

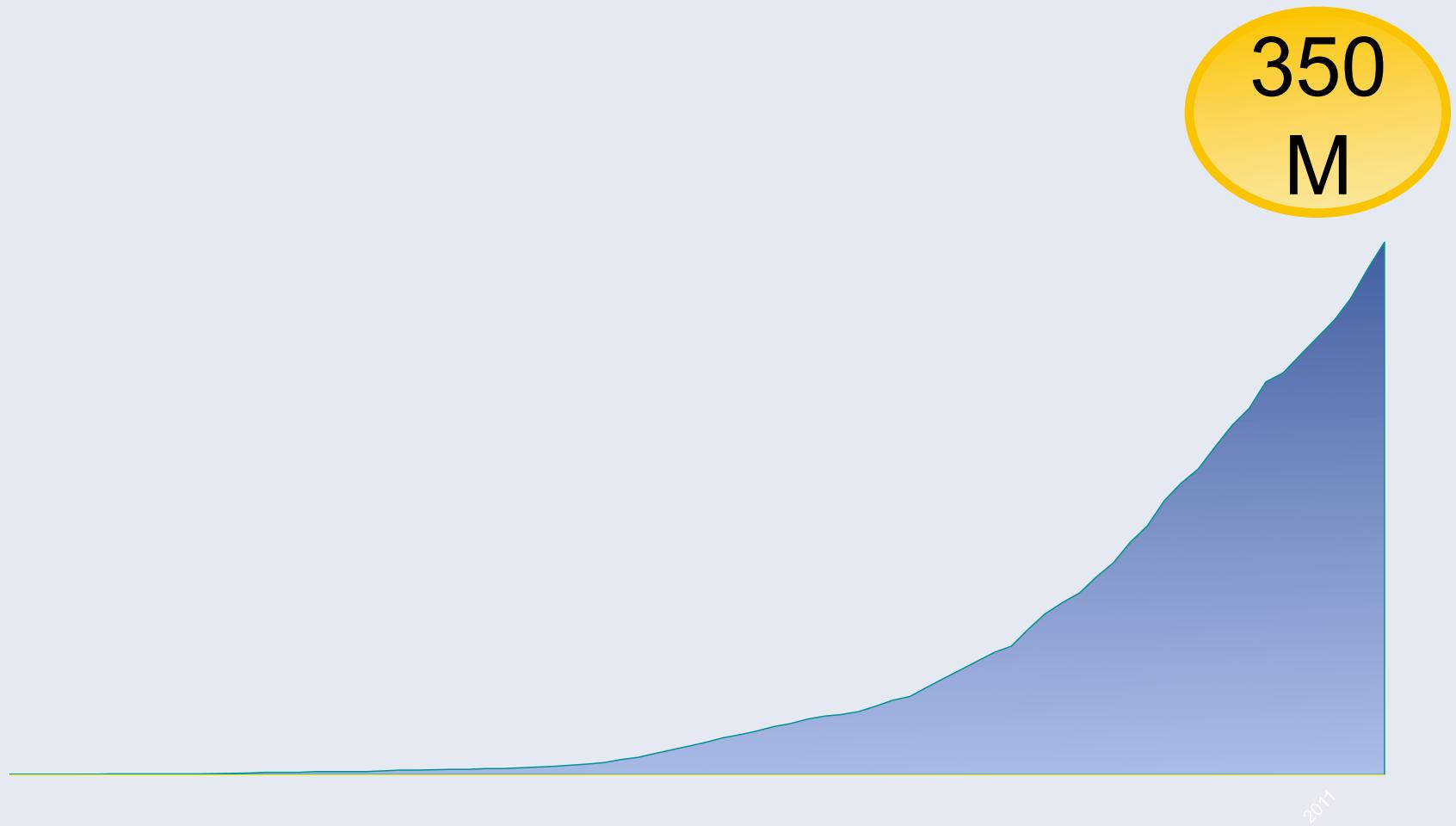
Mobile performance

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

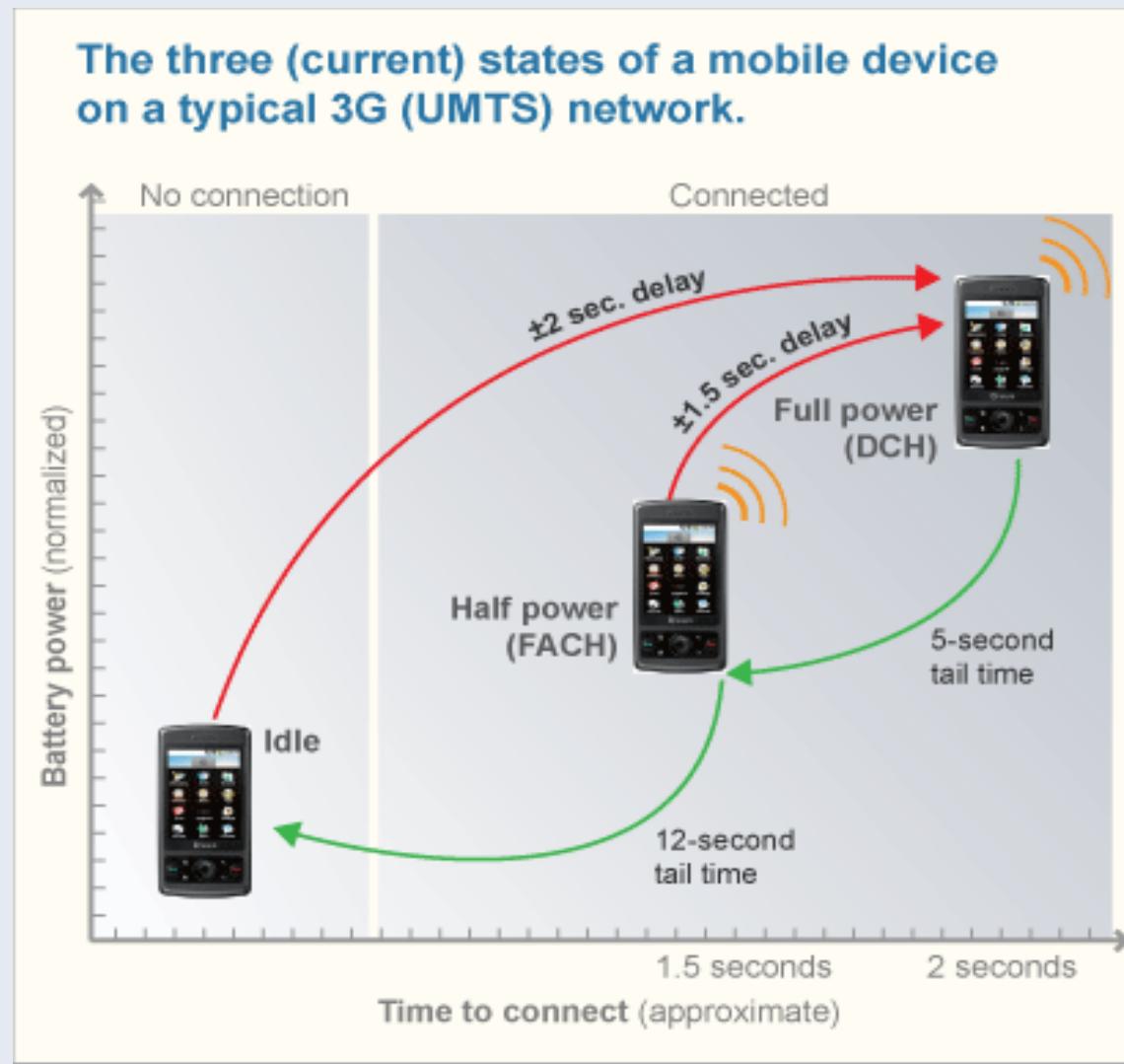
Challenges

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

A call from the carrier...

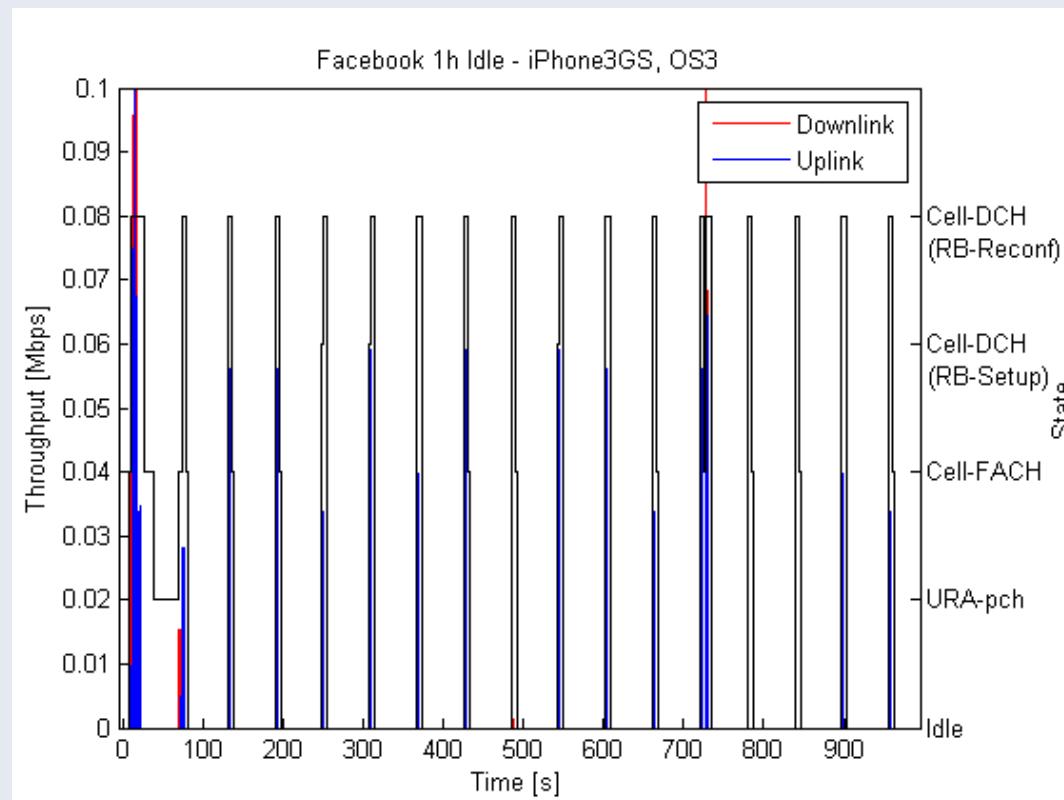


A call from the carrier...

