

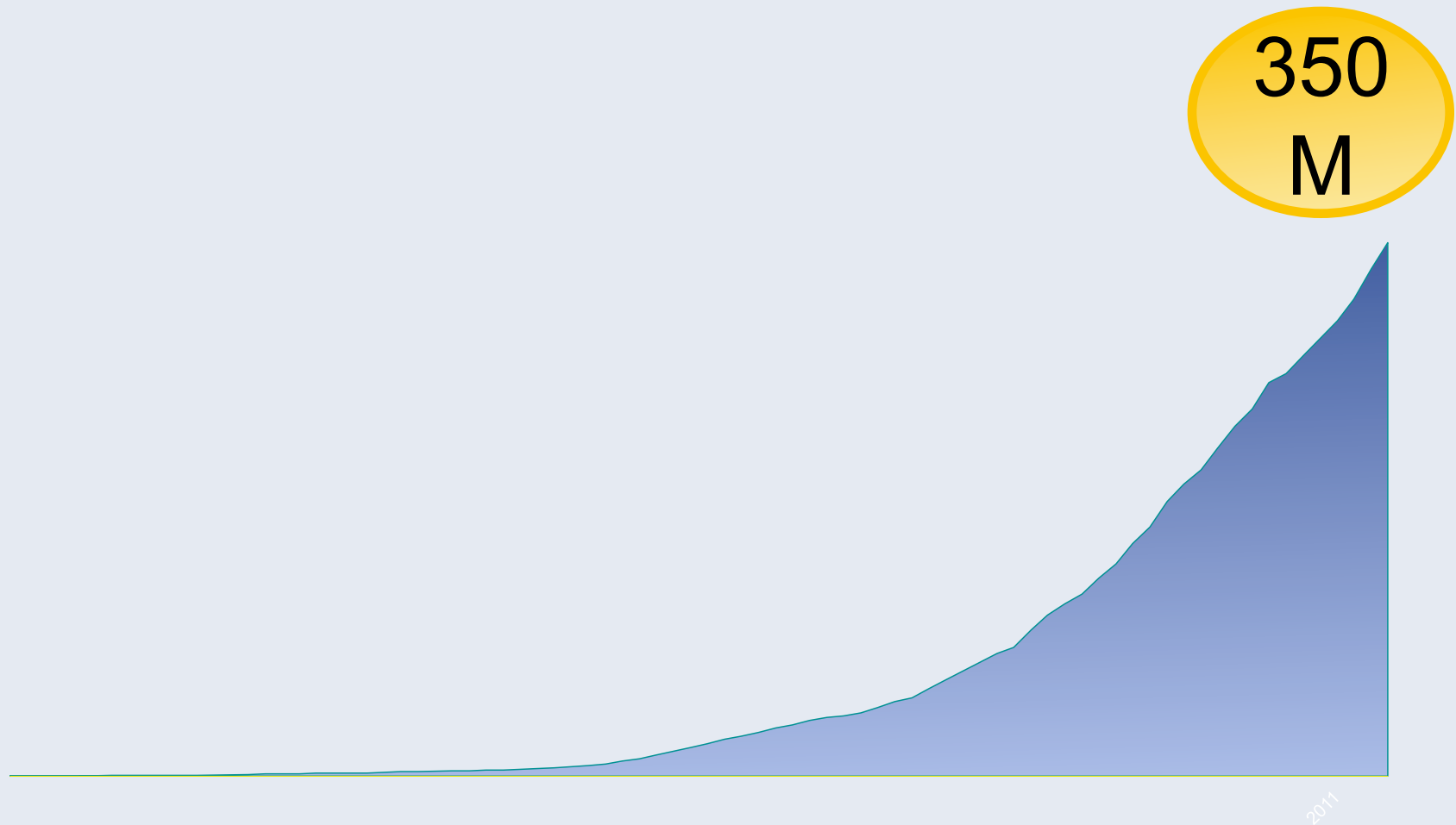
Mobile performance

Xiaoliang “David” Wei

<http://www.DavidWei.org>
www.facebook.com/DavidWei
微博: 魏小亮9

Velocity China, Dec 6th, 2011, Beijing

“Facebook is a mobile company”



<https://www.facebook.com/press/info.php>

Agenda

1 New challenges in mobile

2 Useful (old) tools

3 Q & A

New challenges in mobile

New challenges in mobile

Players in web:

- Users
- Browsers

Players in mobile:

- Users
- Browsers
- Networks
- Devices

New challenges: users

New challenges: users

Different behavior and expectation:

- Battery life is a big concern
- Mobile connectivity
- Touch screen -> scrolling experience



Users: battery life



Expectation

- one day per charge
- the faster pages load, the better
- real time information

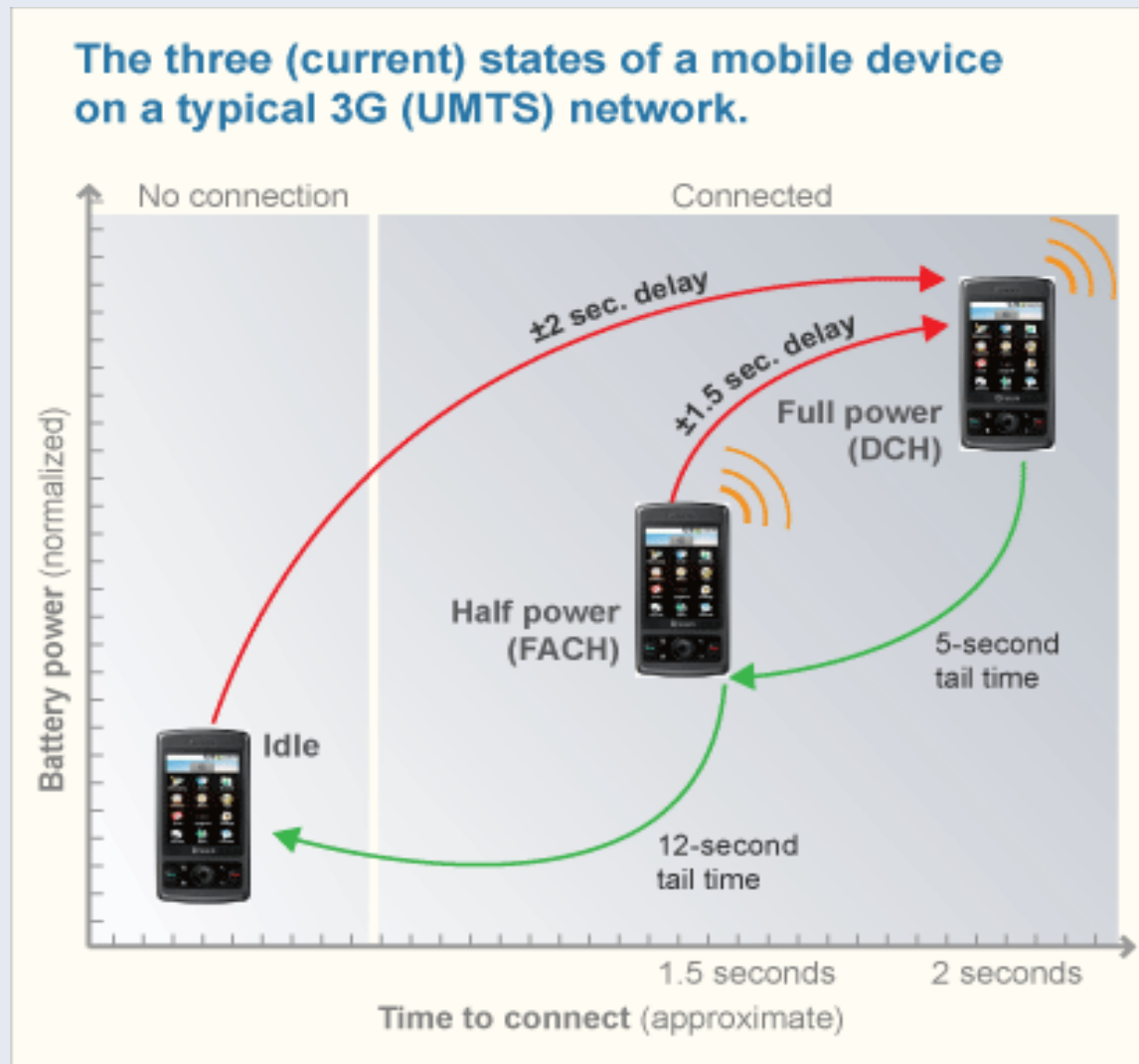
Challenges

- push VS poll, frequency of polling
- Batching / pre-fetching VS on-demand

A call from the carrier...

