LATENCY

& Client-Side Performance

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A TRUE STORY

You decide to build a product/website.

You hire some kickass ninja programmers!

You start coding your site in the coolest language with the strongest amazon EC2 server available.

A TRUE STORY

You go beta.

You realize your site is really slow.
Each query takes 400ms!

A TRUE STORY

You add more servers.

And then add some more servers.

Still slow, so you migrate to mongodb,
add memcached and redis!

You saved some CPU cycles & cut performance by 75%!
Now queries are only taking 100ms!

A TRUE STORY

All this, and then you realize you still have a problem...

While you saved 300ms on the server side,
your users are still waiting another 8 seconds
on the client side!

TODAY, WE’RE TALKING ABOUT

- What & why
- Measuring
- Theory
- 8 Technical tips
- Proving it works

WHY SHOULD YOU TRUST ME ?

- 10+ years in web development
- C#, asp.net, Java, php, nodejs
- On the 'Core' engineering team @ Sears Israel
- Focusing on client side performance for the past ~8months

WHAT IS LATENCY TO US ?

The time measured from the moment a user enters our URL, until the page is 'ready'.

WHY DOES THIS MATTER ?

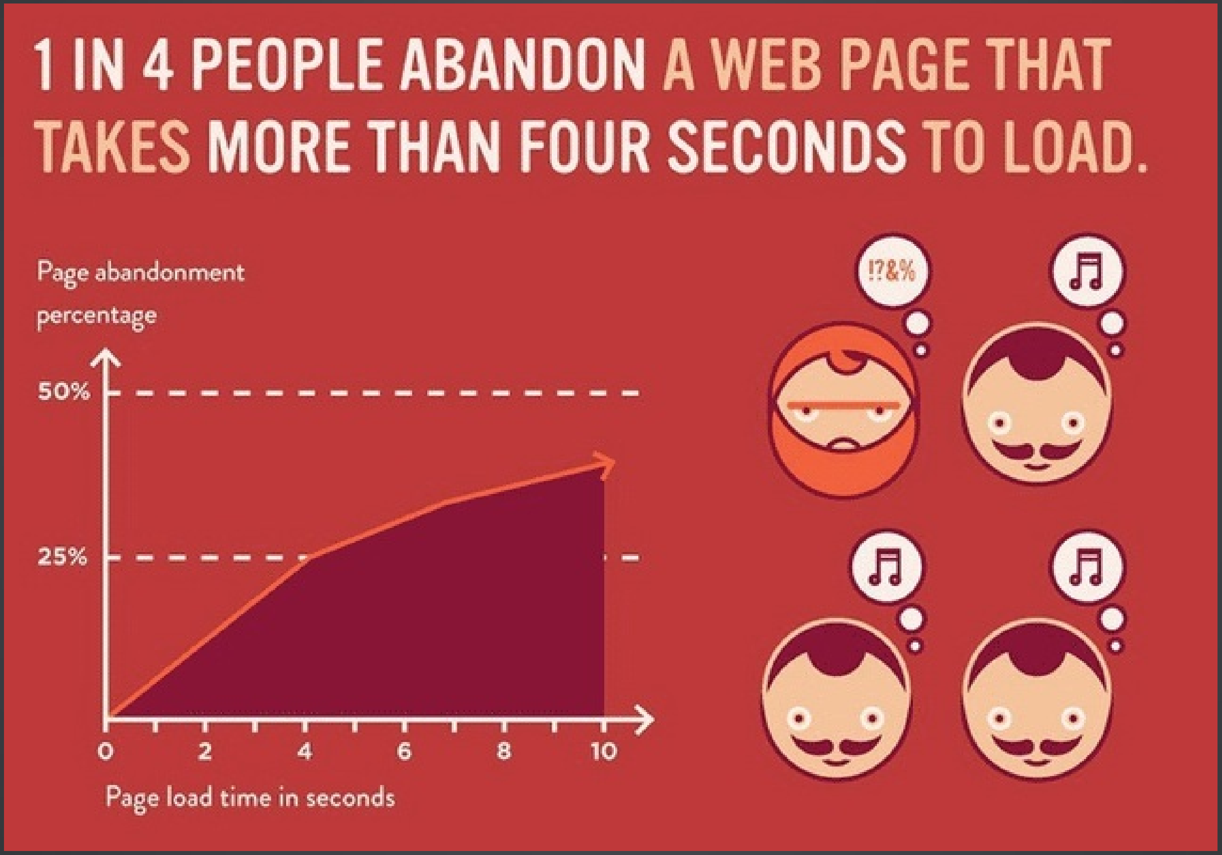
Amazon.com makes about $67 million in sales each day.

IT COULD POTENTIALLY LOSE UP TO $1.6 BILLION PER YEAR BECAUSE OF A 1 SECOND WEB PAGE DELAY.

http://9.mshcdn.com/wp-content/uploads/2012/03/Instant-America-800.jpg

OnlineGraduatePrograms.com

WHY DOES THIS MATTER ?



1 IN 4 PEOPLE ABANDON A WEB PAGE THAT TAKES MORE THAN FOUR SECONDS TO LOAD.

http://9.mshcdn.com/wp-content/uploads/2012/03/Instant-America-800.jpg

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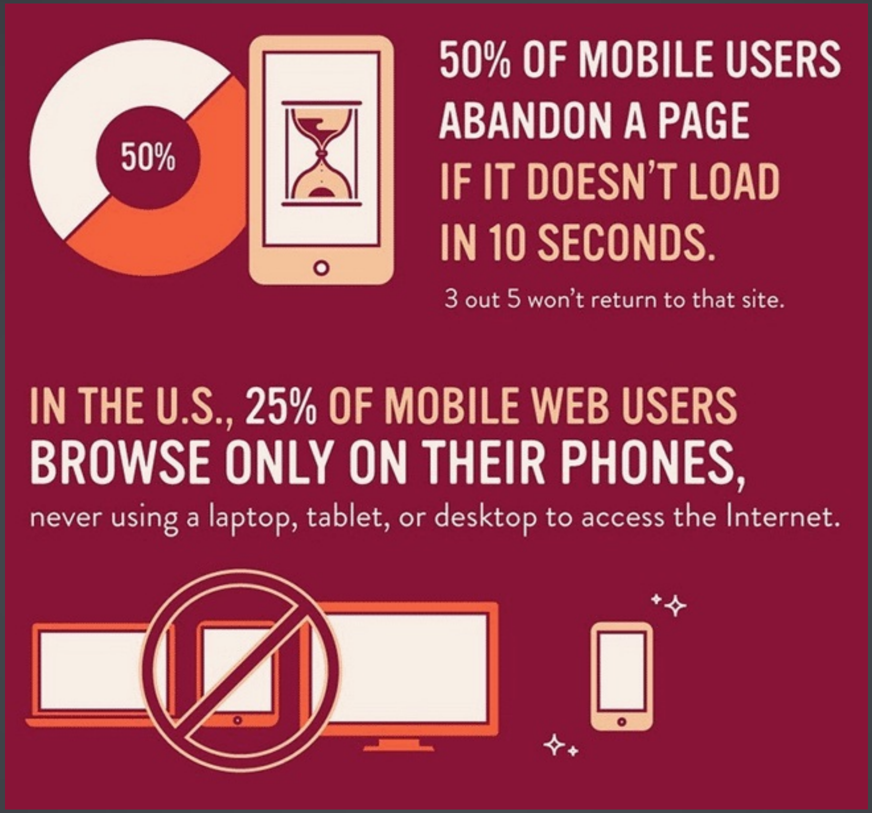
WHY DOES THIS MATTER ?



50% OF MOBILE USERS ABANDON A PAGE IF IT DOESN'T LOAD IN 10 SECONDS.

3 out 5 won't return to that site.

IN THE U.S., 25% OF MOBILE WEB USERS BROWSE ONLY ON THEIR PHONES, never using a laptop, tablet, or desktop to access the Internet.

http://9.mshcdn.com/wp-content/uploads/2012/03/Instant-America-800.jpg

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SO, HOW FAST SHOULD WE BE ?

- < 100 ms = illusion of instant response
- <1 sec = seamless flow of thought
- <10 sec = user starts to lose context
- >10 sec = user is elsewhere...

*Based on a psychological study by Jakob Nielsen

WE CAN’T REALLY BE THAT FAST!

...but we can give the illusion that we are

MEASURING LATENCY ?