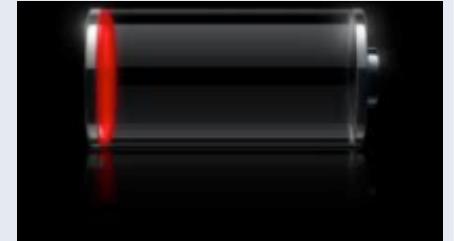


A call from the carrier...

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

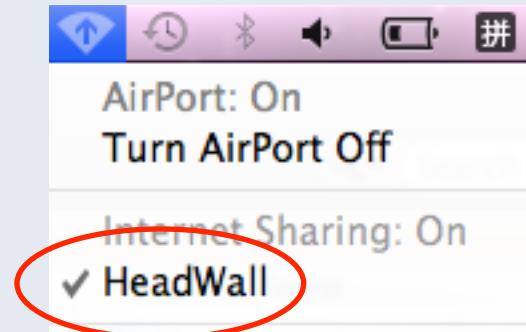




Naïve user



Wire-tapper





Naïve user



魏小亮9

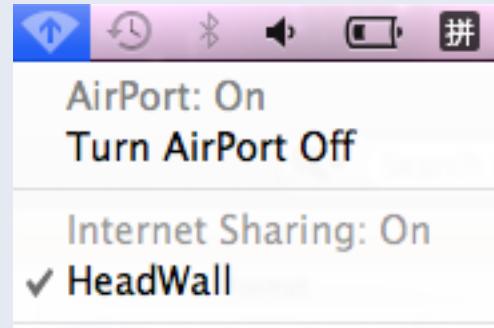
test

来自Android客户端

12分钟前

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Wire-tapper

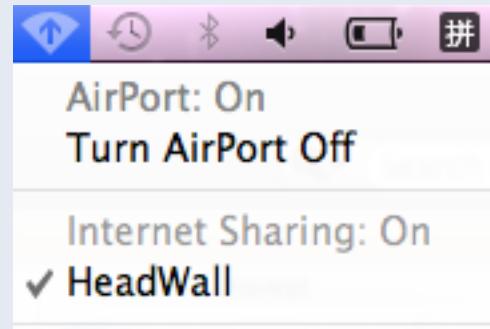




Naïve user



Wire-tapper



8 0.359557 10.0.2.2 123.125.106.233

◀

▽ MIME Multipart Media Encapsulation, Type: multipart/form-data, Bound [Type: multipart/form-data]

First boundary: --5T7ubbgHtcFAkIfgMwV1mi9q7kiNJVRK\r\n

▽ Encapsulated multipart part: (text/plain)

Content-Disposition: form-data; name="content"\r\n

Content-Type: text/plain; charset=UTF-8\r\n

Content-Transfer-Encoding: 8bit\r\n\r\n

▽ Line-based text data: text/plain

test

test

▽ Encapsulated multipart part: (text/plain)

Content-Disposition: form-data; name="ua"\r\n

Content-Type: text/plain; charset=UTF-8\r\n

Content-Transfer-Encoding: 8bit\r\n\r\n

▽ Line-based text data: text/plain

unknown-Google Nexus S__weibo__2.5.2_android

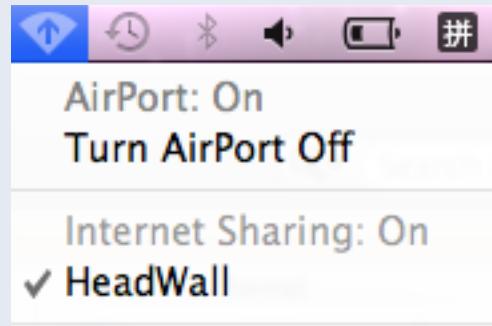


Naïve user



魏小亮9 12分钟前
test
来自Android客户端 转发 | 评论 | 更多

Wire-tapper





Naïve user



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test

来自Android客户端

12分钟前

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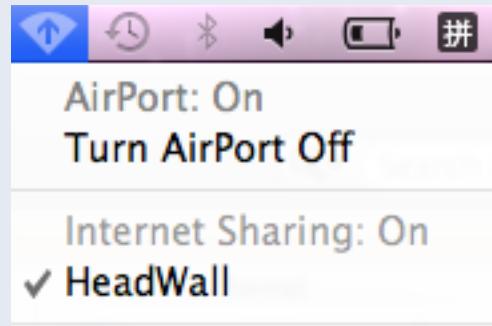
test_from_curl

来自Android客户端

15分钟前

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Wire-tapper

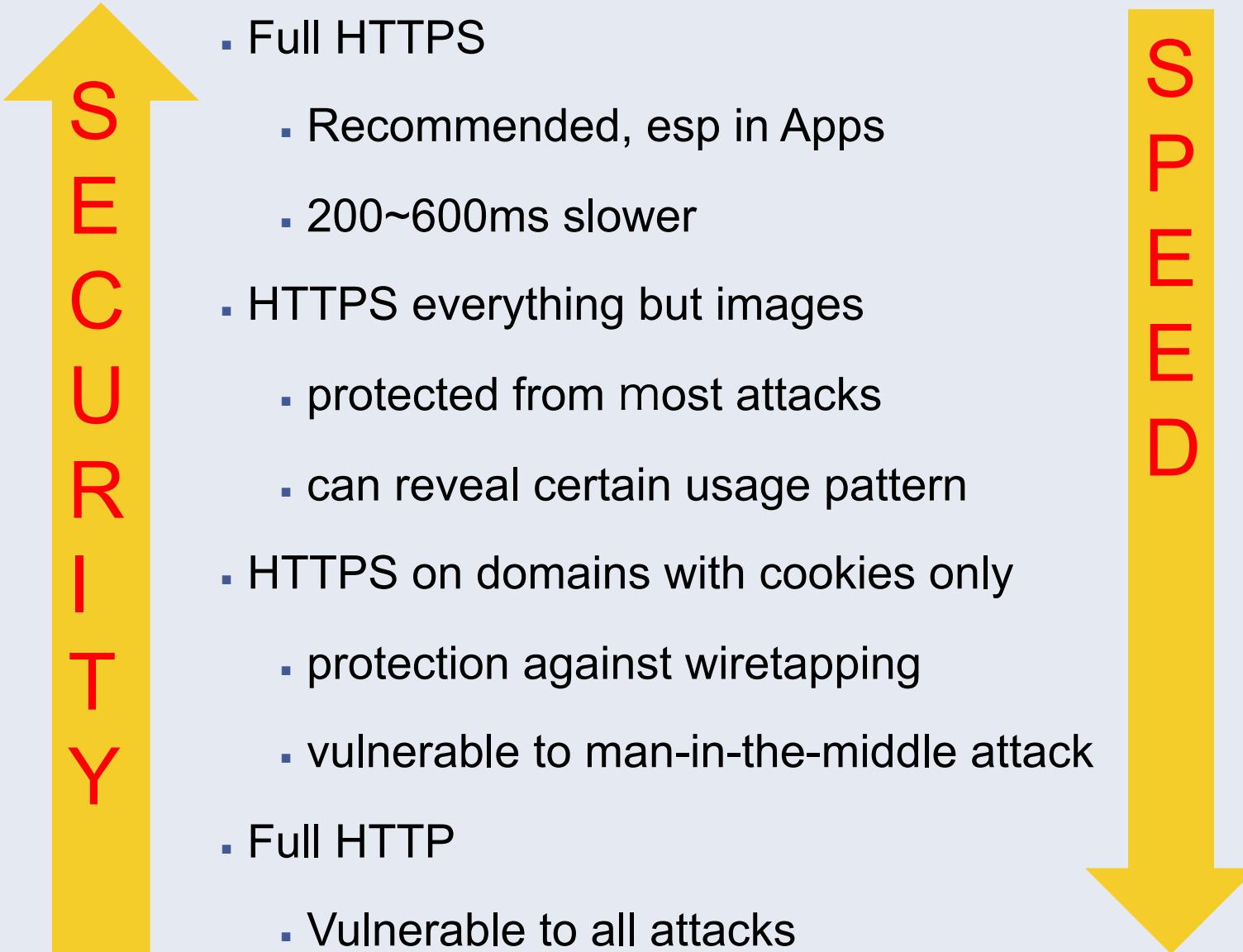


```
8 0.359557 10.0.2.2 123.125.106.233
└─ MIME Multipart Media Encapsulation, Type: multipart/form-data, Boundary: multipart/form-data
    First boundary: --ST7ubbgHtcFAkIfgMwVlmi9q7kiNJVRK\r\n
    └─ Encapsulated multipart part: (text/plain)
        Content-Disposition: form-data; name="content"\r\n
        Content-Type: text/plain; charset=UTF-8\r\n
        Content-Transfer-Encoding: 8bit\r\n\r\n
    └─ Line-based text data: text/plain
        test
        Boundary: \r\n--ST7ubbgHtcFAkIfgMwVlmi9q7kiNJVRK\r\n
        └─ Encapsulated multipart part: (text/plain)
            Content-Disposition: form-data; name="ua"\r\n
            Content-Type: text/plain; charset=UTF-8\r\n
            Content-Transfer-Encoding: 8bit\r\n\r\n
        └─ Line-based text data: text/plain
            unknown-Google Nexus S_weibo_2.5.2_android
```

bogon:touch test\$ curl -F 'content=test_from_curl' -F '2.5.2_android' -F 'from=10255010&c=android' -F 'http://api.weibo.cn/interface/f/ttt/v3/dealmblog.p05a6e041&wm=5277_0822&from=10255010&c=android&ua=unknown&lang=1'