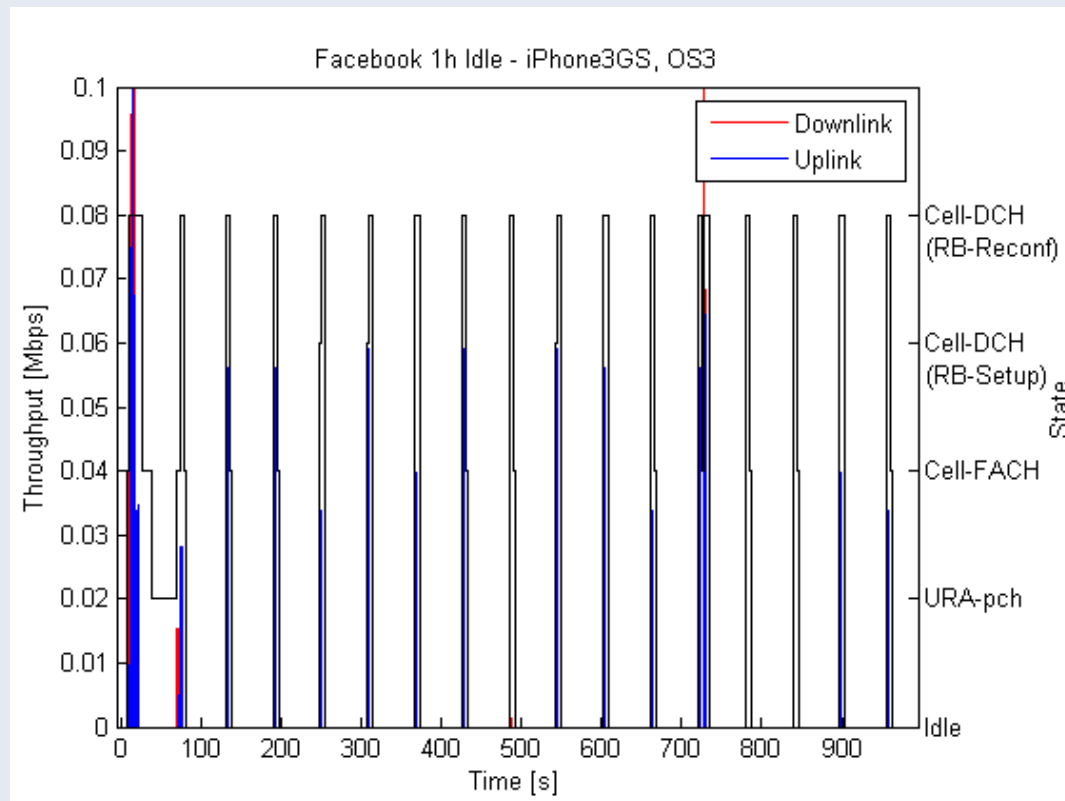


A call from the carrier...



A call from the carrier...

Chat in action



Users: power consumption



Burst in transmission

Prompt in ending connection

- Pages: full download / pre-fetching
- Video: download segments in intervals
- Interactive: polling in different intervals according to user's activities; use push notification if possible
- Don't transmit every minute!

Users: mobile connectivity



Expectation

- Connected anywhere
- Prefer WIFI (faster / cheaper)

Challenges

- Naïve users
- Data security
- Connection type changes

Wire-tapper



AirPort: On
Turn AirPort Off

Internet Sharing: On

✓ HeadWall

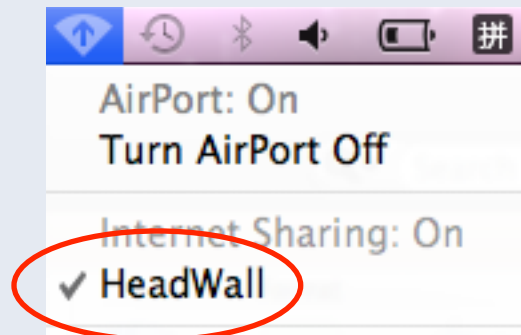




Naïve user



Wire-tapper

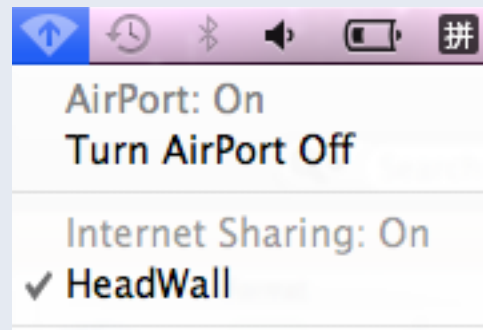




Naïve user



Wire-tapper



魏小亮9

12分钟前

test

来自Android客户端

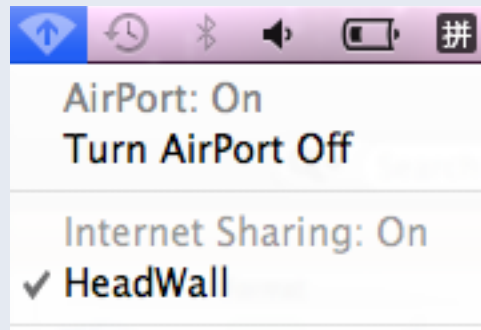
[转发](#) | [评论](#) | [更多](#)



Naïve user



Wire-tapper



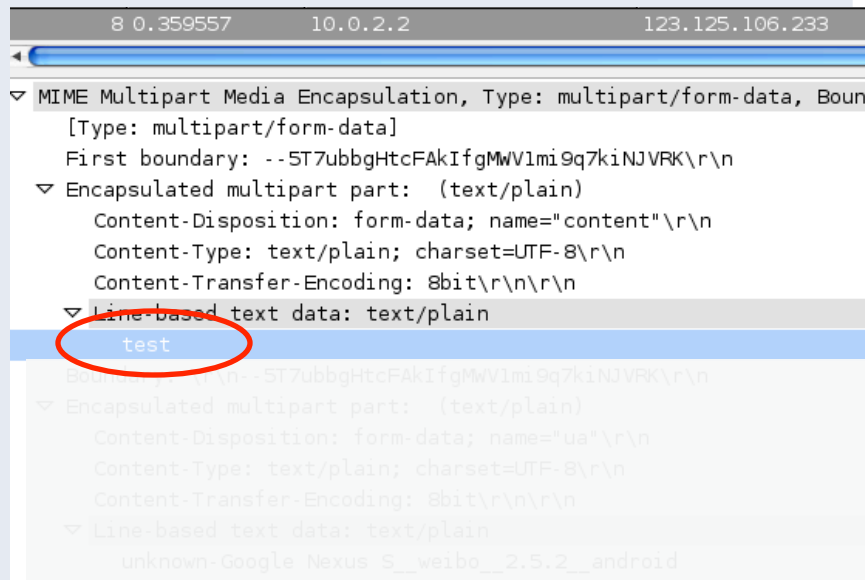
魏小亮9

12分钟前

test

来自Android客户端

转发 | 评论 | 更多

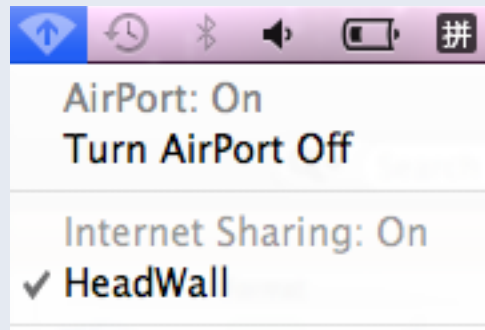




Naïve user



Wire-tapper



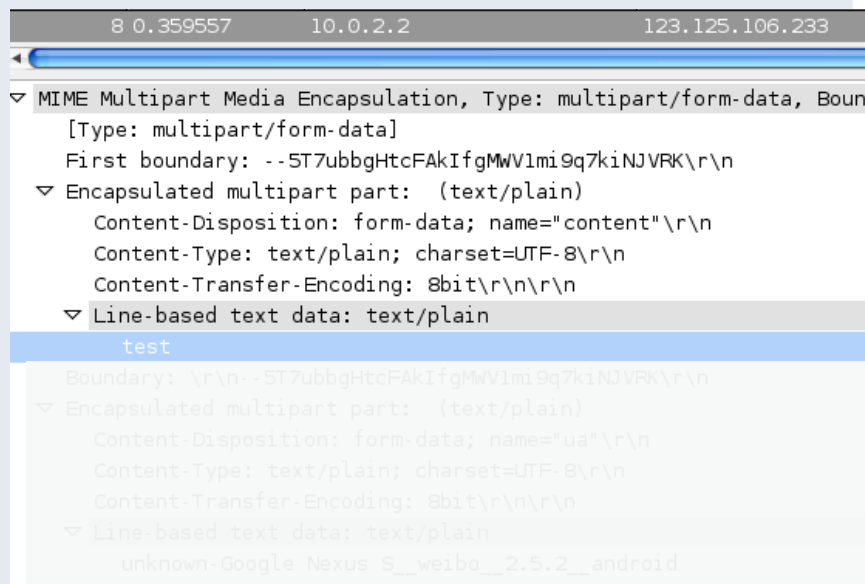
魏小亮9

12分钟前

test

来自Android客户端

转发 | 评论 | 更多



```
bogon:touch test$ curl -F 'content=test_from_curl' -F 'ua=unknown-Google Nexus S_weibo_2.5.2_android' -F 'from=10255010&c=android&ua=unknown-Google Nexus S_weibo_2.5.2_android' -F 'http://api.weibo.cn/interface/f/ttt/v3/dealmblog.p05a6e041&wm=5277_0822&from=10255010&c=android&ua=unknown-Google Nexus S_weibo_2.5.2_android&lang=1'
```

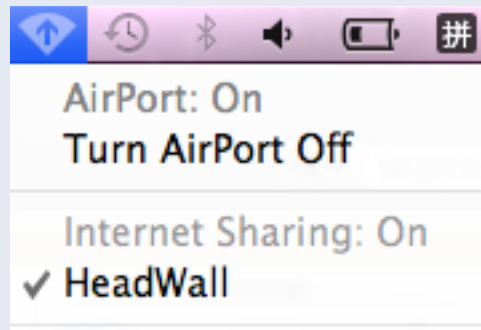
```
<?xml version="1.0" encoding="utf-8" ?><rss><sid>77f2esult>1</result><mblogid>xzUGha9bt</mblogid></rss>bogon
```