- RUM (Real User Monitoring)
- SUM (Synthetic User Monitoring)
- Waterfall Charts

REAL USER MONITORING

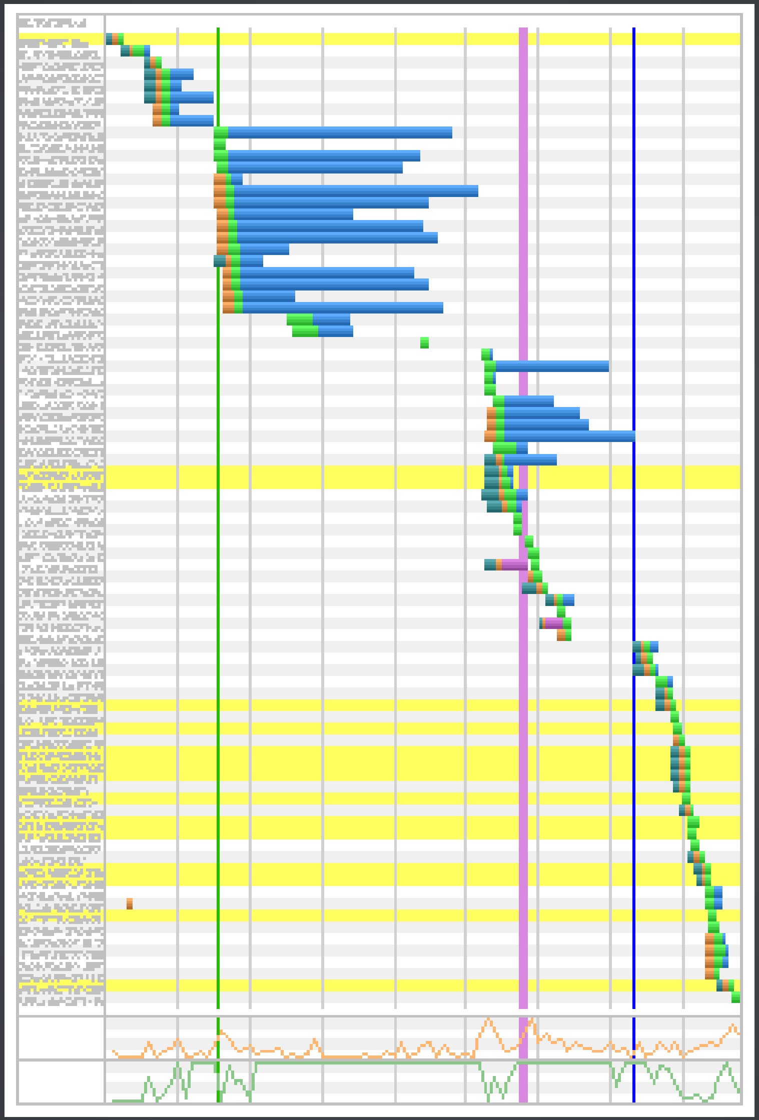
- Gathering data from real clients' machines
- Data is "real"
- No control over the experiment
- Reveals problems that synthetic user monitoring won't

SYNTHETIC USER MONITORING

- Having a dedicated machine for monitoring
- Doesn't necessarily represent your user's experience
- Controlled environment
- Gives us empirical data we can work with, follow, and see our improvements.

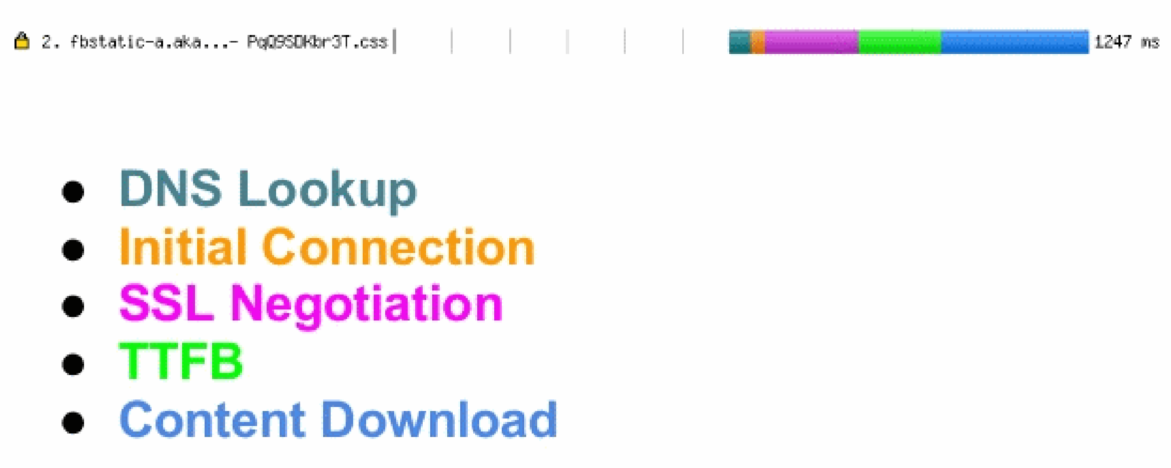
- phantomjs, WebPageTest

WATERFALL CHARTS...



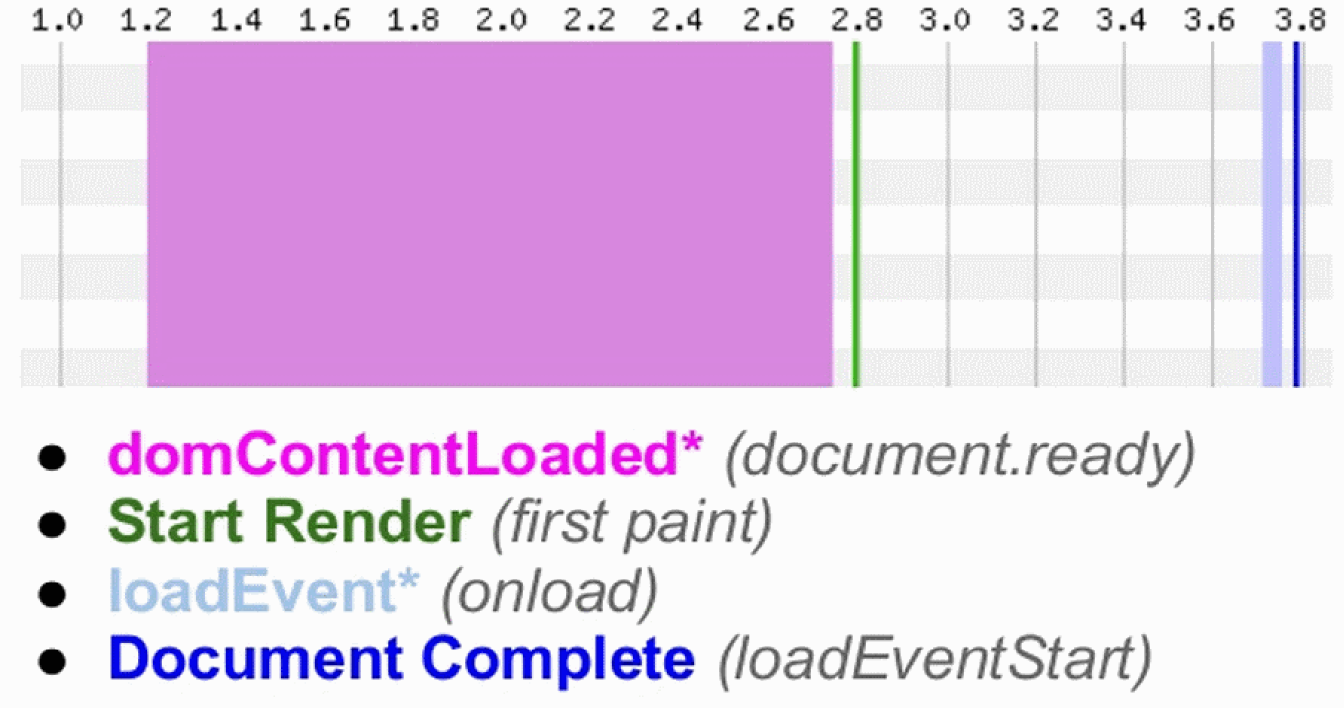
THEORY

ANATOMY OF A REQUEST



- DNS Lookup
- Initial Connection
- SSL Negotiation
- TTFB
- Content Download

RENDERING & LOADING



- Start Render should be as soon as possible
- DOM Ready should be as short possible
- All event lines should be as close as possible

POP QUIZ:

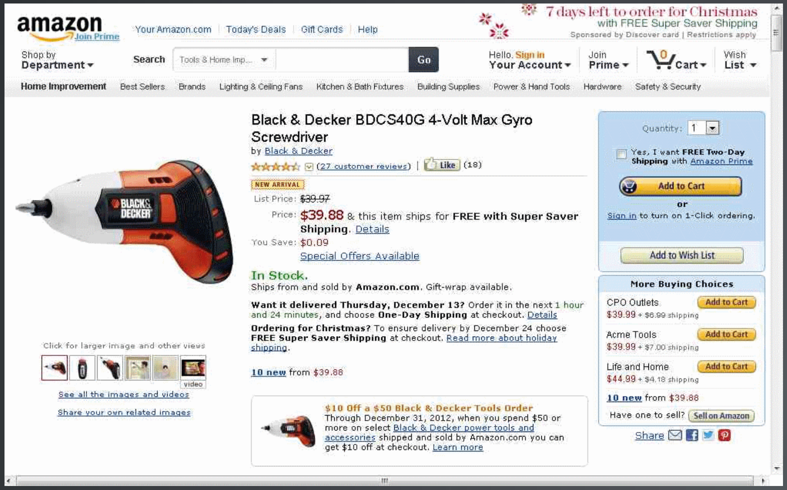
When does

```
$(function() {
    // do something...
});
```

happen ?

SO, WHAT DO WE MEASURE ?

