

One Number, Multiple Metrics

A Multidimensional Approach to Performance

Andrew Scheuermann / @a15n_

Who Am I?

- Management degree + bootcamp
- Senior Engineer at Airbnb
- Cook, read, board games





“ **Load is not a single moment in time** — it’s an experience that no one metric can fully capture. There are **multiple moments** during the load experience that can affect whether a user perceives it as ‘fast’ or ‘slow’.

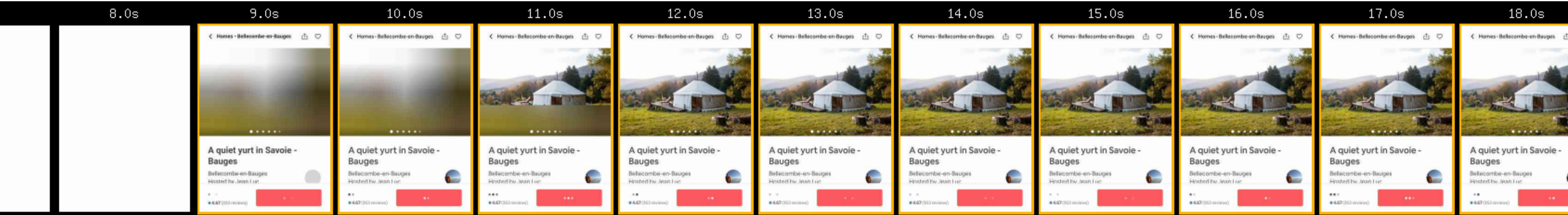
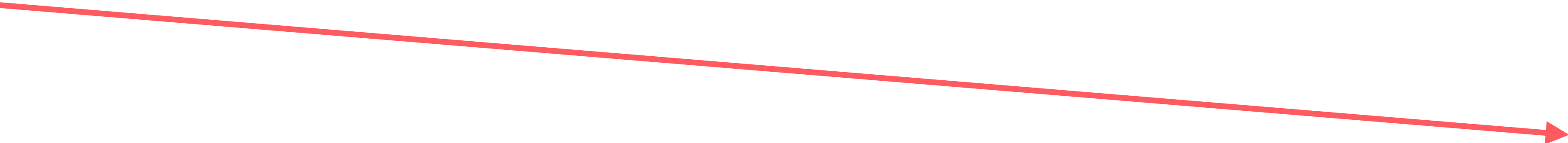
- developers.google.com





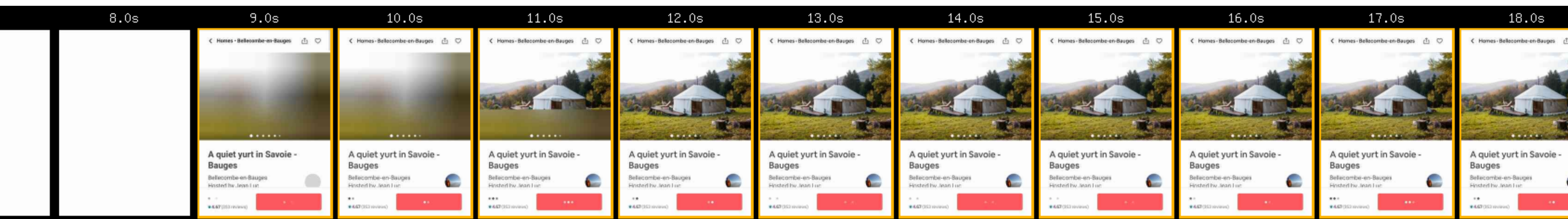
Time To Airbnb Interactive

Reached here



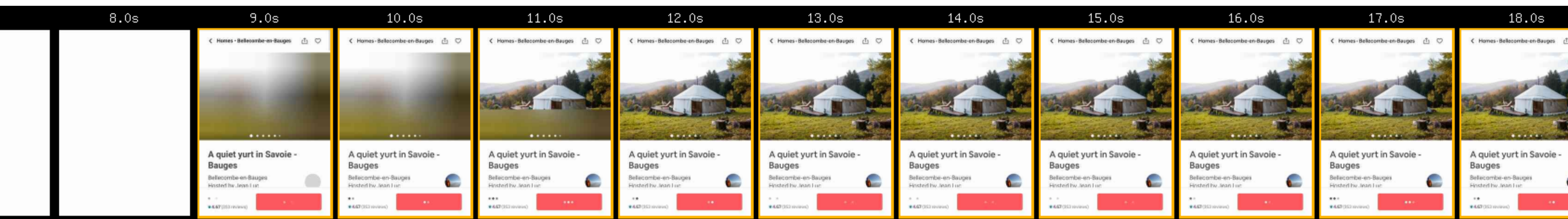
Time To Airbnb Interactive

Reached here



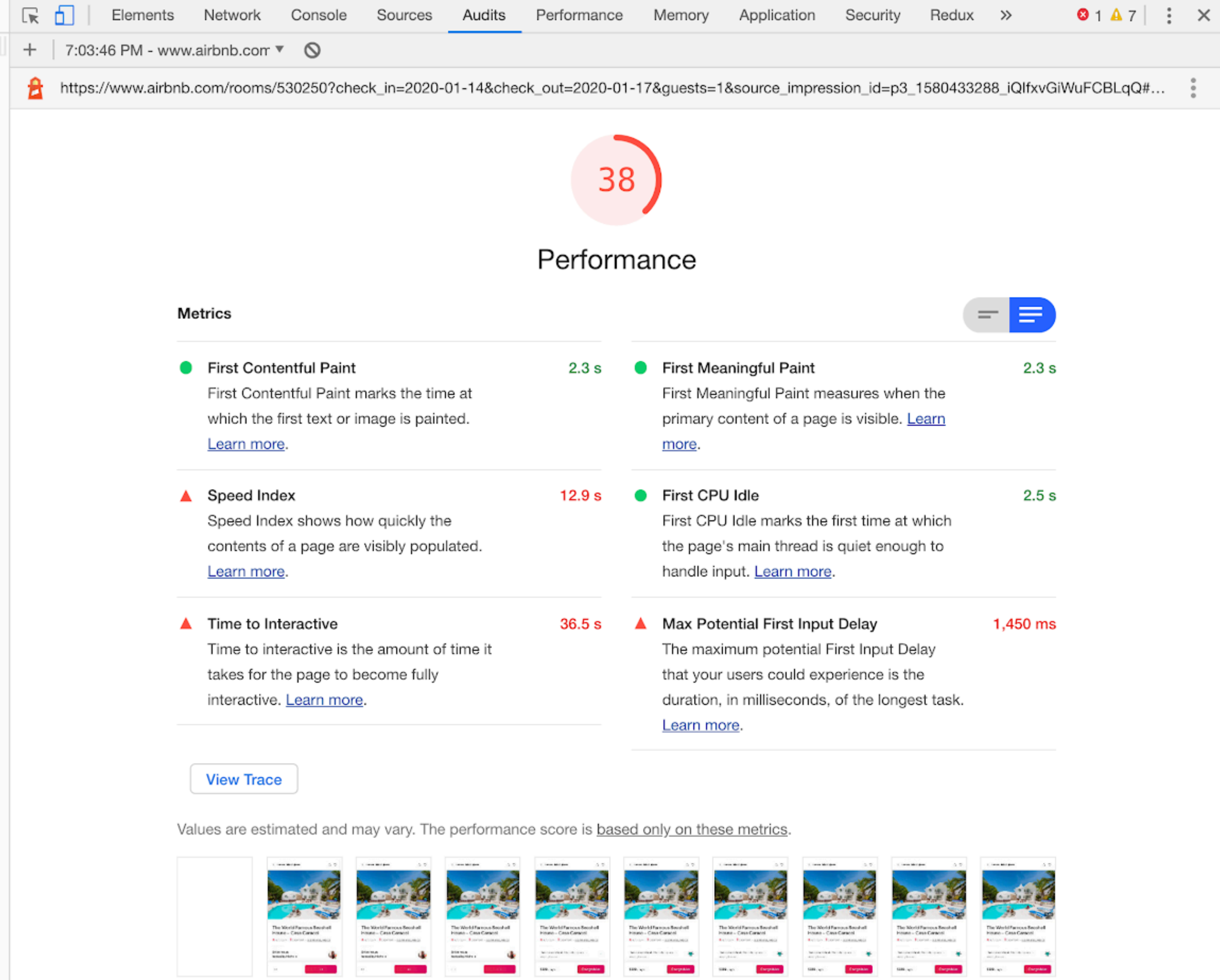
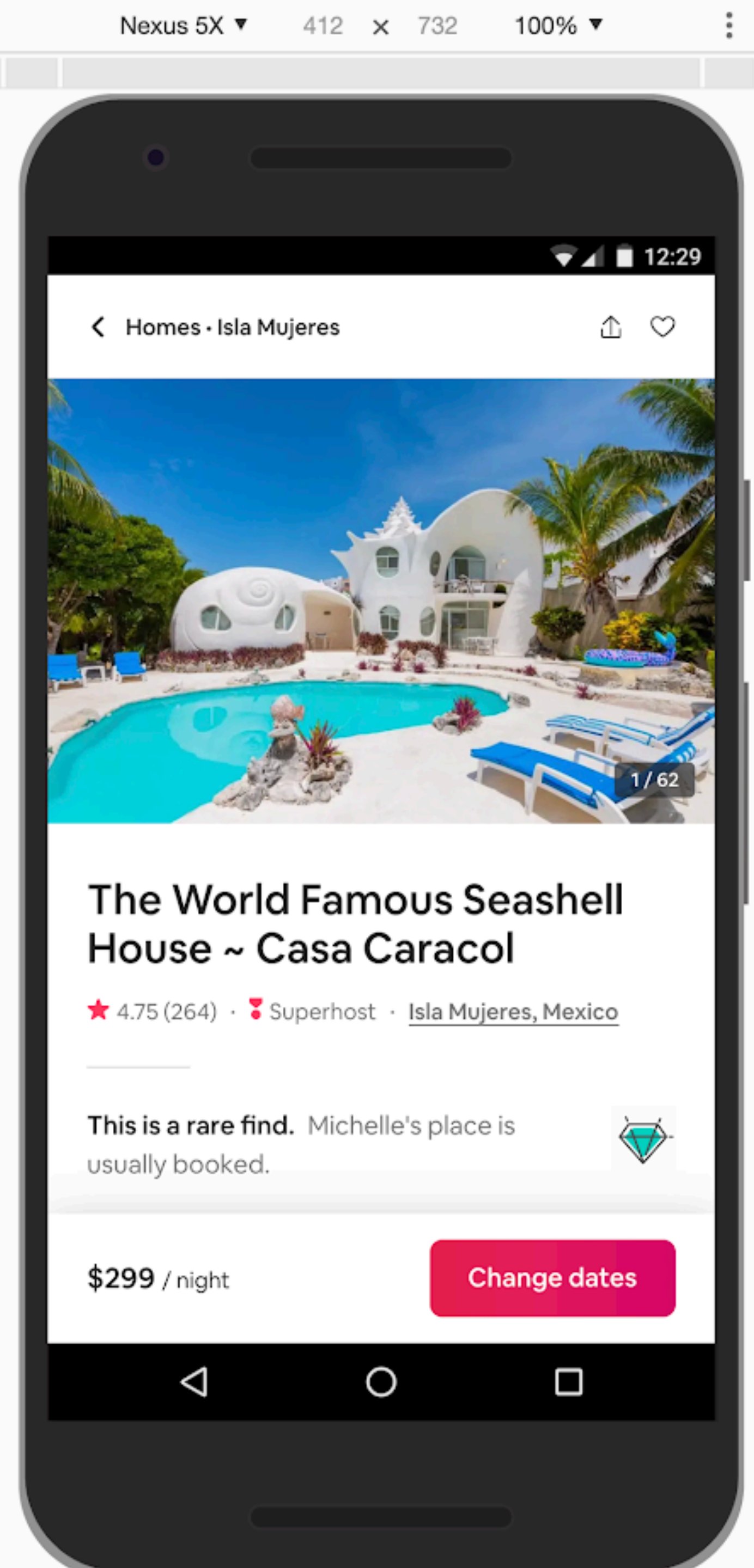
Time To Airbnb Interactive

Reached here



Ignored



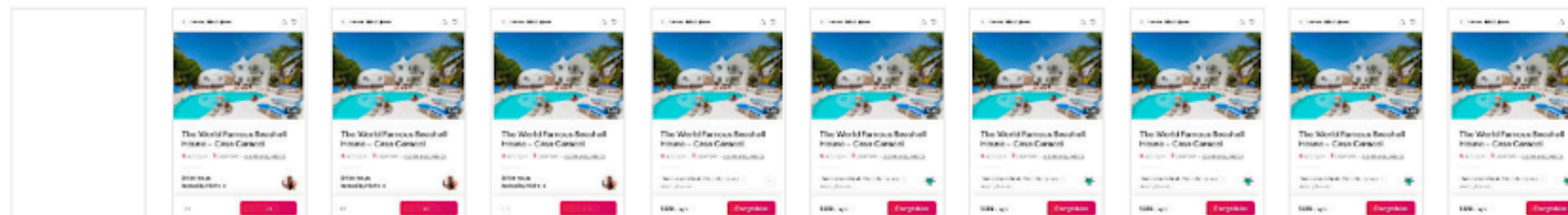


Metrics

● First Contentful Paint First Contentful Paint marks the time at which the first text or image is painted. Learn more.	2.3 s	● First Meaningful Paint First Meaningful Paint measures when the primary content of a page is visible. Learn more.	2.3 s
▲ Speed Index Speed Index shows how quickly the contents of a page are visibly populated. Learn more.	12.9 s	● First CPU Idle First CPU Idle marks the first time at which the page's main thread is quiet enough to handle input. Learn more.	2.5 s
▲ Time to Interactive Time to interactive is the amount of time it takes for the page to become fully interactive. Learn more.	36.5 s	▲ Max Potential First Input Delay The maximum potential First Input Delay that your users could experience is the duration, in milliseconds, of the longest task. Learn more.	1,450 ms

[View Trace](#)

Values are estimated and may vary. The performance score is based only on these metrics.