Naïve user



Wire-tapper



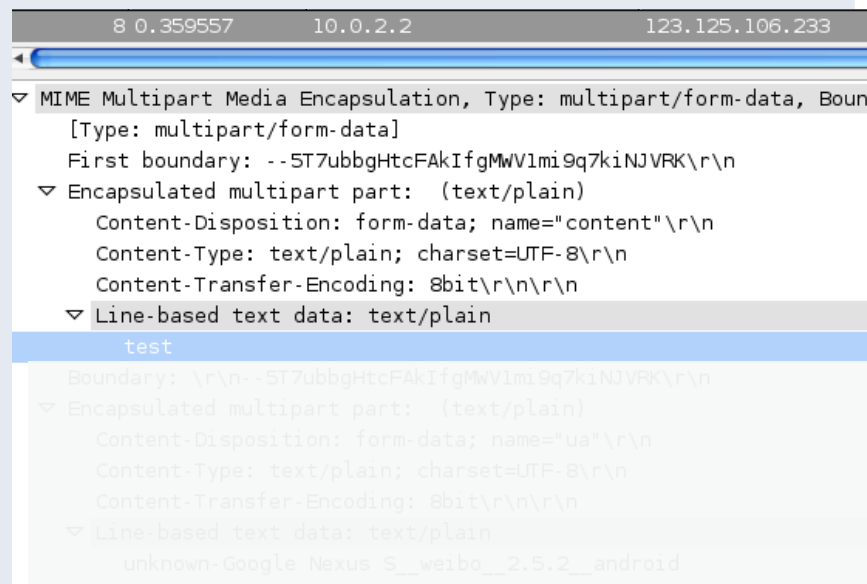
魏小亮9

12分钟前

test

来自Android客户端

转发 | 评论 | 更多



魏小亮9

15分钟前

test_from_curl

来自Android客户端

转发 | 评论 | 更多

```
bogon:touch test$ curl -F 'content=test_from_curl' -F
2.5.2__android' -F 'from=10255010&c=android&us=unkn
' 'http://api.weibo.cn/interface/f/ttt/v3/dealmblog.p
05a6e041&wm=5277_0822&from=10255010&c=android&us=unkn
droid&lang=1'

<?xml version="1.0" encoding="utf-8" ?><rss><sid>77f2
esult>1</result><mblogid>xzUGha9bt</mblogid></rss>bogon
```

Users: security VS speed



S
E
C
U
R
I
T
Y

- Full HTTPS
 - Recommended, esp in Apps
 - 200~600ms slower
- HTTPS everything but images
 - protected from most attacks
 - can reveal certain usage pattern
- HTTPS on domains with cookies only
 - protection against wiretapping
 - vulnerable to man-in-the-middle attack
- Full HTTP
 - Vulnerable to all attacks

S
P
E
E
D

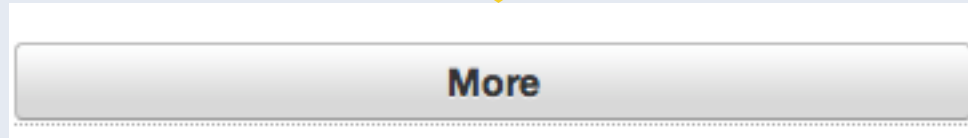
Users: Scrolling

Experience

- Paging
- Scrolling
- Infinite Scroll

Challenges

- Very very tall mobile pages
- Scrolling smoothness (Goal: 60 frames per second = 16msec per frame)



Users: Scrolling



Measurement

- TouchMove event firing frequency
 - Rough approximation
 - Values different for different browsers (iOS/Android)

Performance

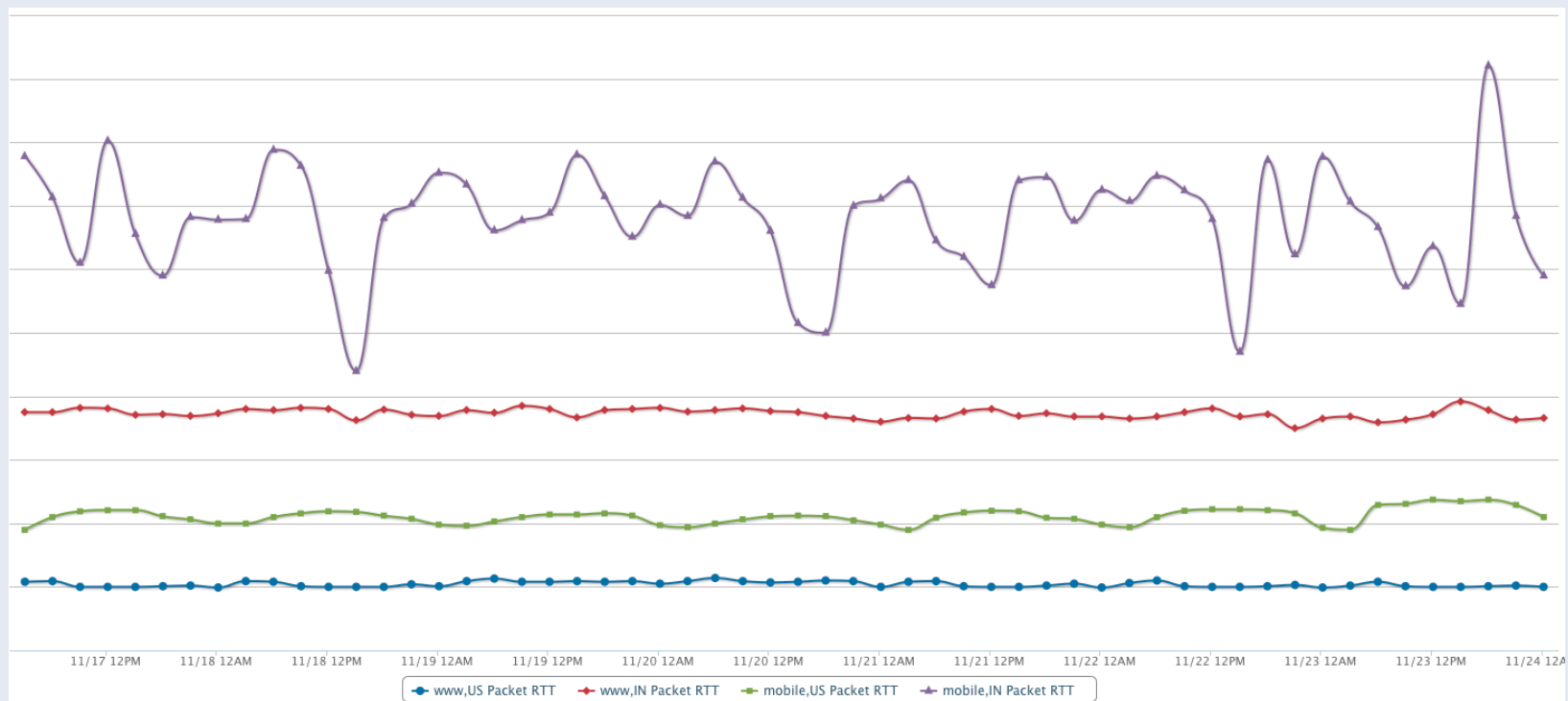
- Pipelining to handle long pages
 - Minimum DOM changes or changes in idle for smoothness
 - DOM recycle
- Use CSS key frames instead of iScroll *
 - Tradeoff between memory and performance

* <http://joehe Witt.com/2011/10/05/fast-animation-with-ios-webkit>

New challenges: networks

Networks: larger role in performance

- Larger portion of the total latency: 50%~90%
- DiffServ / zero-rating
- Link layer protocols: CDMA / GSM; connection timeout



Networks: larger role in performance

Challenges

- Detailed network performance measurement in production
- TCP throughput

Networks: measurement



Doppler measures:

- DNS resolution
- TCP connection setup (3way-handshake)
- Round trip time (RTT)
- TCP throughput

Networks



Doppler:

- $a \leq \langle \text{random number} \rangle$
- http://a-doppler.facebook.com/test_pixel?HTTP1.0&t=1&size=0k

$t_1 = \text{DNS} + \text{New Connection} + \text{RTT}$

Networks

$t_1 = \text{DNS} + \text{New Connection} + \text{RTT}$



Doppler:

- $a \leq \langle \text{random number} \rangle$
- `http://a-doppler.facebook.com/test_pixel?HTTP1.0&t=1&size=0k`
- `http://a-doppler.facebook.com/test_pixel?HTTP1.1&t=2&size=0k`

$t_2 = \text{New Connection} + \text{RTT}$

Networks

$t_1 = \text{DNS} + \text{New Connection} + \text{RTT}$

$t_2 = \text{New Connection} + \text{RTT}$



Doppler:

- $a \leq \langle \text{random number} \rangle$
- `http://a-doppler.facebook.com/test_pixel?HTTP1.0&t=1&size=0k`
- `http://a-doppler.facebook.com/test_pixel?HTTP1.1&t=2&size=0k`
- `http://a-doppler.facebook.com/test_pixel?HTTP1.1&t=3&size=0k`

$t_3 = \text{RTT}$

Networks

$t_1 = \text{DNS} + \text{New Connection} + \text{RTT}$

$t_2 = \text{New Connection} + \text{RTT}$

$t_3 = \text{RTT}$



Doppler:

- $a \leq \langle \text{random number} \rangle$
- http://a-doppler.facebook.com/test_pixel?HTTP1.0&t=1&size=0k
- http://a-doppler.facebook.com/test_pixel?HTTP1.1&t=2&size=0k
- http://a-doppler.facebook.com/test_pixel?HTTP1.1&t=3&size=0k
- http://a-doppler.facebook.com/test_pixel?HTTP1.1&t=4&size=10k

$10k / (t_4 - t_3) \sim \text{TCP bandwidth}$

https://www.facebook.com/note.php?note_id=10150212498738920

Networks

$t1 = \text{DNS} + \text{New Connection} + \text{RTT}$

$t2 = \text{New Connection} + \text{RTT}$

$t3 = \text{RTT}$

$10k / (t4 - t3) \sim \text{TCP bandwidth}$



Doppler:

- $a \leq \langle \text{random number} \rangle$
- http://a-doppler.facebook.com/test_pixel?HTTP1.0&t=1&size=0k
- http://a-doppler.facebook.com/test_pixel?HTTP1.1&t=2&size=0k
- http://a-doppler.facebook.com/test_pixel?HTTP1.1&t=3&size=0k
- http://a-doppler.facebook.com/test_pixel?HTTP1.1&t=4&size=10k
- http://a-doppler.facebook.com/test_pixel?HTTP1.1&t=5&size=40k

$(40k - 10k) / (t5 - t4) \sim \text{TCP bandwidth}$

https://www.facebook.com/note.php?note_id=10150212498738920

Networks: Performance

TCP congestion control:

- Higher RTT => smaller throughput
- Higher loss rate => smaller throughput

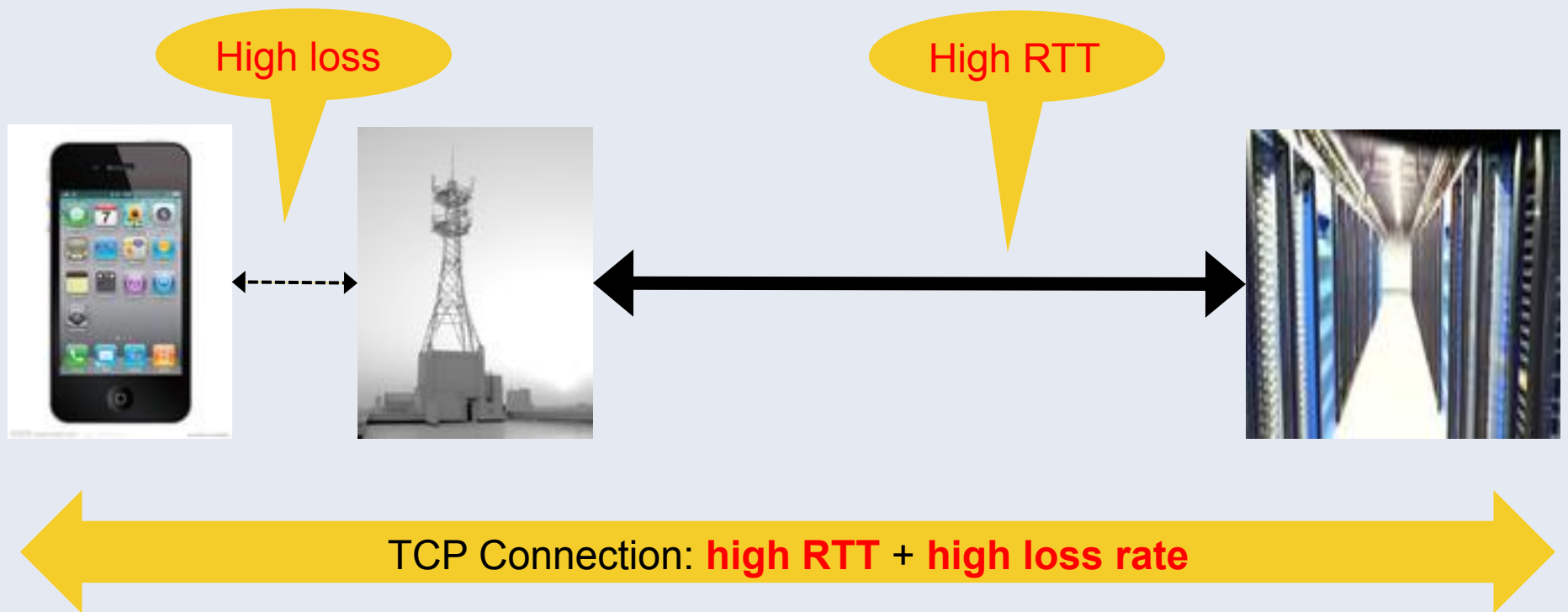
$$throughput \approx \frac{1}{RTT} \sqrt{\frac{1.5}{loss}}$$

Networks: TCP throughput

TCP congestion control:

- Higher RTT => smaller throughput
- Higher loss rate => smaller throughput

$$throughput \approx \frac{1}{RTT} \sqrt{\frac{1.5}{loss}}$$

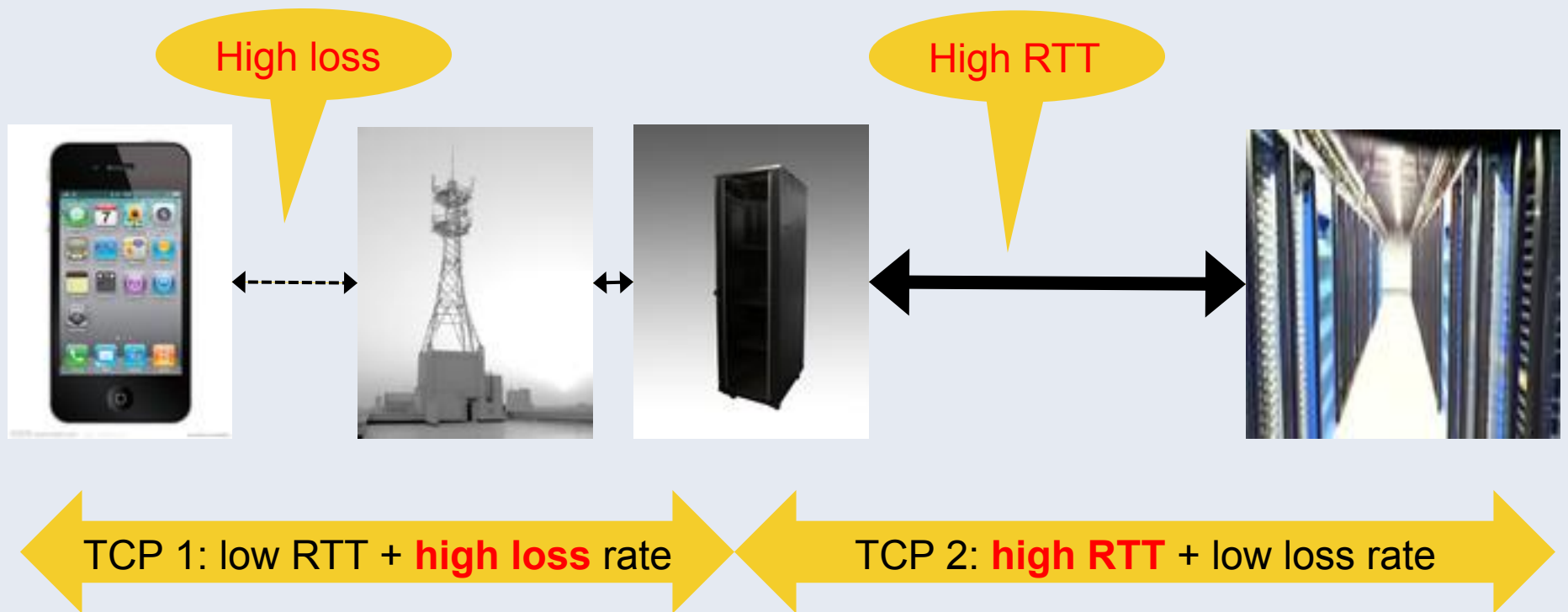


Networks: TCP throughput

TCP termination at edge:

$$\text{throughput} \approx \frac{1}{RTT} \sqrt{\frac{1.5}{\text{loss}}}$$

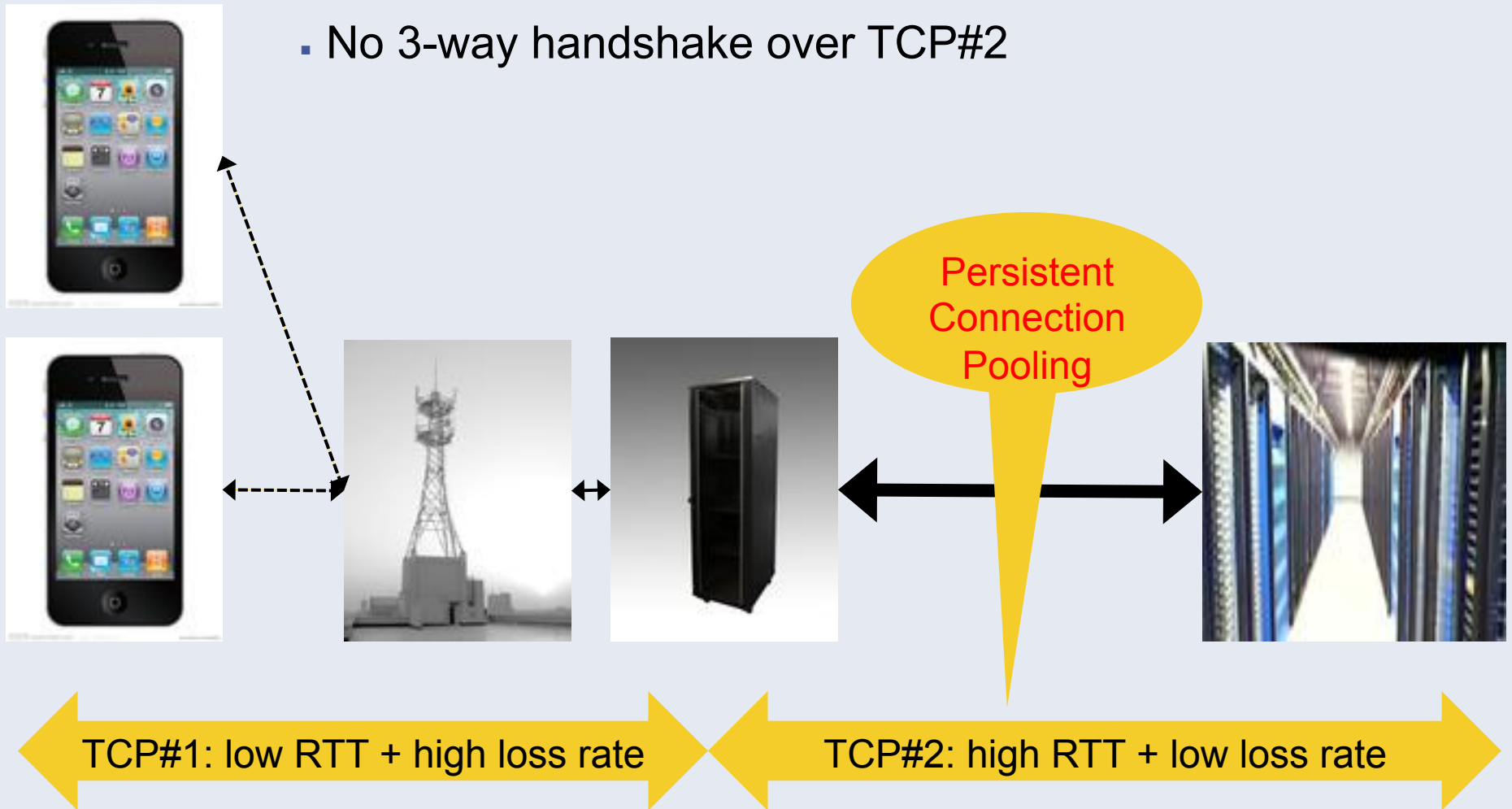
$$\text{throughput} \approx \min \left\{ \frac{1}{RTT_1} \sqrt{\frac{1.5}{\text{loss}_1}}, \frac{1}{RTT_2} \sqrt{\frac{1.5}{\text{loss}_2}} \right\}$$



Networks: TCP termination

Persistent connection pooling

- No 3-way handshake over TCP#2

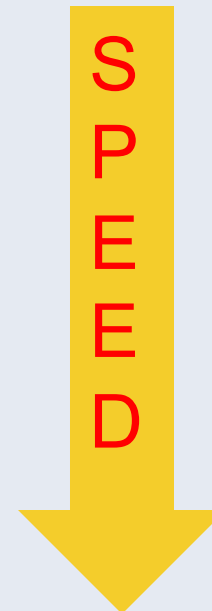
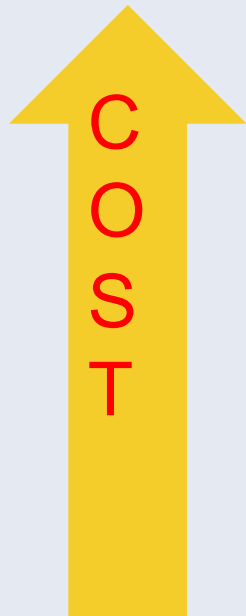


Networks: TCP throughput

$$throughput \approx \frac{1}{RTT} \sqrt{\frac{1.5}{loss}}$$

TCP improvements:

- TCP termination at edge
- ISP-peering
- Server-side WAN accelerator solution
- Linux TCP tuning
 - parameters
 - Algorithms
- Vanilla Linux TCP (no improvements)



New challenges: browsers

Browsers: there is no “Webkit on mobile”!

Variations

- HTTP Pipelining?
- Inline images?
- Background images?
- External CSS?

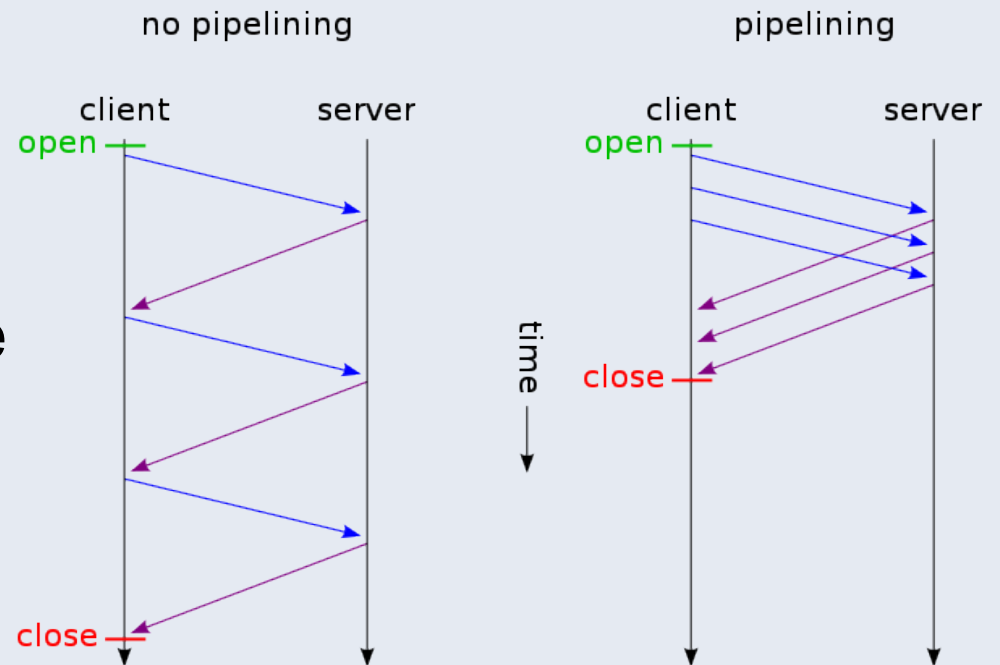
Performance implication

- # of domains
- # of HTTP connections
- Sprites
- HTML size

Browsers: HTTP pipelining

iOS3 vs iOS5 / Android

- 3+ parallel requests in the same connection
- No need for parallel connections by multiple domains



Screen: pixel density

- iPhone 3 vs iPhone 4



Browsers: huge variances

Challenges

- How to recognize the browser's capability?
 - Millions of different User Agent strings
- How to serve different browsers the best contents?
 - Dozens of new capability combinations

Browsers: How to recognize?

Existing libraries

- Browscap: <http://drupal.org/project/browscap>
- wurfl: <http://wurfl.sourceforge.net/>



Browsers: How to recognize?

Existing libraries

- Browscap: <http://drupal.org/project/browscap>
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Grass-root contribution