WINDOW.ONLOAD ?!#@



Black & Decker BDCS40G 4-Volt Max Gyro Screwdriver

by Black & Decker

(27 customer reviews) | Like (18)

List Price: ~~$39.97~~

Price: $39.88 & this item ships for **FREE with Super Saver Shipping**. Details

You Save: $0.09

Special Offers Available

In Stock.

Ships from and sold by **Amazon.com**. Gift-wrap available.

Want it delivered Thursday, December 13? Order it in the next 1 hour and 24 minutes, and choose **One-Day Shipping** at checkout. Details

Ordering for Christmas? To ensure delivery by December 24 choose **FREE Super Saver Shipping** at checkout. Read more about holiday shipping.

10 new from $39.88

$10 Off a $50 Black & Decker Tools Order
Through December 31, 2012, when you spend $50 or more on select Black & Decker power tools and accessories shipped and sold by Amazon.com you can get $10 off at checkout. Learn more

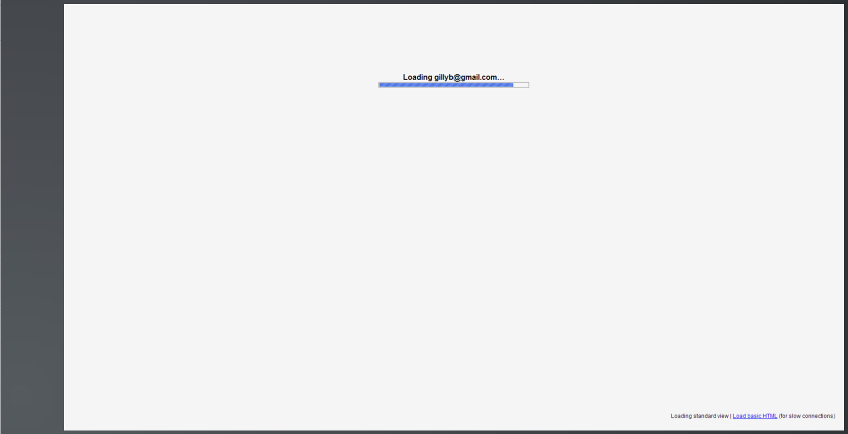
☐ Yes, I want **FREE Two-Day Shipping** with Amazon Prime

Sign in to turn on 1-Click ordering.

CPO Outlets	$39.99 + $6.99 shipping
Acme Tools	$39.99 + $7.00 shipping
Life and Home	$44.99 + $4.18 shipping

10 new from $39.88

Have one to sell?



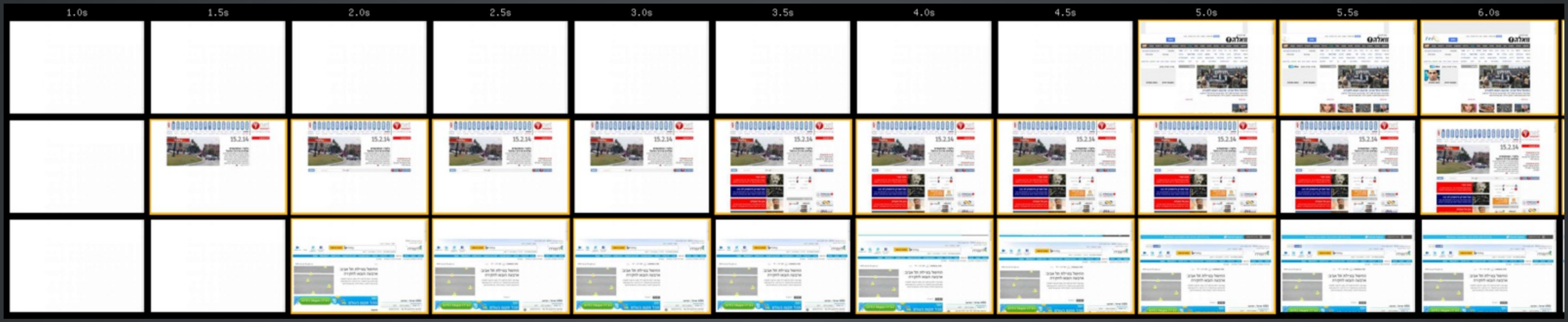
Loading gillyb@gmail.com...

Loading standard view | Load basic HTML (for slow connections)

- Amazon's Product Page loads in ~5-6 seconds
- Gmail is much, much faster...
- Twitter measures 'Time To First Tweet'

SPEED INDEX

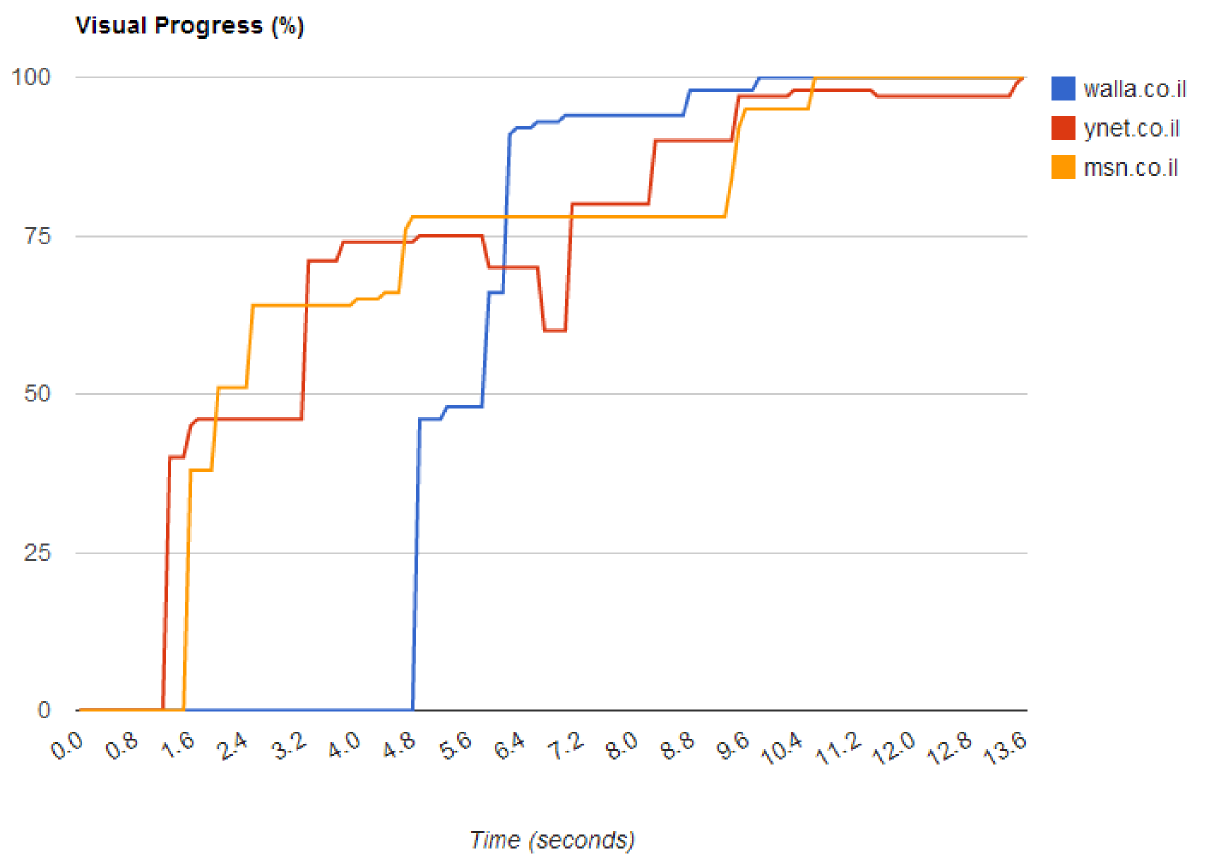
How much does the user see, and how fast ?...