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

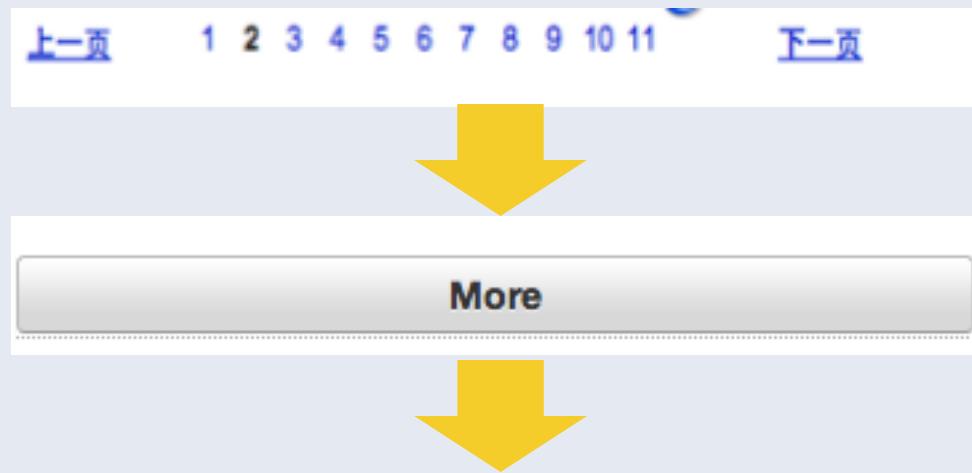
Users: security VS speed



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

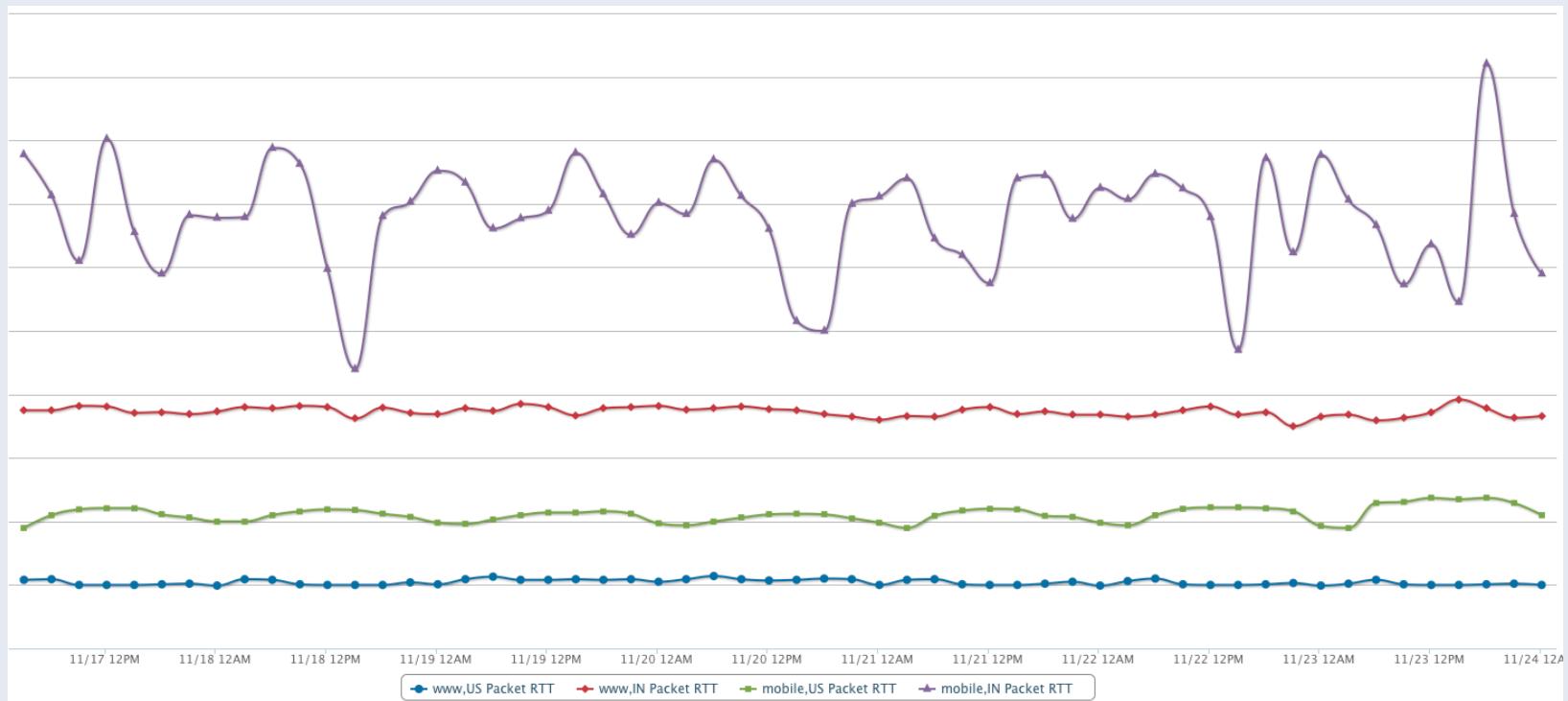
- Pipelining to handle long pages
 - Minimum DOM changes or changes in idle for smoothness
 - DOM recycle
- Use CSS key frames instead of iScroll *
 - Tradeoff between memory and performance

* <http://joehewitt.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

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

Networks



Doppler:

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

t1 = DNS + New Connection + RTT

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

t1 = DNS + New Connection + RTT

Networks



Doppler:

- a <= <random number>
- 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

t2 = New Connection + RTT

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

Networks

t1 = DNS + New Connection + RTT

t2 = New Connection + RTT



Doppler:

- a <= <random number>
- 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

t3 = RTT

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

Networks

t1 = DNS + New Connection + RTT

t2 = New Connection + RTT

t3 = RTT



Doppler:

- a <= <random number>
- 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 / (t4 – t3) ~ TCP bandwidth

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

Networks

t1 = DNS + New Connection + RTT

t2 = New Connection + RTT

t3 = 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

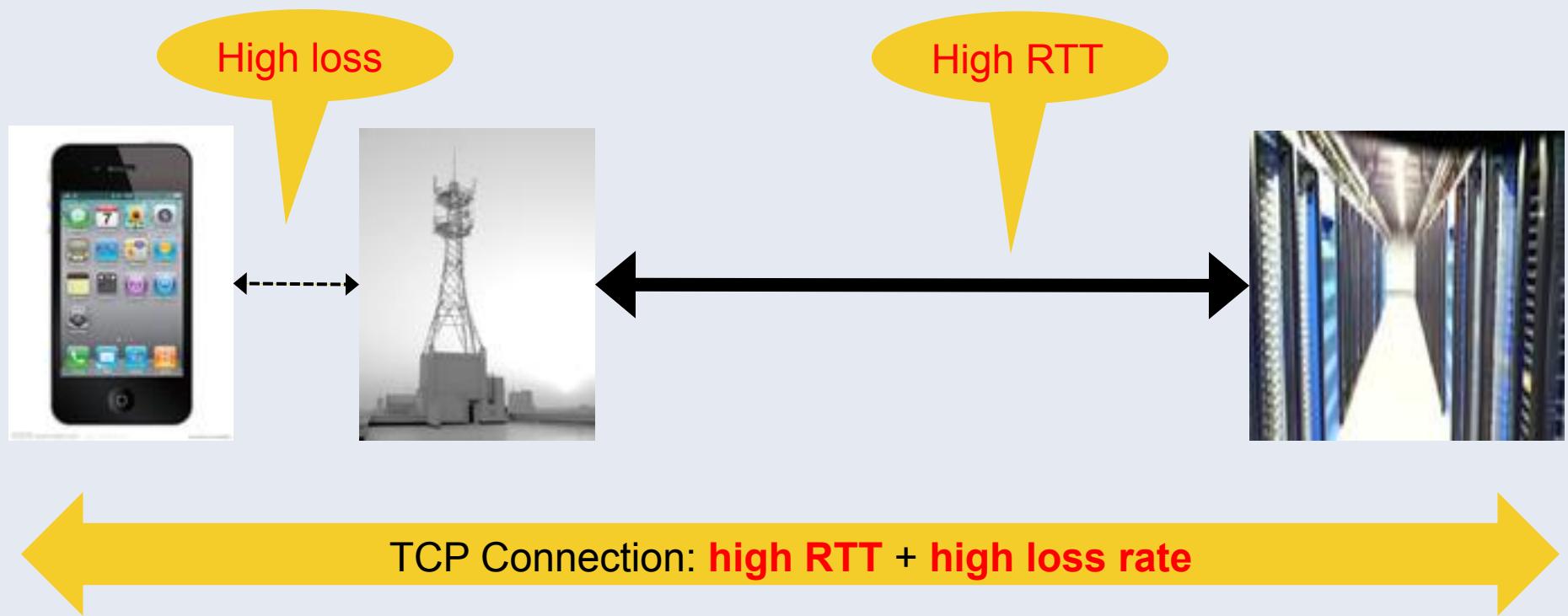
$$\text{throughput} \approx \frac{1}{RTT} \sqrt{\frac{1.5}{loss}}$$

Networks: TCP throughput

TCP congestion control:

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

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

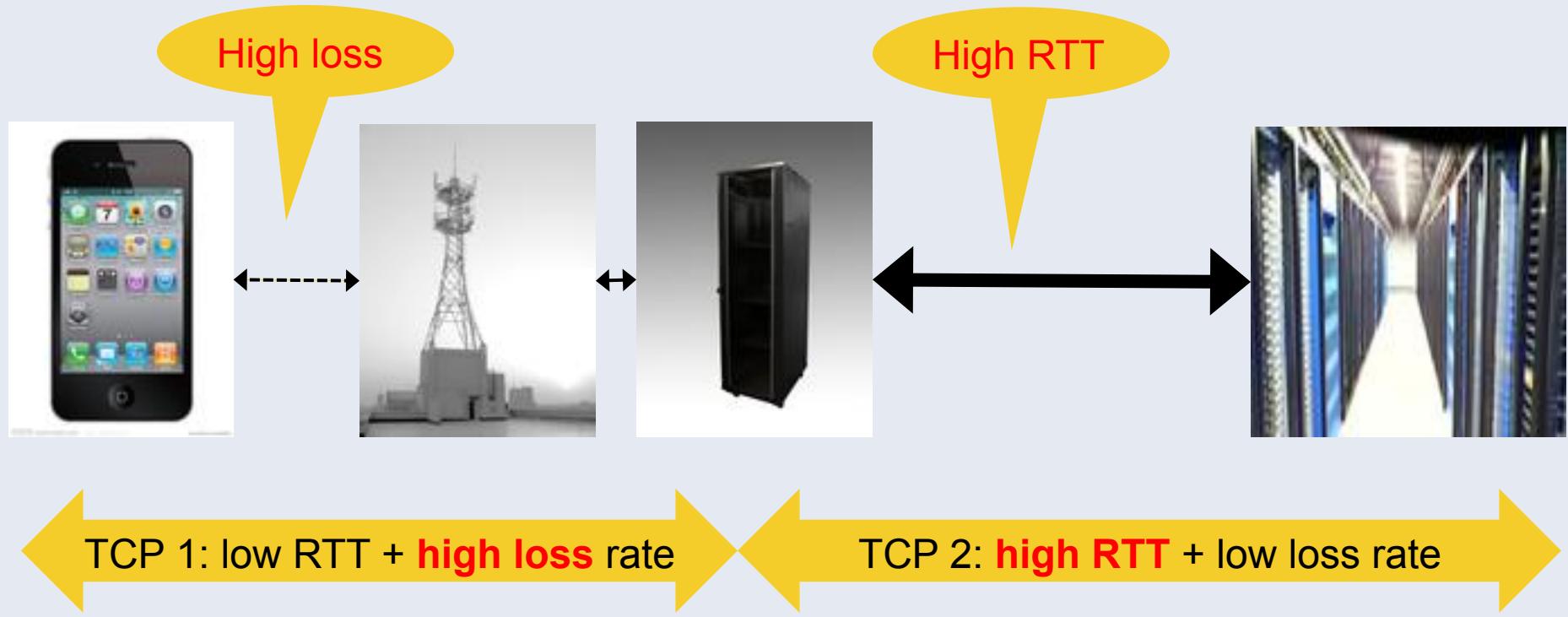


Networks: TCP throughput

TCP termination at edge:

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

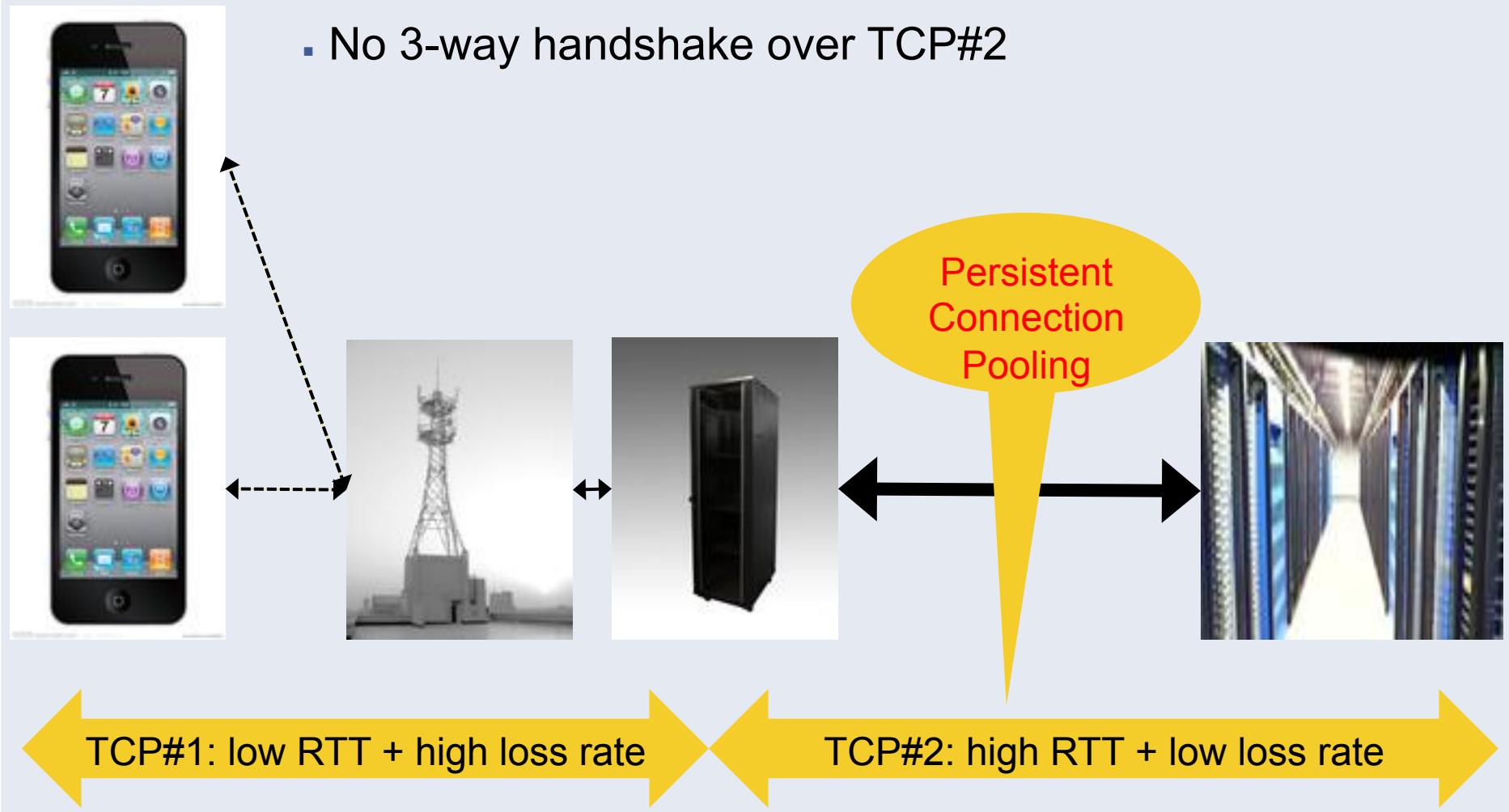
$$\text{throughput} \approx \min \left\{ \frac{1}{RTT_1} \sqrt{\frac{1.5}{loss_1}}, \frac{1}{RTT_2} \sqrt{\frac{1.5}{loss_2}} \right\}$$



Networks: TCP termination

Persistent connection pooling

- No 3-way handshake over TCP#2

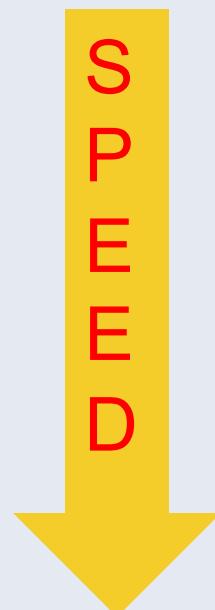
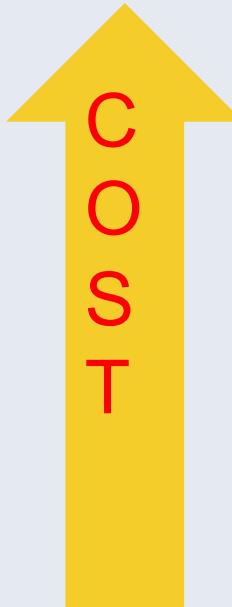


Networks: TCP throughput

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

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”!

Variances

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

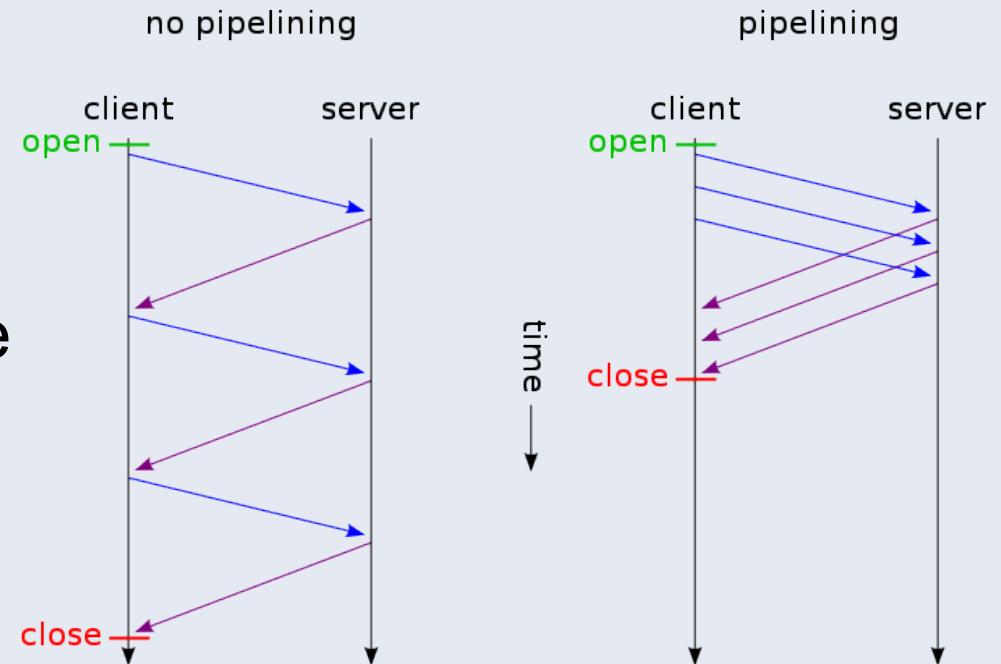
Performance implication

- # 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/>



https://www.facebook.com/note.php?note_id=441195668919

Browsers: How to recognize?

