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Velocity

CONFERENCE

BUILD RESILIENT SYSTEMS AT SCALE

velocity.oreilly.com.cn

#velocityconf

The Quest to Delight Our Users

取悦用户的探索



Alva Cheung



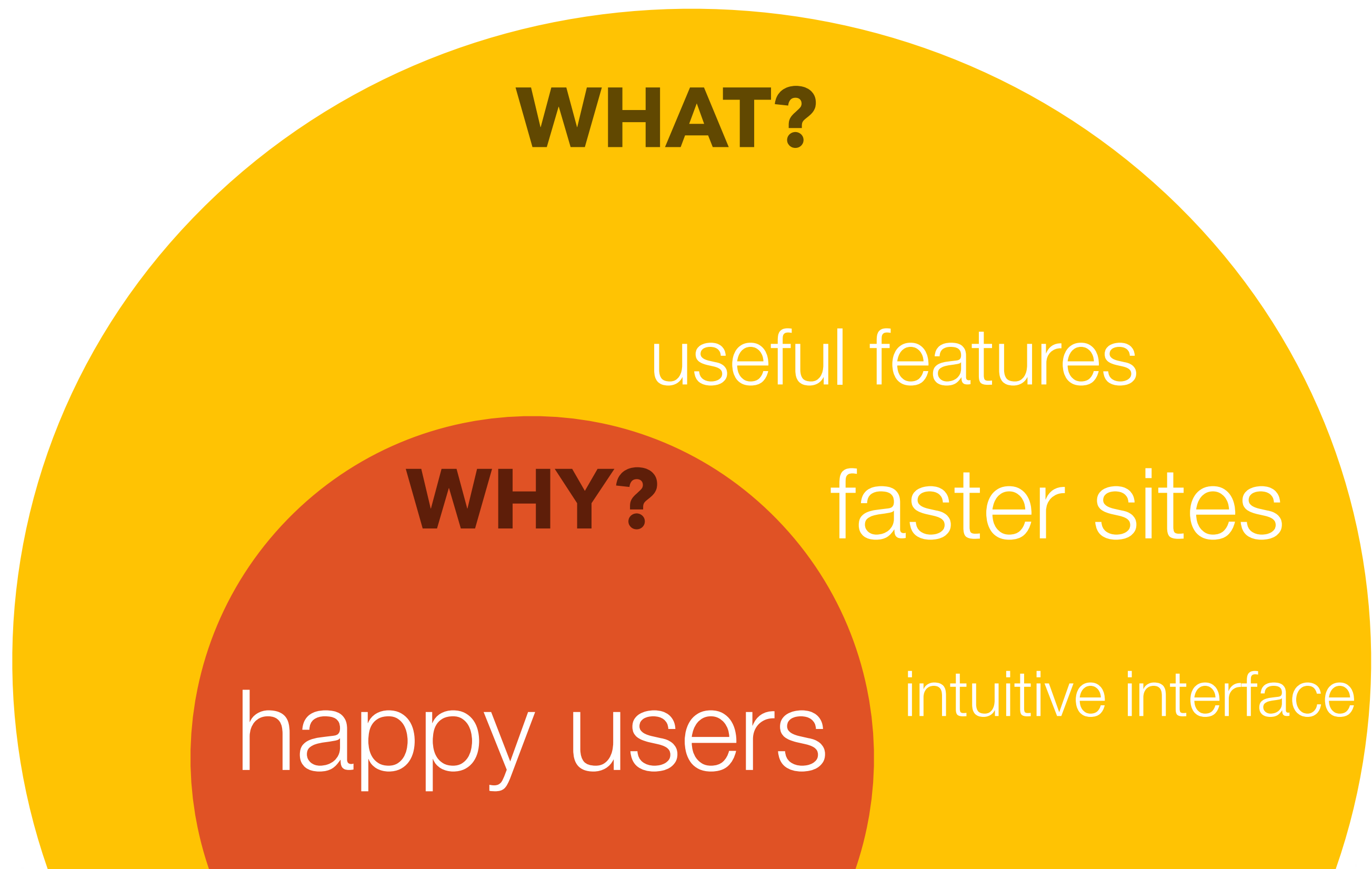
Our quest as an application engineer

Our quest as an application engineer

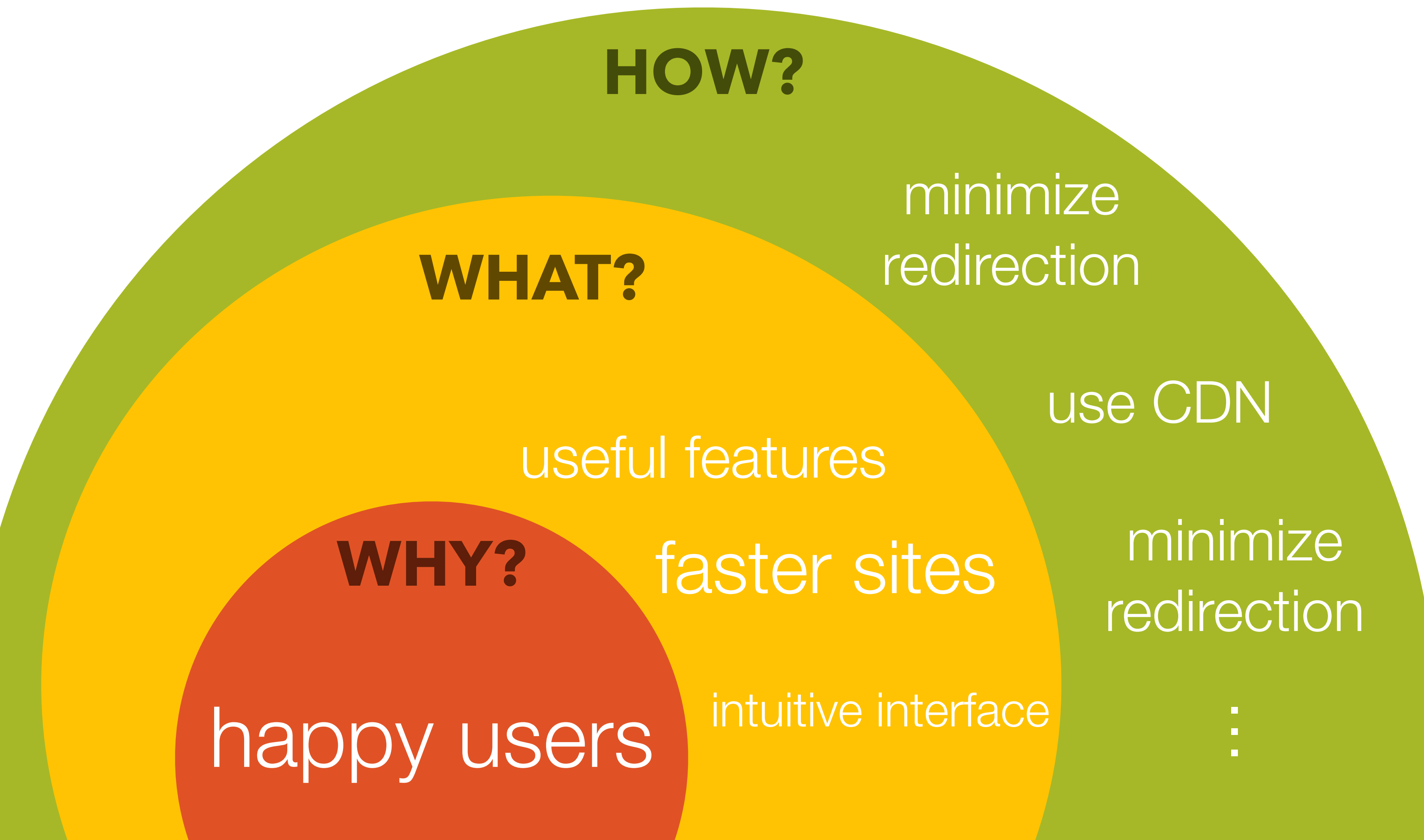
WHY?

happy users

Our quest as an application engineer



Our quest as an application engineer

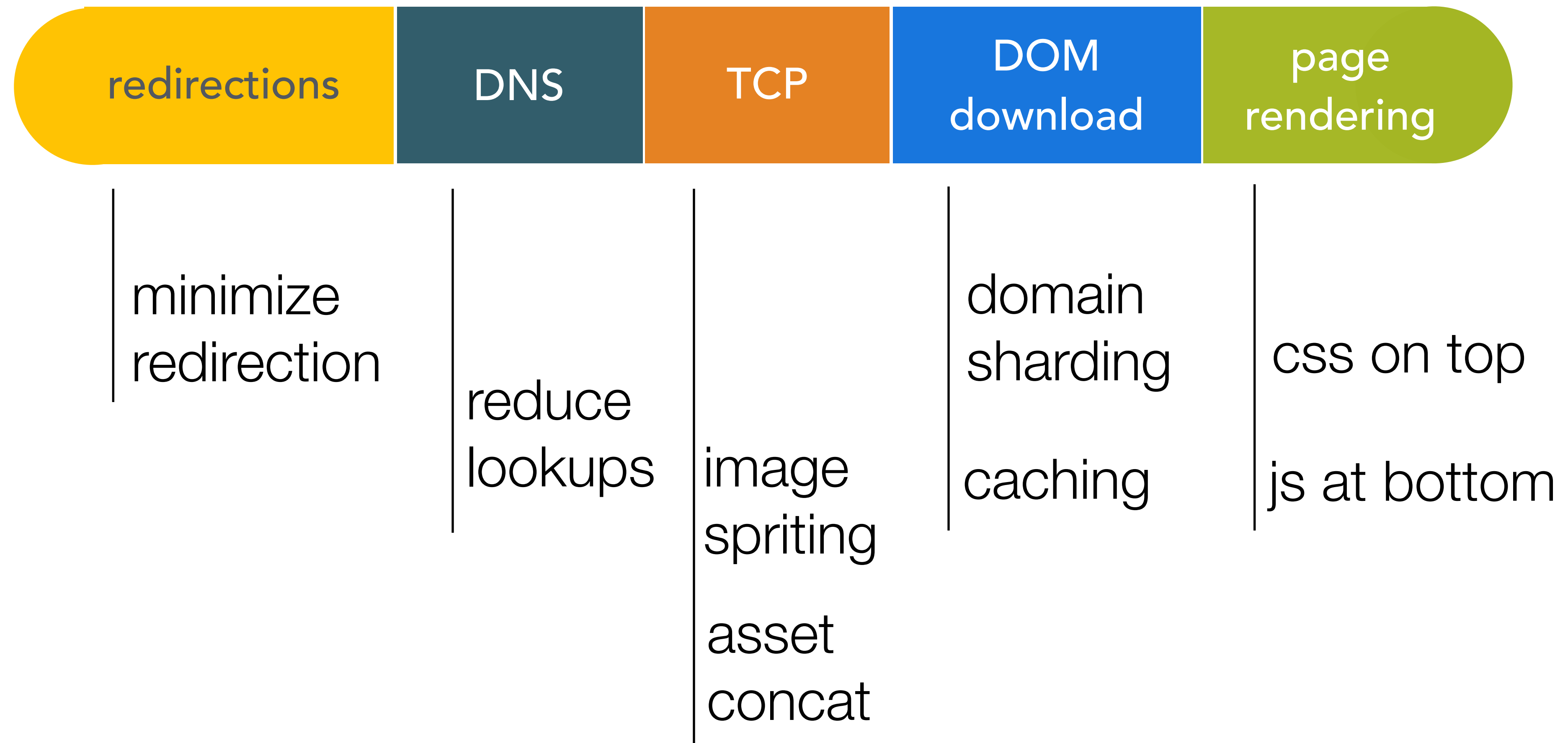


Delighting users, standardized approach

Delighting users, standardized approach



Delighting users, standardized approach

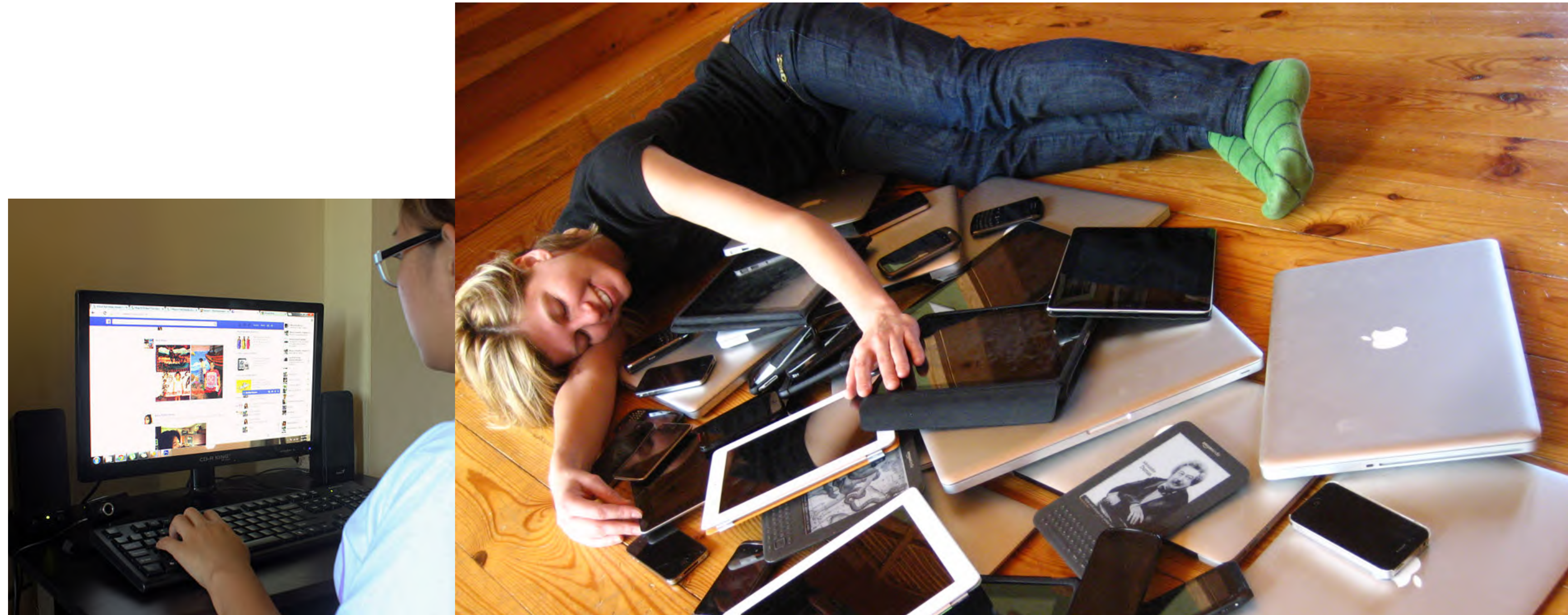


Web landscape changes



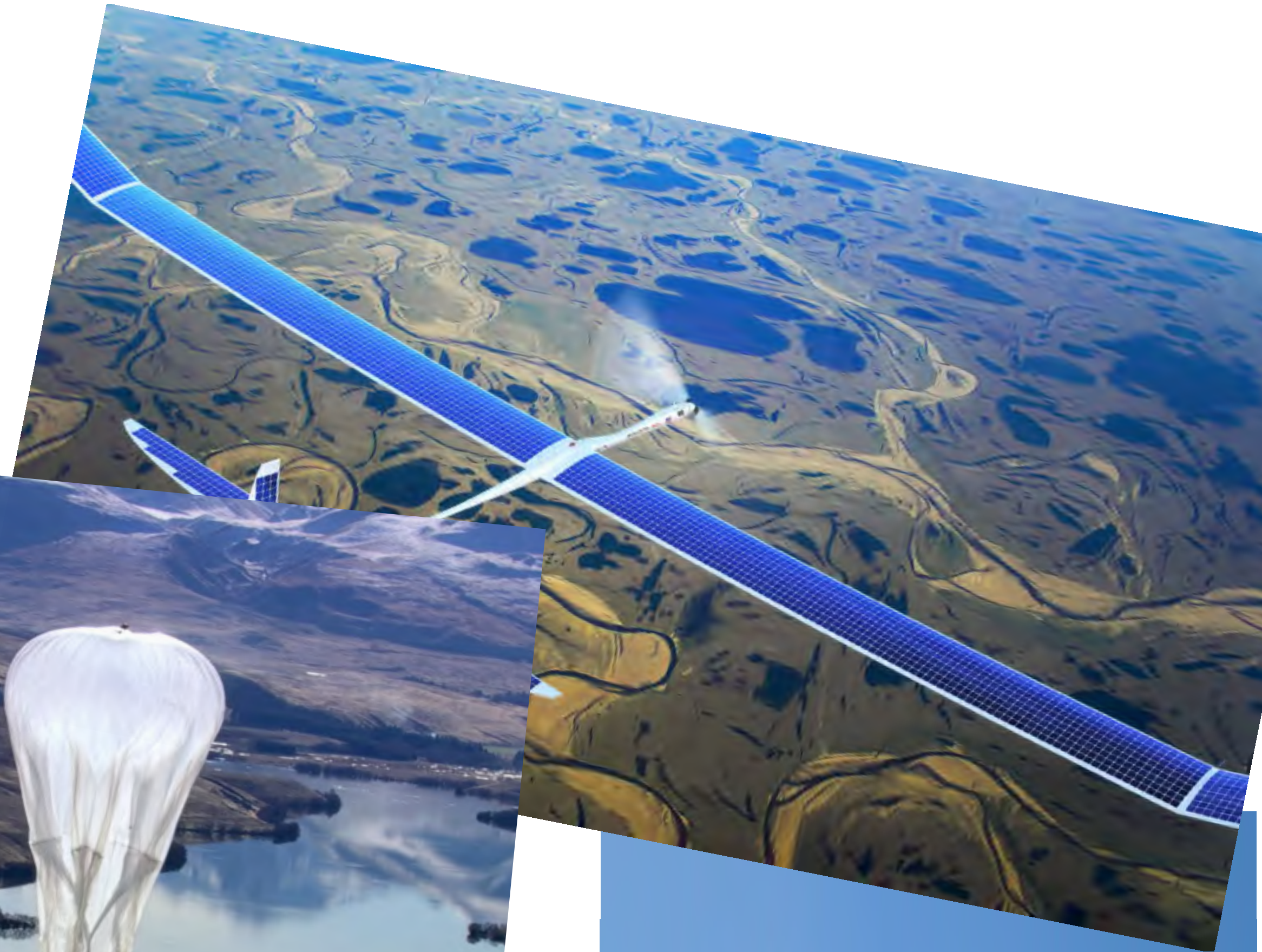
#velocityconf

Web landscape changes



#velocityconf

Web landscape changes



Web landscape changes

Global Rank	Country/Region	Q1 2015 Peak Mbps	QoQ Change	YoY Change
1	Singapore	98.5	17%	71%
2	Hong Kong	92.6	5.6%	40%
3	South Korea	79.0	4.7%	15%
6	Taiwan	71.5	11%	36%
7	Japan	70.1	1.6%	26%
29	Thailand	50.6	9.3%	47%
47	Australia	40.8	10%	29%
52	New Zealand	36.7	7.0%	51%
65	Malaysia	31.5	6.3%	13%
66	Sri Lanka	30.8	24%	97%
92	Vietnam	21.3	23%	74%
94	Philippines	20.3	-7.4%	8.1%
97	China	19.4	8.8%	43%
106	Indonesia	17.5	31%	-9.6%
108	India	17.4	20%	45%

Akamai Q1 2015 State of the Internet Report

Web landscape changes

	Global Rank	Country/Region	Q1 2015 Peak Mbps	QoQ Change	YoY Change
1		Singapore	98.5	17%	71%
2		Hong Kong	92.6	5.6%	40%
	3	South Korea	79.0	4.7%	15%
	6	Taiwan	71.5	11%	36%
	7	Japan	70.1	1.6%	26%
	29	Thailand	50.6	9.3%	47%
	47	Australia	40.8	10%	29%
	52	New Zealand	36.7	7.0%	51%
	65	Malaysia	31.5	6.3%	13%
	66	Sri Lanka	30.8	24%	97%
	92	Vietnam	21.3	23%	74%
	94	Philippines	20.3	-7.4%	8.1%
	97	China	19.1	8.8%	13%
106		Indonesia	17.5	31%	-9.6%
108		India	17.4	20%	45%

15 State of the Internet Report

Web landscape changes



Device	Data rate	Latency
Desktop	10Mbps 100 Mbps 1Gbps	65–145 ms

Data rates and latency for
desktop connection

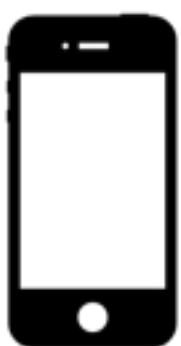
source: <http://chimera.labs.oreilly.com/books/12300000000545>
<http://www.webperformancetoday.com>

Web landscape changes



Device	Data rate	Latency
Desktop	10Mbps 100 Mbps 1Gbps	65–145 ms

Data rates and latency for
desktop connection



Generation	Data rate	Latency
2G	100–400 Kbit/s	300–1000 ms
3G	0.5–5 Mbit/s	100–500 ms
4G	1–50 Mbit/s	< 100 ms

Data rates and latency for an
active mobile connection

source: <http://chimera.labs.oreilly.com/books/12300000000545>
<http://www.webperformancetoday.com>

Web landscape changes

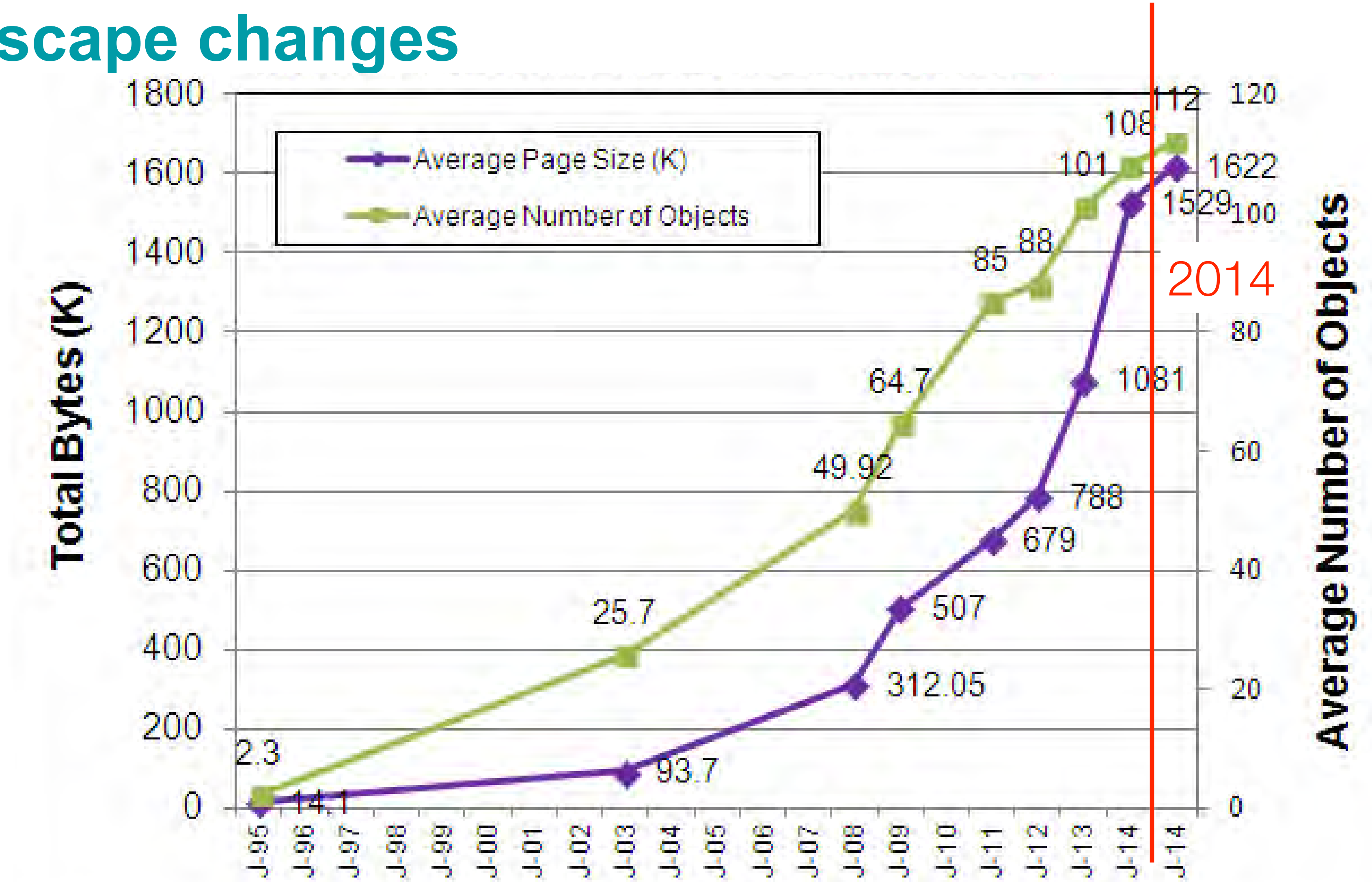
The image illustrates the changes in the web landscape through three different versions of the Yahoo! homepage. The leftmost version shows the classic layout with a red logo and a grid of service links. The middle version shows a personalized experience with a sidebar and a main content area. The rightmost version shows a more modern, news-focused layout with a purple header and a large main content area.

source: <http://www.dailymail.co.uk>

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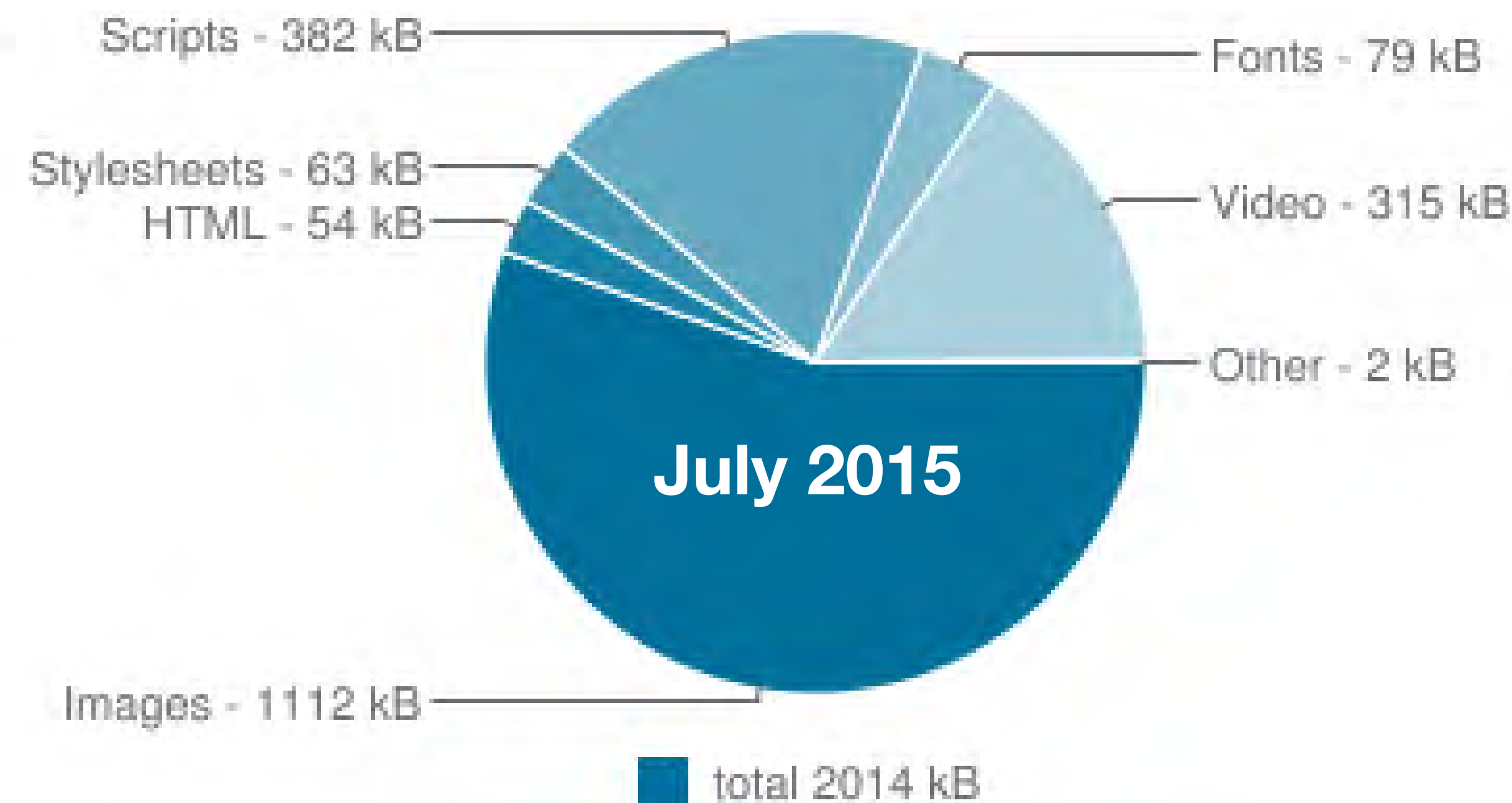
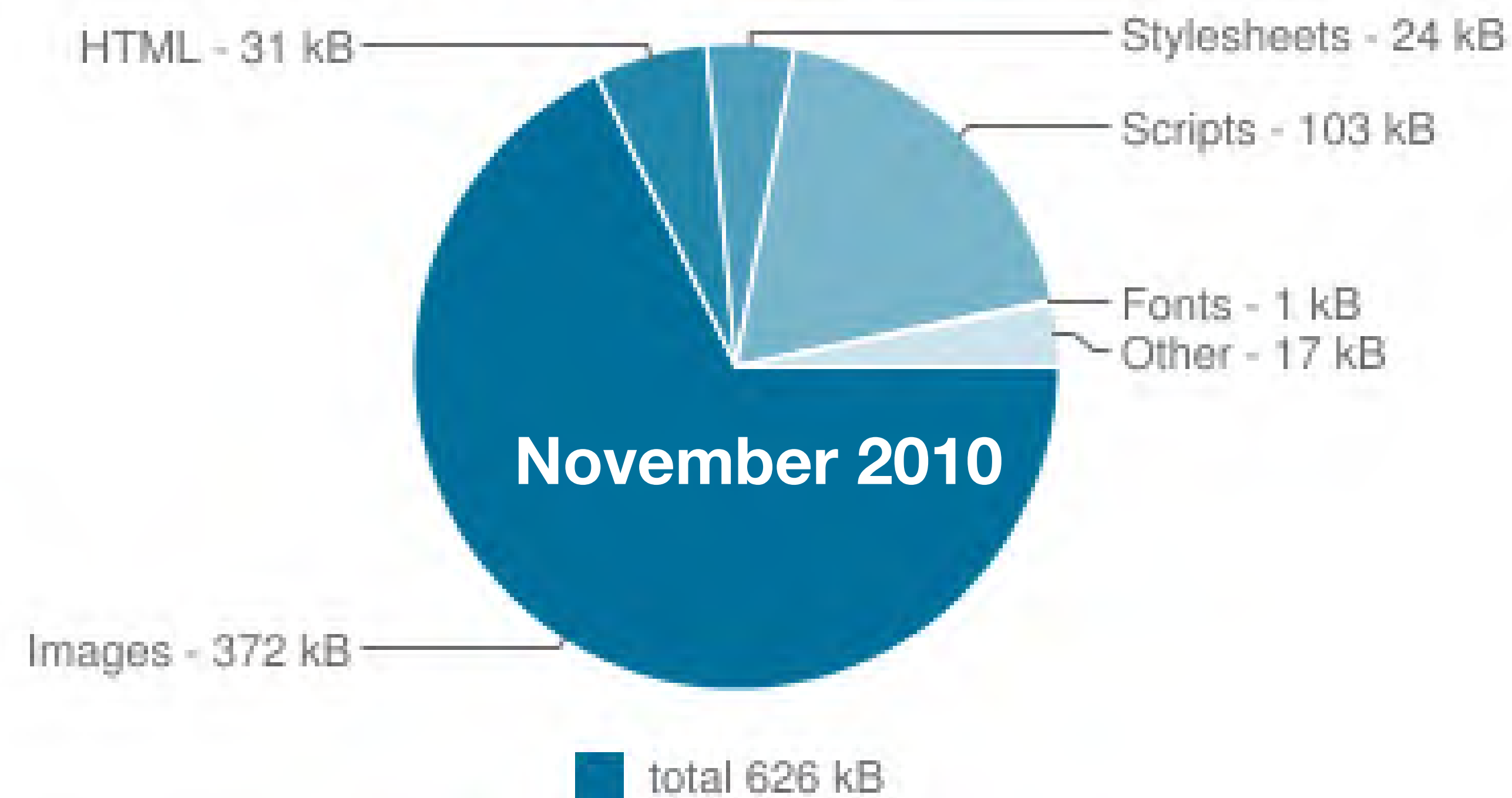
Web landscape changes