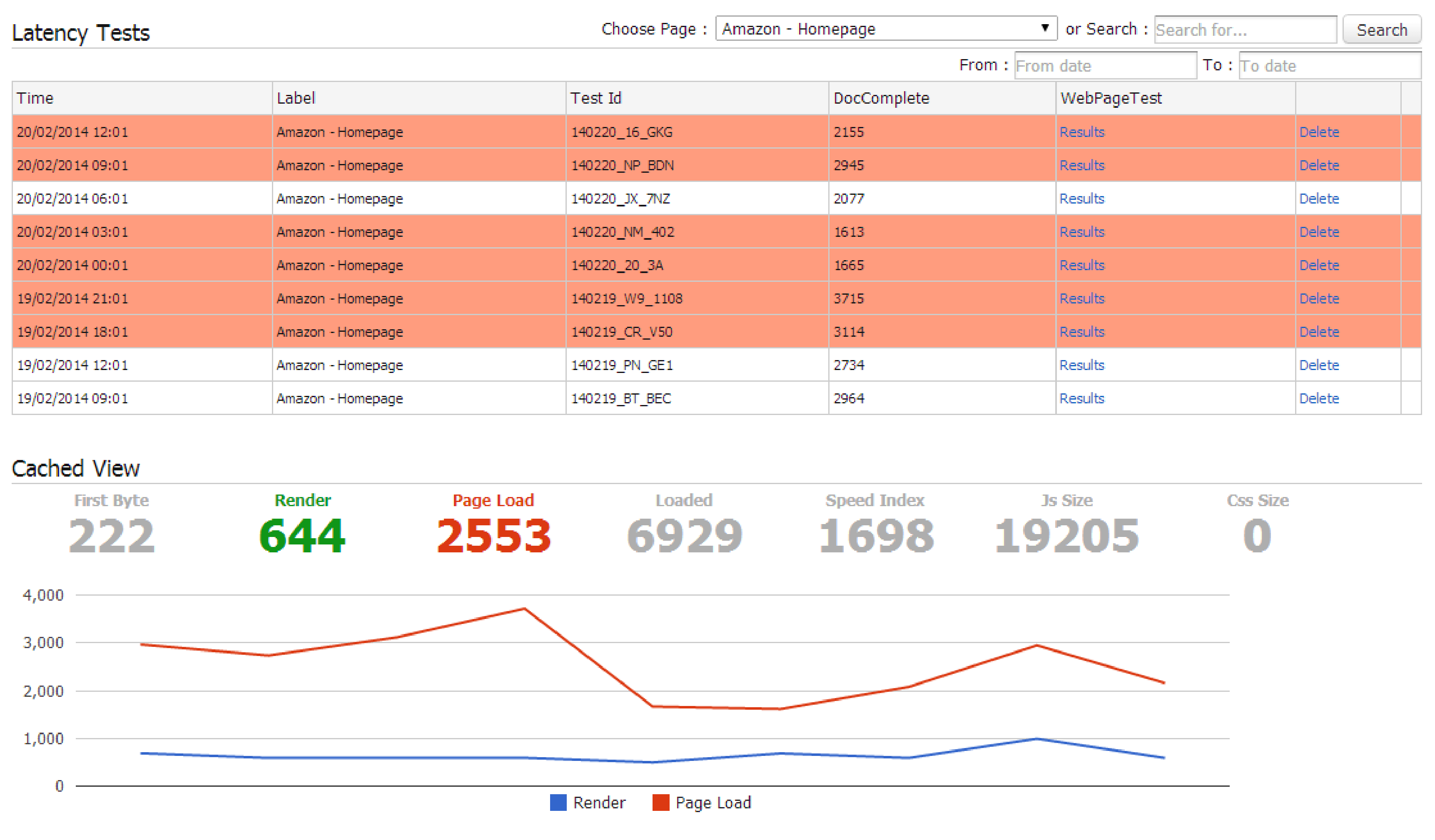
http://www.webpagetest.org/video/compare.php?tests=140215_KW_MVB,140215_Y7_MVC,140215_76_MVE

SPEED INDEX

Measures exactly what the user sees in the viewport



WHAT WE DO



Latency Tests

Choose Page : Amazon - Homepage ▾ or Search : Search for... Search

From : From date To : To date

Time	Label	Test Id	DocComplete	WebPageTest	
20/02/2014 12:01	Amazon - Homepage	140220_16_GKG	2155	Results	Delete
20/02/2014 09:01	Amazon - Homepage	140220_NP_BDN	2945	Results	Delete
20/02/2014 06:01	Amazon - Homepage	140220_JX_7NZ	2077	Results	Delete
20/02/2014 03:01	Amazon - Homepage	140220_NM_402	1613	Results	Delete
20/02/2014 00:01	Amazon - Homepage	140220_20_3A	1665	Results	Delete
19/02/2014 21:01	Amazon - Homepage	140219_W9_1108	3715	Results	Delete
19/02/2014 18:01	Amazon - Homepage	140219_CR_V50	3114	Results	Delete
19/02/2014 12:01	Amazon - Homepage	140219_PN_GE1	2734	Results	Delete
19/02/2014 09:01	Amazon - Homepage	140219_BT_BEC	2964	Results	Delete

Cached View

First Byte	Render	Page Load	Loaded	Speed Index	Js Size	Css Size
222	644	2553	6929	1698	19205	0

SO WHAT CAN WE DO ?

(8 helpful tips)

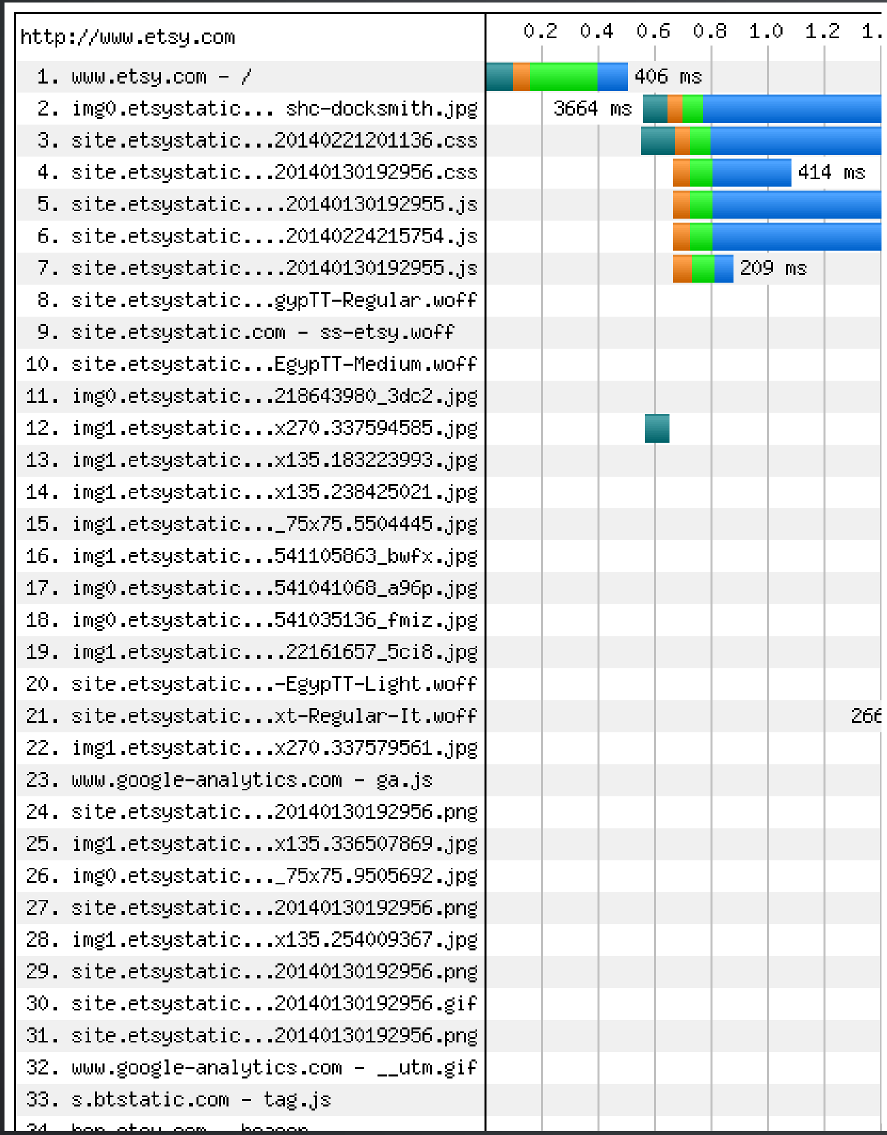
1. DOMAIN SHARDING

- Multiple domains will help download resources faster.
- Too many domains will cause congestion.
- Rule of thumb : at least 2, no more than 4

- Etsy recently discovered that sharding over 2 domains instead of 4 increased performance by 500ms on mobile devices!