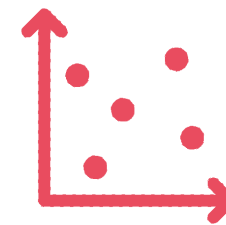
~Lighthouse, with real user data



New System Requirements



Real User Monitoring



**Measure Multiple
Moments**



Comprehensible



Metric Requirements

- User-centric
 - Is it happening?
 - Is it useful?
 - Is it usable?
 - Is it delightful?
- Comprehensive browser coverage
- Direct request + Client-side request

User-centric performance metrics

Nov 8, 2019

Appears in: [Metrics](#)



Philip Walton
[Twitter](#) · [GitHub](#)





**Time To First
Contentful Paint**



**Time To First
Meaningful Paint**



First Input Delay



Total Blocking Time

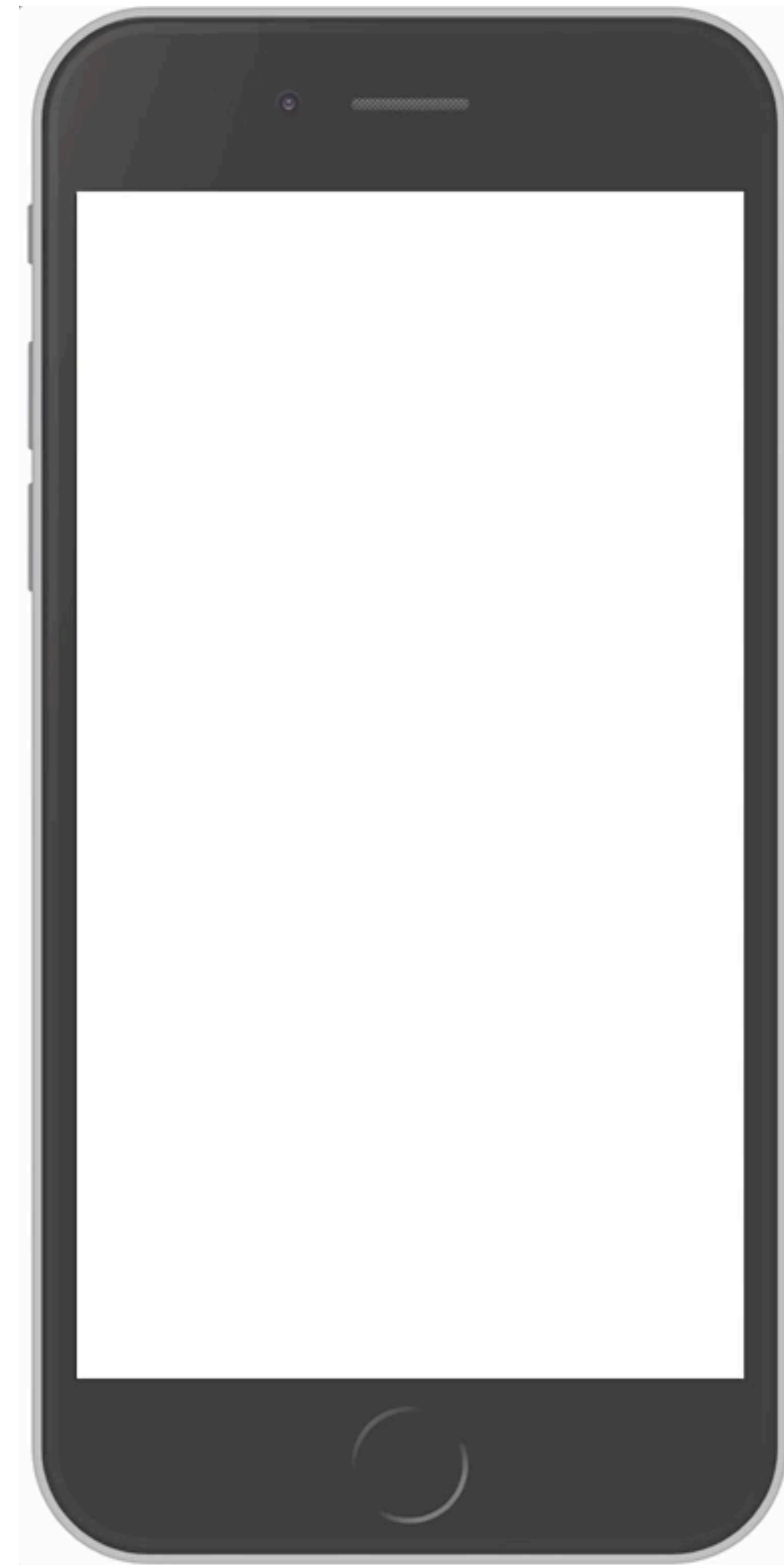


Metrics in Action



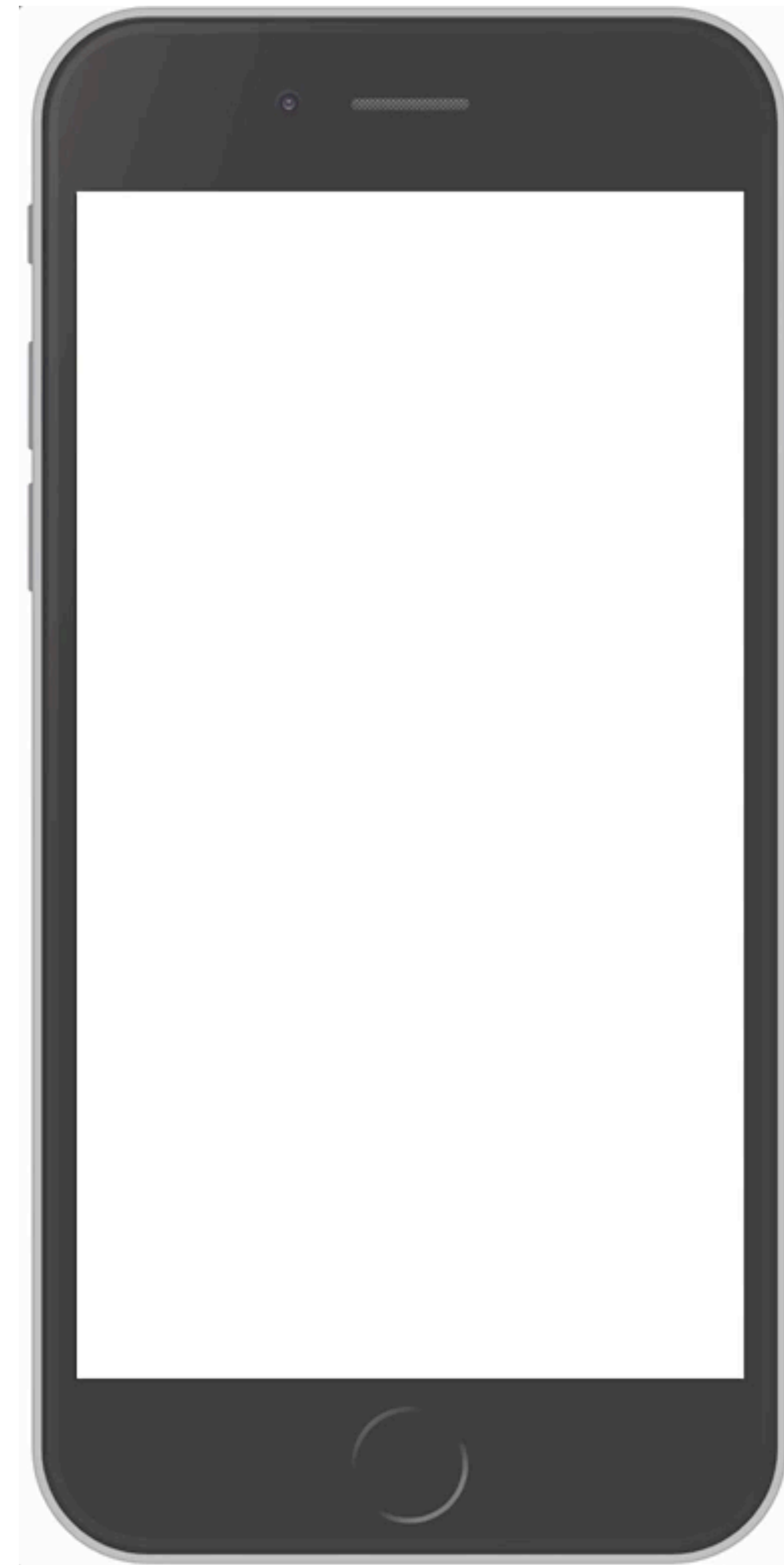
Time To First Contentful Paint

Is it happening?



Time To First Meaningful Paint

Is it useful?



Time To First Meaningful Paint

Is it useful?

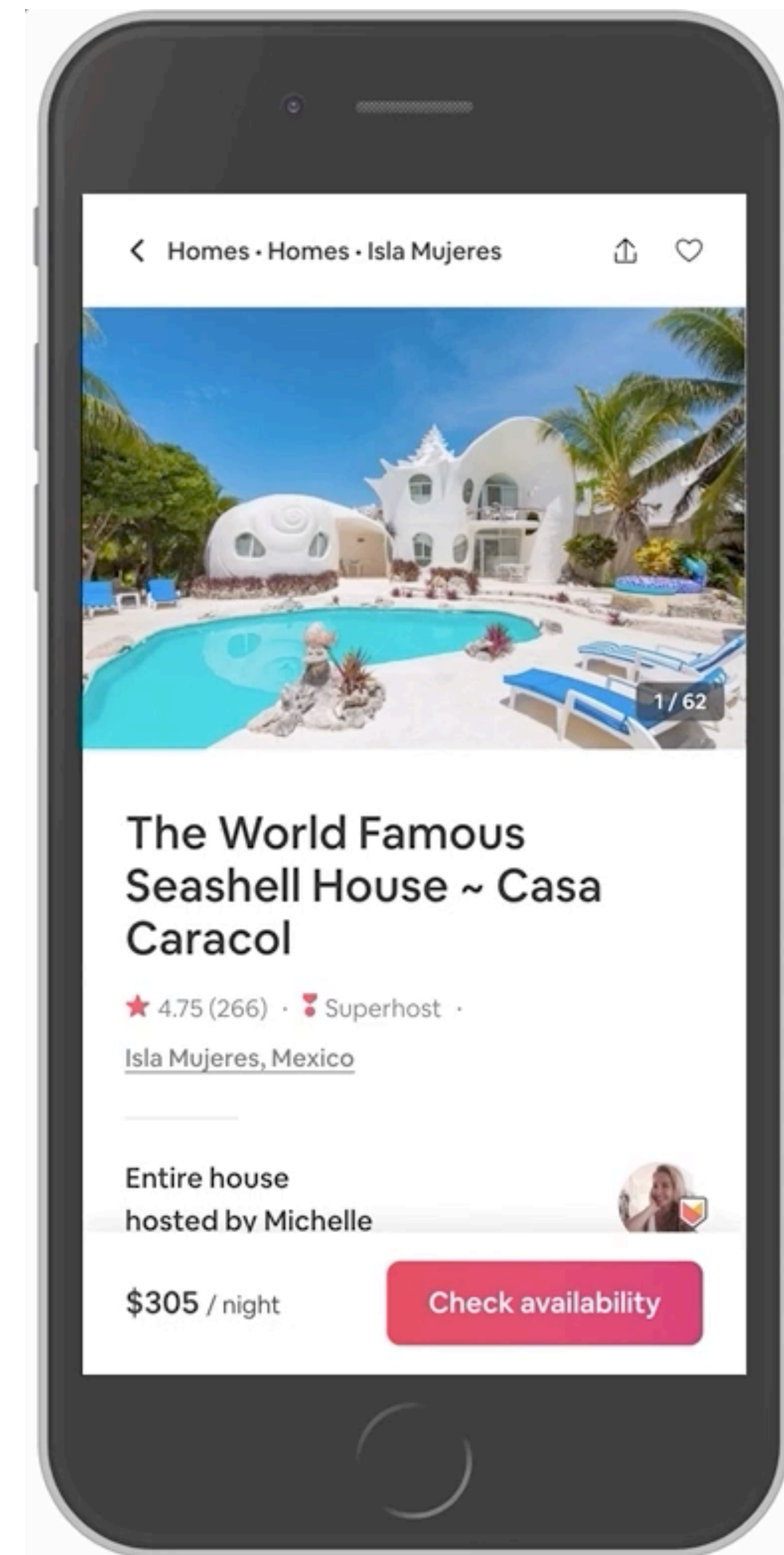


```
// setup  
<image src={src} alt={alt} id="FMP-target" />
```