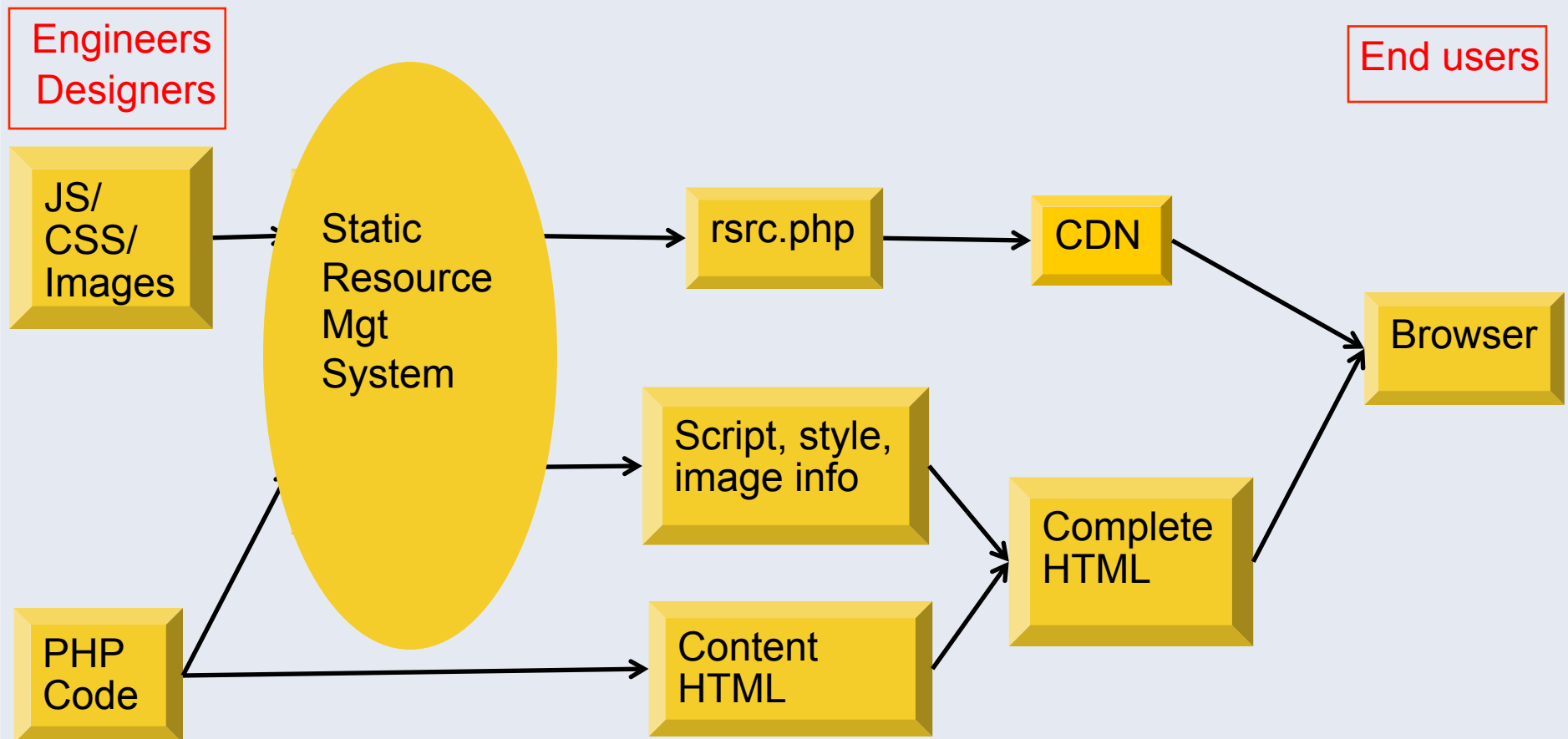
- Improving wurfl by users



Browsers: How to serve?

Haste/Makehaste

- The Facebook scalable static resource management systems



<http://velocity.oreilly.com.cn/2010/index.php?func=session&name=静态网页资源的管理和优化>

A website with 500M active users

Dimensions of parameters

- 10000+ static resources
- x 100+ language translations
- x 3 browser setups
- x 5 packaging strategies
- x 3 user AB testing groups
- x 2 delivery strategies (iframe / raw)
- x 2 minification strategies

- = 3,000,000 + different static resources

To support

- Multiple revisions
- Released in 10 minutes
- Even more dimensions in the future

<http://velocity.oreilly.com.cn/2010/index.php?func=session&name=静态网页资源的管理和优化>

A website with ~~500M~~ 750M+ active users

Dimensions of parameters

- 10000+ static resources
- x 100+ language translations
- x ~~3~~ browser setups
- x 5 packaging strategies
- x 3 user AB testing groups
- x 3 delivery strategies (iframe / raw / inline)
- x 2 minification strategies
- x 4 domain numbers
- x 3 pixel density
- x 2 protocols (HTTP / HTTPS)

To support

- Multiple revisions
- Released in 10 minutes
- Even more dimensions in the future

New challenges: devices

Devices: segmentation

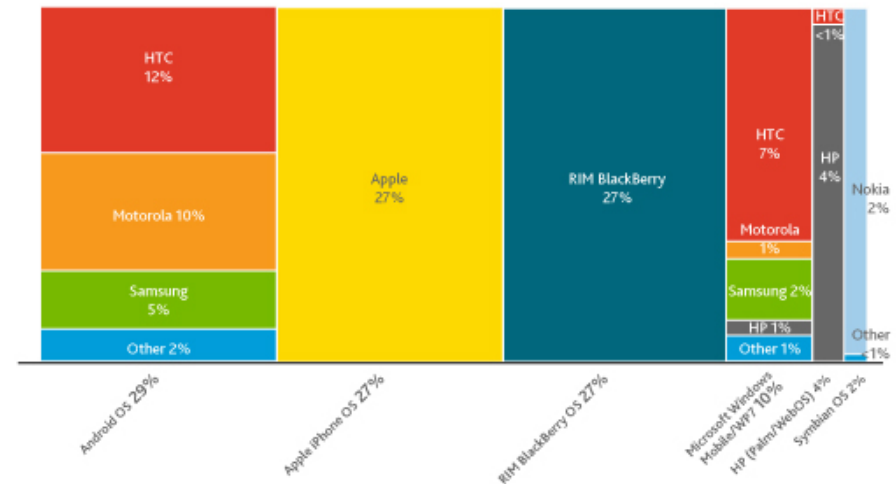
- Android App => Java
- iPhone App => Object C
- Mobile Web => HTML(5)

Challenges:

- Engineer resources
- Product consistency across platforms

Manufacturer operating system share—smartphones

Nov '10 - Jan 11, postpaid mobile subscribers, n=14,701



Source: The Nielsen Company.

nielsen

Devices: segmentation within my family



Devices: Faceweb

Share implementation cross mobile platforms

- Grassroot-WURFL to detect browser capabilities
- Progress enhancement in mobile site
 - functional base HTML
 - JS enhancement
- Hybrid approach in Apps
 - Thin native layer
 - HTML/JS in WebViews



New challenges: summary

Challenges

- New user experience & expectation
- Larger role of networks
- Variance in browsers
- Segmentation in devices

Tools

Safari Develop menu

The image shows a Safari browser window with the Quora website open. The Safari menu bar is visible at the top, with the 'Develop' menu highlighted. The 'Advanced' pane of the Develop menu is open, showing various settings. The 'Show Develop menu in menu bar' option is checked and circled in red. The background shows the Quora website with a search bar, navigation buttons, and a feed of questions.

Safari Menu Bar: Safari File Edit View History Bookmarks Develop Window Help

Address Bar: (188) Home - Quora
http://www.quora.com/

Advanced Pane Settings:

- Universal Access: Never use font sizes smaller than 9
- Press Tab to highlight each item on a webpage
Option-Tab highlights each item.
- Style sheet: None Selected
- Proxies: Change Settings...
- Database storage: 5 MB allowed before asking
- Show Develop menu in menu bar

Quora Website Content:

- Search Questions, Topics and P...
- Add Question Write Post
- New Notifications: 2 items on question Education Startup the education space? Why are they int...
- Jack Jack is now following you. Give t...
- Thursday
- Scott Chun-Yang Chen is now followin...
- Clear 3 New Notifications
- Feed / Settings
- If you injure a bug, should you kill it or let it live?
Chris Piro, Adam D'Angelo, and Kevin Der voted up an answer. 6 Answers • Follow
- 147 Matan Shelomi, Entomologist
Looks like the philosophers and theists have made their cases. As far as entomologists are concerned, insects do not have pain receptors the way vertebrates do. They don't ... (more)
- What happened to the after-midnight flashing yellow lights in downtown Palo Alto?
Paul C. Jeffries and Adam D'Angelo voted up an answer. 1 Answer • Follow
- 28 Jaime O Rodriguez, City of Palo Alto - Chief Transp...
The traffic signals in Downtown Palo Alto typically go into a Flash mode
- Follow People You May Know on Quora: Victor Kam, John Song, Wei Li
- View All 238 Follow All (238)

Safari Develop menu

The image shows a Safari browser window with the 'Develop' menu highlighted in the menu bar. The browser is displaying the Quora website. A settings panel is open, showing the 'Advanced' tab. The 'Show Develop menu in menu bar' option is checked.

Safari Menu Bar: Safari File Edit View History Bookmarks **Develop** Window Help

Address Bar: (188) Home - Quora
http://www.quora.com/

Advanced Settings Panel:

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Quora Page Content:

- New Notifications:** 2 items on question Education Startup the education space? Why are they int...
Jack Jack is now following you. Give t...
Thursday
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- John Song Follow
- Wei Li Follow

View All 238 Follow All (238)

Safari Develop menu

The image shows a screenshot of the Safari browser interface. The top menu bar includes 'Safari', 'File', 'Edit', 'View', 'History', 'Bookmarks', 'Develop', 'Window', and 'Help'. The 'Develop' menu is open, and the 'User Agent' option is selected, which has opened a secondary dropdown menu. In this secondary menu, the option 'Safari iOS 4.3.3 - iPhone' is circled in red. Other options in the 'User Agent' menu include 'Open Page With...', 'Show Web Inspector', 'Show Error Console', 'Show Snippet Editor', 'Show Extension Builder', 'Start Debugging JavaScript', 'Start Profiling JavaScript', 'Send Do Not Track HTTP Header', 'Enable WebGL', 'Disable Caches', 'Disable Images', 'Disable Styles', 'Disable JavaScript', 'Disable Runaway JavaScript Timer', and 'Disable Site-specific Hacks'. The background shows the Quora website with a search bar and a list of notifications.