Growth of average web page size and number of objects

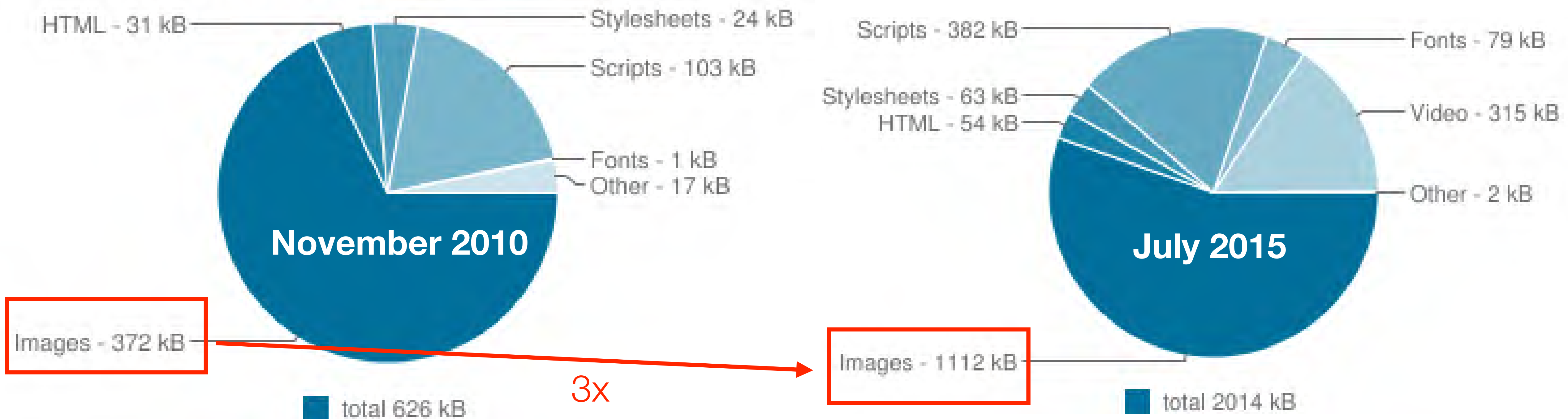
source: websiteoptimization.com

Web landscape changes



source: <http://httparchive.org/>

Web landscape changes



source: <http://httparchive.org/>

Web landscape changes



source: <http://httparchive.org/>

Web landscape changes

Web landscape changes



Stock

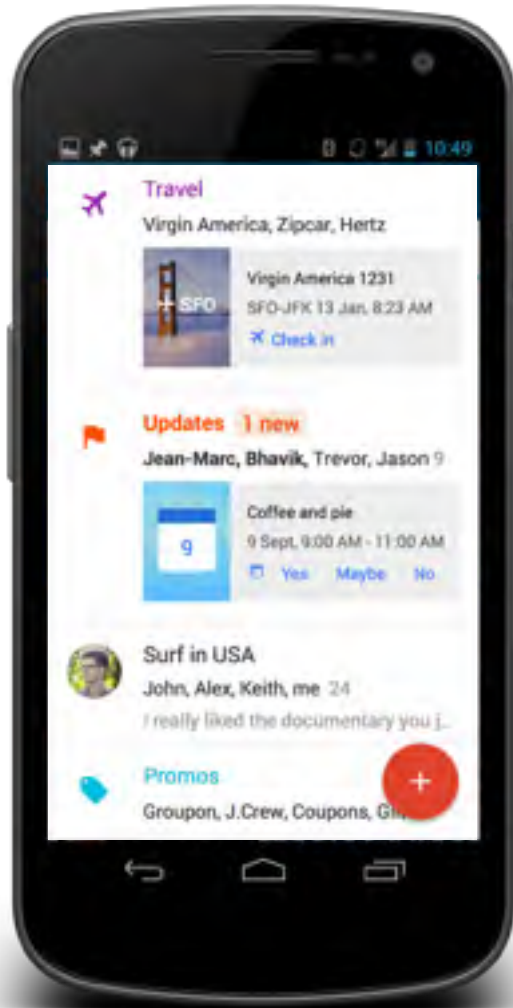


3rd party



WebView

vs



Native app

Web landscape changes



Stock

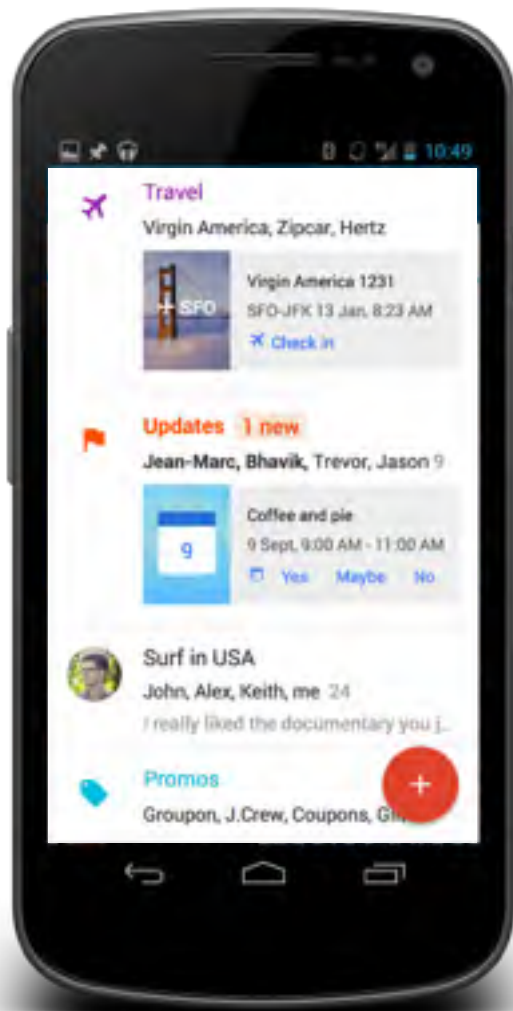


3rd party

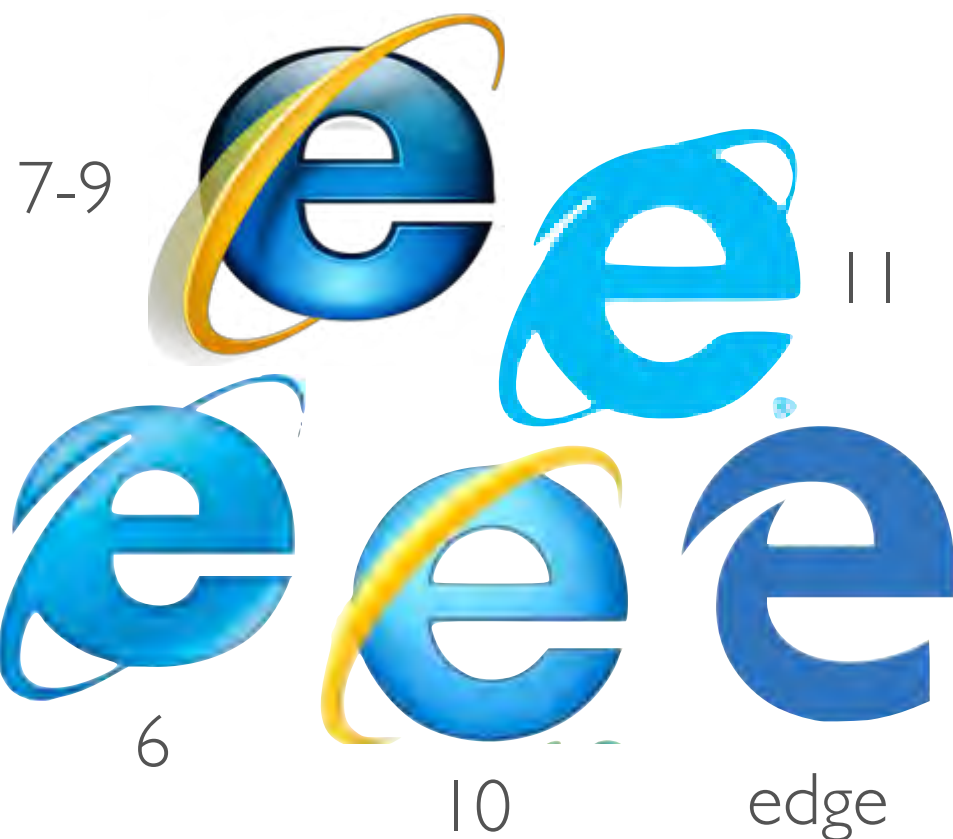


WebView

vs



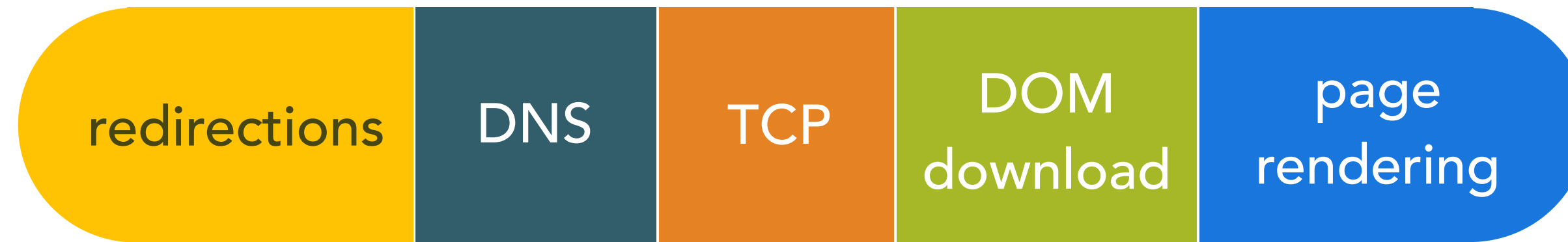
Native app



Delighting users in 2015



Delighting users in 2015



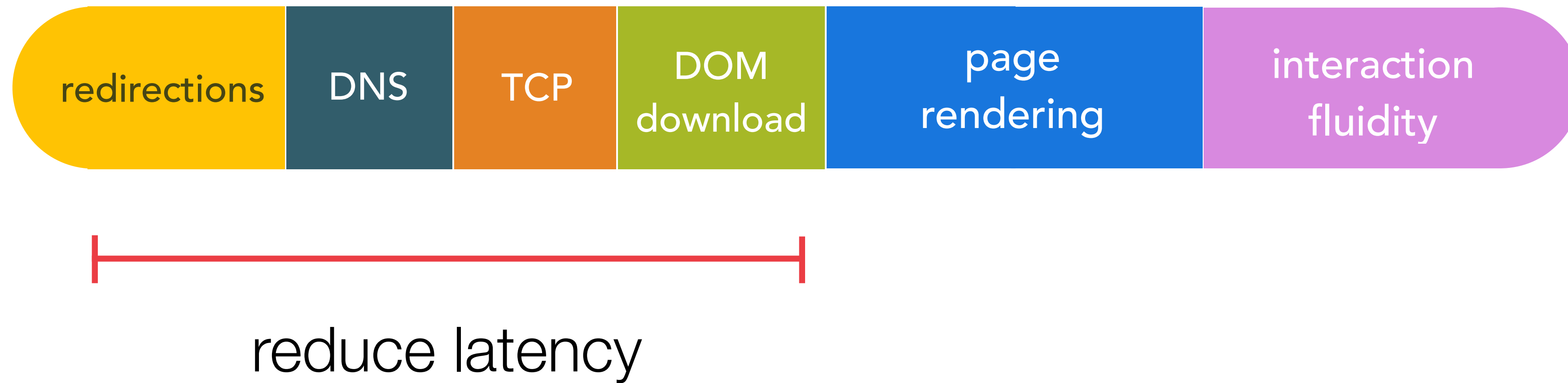
Delighting users in 2015



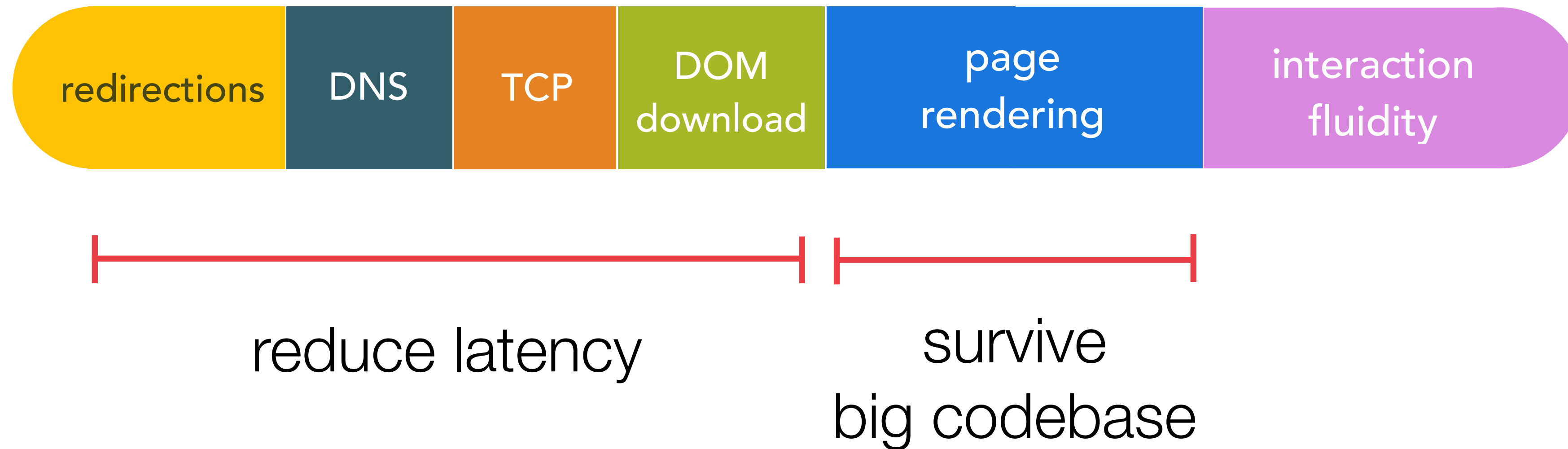
Delighting users in 2015



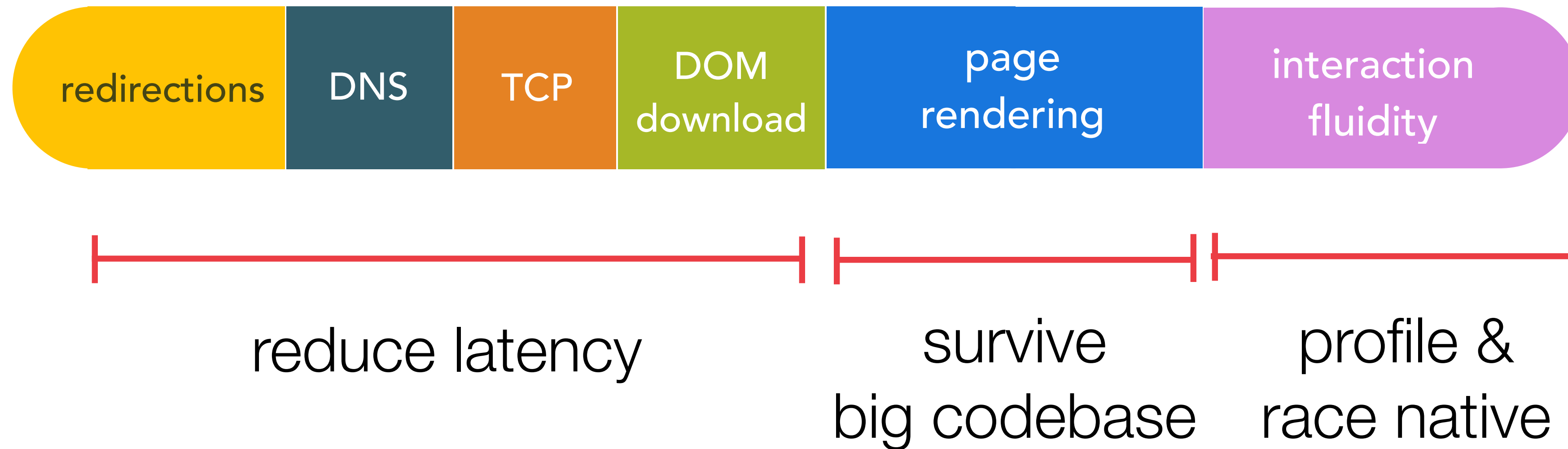
Delighting users in 2015



Delighting users in 2015



Delighting users in 2015



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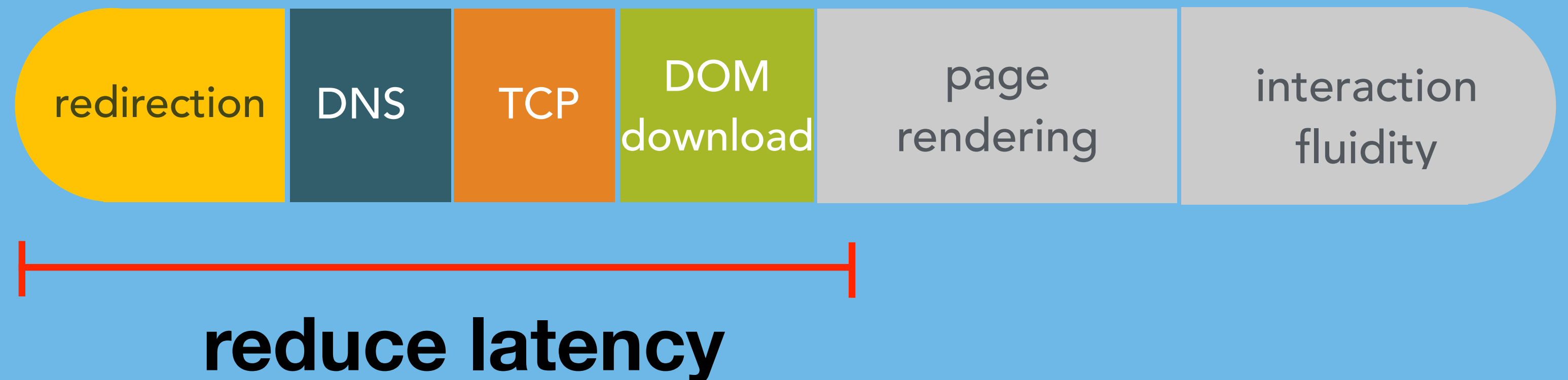
Velocity

CONFERENCE

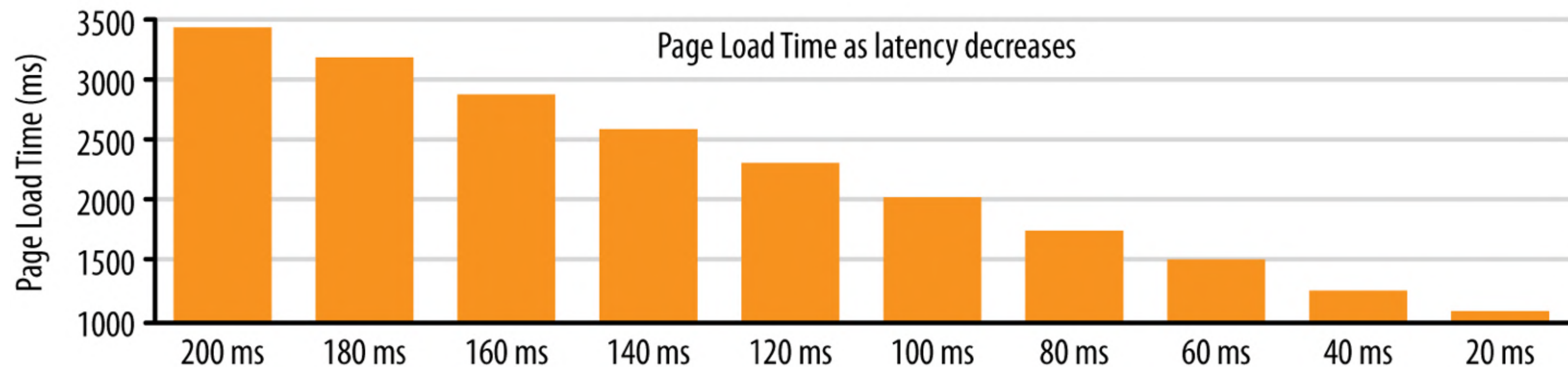
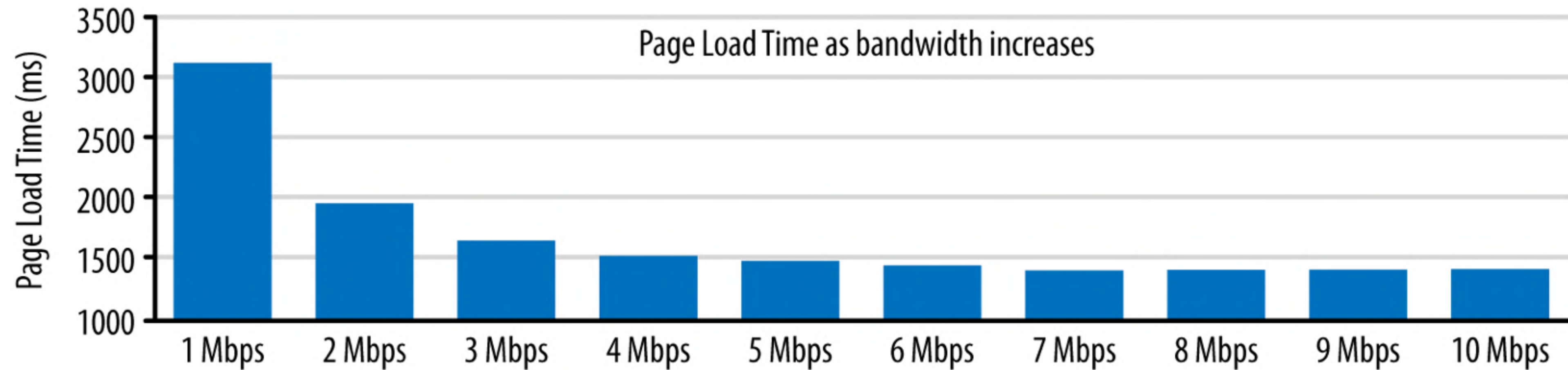
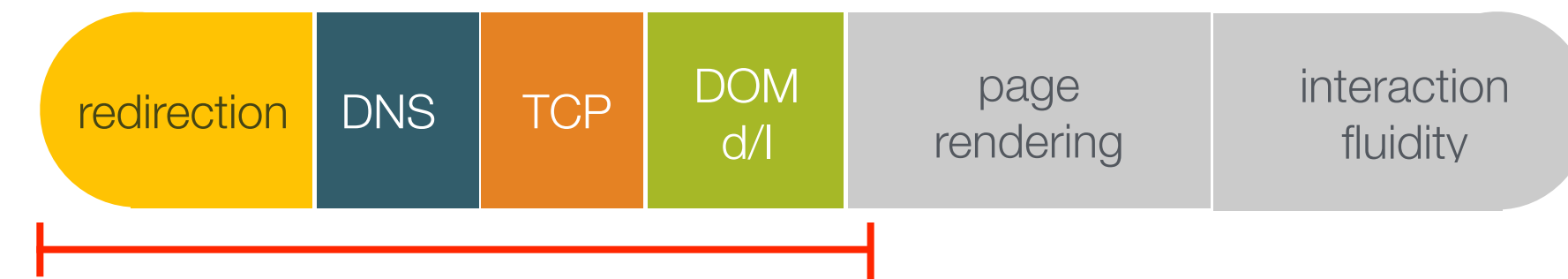
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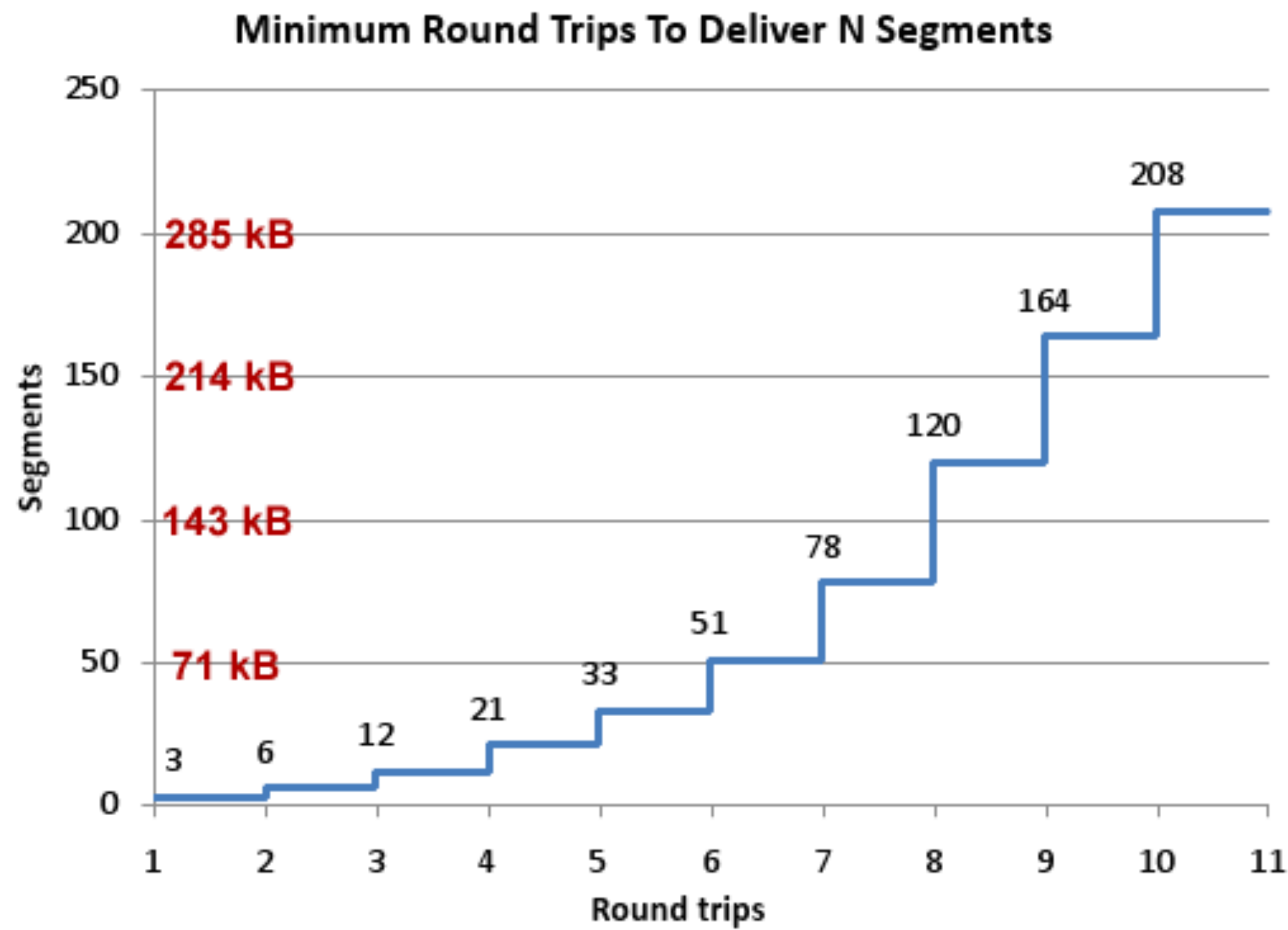
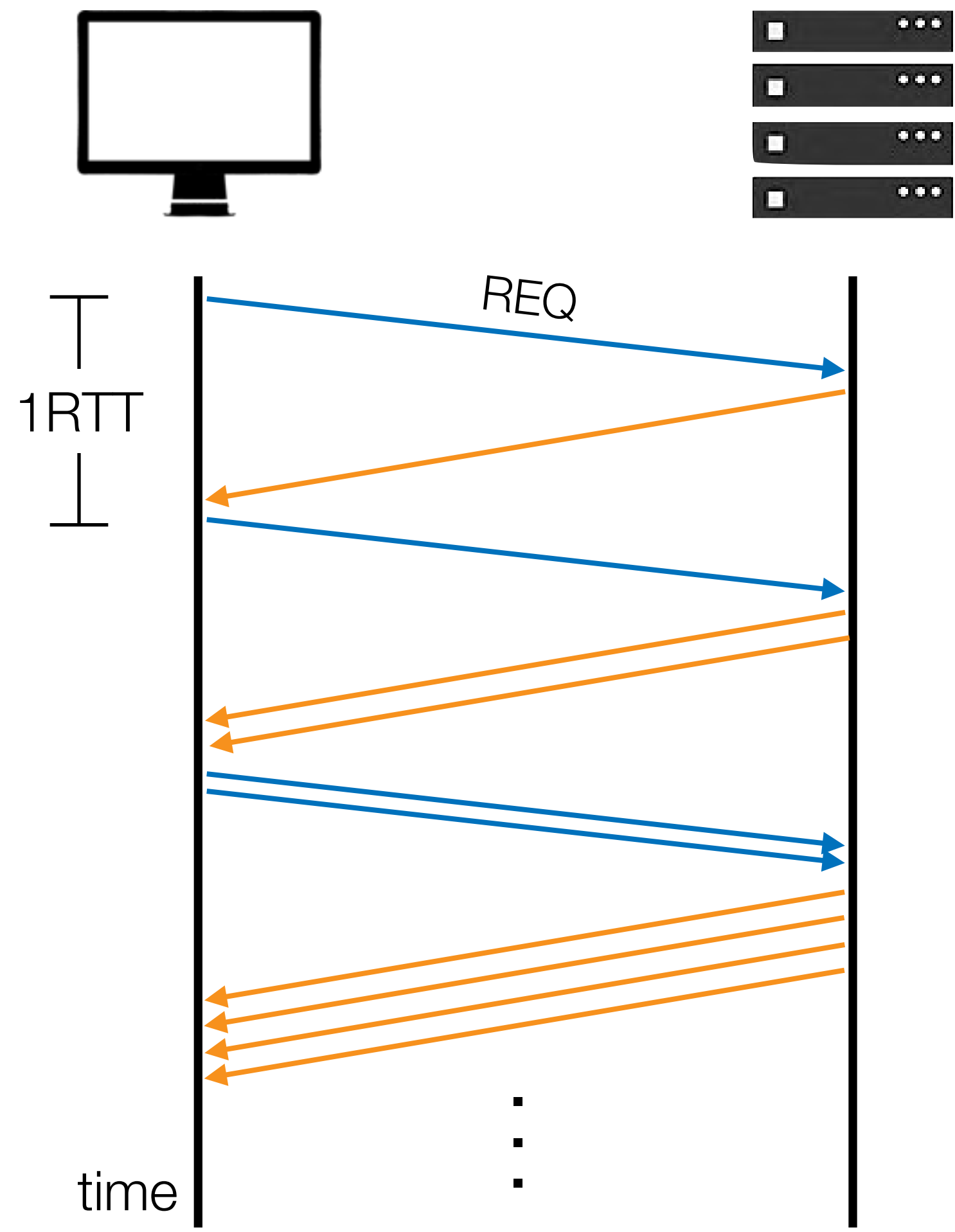


Reducing latency matters



source: <http://chimera.labs.oreilly.com/books/12300000000545>

TCP slow-start penalizes new connections



source: <http://www.stevesouders.com>

HTTP/2 is here!



chrome://net-internals/#http2

HTTP/2 capturing events (9637)

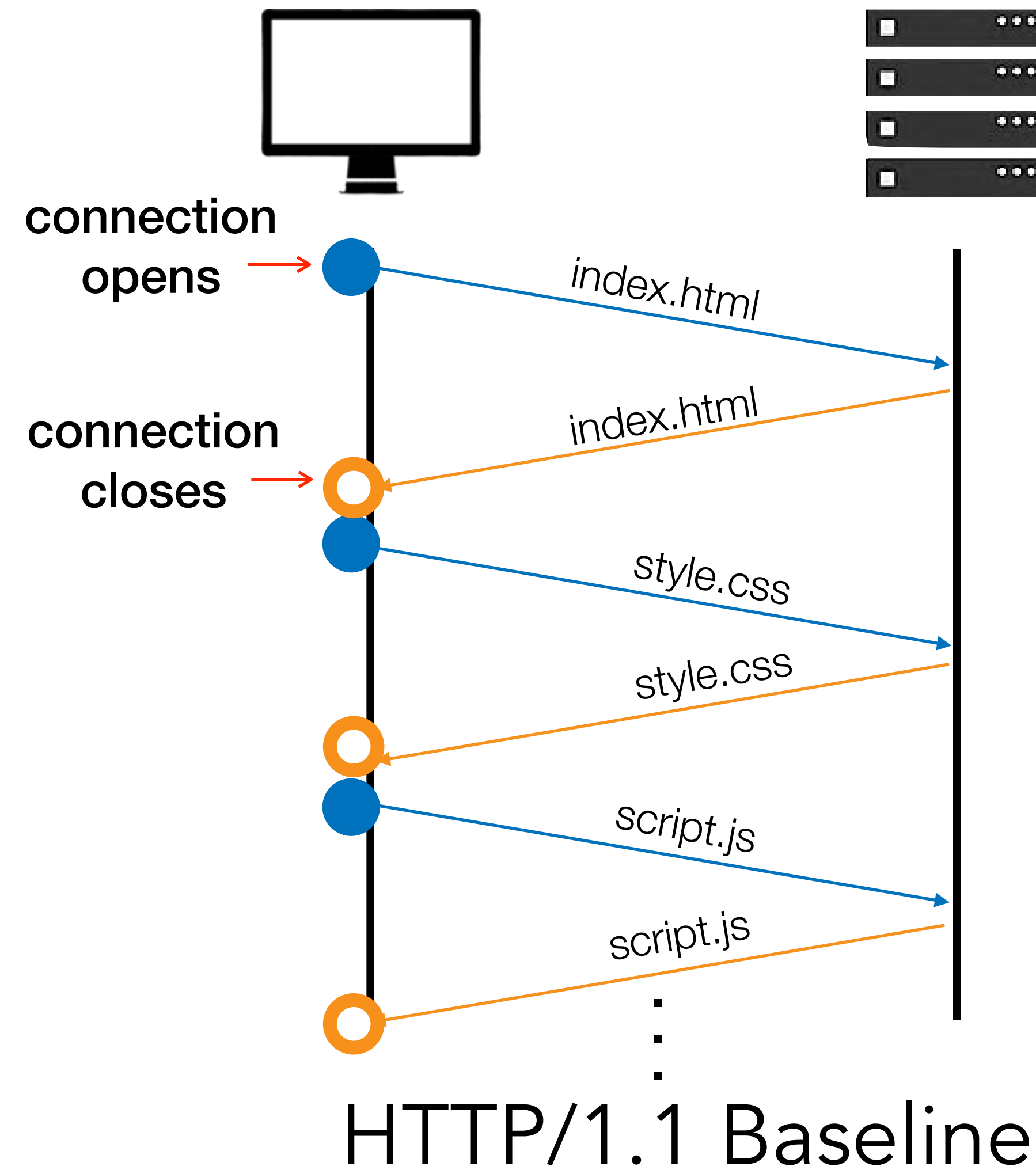
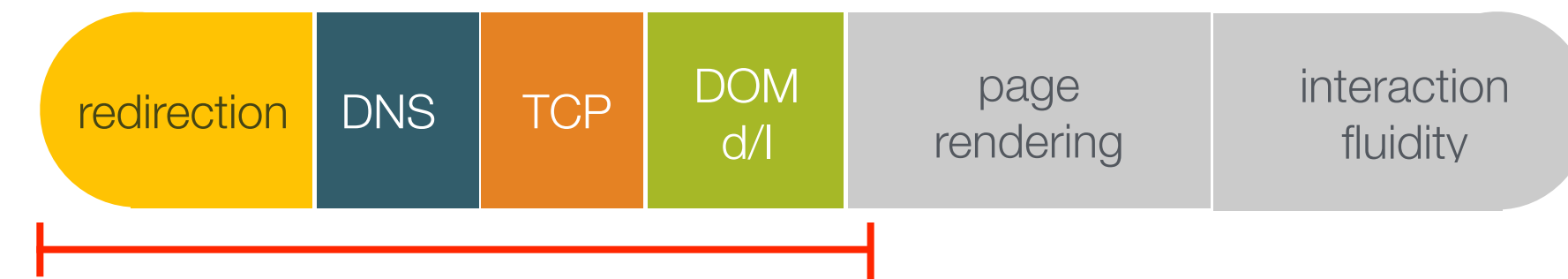
- HTTP/2 Enabled: true
- Use Alternative Service: true
- Next Protocols: http/1.1,spdy/3.1,h2-14,h2

HTTP/2 sessions

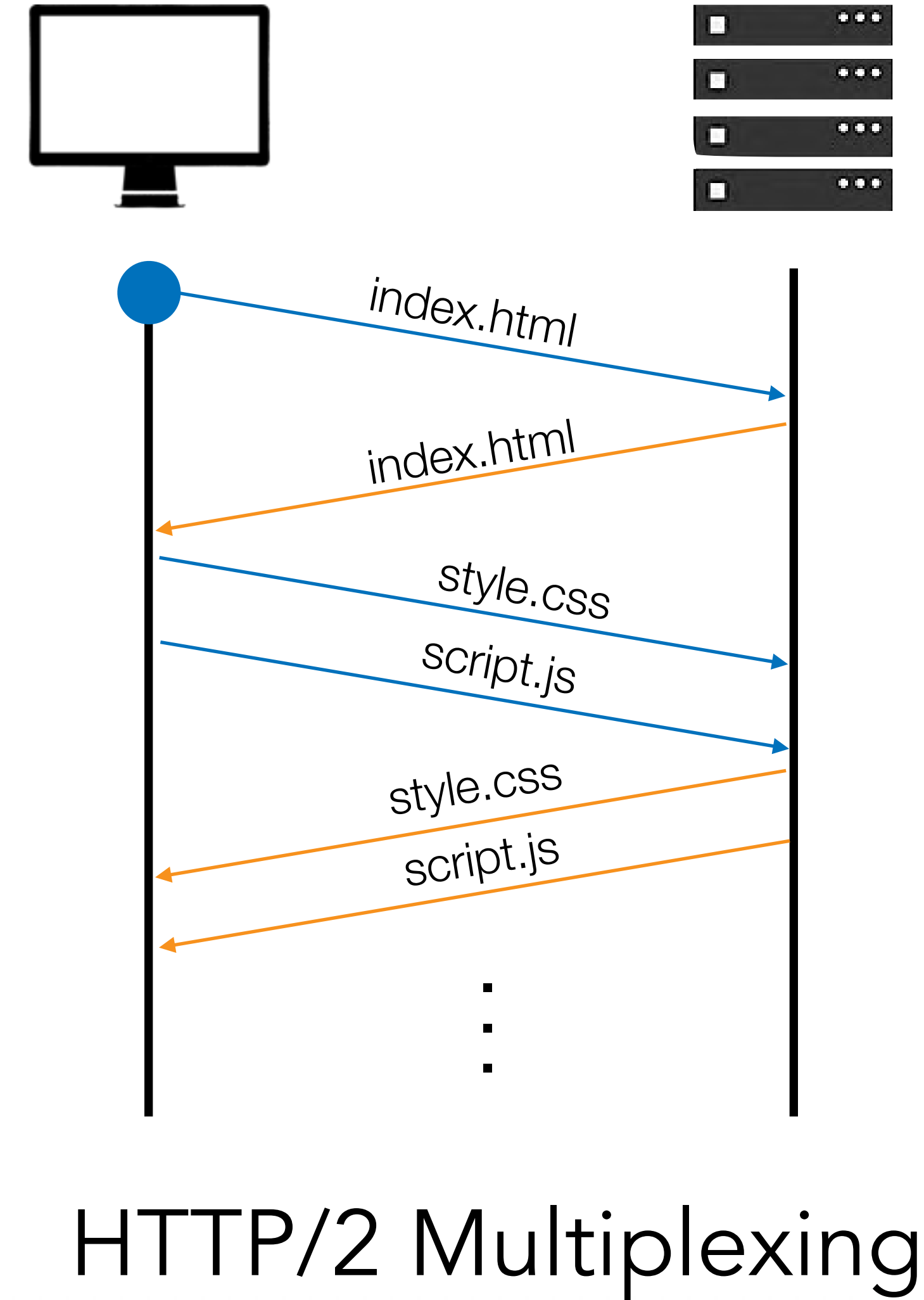
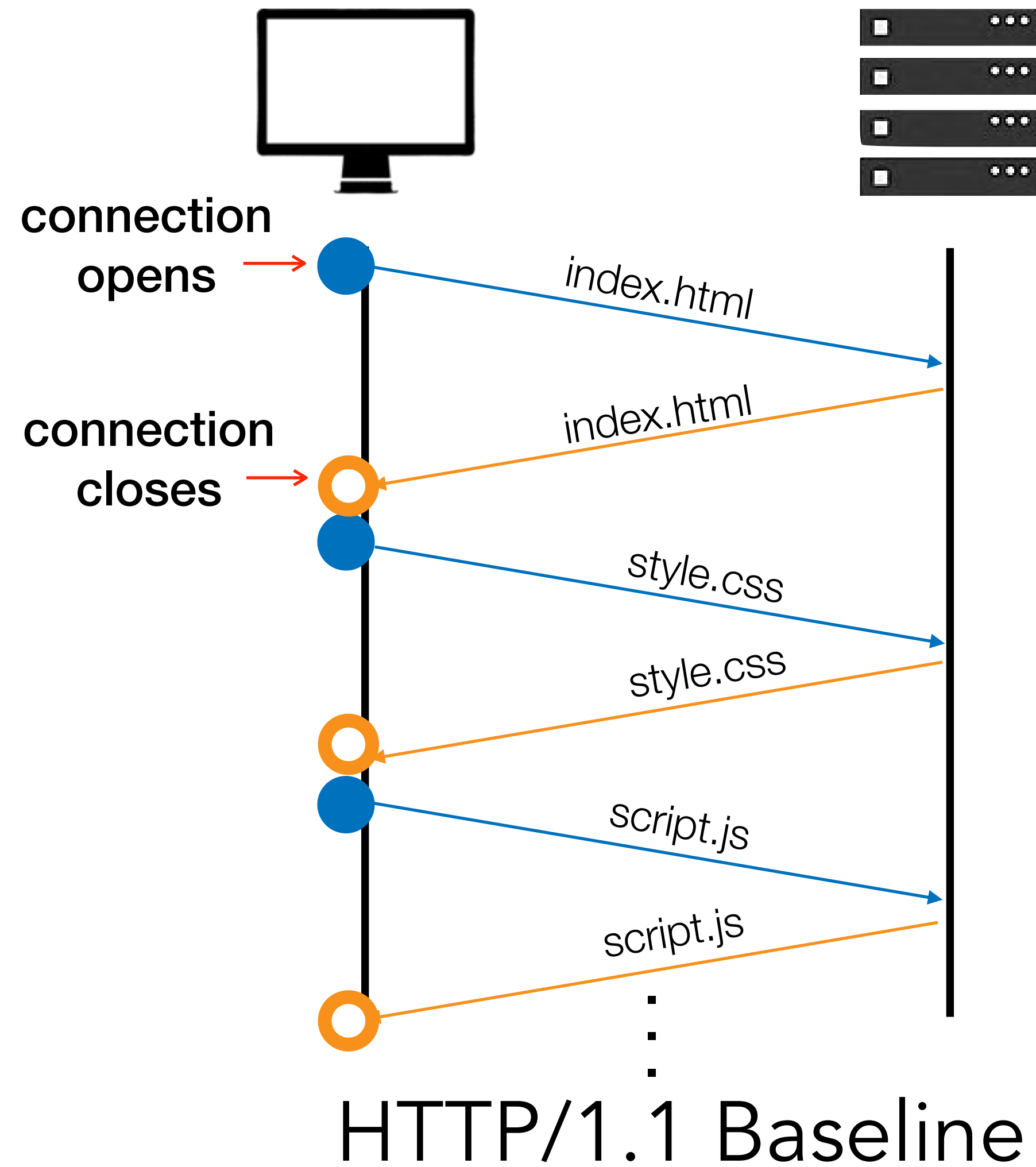
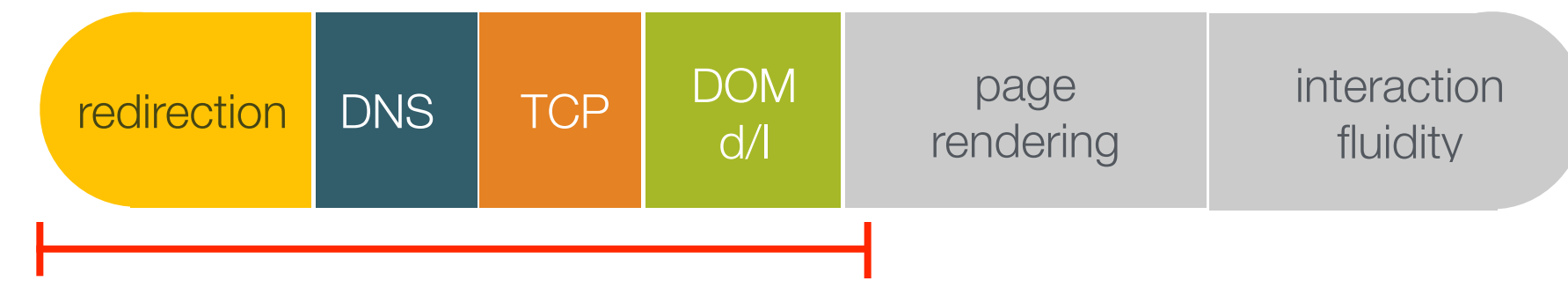
[View live HTTP/2 sessions](#)

Host	Proxy	ID	Protocol Negotiated	Active streams	Unclaimed pushed	Max	Initiated
2542116.fl.s.doubleclick.net:443	direct://	75067	h2	0	0	100	0
55.docs.google.com:443	direct://	76032	h2	0	0	100	1
ajax.googleapis.com:443	direct://	74947	h2	0	0	100	0
clients2.googleusercontent.com:443	direct://	77896	h2	0	0	100	0
clients4.google.com:443 clients6.google.com:443 docs.google.com:443	direct://	73882	h2	0	0	100	6
cs.corp.google.com:443	direct://	71553	h2	0	0	100	3
csi.gstatic.com:443	direct://	77137	h2	0	0	100	0
extensionreporter.googleplex.com:443	direct://	77995	h2	0	0	100	1
fonts.googleapis.com:443	direct://	74913	h2	0	0	100	0
gg.google.com:443	direct://	76081	h2	0	0	100	0

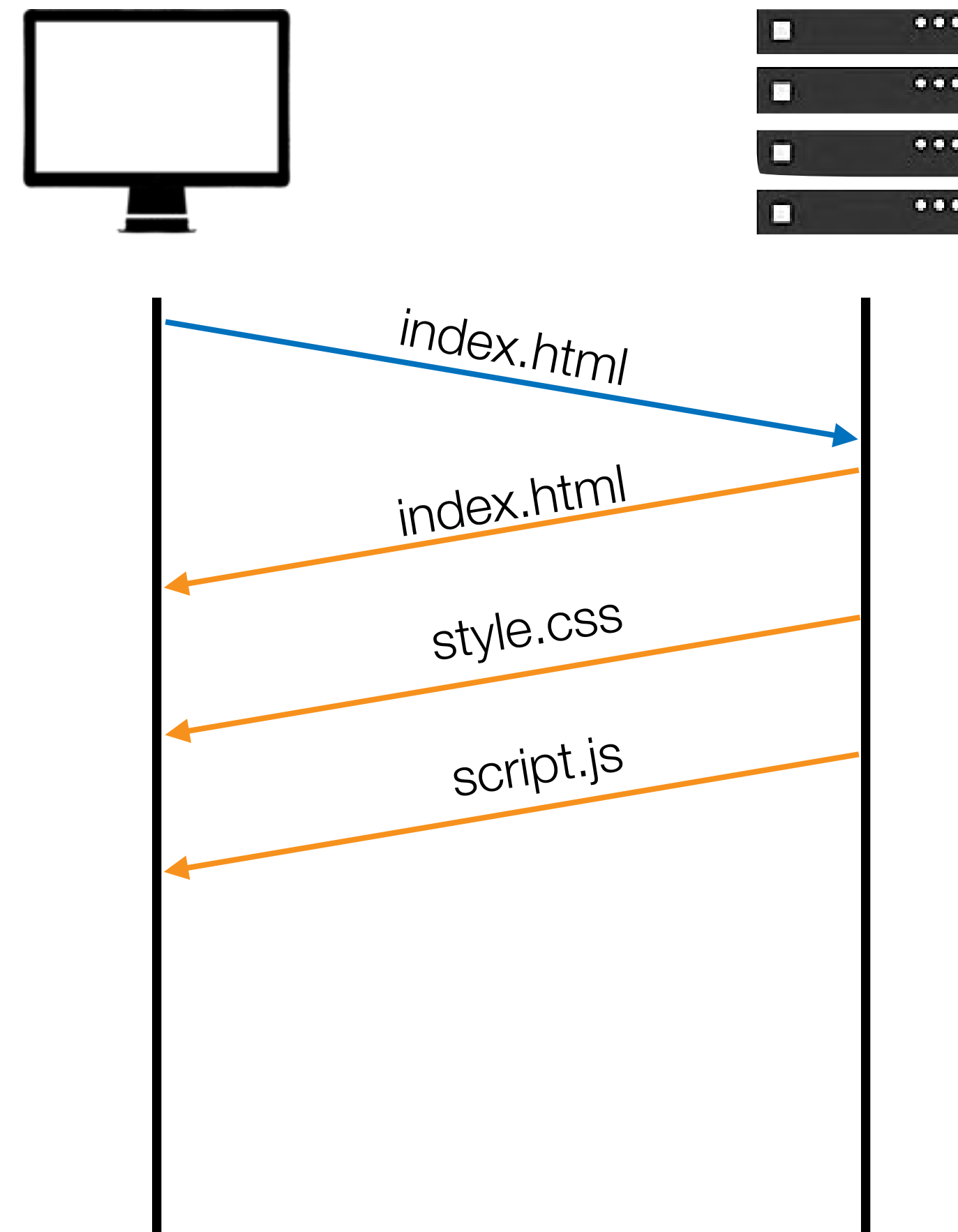
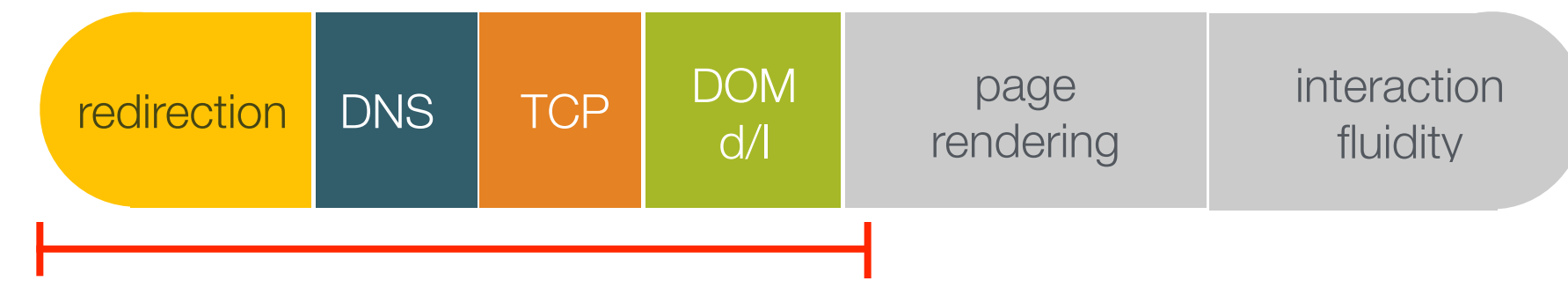
Multiplexing in HTTP/2



