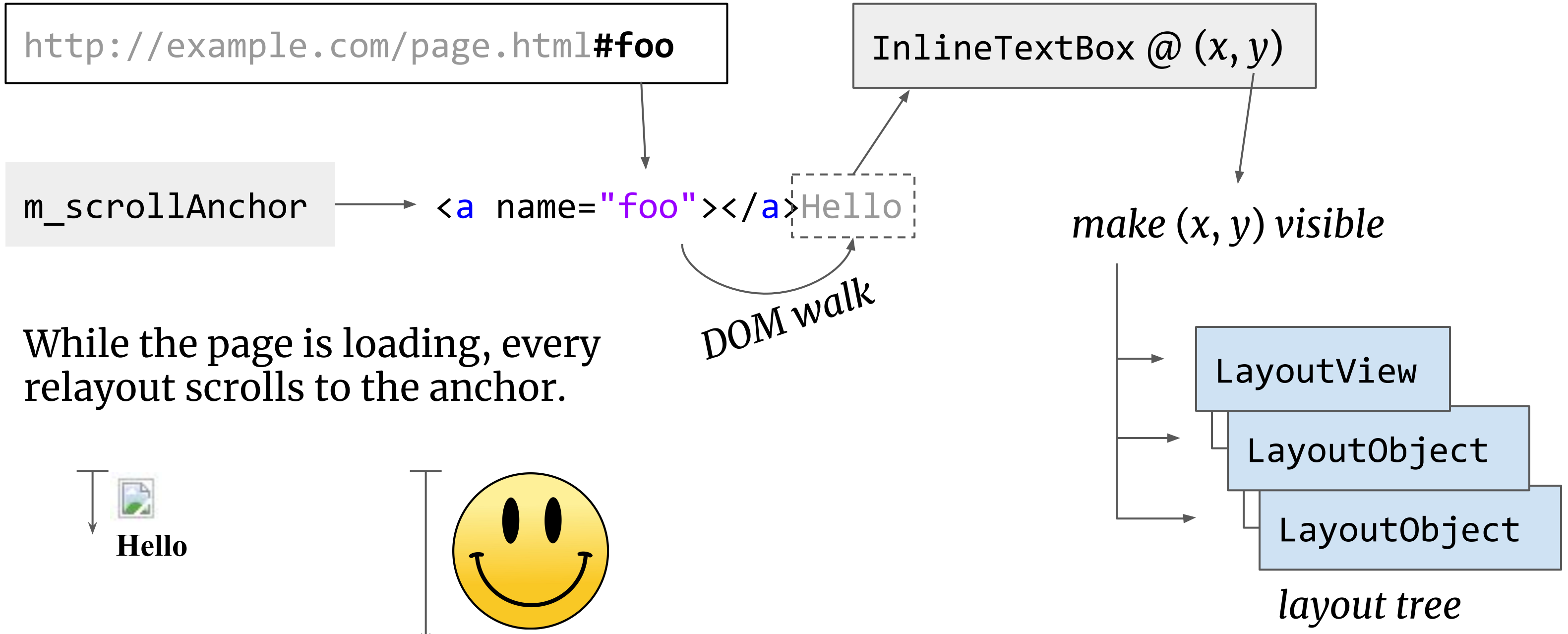


Recent change: defer hover effects and `mousemove` until no scrolls have occurred for 100 ms.

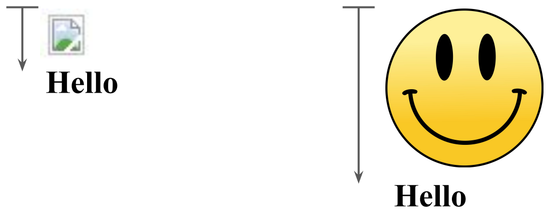
Greatly reduces repaint storms.

ANCHORS

The loader tells the `FrameView` about the **hash fragment**.