Develop Window Help

- Open Page With
- User Agent**
 - ✓ Default (Automatically Chosen)
 - Safari 5.1 — Mac
 - Safari 5.1 — Windows
 - Safari 5.0.6 — Mac
 - Safari iOS 4.3.3 — iPhone**
 - Safari iOS 4.3.3 — iPod touch
 - Safari iOS 4.3.3 — iPad
 - Internet Explorer 9.0
 - Internet Explorer 8.0
 - Internet Explorer 7.0
 - Firefox 4.0.1 — Mac
 - Firefox 4.0.1 — Windows
 - Opera 11.11 — Mac
 - Opera 11.11 — Windows
 - Other...
- Show Web Inspector ⌘⌥I
- Show Error Console ⌘⌥C
- Show Snippet Editor
- Show Extension Builder
- Start Debugging JavaScript
- Start Profiling JavaScript ⌘⌥P
- Send Do Not Track HTTP Header
- Enable WebGL
- Disable Caches
- Disable Images
- Disable Styles
- Disable JavaScript
- Disable Runaway JavaScript Timer
- Disable Site-specific Hacks

Quora Search Questions, Topics and People

[Add Question](#) [Write Post](#)

New Notifications

2 items on question [Education Startups: What are some of the education space? Why are they interesting?](#)

Jack Jack is now following you. [Give topics to Jack.](#) 5
Thursday

Scott Chun-Yang Chen is now following you. Jul 12, 2011

[Clear 3 New Notifications](#)

Feed / Settings [All Notifications](#)

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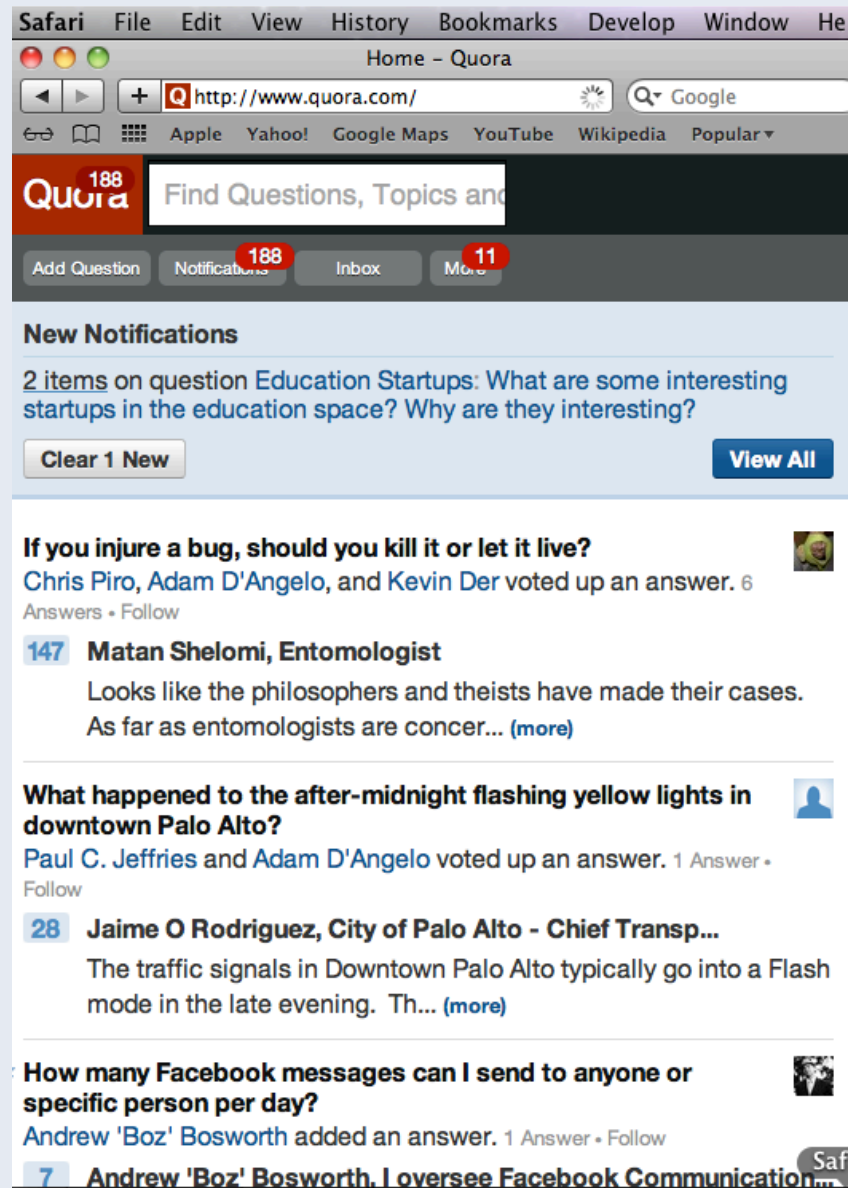
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Follow People You May Know on Quora

- [Victor Kam](#) [Follow](#)
- [John Song](#) [Follow](#)
- [Wei Li](#) [Follow](#)

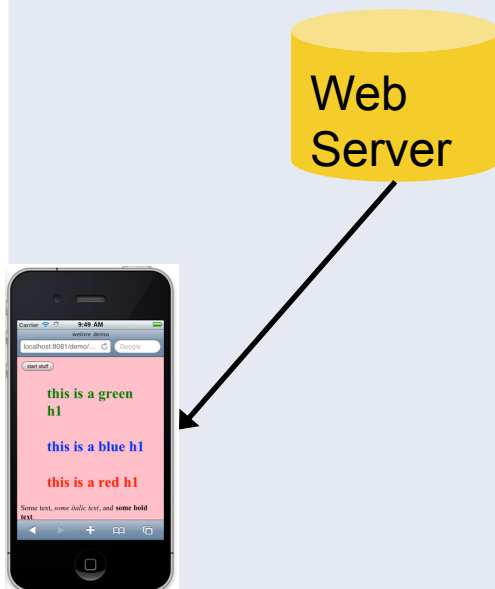
Safari Develop menu



Web Inspector Remote

weinre

- Web Inspector on remote pages
- E.g. ontouchmove events only available on mobile browsers

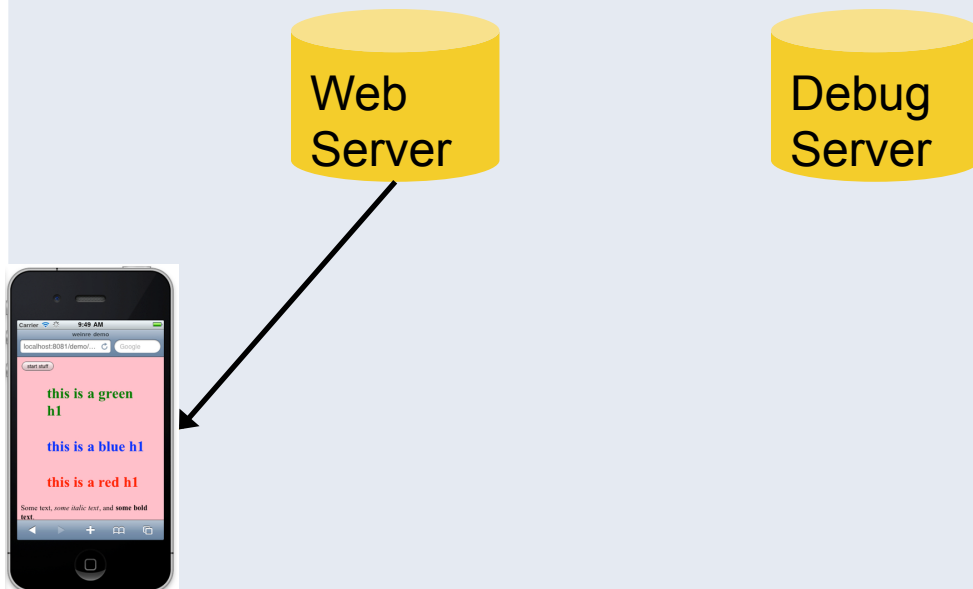


Web Inspector Remote

Weinre

Start debug server which serves:

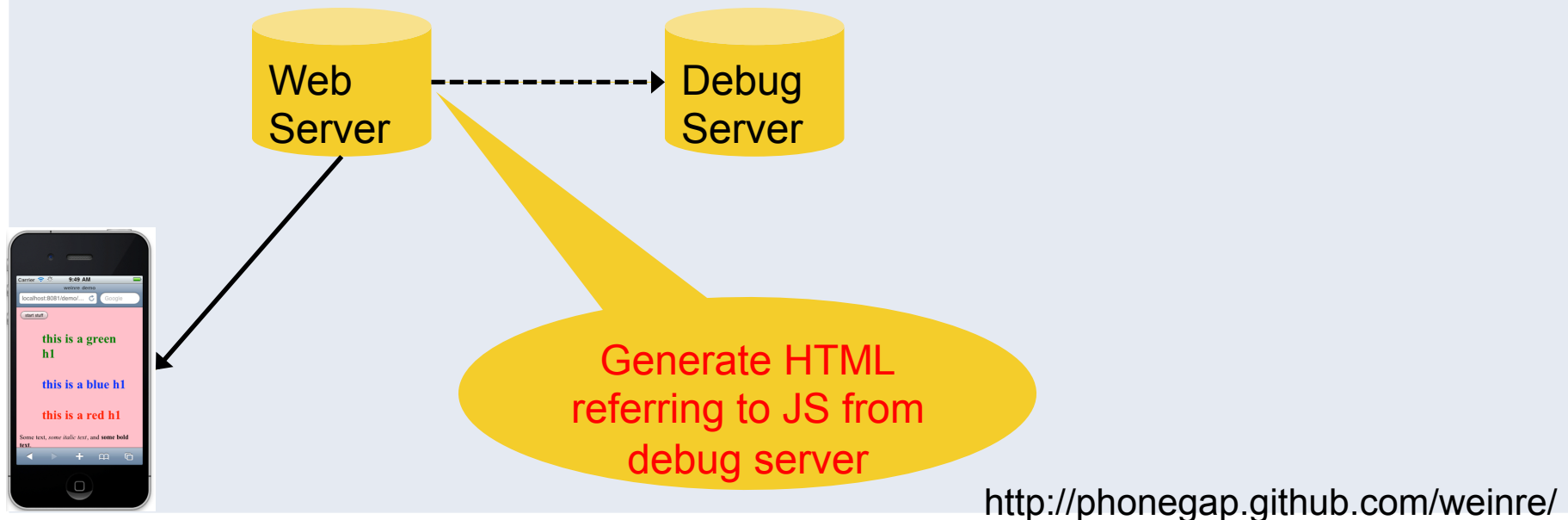
- JS to embed in target page
- Debug console page