Multiplexing in HTTP/2

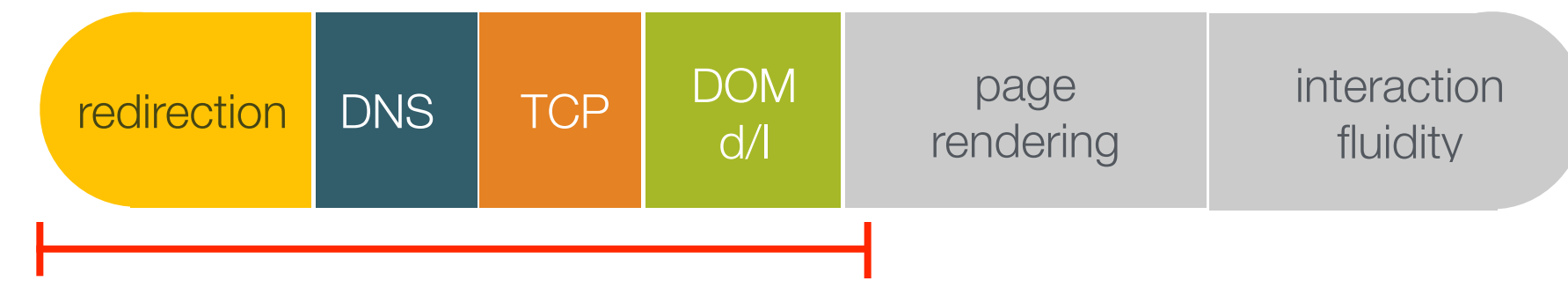


Server push in HTTP/2



HTTP/2 Server push

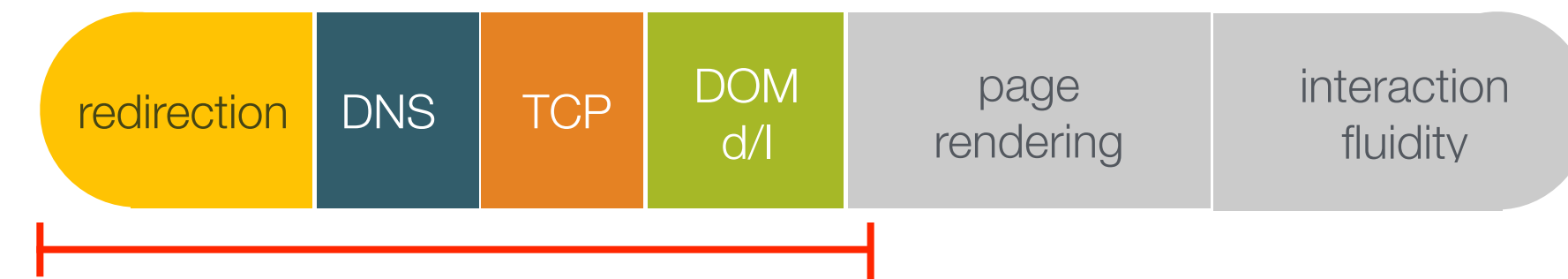
Getting HTTP/2 alone is not enough



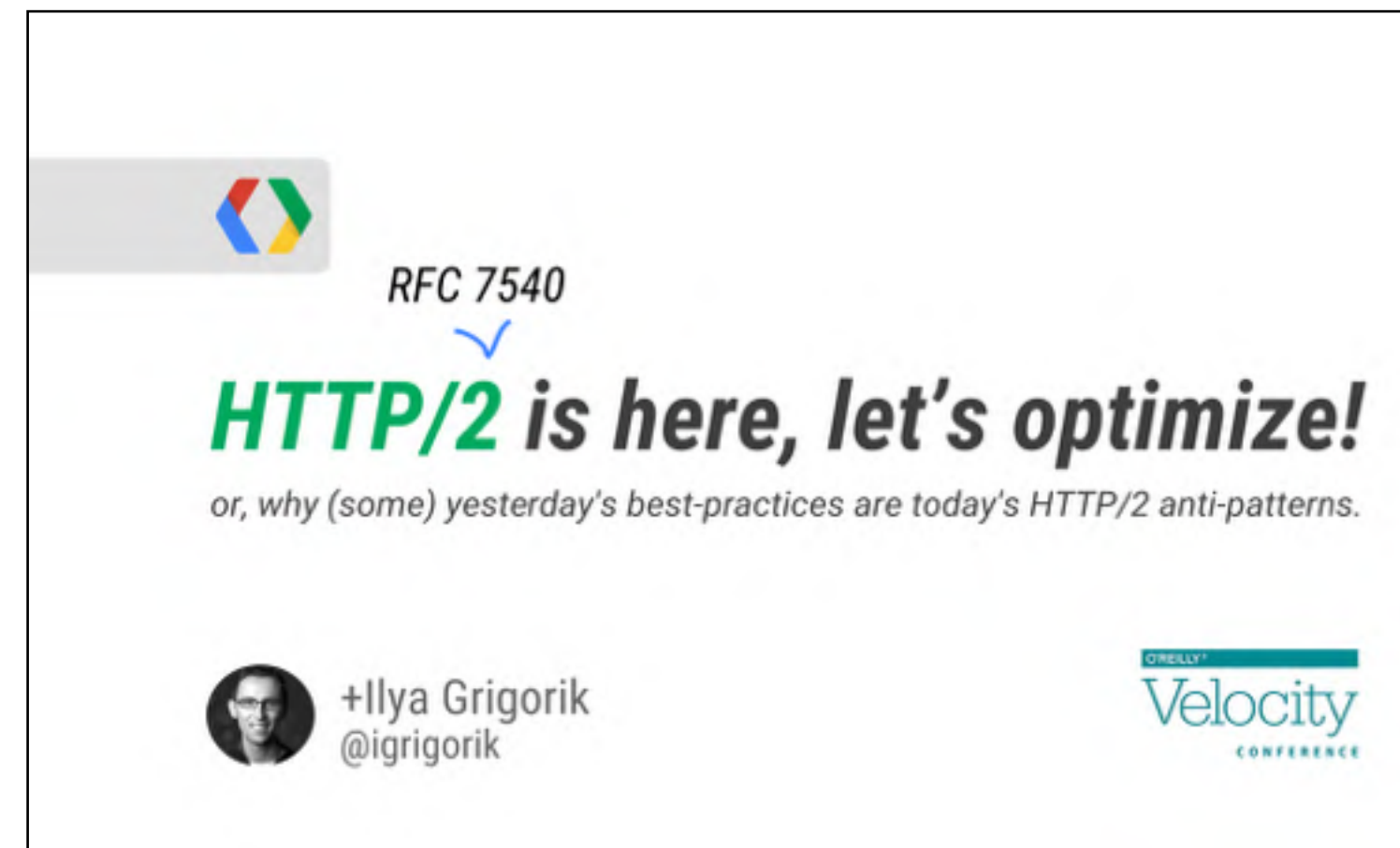
- *Switching to HTTP/2 does not guarantee a faster site*
- *Bad HTTP/2 implementation can hurt*



Getting HTTP/2 alone is not enough



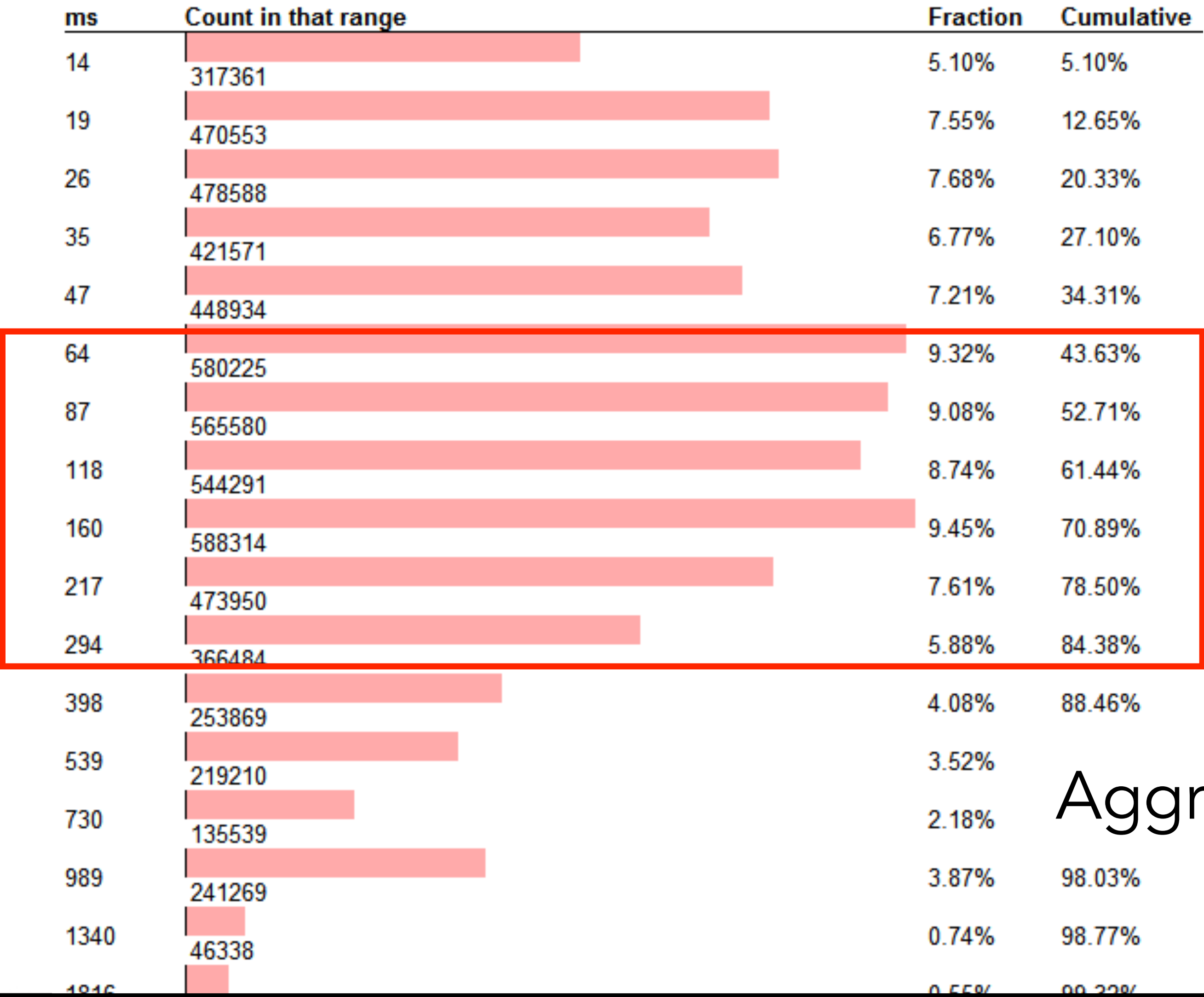
- *Switching to HTTP/2 does not guarantee a faster site*
- *Bad HTTP/2 implementation can hurt*



Great talk from Ilya Grigorik @ Velocity
Santa Clara 2015



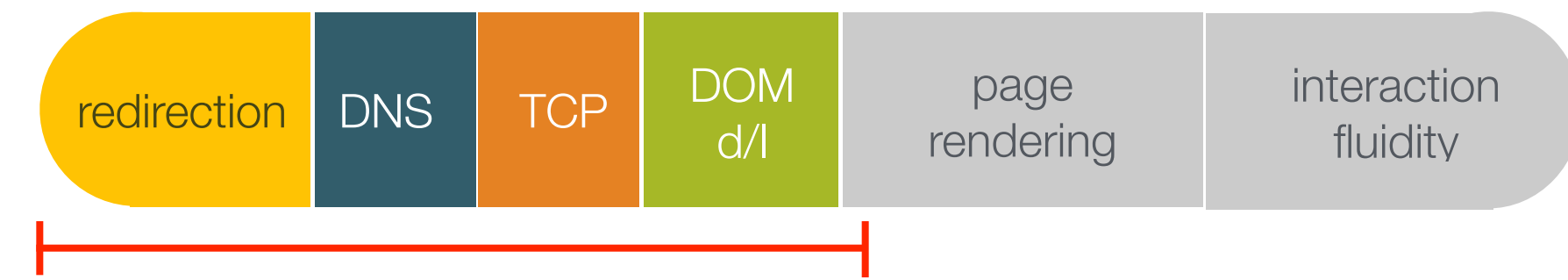
DNS prefetch is getting more important



Aggregated DNS Resolution Times

source: <http://blog.chromium.org/2008/09/dns-prefetching-or-pre-resolving.html>

DNS prefetch



html

```
<link rel="dns-prefetch" href="http://www.alvacheung.com/">
```



9+

Checking prefetch status



Chrome

History

Extensions

Settings

About

Settings

The default browser is currently Google Chrome.

Privacy

Content settings...

Clear browsing data...

Google Chrome may use web services to improve your browsing experience. ` services. [Learn more](#)

☒ Use a web service to help resolve navigation errors

☒ Use a prediction service to help complete searches and URLs typed in the search box

☒ Prefetch resources to load pages more quickly

☐ Automatically report details of possible security incidents to Google

Checking prefetch status



Chrome

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Extensions

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← → ↺

chrome://net-internals/#dns

☆

DNS ▼

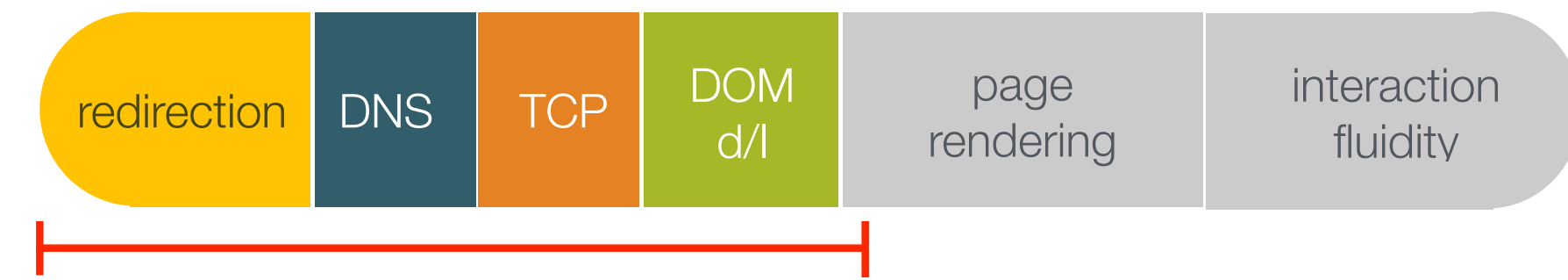
capturing events (8949)

Current State

- Active entries: 14
- Expired entries: 5

Hostname	Family	Addresses	Expires
about.me	IPV4	54.174.231.238 52.5.90.2	2015-07-29 16:52:45.571 [Expired]
alvacheung.com	IPV4	175.41.131.233	2015-07-29 17:42:21.177
amazon.com	IPV4	176.32.98.166 205.251.242.103 72.21.206.6	2015-07-29 16:52:15.165 [Expired]
apis.google.com	IPV4	216.58.192.14	2015-07-29 16:52:46.162 [Expired]
blog.alvacheung.com	IPV4	175.41.131.233	2015-07-29 17:51:17.223
c.go-mpulse.net	IPV4	190.93.246.15 190.93.244.15 141.101.114.15 190.93.245.15 141.101.115.15	2015-07-29 16:56:21.367
clients4.google.com	IPV4	216.58.192.14	2015-07-29 16:53:17.501
coscup.org	IPV4	106.187.90.85	2015-07-29 17:51:44.628
en.wikipedia.org	IPV4	208.80.154.224	2015-07-29 17:01:44.600
inbox.google.com	IPV4	216.58.192.5	2015-07-29 16:56:31.122
oauth.googleusercontent.com	IPV4	74.125.239.42 74.125.239.43 74.125.239.44	2015-07-29 16:52:57.162 [Expired]

DNS record is small enough to miss



DNS record is small enough to miss



```
$ dig google.com

; <=> DiG 9.8.3-P1 <=> google.com
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 39582
;; flags: qr rd ra; QUERY: 1, ANSWER: 11, AUTHORITY: 0, ADDITIONAL: 0

;; QUESTION SECTION:
;google.com.                IN      A

;; ANSWER SECTION:
google.com.                197     IN      A      74.125.224.8
google.com.                197     IN      A      74.125.224.2
google.com.                197     IN      A      74.125.224.7
google.com.                197     IN      A      74.125.224.6
google.com.                197     IN      A      74.125.224.4
google.com.                197     IN      A      74.125.224.5
google.com.                197     IN      A      74.125.224.3
google.com.                197     IN      A      74.125.224.1
google.com.                197     IN      A      74.125.224.9
google.com.                197     IN      A      74.125.224.14
google.com.                197     IN      A      74.125.224.0

;; Query time: 51 msec
;; SERVER: 172.16.255.1#53(172.16.255.1)
;; WHEN: Wed Jul 29 17:17:19 2015
;; MSG SIZE  rcvd: 204
```


DNS record is small enough to miss



```
$ dig google.com

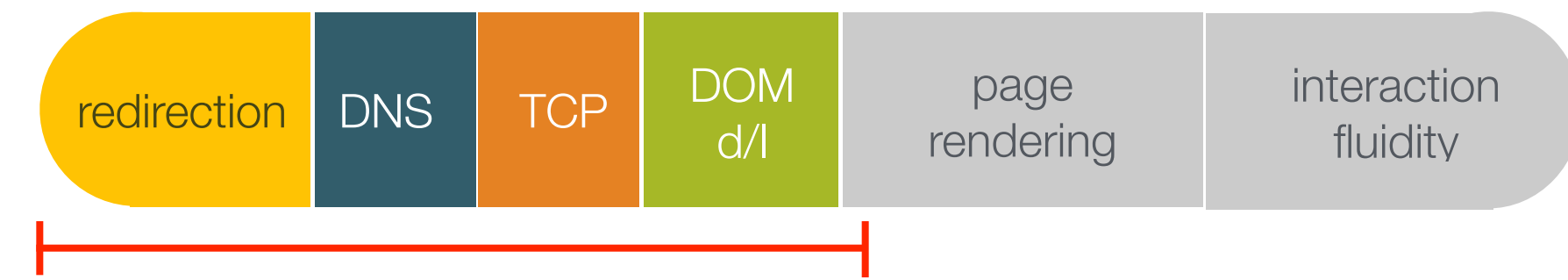
; <=> DiG 9.8.3-P1 <=> google.com
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 39582
;; flags: qr rd ra; QUERY: 1, ANSWER: 11, AUTHORITY: 0, ADDITIONAL: 0

;; QUESTION SECTION:
;google.com.                IN      A

;; ANSWER SECTION:
google.com.                197     IN      A      74.125.224.8
google.com.                197     IN      A      74.125.224.2
google.com.                197     IN      A      74.125.224.7
google.com.                197     IN      A      74.125.224.6
google.com.                197     IN      A      74.125.224.4
google.com.                197     IN      A      74.125.224.5
google.com.                197     IN      A      74.125.224.3
google.com.                197     IN      A      74.125.224.1
google.com.                197     IN      A      74.125.224.9
google.com.                197     IN      A      74.125.224.14
google.com.                197     IN      A      74.125.224.0

;; Query time: 51 msec
;; SERVER: 172.16.255.1#53(172.16.255.1)
;; WHEN: Wed Jul 29 17:17:19 2015
;; MSG SIZE rcvd: 204
```


Other prefetches

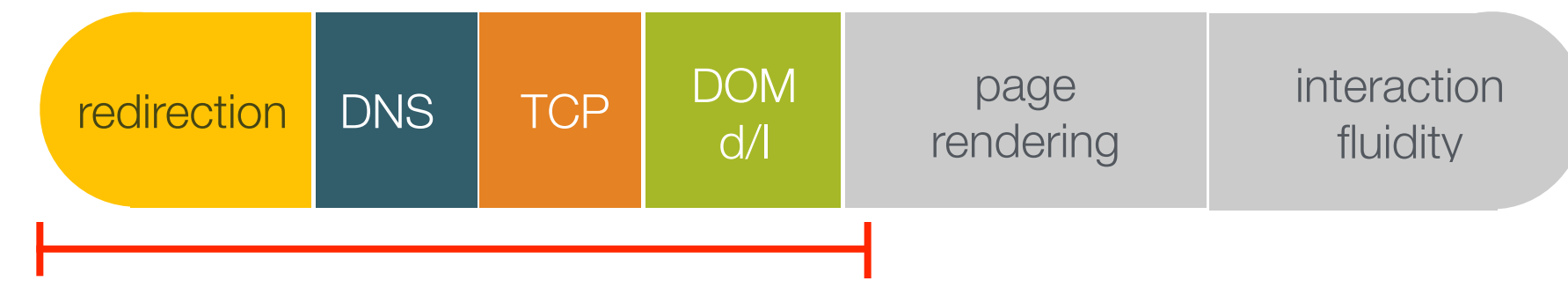


Resource prefetch     9+

```
<link rel="prefetch" href="http://alvacheung.com/">
```

html

Other prefetches



Resource prefetch     9+

html

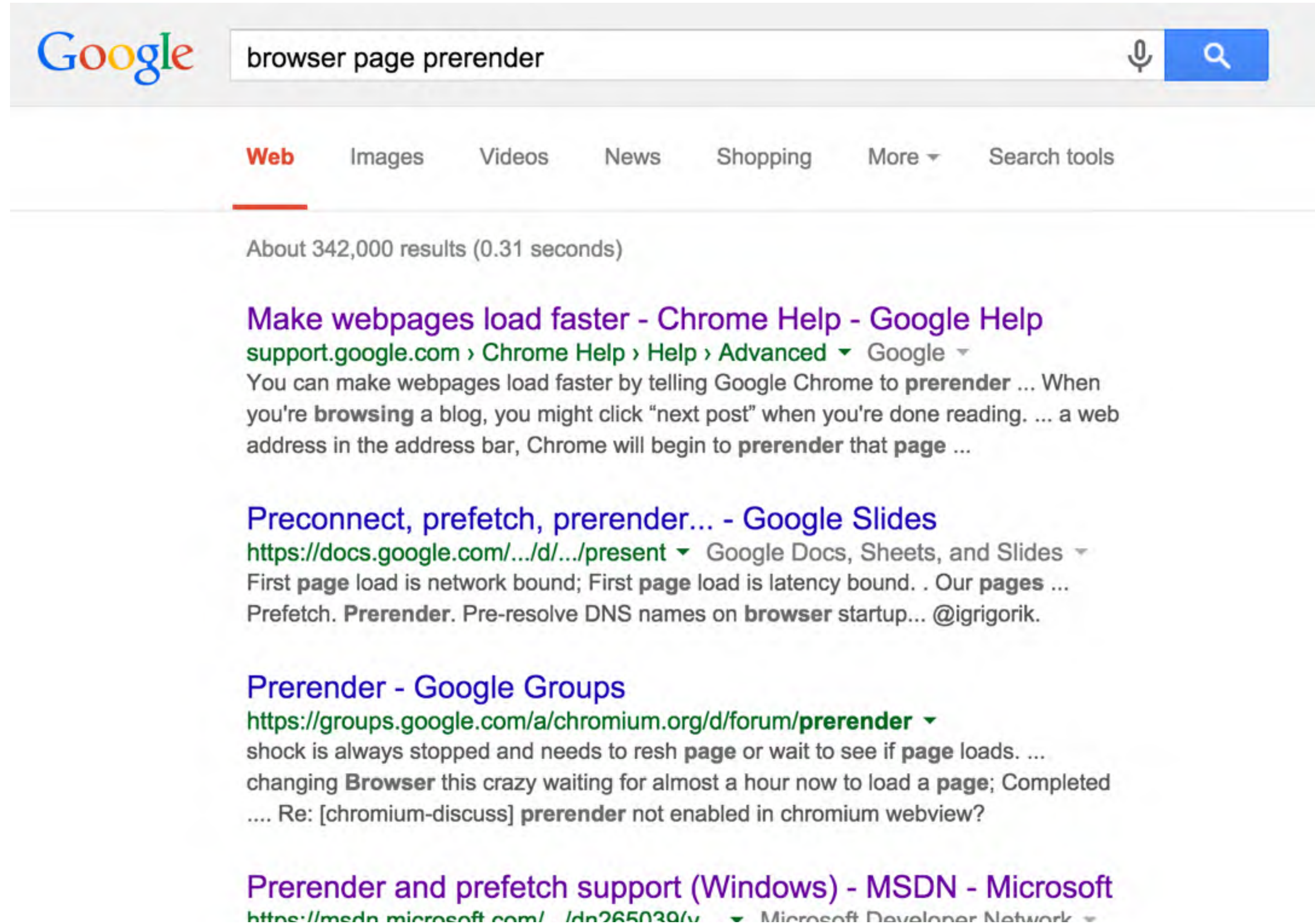
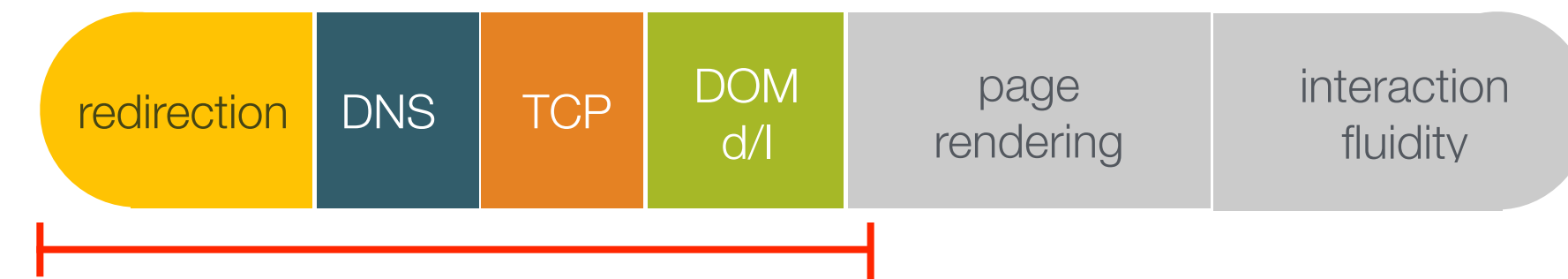
```
<link rel="prefetch" href="http://alvacheung.com/">
```

Page prerender  

html

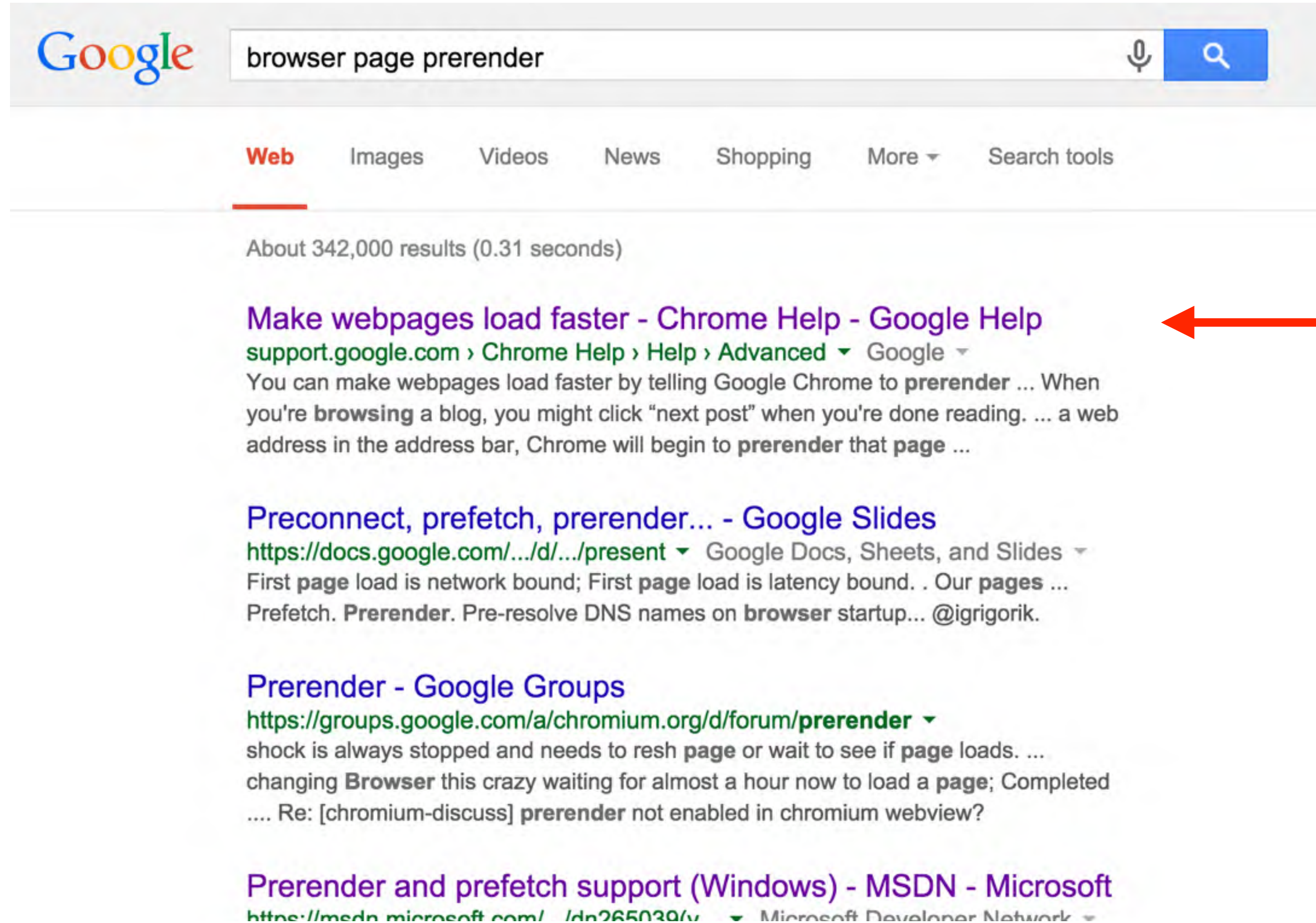
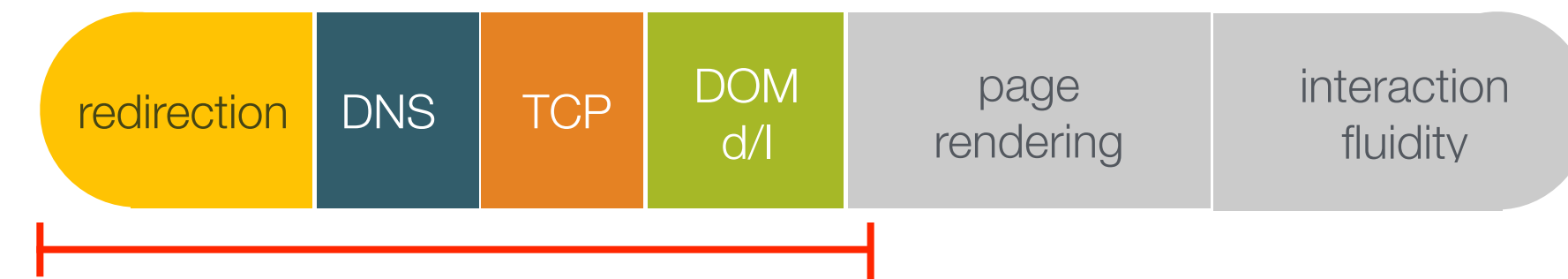
```
<link rel="prerender" href="http://alvacheung.com">
```


Use prerender mindfully



source: <http://google.com>

Use prerender mindfully



click thru:
35%-45%



source: <http://google.com>

Use prerender mindfully



A screenshot of a Google search results page for the query "browser page prerender". The search bar at the top shows the query. Below the search bar, there are tabs for "Web", "Images", "Videos", "News", "Shopping", "More", and "Search tools". The "Web" tab is selected. The results show "About 342,000 results (0.31 seconds)". The first result is "Make webpages load faster - Chrome Help - Google Help" with a snippet about prerendering. The second result is "Preconnect, prefetch, prerender... - Google Slides" with a snippet about network and latency bounds. The third result is "Prerender - Google Groups" with a snippet about Chromium. The fourth result is "Prerender and prefetch support (Windows) - MSDN - Microsoft" with a snippet about Windows support.

← click thru:
35%-45%

← click thru:
15%-20%

source: <http://google.com>

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#velocityconf

redirections

DNS

TCP

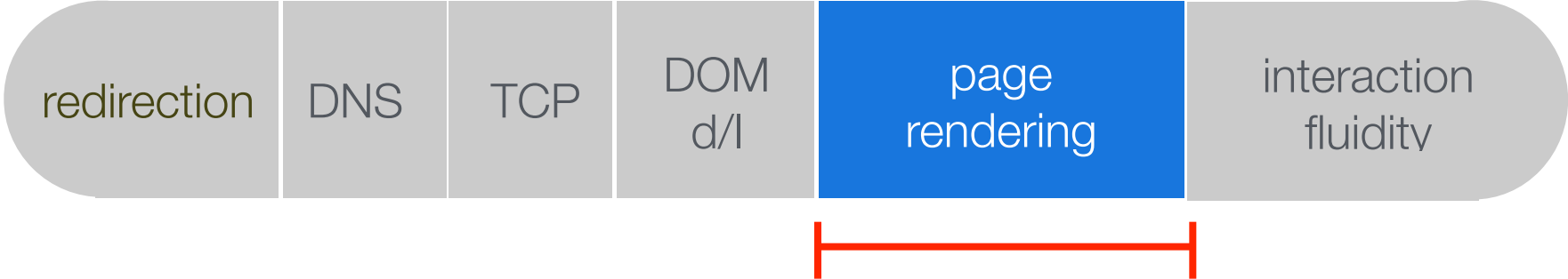
DOM
download

page
rendering

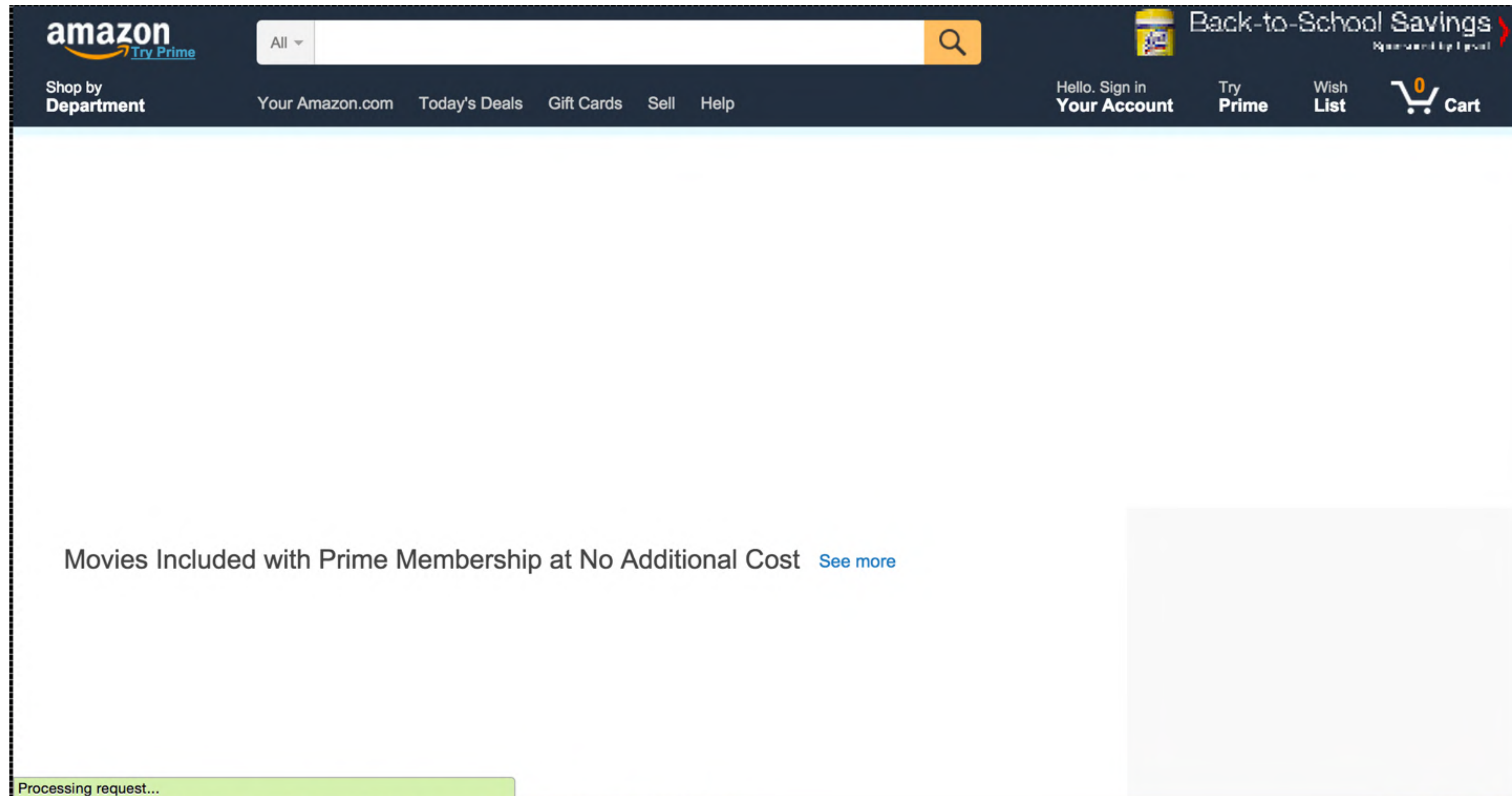
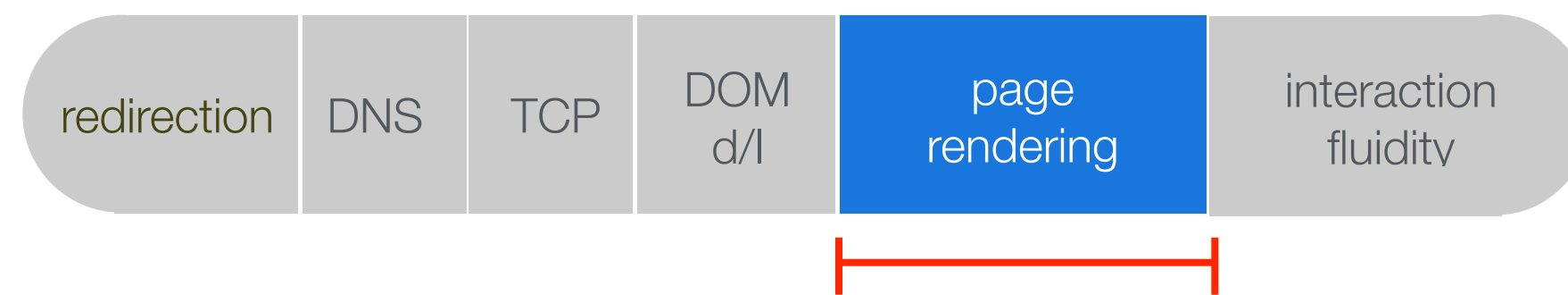
interaction
fluidity