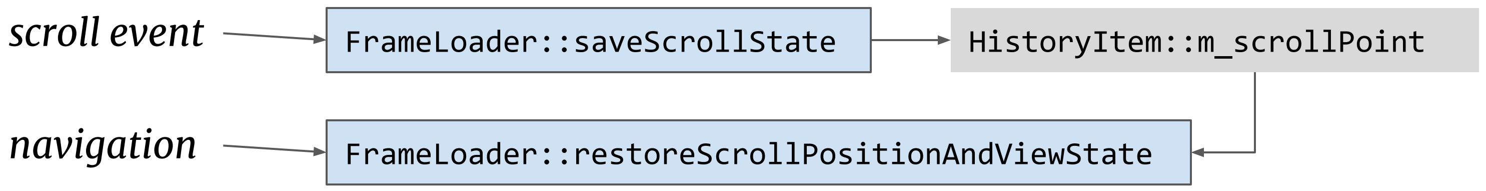


While the page is loading, every relayout scrolls to the anchor.



HISTORY

Each **history item** stores a scroll position along with the URL.


scroll event
FrameLoader::saveScrollState
HistoryItem::m_scrollPoint
navigation
FrameLoader::restoreScrollPositionAndViewState

The page can disable this through the **history API**.

```
history.scrollRestoration = 'manual';
```

History takes precedence over anchors.

RTL

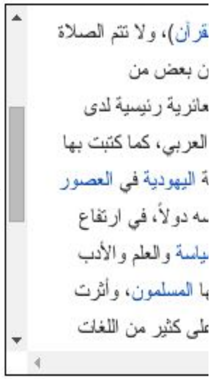
(Coordinate system does not flip.)

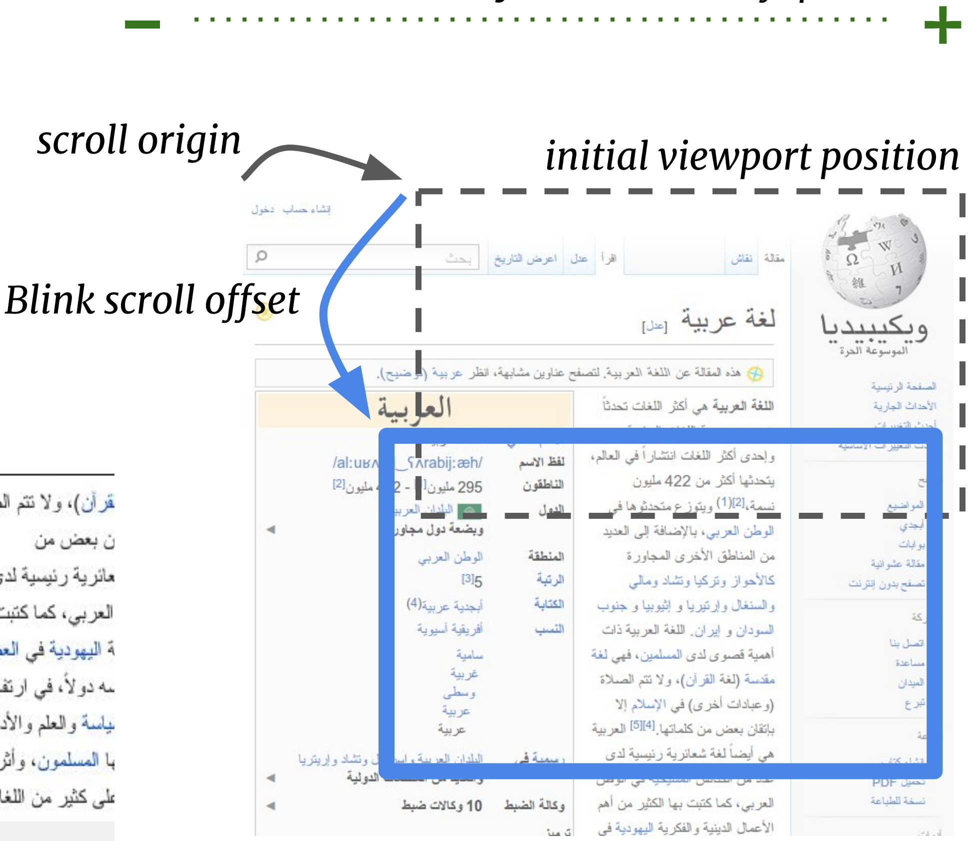
A scroller with `direction: rtl` begins in the rightmost position.