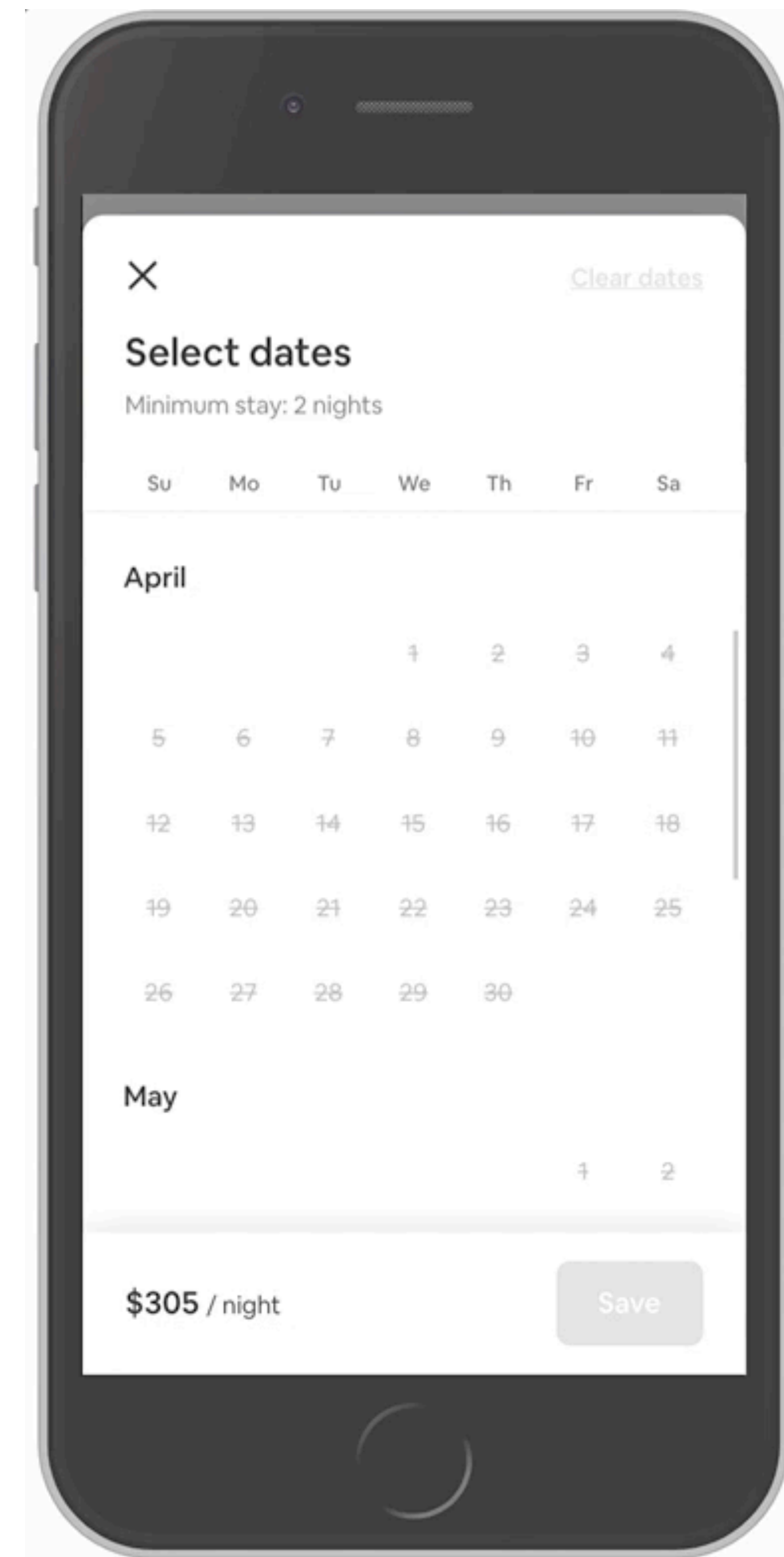
First Input Delay 📱

Is it usable?



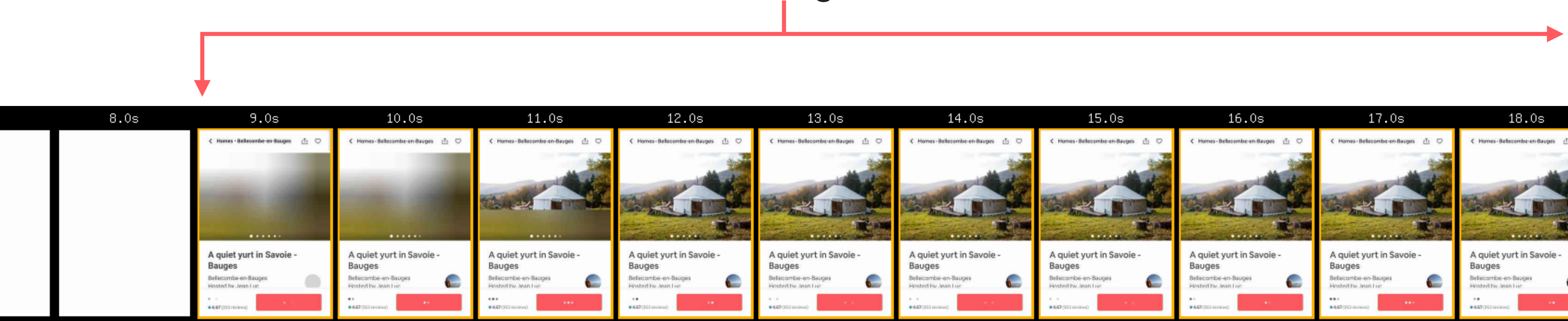
Total Blocking Time

Is it delightful?