**survive
big codebase**

You are not your target audience

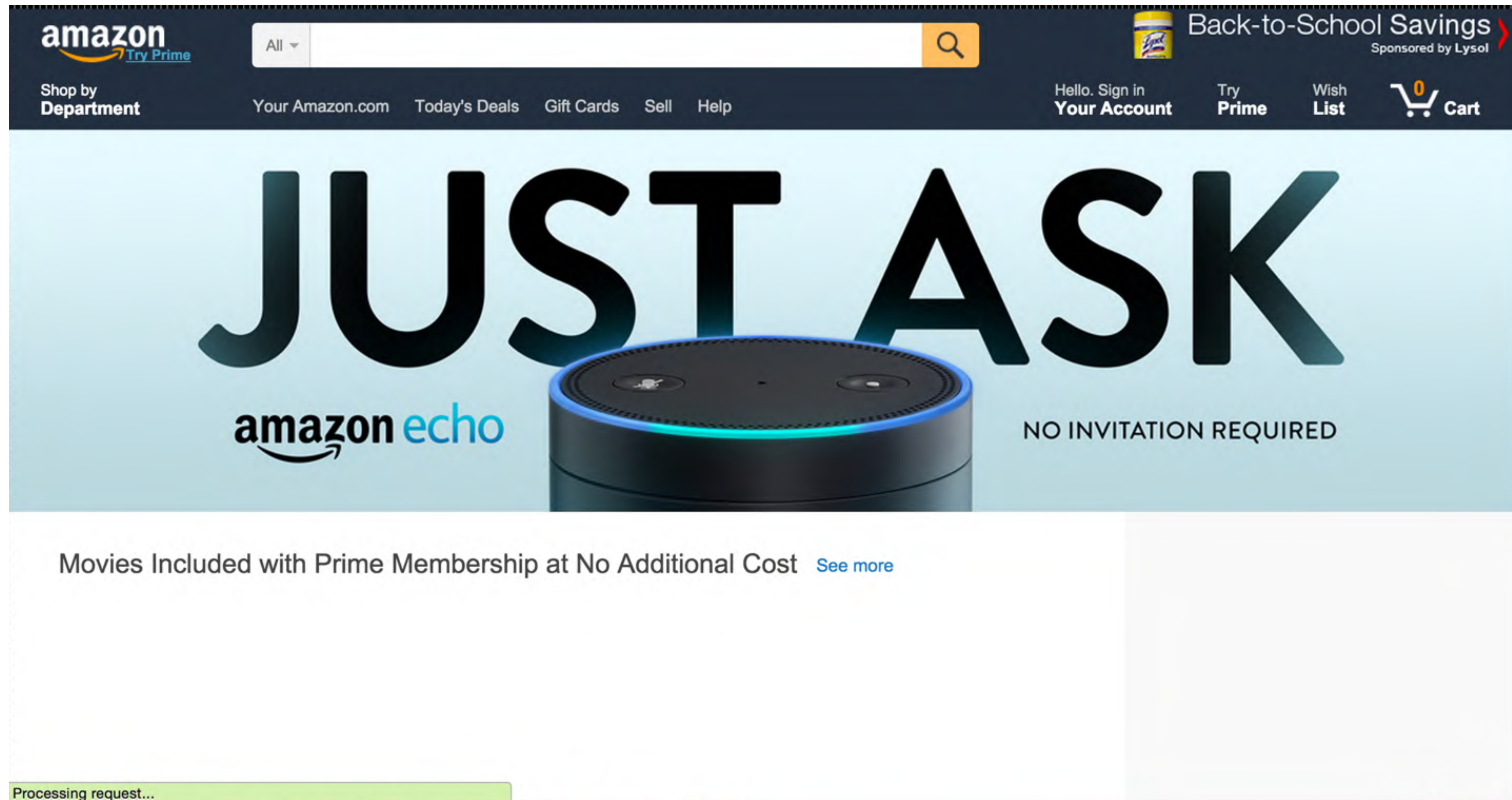


Dealing with large pages

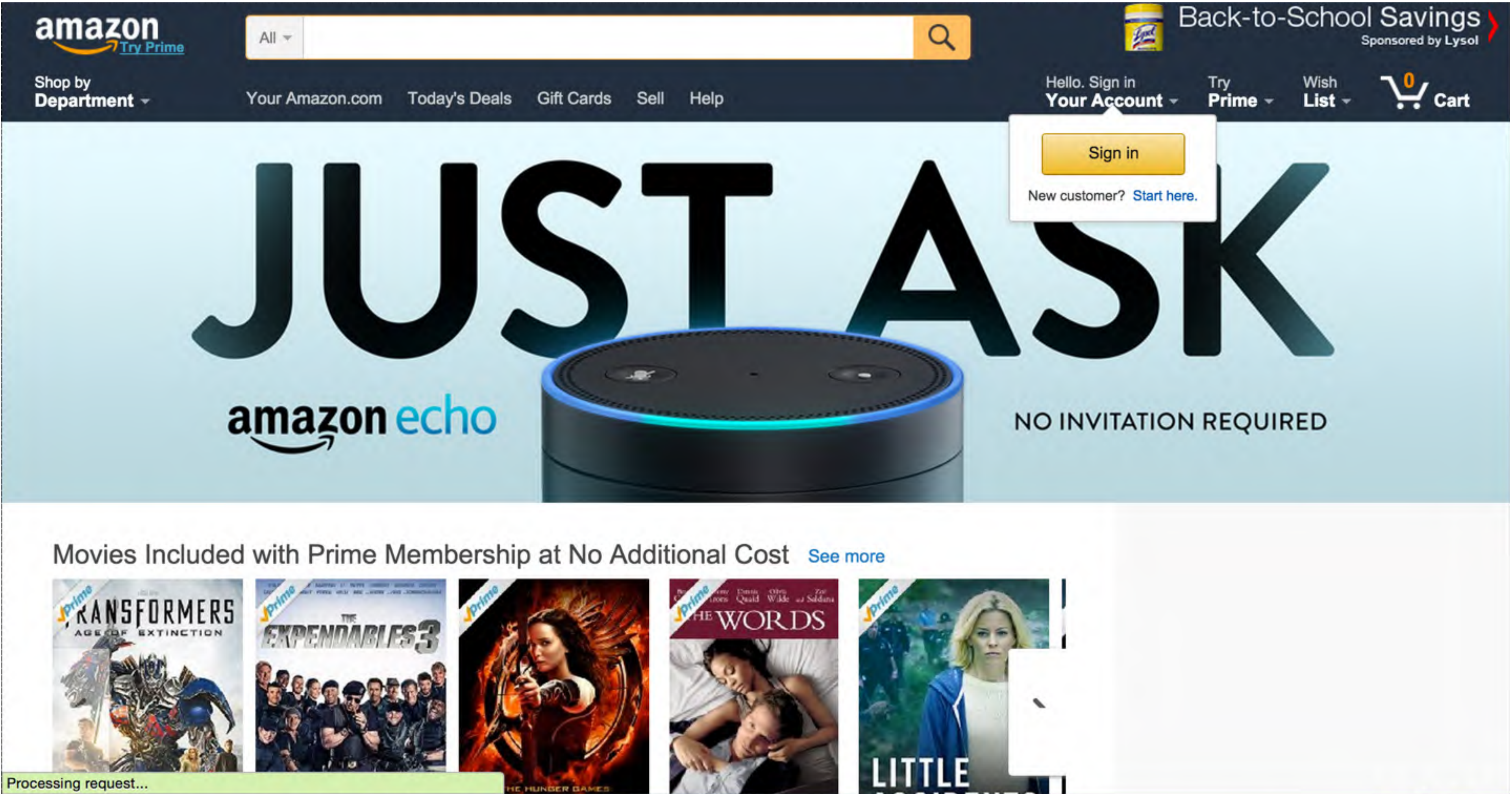
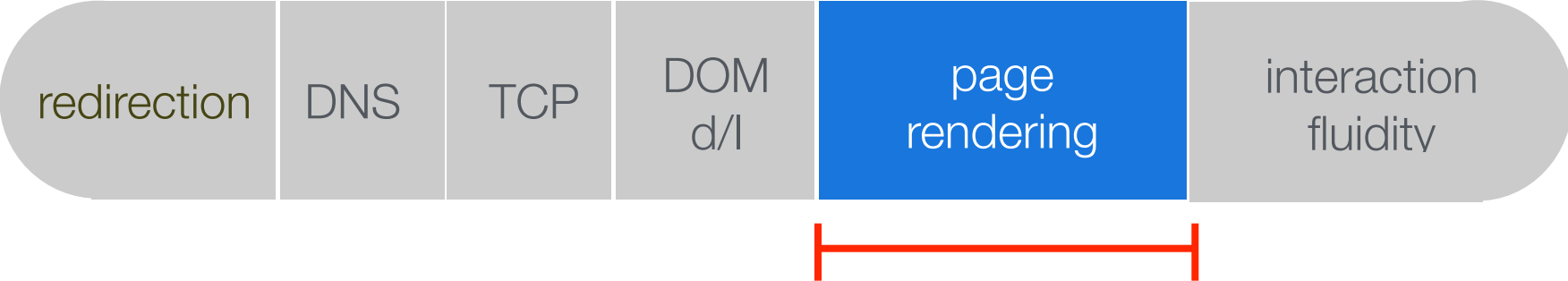


source: <http://amazon.com>

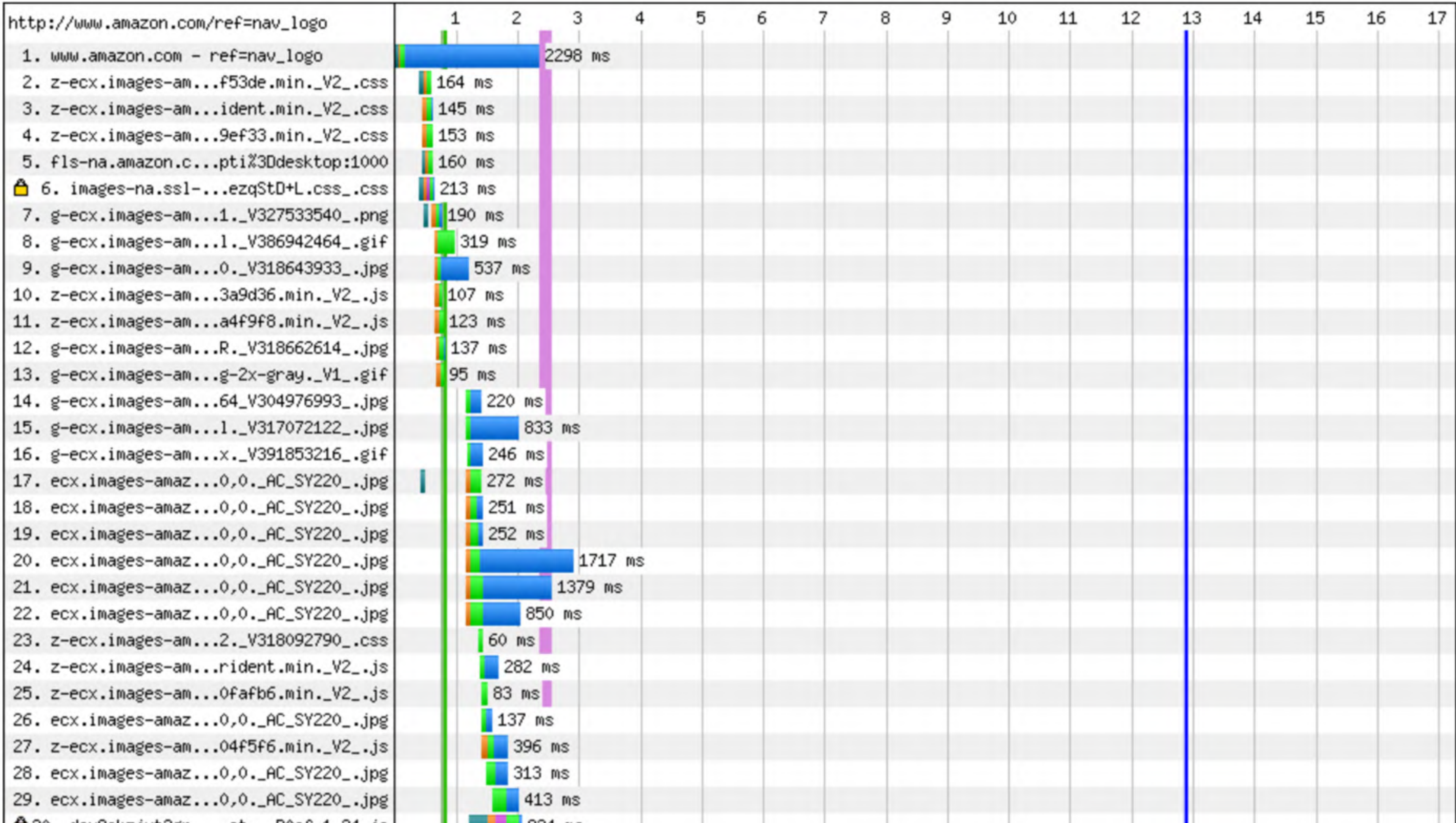
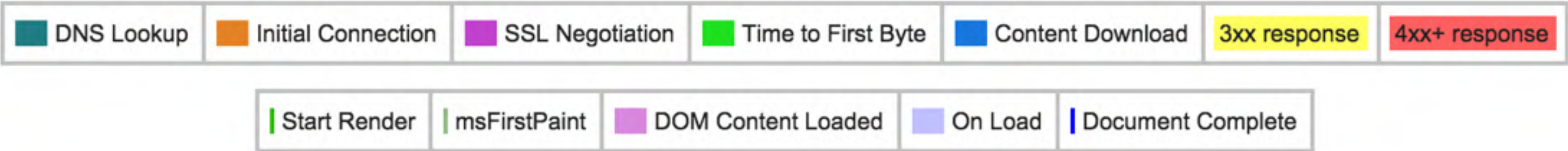
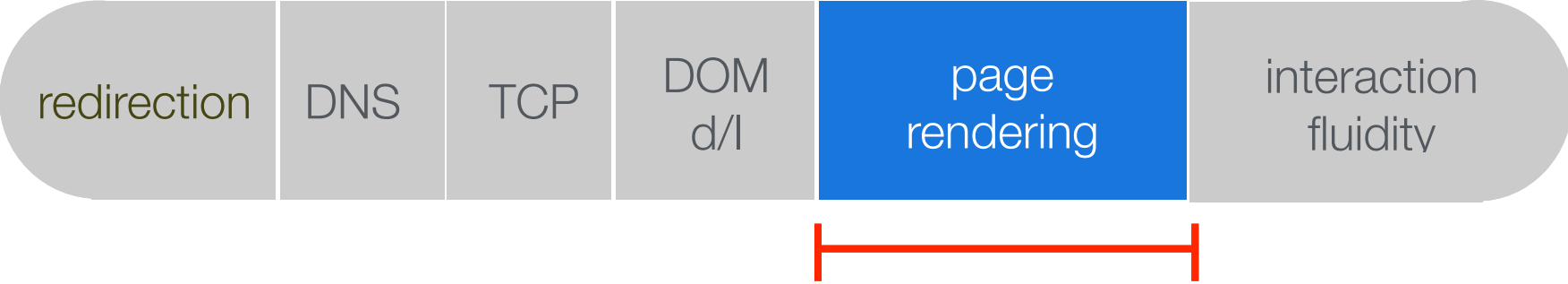
Dealing with large pages



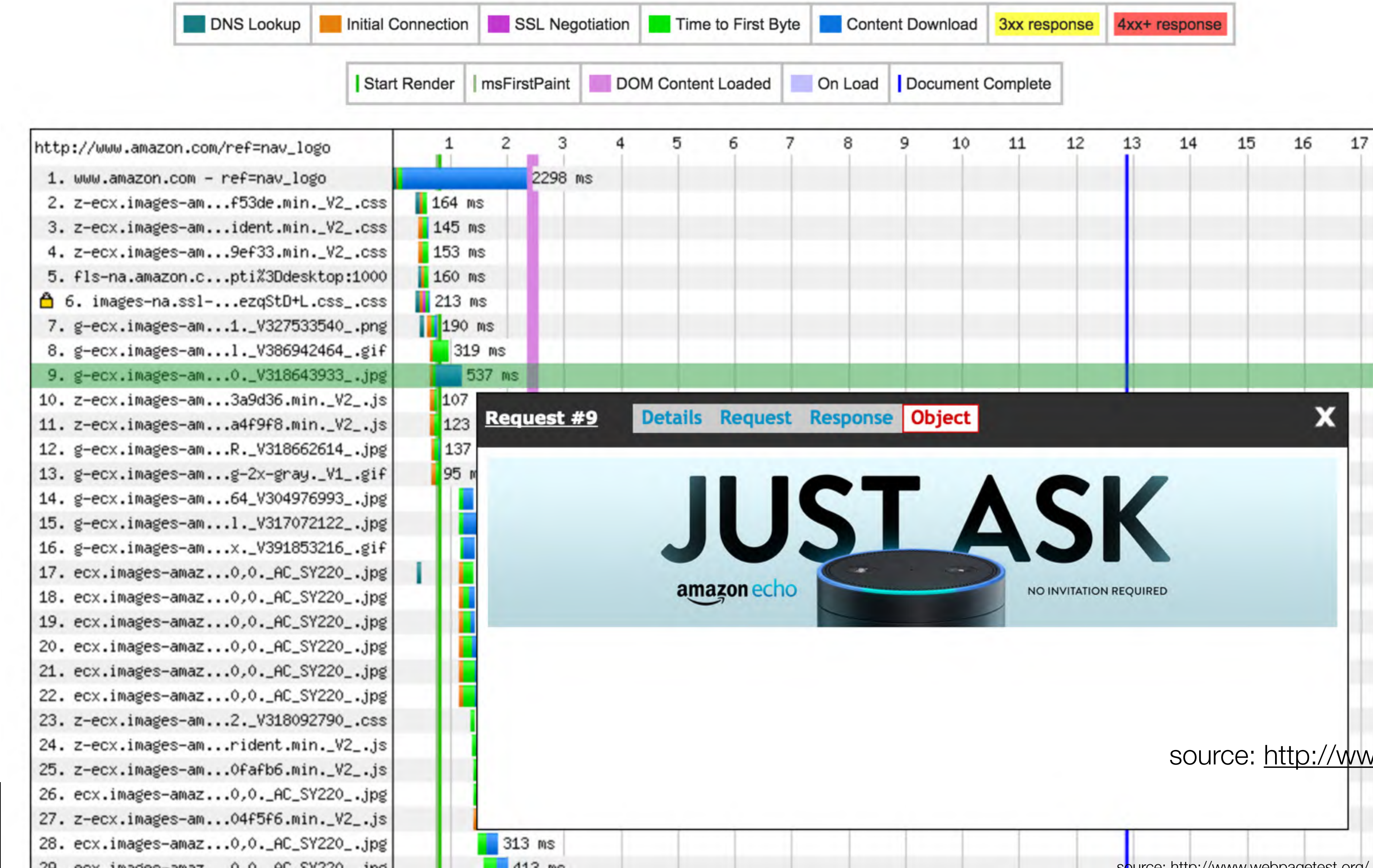
Dealing with large pages



Rendering large pages

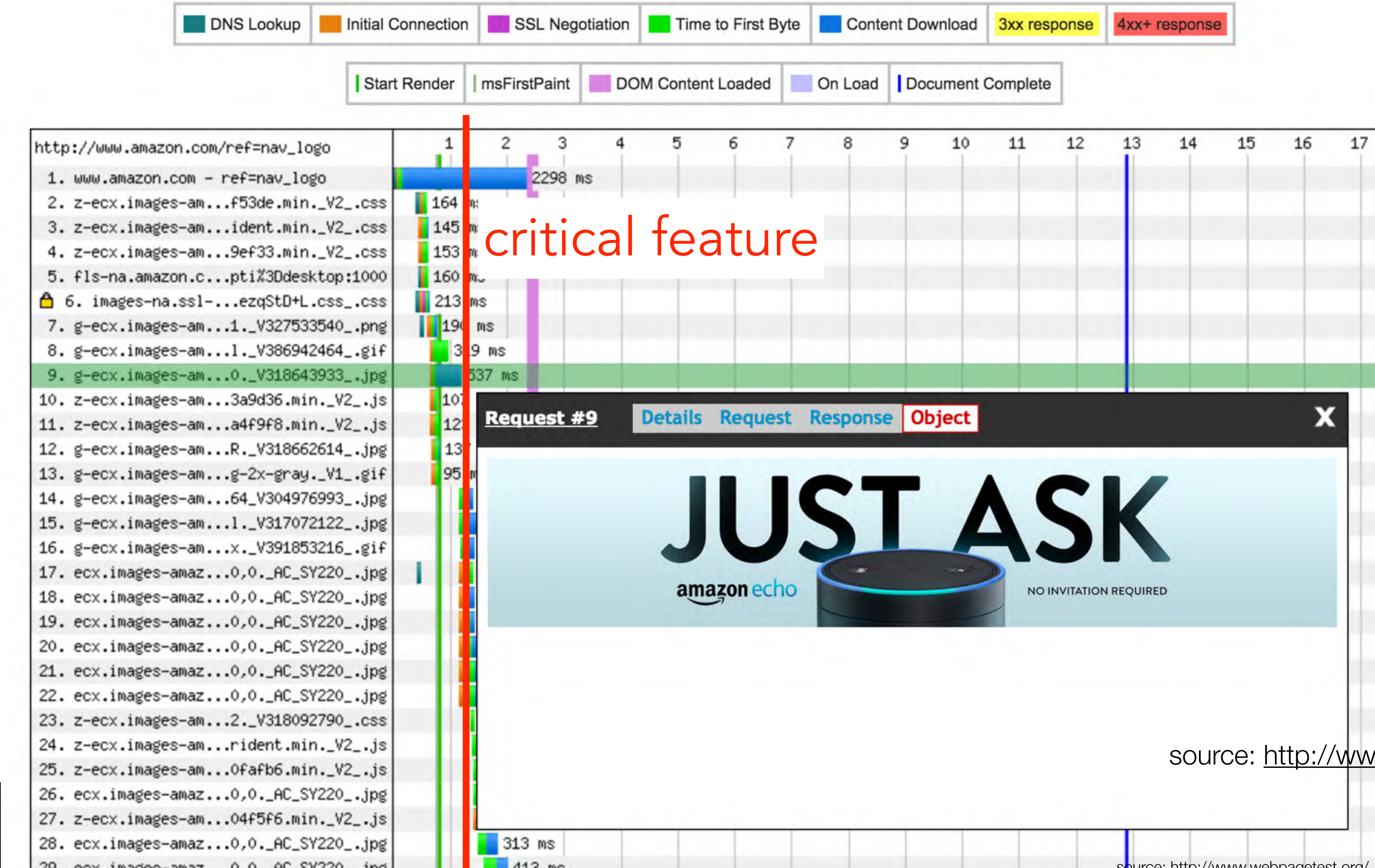


Render your critical feature first



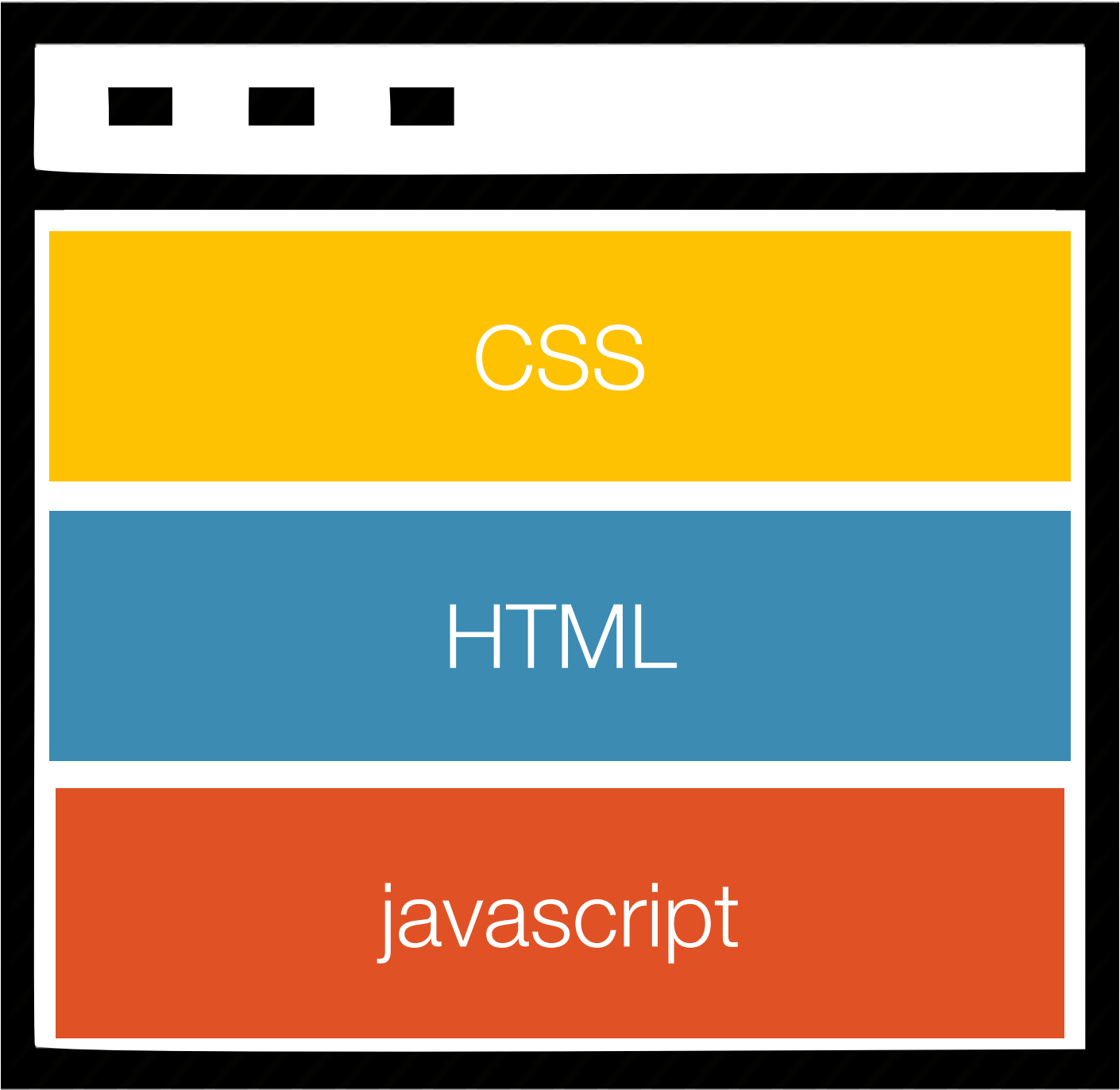
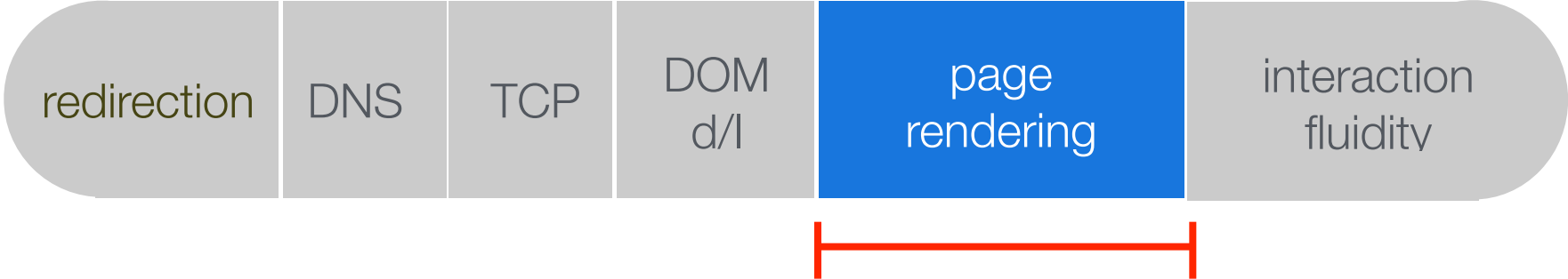
source: <http://www.webpagetest.org/>

Render your critical feature first



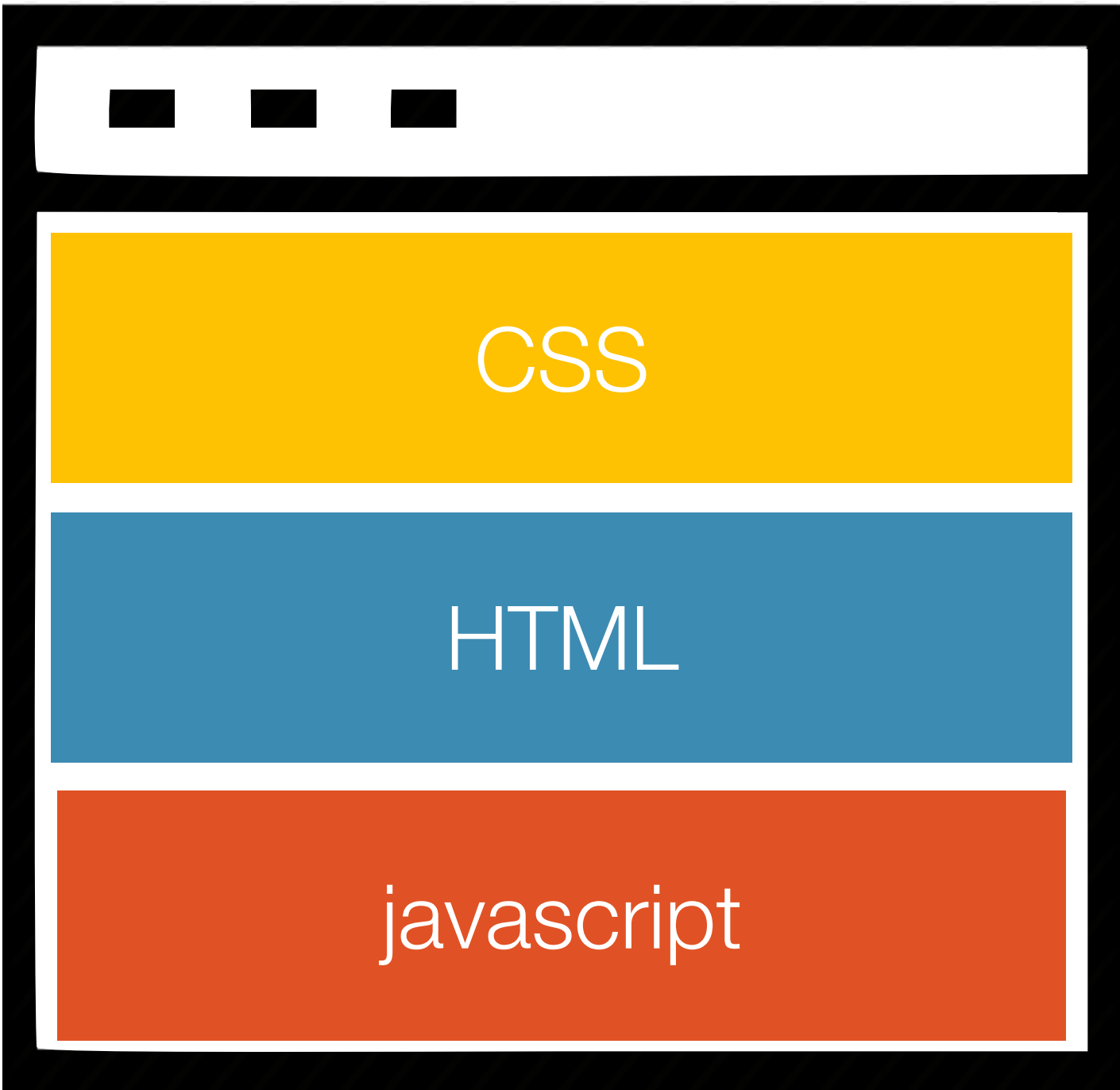
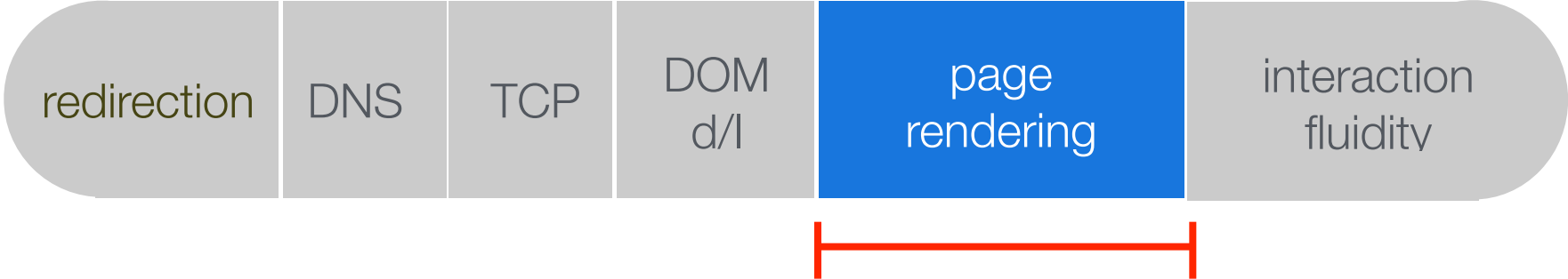
source: <http://www.webpagetest.org/>

Why we care about JS rendering?

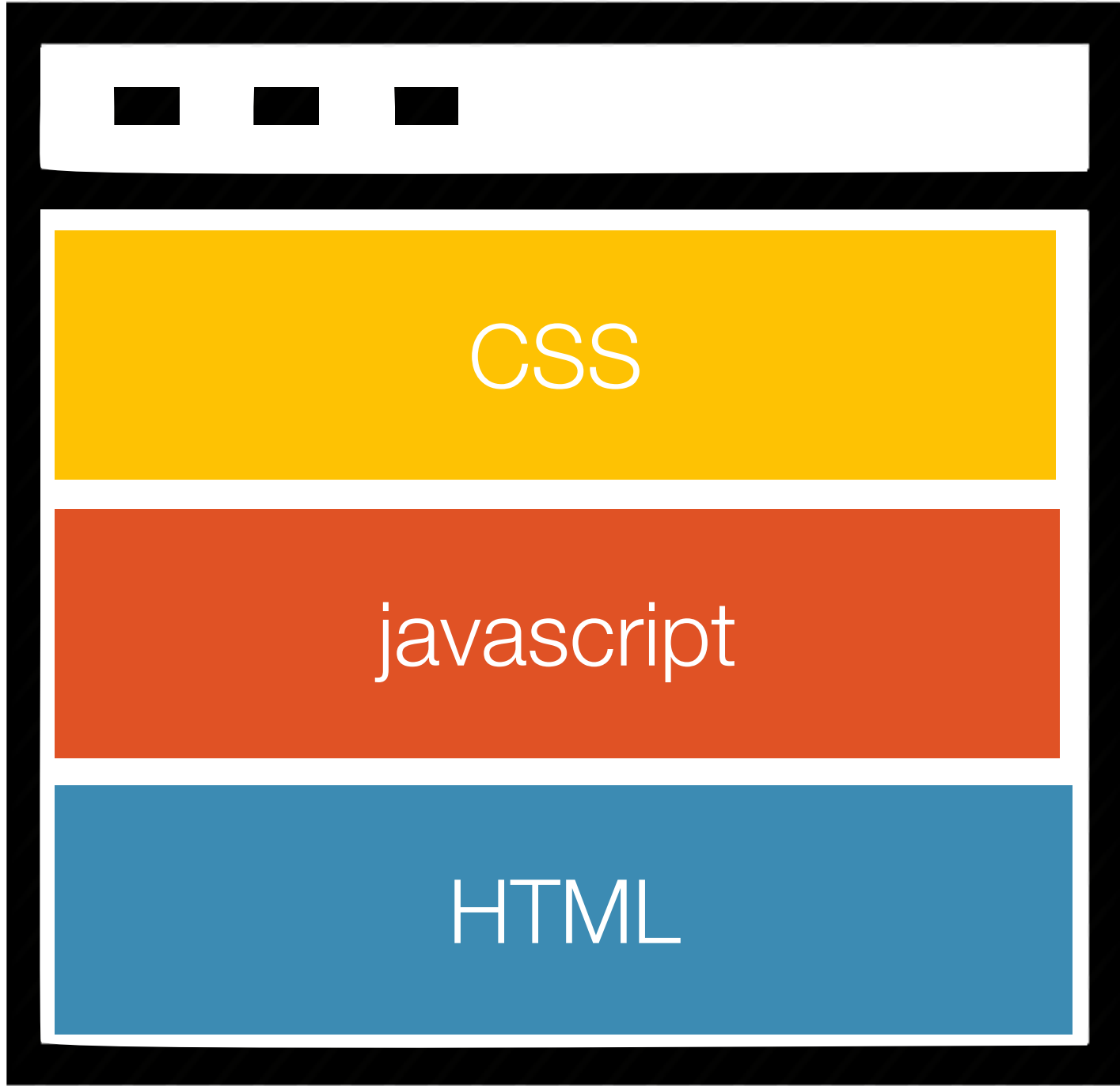


Static websites

Why we care about JS rendering?

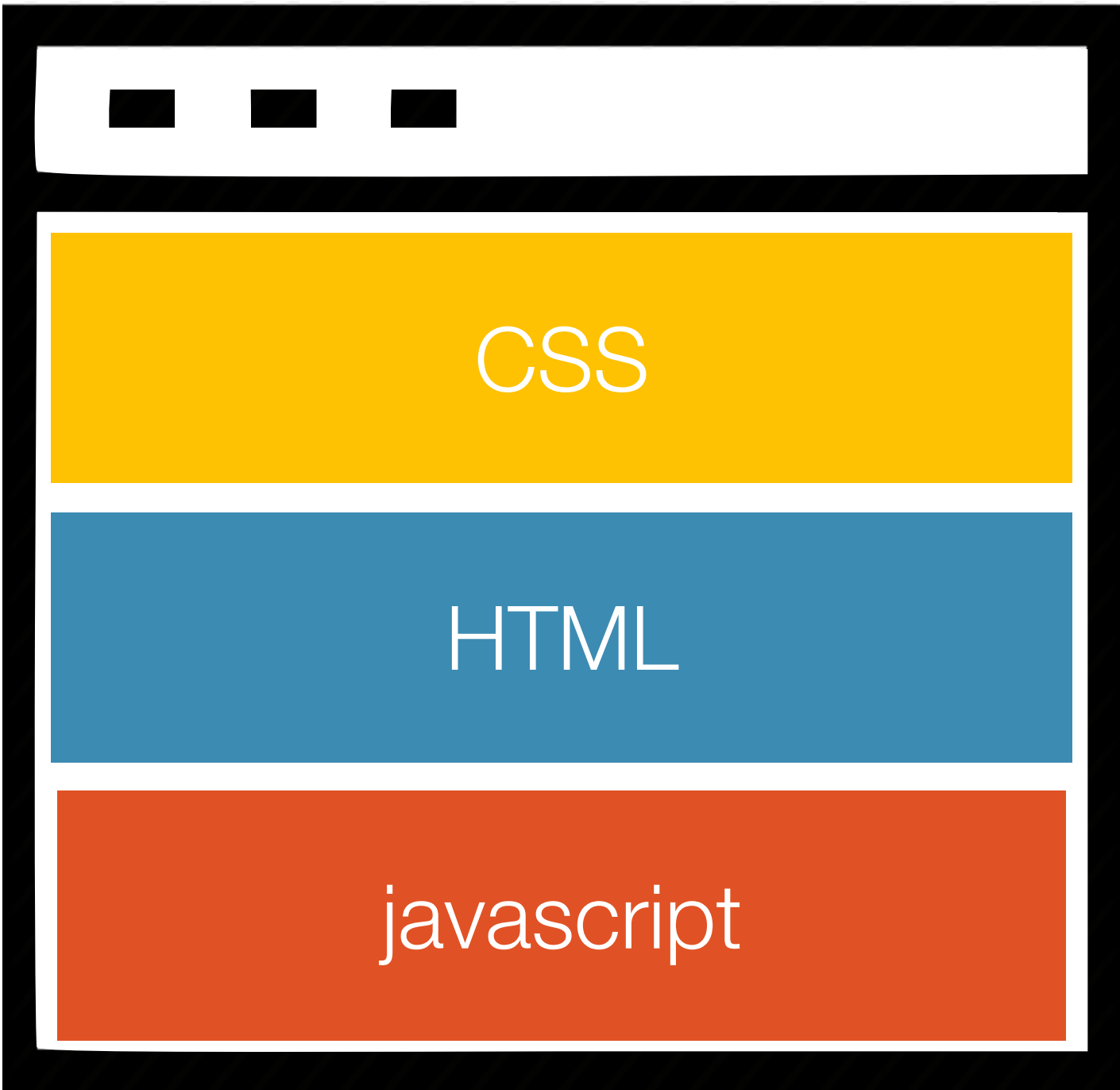
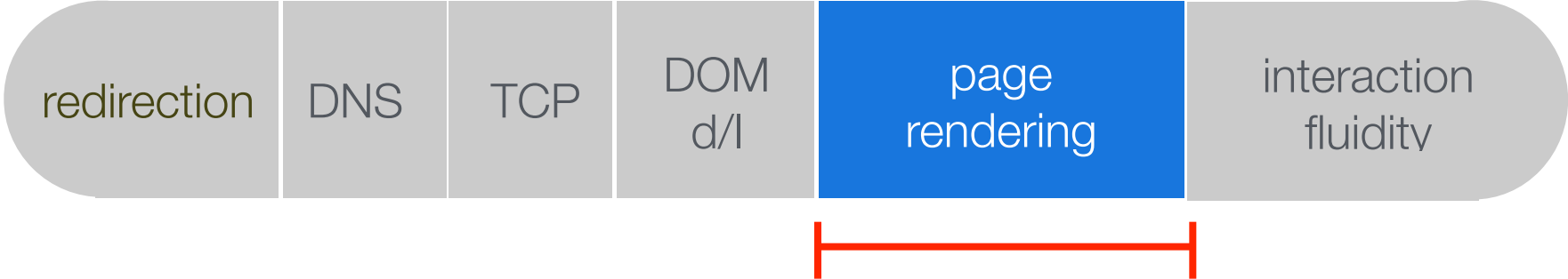


Static websites

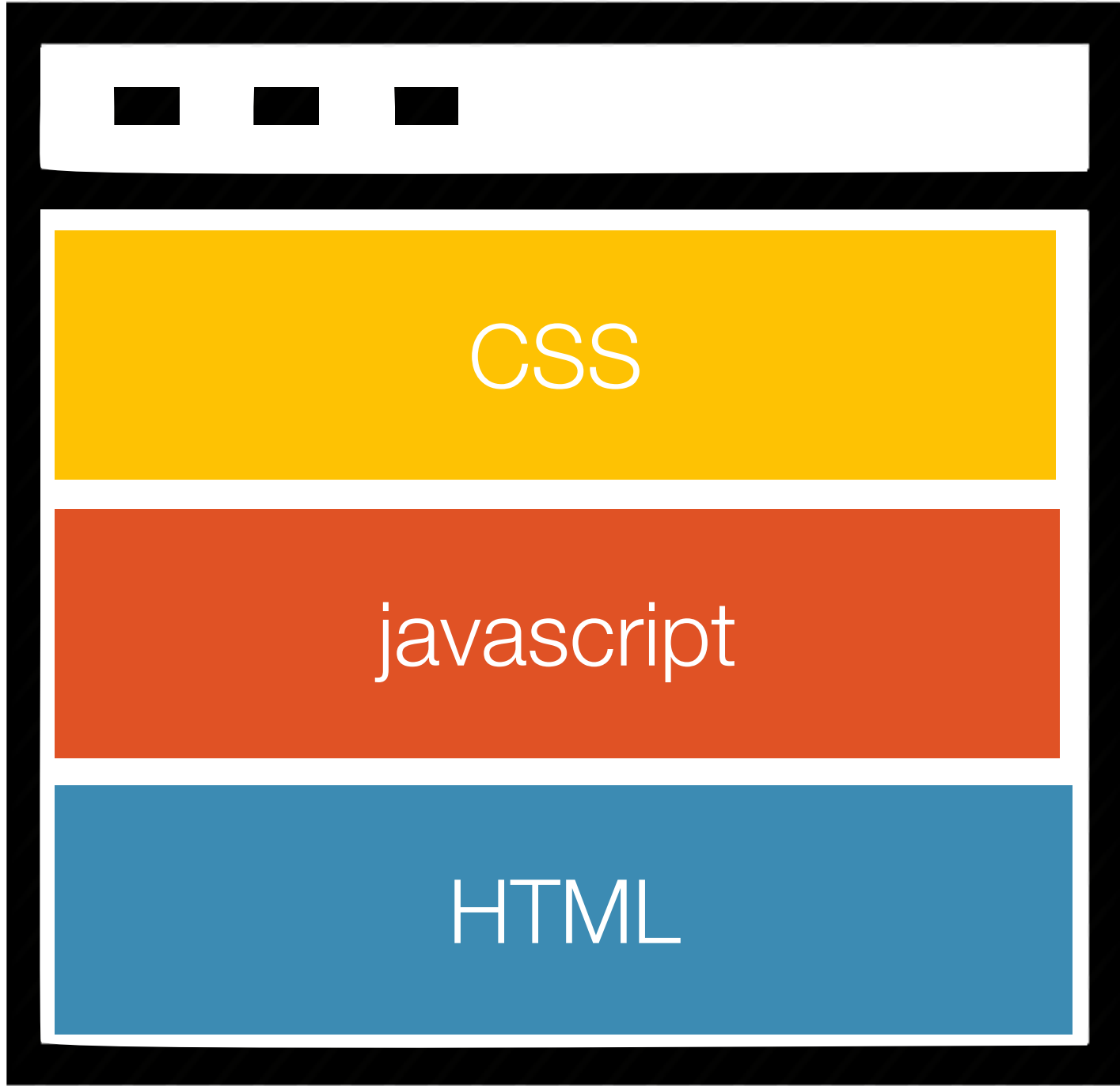


Interactive/js rendered websites

Why we care about JS rendering?