The Blink scroll offset has $x \leq 0$, and is relative to the **scroll origin**.

The `cc::Layer` scroll offset incorporates the scroll origin (as does `element.scrollLeft`).

Elements (but not frames) get left-hand scrollbars.

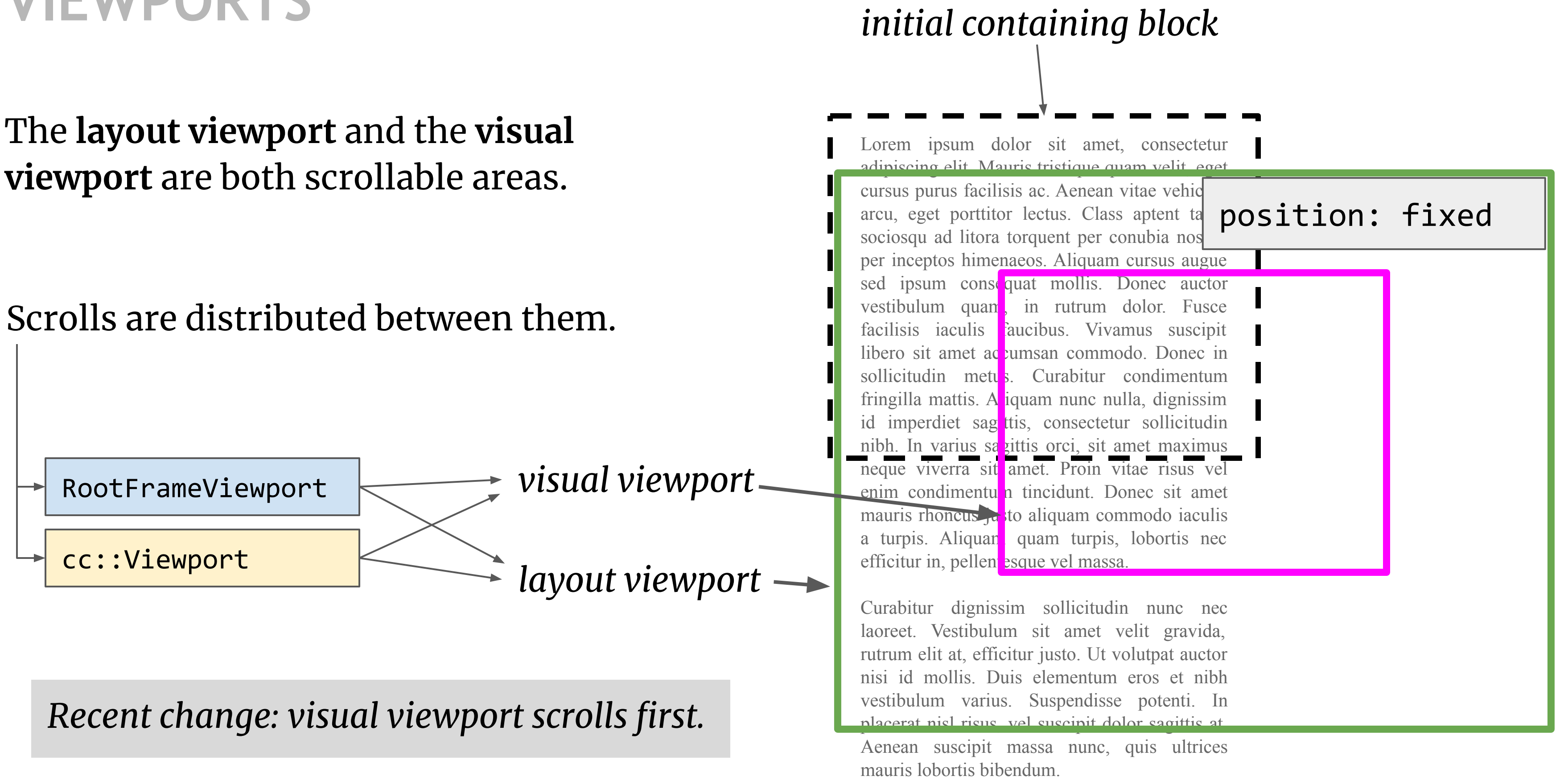




VIEWPORTS

The **layout viewport** and the **visual viewport** are both scrollable areas.