Existing libraries

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



Grass-root contribution

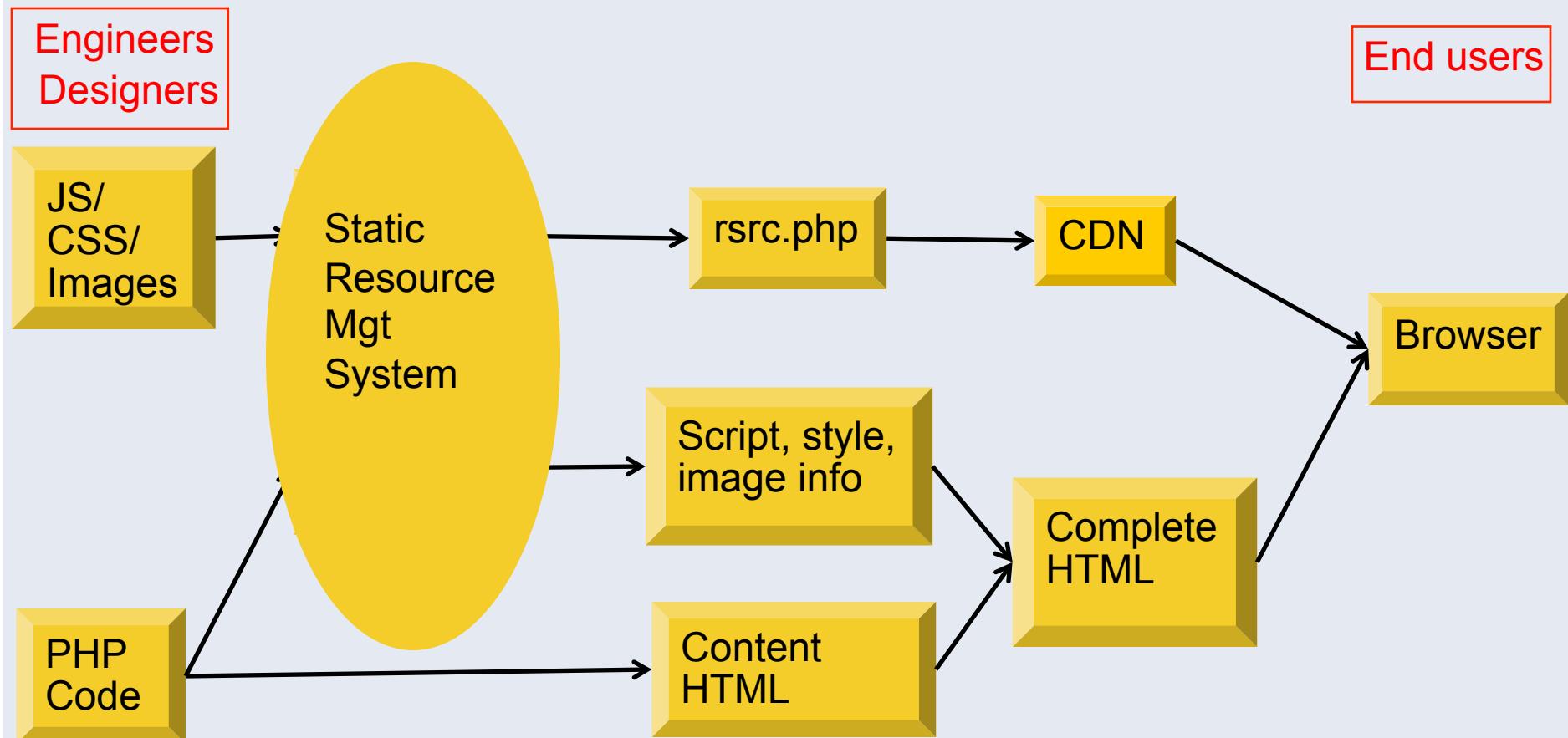
- Improving WURFL by users

https://www.facebook.com/note.php?note_id=441195668919

Browsers: How to serve?

Haste/Makehaste

- The Facebook scalable static resource management systems



A website with 500M active users

Dimensions of parameters

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

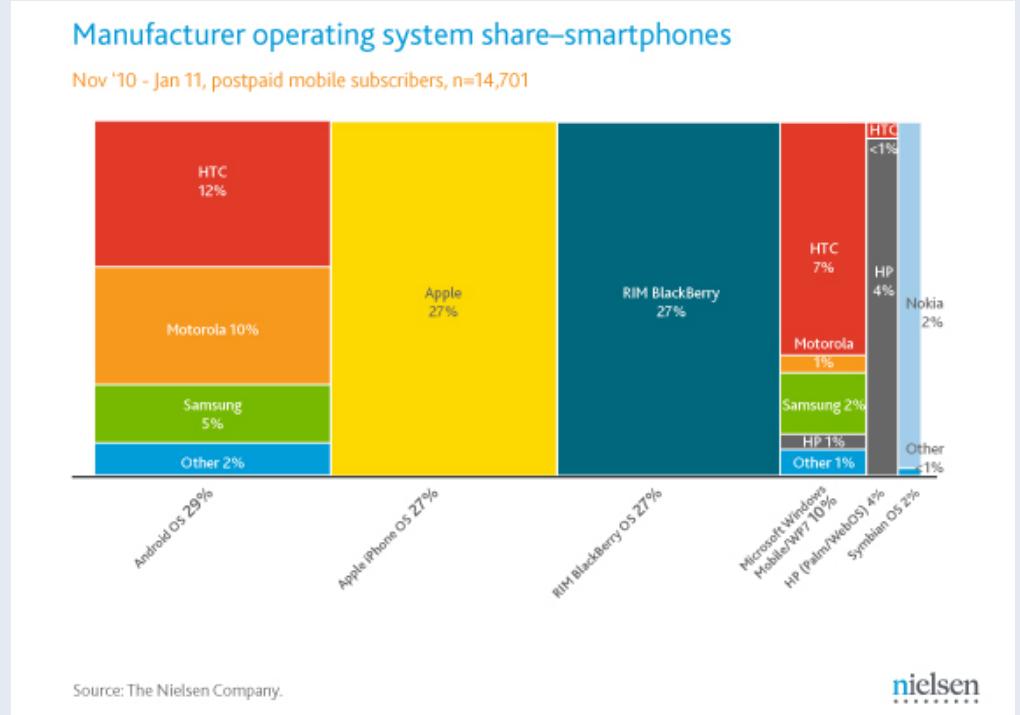
New challenges: devices

Devices: segmentation

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

Challenges:

- Engineer resources
- Product consistency across platforms



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

A screenshot of a Mac OS X desktop showing a Safari browser window. The title bar reads "Safari File Edit View History Bookmarks Develop Window Help". The address bar shows "http://www.quora.com/" and "(188) Home - Quora". Below the address bar is a toolbar with icons for Apple, Yahoo!, Google Maps, YouTube, Wikipedia, and Popular. The main content area displays the Quora homepage with sections for "New Notifications" and "Feed / Settings". A sidebar on the right contains "General", "Appearance", "Bookmarks", "Tabs", "RSS", "AutoFill", "Security", "Privacy", "Extensions", and "Advanced" settings. The "Advanced" tab is selected, showing options for Universal Access, Style sheet, Proxies, Database storage (set to 5 MB), and a checkbox for "Show Develop menu in menu bar" which is checked and circled in red. At the bottom of the screen, there are several user profiles with "Follow" buttons.

Quora Search Questions, Topics and People

Add Question Write Post

New Notifications

2 items on question Education Startup in the education space? Why are they interested?

Jack Jack is now following you. Give them a follow back.

Thursday

Scott Chun-Yang Chen is now following you.

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.

Develop

Universal Access:

- Never use font sizes smaller than 9
- Press Tab to highlight each item on a webpage

Style sheet: None Selected

Proxies: Change Settings...