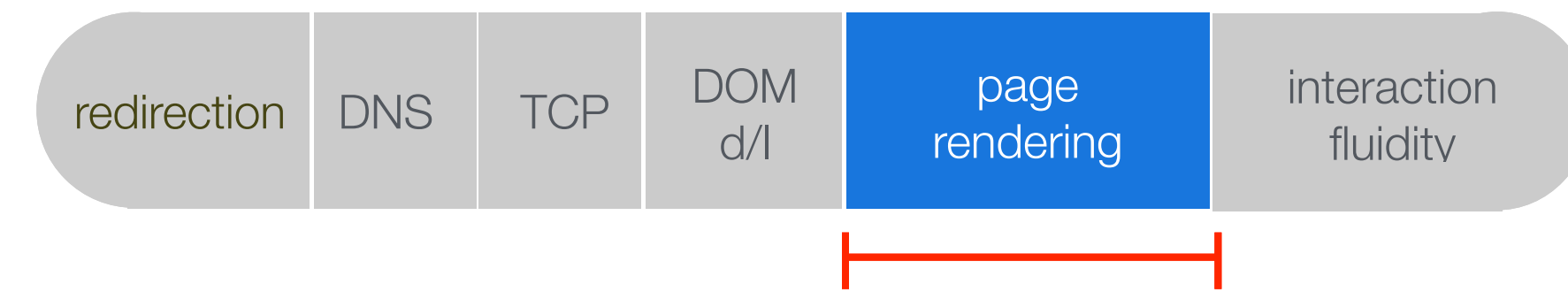
Static websites



Interactive/js rendered websites

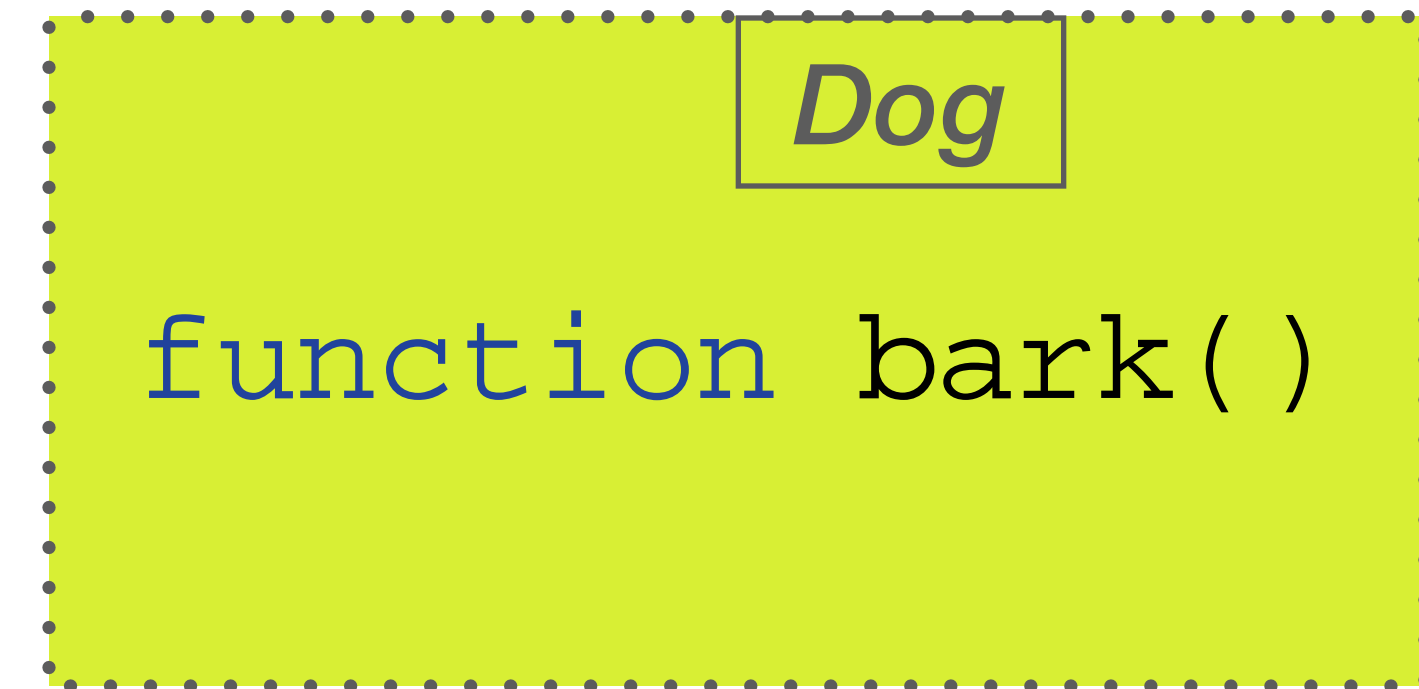


Inline caching optimizes execution

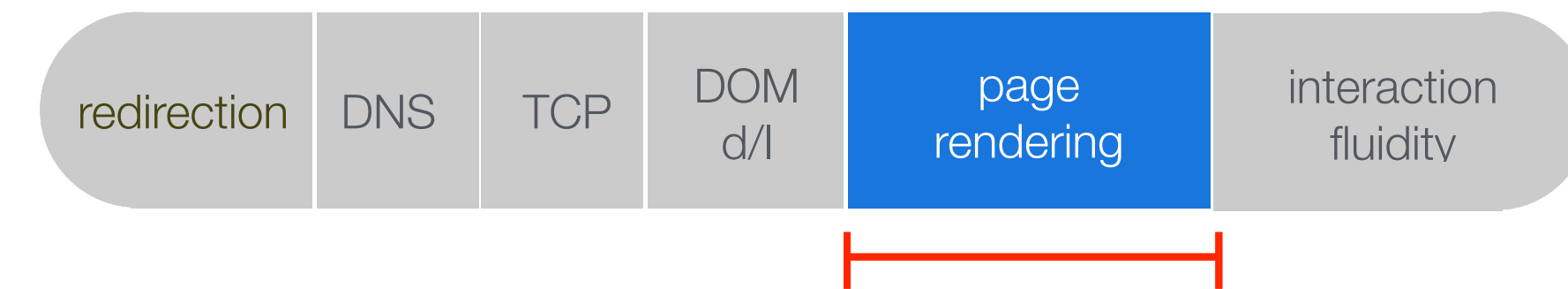


```
dog.bark( )
```

runtime

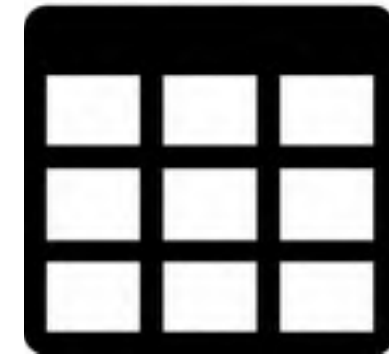


Inline caching optimizes execution

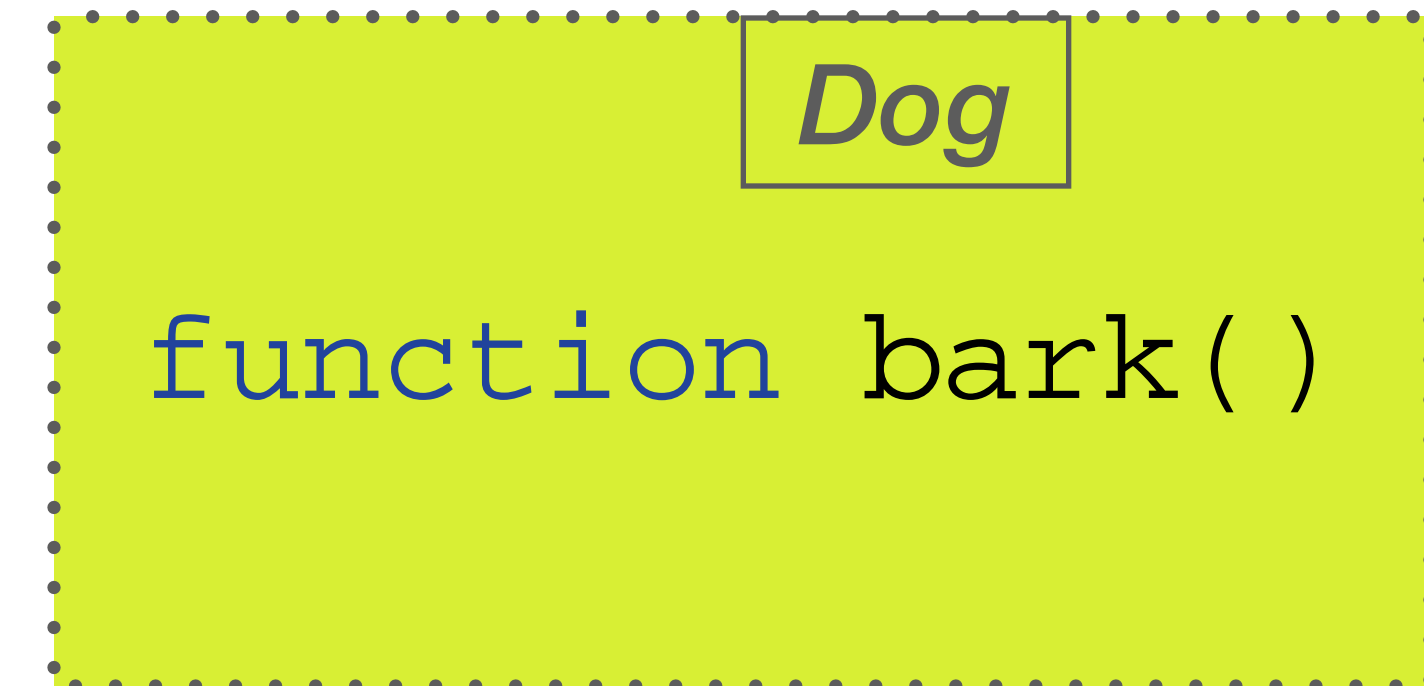


```
dog.bark ( )
```

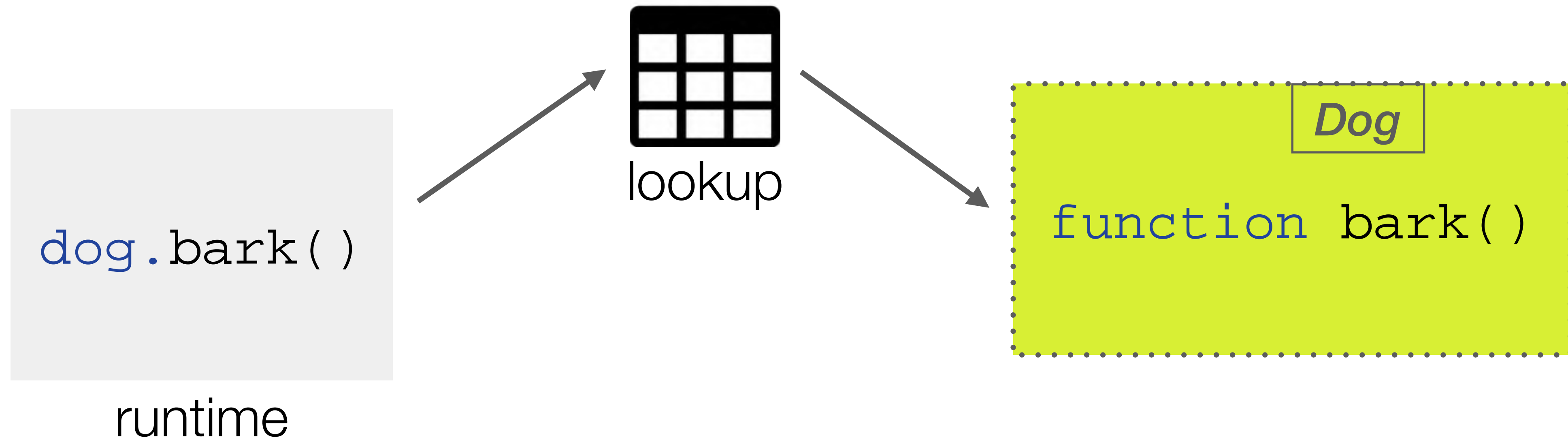
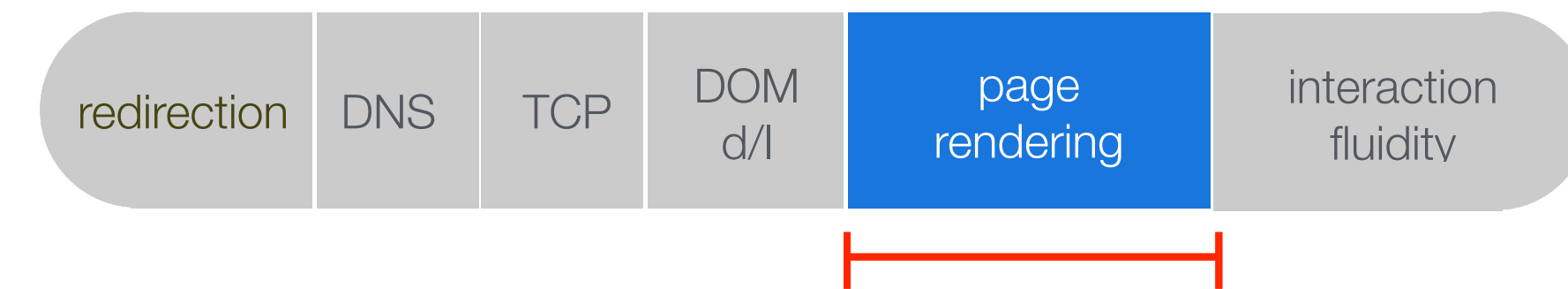
runtime



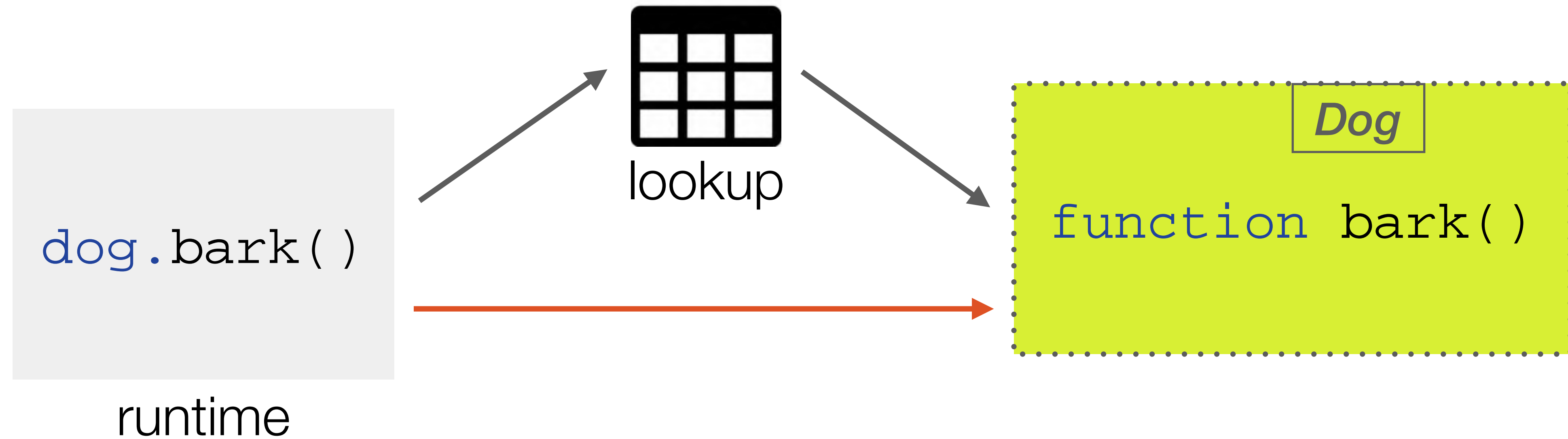
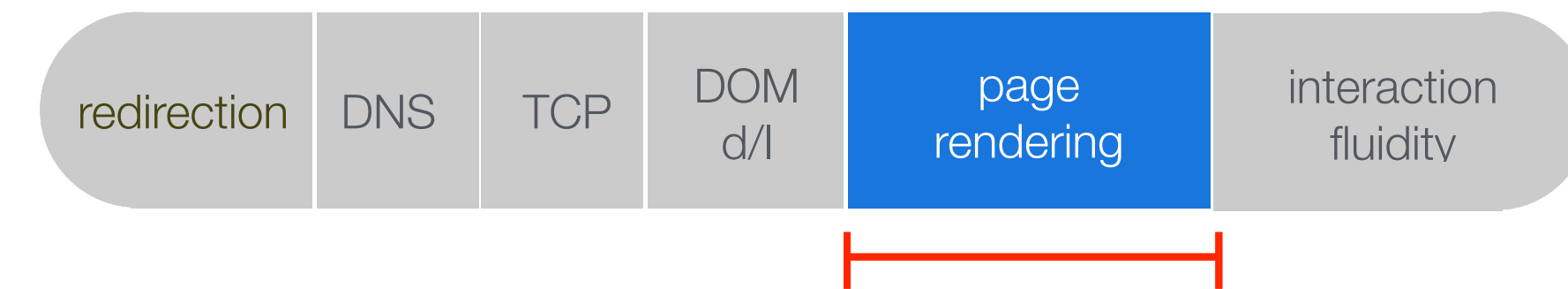
lookup



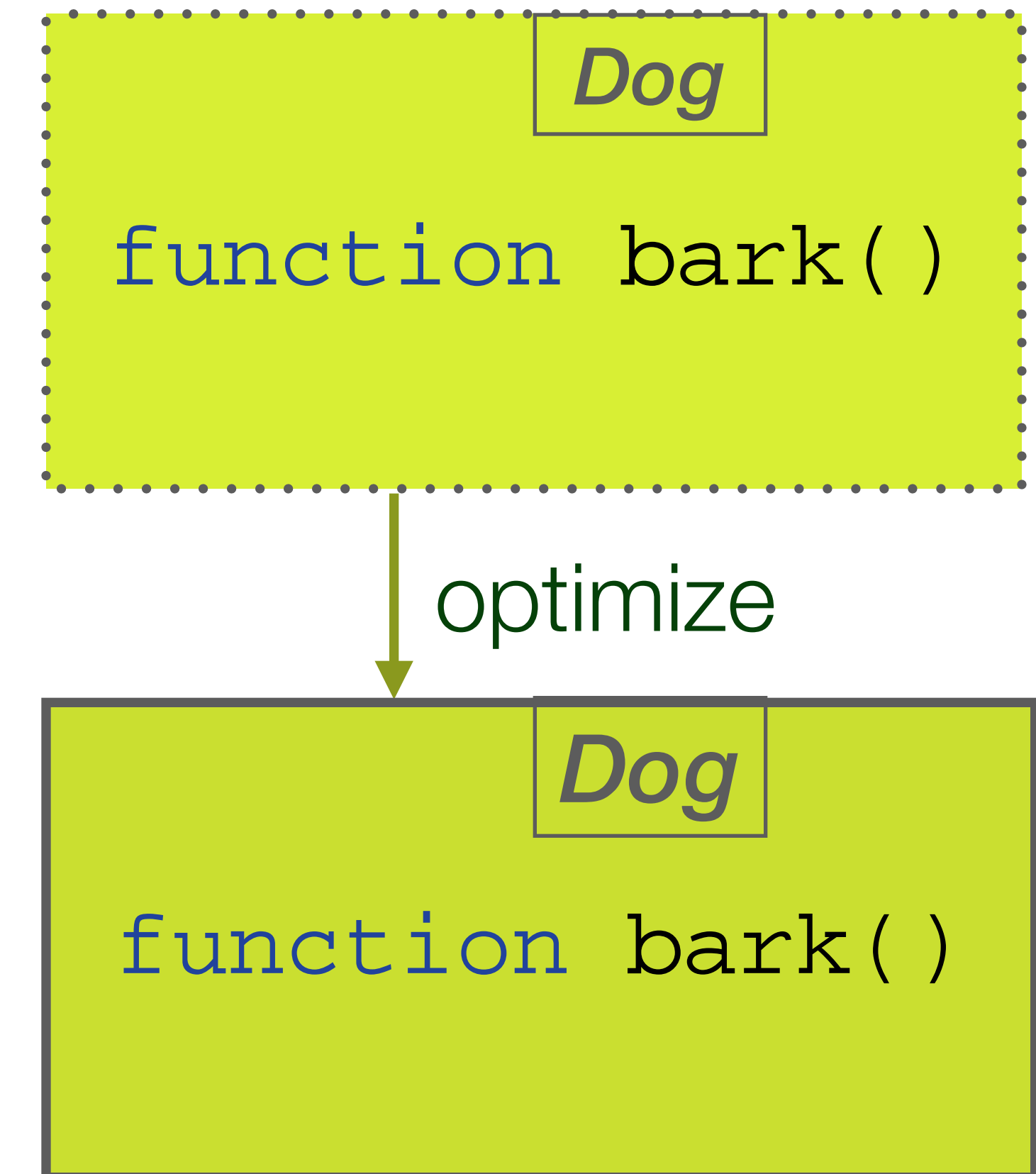
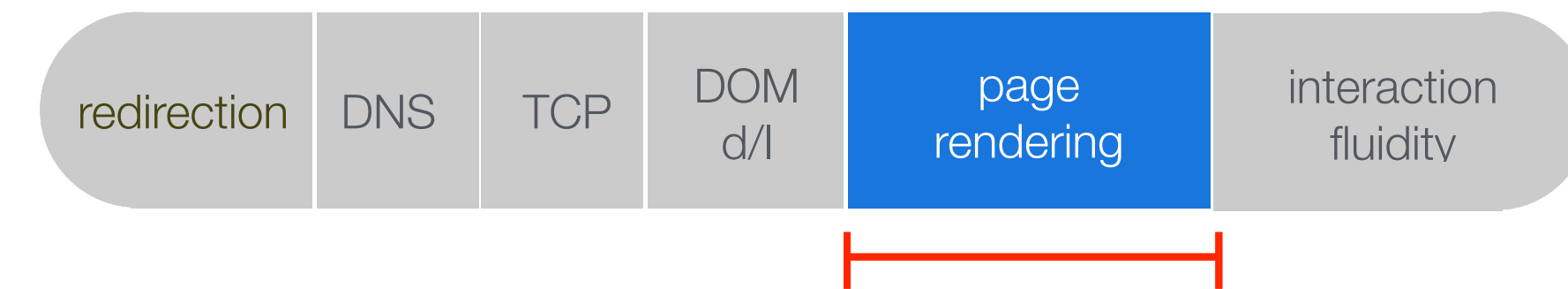
Inline caching optimizes execution



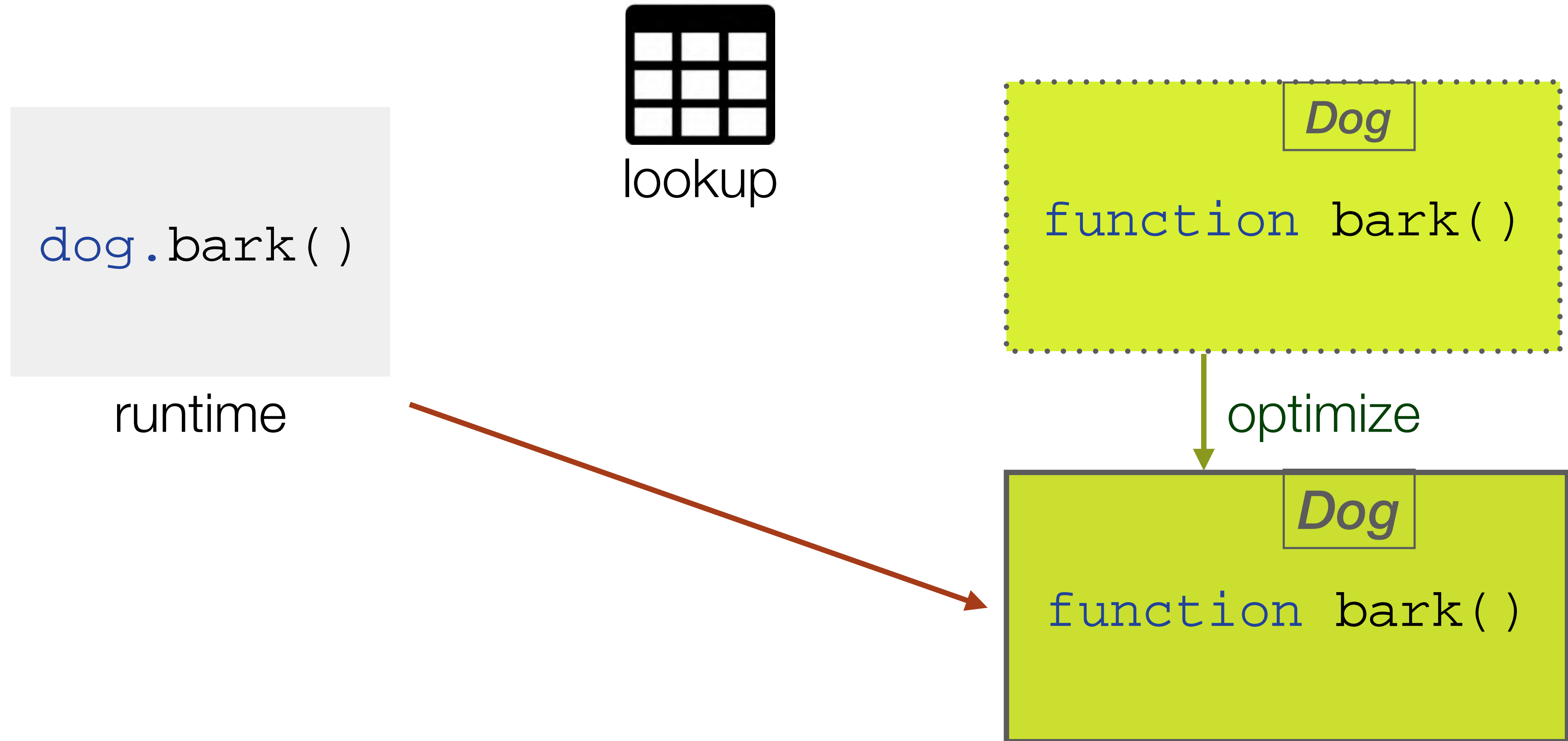
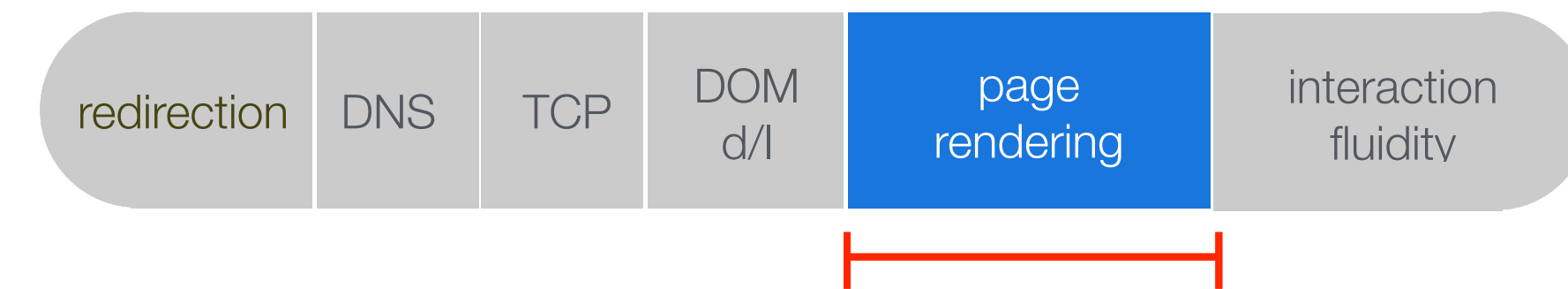
Inline caching optimizes execution



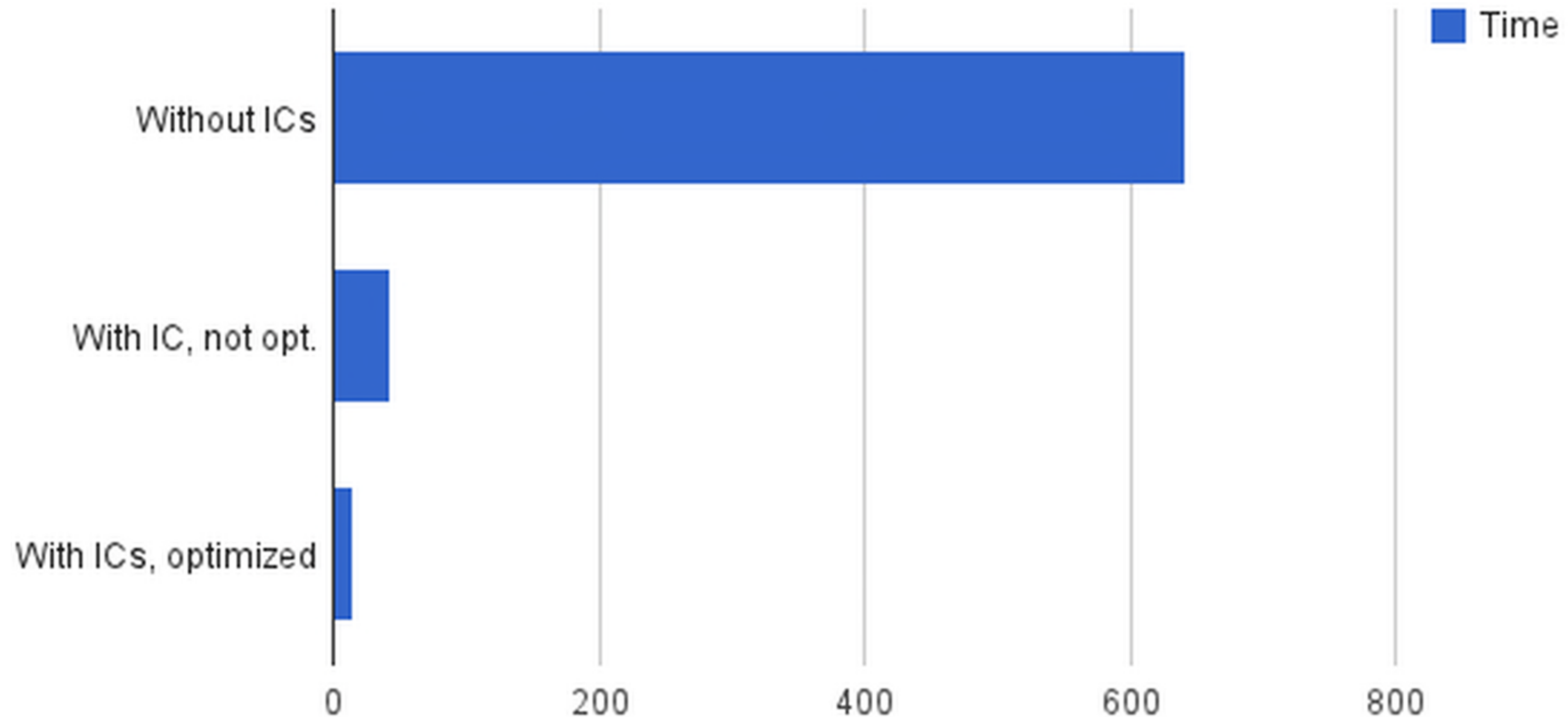
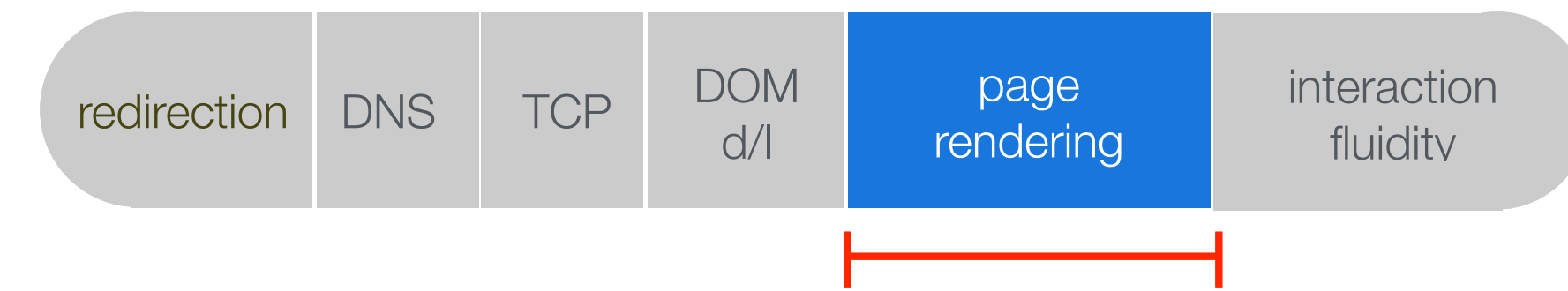
Inline caching optimizes execution



Inline caching optimizes execution



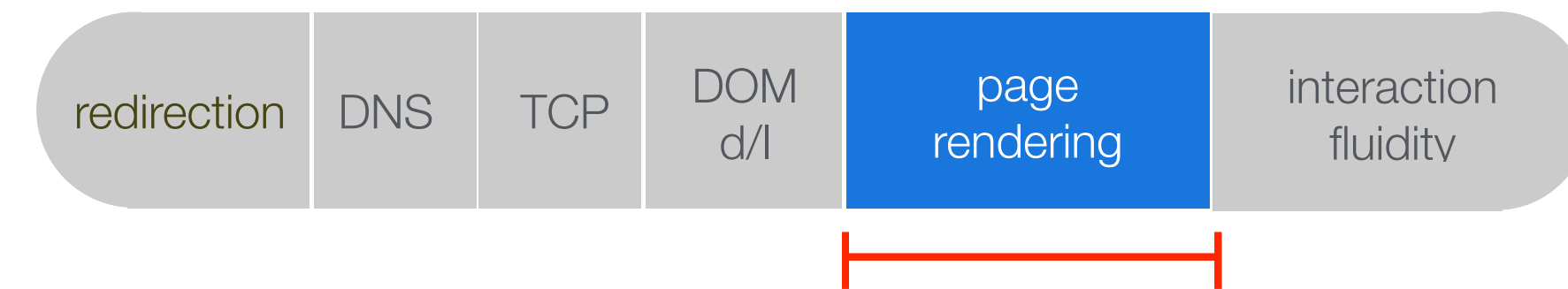
Inline caching optimizes execution



V8 Speedup with inline caching and optimizing compiler

source: <http://v8-io12.appspot.com/#68>

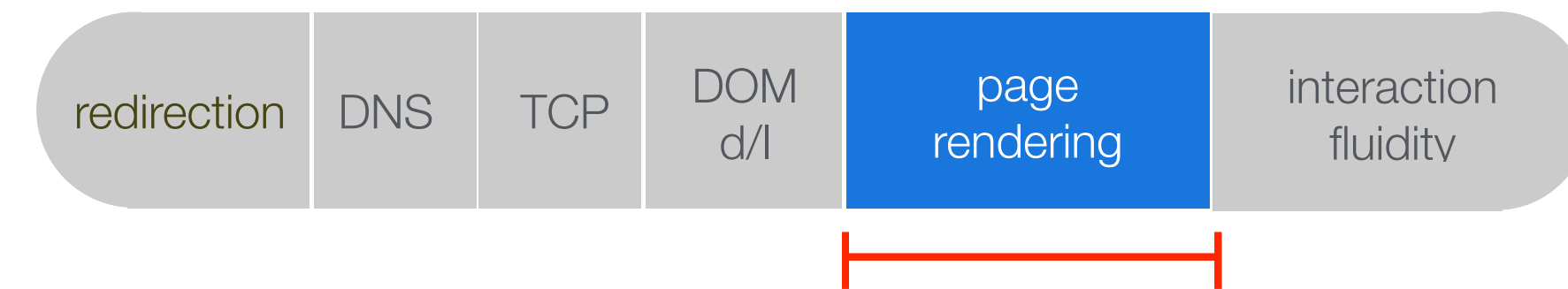
Inline caching can be easily broken



```
function addTwoThings(thing1, thing2) {  
    return thing1 + thing2;  
}  
  
addTwoThings(1, 2);
```

javascript

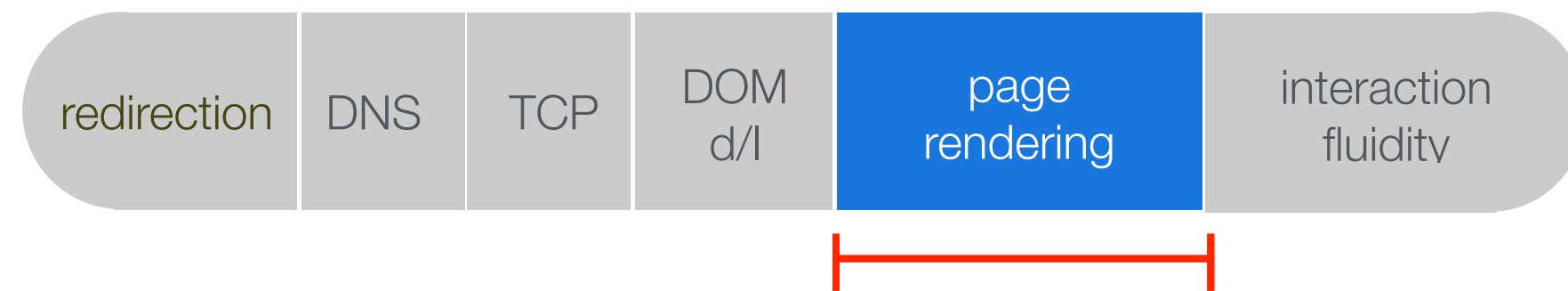
Inline caching can be easily broken



```
function addTwoThings(thing1, thing2) {  
    return thing1 + thing2;  
}  
  
addTwoThings(1, 2);  
addTwoThings(100, 200);
```

javascript

Inline caching can be easily broken



```
function addTwoThings(thing1, thing2) {  
    return thing1 + thing2;  
}
```