Web Inspector Remote

weinre

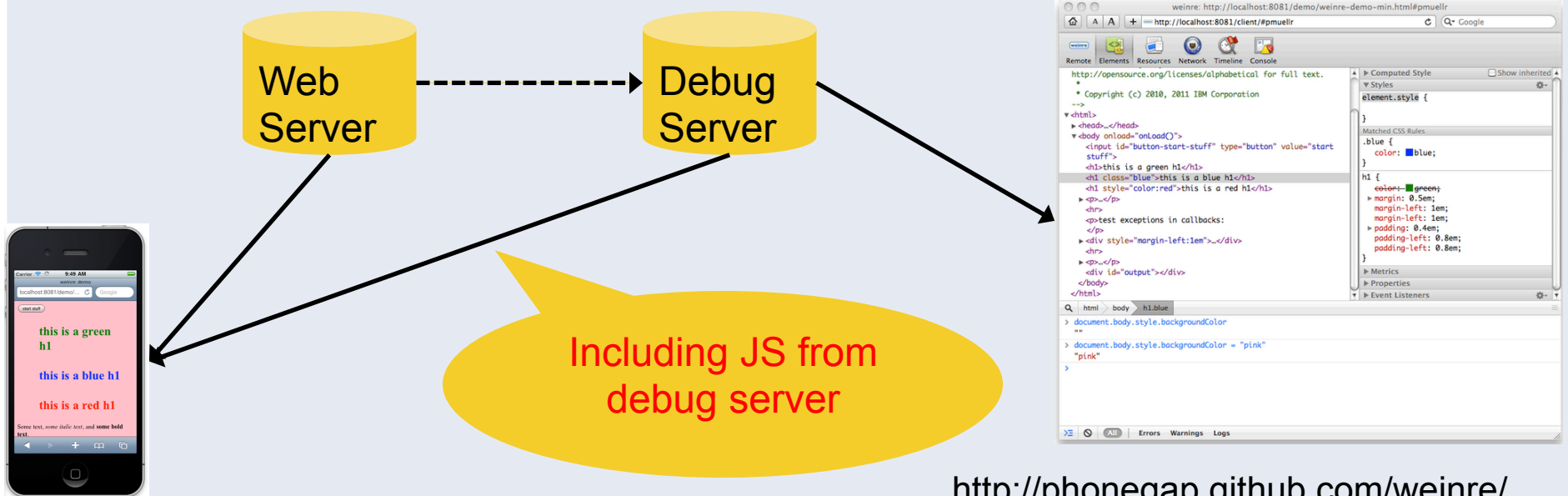
- Change documents in web server to include JS from debug server



Web Inspector Remote

weinre

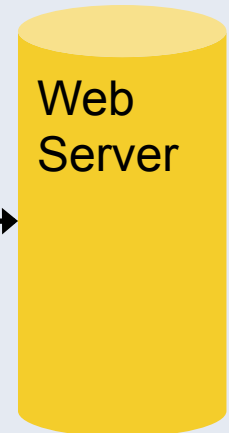
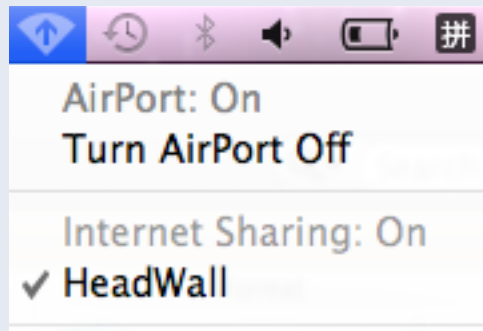
- Load the page on target (phone)
- Load the debug console on a desktop Safari



<http://phonegap.github.com/weinre/>

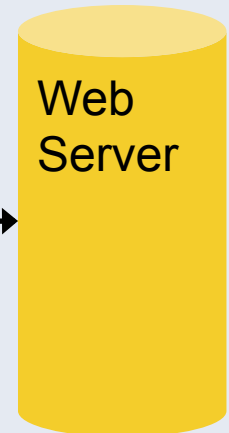
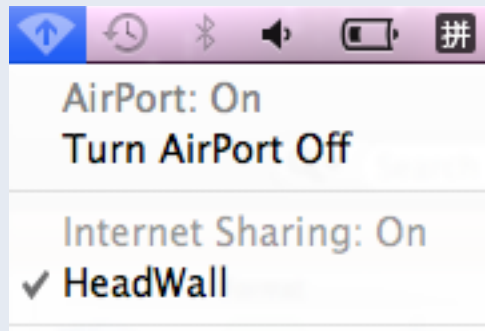
TCP Dump / Wireshark

- Packet Sniffer



TCP Dump / Wireshark

- Packet Sniffer



TCP Dump / Wireshark

- Packet Sniffer

en1 [Wireshark 1.6.4 (SVN Rev 39941 from /trunk-1.6)]

File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help

Filter: `ip.addr == 74.125.93.113` Expression... Clear Apply

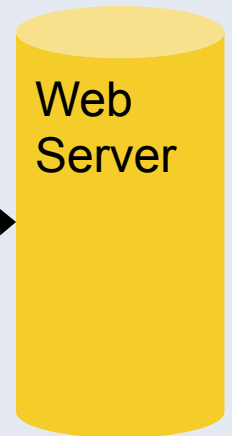
No.	Time	Source	Destination	Protocol	Length	Info
11	0.789878	10.0.2.2	74.125.93.113	TCP	66	57515 > https [ACK]
12	0.794747	10.0.2.2	74.125.93.113	SSL	146	Client Hello
13	1.165344	74.125.93.113	10.0.2.2	TCP	66	https > 57515 [ACK]
14	1.165646	74.125.93.113	10.0.2.2	TLSv1	1434	Server Hello
15	1.165781	74.125.93.113	10.0.2.2	TLSv1	847	Certificate, Server
16	1.175268	74.125.93.113	10.0.2.2	TCP	66	[TCP Dup ACK 15#1]
17	1.407252	10.0.2.2	74.125.93.113	TCP	66	57515 > https [ACK]

Charles

Web debugging proxy: setup



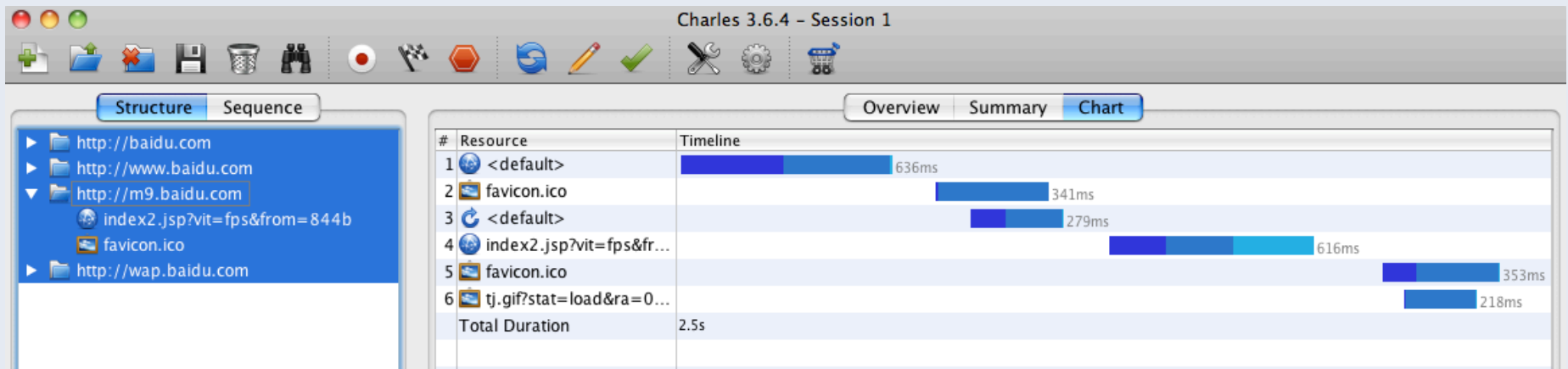
Two screenshots are shown side-by-side. The left screenshot is from an iPhone settings menu, titled '代理设置' (Proxy Settings). It shows '对此网络单独设置' (Settings for this network) turned on, with '代理' (Proxy) set to '10.0.2.1' and '端口' (Port) set to '8888', which is circled in red. The right screenshot is from the Charles Proxy application's 'Proxy Settings' window. The 'Port' field is set to '8888' and is circled in red. The 'Enable transparent HTTP proxying' checkbox is checked.



Charles

Web debugging proxy

- Nice visualization for HTTP traffics
- Can proxy SSL traffic
- Might change browser behaviors



Conclusions

Mobile performances

New challenges

- New challenges across stacks
- Very helpful to have full stack knowledge
- Tools and frameworks still in developments
 - Scalability in terms of # of users, products, engineering teams
 - Tradeoff between performance and other aspects of user experience (reliability / security / cost...)

Mobile performances

I have a dream

- A set of framework & toolsets that allow most mobile app/web developers to focus on products
 - Fast in development
 - Fast by default

Thank you!

Xiaoliang “David” Wei

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Velocity China, Dec 6th, 2011, Beijing