Multiple Metrics

Total Blocking Time 🕒

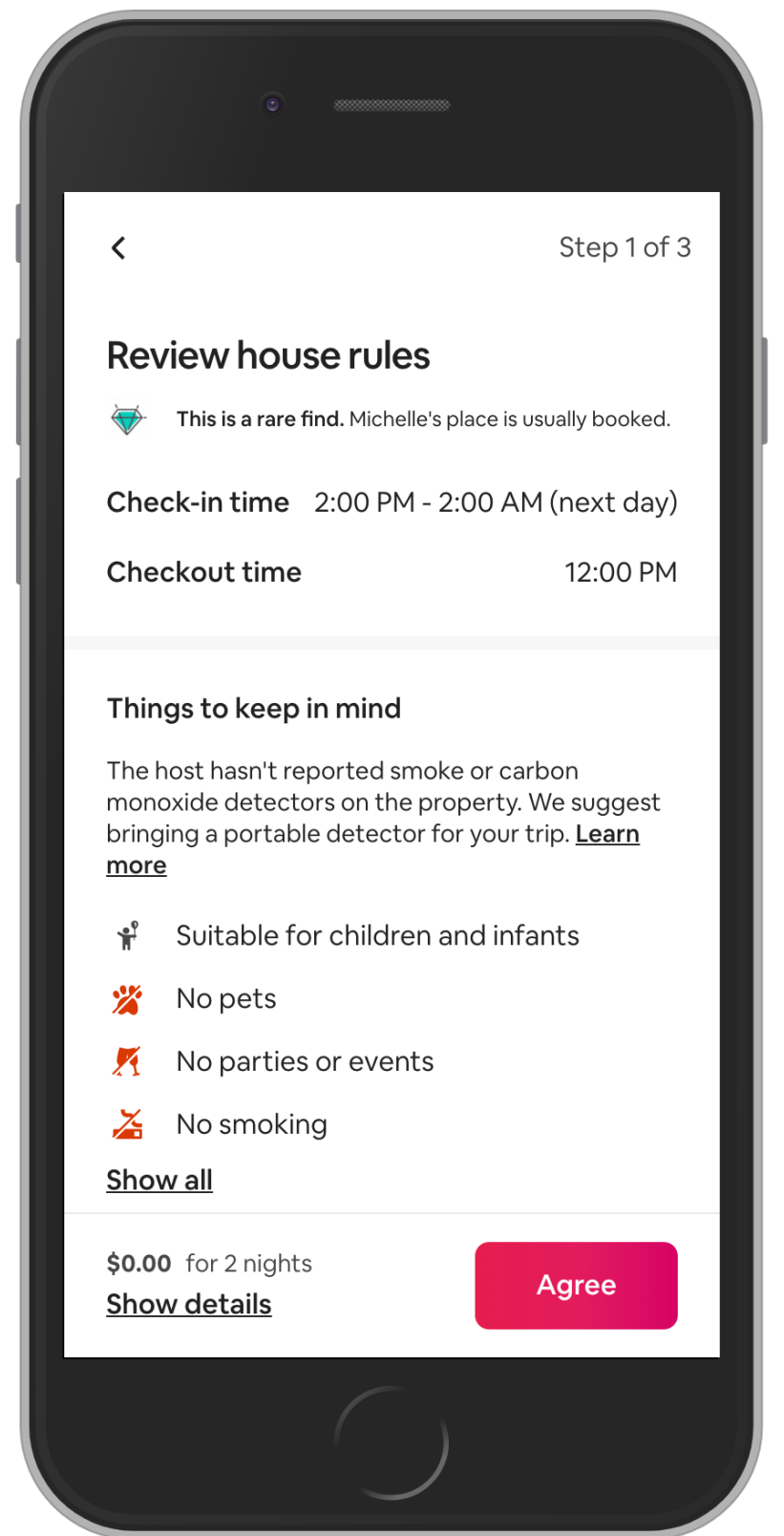
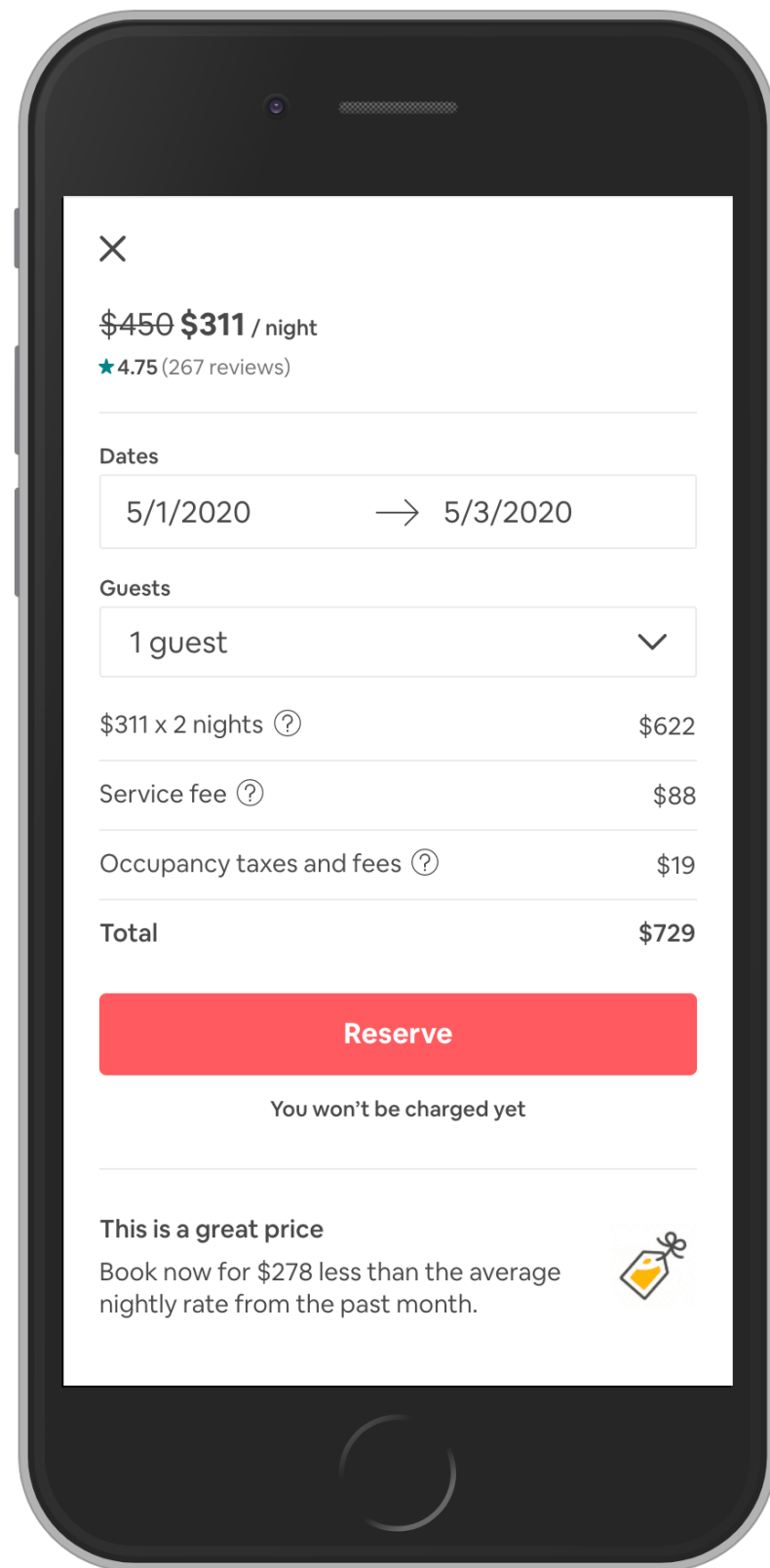
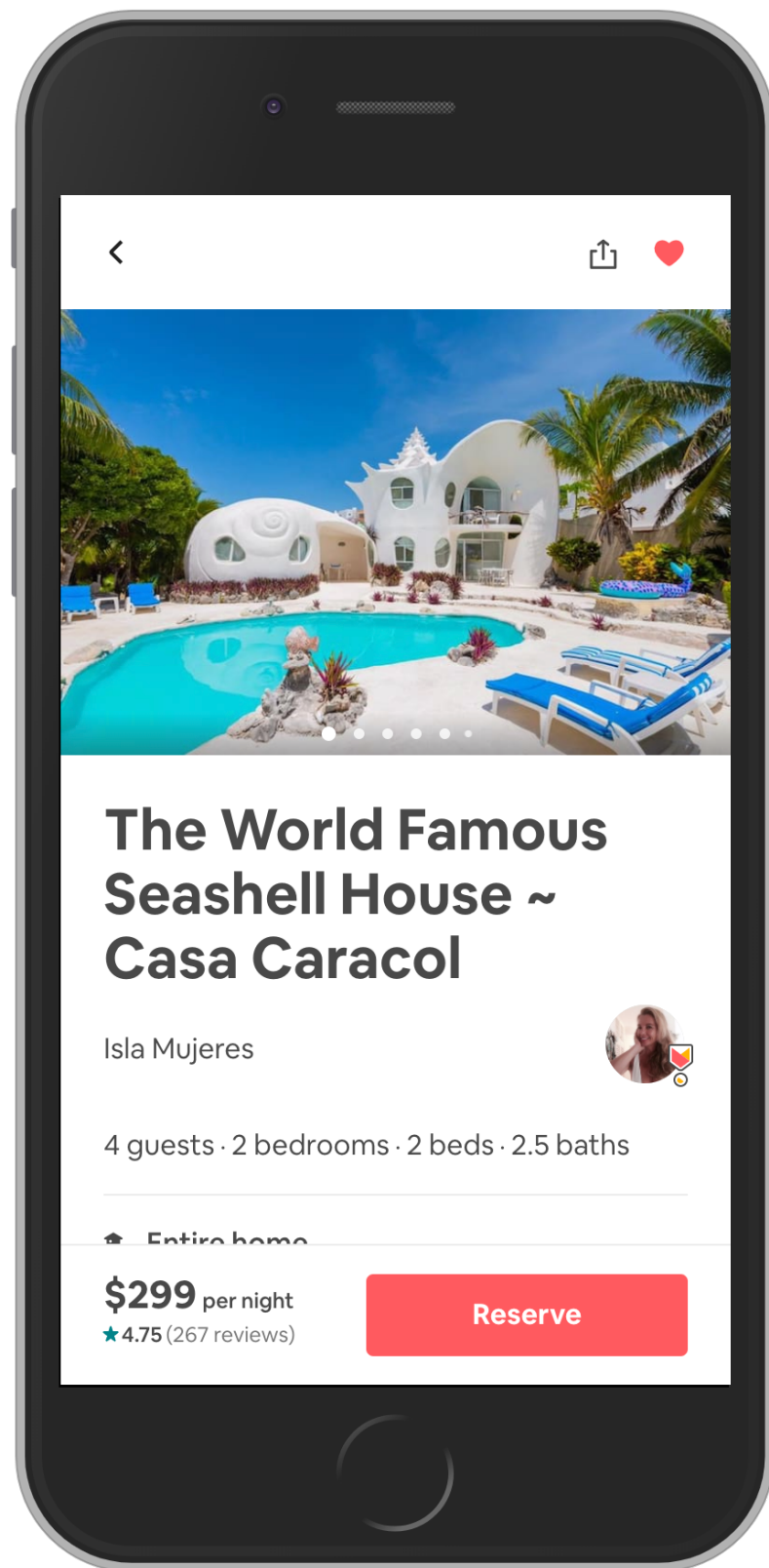
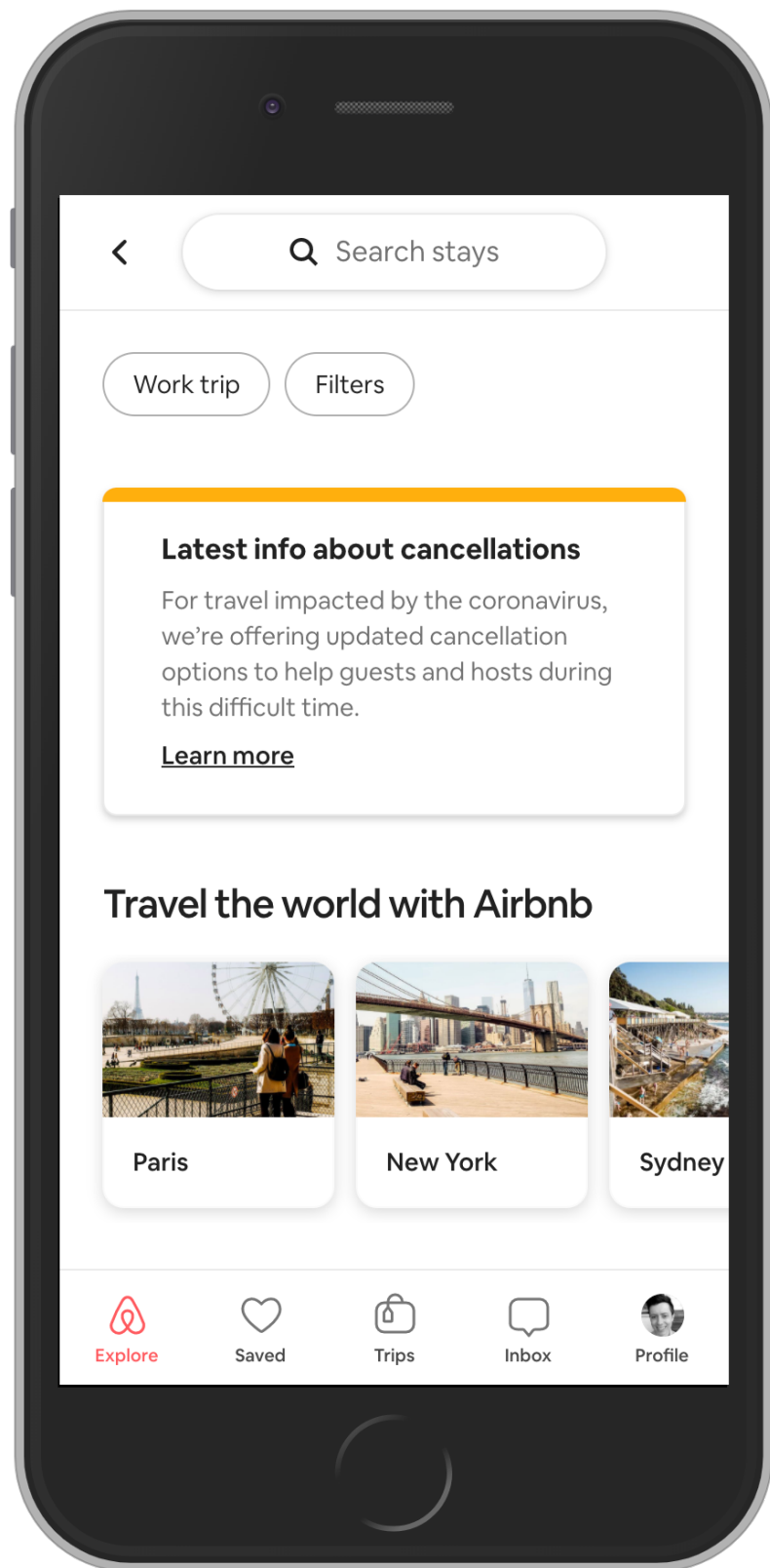
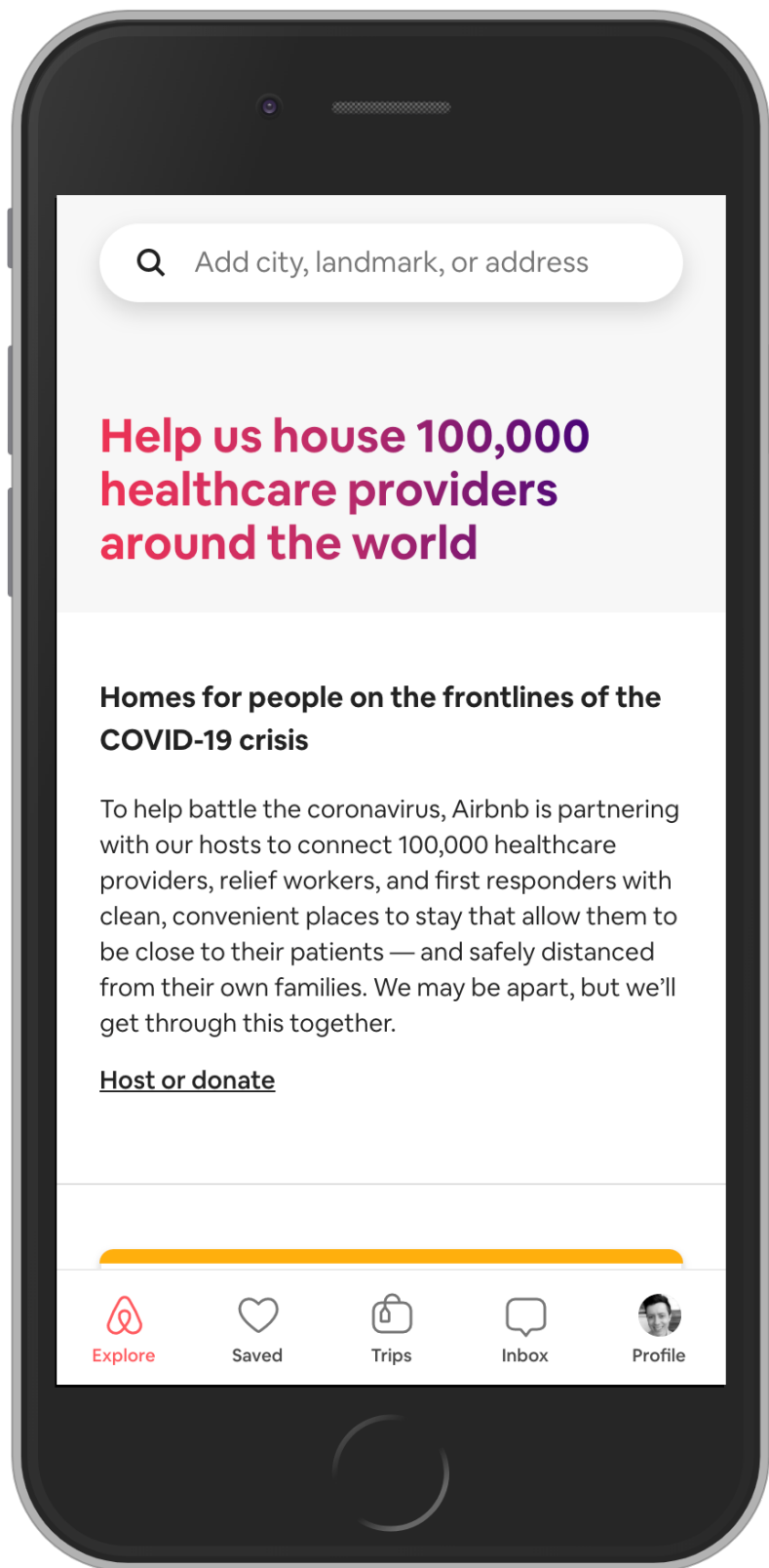


Time To First Meaningful Paint 🖼️

Time To First Contentful Paint 🖋️

First Input Delay 🖱️





airbnb.com?pps=log

Page Performance Score metrics (air/page-performance-score)