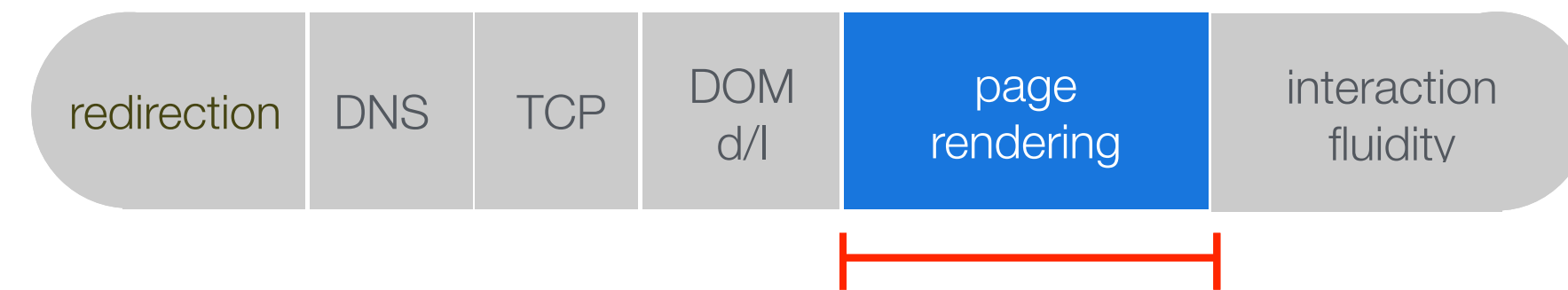
javascript

```
addTwoThings(1, 2);
```

```
addTwoThings(100, 200);
```



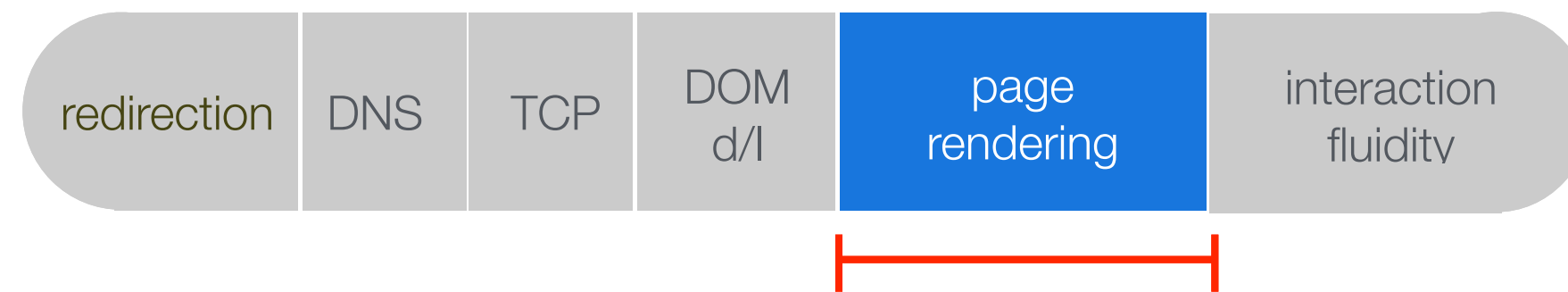
Inline caching can be easily broken



```
function addTwoThings(thing1, thing2) {  
    return thing1 + thing2;  
}  
  
addTwoThings(1, 2);  
addTwoThings(100, 200);  
addTwoThings('a', 'b');
```

javascript

Inline caching can be easily broken

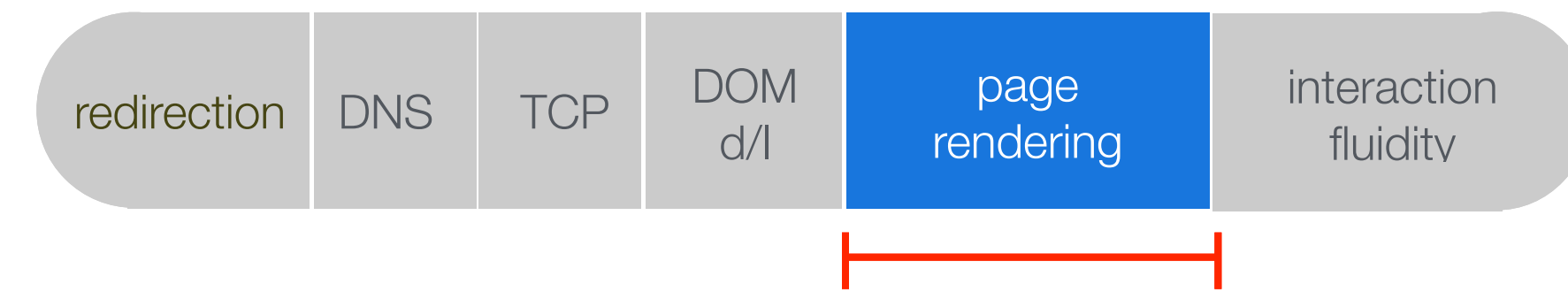


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}  
  
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addTwoThings(100, 200);  
addTwoThings('a', 'b');
```

javascript



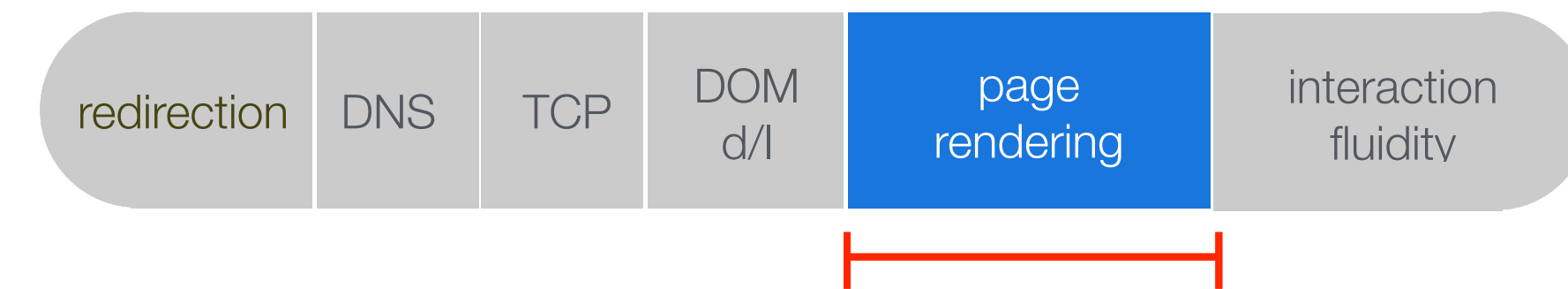
Inline caching can be easily broken



```
function Dog(name) {  
  this.name = name;  
}  
  
var dog1 = new Dog('Jim');
```

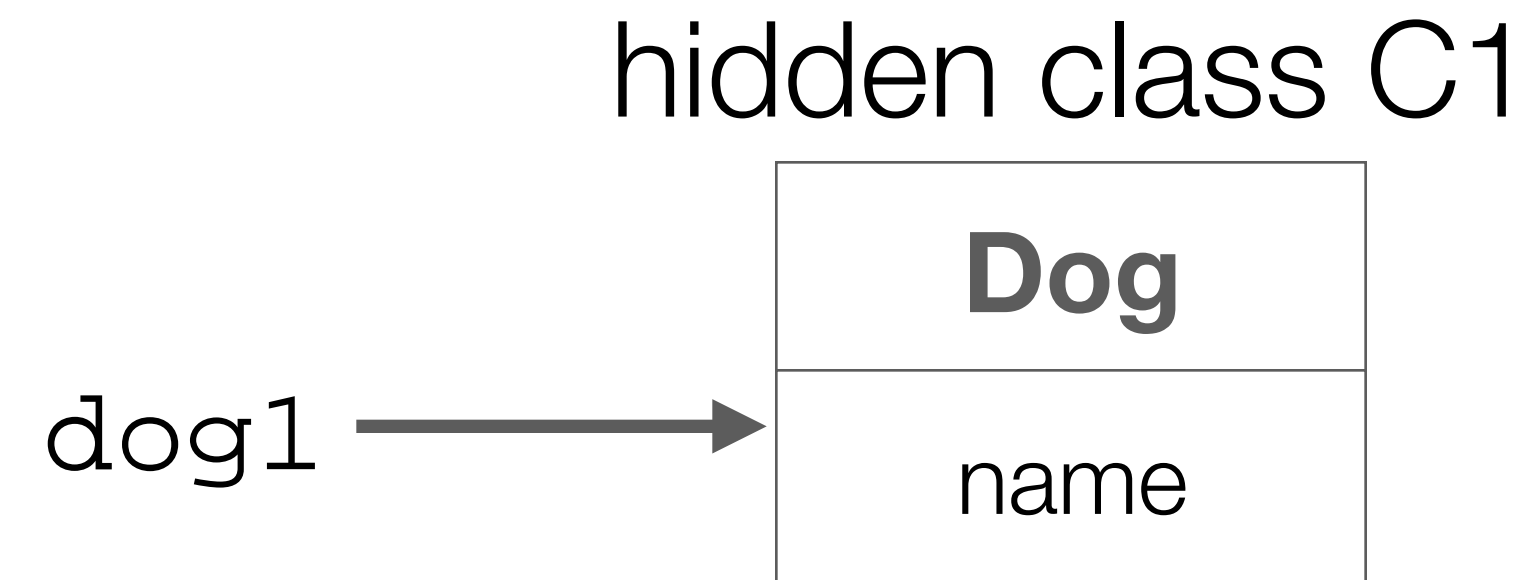
javascript

Inline caching can be easily broken

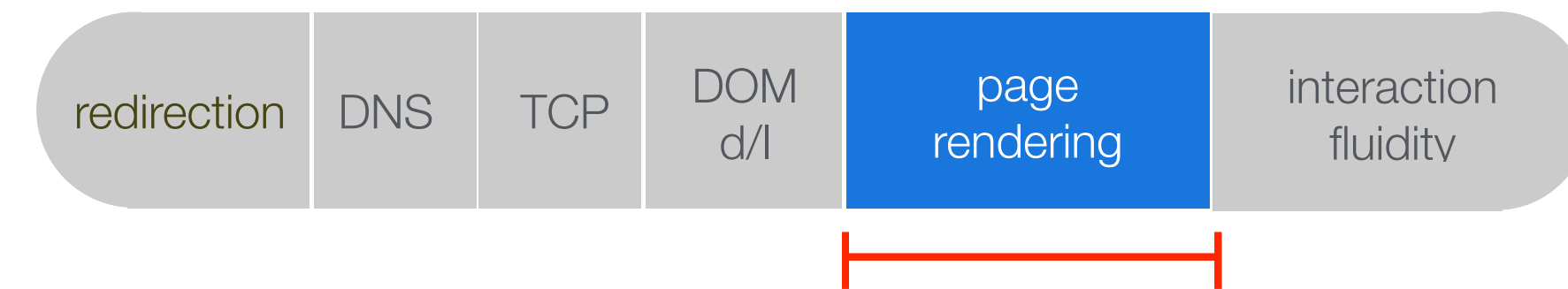


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function Dog(name) {  
  this.name = name;  
}  
  
var dog1 = new Dog('Jim');
```

javascript



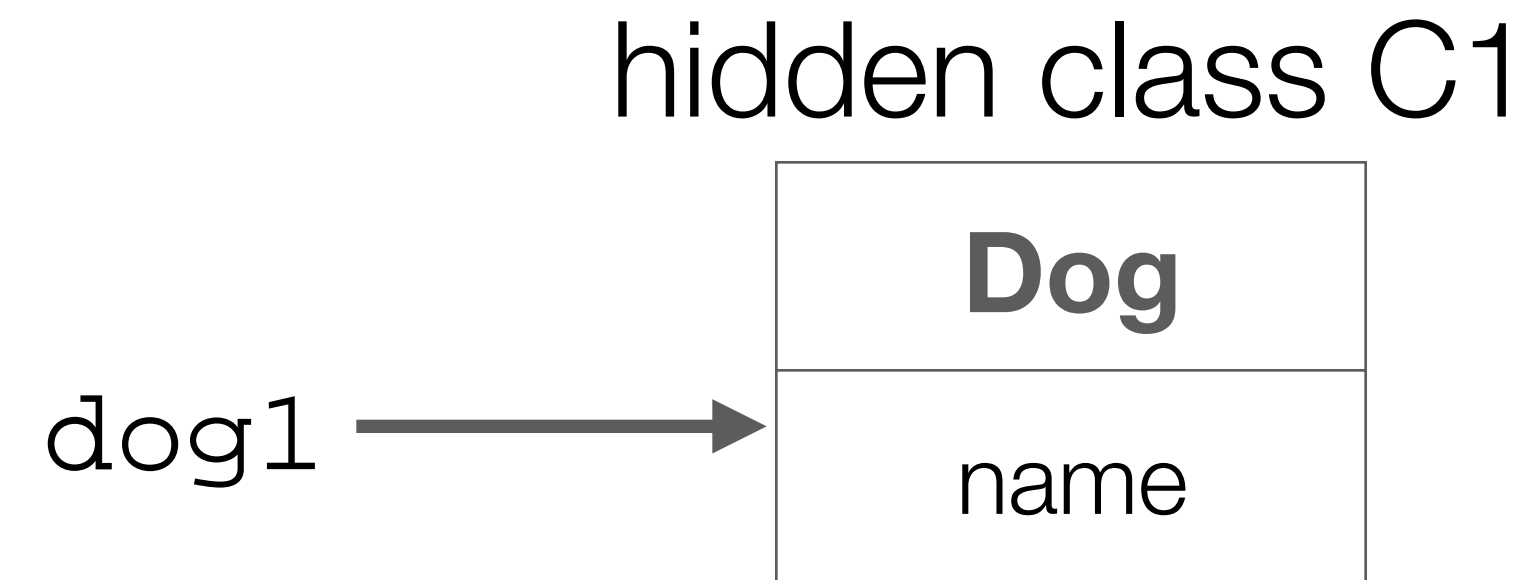
Inline caching can be easily broken



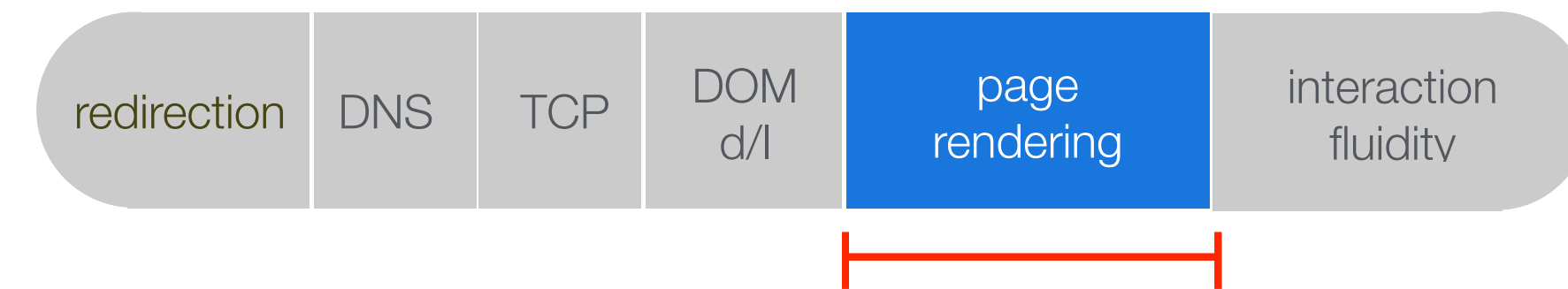
```
function Dog(name) {  
  this.name = name;  
}
```

javascript

```
var dog1 = new Dog('Jim');  
var dog2 = new Dog('Bin');
```



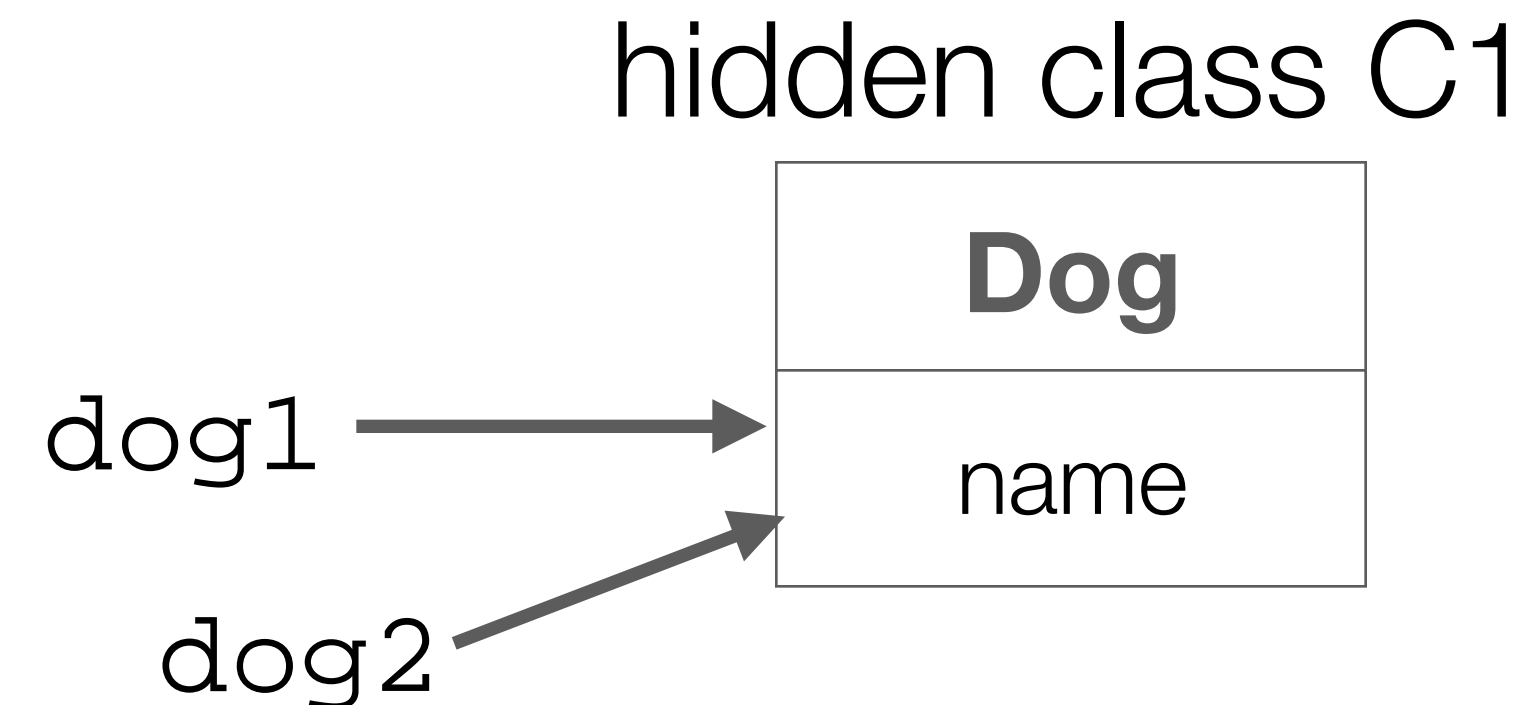
Inline caching can be easily broken



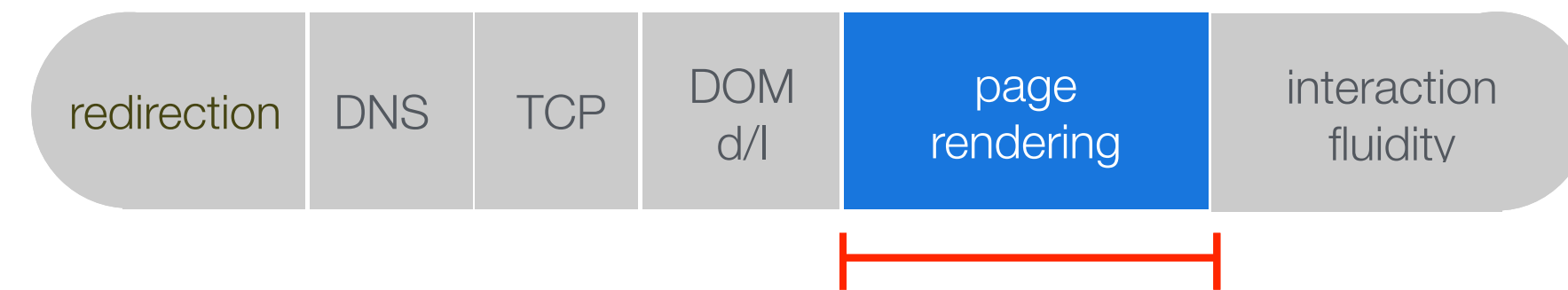
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javascript

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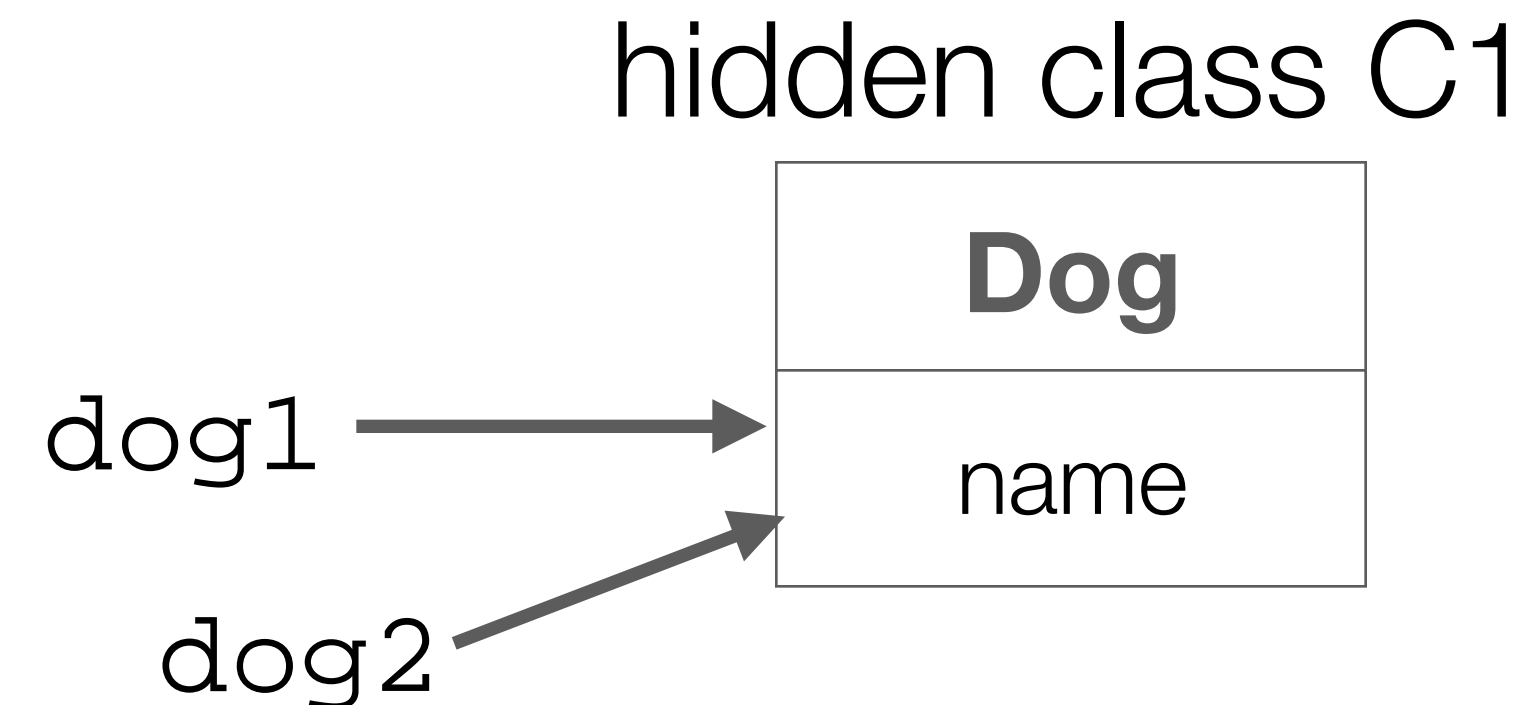
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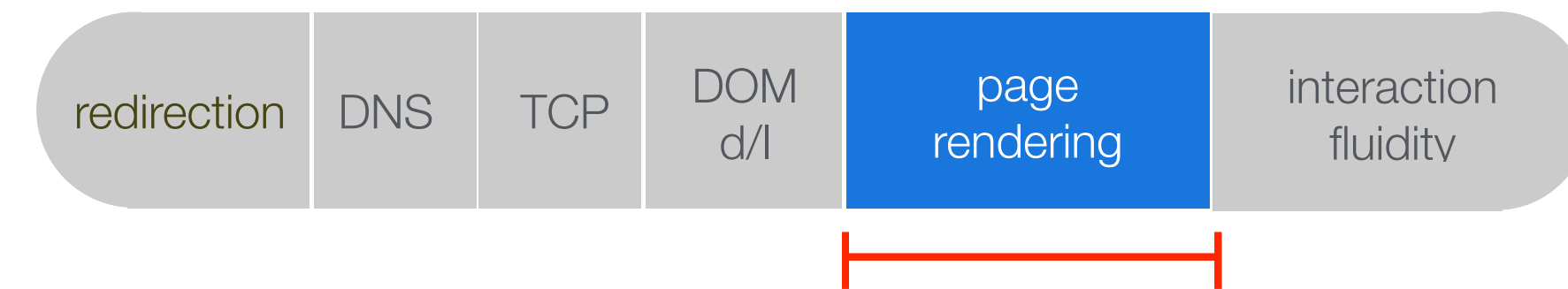
```
function Dog(name) {  
  this.name = name;  
}
```

javascript

```
var dog1 = new Dog('Jim');  
var dog2 = new Dog('Bin');  
dog2.breed = 'chihuahua';
```



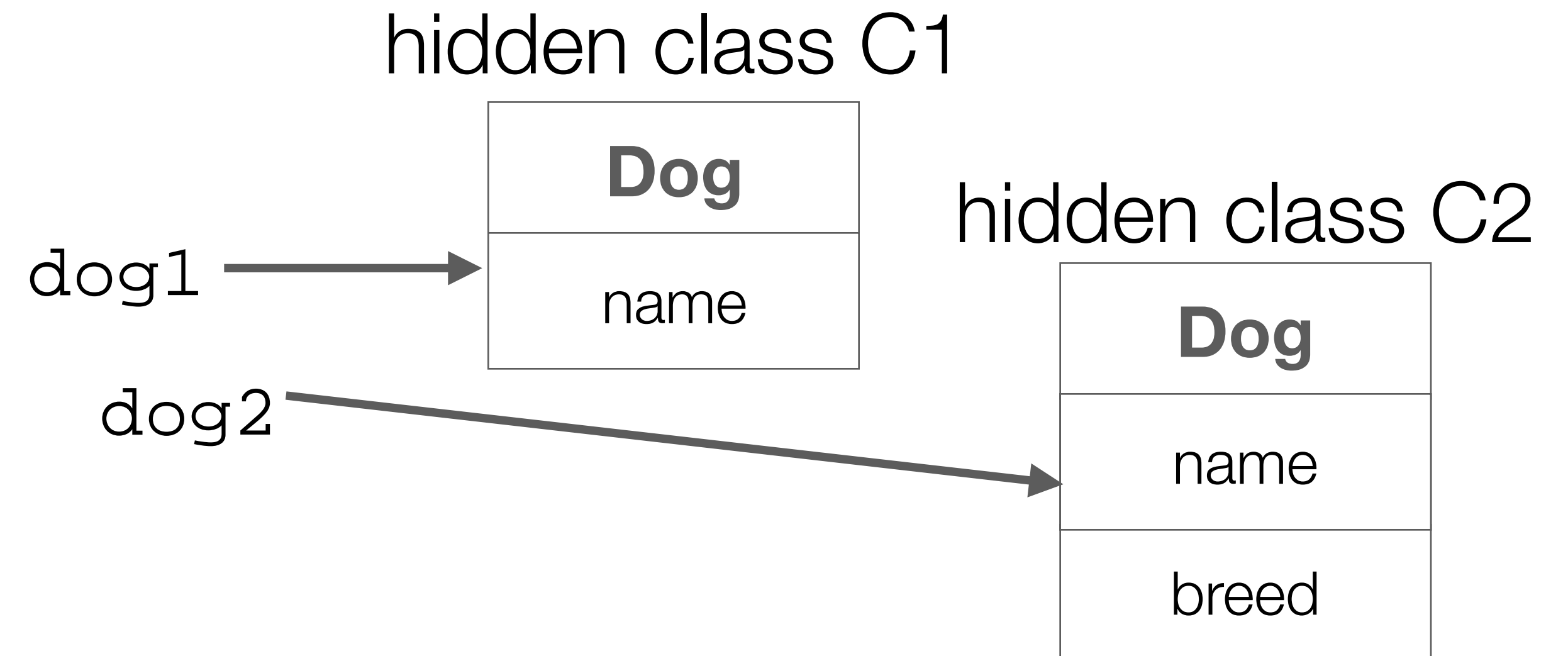
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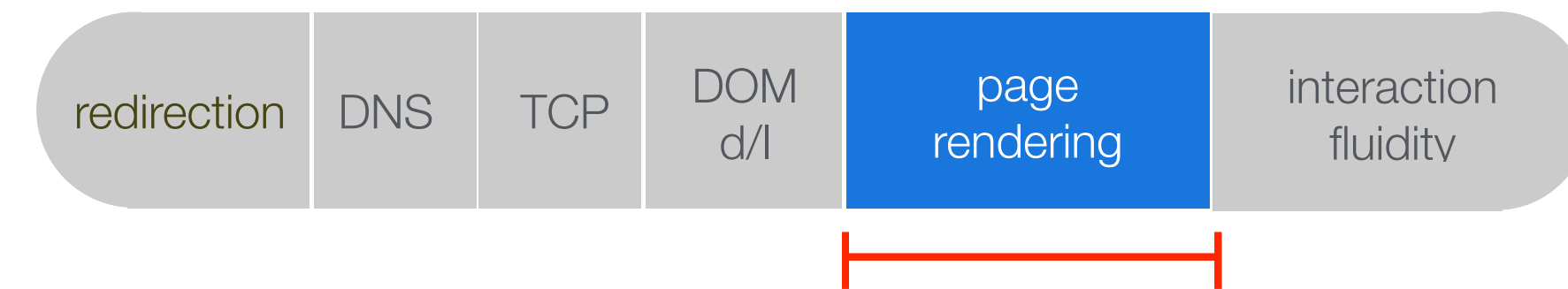
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javascript

```
var dog1 = new Dog('Jim');  
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dog2.breed = 'chihuahua';
```



Compiler helps



closure compiler

- converts javascript to javascript

TypeScript

- converts superset of javascript to javascript



- converts java to javascript

Compiler helps

redirection

DNS

TCP

DOM
d/l

page
rendering

interaction
fluidity

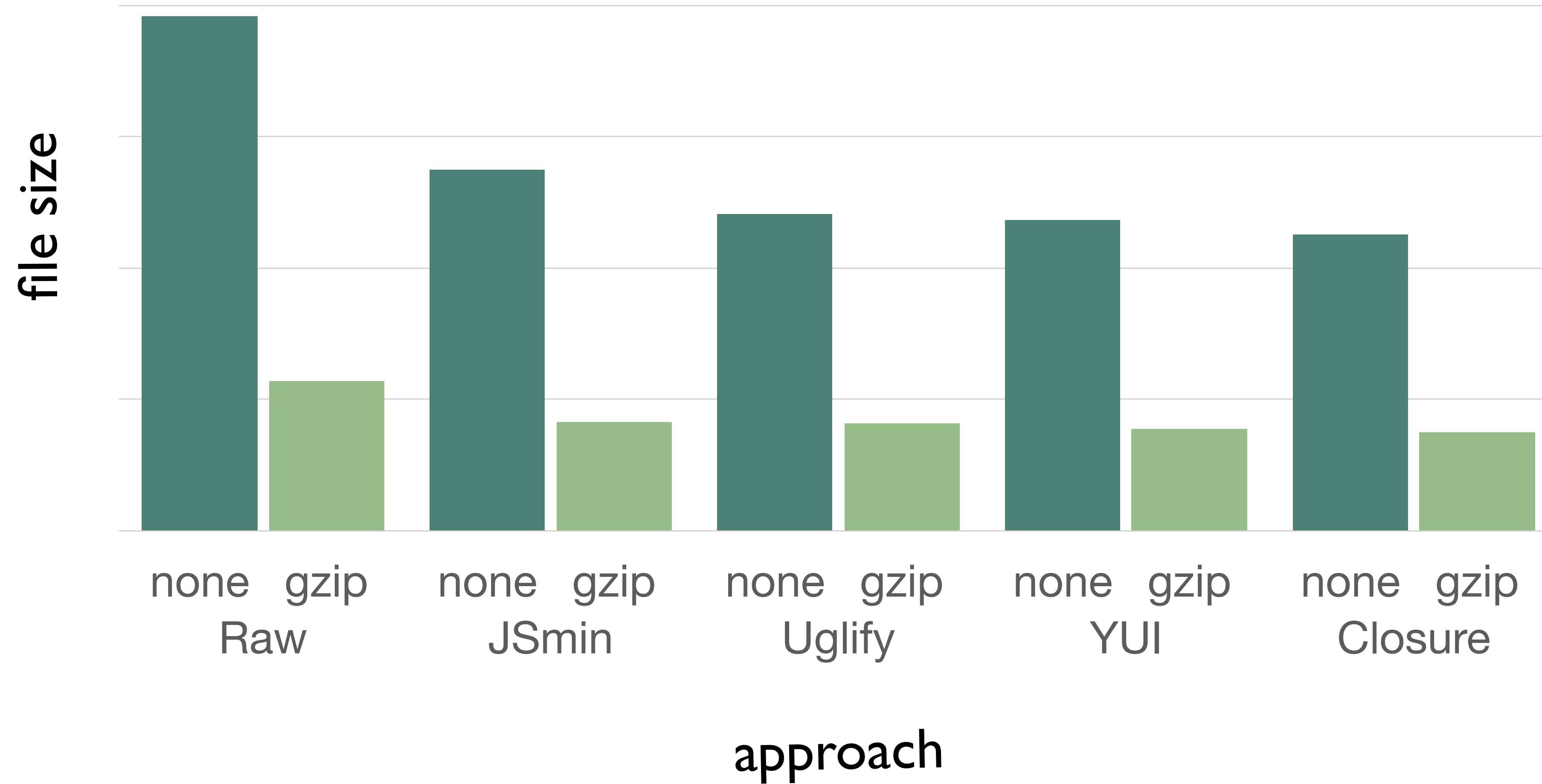
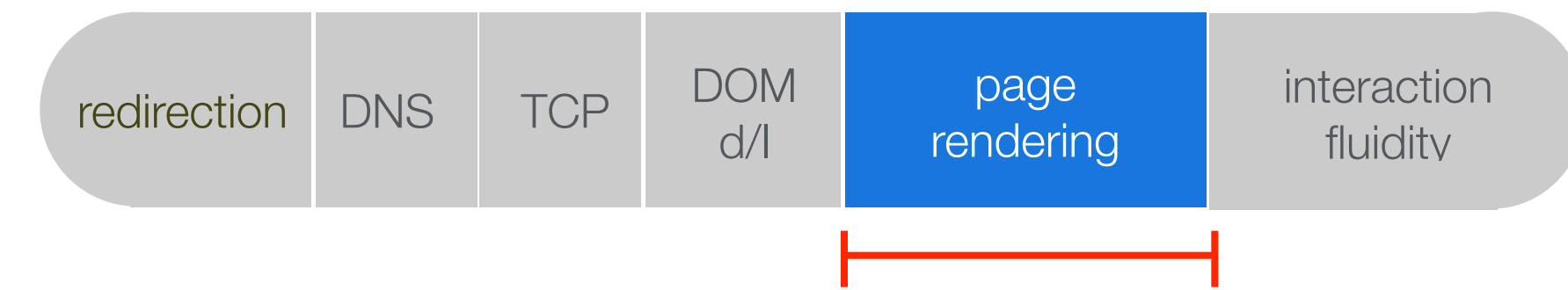
javascript

```
/**
 * My class.
 * @constructor
 */
function MyClass() {
    /** @private {Array<string>} */
    this.beers_ = [];
}

/** @const {string} */
MyClass.MY_BEER = 'stout';

/**
 * @param {number} value Value to be added.
 * @return {boolean} Whether operation succeed.
 */
MyClass.prototype.addValue = function(value) {
    ...
    return true;
};
```


Compiler helps



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Velocity

CONFERENCE

BUILD RESILIENT SYSTEMS AT SCALE

velocity.oreilly.com.cn

#velocityconf

redirections

DNS

TCP

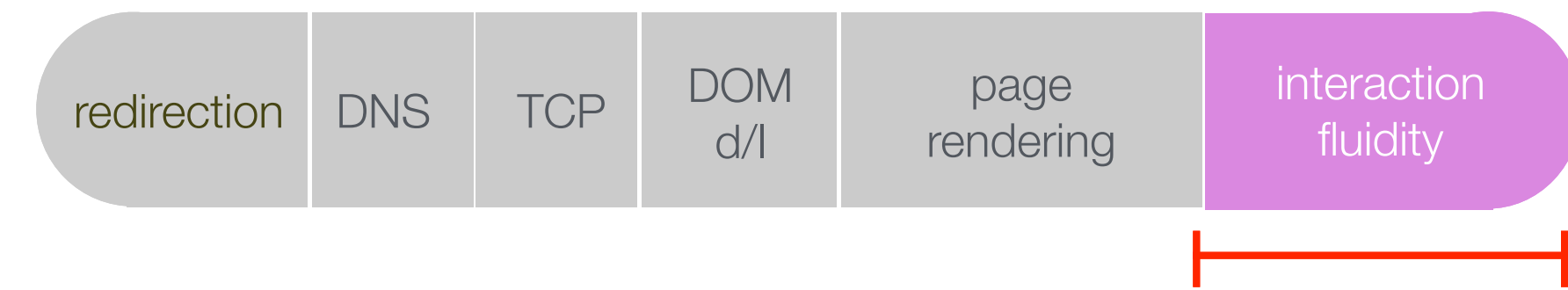
DOM
download

page
rendering

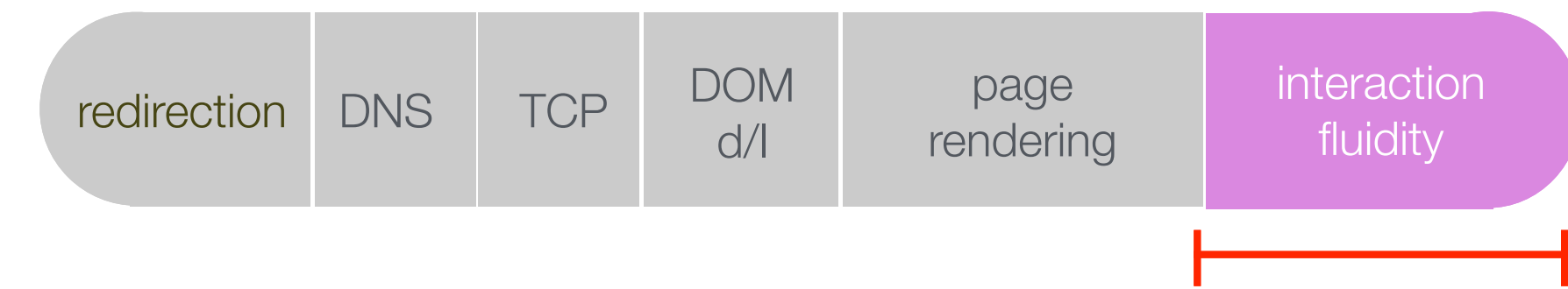
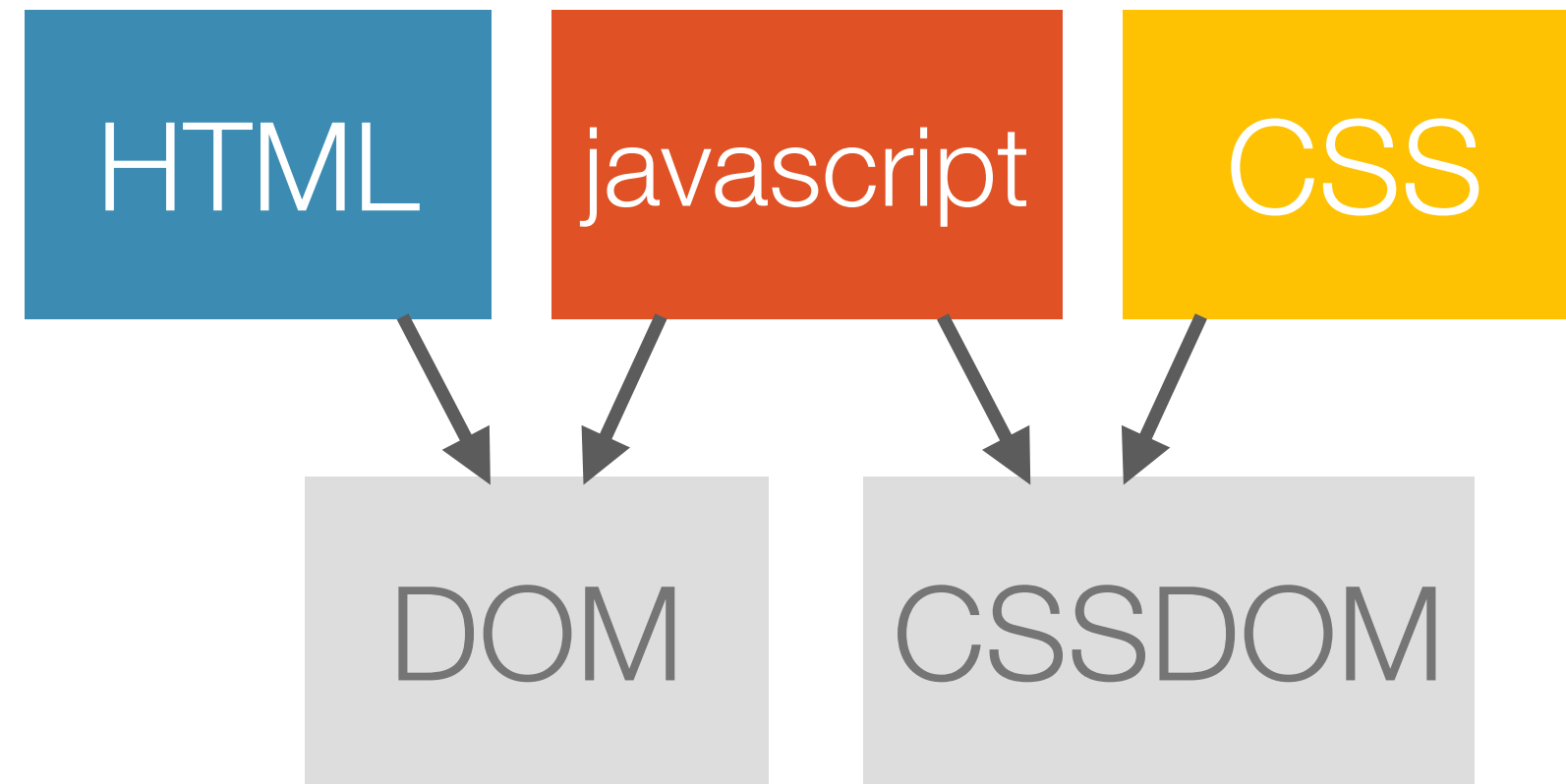
interaction
fluidity