Scrolls are distributed between them.



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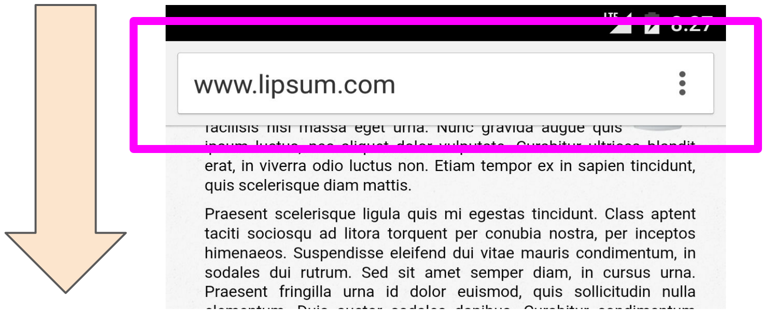
Recent change: visual viewport scrolls first.

TOP CONTROLS

On Android, the **top controls** move in and out of view.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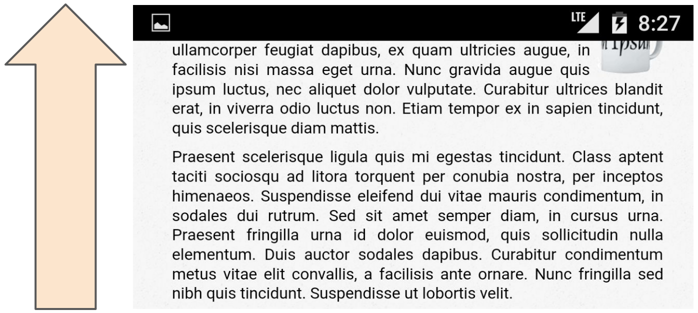
scrolling down



ullamcorper feugiat dapibus, ex quam ultricies augue, in facilisis nisi massa eget urna. Nunc gravida augue quis ipsum luctus, nec aliquet dolor vulputate. Curabitur ultrices blandit erat, in viverra odio luctus non. Etiam tempor ex in sapien tincidunt, quis scelerisque diam mattis.

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scrolling up

Currently, this resizes the initial containing block, causing relayout.

Proposal: always size the ICB as if top controls are shown.

PASSIVE EVENT LISTENERS

Touch / wheel listeners interfere with threaded scrolling, because the event is **cancelable**.

```
doc.addEventListener("touchstart", function(e) {
  e.preventDefault();
});
```

don't scroll!

Proposal: let listeners be **passive**.

can't cancel

```
doc.addEventListener("touchstart", fn, {passive: true});
```

(in progress)