Database storage: 5 MB allowed before asking

Show Develop menu in menu bar

Follow People You May Know on Quora

Victor Kam Follow

John Song Follow

Wei Li Follow

View All 238 Follow All (238)

Safari Develop menu

Safari File Edit View History Bookmarks **Develop** Window Help

(188) Home - Quora

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Advanced

General Appearance Bookmarks Tabs RSS AutoFill Security Privacy Extensions Advanced

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

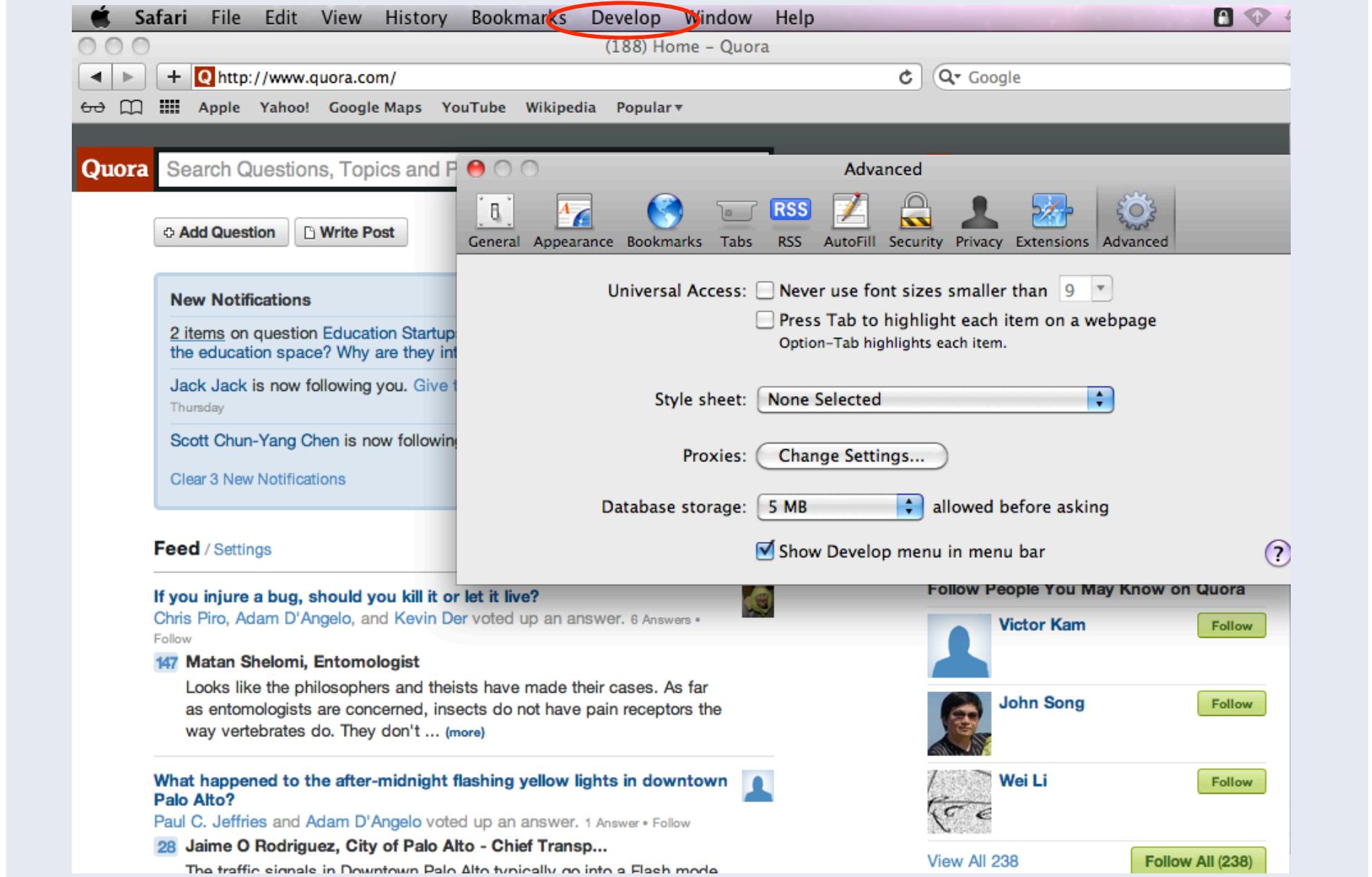
Follow People You May Know on Quora

Victor Kam Follow

John Song Follow

Wei Li Follow

View All 238 Follow All (238)



Safari Develop menu

Screenshot of the Safari browser showing the Develop menu open, specifically the User Agent submenu. The item "Safari iOS 4.3.3 — iPhone" is highlighted with a red oval.

The Develop menu is open, showing the following options:

- Open Page With
- User Agent
- 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
- Disable Site-specific Hacks

The "User Agent" option is selected. A sub-menu for User Agents is displayed, listing various browser versions and platforms. The "Safari iOS 4.3.3 — iPhone" option is circled in red.

The sub-menu for User Agents includes the following items:

- ✓ Default (Automatically Chosen)
- Safari 5.1 — Mac
- Safari 5.1 — Windows
- Safari 5.0.6 — Mac
- Safari iOS 4.3.3 — iPhone** (circled in red)
- 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...

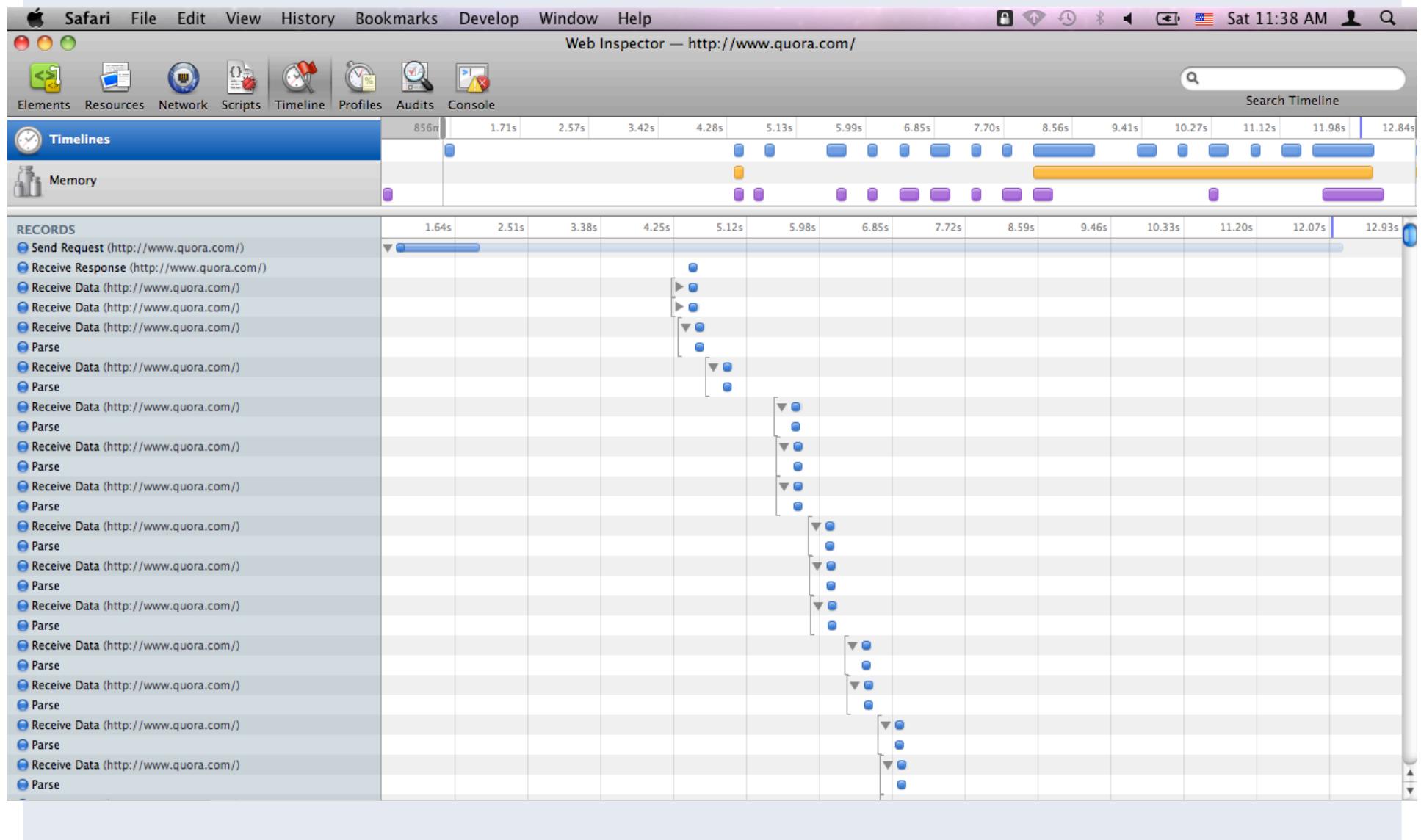
The main Quora page content is visible on the left, showing notifications and a feed of questions.

Safari Develop menu

The screenshot shows a Mac OS X desktop with the Safari browser open. The window title is "Home - Quora". The address bar contains the URL "http://www.quora.com/". Below the address bar is a toolbar with icons for Home, Stop, Back, Forward, Refresh, and a search field. The search field has the text "Google". The main content area is a Quora feed. At the top of the feed, there is a red banner with the Quora logo and the number "188". Below the banner, there is a search bar with the placeholder "Find Questions, Topics and...". Underneath the search bar, there are four buttons: "Add Question", "Notifications" (with a red badge showing "188"), "Inbox", and "More" (with a red badge showing "11"). The main content area is titled "New Notifications". It lists three items:

- If you injure a bug, should you kill it or let it live?** by Matan Shelomi, Entomologist. Chris Piro, Adam D'Angelo, and Kevin Der voted up an answer. 6 answers. Follow.
- What happened to the after-midnight flashing yellow lights in downtown Palo Alto?** by Jaime O Rodriguez, City of Palo Alto - Chief Transp... Paul C. Jeffries and Adam D'Angelo voted up an answer. 1 Answer. Follow.
- How many Facebook messages can I send to anyone or specific person per day?** by Andrew 'Boz' Bosworth. Andrew 'Boz' Bosworth added an answer. 1 Answer. Follow.