**profile &
race native**

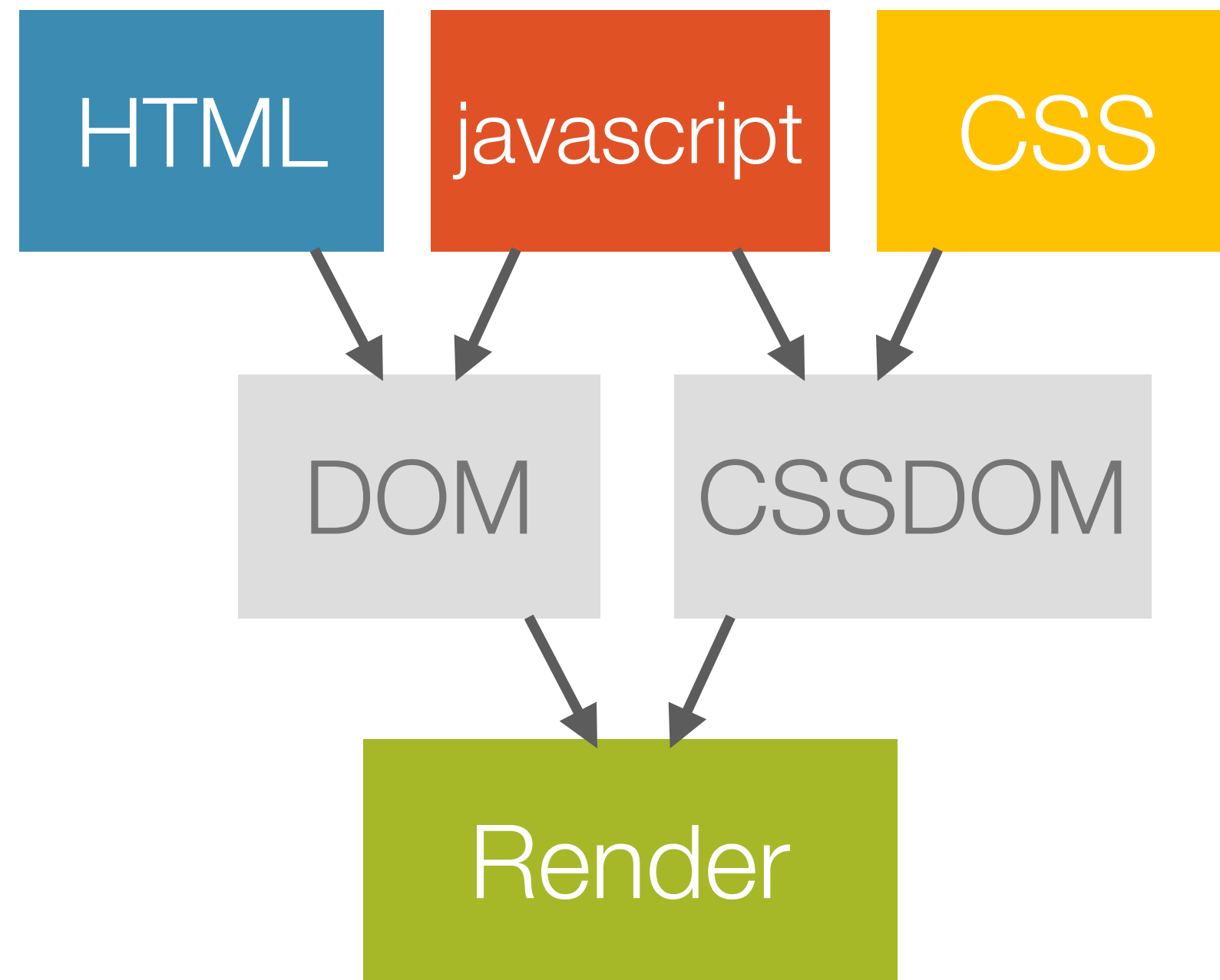
Repaint/Reflow revisit



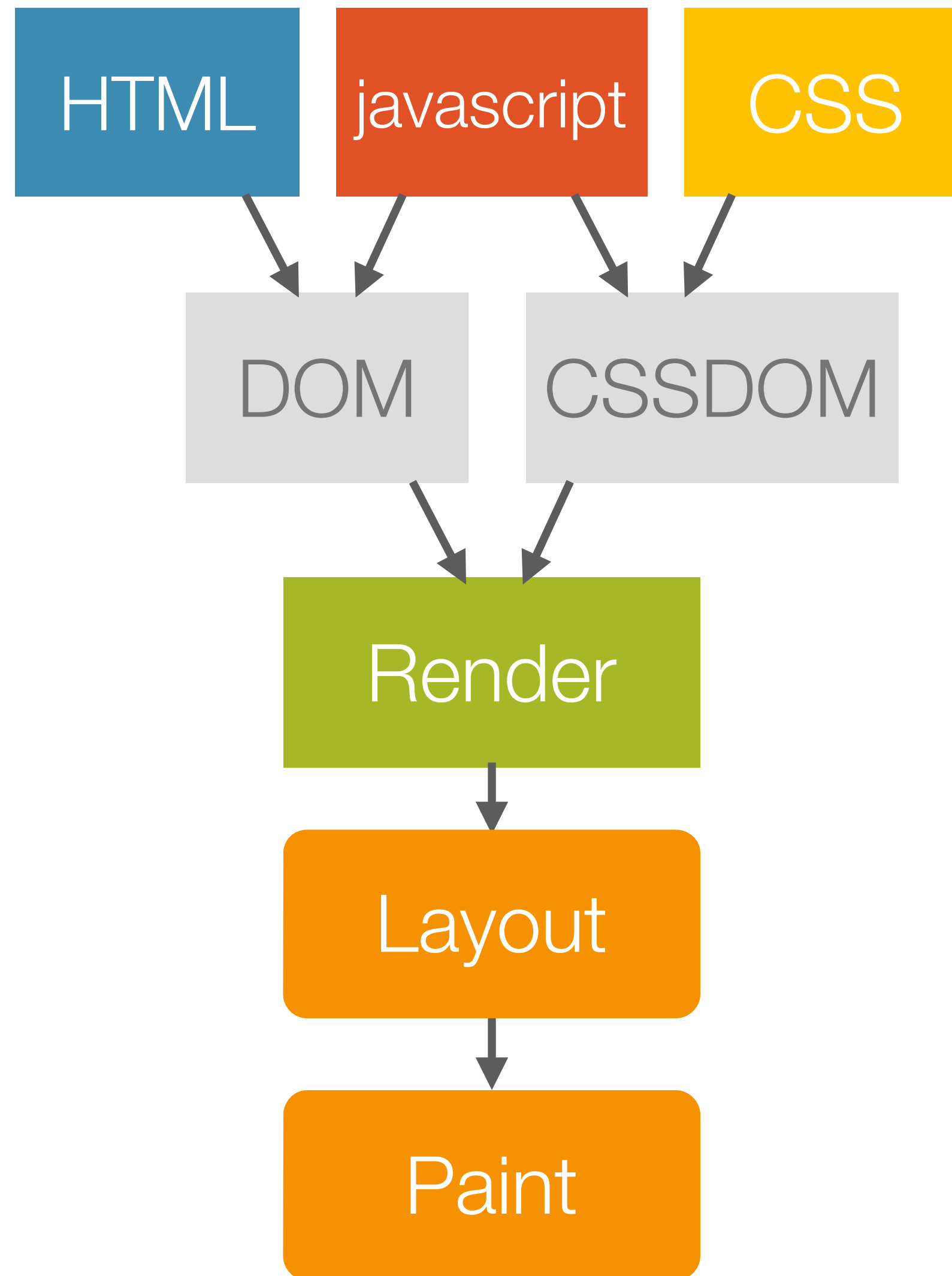
Repaint/Reflow revisit



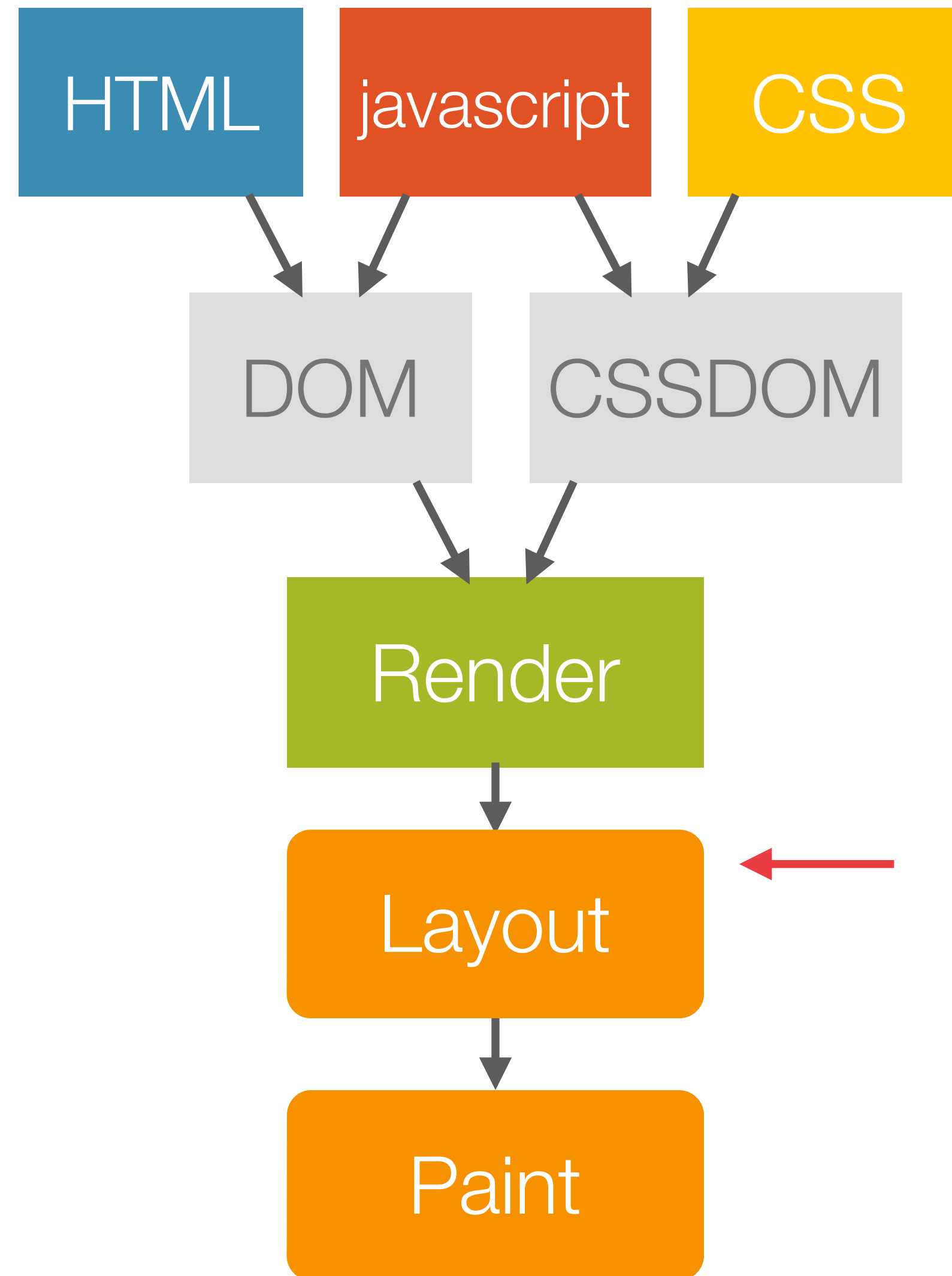
Repaint/Reflow revisit



Repaint/Reflow revisit

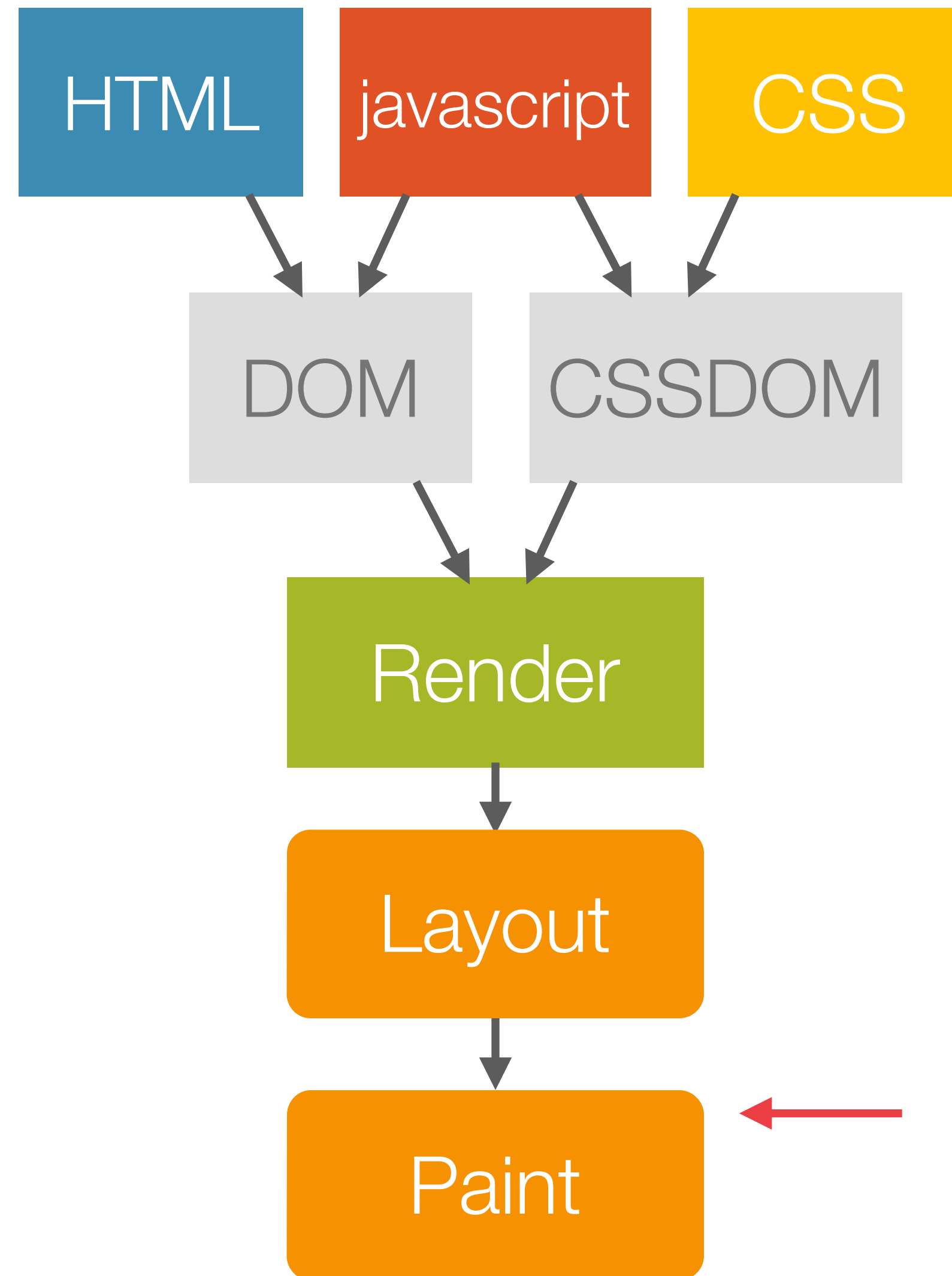


Repaint/Reflow revisit



← reflow (repositioning elements)
eg: change table content
windows resize

Repaint/Reflow revisit



← repaint (redrawing visual)
eg. change text/background color

Measure fps

DeviceGoogle Nexus 6

412 x 7323.5Fit

UA Mozilla/

Network

0100200300400

Google+GmailVoiceWebmore

Inbox

123

456

789

*0#

TextCall

Sign out

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Desktop version

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ElementsNetworkSourcesTimelineProfilesResourcesAuditsConsoleEditThisCookie

View: Capture: Stacks Profile JS Memory Paint

30 fps

60 fps

RECORDS

SummaryLayersPaint Profiler

Range0 --

Aggregated Time

- Idle

Measure fps

DeviceGoogle Nexus 6

412 x 7323.5Fit

UA Mozilla/

Network

0100200300400

Google+GmailVoiceWebmore

Inbox

123

456

789

*0#

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ElementsNetworkSourcesTimelineProfilesResourcesAuditsConsoleEditThisCookie

View: Capture: StacksProfile JSMemoryPaint

30 fps

60 fps

RECORDS

SummaryLayersPaint Profiler

Range0 - -

Aggregated Time

- Idle

Measure fps

Device Google Nexus 6

412 x 732 3.5 Fit

UA Mozilla/

Network

0 100 200 300 400

Google+ Gmail Voice Web more

Inbox

1 2 3

4 5 6

7 8 9

* 0 #

Text Call

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Elements Network Sources Timeline Profiles Resources Audits Console EditThisCookie

View: Capture: Stacks Profile JS Memory Paint

30 fps

60 fps

RECORDS

Summary Layers Paint Profiler

Range 0 - -

Aggregated Time

- Idle

Measure fps on a real device

Developer Tools - www.google.com/voice/m#~voice:s=dialer

www.google.com/voice/m#~voice:s=dialer

Elements

Network

Sources

Timeline

Profiles

Resources

Audits

Console

EditThisCookie

View:

Capture: ☒ Stacks ☒ Profile JS ☐ Memory ☒ Paint

Filter ☒ Loading ☒ Scripting ☒ Rendering ☒ Painting

RECORDS

Summary

Layers

Paint Profiler

Range

0 - -

Aggregated Time

- Idle

30 fps

60 fps

Google+

Gmail

Voice

Web

more

Inbox

1

2 ABC

3 DEF

4 GHI

5 JKL

6 MNO

7 PQRS

8 TUV

9 WXYZ

*

0 +

#

Text

Call

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Factor	Relative Impact (Estimated)
redirection	10%
DNS	15%
TCP	15%
DOM d/I	15%
page rendering	25%
interaction fluidity	30%

https://www.google.com

Google+ Gmail Voice Web more

Inbox

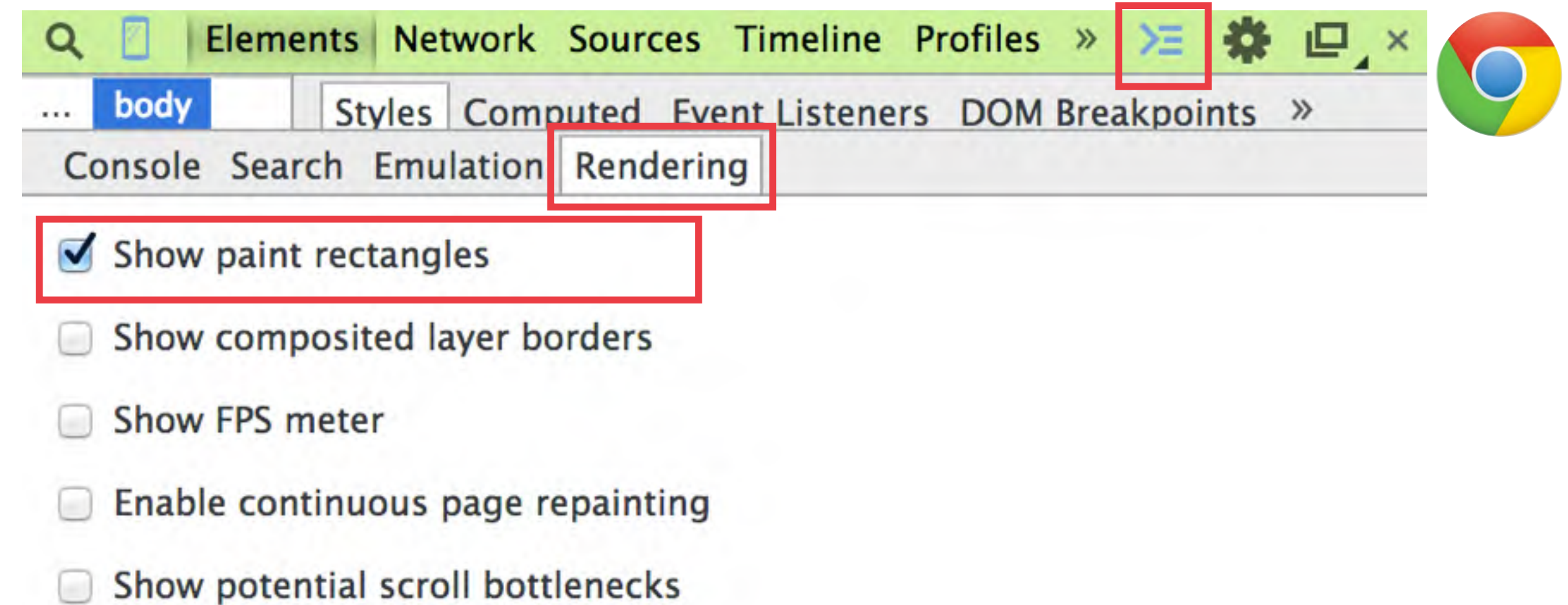
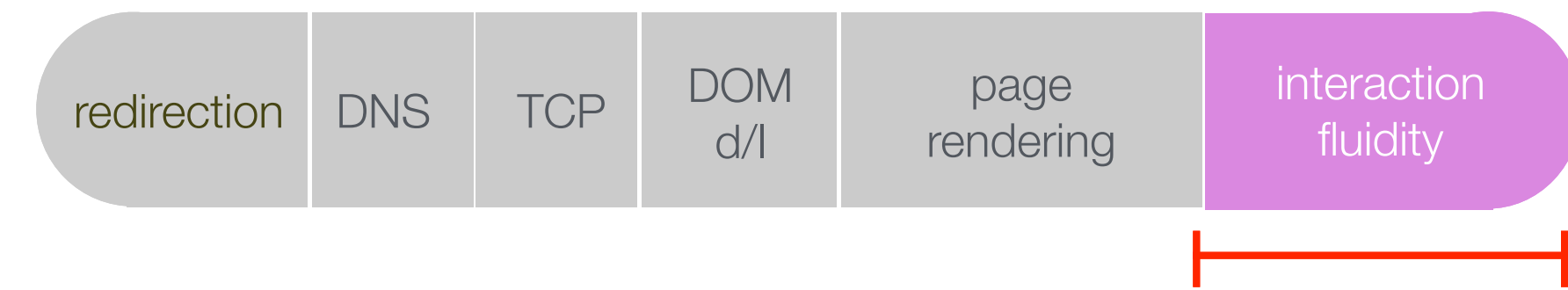
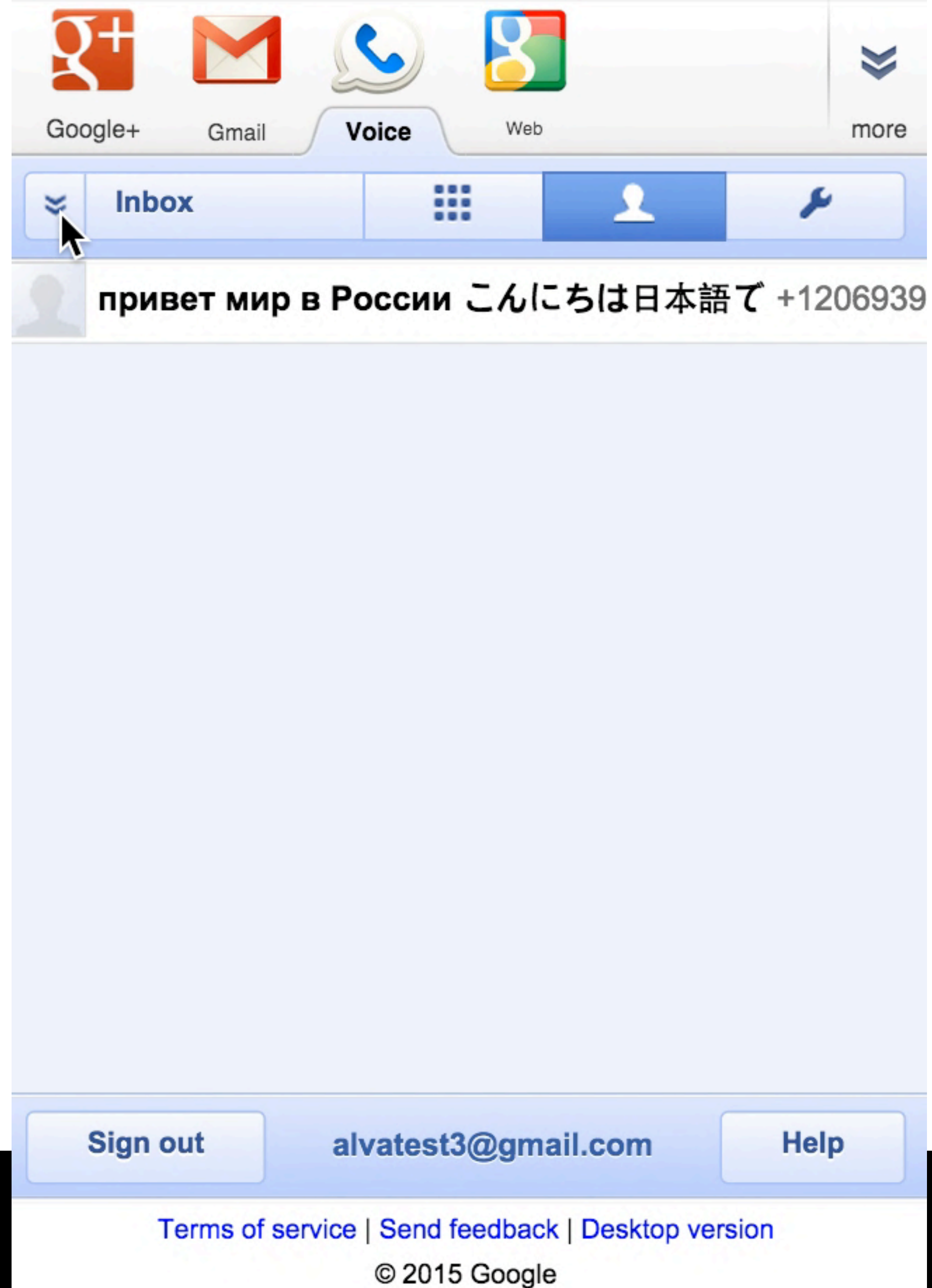
1 2 3
4 5 6
7 8 9
PQRS TUV WXYZ
* 0 #

Text Call

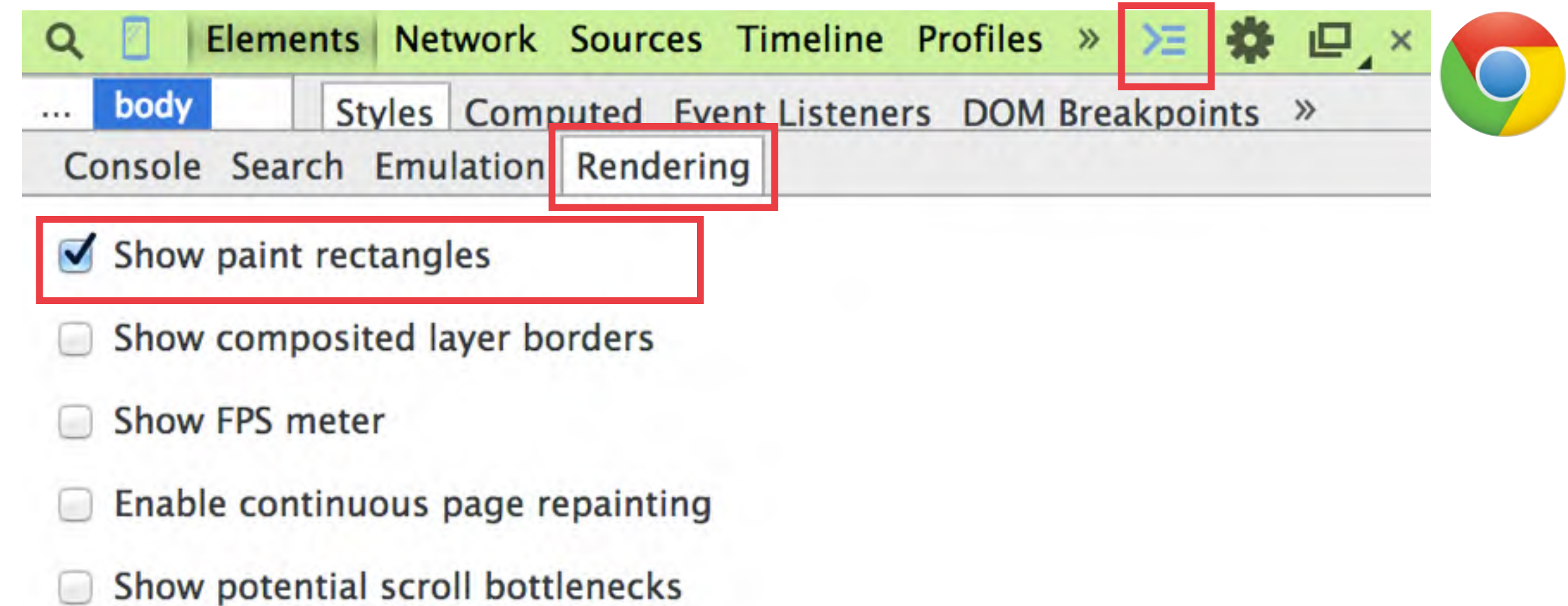
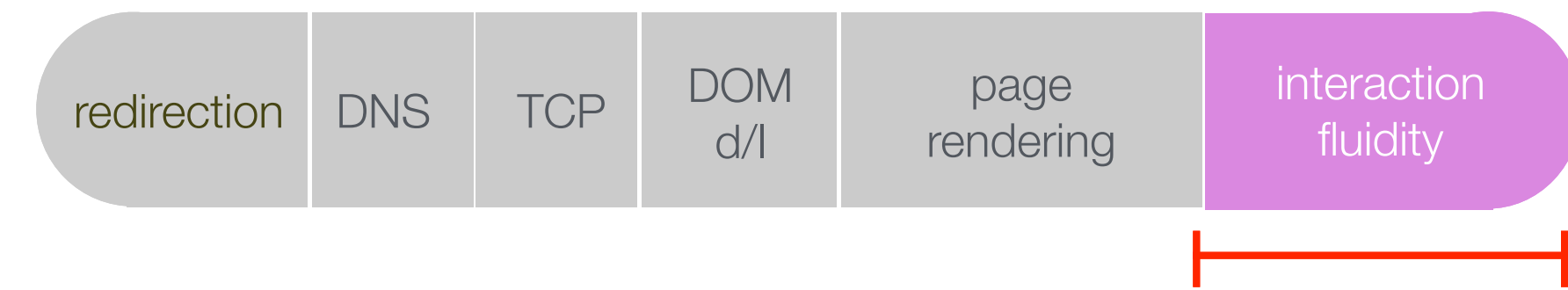
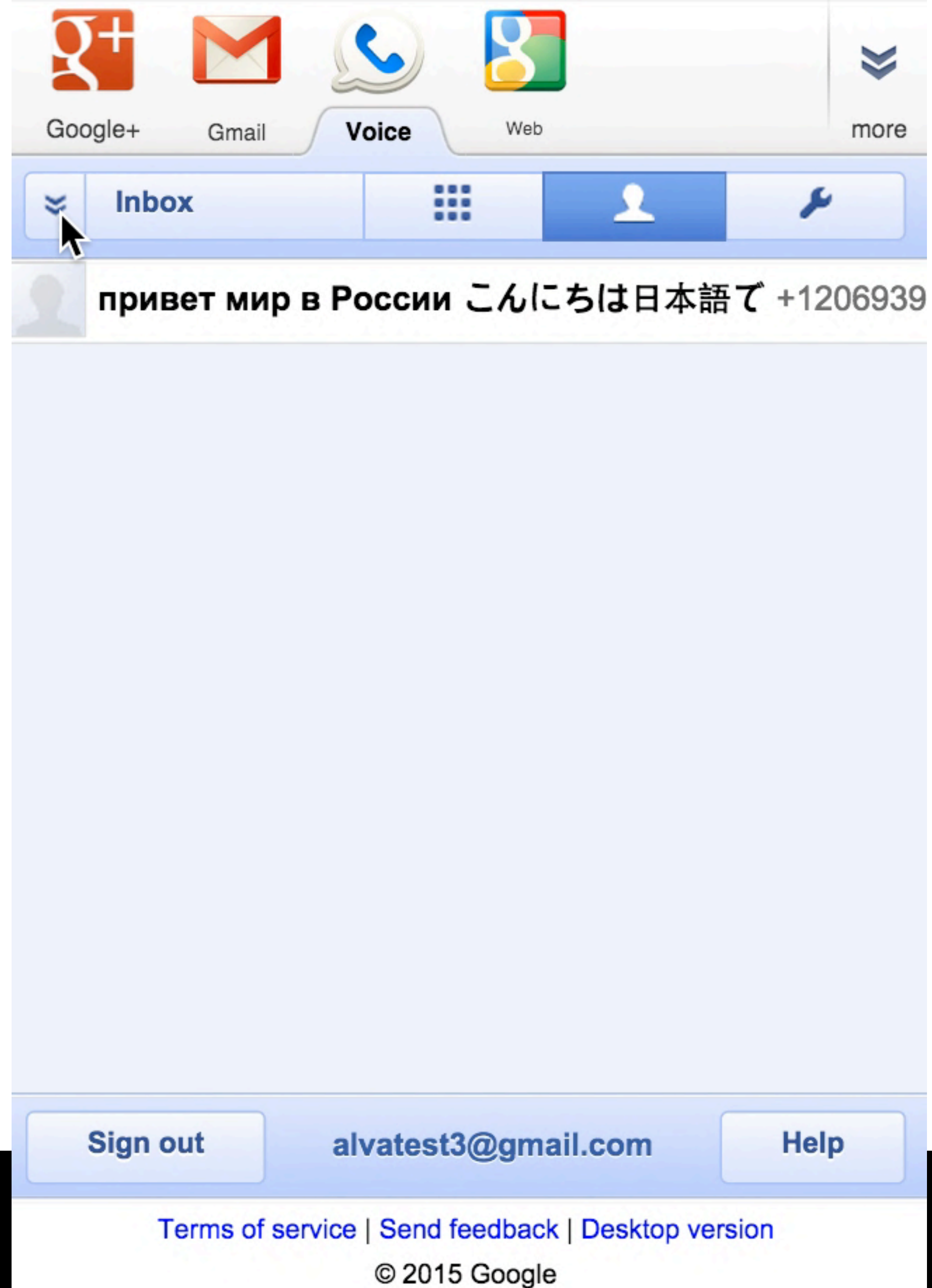
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Measure impact of repaint



Measure impact of repaint



Event debouncing/throttling

redirection

DNS

TCP

DOM
d/I

page
rendering

interaction
fluidity

javascript

```
function throttleEvent(callback, thres) {
  var lastTrigger = 0;
  var that = this;
  var deferTimer;
  return function() {
    var args = arguments;
    var currentTime = new Date().getTime();
    var remainingTime = thres - (currentTime - lastTrigger);
    if (remainingTime < 0) {
      lastTrigger = currentTime;
      clearTimeout(deferTimer);
      callback.apply(that, args);
    } else {
      // Only keep the latest event.
      clearTimeout(deferTimer);
      deferTimer = setTimeout(function() {
        callback.apply(that, args)
      }, remainingTime);
    }
  }
}

document.addEventListener('scroll', throttleEvent(callback, 100));
```


Event debouncing/throttling

redirection

DNS

TCP

DOM
d/I

page
rendering

interaction
fluidity

javascript

```
function throttleEvent(callback, thres) {
```

```
  var lastTrigger = 0;
```

```
  var that = this;
```

```
  var deferT...
```

```
  return fu
```

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  var a
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  var r
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  } els
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```
  }
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  }
```

```
  }
```

```
  }
```

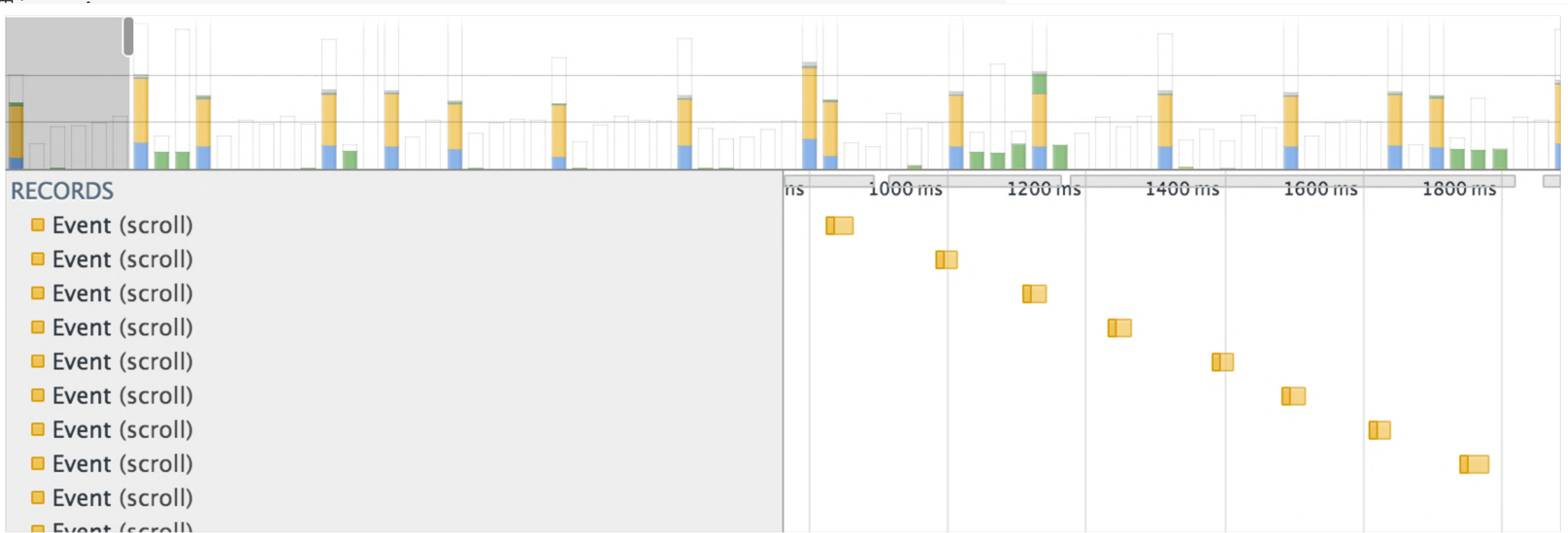
```
  }
```

```
  }
```

```
  }
```

```
  }
```

```
document.addEventListener('scroll', throttleEvent(callback, 100));
```



Event debouncing/throttling

redirection

DNS

TCP

DOM
d/I

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fluidity

javascript

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function throttleEvent(callback, thres) {
```

```
  var lastTrigger = 0;
```

```
  var that = this;
```

```
  var deferT...
```

```
  return fu
```

```
  var a
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  var c
```

```
  var r
```