(`scroll-blocks-on` *is gone)*

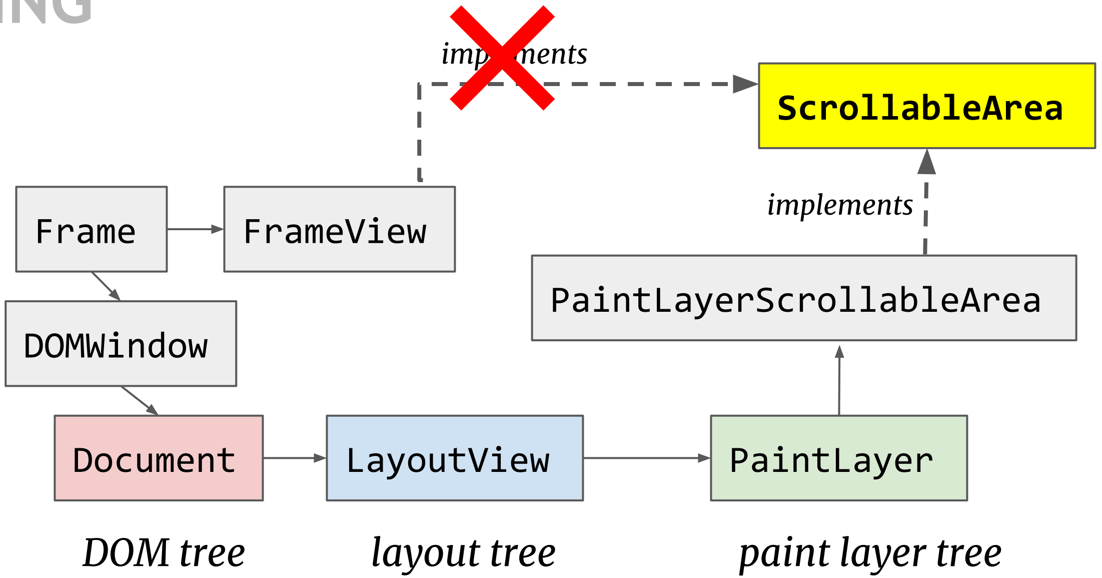
ROOT LAYER SCROLLING

Recall: every PaintLayer has a **ScrollableArea.**

Document has a PaintLayer (the root of the tree).

Why can't the root PaintLayer scroll the document?

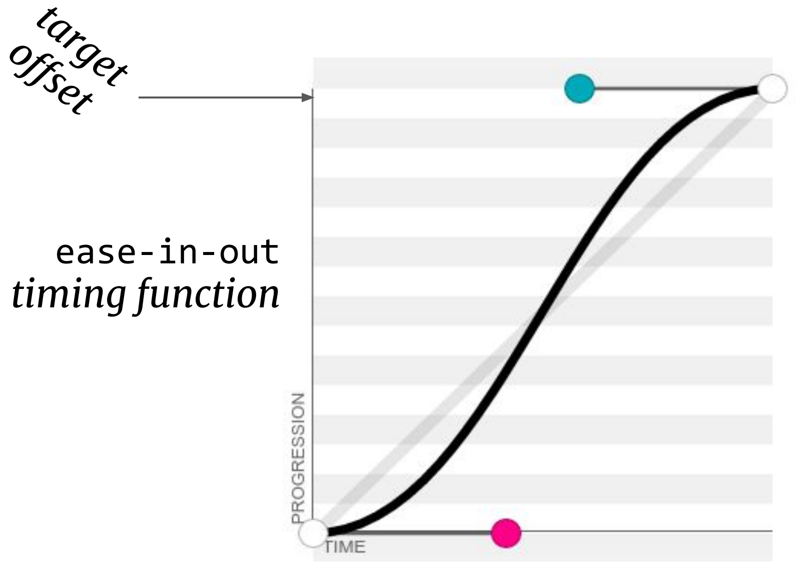
```
--root-layer-scrolls
```



- *eliminates* `FrameView` *scrolling code*
- *document scrolling no longer "special"*
- *reveals bugs in composited* `overflow:scroll`

(in progress)

SMOOTH SCROLLING



(in progress)

Smooth scrolling animates scroll position smoothly up to a target.