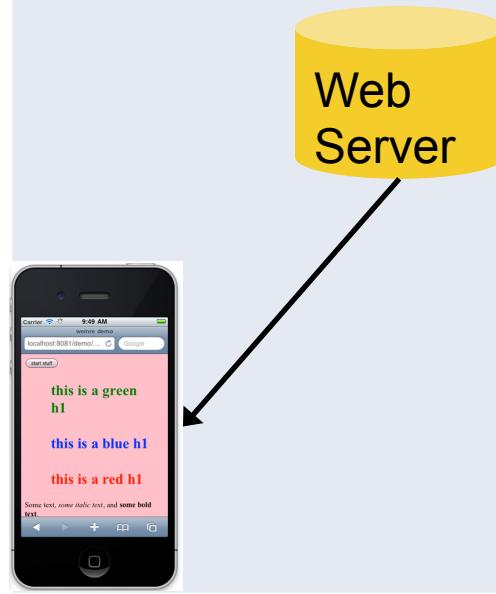
Safari Develop menu: Web Inspector



Web Inspector Remote

weinre

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



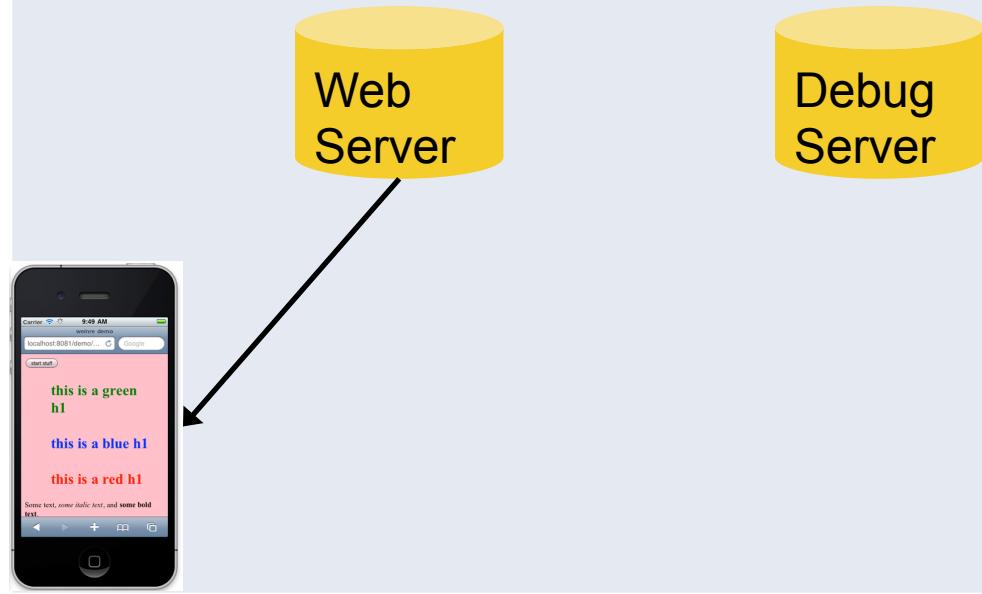
<http://phonegap.github.com/weinre/>

Web Inspector Remote

Weinre

Start debug server which serves:

- JS to embed in target page
- Debug console page

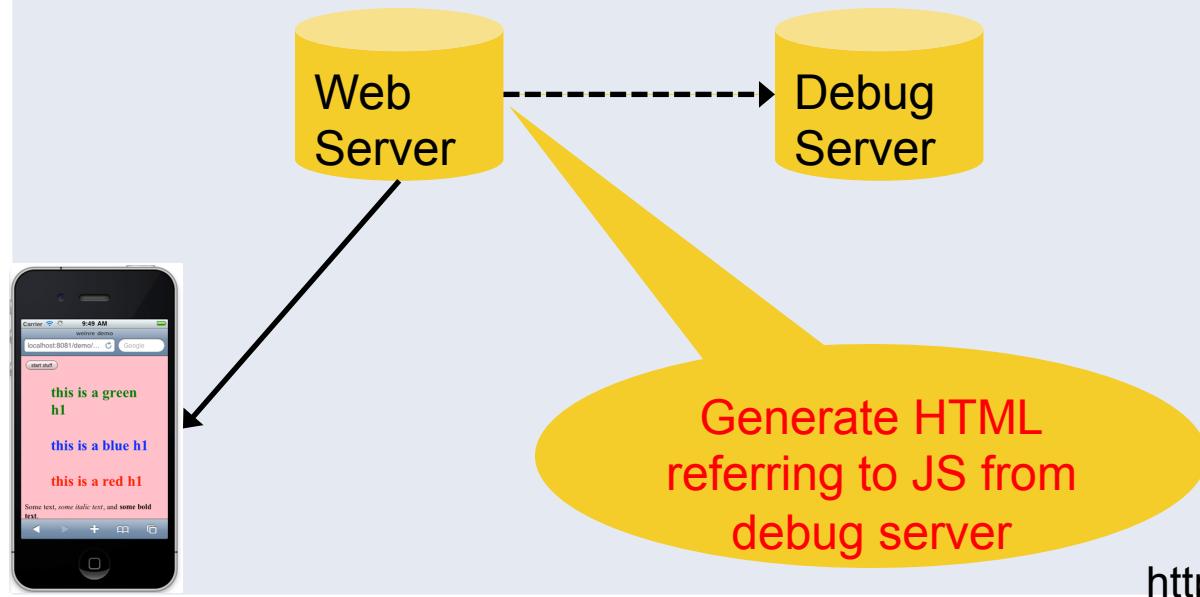


<http://phonegap.github.com/weinre/>

Web Inspector Remote

weinre

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

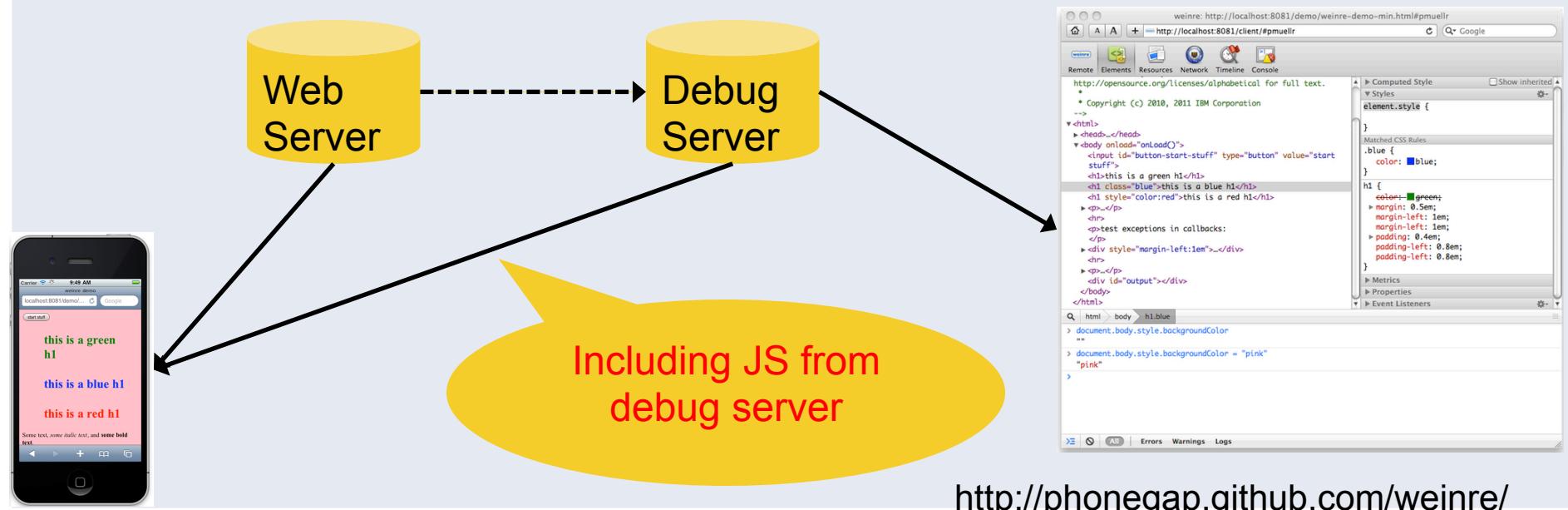


<http://phonegap.github.com/weinre/>

Web Inspector Remote

weinre

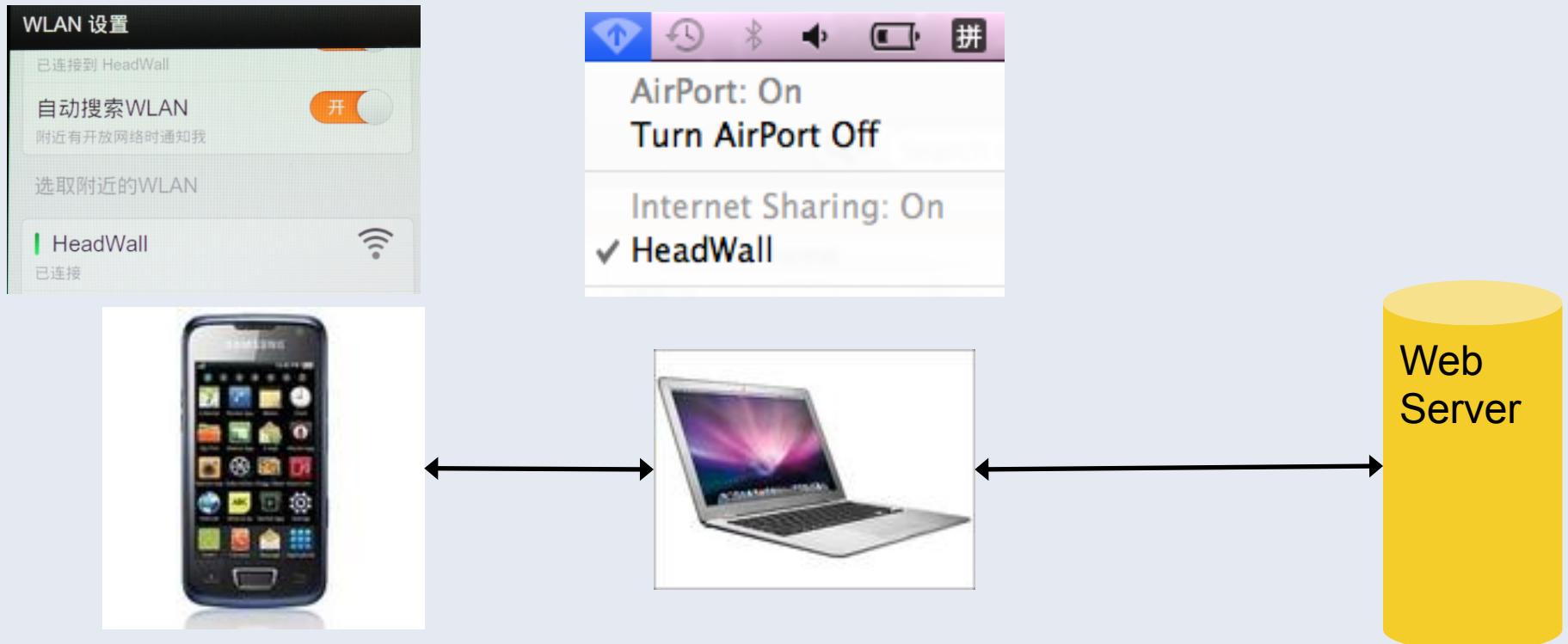
- Load the page on target (phone)
- Load the debug console on a desktop Safari