Pathname = **/experiences/47240**

Time To First Contentful Paint = 1,973 ms

Time To First Meaningful Paint = 2,370 ms

First Input Delay = 13 ms

Total Blocking Time = (see air/pps-tbt)




```
1 <doctype html>
2 <html data-is-hyperloop="true" lang="en" dir="ltr" xmlns:fb="http://ogp.me/ns/fb#"><head><script>window.sherlock_firstbyte = window.performance && window.performance.timing ?
window.performance.timing.responseStart : Number(new Date());</script><script>!function(){ "use strict"; var e=730,n="ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz0123456789+/" ; var t=/(?:^| )bev=(.*)?
(?:;|$)/,o=!1;function a(){return window.bev=window.bev||function(){if(o||"undefined"==typeof document)return null;o=!0;var e=(document.cookie||"").match(t);return e&&2==e.length?decodeURIComponent(e[1]):null}
(),window.bev)!function(){try{if(!a()){var t=function(){for(var e=[],t=15;t>=0;t--)e.push(n[Math.floor(Math.random()*n.length)]);var o=Math.floor(Date.now()/1e3);return"".concat(o,"_").concat(e.join(""))}
();o=t,r=document.location.hostname,c=".".concat(r.slice(r.indexOf("airbnb."))), (i=new Date).setDate(i.getDate()+e),document.cookie=
["bev=" .concat(encodeURIComponent(o)), "expires=" .concat(i.toUTCString()), "path="/" , "domain=" .concat(c), "secure"].join("; " ),window.bev=t,function(e){var n=new
XMLHttpRequest;n.open("POST", "/tracking/events",!0),n.setRequestHeader("Content-Type","application/json; charset=utf-8");var t={event_name:"bev_created",event_data:
{bev:e,page_uri:document.location.pathname,page_referrer:document.referrer}};n.send(JSON.stringify(t))}(t)}}catch(e){window.console&&console.error("Could not set bev cookie:",e)}var o,r,c,i}(){});
3 </script><script>(function(){
4     var pgRequest = new XMLHttpRequest();
5     var diffStamp = Date.now().toString() + Math.random().toString().substring(2);
6     pgRequest.open('GET', '/pg_pixel?r=' + encodeURIComponent(document.referrer || '') + '&diff=' + diffStamp, true);
7     pgRequest.send();
8 })()</script><script>
9 !function(n){var t,r;n(function e(){document.body&&null!=document.createTextNodeIterator(document.body,NodeFilter.SHOW_TEXT,function(e)
{return!!e&&/[^\s]/.test(e.nodeValue)&&"SCRIPT"!=e.parentNode.tagName&&"STYLE"!=e.parentNode.tagName&&0<e.parentNode.offsetHeight,!1).nextNode()||null!=document.querySelector("input[placeholder]")?
n(function(){var e=performance.now();t?t(e):r=e}):n(e)}),self.perfMetrics=self.perfMetrics||{},self.perfMetrics.onFirstContentfulPaint=function(e){r?t(e):t=e})(requestAnimationFrame),function(){var
t,r,i,o,a="FMP-target";function c(){var e=document.getElementById(a);if(o=0,e)if(i===e)t=requestAnimationFrame(c);else if("IMG"===e.tagName||e.complete){var n=performance.now();i=e,r?t(n):o=n}else
t=requestAnimationFrame(c);else t=requestAnimationFrame(c)}t=requestAnimationFrame(c),self.perfMetrics=self.perfMetrics||{},self.perfMetrics.onFirstMeaningfulPaint=function(e){o?
e(o):r=e},self.perfMetrics.startSearchingForFirstMeaningfulPaint=c,self.perfMetrics.stopSearchingForFirstMeaningfulPaint=function(){cancelAnimationFrame(t)})(requestAnimationFrame),function(c,f){var t,r,i,n,o=
[],s={passive:!0,capture:!0},e=new Date,u="pointerup",l="pointercancel";function p(e,n){t||(t=n,r=e,i=new Date,a())}function a(){0<=r&&r<i-e&&(o.forEach(function(e){e(r,t)}),o=[])}function m(e){if(e.cancelable)
{var n=(1e12<e.timeStamp?new Date:performance.now())-e.timeStamp;"pointerdown"===e.type?(o=n,a=e,c(u,t,s),c(l,r,s)):p(n,e)}function t(){p(o,a),i()}function r(){i()}function i(){f(u,t,s),f(l,r,s)}var o,a;n=c,
["click","mousedown","keydown","touchstart","pointerdown"].forEach(function(e){n(e,m,s)}),self.perfMetrics=self.perfMetrics||{},self.perfMetrics.onFirstInputDelay=function(e)
{o.push(e),a()},self.perfMetrics.clearFirstInputDelay=function(){t&&(i=r=t=null)}}(addEventListener,removeEventListener);
10 </script><meta charset="utf-8"/><meta name="locale" content="en"/><meta name="google" content="notranslate"/><link crossorigin="anonymous" href="https://a0.muscache.com/airbnb/static/packages/common-
a9dbf5a01e2f51f25c32a0127755abf7.css" rel="stylesheet" type="text/css" media="all"/><link href="https://a0.muscache.com/airbnb/static/packages/map_search-05b2e8d7a5602d7f9224bf29250fcd41.css" rel="stylesheet"
type="text/css" media="all"/><link href="https://a0.muscache.com/airbnb/static/packages/dls/dls-lite_cereal-d9f6fdb2a0dd4a18c37f8ee01de8ec3d.css" rel="stylesheet" type="text/css" media="all"/><link
href="https://a0.muscache.com/airbnb/static/packages/dls/dls-lite_o2-leftover-3644a5fa97a2e311cd1cd1dab8abaf5f.css" rel="stylesheet" type="text/css" media="all"/><meta property="fb:app_id"
content="138566025676"/><meta property="og:site_name" content="Airbnb"/><meta property="og:locale" content="en_US"/><meta property="og:url" content="https://hyperloop.localhost.airbnb.com/"><meta
property="og:title" content="Vacation Rentals, Homes, Experiences & Places - Airbnb"/><meta property="og:description" content="Unforgettable trips start with Airbnb. Find adventures nearby or in faraway
places and access unique homes, experiences, and places around the world."/><meta property="og:type" content="website"/><link rel="alternate" href="android-app://com.airbnb.android/airbnb/home"/><script
type="application/ld+json">{"@context":"http://schema.org","@type":"WebSite","url":"https://hyperloop.localhost.airbnb.com/","potentialAction":
{"@type":"SearchAction","target":"https://hyperloop.localhost.airbnb.com/s/all?query={search_term_string}","query-input":"required name=search_term_string"}}</script><meta name="description"
content="Unforgettable trips start with Airbnb. Find adventures nearby or in faraway places and access unique homes, experiences, and places around the world."/><meta property="og:image"
content="https://a0.muscache.com/airbnb/static/logos/trips-og-1280x630-9de9c338cc3fd9b5663fb80be0cbe8c2.jpg"/><meta name="viewport" content="width=device-width, initial-scale=1"/><link rel="image_src"
href="https://a0.muscache.com/airbnb/static/logos/trips-og-200x200-a3be4fbbb3b6c5e758804438dea35adc.jpg"/><meta id="csrf-param-meta-tag" name="csrf-param" content="authenticity_token"/><meta id="csrf-token-
meta-tag" name="csrf-token" content=""><title>[dev] Vacation Rentals, Homes, Experiences & Places - Airbnb</title><meta http-equiv="X-UA-Compatible" content="IE=edge,chrome=1"/><meta id="english-canonical-
url" content=""><meta name="twitter:widgets:csp" content="on"/><link rel="canonical" href="https://hyperloop.localhost.airbnb.com/"><link rel="alternate" hrefLang="en" href="https://www.airbnb.com/"><link
rel="alternate" hrefLang="de" href="https://www.airbnb.de/"><link rel="alternate" hrefLang="it" href="https://www.airbnb.it/"><link rel="alternate" hrefLang="es-ES" href="https://www.airbnb.es/"><link
rel="alternate" hrefLang="fr" href="https://www.airbnb.fr/"><link rel="alternate" hrefLang="pt" href="https://www.airbnb.com.br/"><link rel="alternate" hrefLang="da" href="https://www.airbnb.dk/"><link
rel="alternate" hrefLang="en-GB" href="https://www.airbnb.co.uk/"><link rel="alternate" hrefLang="ru" href="https://www.airbnb.ru/"><link rel="alternate" hrefLang="pl" href="https://www.airbnb.pl/"><link
rel="alternate" hrefLang="ko" href="https://www.airbnb.co.kr/"><link rel="alternate" hrefLang="cs" href="https://www.airbnb.cz/"><link rel="alternate" hrefLang="hu" href="https://www.airbnb.hu/"><link
rel="alternate" hrefLang="de-AT" href="https://www.airbnb.at/"><link rel="alternate" hrefLang="pt-PT" href="https://www.airbnb.pt/"><link rel="alternate" hrefLang="el" href="https://www.airbnb.gr/"><link
rel="alternate" hrefLang="tr" href="https://www.airbnb.com.tr/"><link rel="alternate" hrefLang="nl" href="https://www.airbnb.nl/"><link rel="alternate" hrefLang="sv" href="https://www.airbnb.se/"><link
rel="alternate" hrefLang="zh-TW" href="https://www.airbnb.com.tw/"><link rel="alternate" hrefLang="zh-HK" href="https://www.airbnb.com.hk/"><link rel="alternate" hrefLang="en-SG"
href="https://www.airbnb.com.sg/"><link rel="alternate" hrefLang="id" href="https://www.airbnb.co.id/"><link rel="alternate" hrefLang="ms" href="https://www.airbnb.com.my/"><link rel="alternate"
hrefLang="en-AU" href="https://www.airbnb.com.au/"><link rel="alternate" hrefLang="ja" href="https://www.airbnb.jp/"><link rel="alternate" hrefLang="is" href="https://www.airbnb.is/"><link rel="alternate"
hrefLang="no" href="https://www.airbnb.no/"><link rel="alternate" hrefLang="de-CH" href="https://www.airbnb.ch/"><link rel="alternate" hrefLang="fr-CH" href="https://fr.airbnb.ch/"><link rel="alternate"
hrefLang="it-CH" href="https://it.airbnb.ch/"><link rel="alternate" hrefLang="en-NZ" href="https://www.airbnb.co.nz/"><link rel="alternate" hrefLang="en-CA" href="https://www.airbnb.ca/"><link
rel="alternate" hrefLang="fr-CA" href="https://fr.airbnb.ca/"><link rel="alternate" hrefLang="nl-BE" href="https://www.airbnb.be/"><link rel="alternate" hrefLang="fr-BE" href="https://fr.airbnb.be/"><link
rel="alternate" hrefLang="fi" href="https://www.airbnb.fi/"><link rel="alternate" hrefLang="en-IE" href="https://www.airbnb.ie/"><link rel="alternate" hrefLang="ga-IE" href="https://ga.airbnb.ie/"><link
rel="alternate" hrefLang="ca" href="https://www.airbnb.cat/"><link rel="alternate" hrefLang="en-IN" href="https://www.airbnb.co.in/"><link rel="alternate" hrefLang="hi-IN" href="https://hi.airbnb.co.in/">
<link rel="alternate" hrefLang="es-MX" href="https://www.airbnb.mx/"><link rel="alternate" hrefLang="es-CL" href="https://www.airbnb.cl/"><link rel="alternate" hrefLang="es-CR"
href="https://www.airbnb.co.cr/"><link rel="alternate" hrefLang="es-VE" href="https://www.airbnb.co.ve/"><link rel="alternate" hrefLang="es-AR" href="https://www.airbnb.com.ar/"><link rel="alternate"
hrefLang="es-BO" href="https://www.airbnb.com.bo/"><link rel="alternate" hrefLang="es-BZ" href="https://www.airbnb.com.bz/"><link rel="alternate" hrefLang="es-CO" href="https://www.airbnb.com.co/"><link
rel="alternate" hrefLang="es-EC" href="https://www.airbnb.com.ec/"><link rel="alternate" hrefLang="es-GT" href="https://www.airbnb.com.gt/"><link rel="alternate" hrefLang="es-HN"
href="https://www.airbnb.com.hn/"><link rel="alternate" hrefLang="es-NI" href="https://www.airbnb.com.ni/"><link rel="alternate" hrefLang="es-PA" href="https://www.airbnb.com.pa/"><link rel="alternate"
hrefLang="es-PE" href="https://www.airbnb.com.pe/"><link rel="alternate" hrefLang="es-PY" href="https://www.airbnb.com.py/"><link rel="alternate" hrefLang="es-SV" href="https://www.airbnb.com.sv/"><link
rel="alternate" hrefLang="en-MT" href="https://www.airbnb.com.mt/"><link rel="alternate" hrefLang="mt-MT" href="https://mt.airbnb.com.mt/"><link rel="alternate" hrefLang="en-GY"
href="https://www.airbnb.gy/"><link rel="alternate" hrefLang="en-AE" href="https://www.airbnb.ae/"><link rel="alternate" hrefLang="tl" href="https://www.airbnb.com.ph/"><link rel="alternate" hrefLang="vi"
href="https://www.airbnb.com.vn/"><link rel="alternate" hrefLang="en-ZA" href="https://www.airbnb.co.za/"><link rel="alternate" hrefLang="xh-ZA" href="https://xh.airbnb.co.za/"><link rel="alternate"
hrefLang="zu-ZA" href="https://zu.airbnb.co.za/"><link rel="alternate" hrefLang="uk" href="https://www.airbnb.com.ua/"><link rel="alternate" hrefLang="en" href="https://airbnbeventspaces.com/"><link
```

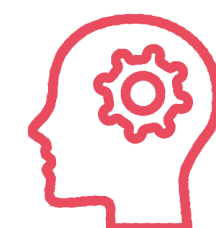

New System Requirements



Real User Monitoring



Measure Multiple Moments



Comprehensible



One Number



“ That which is measured improves.
That which is measured **and**
reported improves exponentially.