input-driven: `--enable-smooth-scrolling`

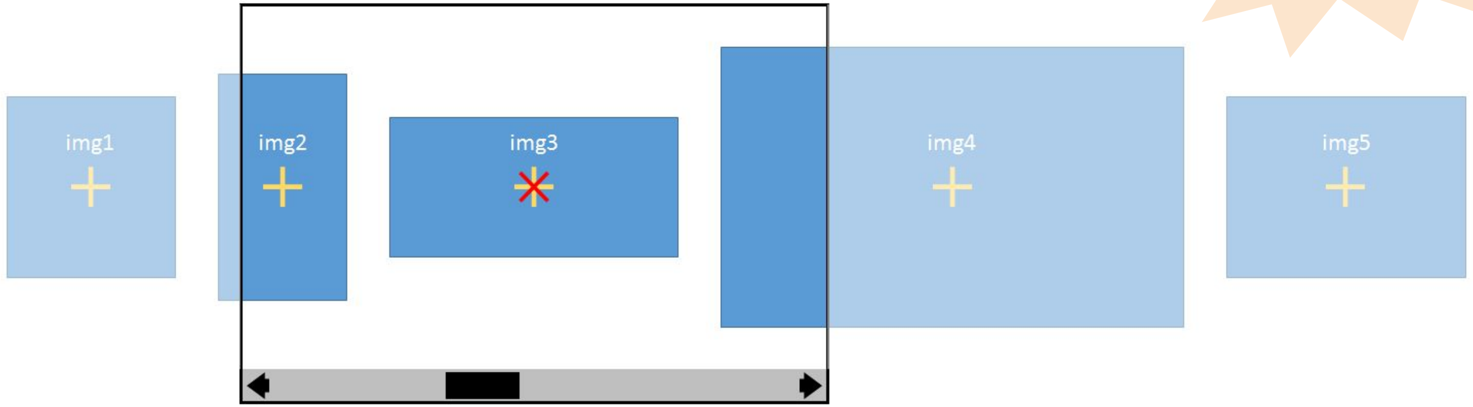
script-driven:

```
element.scroll({
  left: "10",
  top: "10",
  behavior: "smooth"
});
```

`--enable-experimental-web-platform-features`

SNAP POINTS

(in progress)



```
.gallery {
    scroll-snap-destination: 50% 50%;
    scroll-snap-type: mandatory;
}
```

snap to element center

"hard" snap

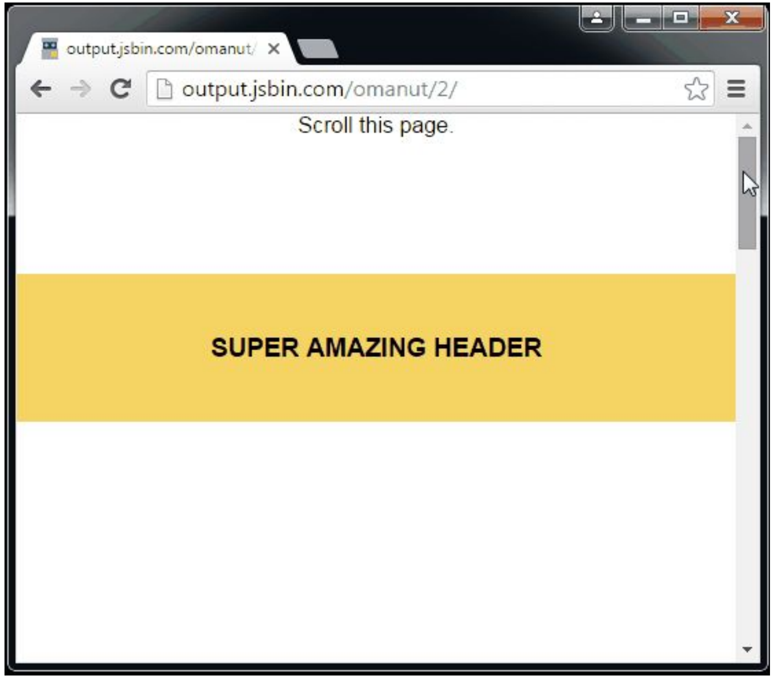
```
--enable-blink-features=CSSScrollSnapPoints
```

POSITION STICKY

(in progress)

```
.header {
    position: sticky;
    top: 0;
}
```

stick to the top


output.jsbin.com/omanut/2/

Scroll this page.