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  if (r
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```

```
  c
```

```
  } els
```

```
  /
```

```
  c
```

```
  d
```

```
  }
```

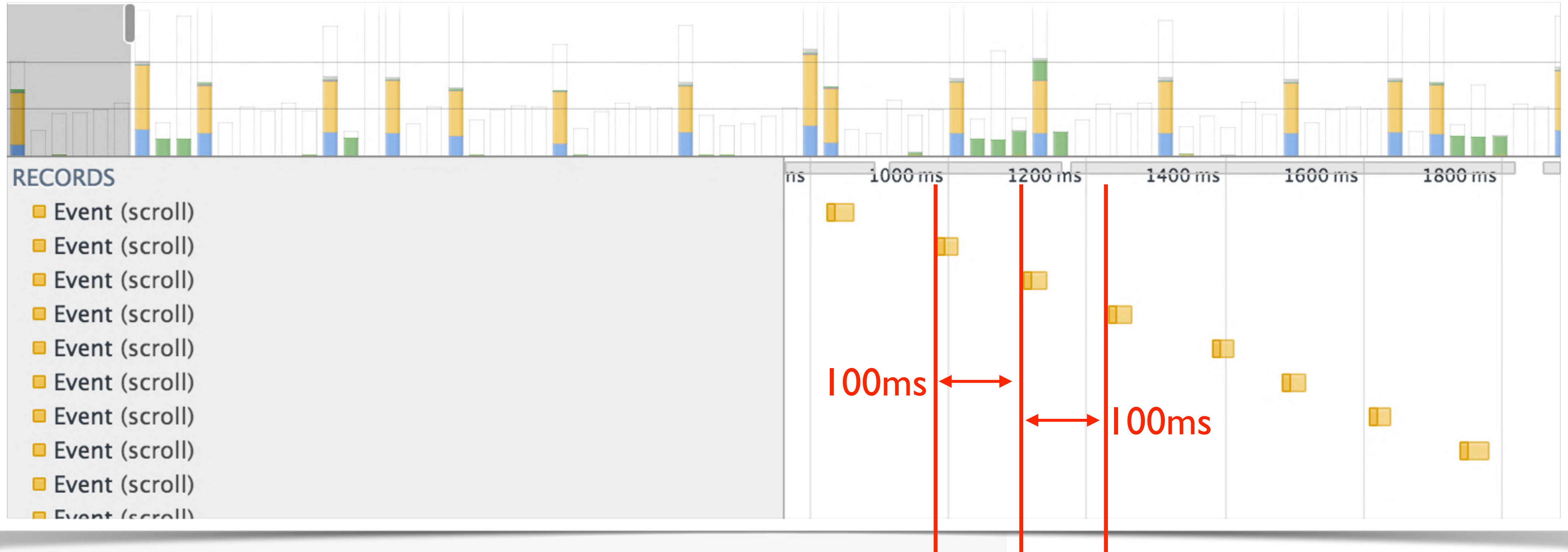
```
  }
```

```
  }
```

```
  }
```

```
  }
```

```
document.addEventListener('scroll', throttleEvent(callback, 100) );
```



Use the DOM change queue



```
$div = $('#content');  
elements = ['a', 'b', 'c', 'd'];  
for (var i=0, j=elements.length; i<j; i++){  
    $div.append(elements[i]);  
}
```

javascript

Use the DOM change queue

redirection

DNS

TCP

DOM
d/l

page
rendering

interaction
fluidity

```
$div = $('#content');  
elements = ['a', 'b', 'c', 'd'];  
for (var i=0, j=elements.length; i<j; i++){  
    $div.append(elements[i]);  
}
```

javascript

```
$div = $('#content');  
elements = ['a', 'b', 'c', 'd'];  
for (var i=0, j=elements.length; i<j; i++){  
    //one line of evilness  
    var a = $(window).scrollTop;  
    $div.append(elements[i]);  
}
```

javascript

Use the DOM change queue

redirection

DNS

TCP

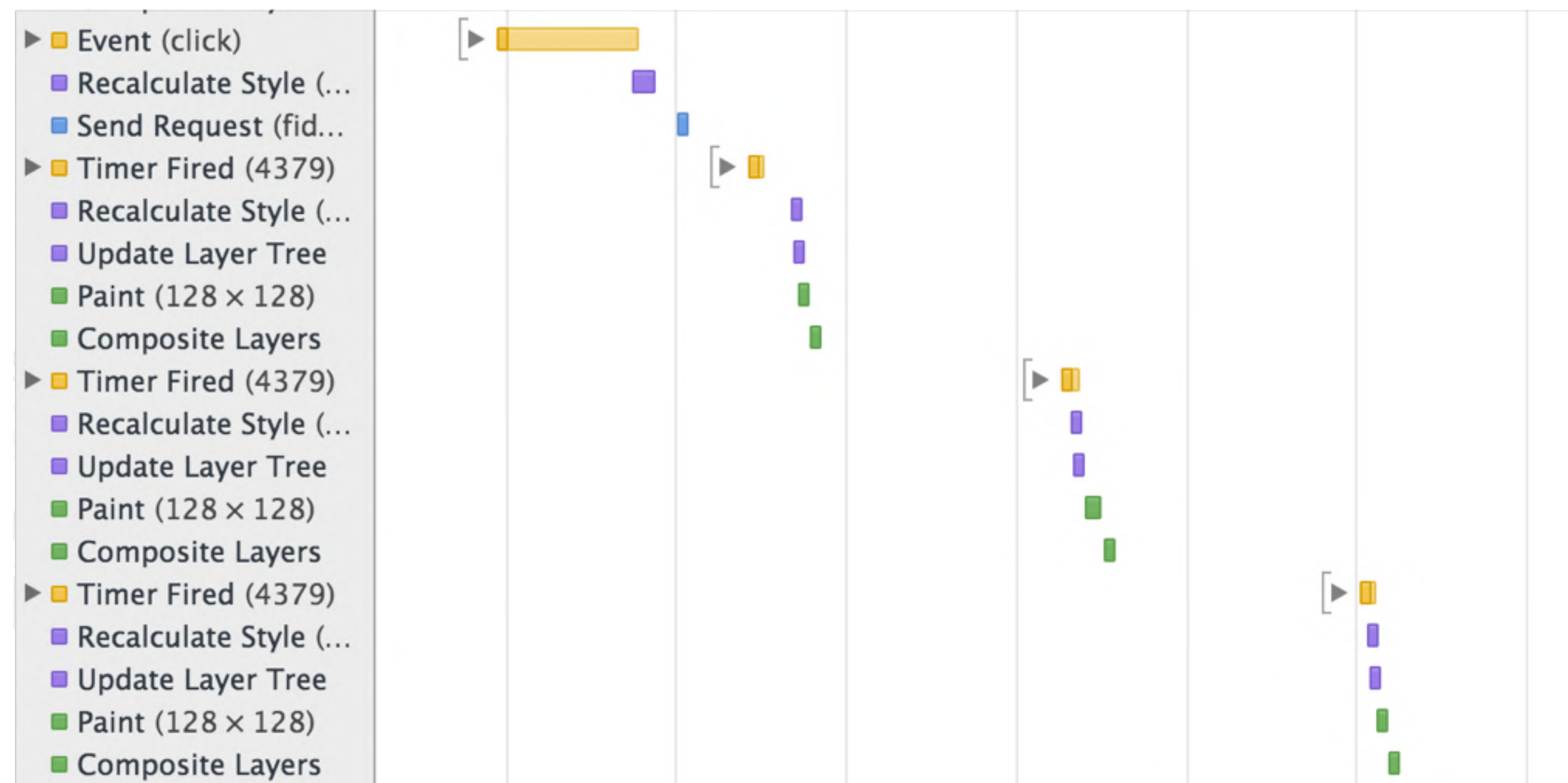
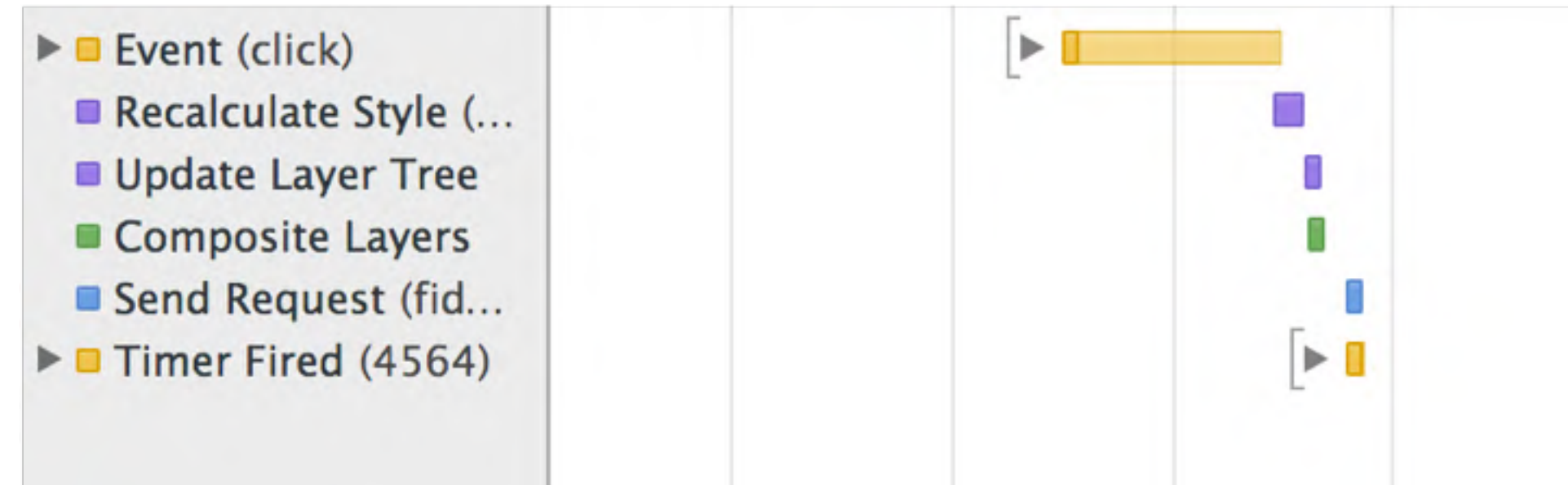
DOM
d/l

page
rendering

interaction
fluidity

```
$div = $('#content');  
elements = ['a', 'b', '  
for (var i=0, j=element  
$div.append(elements[i]);  
}
```

```
$div = $('#content');  
elements = ['a', 'b', 'c'  
for (var i=0, j=element  
//one line of evilne  
var a = $(window).sc  
$div.append(elements  
}
```



Use the DOM change queue

redirection

DNS

TCP

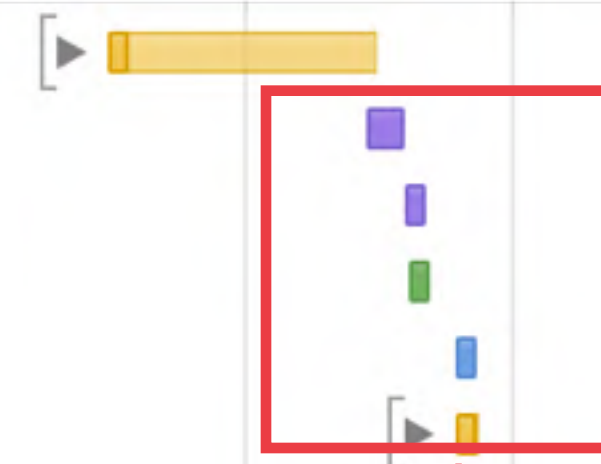
DOM
d/l

page
rendering

interaction
fluidity

```
$div = $('#content');  
elements = ['a', 'b', '  
for (var i=0, j=element  
$div.append(elements[i]);  
}
```

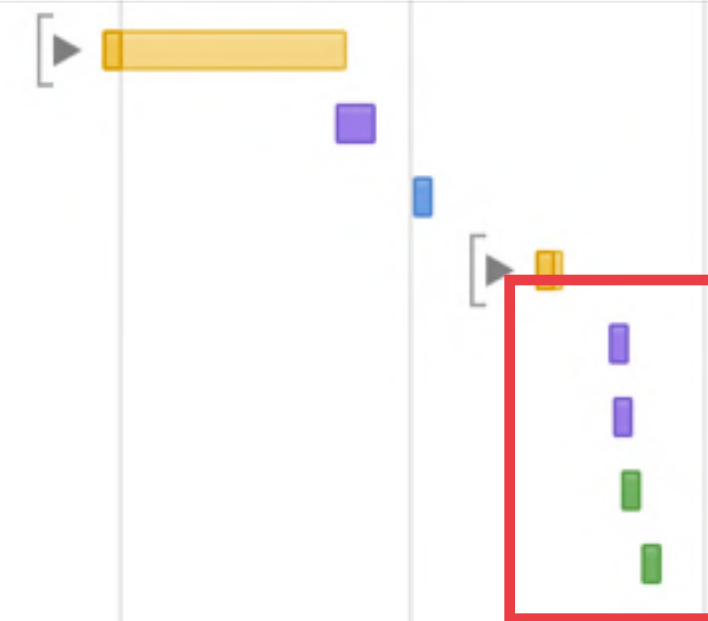
- Event (click)
- Recalculate Style (...)
- Update Layer Tree
- Composite Layers
- Send Request (fid...
- Timer Fired (4564)



one cached reflow

```
$div = $('#content');  
elements = ['a', 'b', 'c'  
for (var i=0, j=element  
//one line of evilne  
var a = $(window).sc  
$div.append(elements  
}
```

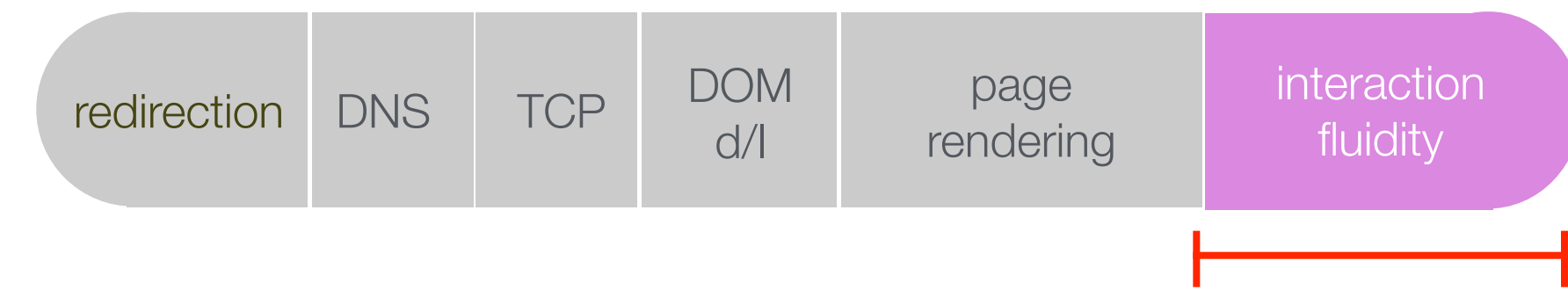
- Event (click)
- Recalculate Style (...)
- Send Request (fid...
- Timer Fired (4379)
- Recalculate Style (...)
- Update Layer Tree
- Paint (128 x 128)
- Composite Layers
- Timer Fired (4379)
- Recalculate Style (...)
- Update Layer Tree
- Paint (128 x 128)
- Composite Layers
- Timer Fired (4379)
- Recalculate Style (...)
- Update Layer Tree
- Paint (128 x 128)
- Composite Layers



multiple reflows



Distract users from noticing slowness



Distract users from noticing slowness

redirection

DNS

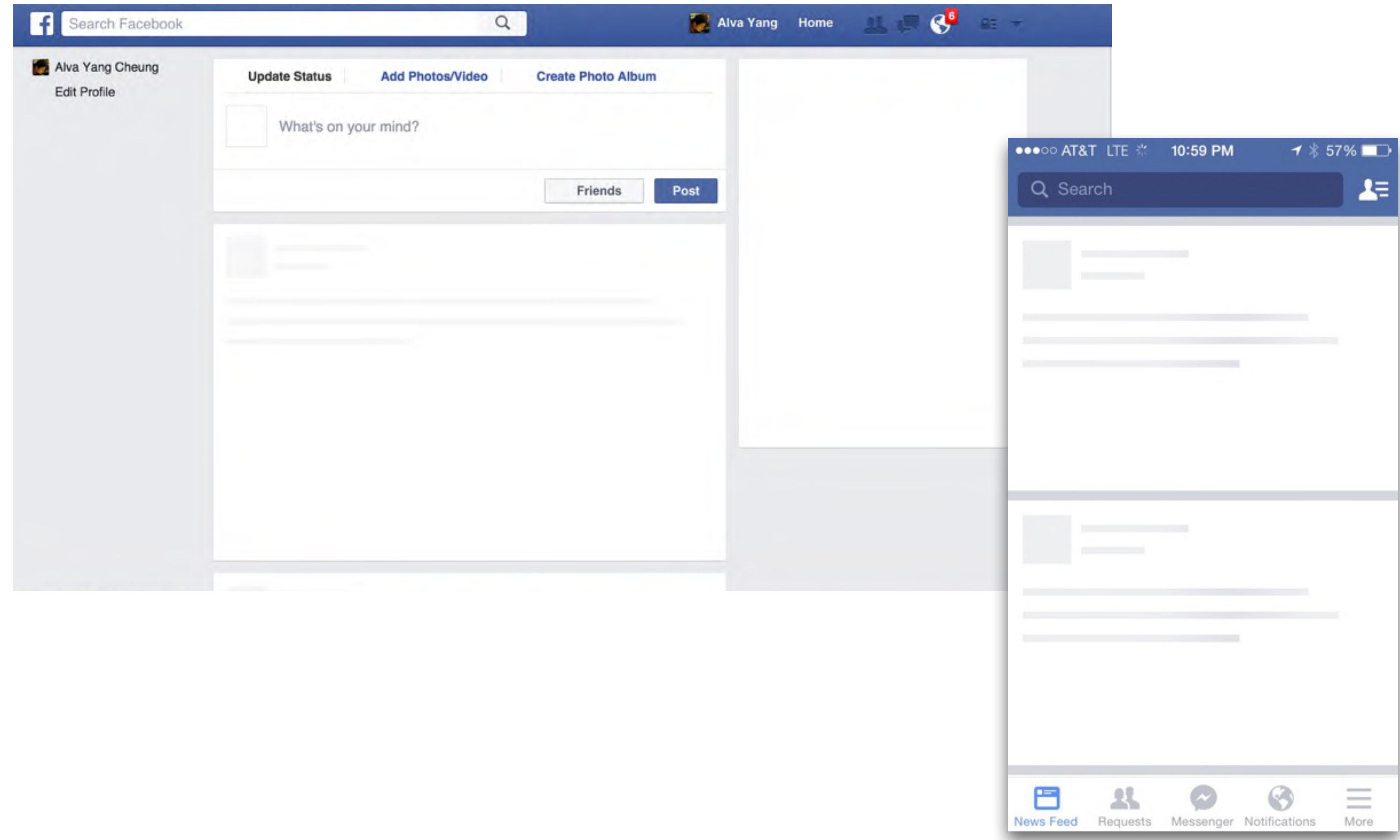
TCP

DOM
d/I

page
rendering

interaction
fluidity

- Placeholders



Distract users from noticing slowness

redirection

DNS

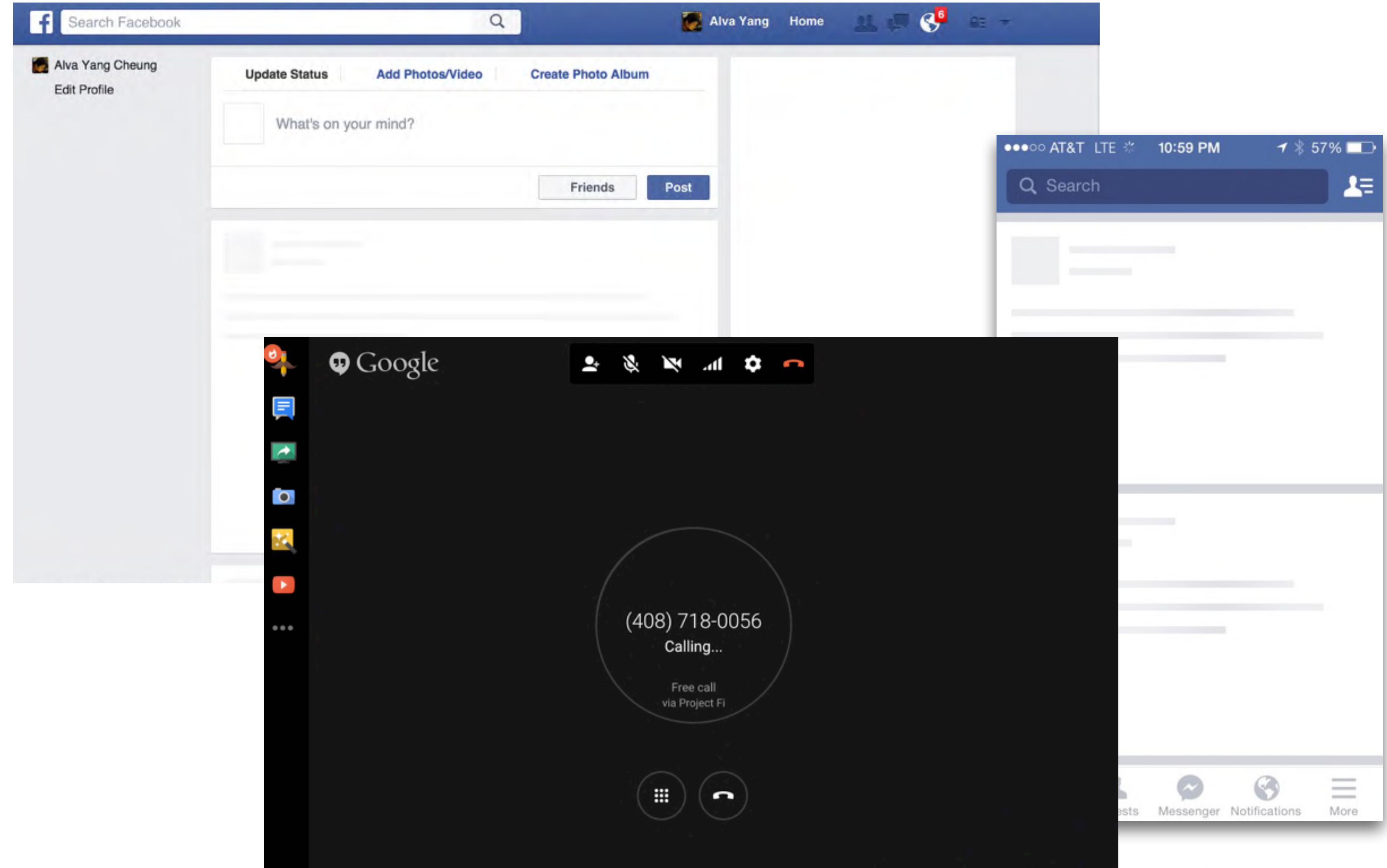
TCP

DOM
d/I

page
rendering

interaction
fluidity

- Placeholders
- Animations



Distract users from noticing slowness

redirection

DNS

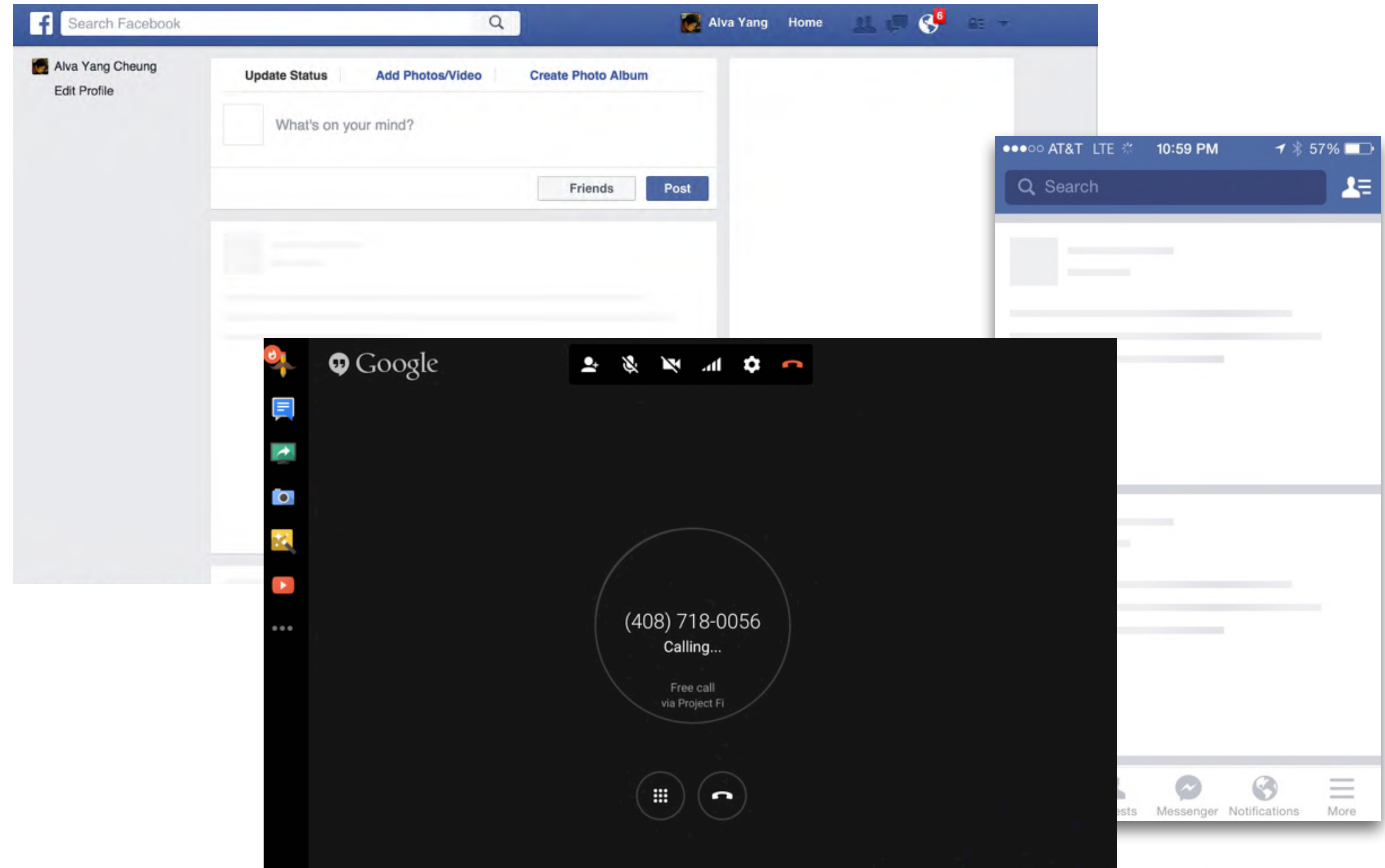
TCP

DOM
d/I

page
rendering

interaction
fluidity

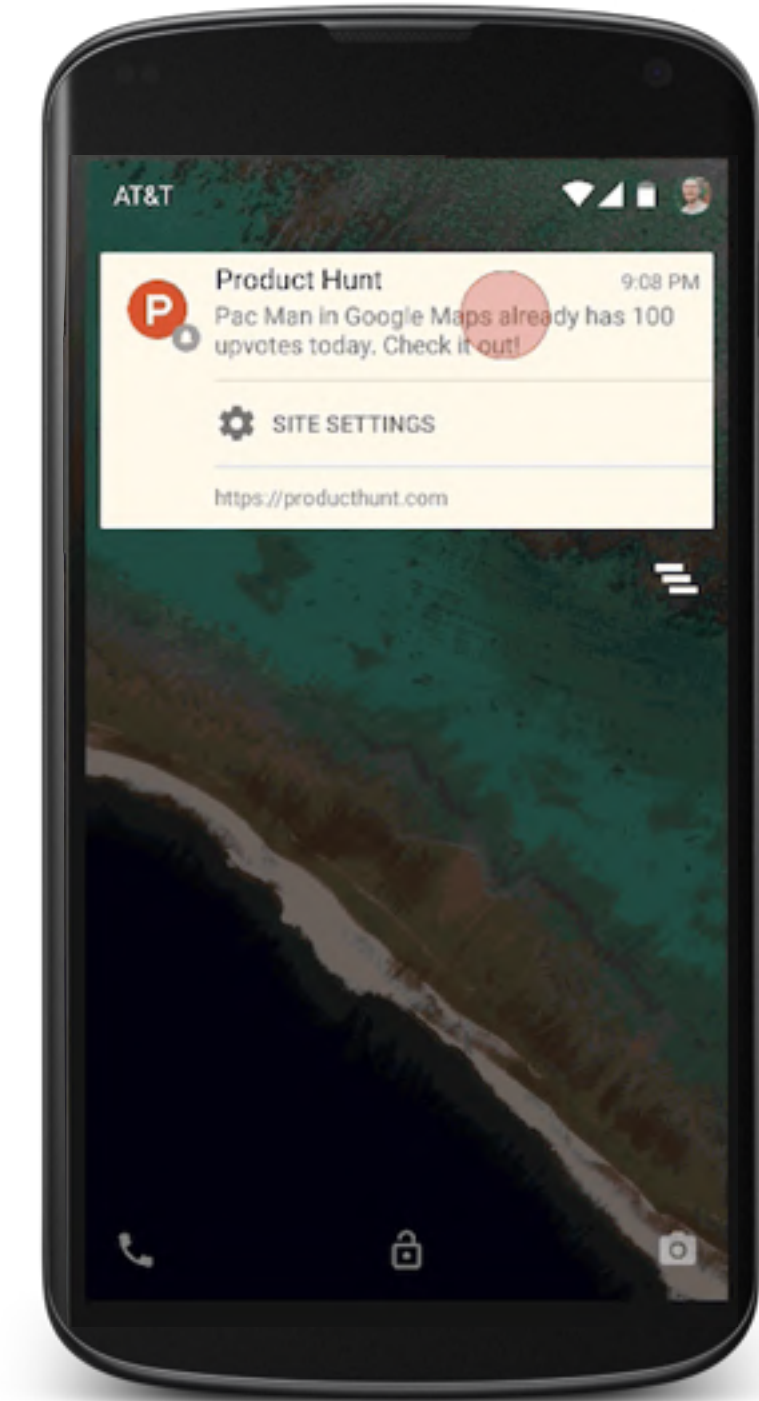
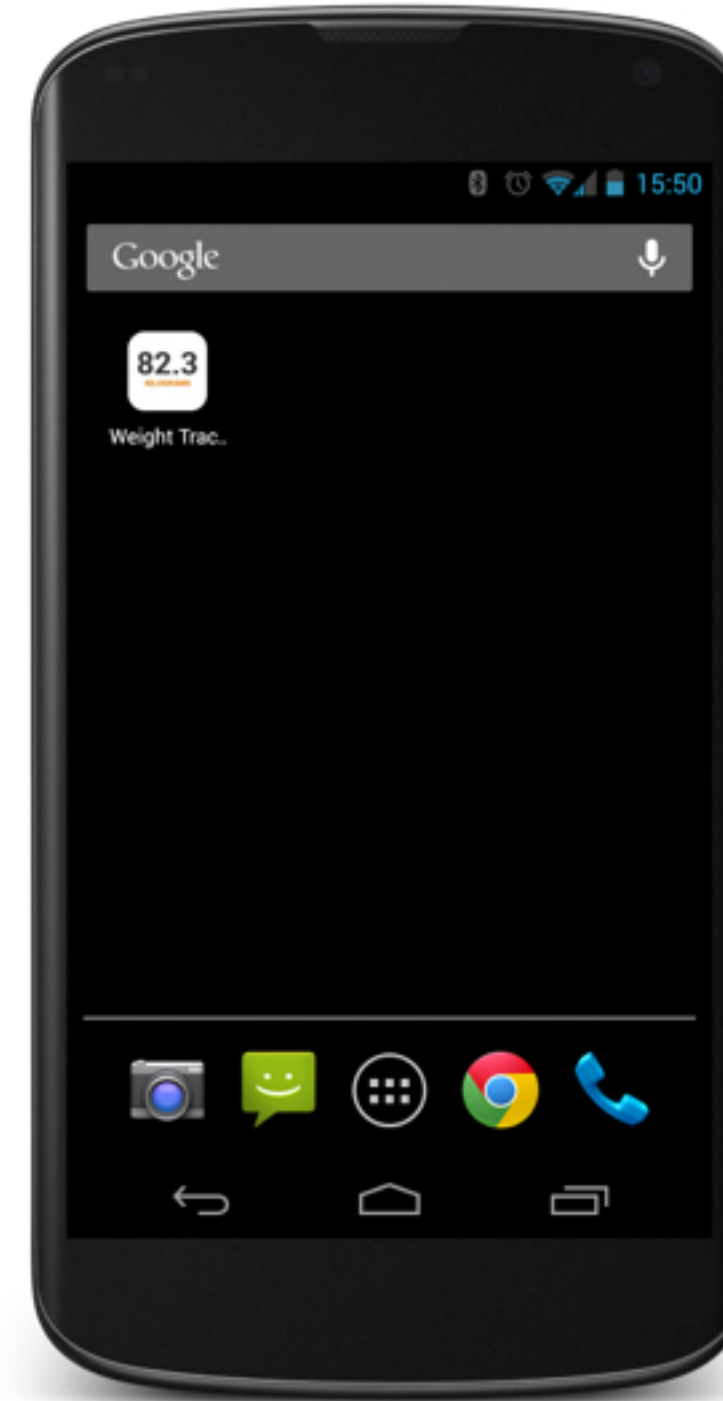
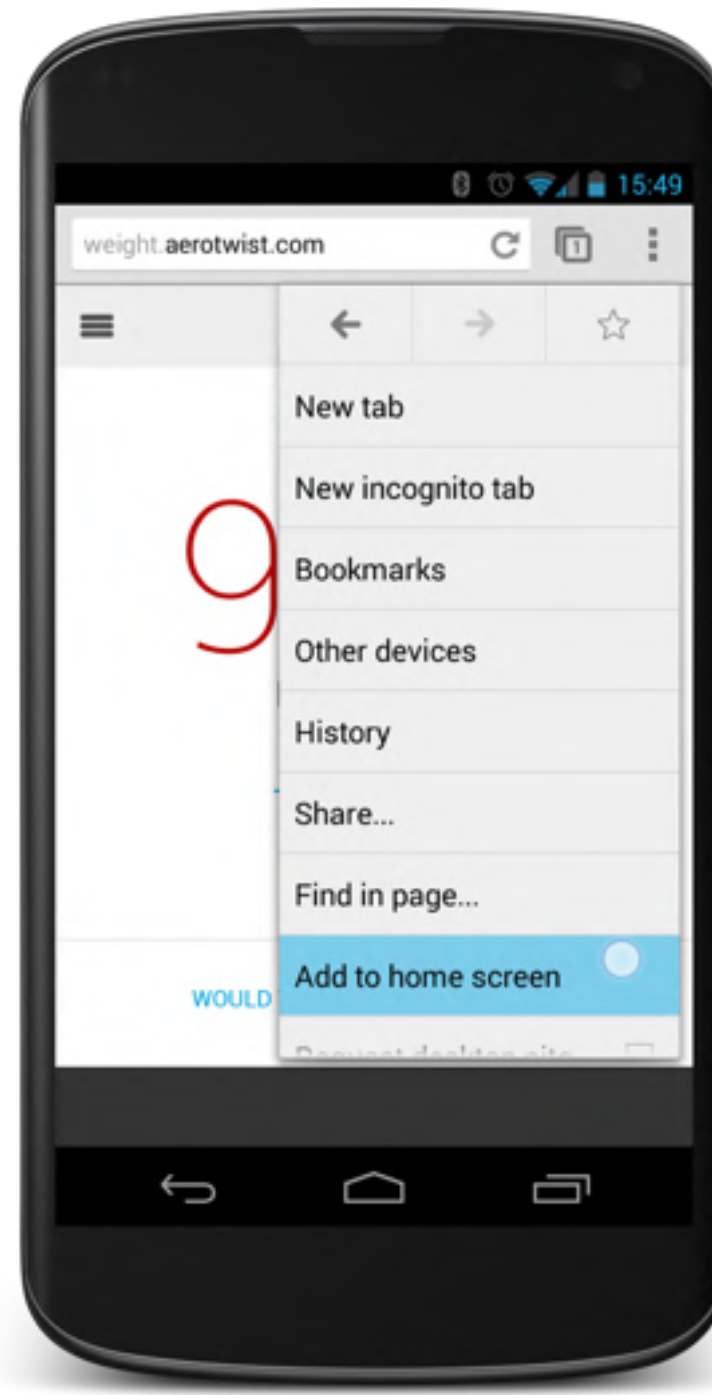
- Placeholders
- Animations
- Partial loading



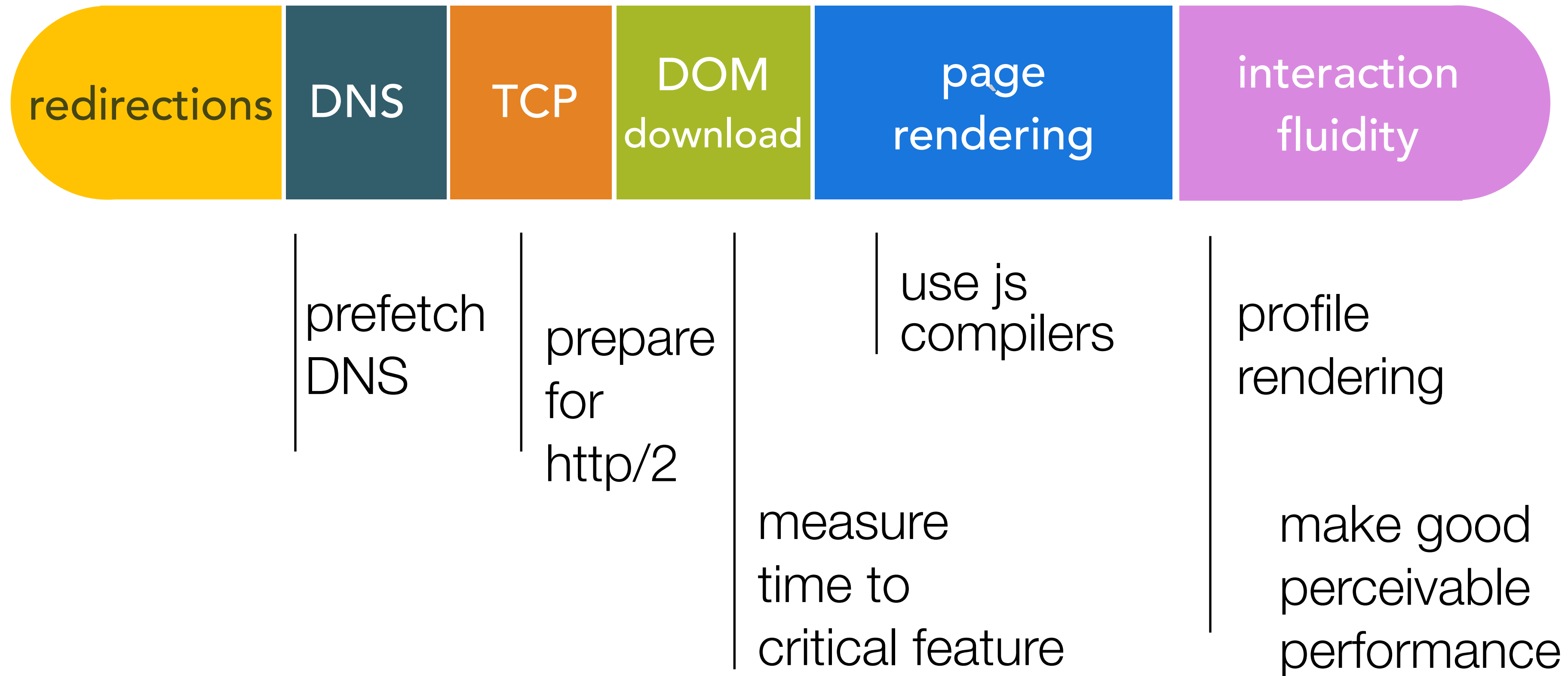
Prepare to get offline



- navigator.onLine
- "Add to home screen" + Service worker
- Push API



Try these!



Alva Cheung

slides: <http://tinyurl.com/alva-v2015-happy>