Karl Pearson





**Time To First
Contentful Paint**



**Time To First
Meaningful Paint**

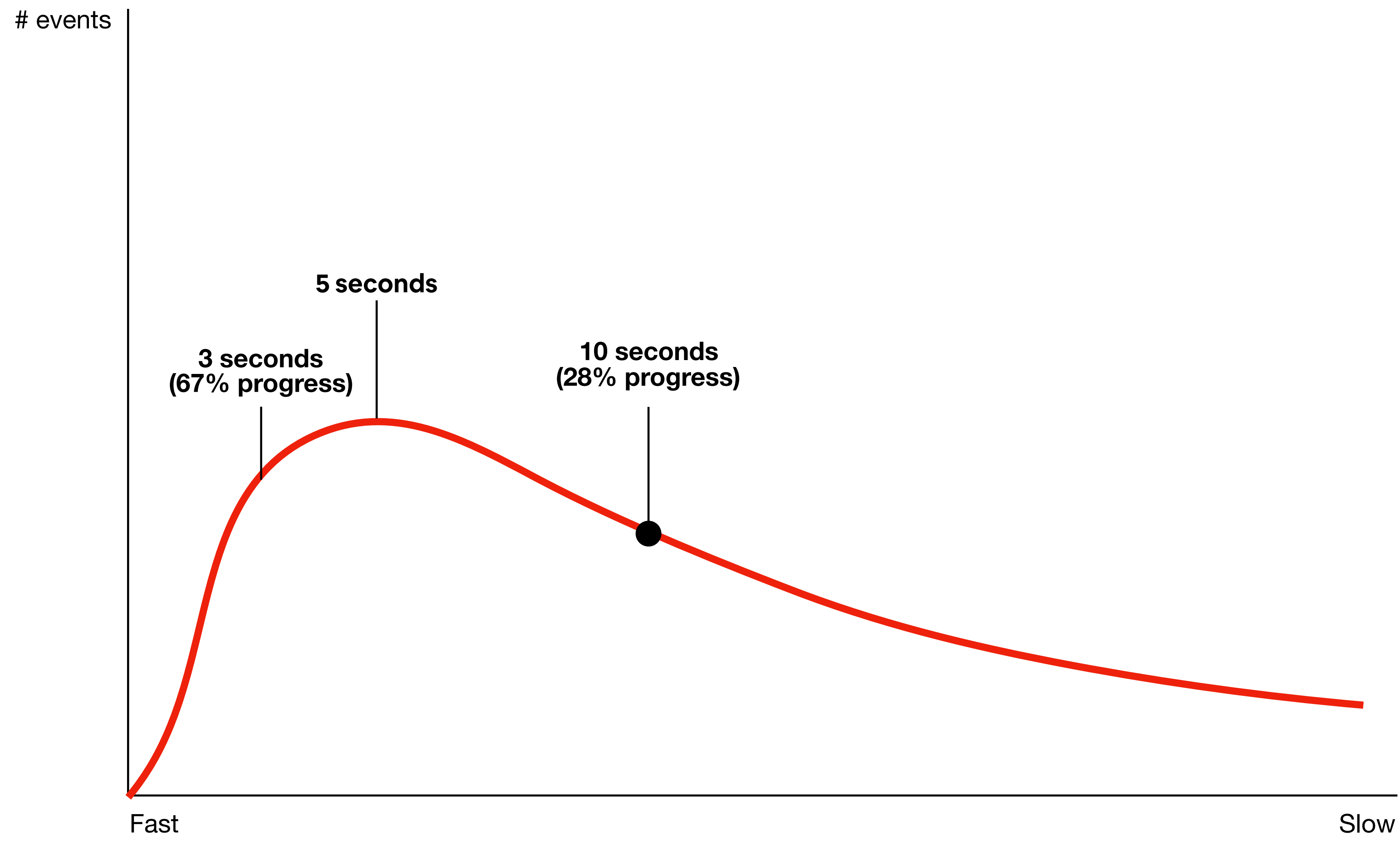


First Input Delay

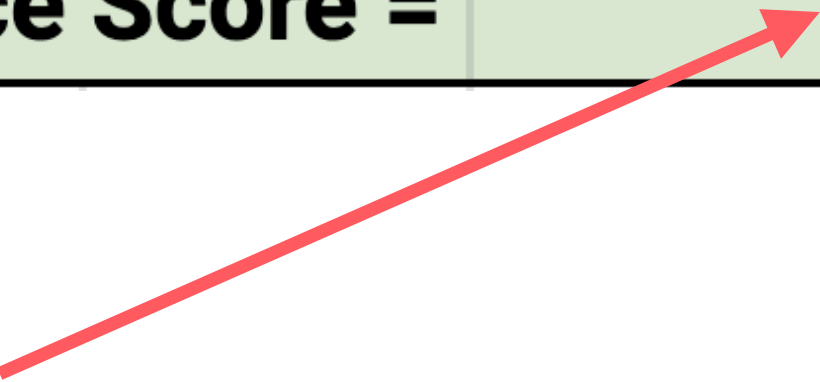


Total Blocking Time





Metric	P95 Value (ms)	Median	Falloff	Score	Weight	Contribution
Time To First Contentful Paint	5,000	5,000	150	50.0	35%	17.5
Time To First Meaningful Paint	8,000	8,000	150	50.0	15%	7.5
First Input Delay	200	200	50	50.0	35%	17.5
Total Blocking Time	7,000	7,000	150	50.0	15%	7.5
Page Performance Score =						50.0