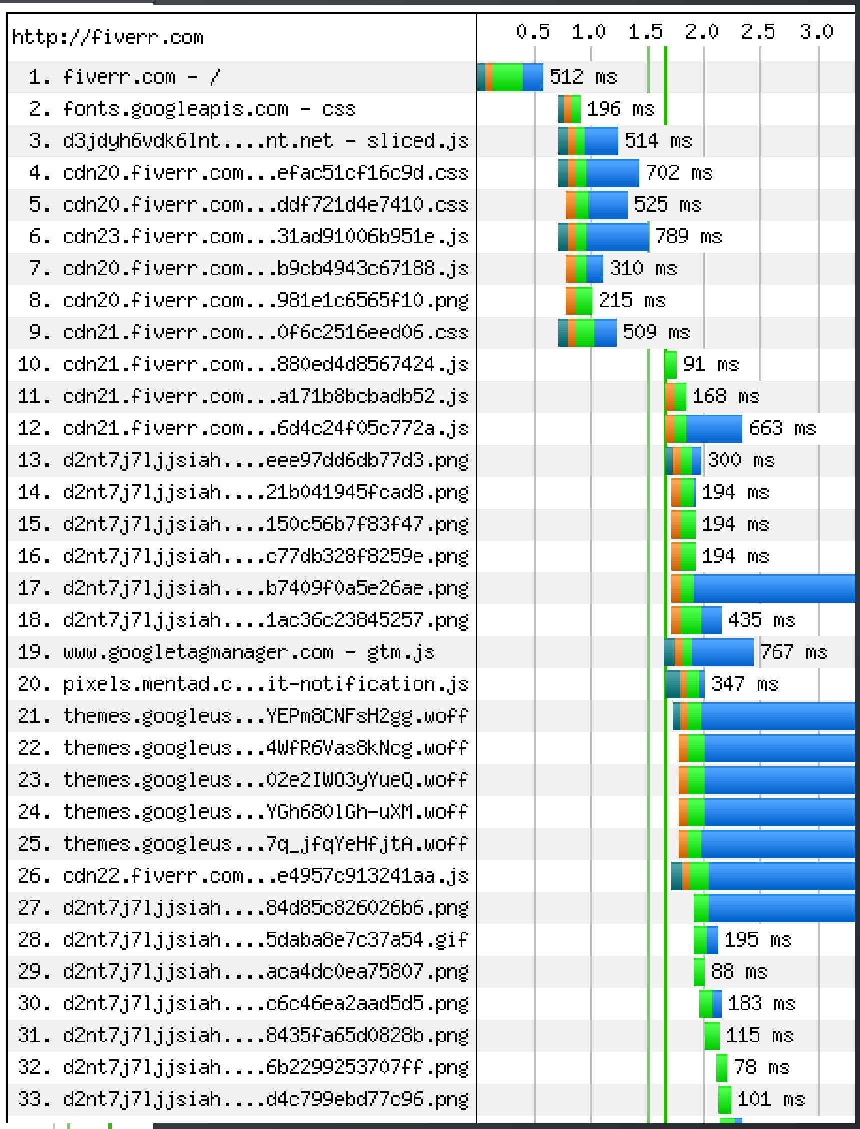
1. DOMAIN SHARDING

ETSY.COM



```
http://www.etsy.com                              0.2  0.4  0.6  0.8  1.0  1.2  1.
 1. www.etsy.com - /                             406 ms
 2. img0.etsystatic... shc-docksmith.jpg         3664 ms
 3. site.etsystatic...20140221201136.css
 4. site.etsystatic...20140130192956.css         414 ms
 5. site.etsystatic....20140130192955.js
 6. site.etsystatic....20140224215754.js
 7. site.etsystatic....20140130192955.js         209 ms
 8. site.etsystatic...gypTT-Regular.woff
 9. site.etsystatic.com - ss-etsy.woff
10. site.etsystatic...EgypTT-Medium.woff
11. img0.etsystatic...218643980_3dc2.jpg
12. img1.etsystatic...x270.337594585.jpg
13. img1.etsystatic...x135.183223993.jpg
14. img1.etsystatic...x135.238425021.jpg
15. img1.etsystatic..._75x75.5504445.jpg
16. img1.etsystatic...541105863_bwfx.jpg
17. img0.etsystatic...541041068_a96p.jpg
18. img0.etsystatic...541035136_fmiz.jpg
19. img1.etsystatic....22161657_5ci8.jpg
20. site.etsystatic...-EgypTT-Light.woff
21. site.etsystatic...xt-Regular-It.woff         266
22. img1.etsystatic...x270.337579561.jpg
23. www.google-analytics.com - ga.js
24. site.etsystatic...20140130192956.png
25. img1.etsystatic...x135.336507869.jpg
26. img0.etsystatic..._75x75.9505692.jpg
27. site.etsystatic...20140130192956.png
28. img1.etsystatic...x135.254009367.jpg
29. site.etsystatic...20140130192956.png
30. site.etsystatic...20140130192956.gif
31. site.etsystatic...20140130192956.png
32. www.google-analytics.com - __utm.gif
33. s.btstatic.com - tag.js
34. bcn.etsy.com - beacon
```

FIVERR.COM



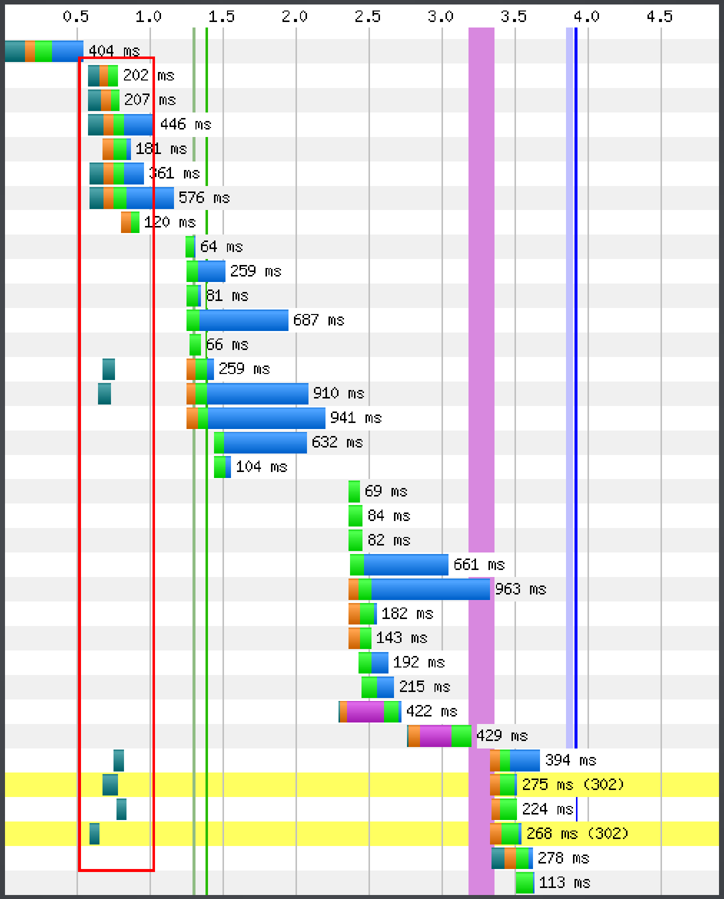
```
http://fiverr.com                                0.5  1.0  1.5  2.0  2.5  3.0
 1. fiverr.com - /                               512 ms
 2. fonts.googleapis.com - css                   196 ms
 3. d3jdyh6vdk6lnt....nt.net - sliced.js         514 ms
 4. cdn20.fiverr.com...efac51cf16c9d.css         702 ms
 5. cdn20.fiverr.com...ddf721d4e7410.css         525 ms
 6. cdn23.fiverr.com...31ad91006b951e.js         789 ms
 7. cdn20.fiverr.com...b9cb4943c67188.js         310 ms
 8. cdn20.fiverr.com...981e1c6565f10.png         215 ms
 9. cdn21.fiverr.com...0f6c2516eed06.css         509 ms
10. cdn21.fiverr.com...880ed4d8567424.js         91 ms
11. cdn21.fiverr.com...a171b8bcbadb52.js         168 ms
12. cdn21.fiverr.com...6d4c24f05c772a.js         663 ms
13. d2nt7j7ljjsiah....eee97dd6db77d3.png         300 ms
14. d2nt7j7ljjsiah....21b041945fcad8.png         194 ms
15. d2nt7j7ljjsiah....150c56b7f83f47.png         194 ms
16. d2nt7j7ljjsiah....c77db328f8259e.png         194 ms
17. d2nt7j7ljjsiah....b7409f0a5e26ae.png
18. d2nt7j7ljjsiah....1ac36c23845257.png         435 ms
19. www.googletagmanager.com - gtm.js            767 ms
20. pixels.mentad.c...it-notification.js         347 ms
21. themes.googleus...YEPm8CNFsH2gg.woff
22. themes.googleus...4WfR6Vas8kNcg.woff
23. themes.googleus...02e2IWO3yYueQ.woff
24. themes.googleus...YGh6801Gh-uXM.woff
25. themes.googleus...7q_jfqYeHfjtA.woff
26. cdn22.fiverr.com...e4957c913241aa.js
27. d2nt7j7ljjsiah....84d85c826026b6.png
28. d2nt7j7ljjsiah....5daba8e7c37a54.gif         195 ms
29. d2nt7j7ljjsiah....aca4dc0ea75807.png         88 ms
30. d2nt7j7ljjsiah....c6c46ea2aad5d5.png         183 ms
31. d2nt7j7ljjsiah....8435fa65d0828b.png         115 ms
32. d2nt7j7ljjsiah....6b2299253707ff.png         78 ms
33. d2nt7j7ljjsiah....d4c799ebd77c96.png         101 ms
```

2. PREFETCH DNS

- Now you have multiple domains, your client needs to resolve each URL
- You can request these up front, and have the browser do it asynchronously.

```
<link rel="dns-prefetch" href="//cdn1.someCDN.net" />
```