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

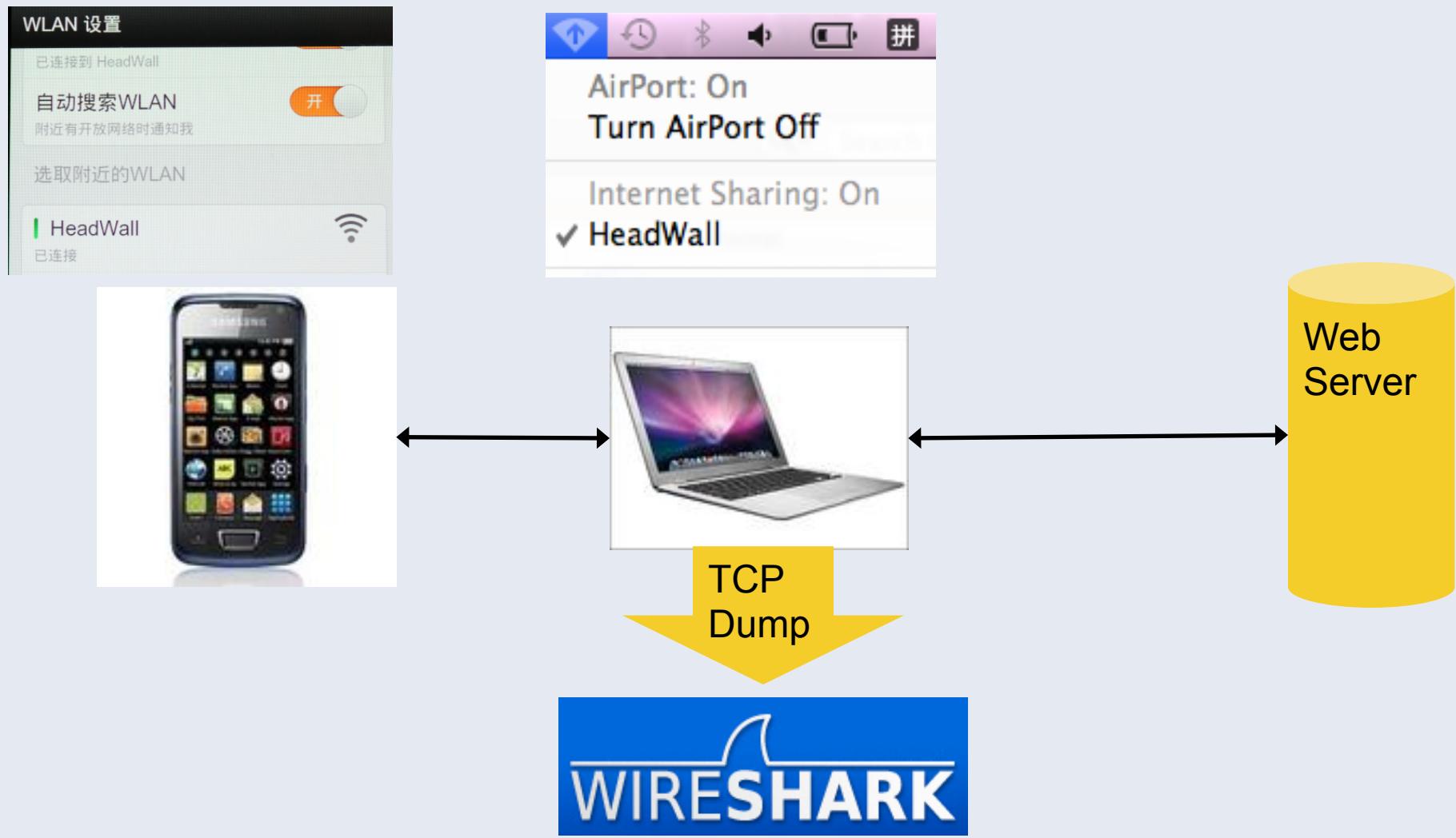
TCP Dump / Wireshark

- Packet Sniffer



TCP Dump / Wireshark

- Packet Sniffer



TCP Dump / Wireshark

- Packet Sniffer

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

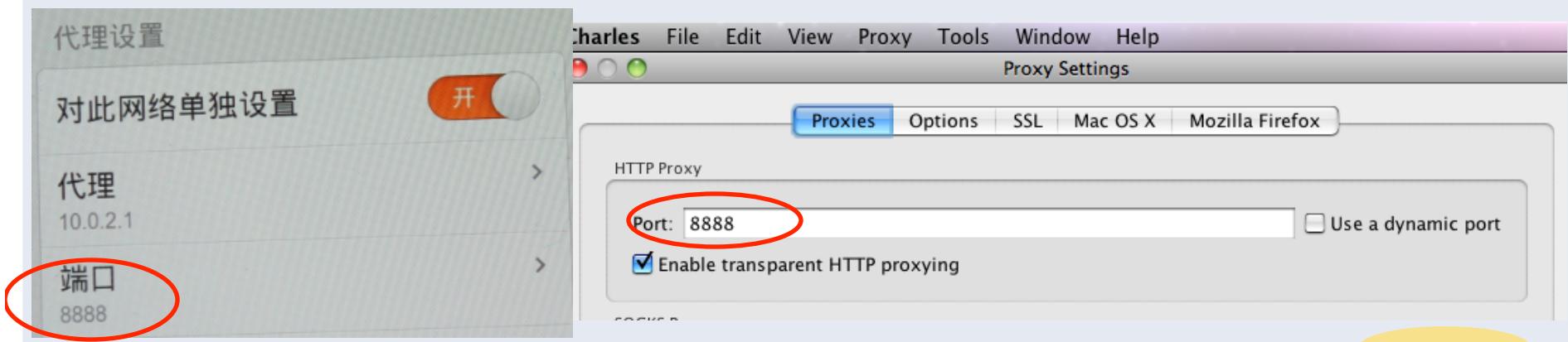
File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help

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]

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Web debugging proxy: setup

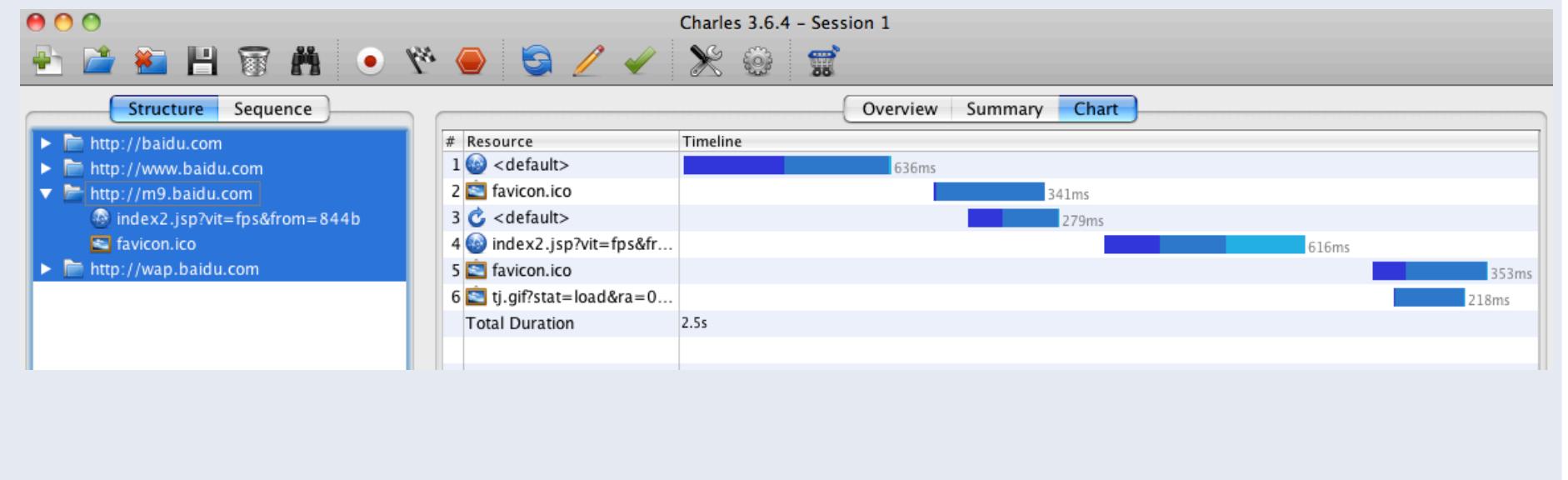


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Web debugging proxy



- 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

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

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