New System Requirements



Real User Monitoring



Measure Multiple Moments



Comprehensible

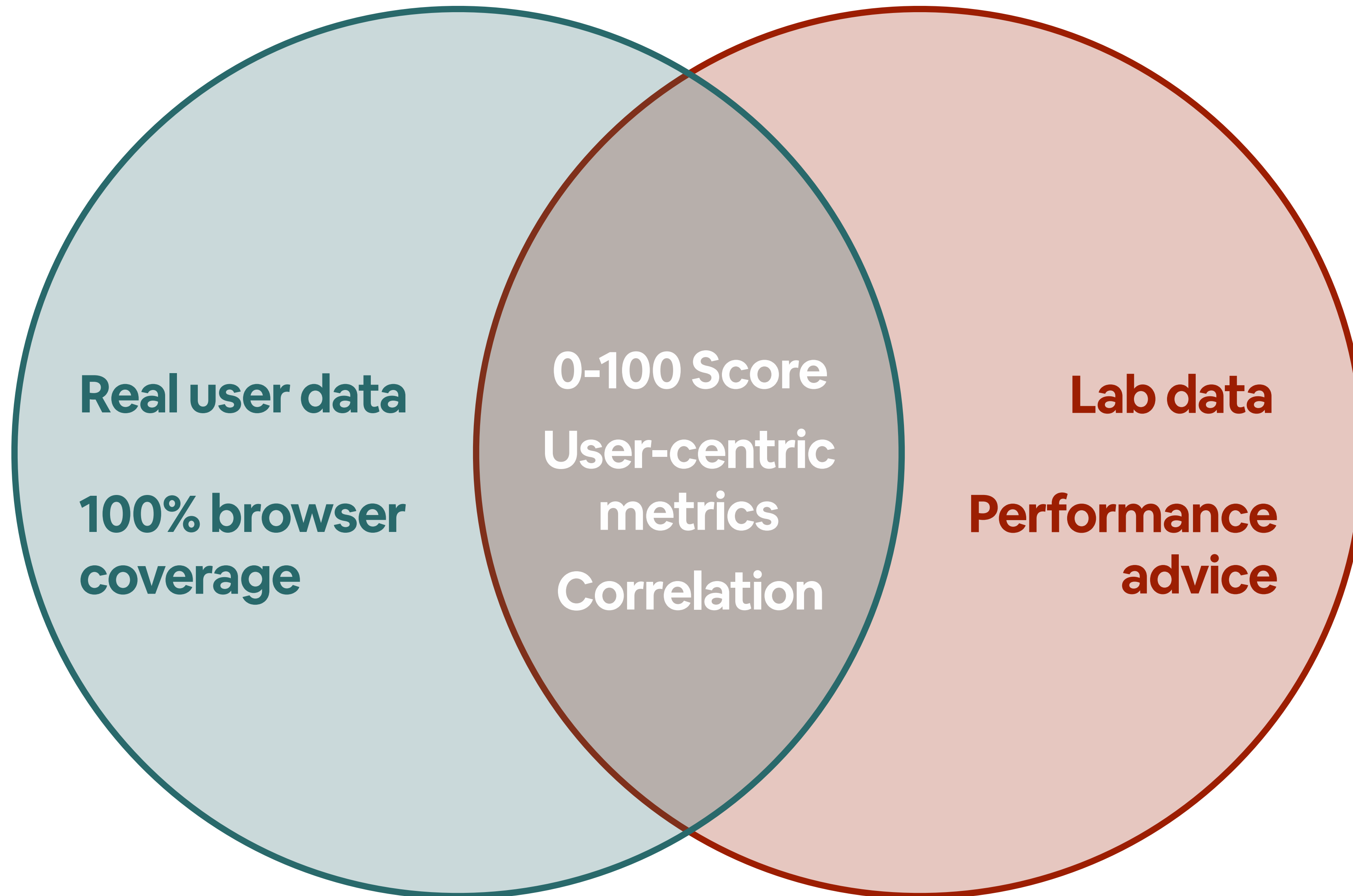


Page Performance Score



PPS

Lighthouse



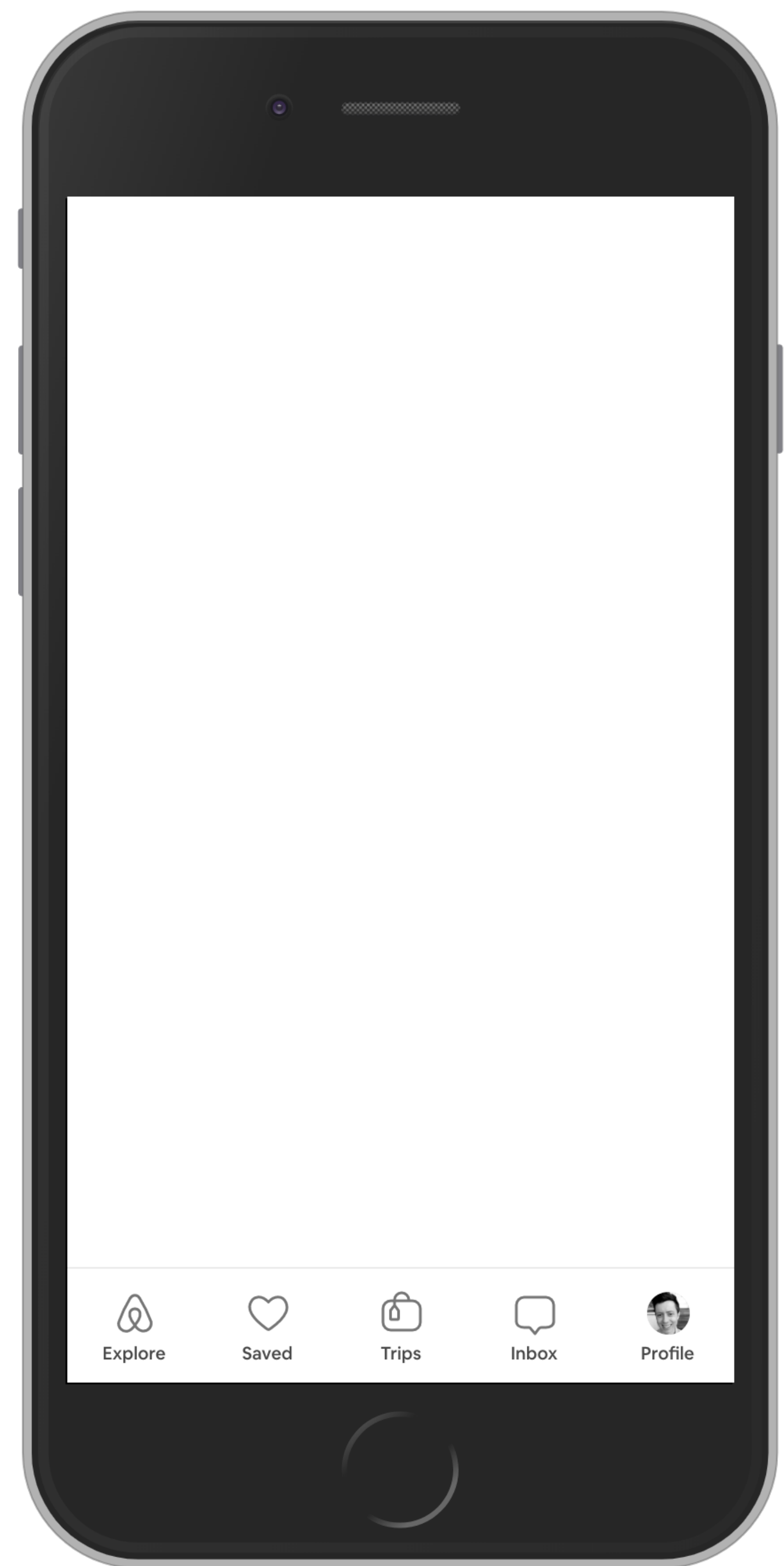
Case Studies



Service Worker



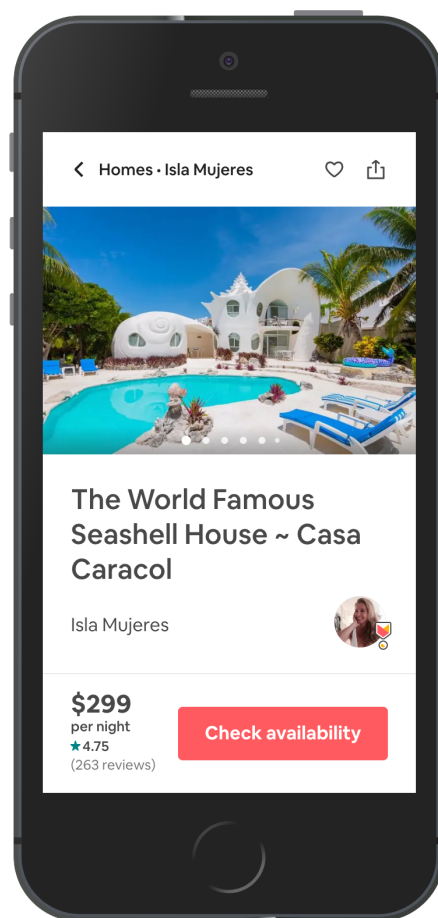
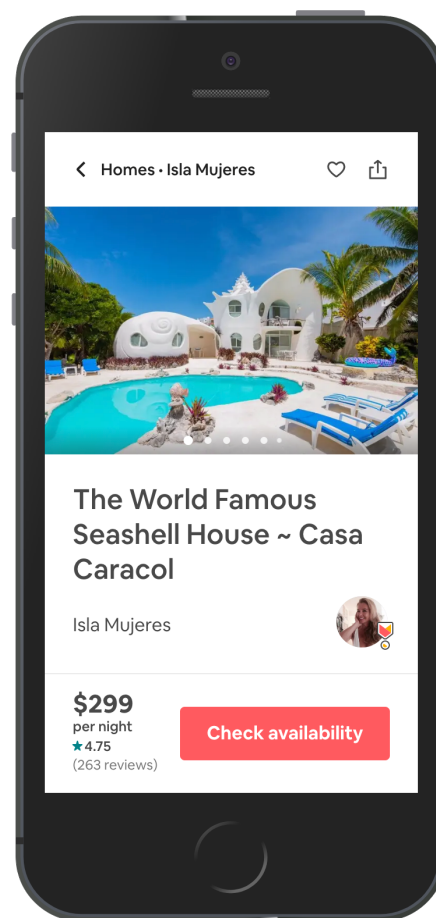
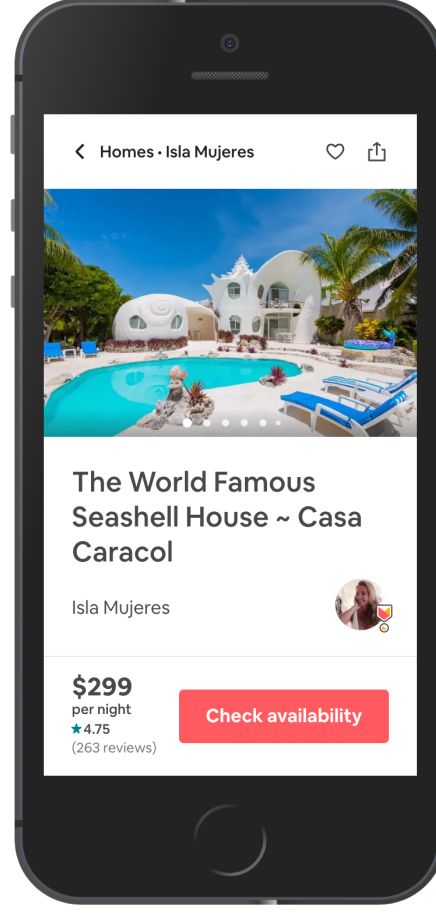
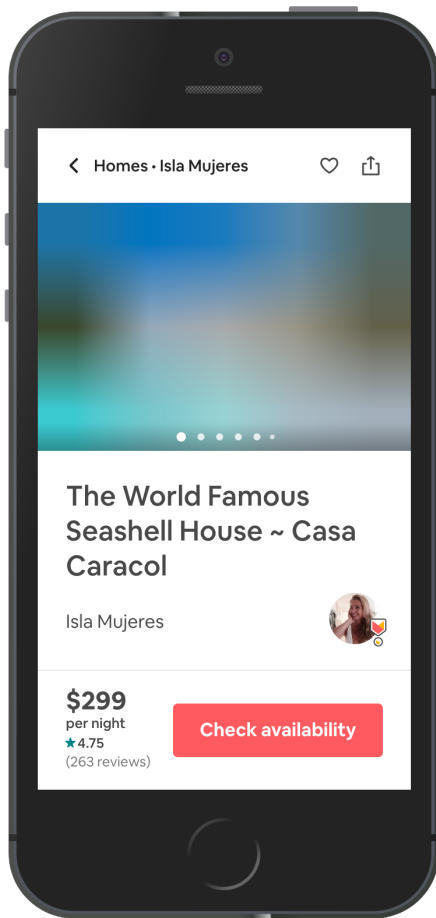
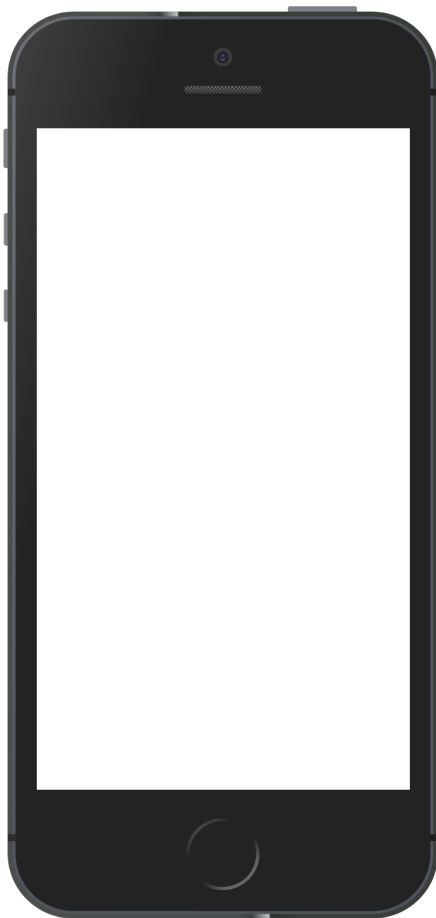
- First time visitors download the service worker
- Repeat visitors saw the App Shell
- A/B tested



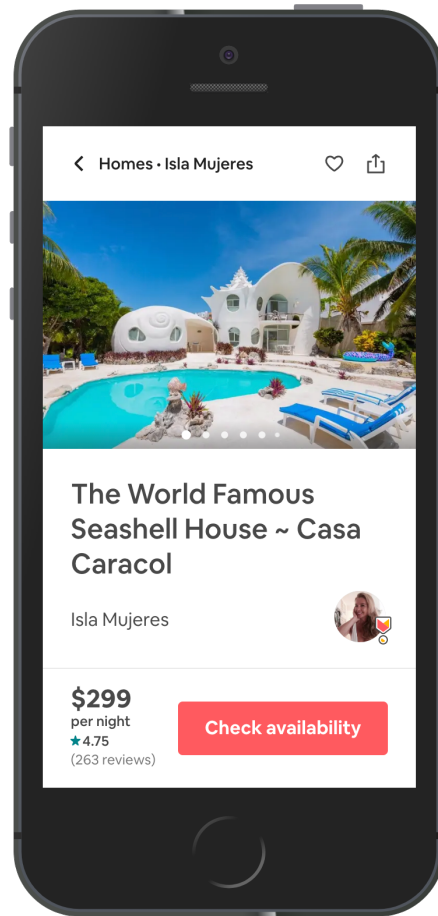
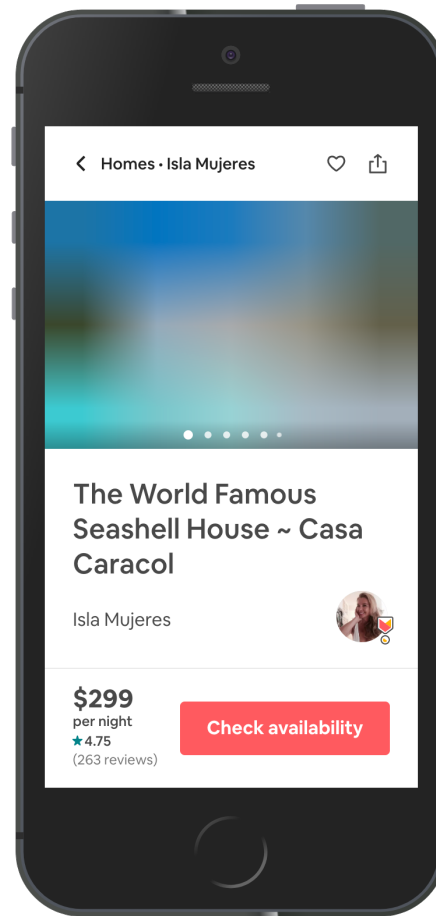
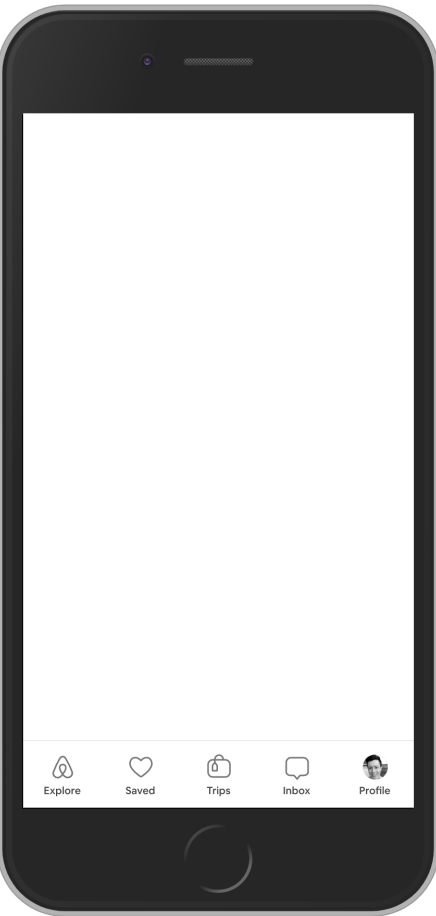
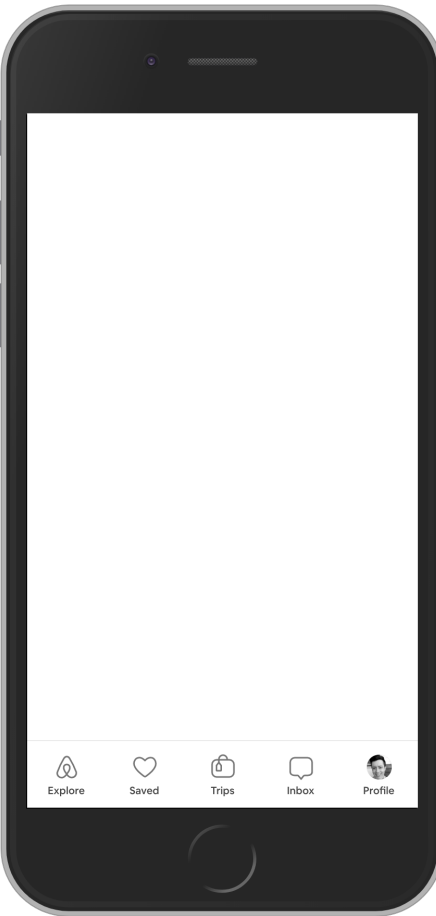
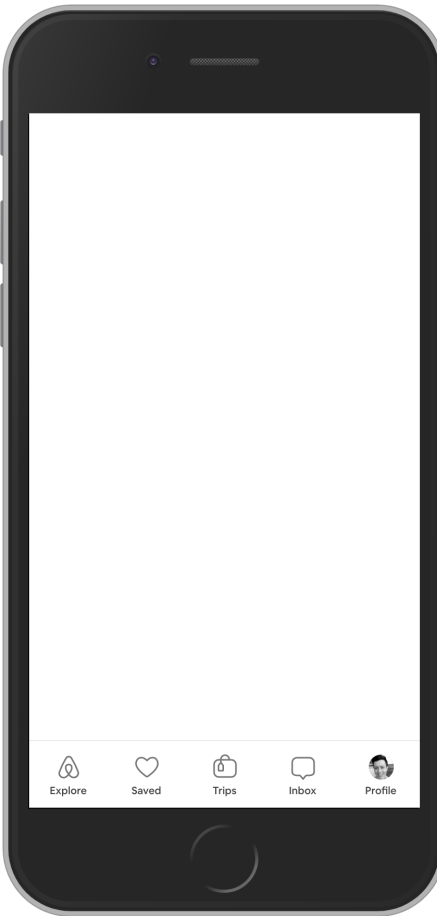
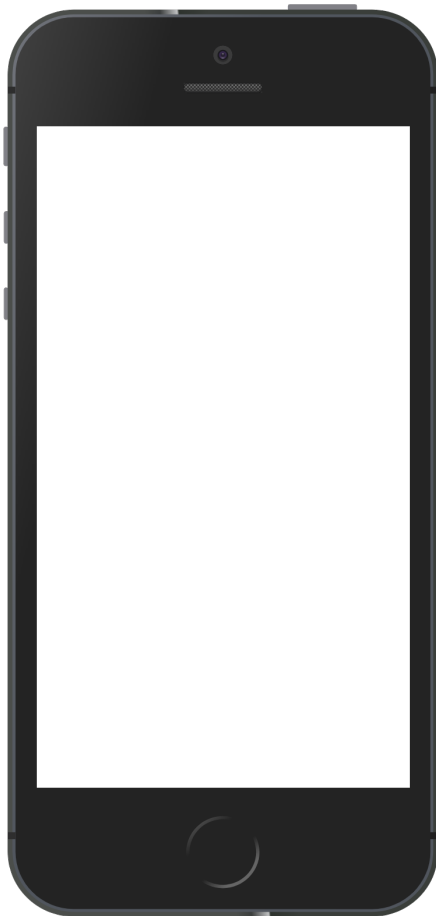
Seconds