2. PREFETCH DNS



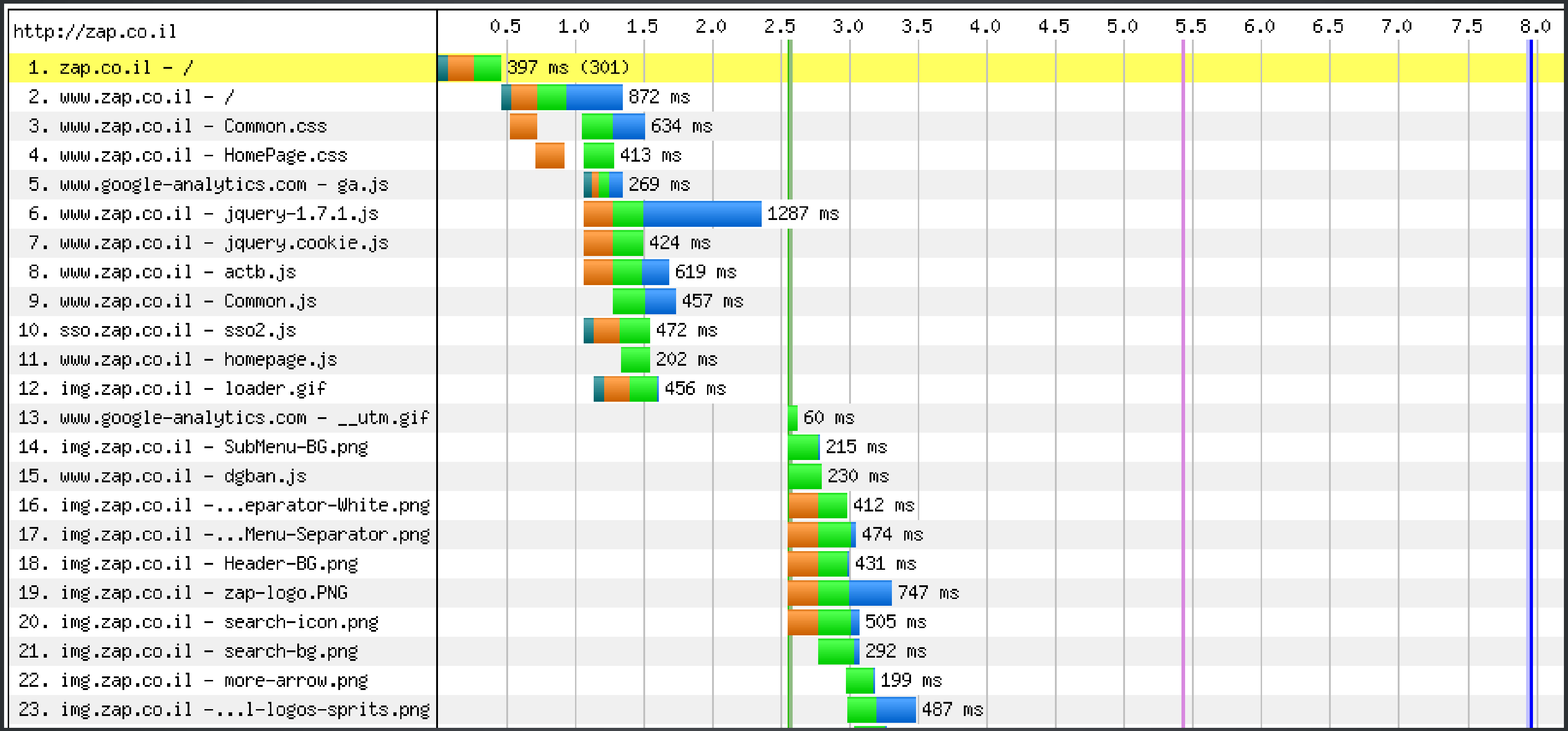
http://www.webpagetest.org/result/140218_79_12MX

3. SCRIPTS & CSS

- CSS should be in the <head/> tag to avoid choppy layout.
- JS should be at end of page not to block rendering

- Experiment with inlining the resources necessary only for use above the fold.

3. SCRIPTS & CSS

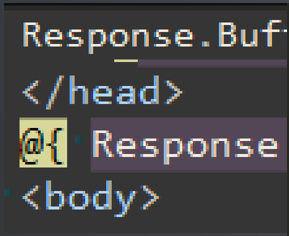


http://zap.co.il	
1. zap.co.il - /	397 ms (301)
2. www.zap.co.il - /	872 ms
3. www.zap.co.il - Common.css	634 ms
4. www.zap.co.il - HomePage.css	413 ms
5. www.google-analytics.com - ga.js	269 ms
6. www.zap.co.il - jquery-1.7.1.js	1287 ms
7. www.zap.co.il - jquery.cookie.js	424 ms
8. www.zap.co.il - actb.js	619 ms
9. www.zap.co.il - Common.js	457 ms
10. sso.zap.co.il - sso2.js	472 ms
11. www.zap.co.il - homepage.js	202 ms
12. img.zap.co.il - loader.gif	456 ms
13. www.google-analytics.com - __utm.gif	60 ms
14. img.zap.co.il - SubMenu-BG.png	215 ms
15. www.zap.co.il - dgban.js	230 ms
16. img.zap.co.il -...eparator-White.png	412 ms
17. img.zap.co.il -...Menu-Separator.png	474 ms
18. img.zap.co.il - Header-BG.png	431 ms
19. img.zap.co.il - zap-logo.PNG	747 ms
20. img.zap.co.il - search-icon.png	505 ms
21. img.zap.co.il - search-bg.png	292 ms
22. img.zap.co.il - more-arrow.png	199 ms
23. img.zap.co.il -...l-logos-sprits.png	487 ms

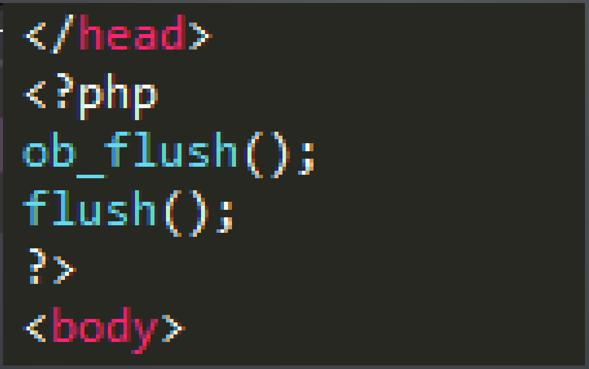
http://www.webpagetest.org/result/140214_YH_E0Z

4. CHUNKED RESPONSE

- Return the first chunk to the browser asap
- First chunk should be after '</head>'
- Tells browser to start downloading resources earlier

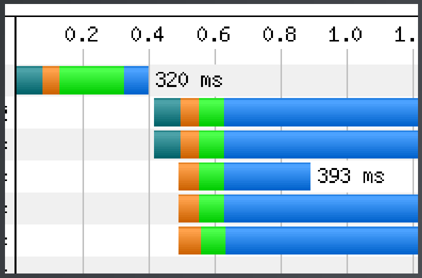


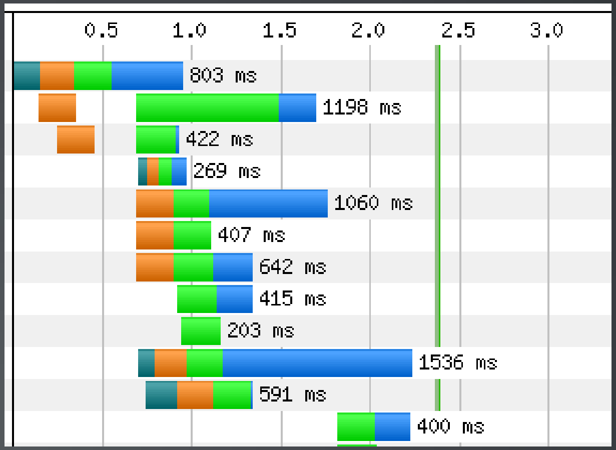
```
Response.Buf
</head>
@{ Response
<body>
```



```
</head>
<?php
ob_flush();
flush();
?>
<body>
```