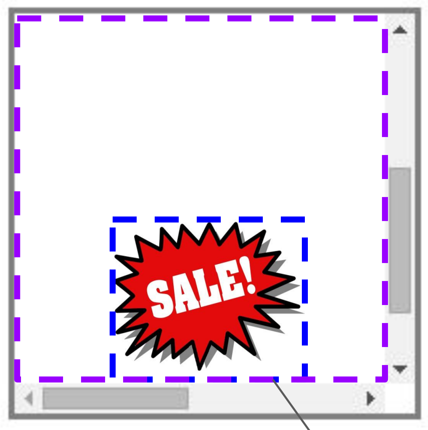
SUPER AMAZING HEADER

INTERSECTION OBSERVER

(in progress)

Invoke a callback when an element scrolls into view.

```
new IntersectionObserver(function(changes) {...}, {}).observe(element);
```



current techniques use expensive polling

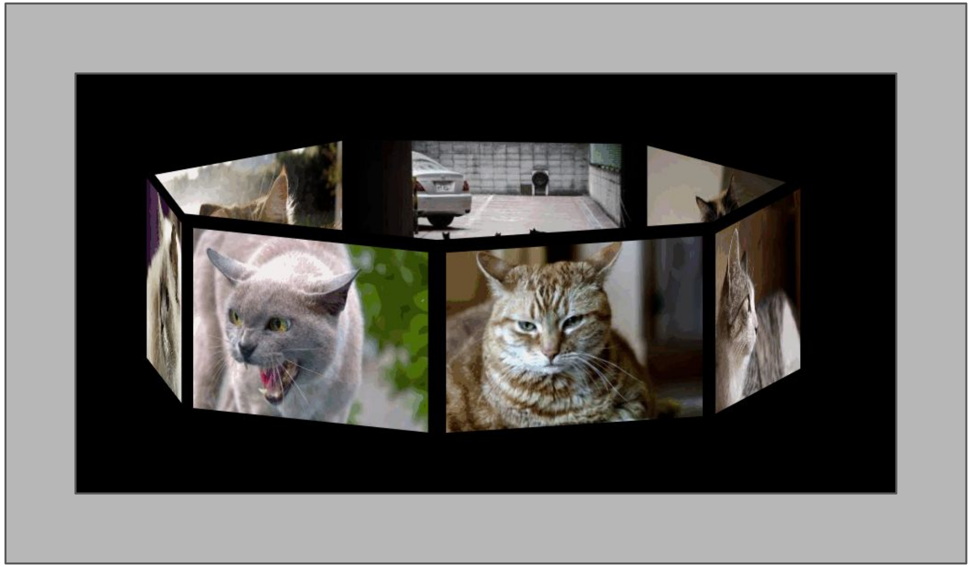
record ad impression

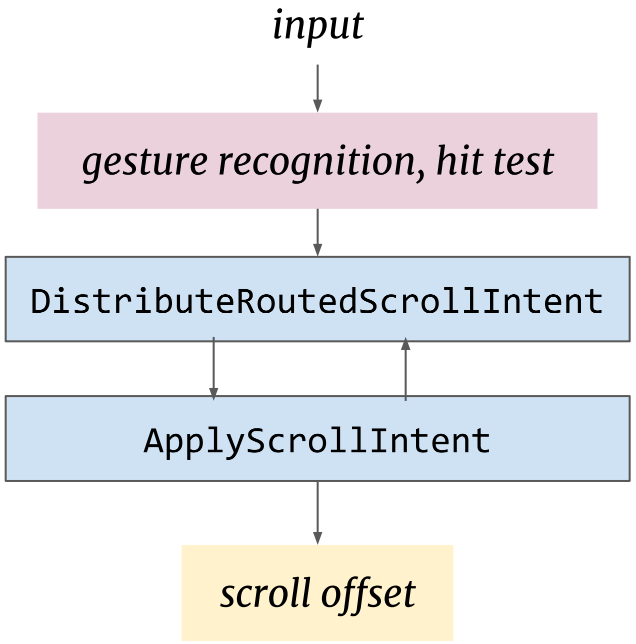
SCROLL CUSTOMIZATION

(in progress)

Proposal: primitives for rich scroll effects in JS.

- *arbitrary composition with native scrollers*
- *use with* ***CompositorWorker*** *for threaded scrolls*





The End

special thanks to technical reviewers:

rbyers, tdresser, bokan, majidvp, chrishtr

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