Default



Service Worker



Time To First Contentful Paint	20% faster
Time To First Meaningful Paint	67% slower
Page Views	1.1% higher
Bookings	0.6% higher

New Calendar



Old

\$139 per night

★4.86 (1449 reviews)

Dates

Check-in

→

Checkout

←

March 2020

→

Su	Mo	Tu	We	Th	Fr	Sa
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

New

←

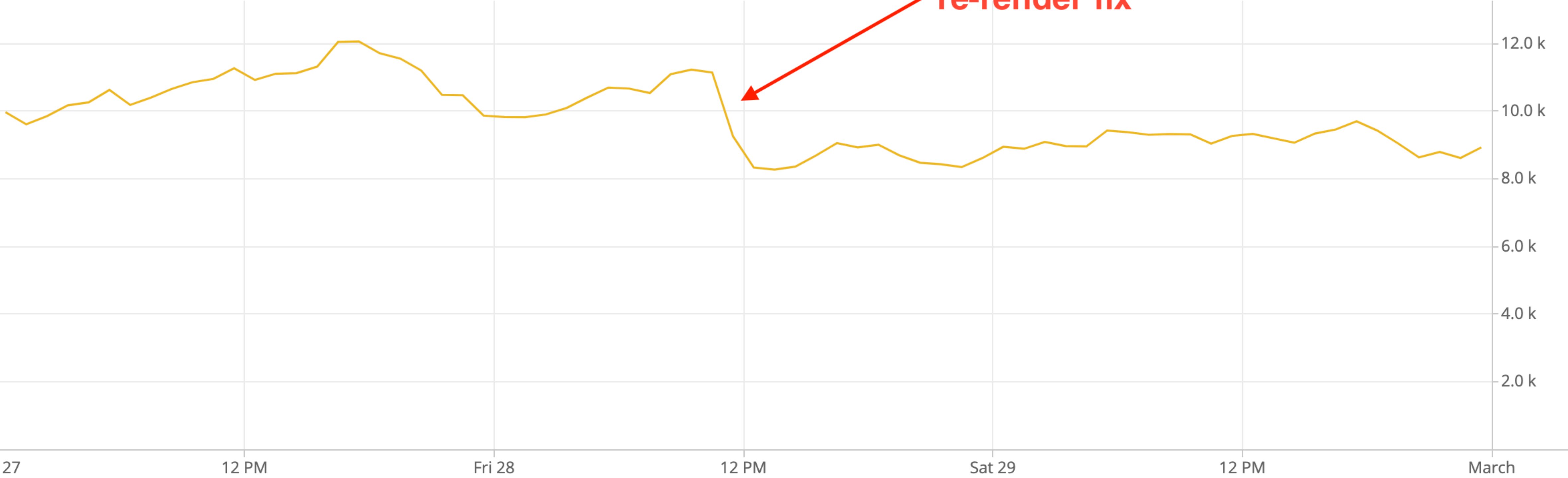
March

→

Su	Mo	Tu	We	Th	Fr	Sa	Su	Mo	Tu	We	Th	Fr	Sa
1	2	3	4	5	6	7				1	2	3	4
8	9	10	11	12	13	14	5	6	7	8	9	10	11
15	16	17	18	19	20	21	12	13	14	15	16	17	18
22	23	24	25	26	27	28	19	20	21	22	23	24	25
29	30	31					26	27	28	29	30		

[Clear dates](#)

Total Blocking Time p95 (ms): 10.0 k



Google Map



Isla Mujeres, Mexico

Residential area of Isla Mujeres is unique..away from the tourists and busy hotels...you can enjoy the stars at night and be incredibly tranquil.

[Read more about the neighborhood](#) ✓



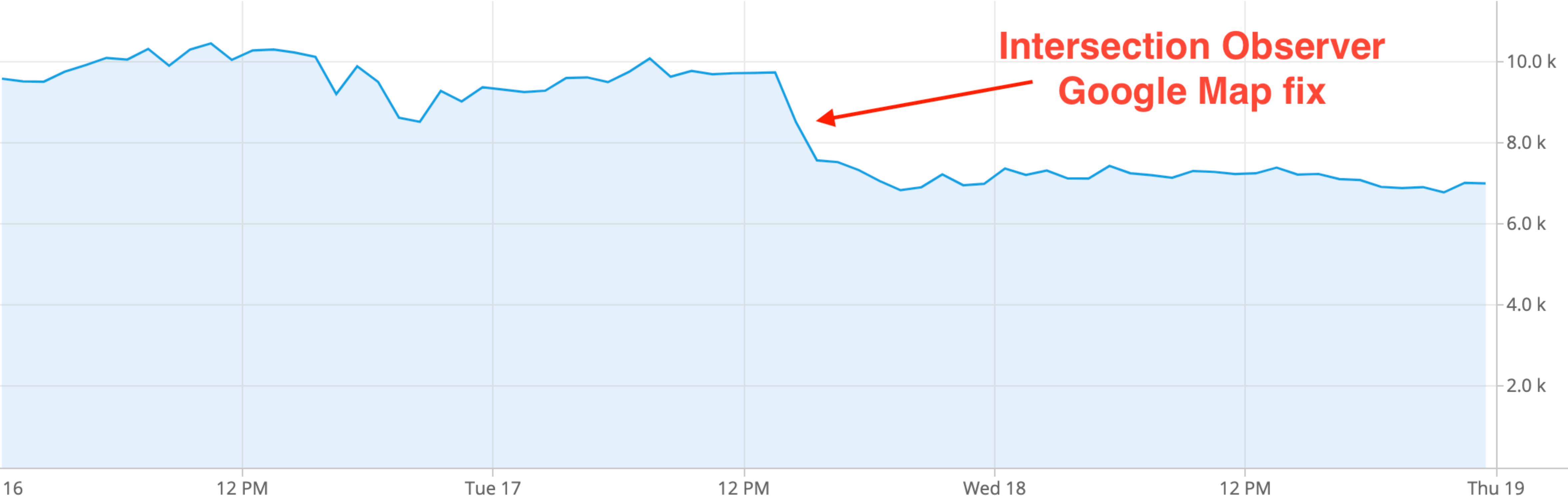
The map shows this place's specific location.

▲ Reduce the impact of third-party code — Third-party code blocked the main thread for 930 ms ^

Third-party code can significantly impact load performance. Limit the number of redundant third-party providers and try to load third-party code after your page has primarily finished loading. [Learn more.](#)

Third-Party	Size	Main-Thread Blocking Time
Google Maps	577 KB	318 ms
Google/DoubleClick Ads	69 KB	259 ms
Google Tag Manager	57 KB	209 ms
Facebook	119 KB	47 ms
Google CDN	278 KB	40 ms
Other Google APIs/SDKs	30 KB	33 ms
Google Analytics	19 KB	21 ms
Bing Ads	8 KB	0 ms
Twitter Online Conversion Tracking	2 KB	0 ms
Yahoo!	1 KB	0 ms

Total Blocking Time p95 (ms): 8.0 k



Client-Side Route to Wishlists



Direct Request

Our response to the COVID-19 pandemic

We are now offering Guests full refunds and Hosts no charge cancellations for reservations booked on or before March 14th with a check in date of April 14th or earlier. Please note this policy will not cover any new bookings.

[Learn more](#)

Explore Airbnb



Stays



Experiences



Restaurants

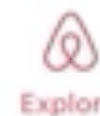
Places to stay around the world

 A beautiful western ranch est. 2019-03-06 02:10:12 +00:00

 Neural Rubie Orchard

United States

United States



Explore



Saved



Trips



Inbox



Profile

Client Request

Our response to the COVID-19 pandemic

We are now offering Guests full refunds and Hosts no charge cancellations for reservations booked on or before March 14th with a check in date of April 14th or earlier. Please note this policy will not cover any new bookings.

[Learn more](#)

Explore Airbnb



Stays




Experiences



Restaurants

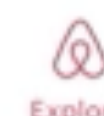
Places to stay around the world

 A beautiful western ranch est. 2019-03-06 02:10:12 +00:00

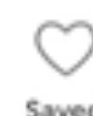
 Neural Rubie Orchard

United States

United States



Explore



Saved



Trips



Inbox



Profile

Time To First Contentful Paint	20% faster
Time To First Meaningful Paint	4% faster
First Input Delay	27% faster
Total Blocking Time	39% lower
Page Views	6% higher

Learnings



Speed	Seconds
Good	<3
Average	3-5
Slow	>5

Speed	Seconds	Score
Good	<3	>70
Average	3-5	60-69
Slow	>5	<60



```
// setup
```

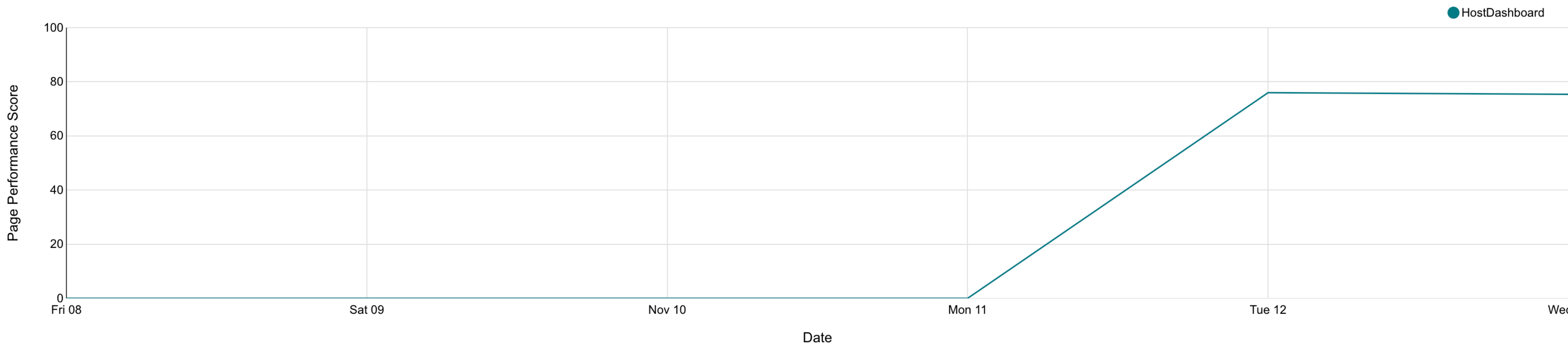
```
<image src={src} alt={alt} id="FMP-target" />
```

Page Performance Dashboard ☆

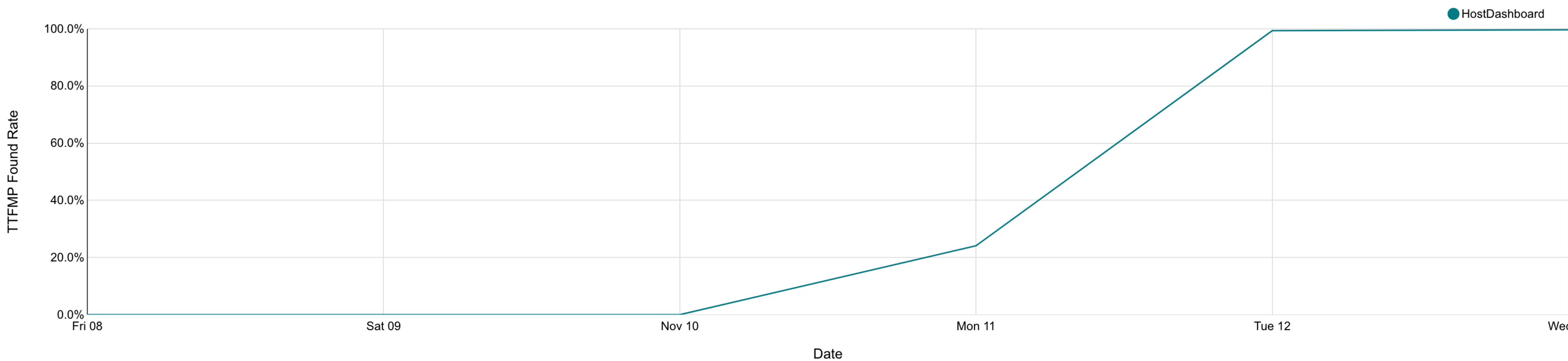
Edit dashboard



Page Performance Score



TTFMP Found Rate



Meta Metrics

- First Input Delay
 - Time To Initial Hydrate
 - Time To First Input
- Total Blocking Time
 - Number of Blocking Tasks
 - Longest Blocking Task Duration
 - Longest Blocking Task Index
 - Page Duration



PPS Weights

First Contentful Paint First Meaningful Paint First Input Delay Total Blocking Time

PPS V1

PPS V2

0%

25%

50%

75%

100%



KEY TAKEAWAYS

Load is not a single moment

Measure multiple, user-centric metrics

Real User Monitoring

Combine into a single number



Resources

Blog post: <https://web.dev/user-centric-performance-metrics/>

@a15n_

Polyfills (open source coming soon)

Score Calculator: shorturl.at/lnwBN