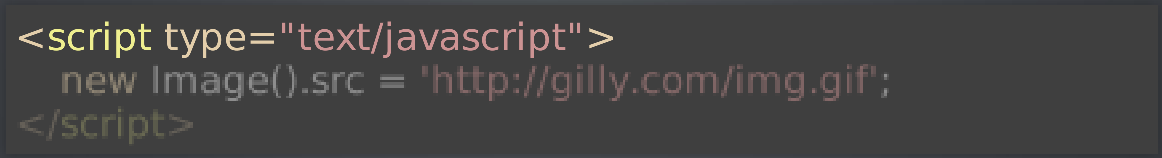
4. CHUNKED RESPONSE





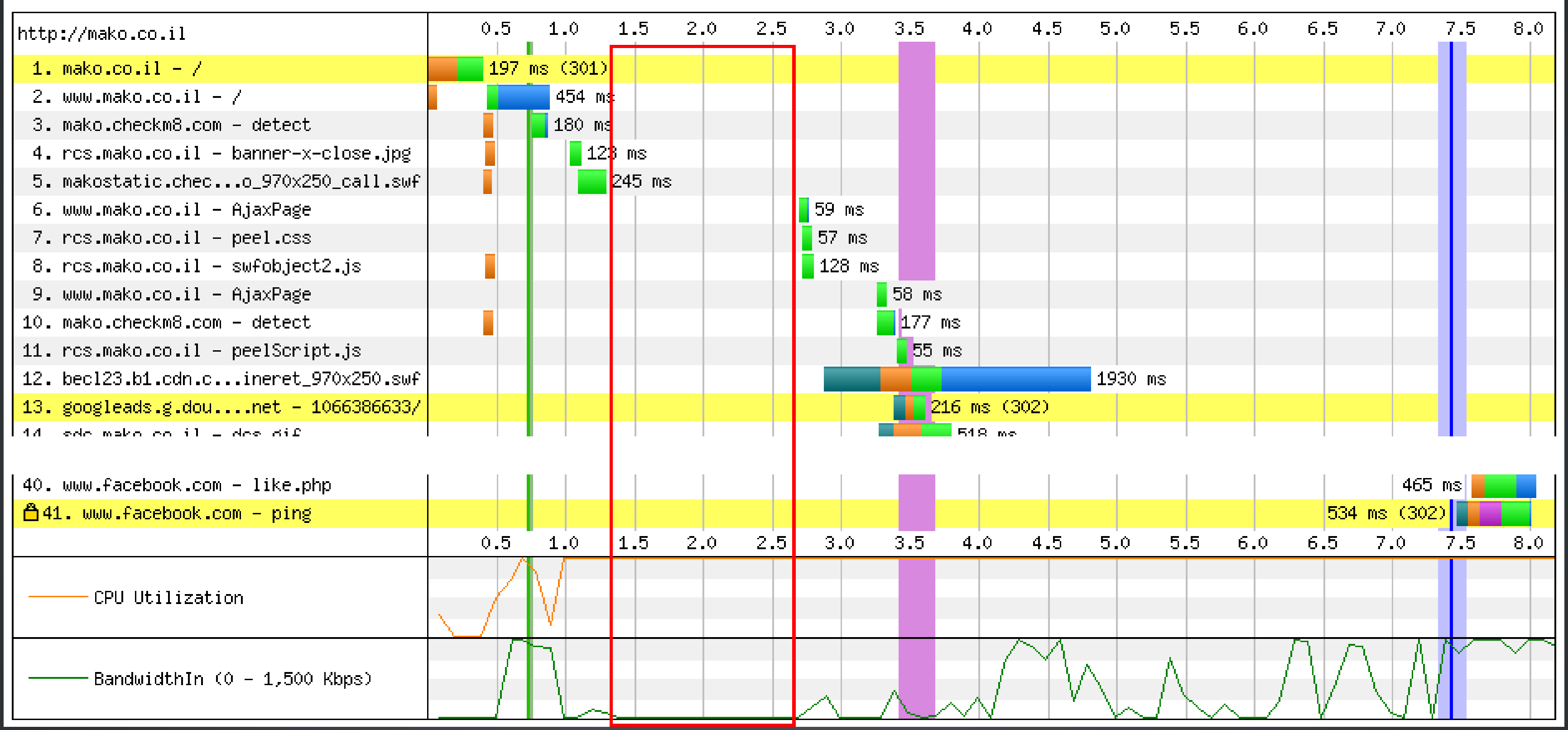
5. LAZY LOADING

- Images can get in the way of downloading other resources
- No need to download images below the fold
- But force the browser to download critical images first



```
<script type="text/javascript">
   new Image().src = 'http://gilly.com/img.gif';
</script>
```

NETWORK SILENCE...

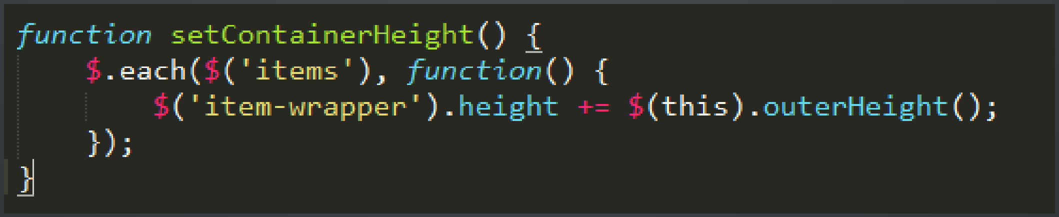


http://mako.co.il	
1. mako.co.il - /	197 ms (301)
2. www.mako.co.il - /	454 ms
3. mako.checkm8.com - detect	180 ms
4. rcs.mako.co.il - banner-x-close.jpg	123 ms
5. makostatic.chec...o_970x250_call.swf	245 ms
6. www.mako.co.il - AjaxPage	59 ms
7. rcs.mako.co.il - peel.css	57 ms
8. rcs.mako.co.il - swfobject2.js	128 ms
9. www.mako.co.il - AjaxPage	58 ms
10. mako.checkm8.com - detect	177 ms
11. rcs.mako.co.il - peelScript.js	55 ms
12. becl23.b1.cdn.c...ineret_970x250.swf	1930 ms
13. googleads.g.dou....net - 1066386633/	216 ms (302)
14. sdc.mako.co.il - dcs.gif	518 ms
40. www.facebook.com - like.php	465 ms
41. www.facebook.com - ping	534 ms (302)

http://www.webpagetest.org/result/140214_V0_ESK/

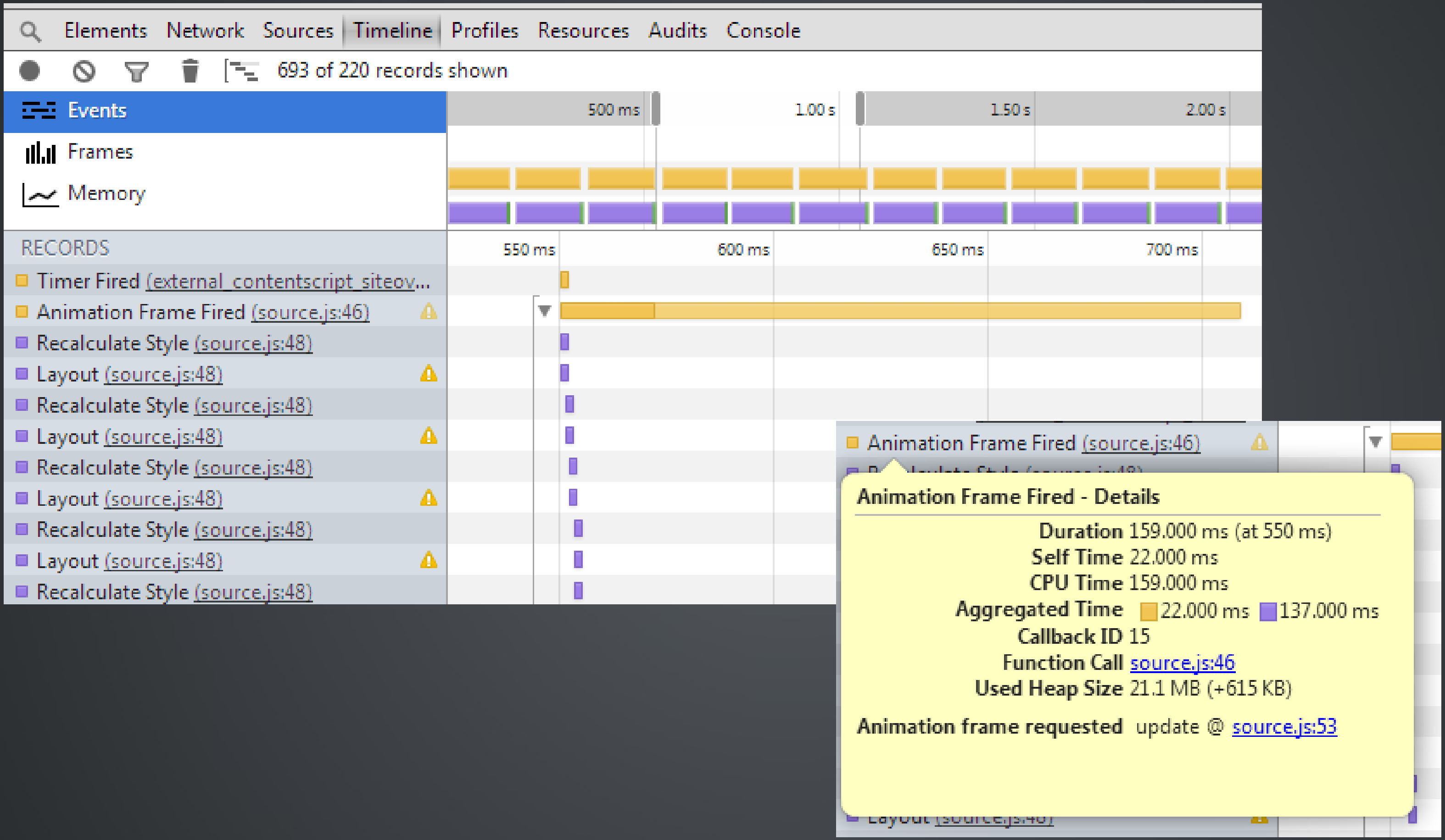
6. FORCING DOM LAYOUT

- Setting and getting element's properties
- The bigger the DOM the more time this
  will take.
- Easily spotted in developers tools
- Avoid this by first getting everything, and then setting everything.



```
function setContainerHeight() {
    $.each($('items'), function() {
        $('item-wrapper').height += $(this).outerHeight();
    });
}
```

6. FORCING DOM LAYOUT



693 of 220 records shown

RECORDS

Timer Fired (external_contentscript_siteov...

Animation Frame Fired (source.js:46)

Recalculate Style (source.js:48)

Layout (source.js:48)

Recalculate Style (source.js:48)

Layout (source.js:48)

Recalculate Style (source.js:48)

Layout (source.js:48)

Recalculate Style (source.js:48)

Layout (source.js:48)

Recalculate Style (source.js:48)

Animation Frame Fired (source.js:46)

Animation Frame Fired - Details

Duration 159.000 ms (at 550 ms)
Self Time 22.000 ms
CPU Time 159.000 ms
Aggregated Time 🟨22.000 ms 🟪137.000 ms
Callback ID 15
Function Call source.js:46
Used Heap Size 21.1 MB (+615 KB)

Animation frame requested update @ source.js:53

7. EFFICIENT CSS

- Use CSS `transform` where possible instead of JS animations.
- This will use the GPU to render the element
- Consumes more memory but increases frame rate

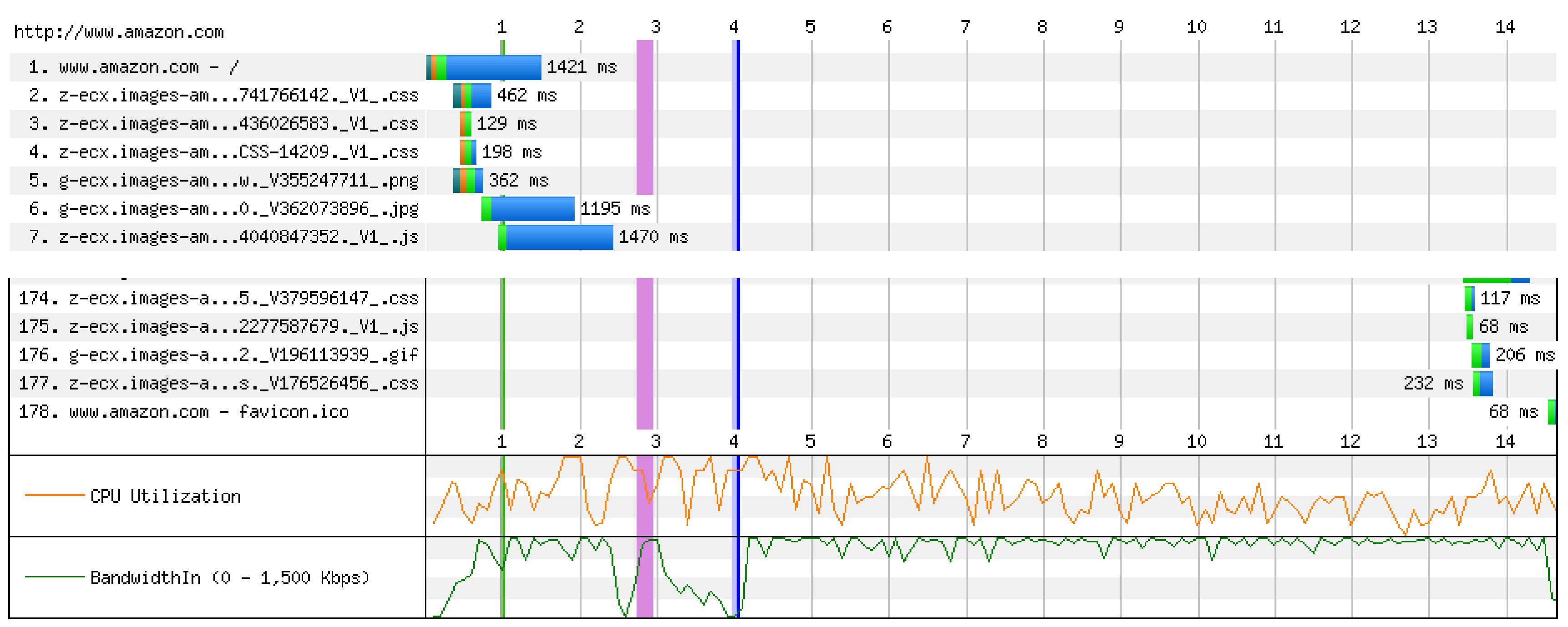
```
transform: translate3d(0, 0, 0);
```

8. PRELOADING RESOURCES

- You know which resources other pages on your site require.
- You know which page users will land on.
- Use this knowledge to 'feed' the users' browser with resources to be ready!

*Make sure not to execute anything!

8. PRELOADING RESOURCES



- amazon.com load ~30-40 resources after 'page-load'
- http://www.webpagetest.org/result/140215_RY_F6B

SO...
IS IT WORTH IT ?

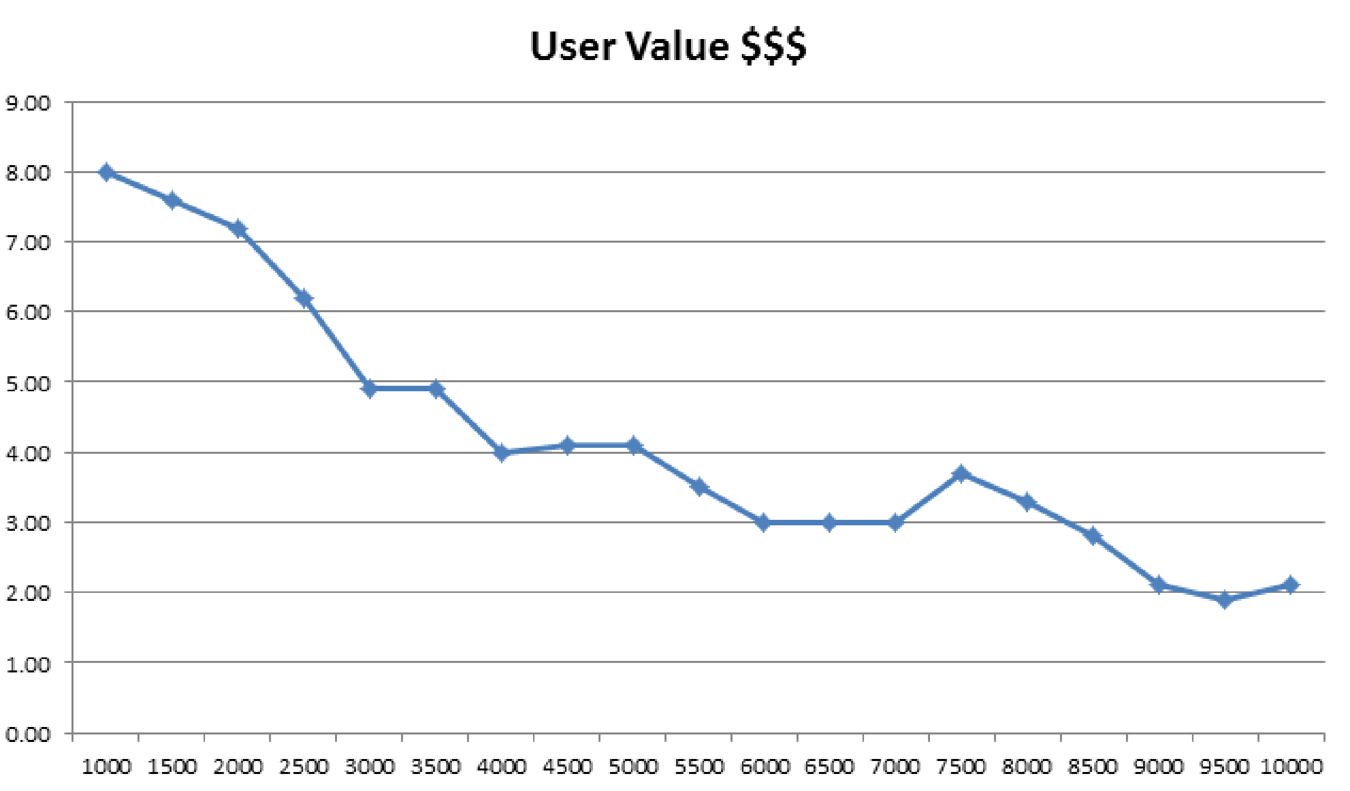
MEASURE & PROVE

- You already have multiple test groups
  - Users getting good performance
  - Users getting bad performance

- Correlate these groups to their overall 'value'

MEASURE & PROVE

You should see a clear correlation!



(*not our real stats)

</presentation>

THANK YOU!

STILL INTERESTED ?...

gillyb@gmail.com
www.DebuggerStepThrough.com

We're hiring!
jobs@sears.co.il

REFERENCES

- Google's Waterfall antipatterns - http://www.youtube.com/watch?v=O5az5D51ACQ
- Yahoo's best practices - http://developer.yahoo.com/performance/rules.html
- Google on HTTP Caching - https://developers.google.com/speed/articles/caching
- RFC 2616 HTTP Headers spec - http://www.w3.org/Protocols/rfc2616/rfc2616-sec14.html
- Web performance metrics - http://blog.kissmetrics.com/loading-time/?wide=1
- Advanced waterfall analysis - http://www.webperformancetoday.com/2010/07/14/waterfalls-401-advanced-analysis-for-non-beginners/
- http://www.webperformancetoday.com (many posts)
- Ilya Grigorik's blog - http://www.igvita.com/
- WebPageTest - http://webpagetest.org
- Moving beyond window.onload() - http://www.stevesouders.com/blog/2013/05/13/moving-beyond-window-onload/
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- Reducing domain sharding - http://calendar.perfplanet.com/2013/reducing-domain-sharding/
- Even faster websites by Steve Souders - http://amzn.to/M2T2ai
- Debugging CSS & Render Performance - http://www.youtube.com/watch?v=gqc88qWuiI4